OCR A-LEVEL PHYSICS A

PHYSICS



EXAM QUESTION PACK

UNIT G481 OLD SPECIFICATION PAPERS

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OCR
Oxford Cambridge and RSA

Tuesday 23 May 2017 – Morning

AS GCE PHYSICS A

G481/01 Mechanics

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Duration: 1 hour

* G 4 8 1 0 1 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 **(a)** Define *power*.

.....

..... **[1]**

(b) Fig. 1.1 shows a small electric motor used to lift an object.

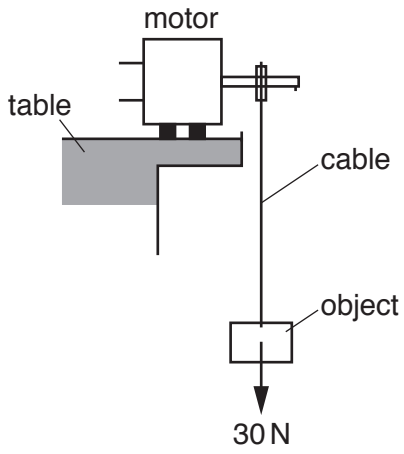


Fig. 1.1

The weight of the object is 30 N. The efficiency of the motor is 5.0%. The motor lifts the object vertically at a constant speed of 8.4 cm s^{-1}.

(i) State the tension in the cable. Justify your answer.

.....

.....

..... **[2]**

(ii) Calculate the rate at which work is done in lifting the object vertically against the force of gravity.

rate of work done = ...J s^{-1} **[2]**

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(iii) Calculate the input power to the electric motor.

power = ...W **[1]**

(iv) Explain why the tension in the cable is different when the object is accelerating upwards.

.....

.....

.....

.....

..... **[2]**

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2 **(a)** The list below contains scalar and vector quantities.

pressure speed force power acceleration displacement

(i) Underline **all** of the vector quantities. **[1]**

(ii) List **two** quantities which when multiplied together give a quantity having the unit joule (J).

..... **[1]**

(iii) Name the quantity having the unit $kg\,m\,s^{-2}$.

..... **[1]**

(b) A hot air balloon rises with a vertical velocity of $7.0\,m\,s^{-1}$. A steady wind pushes the balloon with a horizontal velocity *v*.

Fig. 2.1 shows the velocity vectors for the balloon and the wind.

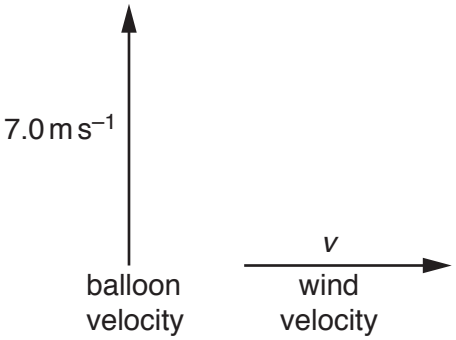


Fig. 2.1 (not to scale)

The magnitude of the resultant velocity of the balloon is $8.8\,m\,s^{-1}$.

(i) On Fig. 2.1, draw an arrow labelled **R** to show the approximate direction of the resultant velocity of the balloon. **[1]**

(ii) State why the magnitude of the resultant velocity of the balloon is not the sum of the speeds of the balloon and the wind.

.....

..... **[1]**

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(iii) With the help of a vector triangle, determine the magnitude of the wind velocity v and the angle θ between the resultant velocity of the balloon and the horizontal.

v = ... $m\,s^{-1}$

θ = ...° **[4]**

(iv) Fig. 2.2 shows another balloon travelling with constant velocity $9.3\,m\,s^{-1}$.

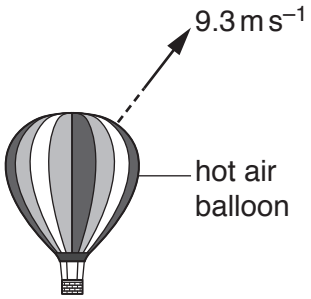


Fig. 2.2

Apart from the upthrust and the wind there are two other forces acting on the balloon.
State these two forces.
Draw labelled arrows on Fig. 2.2 to indicate their approximate directions.
State the direction of the resultant of these two forces.

.....

.....

..... **[3]**

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3 Fig. 3.1 shows a block of wood on a smooth slope.

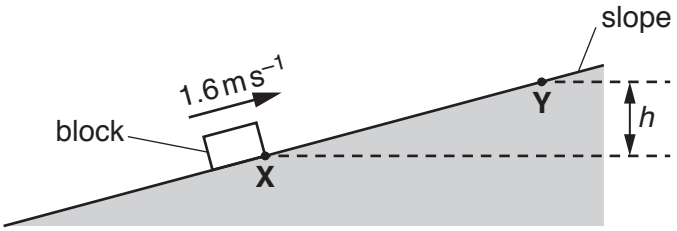


Fig. 3.1

At time $t = 0$ the block is at point **X** and has a velocity of $1.6\,m\,s^{-1}$ up the slope. The block comes to rest at point **Y**. It then slides back down the slope. The magnitude of the deceleration of the block from **X** to **Y** is $2.5\,m\,s^{-2}$.
The mass of the block is 310 g.

(a) Calculate the time t for the block to travel from **X** to **Y**.

$t =$ .....s **[2]**

(b) Calculate the distance between points **X** and **Y**.

distance = ... m **[2]**

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(c) Calculate the kinetic energy E_k of the block at the **midpoint** between **X** and **Y**.

E_k = ... J **[3]**

(d) Calculate the vertical height h gained by the block as it travels from **X** to **Y**.

h = ... m **[2]**

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4 **(a)** **(i)** State what is meant by the *force constant* of a wire.

.....

..... **[1]**

(ii) A student is investigating wires **A** and **B** made from the same material. The wires have the same length. Wire **A** is thicker than wire **B**.
Explain which of these wires has a greater value of force constant.

.....

.....

.....

..... **[2]**

(b) A compression spring is attached to a block of metal. The block and the spring fall vertically towards the horizontal ground as shown in Fig. 4.1.

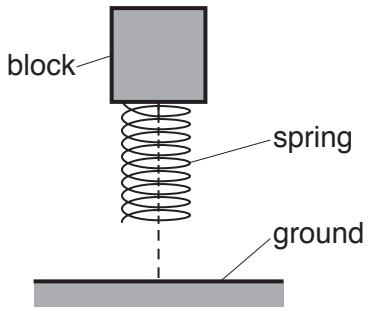


Fig. 4.1

The spring has negligible mass.
At time $t = 0$ the spring touches the ground. Fig. 4.2 shows the variation of the compression x of the spring with time t.

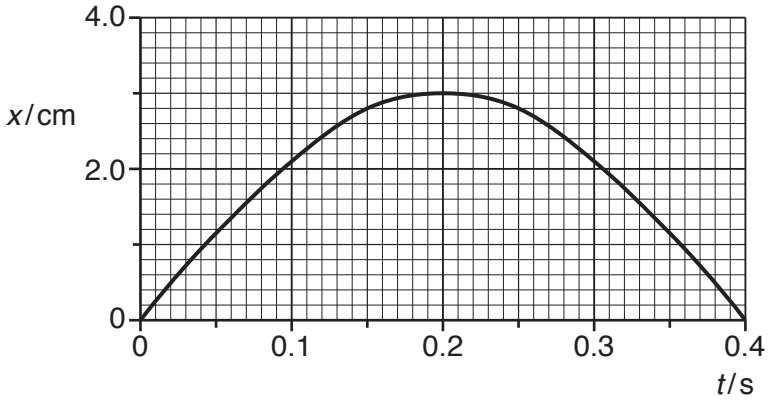


Fig. 4.2

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(i) Explain how you can use the graph in Fig. 4.2 to determine the maximum speed of the block.

.....

.....

.....

..... **[2]**

(ii) The force constant of the spring is $24\,N\,m^{-1}$.
Use Fig. 4.2 to determine the maximum elastic potential energy E for the spring between $t = 0$ and $0.4\,s$.

$E =$ ..... J **[3]**

(iii) Describe the energy changes of the block and the spring from $t = 0$ to $t = 0.2\,s$.

.....

.....

.....

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.....

.....

..... **[3]**

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5 **(a)** Define *moment of a force.*

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(b) Fig. 5.1 shows a **uniform** beam at rest in a horizontal position.

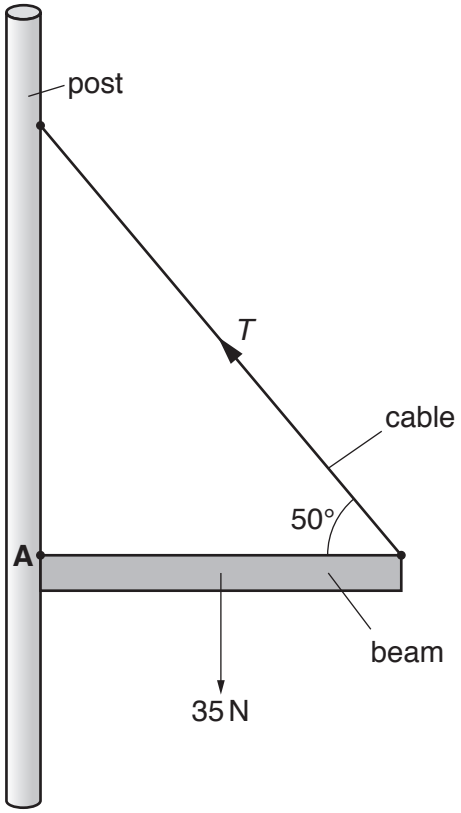


Fig. 5.1

The beam has weight 35 N, length 0.82 m and cross-sectional area 12 cm^2.
Fig. 5.1 shows one end of the beam hinged to a vertical post at point **A**. A cable is attached to the other end. The angle between cable and beam is 50°.

(i) Calculate the density ρ of the beam.

ρ = ... $kg\,m^{-3}$ **[3]**

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(ii) Take moments about **A** to calculate the tension T in the cable.

$T =$ .....N **[3]**

(iii) On Fig. 5.1 draw an arrow to represent the force acting on the beam at the hinge **A**. **[2]**

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6 **(a)** One end of a thin metal wire is secured to the ceiling and a mass is hung from its other end.

Describe how you can determine the stress in the wire using laboratory equipment.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

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..... **[4]**

(b) Fig. 6.1 shows the stress against strain graphs for two materials **A** and **B**.

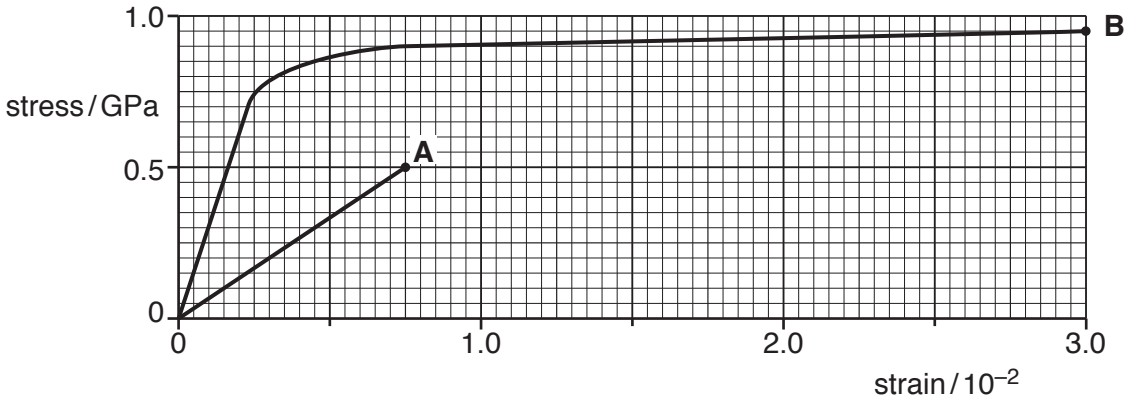


Fig. 6.1

(i) Describe the properties of each of the materials **A** and **B**.

material **A**: .....

.....

.....

.....

.....

.....

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material **B**: .....

.....

.....

.....

.....

..... **[4]**

(ii) Determine the Young modulus *E* of material **B**.

E = ...Pa **[3]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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GCE

Physics A

Unit **G481/01**: Mechanics

Advanced Subsidiary GCE

Mark Scheme for June 2017

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Annotations

Annotation	Meaning
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
FT	Follow through
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error or reading/transcription error (*dual purpose*)
SF	Error in number of significant figures
	Correct response
AE	Arithmetic error
	Wrong physics or equation

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Abbreviations used in detailed mark scheme

Abbreviation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

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Subject-specific Marking Instructions

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures and rounding errors:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf. If an answer is given to fewer than 2 sf, then penalise once only in the entire paper. Any exception to this rule will be mentioned in the Guidance.

Penalise a rounding error once only in the entire paper.

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Question			Answer	Marks	Guidance
1	a		Power is the rate of work done / power is the rate of energy transfer	B1	**Allow**: power = energy/time or energy <u>per</u> (unit) time or power = work/time **Allow**: equation using symbols if meanings are stated **Ignore** any reference to units
	b	i	(The tension is) equal to the weight / 30 N Since object has constant speed / no acceleration the <u>net / resultant</u> force on the object is zero.	B1 B1	
		ii	rate of work done = 30 × 0.084 rate of work done = 2.5 (J s^{-1})	C1 A1	**Allow** 1 mark for 252 (J s^{-1}); cm not converted into m
		iii	input power = 2.5/0.05 input power = 50 (W)	 B1	 Possible ecf from **ii**
		iv	The tension would be greater than 30 N / weight of object Explanation in terms of resultant / net upward force (*F)* = *ma*	B1 B1	**Allow** tension would be larger **Not** acceleration **causes** a (resultant/net) force
			Total	**8**	

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Question			Answer	Marks	Guidance
2	a	i	force, acceleration and displacement all underlined.	B1	
		ii	force and displacement	B1	**Not** force and distance
		iii	Force	B1	
	b	i	An arrow at an angle upwards and to the right	B1	Allow a single arrow without the label **R**
		ii	(The resultant velocity is not the sum of the speeds because) velocity is a vector quantity / velocity (also) has direction (AW)	B1	
		iii	A suitable vector triangle with at least **two** vectors correctly labelled $8.8^2 = 7.0^2 + v^2$ (Any subject) v = 5.3 (m s^{-1}) θ = 53°	B1 C1 A1 A1	**Note**: Ignore arrows **Allow** full credit for a scale drawing when v is within $\pm$ 0.1 m s^{-1} and θ is within $\pm$ 1°
		iv	Weight acts vertically down Drag / air resistance is opposite to the direction of the velocity (9.3 m s^{-1}) The resultant of the two forces is downward and to the left and at a greater angle to the horizontal (or steeper) than the velocity (9.3 m s^{-1}) vector / between drag and weight	B1 B1 B1	 **Allow** use of labelled diagram
			Total	**12**	

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Question			Answer	Marks	Guidance
3	a		($v = u + at$); $0 = 1.6 - 2.5t$ (Any subject) $t = 0.64$ (s)	C1 A1	
	b		($v^2 = u^2 + 2as$); $0 = 1.6^2 - 2 \times 2.5 \times s$ (Any subject) distance = 0.51 (m)	 C1 A1	**Allow** alternative methods Possible ecf from **a**
	c		Initial $E_k = ½ \times 0.310 \times 1.6^2$ (= 0.3968) At midpoint $E_k = ½ \times$ [initial E_k] = $½ \times 0.3968$ $E_k = 0.20$ (J)	C1 C1 A1	**Allow** alternative methods with possible ecf from **b** . eg At midpoint v^2 is halved or $v^2 = 1.6^2/2$ or SUVAT using distance = ½ x 0.51 hence $v_{1/2} = 1.1(3)$ m s^{-1}) At midpoint $E_k = ½ \times 0.310 \times (1.6^2/2)$ **Allow** 1 sf answer
	d		$½ \times 0.310 \times 1.6^2 = 0.310 \times 9.81 \times h$ $h = 0.13$ (m)	C1 A1	**Allow** alternative methods E.g: $(0.51 \times 2.5)/9.81 = 0.13$ (m) Possible ecf from **b**
			Total	**9**	

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Question			Answer	Marks	Guidance
4	a	i	force constant = force/extension or force per (unit) extension	B1	**Allow** tension instead of force and compression instead of extension **Allow**: equation using symbols if meanings are stated
		ii	For the same force **A** has a smaller extension Wire **A** has the greater force constant	M1 A1	**Alternative**: For the same extension **A** has the greater force / Use of Young modulus = stress/strain to show k ∝ A M1 Wire **A** has greater force constant A1
	b	i	The gradient of graph / tangent (to graph) is equal to the speed Draw a tangent to the graph at $t = 0$ s and find its gradient	B1 B1	**Allow** any t between 0.0 and 0.04 s
		ii	$E = ½ kx^2$ and $x = 3.0$ cm (from Fig. 4.2) $E = ½ \times 24 \times 0.03^2$ $E = 1.1 \times 10^{-2}$ (J)	C1 C1 A1	**Allow** 2 marks for 110 (J); cm not converted into m
		iii	The GPE and KE of the block decreases The strain/elastic potential energy in the spring increases / (KE and GPE) energy transferred /converted to EPE in the spring At $t = 0.2$ s, the block has no KE and the spring has maximum strain/elastic potential energy	B1 B1 B1	Ignore any reference to the GPE and KE of the spring since it has negligible mass Ignore reference to GPE of block at t = 0.2 s
			Total	**11**	

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Question			Answer	Marks	Guidance
5	a		Moment of a force is the product of force and the perpendicular distance from a point / pivot / fulcrum	B1	✎ The term **perpendicular** must be spelled correctly to gain this mark
	b	i	mass = 35/9.81 (= 3.57 kg) volume = $0.82 \times 12 \times 10^{-4}$ (= 9.84 x 10^{-4} m³) $\rho = \frac{3.57}{0.82 \times 12 \times 10^{-4}}$ ρ = 3.6×10^{3} (kg m^{-3})	C1 C1 A1	 **Allow** 2 marks for an answer 3.6×10^{n}, where $n \neq 3$
		ii	Either (moment =) 0.41×35 or (moment =) $0.82 \times T\sin 50°$ $0.41 \times 35 = T \times 0.82 \times \sin 50°$ T = 23 (N)	C1 C1 A1	 Answer to 3 sf =22.8 N
		iii	Upward arrow through **A** at an angle less than 90° to the vertical and to the right of the pole Line passes through intersection of weight and tension vectors	M1 A1	
			Total	**9**	

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Question			Answer	Marks	Guidance
6	a		The <u>diameter</u> of the wire measured using a micrometer / vernier (calliper)	B1	The term **micrometer** or **vernier** must be spelled correctly to gain this mark
			The mass *M* suspended is measured using a balance / tension(or force) *F* in the wire is measured with the mass suspended using a force(or newton) meter	M1	
			(cross-sectional) area $A = \frac{\pi d^2}{4}$, where *d* is the diameter	M1	**Not** <u>surface</u> area **Allow** $A = \pi r^2$, where *r* (= *d/2)* is the radius
			stress = $\frac{Mass \times g}{Area}$ or stress = $\frac{Weight}{Area}$ or stress = $\frac{Force}{Area}$	A1	**Allow**: Use of M, W F and A if the words mass, weight, force (or tension) and area have been used previously
	b	i	material **A**: Elastic / obeys Hooke's law (AW) Brittle	 B1 B1	
			material **B**: Elastic / obeys Hooke's law up to elastic limit / over straight section / for strain < 0.25% (AW) Then shows **plastic** behaviour (for strain > 0.25% AW)	 B1 B1	 **Allow** malleable or ductile
		ii	*E* = gradient (linear region)	C1	
			$E = \frac{0.75 \times 10^9}{0.25 \times 10^{-2}}$	C1	
			$E = 3.0 \times 10^{11}$ (Pa)	A1	**Allow** $\pm$ 0.1 $\times$ 10^{11} (Pa) **Allow** 2 marks if answer is 3.0 $\times$ 10^n, where n $\neq$ 11 **Allow** 1 sf answer
			Total	**11**	

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Candidate forename		Candidate surname	

Centre number						Candidate number				

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Answer **all** the questions.

1 **(a)** Define *acceleration*.

.....

..... **[1]**

(b) Explain why acceleration is a vector quantity.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(c) Fig. 1.1 shows the graph of velocity *v* against time *t* for a moving object.

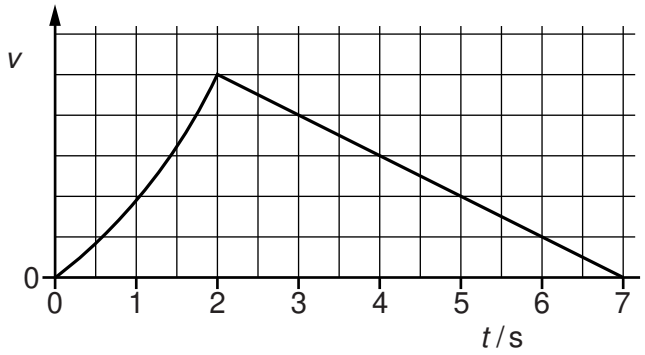


Fig. 1.1

(i) Describe the motion of the object from

1 $t = 0$ to $t = 2\,s$

.....

..... **[1]**

2 $t = 2\,s$ to $t = 7\,s$.

.....

..... **[1]**

(ii) Explain how Fig. 1.1 shows that the distance travelled by the object from $t = 0$ to $t = 2\,s$ is **shorter** than the distance travelled from $t = 2\,s$ to $t = 7\,s$.

.....

.....

..... **[1]**

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(d) The ventricle is one of two chambers in the heart that collects and expels blood. The left ventricle of the heart expels blood around the body. It accelerates blood from rest to a velocity of $0.26\,m\,s^{-1}$. The distance travelled by the blood during this acceleration is 0.020 m.

Assuming that the blood is accelerated uniformly, calculate the time taken for this acceleration.

time = ... s **[2]**

Question 2 begins on page 4

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2 **(a)** Aristotle and Galileo had different ideas about the way in which objects fall to the ground. Compare these ideas.

.....

.....

.....

.....

.....

..... **[2]**

(b) Fig. 2.1 shows the graph of velocity against time for a parachutist falling vertically through the air. The initial vertical velocity is zero.

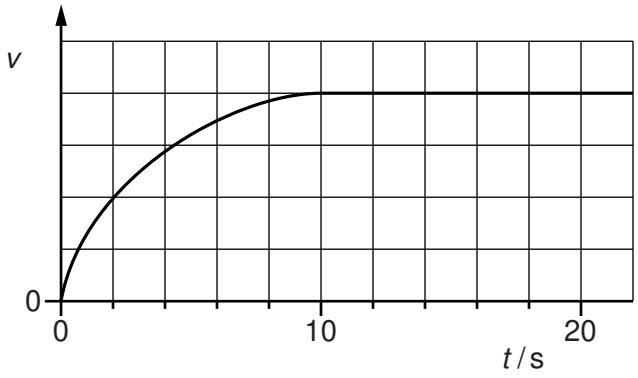


Fig. 2.1

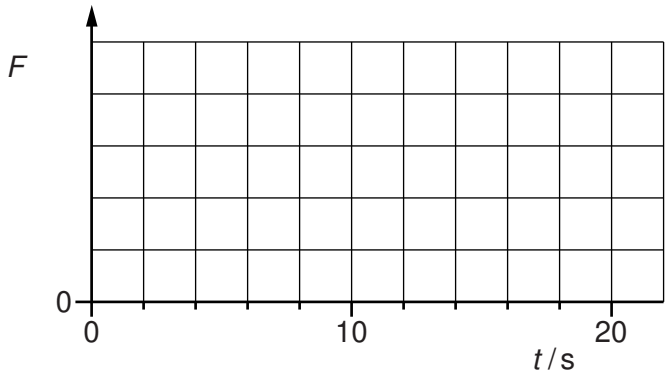


Fig. 2.2

(i) State **two** factors that affect the magnitude of the drag force on the parachutist.

.....

..... **[1]**

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(ii) State and explain the magnitude of the acceleration of the parachutist at the start of the fall.

.....

.....

.....

..... **[2]**

(iii) On Fig. 2.2 sketch a graph to show the variation of the size of the **resultant** force *F* acting on the parachutist with time *t*. **[2]**

(iv) The total mass of the parachutist is 80 kg. Calculate the drag force acting on the parachutist at an acceleration of 3.0 m s^{-2}.

drag force = ... N **[3]**

Question 3 begins on page 6

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3 Fig. 3.1 shows a stunt rider on a powerful motorbike at **X** at the top of a ramp.

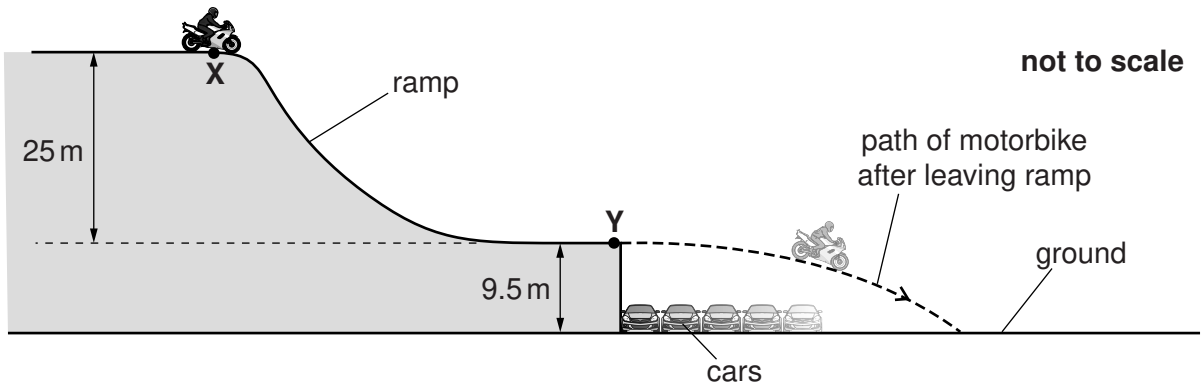


Fig. 3.1

The total mass of motorbike and rider is 190 kg. The height difference between the top and the bottom of the ramp is 25 m. The rider uses the engine to accelerate down the ramp. He leaves the end of the horizontal section of the ramp at **Y** with a speed of 30 m s^{-1}.

(a) Calculate the loss of gravitational potential energy E_p of the rider and motorbike from **X** to **Y**.

E_p = ... J **[1]**

(b) Calculate the kinetic energy E_k of the rider and motorbike at **Y**.

E_k = ... J **[1]**

(c) Explain why your answer to **(b)** is **greater** than your answer to **(a)**.

.....

.....

..... **[1]**

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(d) The total distance travelled by the motorbike from **X** to **Y** along the ramp is 120 m. Calculate the average accelerating force that the motorbike engine provides along the ramp.

force = ... N **[2]**

(e) The end of the ramp at **Y** is at a height of 9.5 m above the ground. The motorbike travels through the air after leaving the ramp and flies over a number of cars lined up side by side. Assume air resistance has negligible effect on the motion of the rider and motorbike.

(i) Show that the time taken for the motorbike to travel from **Y** to the ground is 1.4 s.

[2]

(ii) Each of the cars has a width of 1.8 m. Estimate the number of cars the motorbike can clear.

number = ... **[2]**

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4 Fig. 4.1 shows a cyclist.

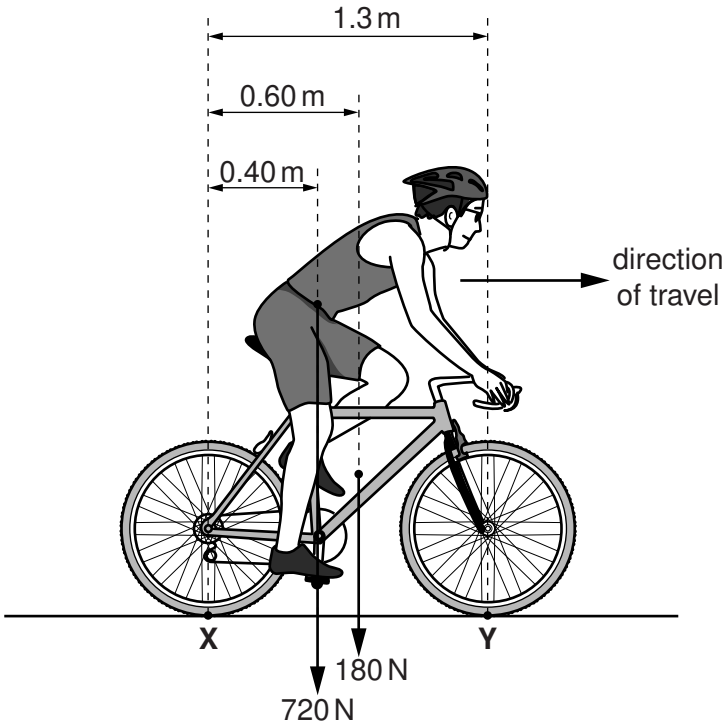


Fig. 4.1

The bicycle tyres are in contact with the road at **X** and **Y**. The cyclist is travelling at **constant** velocity on a level road. The weight of the bicycle is 180 N and the weight of the cyclist is 720 N.

(a) State the magnitude of the resultant force acting on the cyclist. Explain your answer.

.....

.....

..... **[2]**

(b) Define *moment of a force*.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

..... **[1]**

(c) Explain why the two vertical forces acting on the tyres at **X** and **Y** do not form a couple.

.....

.....

..... **[1]**

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(d) Take moments about **X** to determine the size of the vertical force *F* acting **on** the tyre at **Y**.

F = ... N **[3]**

(e) The cyclist leans further forward. How does this affect the force on the tyre at **X**? Explain your answer.

.....

.....

.....

.....

..... **[2]**

Question 5 begins on page 10

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5 **(a)** An airbag is an important safety feature in a car. During a collision, the driver's airbag is triggered by an accelerometer. The airbag inflates in less than 40 ms. The airbag has holes and starts to deflate after about 0.3 s.

(i) Suggest what might happen to the driver in a collision if the airbag did not have holes.

.....

..... **[1]**

(ii) Explain how an airbag reduces the impact force on the driver.

.....

.....

.....

.....

.....

.....

..... **[3]**

(b) The table below shows how the braking distance x for a car depends on its initial speed u.

u / m s^{-1}	5.0	10	20	40
x / m	2.0	8.0	32	128

(i) State the relationship between x and u.

.....

..... **[1]**

(ii) The reaction time of a driver is 0.60 s. Calculate the **stopping distance** of the car when u is 30 m s^{-1}.

distance = ... m **[3]**

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(c) Many cars are fitted with GPS receivers. Fig. 5.1 illustrates the technique of trilateration which is used by a GPS receiver to determine the location of a car on the Earth's surface.

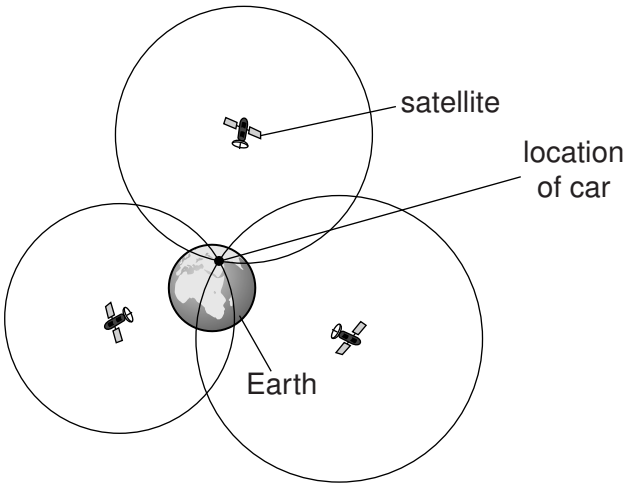


Fig. 5.1

(i) Explain what the circle around each satellite in Fig. 5.1 represents.

.....

..... **[1]**

(ii) Explain how a GPS receiver determines the distance between the car and a satellite.

.....

.....

.....

..... **[2]**

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6 (a) (i) Define the *force constant* of a spring.

.....

..... **[1]**

(ii) Fig. 6.1 shows a load supported by two identical springs arranged in parallel.

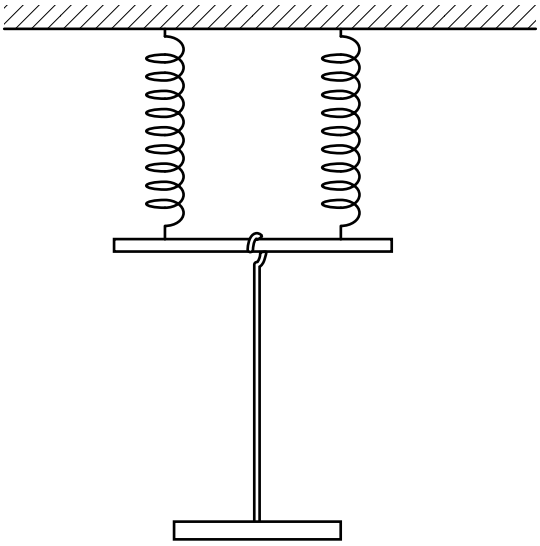


Fig. 6.1

Explain why the force constant of the parallel arrangement of springs is twice the force constant of one spring.

.....

.....

..... **[1]**

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(b) Fig. 6.2 shows a thin strip of aluminium which is secured by a clamp stand.

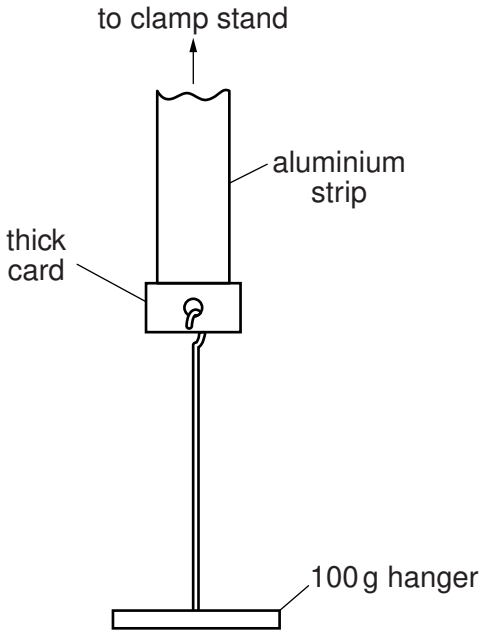


Fig. 6.2

The width of the strip has been measured to be 1.0 cm. A piece of thick card is taped to the lower end of the strip. A 100 g mass hanger is hooked through the card as shown in Fig. 6.2. A number of 100 g slotted masses and a micrometer are also available.

Describe how you would use the equipment to determine the **breaking stress** of aluminium.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

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(c) Fig. 6.3 shows the graph of stress against strain for a wire made from a ductile material.

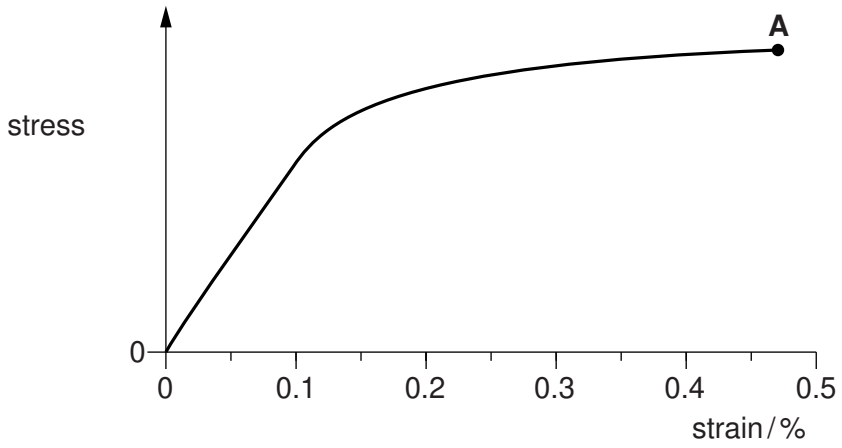


Fig. 6.3

(i) Describe the behaviour of the wire when the strain is less than 0.05%.

.....

.....

..... **[1]**

(ii) The wire is used to support a heavy load. The strain in the wire is 0.3%. Describe what happens to the wire when the load is removed.

.....

.....

..... **[1]**

(iii) A student suggests that the ratio of stress to strain at point **A** is equal to the Young modulus of the material. Explain whether or not this suggestion is correct.

.....

.....

..... **[1]**

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7 A crane is used to lift a shipping container. The container has a mass of 2.8×10^4 kg and is lifted by **four** identical steel cables attached to the container as shown in Fig. 7.1.

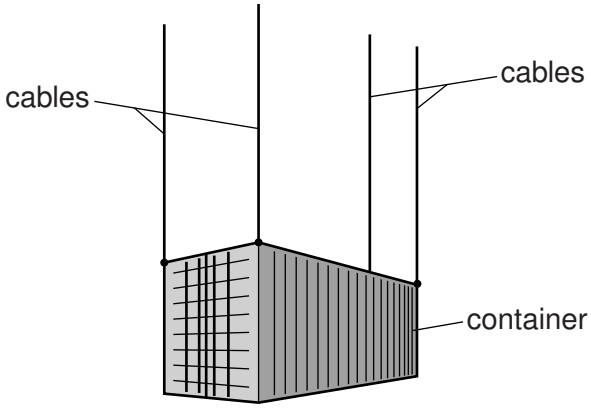


Fig. 7.1

Each cable has length 32 m and cross-sectional area 4.5×10^{-4} m^2. The container is lifted vertically at a **constant velocity**. The Young modulus of steel is 2.1×10^{11} Pa.

(a) Calculate the extension in mm of each cable.

extension = ... mm **[4]**

(b) The container is suddenly accelerated upwards. Explain the effect, if any, on the extension of the cables.

.....

.....

.....

..... **[2]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page. The question number(s) must be clearly shown in the margin.

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GCE

Physics A

Unit **G481**: Mechanics

Advanced Subsidiary GCE

Mark Scheme for June 2016

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations available in RM Assessor

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
TE	Transcription error
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
SF	Error in number of significant figures
	Correct response
	Wrong physics or equation

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Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

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CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

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Q 1	Answer	Marks	Guidance
(a)	(Acceleration =) rate of change of <u>velocity</u>	B1	**Allow**: Equations $a = \frac{v-u}{t}$ and $a = \frac{\Delta v}{t}$ as long as labels, *v*, *u*, Δv and *t* are defined. **Not**: 'speed' instead of 'velocity'
(b)	It has <u>direction</u> (and magnitude)	B1	**Must use ticks on Scoris to show where the marks are awarded** ✎ '***direction'*** must be spelled correctly to gain the mark.
(c)(i)	**1** Increasing acceleration **2** Constant deceleration	B1 B1	**Not:** answers using rate of acceleration - for either mark **Not**: Constant acceleration **Allow**: constant negative acceleration **Allow:** uniform /steady deceleration
(c)(ii)	The area under the graph from *t* = 0 to *t* = 2 s is smaller (AW)	B1	
(d)	$s = \frac{1}{2}(v+u)t$ $0.020 = \frac{1}{2}(0.26) \times t$ time = 0.15 (s)	C1 A1	Arriving at an acceleration of 1.69 m s^{-2} and no further works scores zero. **Allow**: Alternative approaches **Note**: Answer to 3 sf is 0.154 (s) **Note**: '0.020/0.26 = 0.77 (s)' scores zero
	Total	**7**	

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Q 2	Answer	Marks	Guidance
(a)	Aristotle: Heavier/massive objects fall faster (AW) Galileo: All objects (irrespective of their mass) fall at the same rate / have same acceleration (of free fall)	B1 B1	**Allow**: 'the same rate of acceleration' for this B1 mark
(b)(i)	Any **two** from: • speed • area • density of air / viscosity of air • streamlining / texture of clothing	B1	**Not**: 'wind' for 'speed' **Allow:** surface / frontal area
(b)(ii)	Acceleration is equal to 9.8(1) $\underline{\text{m s}^{-2}}$ / *g* There is no drag / net force = weight / 'only force acting is *mg*'	B1 B1	
(b)(iii)	Correct shape curve with finite value at $t = 0$ Value of $F = 0$ after 10 s	B1 B1	**Allow** a tolerance of +/- 0.5 of a square
(b)(iv)	weight = 80×9.81 or 784.8 (N) or (net force) = 80×3 or 240 (N) (80×9.81) – drag = 240 drag = 540 (N)	C1 C1 A1	**Note**: The first C1 mark is either for the weight or the net force **Note**: Answer to 3sf is 545 (N) and 544.8 (N) to 4sf
	Total	**10**	

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Q 3	Answer	Marks	Guidance
(a)	$E_p = 190 \times 9.81 \times 25$ $E_p = 4.7 \times 10^4$ (J)	B1	**Note**: Answer is 4.66×10^4 to 3sf
(b)	$E_k = ½ \times 190 \times 30^2$ $E_k = 8.6 \times 10^4$ (J)	B1	**Note:** Answer is 8.55×10^4 to 3sf
(c)	Work done by the motorbike / energy from the engine (AW)	B1	**Note**: There must be reference to work or energy **Allow:** chemical energy to kinetic energy / E_K
(d)	work done = change in energy force $\times$ 120 = $(8.55 - 4.66) \times 10^4$ force = 320 (N)	C1 A1	Possible ecf from **(a)** and **(b)**
(e)(i)	($s = ½ at^2$ – for the vertical fall) $9.5 = ½ \times 9.81 \times t^2$ (Any subject) $t = \sqrt{(2 \times 9.5)/9.81}$ or 1.39 time = 1.4 (s)	M1 M1 A0	
(e)(ii)	Horizontal velocity = 30 m s^{-1} distance = 1.4×30 or 42 (m) (number of cars =) 42/1.8 (number of cars =) 23	C1 A1	 **Allow**: 23.3 cars **Allow:** 22 if height of last car is mentioned
	Total	**9**	

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Q 4	Answer	Marks	Guidance
(a)	The resultant force is zero There is no acceleration	B1 B1	**Not** 'in equilibrium' **Not**: constant velocity; since this is in the question
(b)	(moment of a force =) force × perpendicular distance from point / pivot	B1	**Must use ticks on Scoris to show where the marks are awarded** ✓ '***perpendicular'*** must be spelled correctly to gain the mark.
(c)	Forces are in the same direction / The forces are not opposite / The forces are not equal (in magnitude)	B1	
(d)	(clockwise moments =) (720 × 0.40) + (180 × 0.60) or 396 (N m) sum of clockwise moments = sum of anticlockwise moments 396 = 1.3 *F* *F* = 300 (N)	C1 C1 A1	 **Allow**: 2 marks for '720 × 0.40 = 1.3 × *F*, *F* = 221 (N)' or 180 × 0.60 = 1.3 × *F*, *F* = 83 (N)' **Note**: Answer is 305 (N) to 3 sf and 304.6 (N) to 4 sf
(e)	The force at **X** decreases The force at **Y** increases / greater clockwise moment / $F_X + F_Y = 900$ (N)	B1 B1	 **Allow**: the rider's centre of gravity / mass moves further from **X**
	Total	**9**	

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Q 5	Answer	Marks	Guidance
(a)(i)	The driver's head will bounce back / 'whiplash'	B1	**Allow**: suffocation **Allow**: the airbag will be (too) rigid / not collapse so the force on the head will still be large (AW)
(a)(ii)	Time to stop is longer Magnitude of deceleration is smaller *F* = *ma* used correctly to explain why the force is smaller **Alternative** Time to stop is longer $F = \frac{mv - mu}{\Delta t}$ or $F = \frac{\Delta mv}{\Delta t}$ used to explain why the force is smaller Change in momentum is constant	B1 B1 B1 B1 B1 B1	 **Allow**: 'smaller acceleration' **Allow**: use of $F \propto a$ **Allow:** p for mv **Allow:** omissions of delta
(b)(i)	$x \propto u^2$ or doubling the speed increases the distance by a factor of 4	B1	
(b)(ii)	thinking distance = 30 × 0.6 or 18 (m) braking distance = 0.08 × u^2 or 0.08 × 30^2 or 72 (m) stopping distance = 18 + 72 stopping distance = 90 (m)	C1 C1 A1	
(c)(i)	Circle shows the possible position(s) of the car from a satellite	B1	**Allow:** 'where' a car can be. **Allow**: The car is at the intersection of the spheres. **Not:** the area / region / space where a car can be
(c)(ii)	The time taken for (coded) signal to travel from satellite to the receiver is determined The distance is calculated by multiplying the time by *c* / 3 × 10^8 m s^{-1} / speed of light / radio waves / microwaves	B1 B1	**Not**: if any signal travels from the GPS in the car to the satellite
	Total	**11**	

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Q 6	Answer	Marks	Guidance
(a)(i)	force/extension or force/change in length	B1	**Allow**: force per unit extension or force per unit compression
(a)(ii)	Tension/force in each spring is halved so the extension (of each spring) is also halved. (Therefore the force constant is twice that of one spring.)	B1	**Allow**: the extension of each spring is halved, the force is the same (for the system, hence the force constant doubles)
(b)	Measure the thickness of the strip (using the micrometer) and calculate its (cross-sectional) area Load the hanger until the strip breaks. Calculate the (maximum) weight of the masses using $W = mg$. breaking stress = (maximum) weight/(cross-sectional) area	B1 B1 B1	**Not**: surface area **Allow**: 'force' for 'weight' **Allow:** breaking stress = (maximum) force/(cross-sectional) area **Allow**: F/A if the words force and area have been used in the answer
(c)(i)	Any **one** from: Elastic (behaviour) / obeys Hooke's law / stress is proportional to strain	B1	
(c)(ii)	It will be longer / permanent strain / suffer plastic deformation (AW)	B1	
(c)(iii)	The statement is incorrect because the Young modulus can only be determined from the linear region of the graph.	B1	**Allow**: Young modulus only applies to elastic behaviour **Allow:** stress is not proportional to strain as the line is curved **Not:** stress is not proportional to strain
	Total	**8**	

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Q 7	Answer	Marks	Guidance
(a)	weight = $2.8 \times 10^4 \times 9.81$ or 2.75×10^5 (N)	C1	
	stress in each cable = $\frac{1}{4} \times \frac{2.75 \times 10^5}{4.5 \times 10^{-4}}$ or 1.53×10^8 (Pa)	C1	
	strain = $\frac{1.53 \times 10^8}{2.1 \times 10^{11}}$ or 7.28×10^{-4}	C1	If g is omitted do not award the first mark but allow ECF for a possible maximum of 3/4 marks. Use FT on the calculation.
	extension = $7.52 \times 10^{-4} \times 32$ or 0.023 (m)		
	extension = 23 (mm)	A1	**Allow**: 3 marks for 93 (mm) – factor of 4 omitted **Alternative approach:** weight = = $2.8 \times 10^4 \times 9.81$ or 2.75×10^5 (N) C1 extension = $\frac{FL}{AE}$ any subject C1 extension = $\frac{0.25 \times 2.75 \times 10^5 \times 32}{4.5 \times 10^{-4} \times 2.1 \times 10^{11}}$ C1 extension = 23 (mm) A1
(b)	Extension will increase	B1	
	The tension > weight (for acceleration)	B1	**Allow**: the tension increases to cause the acceleration **Allow**: Net force is upwards so tension / force in the cables increases
	Total	**6**	

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Tuesday 19 May 2015 – Morning

AS GCE PHYSICS A

G481/01 Mechanics

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Duration: 1 hour

* G 4 8 1 0 1 *

* 4 8 6 5 0 3 1 7 1 6 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.



Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means for example you should:
- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
- organise information clearly and coherently, using specialist vocabulary when appropriate.

- This document consists of **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 In each of the following questions a description of a graph is given.

Insert the correct labels for the axes on the dotted lines in Fig. 1.1 to Fig. 1.4.

The first one has been completed for you.

The area under the graph shown in Fig. 1.1 is equal to the elastic potential energy of a spring.

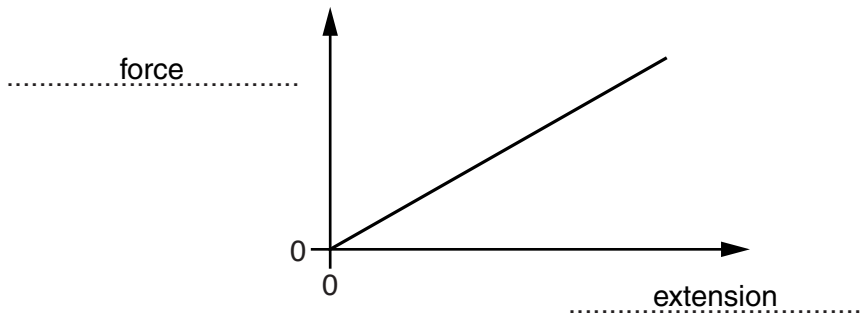


Fig. 1.1

(a) The area under the graph shown in Fig. 1.2 is equal to the displacement of a ball.

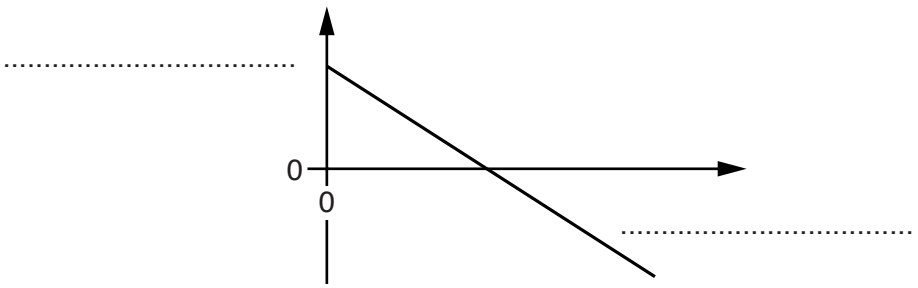


Fig. 1.2

[1]

(b) The gradient of the graph shown in Fig. 1.3 is the Young modulus of a material.

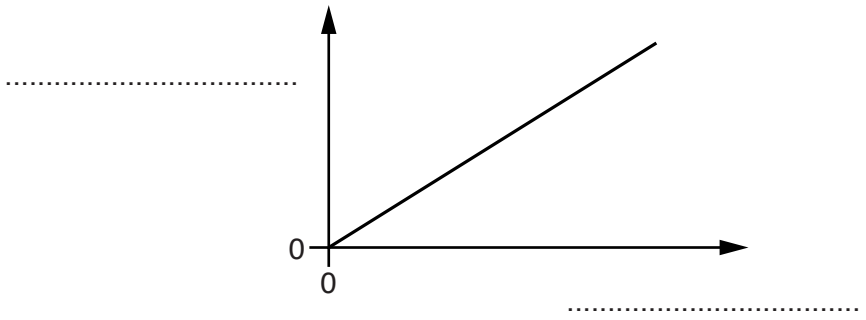


Fig. 1.3

[1]

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(c) The gradient of the graph shown in Fig. 1.4 is the force constant of a wire.

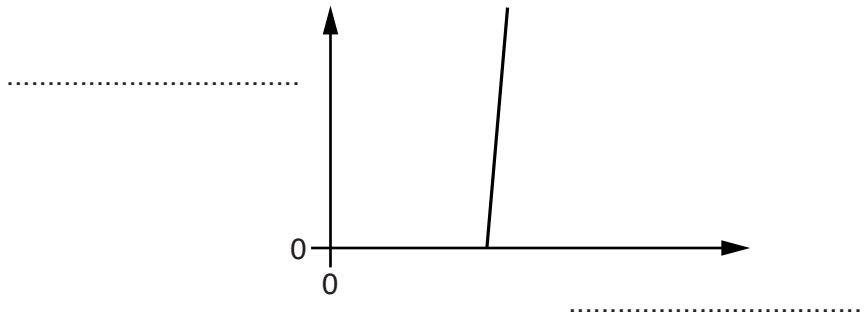


Fig. 1.4

[1]

Turn over for next question

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2 **(a)** *Energy* and *work done* are scalar quantities and have the same unit as each other.

State **two** other scalar quantities in physics that have the same unit as each other.

.....

..... **[1]**

(b) Two forces **A** and **B** act through the same point in an object. These two forces are shown in Fig. 2.1. No other forces act on the object.

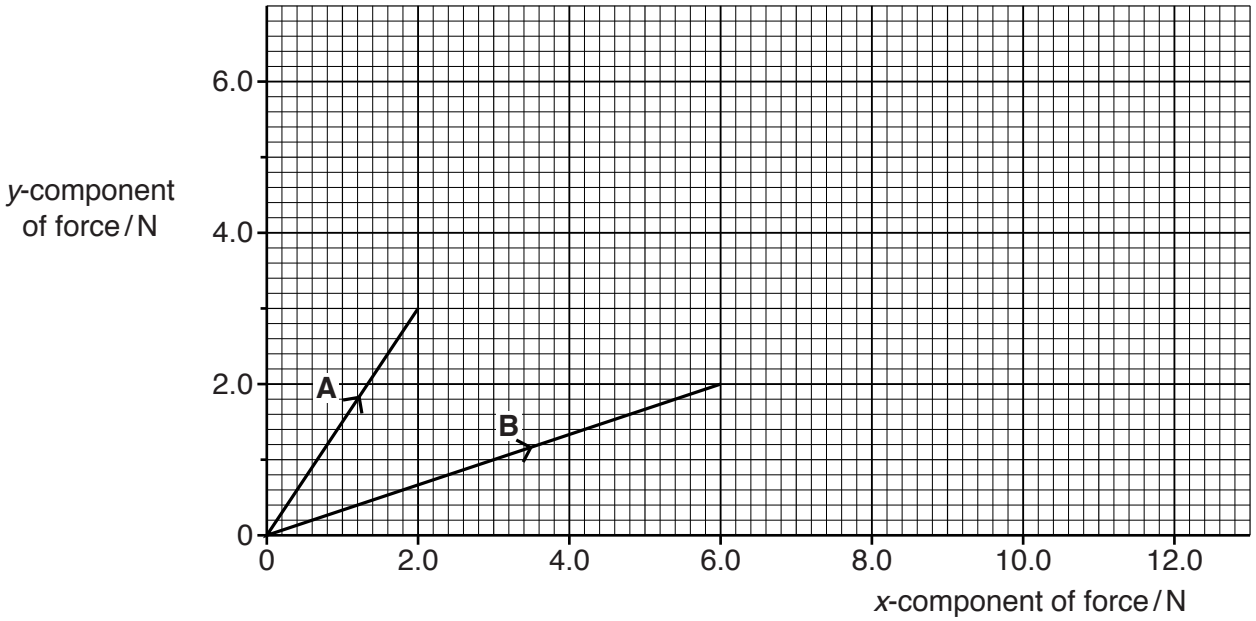


Fig. 2.1

(i) Use Fig. 2.1 to determine the *x*- and *y*- components of the force **B**.

x-component = ... N

y-component = ... N
[1]

(ii) Use Fig. 2.1 to determine the magnitude of the resultant of the two forces **A** and **B**.

resultant force = ... N **[3]**

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(c) Fig. 2.2 shows a jet of water from the end of a hosepipe.

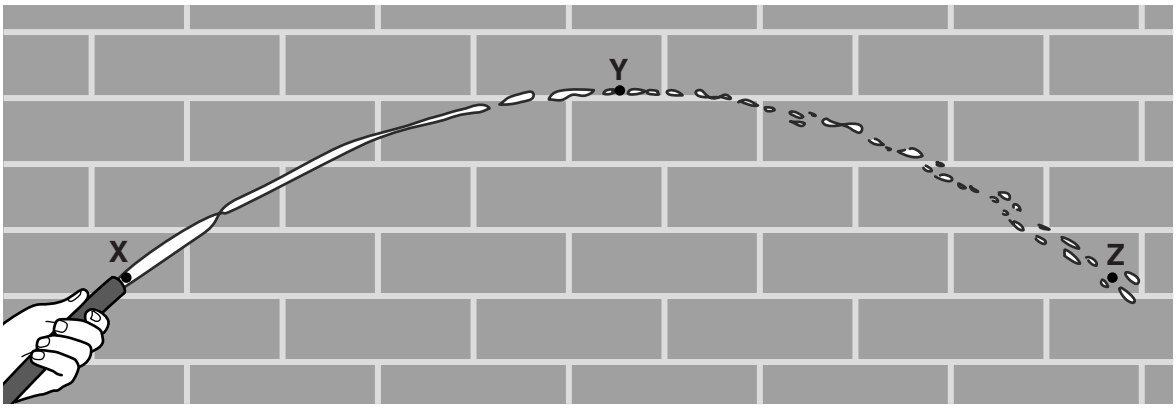


Fig. 2.2

Air resistance has negligible effect on the motion of the water jet. The water jet reaches maximum height at point **Y**.

(i) State the direction of the force acting on the water at **Y**.

..... **[1]**

(ii) Describe and explain how the horizontal component of the velocity of the water varies from point **X** to point **Y**.

.....

.....

.....

.....

..... **[2]**

(iii) Describe how the vertical component of the velocity of the water varies from point **X** to point **Z**.

.....

.....

.....

.....

.....

..... **[2]**

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3 **(a)** Fig. 3.1 shows the path taken by an aircraft as it flies from **A** to **B**.

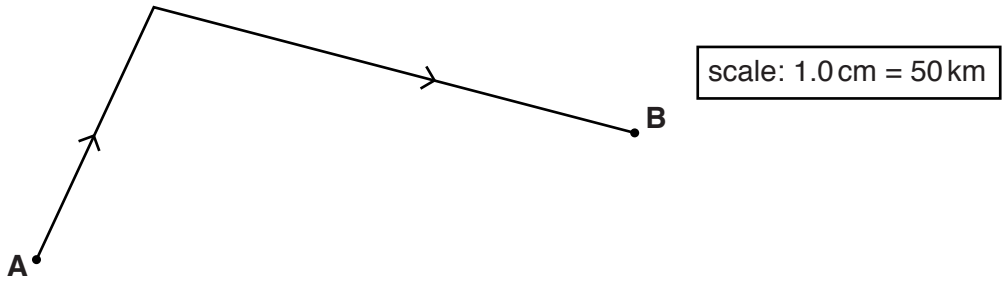


Fig. 3.1

On Fig. 3.1, a distance of 1.0 cm represents a distance of 50 km travelled by the aircraft. The aircraft takes 25 minutes to travel from **A** to **B**.

(i) Use Fig. 3.1 to determine the magnitude of the average velocity of the aircraft as it travels from **A** to **B**.

average velocity = ... $m\,s^{-1}$ **[3]**

(ii) Without doing any calculations, explain why the average speed of the aircraft is not the same as the magnitude of its average velocity.

.....

.....

..... **[1]**

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(b) Io is one of the many moons of Jupiter. It travels at constant speed around Jupiter in a circular orbit of radius 4.2×10^8 m. Io takes 1.5×10^5 s to orbit once around Jupiter.

(i) Calculate the speed of Io in its orbit.

speed = ... $m\,s^{-1}$ **[2]**

(ii) Io has several active volcanoes on its surface. One of these volcanoes produces jets of sulphur with a velocity of $1.3\,km\,s^{-1}$ that rise to 470 km above the volcano.

Calculate the constant acceleration of free fall on the surface of Io.

acceleration = ... $m\,s^{-2}$ **[3]**

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4 **(a)** An object falling towards the ground has both kinetic energy and gravitational potential energy.

Explain what is meant by *gravitational potential energy* without using an equation.

.....

..... **[1]**

(b) A ball of mass 0.20 kg is thrown vertically downwards at a speed of $15\,m\,s^{-1}$ towards the ground from a height of 2.8 m. The ball hits the ground and rebounds at a speed of $12\,m\,s^{-1}$, as shown in Fig. 4.1. Assume air resistance has negligible effect on the motion of the ball.

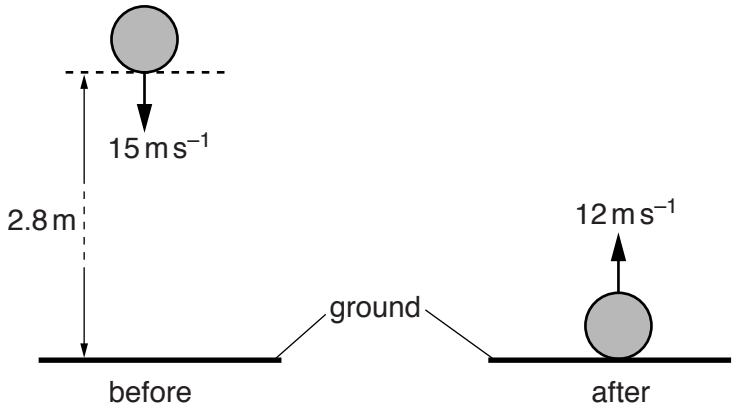


Fig. 4.1

(i) Calculate the speed of the ball just before it hits the ground.

speed = ... $m\,s^{-1}$ **[2]**

(ii) Calculate the energy transferred to the ground during the impact.

energy transferred = ... J **[3]**

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(iii) The time of impact of the ball with the ground is 0.065 s.

Calculate the magnitude of the average force exerted by the ground on the ball during the impact.

force = ... N **[2]**

5 A student wants to carry out an experiment to determine the input power to a small electric motor without using electrical meters. The motor is used to lift light loads. The efficiency of the motor is 15%. Describe how this student can determine the input power to the motor. Your description should include:

- the measurements taken
- the instruments used to take the measurements
- how the measurements are used to determine the input power to the motor.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

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..... **[4]**

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6 **(a)** The drag force F acting on a car travelling at a speed v is given by the equation

$$F = kAv^2$$

where A is the area of the front of the car.

Show that a suitable unit for the quantity k is kg m^{-3}.

[2]

(b) A table tennis ball experiences drag as it travels through the air. Fig. 6.1 shows the ball in three different situations, **A**, **B** and **C**.

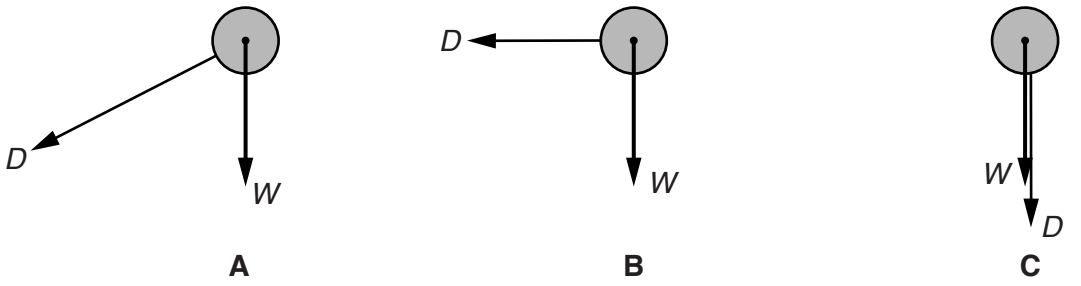


Fig. 6.1

The ball has weight W and the drag force is D.

(i) On Fig. 6.1 draw an arrow to show the **direction** of travel of the ball in situation **A**. **[1]**

(ii) In situation **B** the magnitude of the weight and the drag are the same.

Explain whether or not the ball is travelling at its terminal velocity.

.....

.....

..... **[1]**

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(iii) Describe and explain the motion of the ball in situation **C**.

.....

.....

..... **[2]**

(c) Fig. 6.2 shows a DVD held above the ground.



Fig. 6.2

The DVD is dropped from rest. The circular face remains horizontal as it falls. The DVD does not reach terminal velocity before it hits the ground.

Describe and explain how the acceleration of the DVD varies from the instant it is dropped until just before it hits the ground.

.....

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..... **[4]**

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7 **(a)** A block of concrete rests on the ground, as shown in Fig. 7.1.

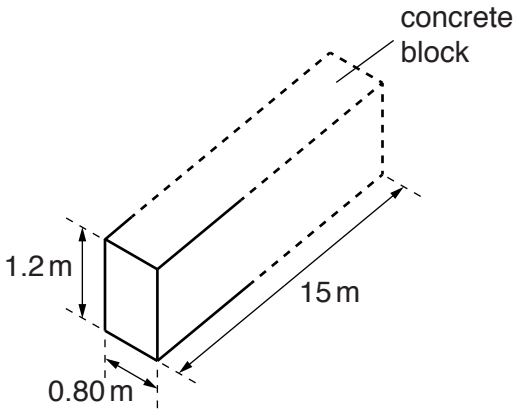


Fig. 7.1

The concrete block is 15 m long, 0.80 m wide and 1.2 m high. The density of concrete is 2.4×10^3 kg m^{-3}. Calculate

(i) the weight of the concrete

weight = ... N **[2]**

(ii) the pressure exerted on the ground by the block of concrete.

pressure = ... Pa **[2]**

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(b) Fig. 7.2 shows two vertical walls supporting a uniform horizontal platform in equilibrium.

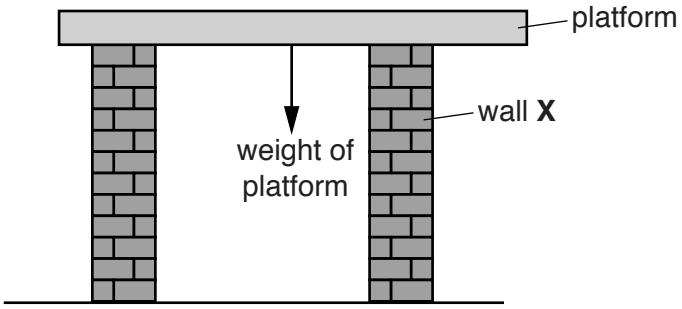


Fig. 7.2

(i) The net force acting on the platform is zero. State another condition that applies to this platform.

.....

..... **[1]**

(ii) The walls exert upward forces on the platform. An engineer suggests that the wall **X** should be moved a little further away from the centre of gravity of the platform and the opposite wall left where it is.

State and explain the effect this change would have on the force exerted by wall **X** on the platform.

.....

.....

.....

.....

..... **[2]**

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8 **(a)** Fig. 8.1 shows a graph of stress against strain for rubber.

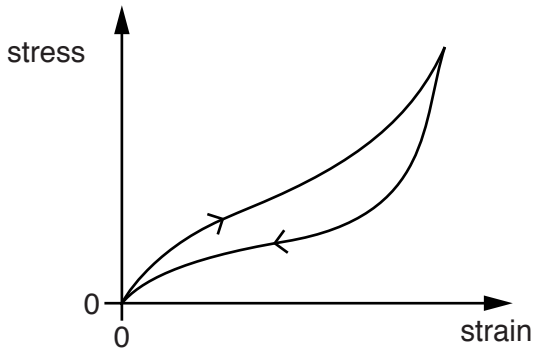


Fig. 8.1

Use Fig. 8.1 to describe the main physical properties of this material.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

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..... **[3]**

(b) Fig. 8.2 shows a metal strip pulled from its ends until it breaks.

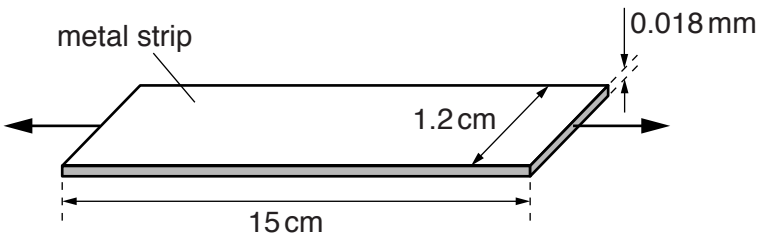


Fig. 8.2

The strip is 15 cm long, 1.2 cm wide and 0.018 mm thick. The breaking force for this strip is 16 N. The Young modulus of the metal is 7.1×10^{10} Pa.

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(i) Calculate the extension of the metal strip when it breaks. State one assumption made in your calculation.

extension = ... m **[3]**

assumption: .....

..... **[1]**

(ii) Calculate the breaking force of a rod of radius 0.60 cm made from the same metal.

breaking force = ... N **[2]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page. The question number(s) must be clearly shown in the margin.

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OCR
Oxford Cambridge and RSA

GCE

Physics A

Unit **G481/01**: Mechanics

Advanced Subsidiary GCE

Mark Scheme for June 2015

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations

Annotation	Meaning
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
FT	Follow through
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error or reading/transcription error (*dual purpose*)
SF	Error in number of significant figures
	Correct response
AE	Arithmetic error
	Wrong physics or equation

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Abbreviations used in detailed mark scheme

Abbreviation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

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Subject-specific Marking Instructions

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures and rounding errors:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf. If an answer is given to fewer than 2 sf, then penalise once only in the entire paper. Any exception to this rule will be mentioned in the Guidance.
Penalise a rounding error once only in the entire paper.

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Question			Answer	Marks	Guidance
1	a		velocity against time	B1	**Not** 'speed' for velocity **Not** time against velocity Ignore units
	b		stress against strain	B1	Ignore units
	c		force / load / tension against length (of wire)	B1	**Not** force against extension **Not** 'weight' for force **Not** 'distance' for length Ignore units
			Total	**3**	

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Question			Answer	Marks	Guidance
2	a		pressure and stress or pressure and Young modulus or stress and Young modulus or moment (of a force) and torque (of a couple)	B1	**Allow** other correct combinations **Allow** the following: • e.m.f. and p.d. • Any two from frequency, activity, decay constant and Hubble constant because of the s^{-1} **Ignore** any units given (even if incorrect) **Special case**: Allow quantities with no units, e.g. strain and efficiency. **Not** any combination of length, distance and extension
	b	i	*x*-component = 6.0 (N) and *y*-component = 2.0 (N)	B1	**Allow** 1 sf answers **Allow** tolerance ± 0.1 N **Not** *x*-component = 2.0 (N) and *y*-component = 6.0 (N)
		ii	resultant components are 8.0 (N) and 5.0 (N) $F^2 = 8.0^2 + 5.0^2$ force = 9.4 (N)	C1 C1 A1	**Allow**: 1 sf values for this C1 mark Possible ecf from **(b)(i)** with *x*-components = 2 + **b(i)** and *y*-component = 3 + **b(i)**. **Note**: Answer is 9.43 to 3sf **Not** an answer left in square root form, e.g $\sqrt{89}$ **Allow** full credit for a scale drawing; marks awarded as below: • A dot / cross / mark at 8.0,5.0 (± 0.1) C1 • Line drawn from 0,0 to 8.0,5.0 C1 • force = 9.4 ± 0.1 (N) A1
	c	i	Down	B1	**Allow** a downward arrow on Fig. 2.2

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Question			Answer	Marks	Guidance
		ii	Horizontal component of the velocity is constant There is no horizontal force	B1 B1	**Allow**: There is no horizontal acceleration **Allow**: Weight / *g* has no horizontal component or Weight / *g* is 90° to the horizontal or Weight / *g* is vertical or 'there is only a vertical force' (**Not** 'gravity' for 'weight'; allow 'force of gravity')
		iii	Any two from: • It decreases from **X** to **Y** • It is zero at **Y** / It has the same magnitude at **X** and Z • It increases from **Y** to **Z** • It is positive from **X** to **Y** and negative from **Y** to **Z** (or vice versa)	B1 × 2	**Ignore** description in terms of acceleration or deceleration **Allow** it changes sign / direction from **X** to **Z**
			Total	**10**	

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Question			Answer	Marks	Guidance
3	a	i	Length from **A** to **B** = 8.0 (cm) displacement = 400 (km) or time = 1500 (s) average velocity = $400 \times 10^3/1500$ average velocity = 270 (m s^{-1})	C1 C1 A1	**Allow** $\pm$ 0.1 cm Possible ecf within the calculation for an incorrect value for length **AB**. **Note** no credit if distance is used.
		ii	(The average speed is different because) the <u>distance</u> (travelled) is different / not the same / greater than the <u>displacement</u>	B1	
	b	i	distance = $2 \times \pi \times 4.2 \times 10^8$ speed = $\frac{2\times\pi\times4.2\times10^8}{1.5\times10^5}$ speed = 1.8×10^4 (m s^{-1})	C1 A1	 **Note**: Answer to 3 sf is 1.76×10^4 (m s^{-1}) **Not** 5600π (m s^{-1})
		ii	($0 = u^2 - 2as$) $(1.3\times10^3)^2 = 2\times a\times470\times10^3$ (Any subject) $a = \frac{(1.3\times10^3)^2}{2\times470\times10^3}$ (*a* must be the subject) acceleration = 1.8 (m s^{-2})	C1 C1 A1	**Allow** full credit for '$mgh = ½ mu^2$' approach **Ignore** signs **Allow**: 2 marks for 1.8×10^n; $n \neq 0$
			Total	**9**	

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Question			Answer	Marks	Guidance
4	a		GPE linked to 'position' / height (in a gravitational field)	B1	**Allow**: GPE linked to an object 'raised' / 'lowered' (on the Earth)
	b	i	$v^2 = u^2 + 2as$ $v^2 = 15^2 + (2 \times 9.81 \times 2.8)$ or $v = \sqrt{280}$ speed = 17 (m s^{-1})	C1 A1	**Allow** other correct methods **Note**: Answer is 16.7 m s^{-1} to 3sf
		ii	(initial energy =) ½ × 0.20 × 16.7^2 or (initial energy =) 0.20 × 9.81 × 2.8 + ½ × 0.20 × 15^2 (final energy =) ½ × 0.20 × 12^2 energy lost = 14 (J)	C1 C1 A1	Possible ecf from **b(i)** **Special case:** 1 mark for 8.1 (J); the difference in the initial KE (½ × 0.20 × 15^2) and the final KE (½ × 0.20 × 12^2)
		iii	change in velocity = 17 + 12 (= 29 m s^{-1}) or 16.7 + 12 (= 28.7 m s^{-1}) *F = ma* force = $0.20 \times \frac{29}{0.065}$ or force = $0.20 \times \frac{28.7}{0.065}$ force = 89 (N) or force = 88 (N)	C1 A1	Possible ecf from **(b)(i)** **Allow** 1 mark for 'force = $0.20 \times \frac{(b)(i) - 12}{0.065}$' calculated with an answer.
			Total	**8**	

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Question			Answer	Marks	Guidance
5			Any <u>one</u> from: • Mass obtained using a balance / scales • Weight / load obtained using a newtonmeter / spring balance • Distance / height obtained using a ruler / metre stick / measuring tape	B1	
			Time obtained using a clock / (stop)watch / timer or light-gate <u>and</u> timer or light-gate <u>and</u> data-logger	B1	✎ The term **clock** / **(stop)watch / timer /data-logger** must be spelled correctly to gain this mark
			(output power =) 'mass × *g* × distance'/time or 'weight × distance/time' or 'weight × speed'	B1	**Allow** symbols, e.g *mgh/t*, *Wh/t* and *Wv*
			input power = output power/0.15	B1	
			Total	**4**	

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Question			Answer	Marks	Guidance
6	a		$F \rightarrow$ kg m s^{-2} **or** $A \rightarrow$ m^2 and $v \rightarrow$ m s^{-1}	M1	**Alternative**: (units on rhs:) kg $m^{-3} \times m^2 \times m^2 s^{-2}$ **or** (unit for lhs:) = kg m s^{-2} M1
			Manipulation leading to $k \rightarrow$ kg m^{-3}	M1	Manipulation leading to same units on both sides M1
			$k \rightarrow$ kg m^{-3}	A0	**Allow** other correct methods
	b	i	Arrow directly opposite to *D* on Fig. 6.1	B1	**Ignore** position and length of arrow
		ii	The ball is not at terminal velocity, since *D* and *W* are not (directly) opposite / The ball is not at terminal velocity because there is a net force	B1	**Not** *D* and *W* are at 90°
		iii	It is travelling (vertically) upwards	M1	
			It will slow down / It decelerates / It accelerates (vertically) downwards / There is a net downward force / drag opposes motion	A1	
	c		At the start, acceleration = *g* (because there is no drag)	B1	**Allow** 9.8(1) m s^{-2} / acceleration of free fall / acceleration due to gravity (**Not** 'gravity' on its own) **Not** rate of acceleration is *g*
			Drag increases (as its speed increases / accelerates)	B1	
			net force decreases or net force < weight	B1	
			(As it falls) acceleration decreases / (As it falls) acceleration < *g*	B1	**Not** 'rate of acceleration decreases' unless it is qualified or 'acceleration slows down'
			Total	**10**	

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Question			Answer	Marks	Guidance
7	a	i	mass = 2400 × (0.80 × 1.2 × 15) / mass = 3.46×10^4 (kg) weight = $3.46 \times 10^4 \times 9.81$ weight = 3.4×10^5 (N)	C1 A1	
		ii	pressure = $3.4 \times 10^5/(15 \times 0.80)$ pressure = 2.8×10^4 (Pa)	C1 A1	Possible ecf from **(a)(i)**
	b	i	Net moment is zero (about any point / axis).	B1	**Allow** 'clockwise moment(s) = anticlockwise moment(s)' **Allow** net torque is zero
		ii	The force exerted (at **X**) decreases. Correct explanation, e.g: The moment must be the same (about the other wall / pivot) and the distance (from it) has increased.	M1 A1	 **Allow** 'force × (perpendicular) distance' for moment
			Total	**7**	

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Question			Answer	Marks	Guidance
8	a		The material is elastic / strain is zero when stress is removed / returns to its original shape when force is removed / there is no plastic deformation	B1	✍ The term **elastic / remove(d) / plastic** must be spelled correctly to gain this mark **Ignore** 'polymeric' **Not** 'it is ductile and elastic'
			It does not obey Hooke's law	B1	**Allow**: Stress is not proportional to strain / force is not proportional to extension
			The loading and unloading graphs are different (AW)	B1	**Allow**: It shows hysteresis / heat produced (when loaded and unloaded)
	b	i	(breaking) stress = $\frac{16}{0.012\times0.018\times10^{-3}}$ or 7.41×10^{7} (Pa)	C1	**Alternative:** $x=\frac{FL}{EA}$ (Any subject) C1
			strain = $\frac{7.41\times10^{7}}{7.1\times10^{10}}$ or 1.04×10^{-3}	C1	extension = $\frac{16\times0.15}{7.1\times10^{10}\times(0.012\times0.018\times10^{-3})}$ C1
			extension = $1.04\times10^{-3}\times0.15$		extension = 1.6×10^{-4} (m) A1
			extension = 1.6×10^{-4} (m)	A1	
			assumption: Hooke's law obeyed / elastic limit is not exceeded / not plastically deformed / (cross-sectional) area is the same / thickness is the same / width is the same / no 'necking' / material is brittle	B1	
		ii	(breaking) stress = same $\frac{F}{\pi\times(0.60\times10^{-2})^{2}}=7.41\times10^{7}$	C1	**Allow** other correct methods Possible ecf from **(b)(i)**
			force = 8.4×10^{3} (N)	A1	
			Total	**9**	

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OCR

Tuesday 20 May 2014 – Morning

AS GCE PHYSICS A

G481/01 Mechanics

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Duration: 1 hour

* G 4 8 1 0 1 *

* 1 3 1 1 2 3 1 4 5 2 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.



Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means for example you should:
- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
- organise information clearly and coherently, using specialist vocabulary when appropriate.

- This document consists of **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 **(a)** Define *velocity*.

.....

..... **[1]**

(b) The mass of an ostrich is 130 kg. It can run at a maximum speed of 70 kilometres per hour.

(i) Calculate the maximum kinetic energy of the ostrich when it is running.

kinetic energy = ... J **[3]**

(ii) Scientists have recently found fossils of a prehistoric bird known as Mononykus. Fig. 1.1 shows what the Mononykus would have looked like.



Fig. 1.1

According to a student, the Mononykus looks similar to our modern day ostrich. The length, height and width of the Mononykus were all **half** that of an ostrich.
Estimate the mass of the Mononykus. Explain your reasoning.

.....

.....

.....

..... **[2]**

[Total: 6]

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2 Fig. 2.1 shows an object held horizontally by a string.

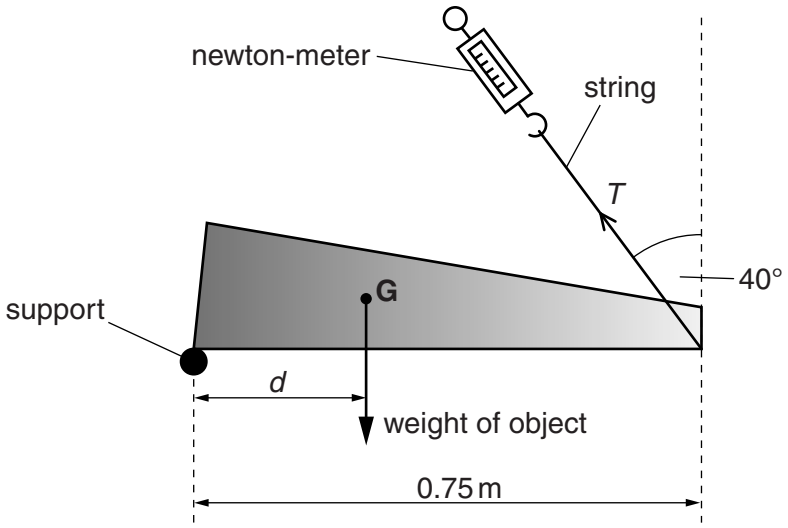


Fig. 2.1

One end of the object rests on a support and the other end is held by the string. The object is in equilibrium. Point **G** is the centre of gravity of the object. The mass of the object is 1.2 kg. The tension *T* in the string is 5.1 N. The string makes an angle of 40° with the vertical.

(a) Take moments about the support and calculate the distance *d*.

d = ... m **[3]**

(b) Explain why the force at the support cannot be vertically upwards.

.....

.....

.....

..... **[1]**

[Total: 4]

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3 **(a)** Fig. 3.1 shows the stress against strain graph for a metal **X** up to its breaking point.

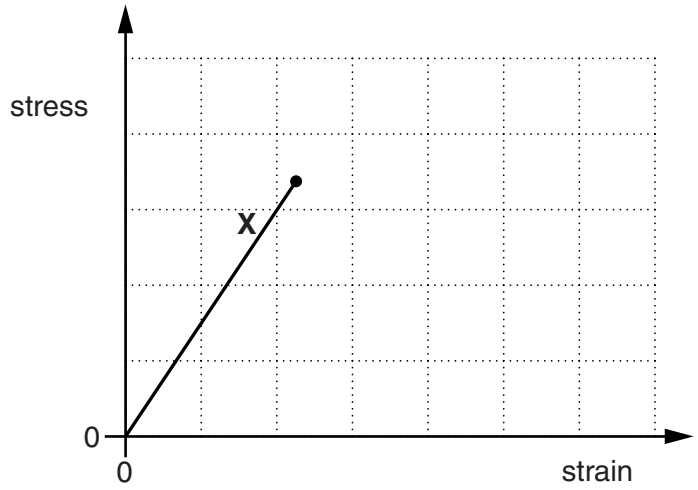


Fig. 3.1

(i) Use Fig. 3.1 to state the physical properties of this metal.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

..... **[2]**

(ii) On the axes of Fig. 3.1, sketch a graph for a ductile material, having a larger Young modulus value than the metal **X**, up to its breaking point. **[2]**

(b) Fig. 3.2 shows a stationary cable car.

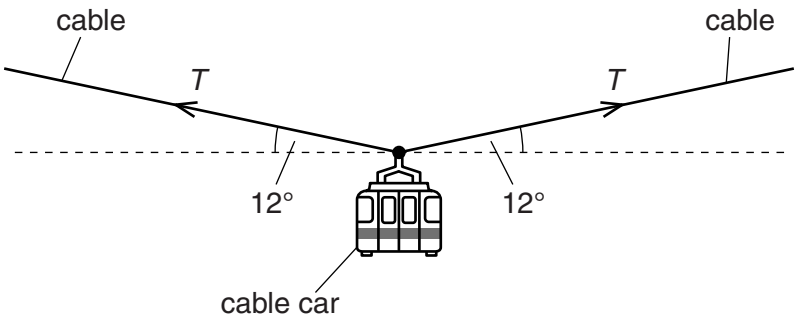


Fig. 3.2

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The cable on both sides of the car is at an angle of 12° to the horizontal. The radius of the cable is 2.6×10^{-2} m. The stress in the cable is 1.8×10^{7} Pa. The Young modulus of the material of the cable is 2.0×10^{11} Pa.

(i) Calculate the strain experienced by the cable.

strain = ... **[2]**

(ii) Calculate the tension T in the cable.

T = ... N **[2]**

(iii) Calculate the weight of the cable car.

weight = ... N **[3]**

[Total: 11]

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4 **(a)** Fig. 4.1 shows the path of a tennis ball after bouncing on the ground at **A** and hitting a vertical wall at **B**.

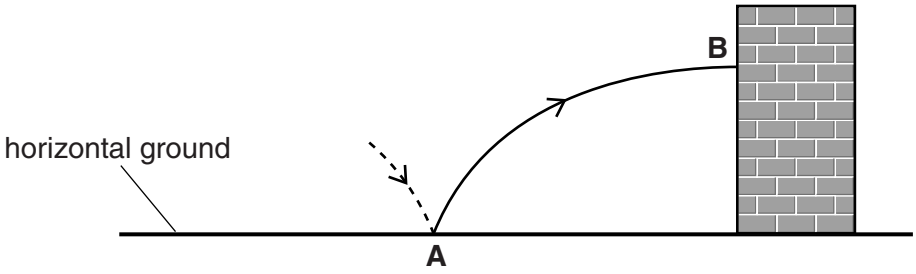


Fig. 4.1

The ball is travelling horizontally as it hits the wall at **B**. Air resistance has negligible effect on the motion of the ball.

(i) Explain why the horizontal component of the velocity of the ball remains constant as it moves from **A** to **B**.

.....

..... **[1]**

(ii) The ball loses some of its kinetic energy when it hits the wall at **B**. It leaves the wall horizontally.

1 On Fig. 4.1, sketch the path of the ball between bouncing at the wall and hitting the ground.

2 Explain how the time taken for the ball to travel from **A** to **B** compares with the time it takes to travel from **B** to the ground.

.....

.....

.....

[3]

(b) A student is given a metre rule, a stopwatch and a tennis ball.
Explain how this equipment can be used to determine an **approximate** value for the acceleration *g* of free fall.

.....

.....

.....

.....

.....

.....

..... **[3]**

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(c) Fig. 4.2 shows a tennis ball moving up a smooth ramp at time $t = 0$.

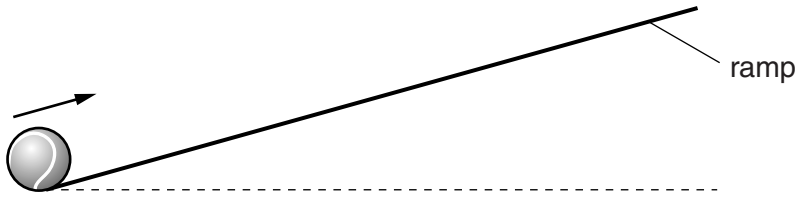


Fig. 4.2

Fig. 4.3 shows a graph of velocity v against time t for this ball.

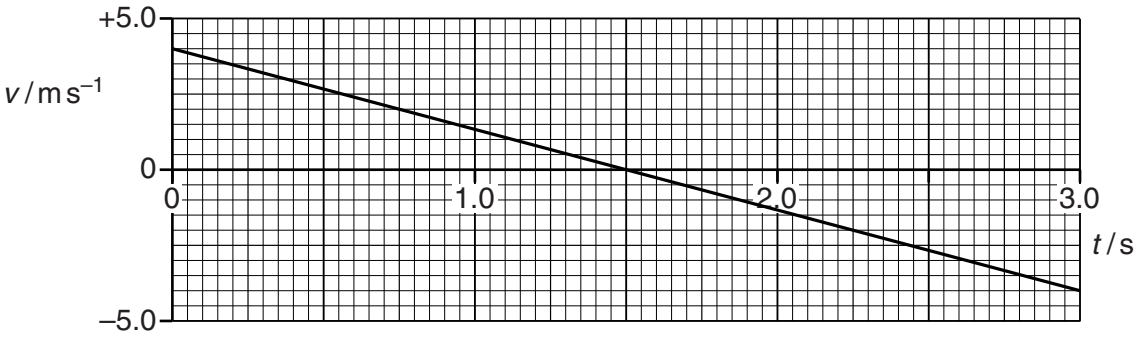


Fig. 4.3

(i) Describe, without calculation, the motion of the ball between $t = 0$ and $t = 3.0$ s.

.....

.....

.....

.....

..... **[3]**

(ii) Calculate the maximum distance D travelled by the ball up the ramp.

$D =$ ..... m **[2]**

[Total: 12]

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5 **(a)** A student holds a golf ball and a table tennis ball out of an upper window of a tall building. The balls are released at the same time. Both balls have the same size. The golf ball has a **greater mass** than the tennis ball. One of the balls reaches a greater terminal velocity.

(i) State and explain the acceleration of the golf ball immediately after it is released.

.....

.....

..... **[2]**

(ii) By referring to the forces acting on the golf ball, explain what is meant by *terminal velocity*.

.....

..... **[1]**

(iii) Explain which of the two balls reaches the greater terminal velocity.

.....

.....

.....

.....

.....

..... **[3]**

(b) Fig. 5.1 shows a graph of drag D against speed v for a lorry.

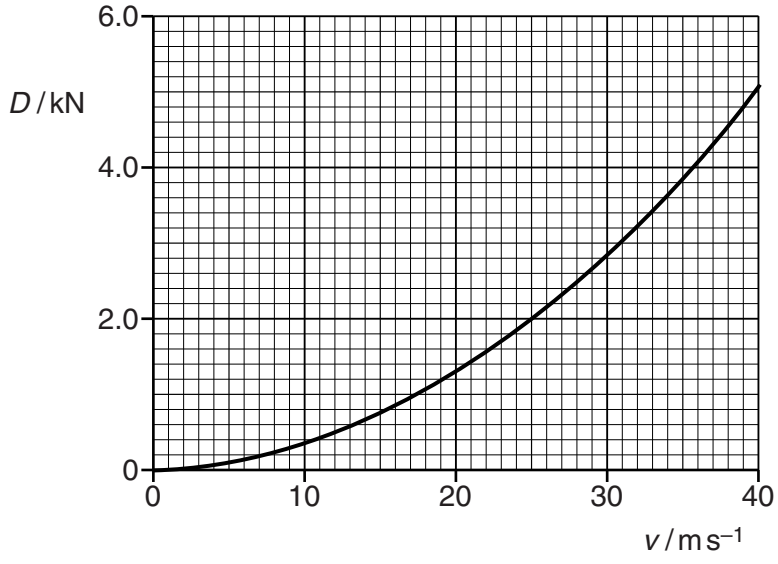


Fig. 5.1

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The lorry has mass 8000 kg. Its engine provides a **constant** forward force of 3200 N.

(i) Calculate the instantaneous acceleration of the lorry when travelling on a level road at a speed of 25 m s^{-1}.

acceleration = ... m s^{-2} **[3]**

(ii) Explain why this lorry cannot travel at a speed of 40 m s^{-1} on a level road.

.....

..... **[1]**

(c) The lorry driver wears a seat belt. Describe and explain how a seat belt reduces the force on a driver during the impact in an accident.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

[Total: 13]

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6 **(a)** Define *work done by a force*.

.....

.....

..... **[1]**

(b) A crate is pushed along a rough horizontal surface at a constant speed. State what happens to the work done on the crate.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

..... **[1]**

(c) Define the *watt*.

.....

..... **[1]**

(d) Fig. 6.1 shows an electric crane lifting a mechanical digger.

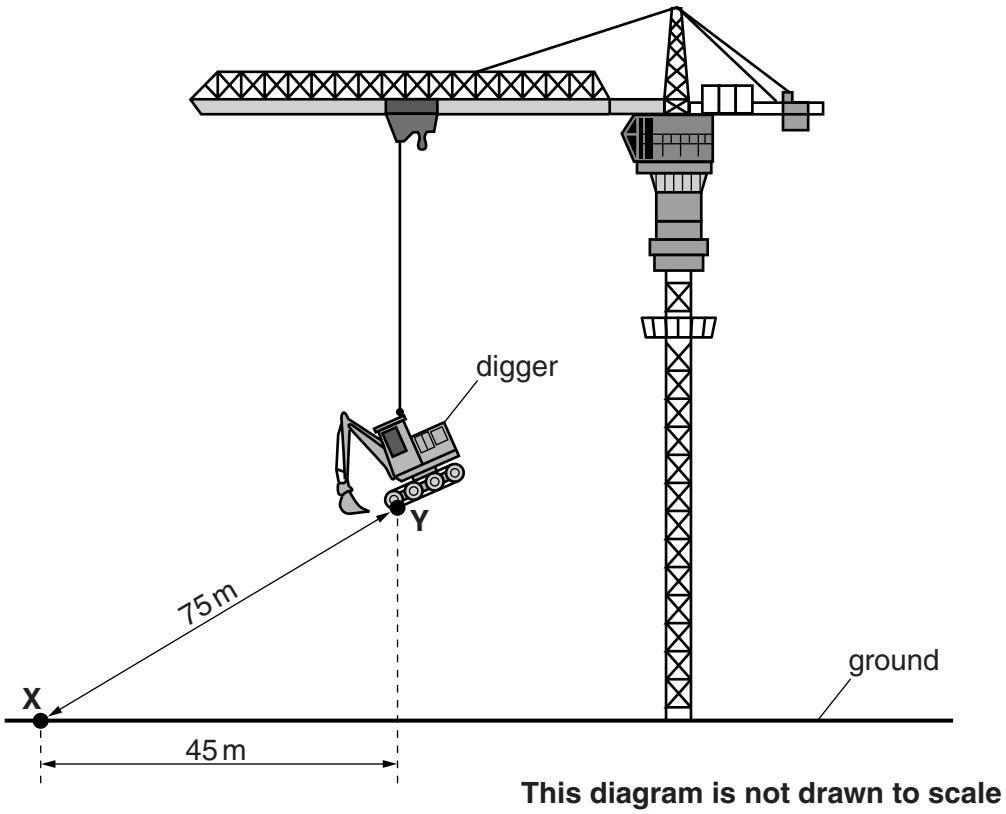


Fig. 6.1

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The mass of the digger is 5200 kg. The crane takes 1.5 minutes to lift the digger from **X** to **Y**.

(i) Calculate the rate of work done to lift the digger from **X** to **Y**.

rate of work done = ... $J\,s^{-1}$ **[3]**

(ii) The total input power to the motors of the crane is 170 kW. Calculate the efficiency of the lifting operation.

efficiency = ... % **[1]**

[Total: 7]

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7 A light spring of unextended length 2.0 cm is hung from a fixed point. An object of weight 3.0 N is hung from the other end of the spring. Fig. 7.1 shows the length of the spring when the object is in equilibrium.

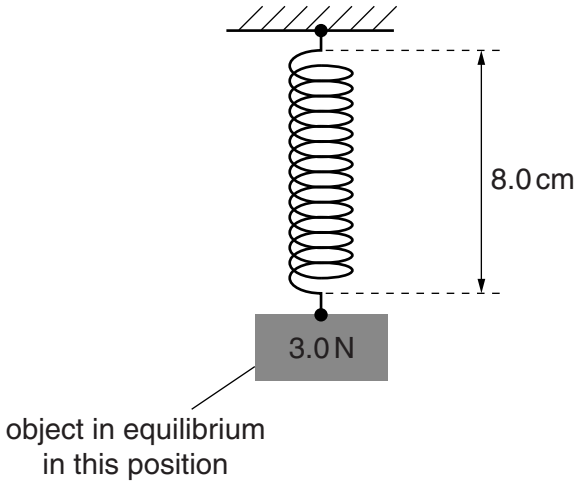


Fig. 7.1

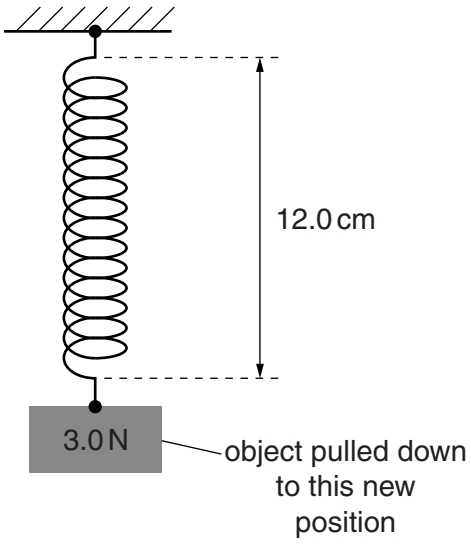


Fig. 7.2

(a) Show that the force constant of the spring is 50 N m^{-1}.

[1]

(b) The object is pulled vertically downwards. Fig. 7.2 shows the new length of the spring.

(i) Calculate the change in the elastic potential energy ΔE in the spring.

ΔE = ... J **[3]**

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(ii) The object is released from its position shown in Fig. 7.2. Calculate the initial upward acceleration *a* of the object.

a = ... $m s^{-2}$ **[3]**

[Total: 7]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

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Oxford Cambridge and RSA

GCE

Physics A

Unit **G481/01**: Mechanics

Advanced Subsidiary GCE

Mark Scheme for June 2014

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It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	correct response
	incorrect response
BOD	benefit of the doubt (where professional judgement has been used)
NBOD	benefit of the doubt **not** given
ECF	error carried forward
^	information omitted
CON	contradiction (in cases where candidates contradict themselves in the same response)
FT	follow through
SF	error in number of significant figures
POT	error in the power of 10 in calculation
AE	arithmetic or calculation error
NAQ	not answered question
?	wrong physics
RE	reading error

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Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/ = alternative and acceptable answers for the same marking point
(1) = separates marking points
allow = answers that can be accepted
not = answers which are not worthy of credit
reject = answers which are not worthy of credit
ignore = statements which are irrelevant
( ) = words which are not essential to gain credit
__ = underlined word (or the equivalent) must be present in answer to score a mark
ecf = error carried forward
AW = alternative wording
ora = or reverse argument

Subject-specific Marking Instructions

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

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If the data given in a question is to 2 sf, then allow answers to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.

Any exception to this rule will be mentioned in the Additional Guidance.

IMPORTANT UPATE:

ADDITIONAL OBJECTS: You **must** annotate the additional objects for each script you mark. If no credit is to be awarded for the additional object, please use annotation as agreed at the SSU, likely to be 'seen', a cross or the highlighting tool.

CROSSED OUT, RUBRIC ERROR (OPTIONAL QUESTIONS) AND MULTIPLE RESPONSES
Crossed-out Responses: Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.
Rubric Error Responses – Optional Questions: Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*
Multiple Choice Question Responses: When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.
Contradictory Responses: When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**): Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**): If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response): Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

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Question			Answers	Marks	Guidance
1	(a)		velocity = rate of <u>change</u> of displacement	B1	**Allow** $v = \frac{\Delta s}{\Delta t}$ where Δs = <u>change</u> in displacement Δt = time (taken) **Allow** displacement travelled/time **Allow** 'velocity = displacement/time' when followed by 'velocity = rate of change of displacement' **Not** 'velocity = displacement/time' or 'distance/time' **Not** mixture of quantity and unit, e.g. change of displacement per second **Not** 'speed in a specific direction'
	(b)	(i)	speed = 70000/3600	C1	**Note**: speed = 19.4... (m s^{-1}) will score this C1 mark
			KE = $\frac{1}{2} \times 130 \times \left(\frac{70000}{3600}\right)^2$	C1	
			kinetic energy = 2.5×10^4 (J)	A1	**Note**: Using 19.4 (m s^{-1}) gives 2.446.. $\times 10^4$ (J); hence an answer of 2.4×10^4 (J) will score full marks **Allow** maximum of 2 marks if 19 (m s^{-1}) is used – answer is 2.34… $\times 10^4$ (J) **Allow** 1 mark for ½ × 130 × (70000/60)^2 = 8.84(7) × 10^7 (J) **Note**: No credit for ½ × 130 × v^2 with any other incorrect value for v, including v = 70 and 70000 **Note**: Bald answer of 2.5×10^4 (J) scores full marks **Note**: If the correct equation for KE is written and then the squaring of the speed is omitted, allow ecf as shown below: E = ½ mv^2 = ½ × 130 × 19.4 = 1.3×10^3 (J) ✓× ✓ 2 marks

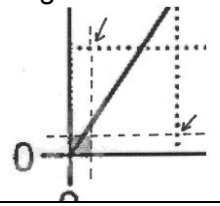
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Question			Answers	Marks	Guidance
	(b)	(ii)	Mass of Mononykus is 1/8 (of the mass of an ostrich) or mass of Mononykus is 16 (kg). Correct reasoning: Volume decreases by (a factor of) 8 **and** density assumed to be the same.	B1 B1	 **Allow** use of V for volume and ρ for density
			Total	**6**	

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Question			Answers	Marks	Guidance
2	(a)		$5.1\times\cos 40\times 0.75$ or $d\times 1.2\times g$ $5.1\times\cos 40\times 0.75 = d\times 1.2\times 9.81$ $d = \dfrac{5.1\times\cos 40\times 0.75}{1.2\times 9.81}$ d = 0.25 (m)	C1 C1 A1	**Allow** 2 marks if sine of the angle is used instead of cosine; this gives an answer of 0.21 (m). **Allow** use of 9.8 (m s^{-2}) **Note**: '5.1 × 0.75 = d × 1.2 × 9.81; d = 0.32.. (m)' scores 1 mark because of the first C1
	(b)		The string provides a horizontal force (to the left), hence there must be a horizontal force at the support (to the right, therefore the force at the support cannot be vertical). (AW) Or If the force was just vertical at the support then the object would move to the left (and so will not be in equilibrium). (AW) Or Force at support is at an angle and passes through the point of intersection (of the lines of action) of the weight and the tension. (AW)	B1	**Allow** Tsin40 for the horizontal force
			Total	**4**	

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Question			Answers	Marks	Guidance
3	(a)	(i)	The material is brittle. The material is also elastic.	B1 B1	**The term *brittle* to be included and spelled correctly to gain the first B1 mark.** **Allow** 'does not show plastic (deformation)'
		(ii)	Straight line through origin followed by correct curve to show plastic behaviour. Straight line has greater gradient than **X**.	B1 B1	**Note:** Tolerance for the origin is shown below 
	(b)	(i)	strain = $\frac{1.8\times10^{7}}{2.0\times10^{11}}$ (Any subject) strain = 9.0×10^{-5}	C1 A1	The mark is for the correct use of strain = stress ÷ E **Allow** 1 sf answer **Ignore** any unit given
		(ii)	$1.8\times10^{7}=\frac{T}{\pi\times(2.6\times10^{-2})^{2}}$ (Any subject) tension = 3.8×10^{4} (N)	C1 A1	The mark is for the correct use of stress = $\frac{F}{A}$
		(iii)	$2T\sin12=W$ weight = $2\times3.8\times10^{4}\times\sin12$ (Any subject) weight = 1.6×10^{4} (N)	C1 C1 A1	 Possible ecf from **(ii)** **Allow** 2 marks for 7.9×10^{3} (N); factor of 2 omitted **Special case:** Using cos12 instead of sin12 gives 7.4..$\times10^{4}$ (N), allow maximum of 2 marks **Allow** full credit for correct calculation using the sine or the cosine rule **Allow** full credit for an answer using a correct scale drawing: Correct sketch of vector diagram C1; correct vector diagram drawn to scale C1; weight = $(1.6\pm0.2)\times10^{4}$ (N) A1
			Total	**11**	

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Question			Answers	Marks	Guidance
4	(a)	(i)	There is only a vertical force / weight is vertical / no horizontal force(s) / acceleration is vertical	B1	**Not** 'horizontal acceleration is zero' – since horizontal velocity is constant is given in the question
		(ii)	1 Correct sketch of the rebound path.	B1	**Note**: The ball must hit the ground closer to wall. The rebound path should be curved and below the original path.
			2 The time is the same.	M1	
			For both, the height / vertical distance and (vertical) acceleration are the same.	A1	**Allow** $s = \frac{1}{2}at^2$ with *s* and *a* are the same (for both)
	(b)		Drop the ball from a given height **and** measure time of fall.	B1	
			$s = ut + \frac{1}{2}at^2$ **and** $u = 0$ or $s = \frac{1}{2}at^2$	B1	**Allow** $a \equiv g$ and $h \equiv s$
			(The acceleration of free fall is determined using) $a = 2s/t^2$	B1	**Note:** *a* must be the subject to gain this B1 mark **Note**: $a = 2s/t^2$ will score the last two B1 marks **Allow** full credit for graphical approach: Drop ball from different heights & measure the times of fall (B1) ; plot a graph of *s* against t^2 (B1) ; $g = 2 \times$ gradient (B1)
	(c)	(i)	Constant deceleration or uniform deceleration or constant negative acceleration or constant rate (of change) of velocity	B1	**Allow** constant / uniform acceleration / acceleration is 2.66.. ($m\ s^{-2}$) **Allow** 'constant rate of deceleration or acceleration' **Not** 'slowing down'
			(Momentarily) stops at 1.5 (s) or reaches maximum height at 1.5 (s)	B1	
			Clear idea of returning back. (AW)	B1	**Allow**: (The ball) goes up and (then) down (the ramp) **Not**: velocity changes sign or direction changes
		(ii)	distance = $\frac{1}{2} \times 4.0 \times 1.5$	C1	**Note**: Speed in range 3.0 to 5.0 ($m\ s^{-1}$) and $v \neq 4.0$ ($m\ s^{-1}$), then possible ecf
			distance = 3.0 (m)	A1	**Allow** 1 sf answer **Allow** full credit for correct use of equation(s) of motion **Special case:** total distance travelled is calculated; allow 1 mark for an answer of 6.0 (m)
			Total	**12**	

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Question			Answers	Marks	Guidance
5	(a)	(i)	9.8(1) $\underline{\text{m s}^{-2}}$ / *g* / acceleration of free fall The only force acting is weight / drag force is zero	B1 B1	
		(ii)	(The maximum velocity when) drag = weight	B1	
		(iii)	The golf ball experiences greater drag (at terminal velocity to equal its larger weight) (AW) Drag increases with speed or drag $\propto v^2$ or the golf ball takes longer time to reach its terminal velocity or the golf ball accelerates for longer time The golf ball (has greater terminal velocity)	B1 B1 B1	
	(b)	(i)	drag = 2000 (N) from the graph net force = 3200 - 2000 (N) / net force = 1200 (N) acceleration = 1200/8000 acceleration = 0.15 (m s^{-2})	C1 C1 A1	 Possible ecf if reading off graph is incorrect No credit for 3200/8000 = 0.4(0 m s^{-2}) or 2000/8000 = 0.25 (m s^{-2})
		(ii)	The drag force will be greater than the (constant) forward force (which cannot be) or at 32 (m s^{-1} drag) force is 3200 $\pm$ 100 (N) or at 40 (m s^{-1} drag) force is 5100 $\pm$ 100 (N)	B1	**Allow** maximum speed is 32 (m s^{-1})
	(c)		The time taken (for the driver) to stop is more or distance travelled (by the driver) is greater. $F = ma$ *a* decreases (hence *F* is smaller) or $Fx = KE$ KE is the same (hence *F* is smaller) or $F = \Delta p/\Delta t$ Δp is the same (hence *F* is smaller)	B1 B1 B1 B1 B1 B1 B1	**Allow** 'it takes longer to stop' or 'increases impact time' **Not** slower acceleration KE $\equiv$ *W* (for work done)
			Total	**13**	

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Question			Answers	Marks	Guidance
6	(a)		force × distance <u>moved</u> / <u>travelled</u> in the direction of the force	B1	**Allow** force × displacement in direction of force
	(b)		(Work done against friction generates) heat / thermal energy / internal energy	B1	**The term *heat* / *thermal* / *internal* to be included and spelled correctly to gain the B1 mark.**
	(c)		1 J (of work done) <u>per</u> second	B1	**Allow** (1 W = 1) J s^{-1} or J/s **Allow** (1) joule<u>s</u> per second **Not** W = 1 J <u>in</u> 1 s **Allow** full credit as long as the definition for the 'watt' is not confused with the definition for 'power' (Examples: • power = rate of work done; W = 1 J s^{-1} ✓ • The rate of work done. It is J per s × • watt = rate of work done, W = 1 J s^{-1} ×)
	(d)	(i)	vertical distance = $(75^2 - 45^2)^{1/2}$ or vertical distance = 60 (m) work done = 5200 × 9.81 × 60 or work done = 3.06×10^6 (J) power = $3.06 \times 10^6/90$ power = 3.4×10^4 (J s^{-1})	C1 C1 A1	**Allow** 2 marks for an answer of 2.04×10^6 (J s^{-1}); 1.5 used instead of 90 s No credit for [5200 × *g* × 75]/90 or [5200 × *g* × 45]/90
		(ii)	efficiency = $\frac{34}{170} \times 100$ efficiency = 20 %	B1	Possible ecf from **(i)**
			Total	**7**	

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Question			Answers	Marks	Guidance
7	(a)		force constant = $\frac{3.0}{0.06}$ (Any subject) force constant = 50 (N m^{-1})	M1 A0	**Not** 3.0/6.0 = 50 (N m^{-1}) **Note**: There is no mark for the answer because it is given on the paper; the mark is for the working.
	(b)	(i)	(E_i =) ½ × 50 × 0.06^2 or ½ × 3.0 × 0.06 or 0.09 (J) (E_f =) ½ × 50 × 0.10^2 or ½ × 5.0 × 0.10 or 0.25 (J) ΔE = 0.25 – 0.09 ΔE = 0.16 (J)	C1 C1 A1	**Special case** '½ × 50 × (0.10 - 0.06)^2 = 0.04 (J)' mark or '½ × 50 × (0.12 - 0.08)^2 = 0.04 (J)' scores 1
		(ii)	tension in spring = 50 × 0.10 or tension in spring = 5.0 (N) net force = 5.0 – 3.0 and mass of object = 3.0/9.81 *a* = 2.0/(0.3058..) *a* = 6.5 (m s^{-2})	C1 C1 A1	**Special case:** 5.0/(3.0/9.81) = 16.35 (m s^{-2}) scores 1 mark because of the first C1 mark **Note**: *a* = 16.35 – 9.81 = 6.5(4 m s^{-2}) scores full marks
			Total	**7**	

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RECOGNISING ACHIEVEMENT

Monday 20 May 2013 – Afternoon

AS GCE PHYSICS A

G481/01 Mechanics

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Duration: 1 hour

G481 7006 13

G 4 8 1 0 1

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.



Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means for example you should:
- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
- organise information clearly and coherently, using specialist vocabulary when appropriate.

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Answer **all** the questions.

1 **(a)** A student writes four incorrect statements shown in the table below. The error in each statement is circled. Write the correct answer for the circled unit or number; one has already been done for you.

Incorrect statement	Correct unit or number
The weight of a person is about 700 (**kg**).	N
The atmosphere exerts a pressure of about 1.0×10^5 (**$N\,m^2$**).	
A force of 1 N may be written as 1 kg (**$m^{-1}\,s^{-1}$**).	
1 GW is (**10**) times bigger than 1 MW.	

[2]

(b) Fig. 1.1 shows the apparatus used to determine the density of glass.

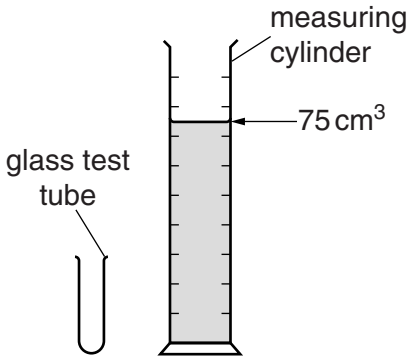


Fig. 1.1

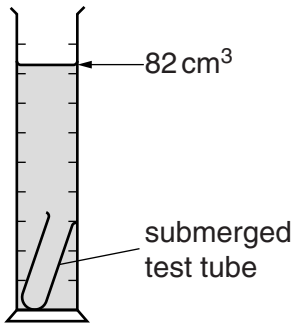


Fig. 1.2

The glass test tube has mass 1.6×10^{-2} kg. The measuring cylinder is partly filled with water. The test tube is gently pushed into the water until it is fully submerged as shown in Fig. 1.2. The level of the water inside the measuring cylinder increases from 75 cm^3 to 82 cm^3.

Calculate the density of the test tube glass in $kg\,m^{-3}$.

density = ... $kg\,m^{-3}$ **[2]**

[Total: 4]

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2 **(a)** Explain why force is a *vector* quantity.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(b) Fig. 2.1 shows the forces acting on a water drop on the windscreen of a stationary car.

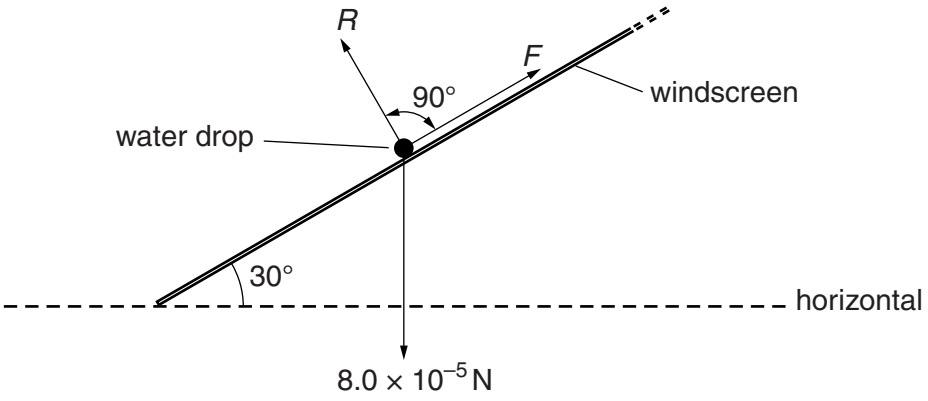


Fig. 2.1

The windscreen makes an angle of 30° to the horizontal. The weight of the water drop is 8.0×10^{-5} N. The normal contact force on the water drop is *R*. There is also a force *F* acting on the water drop as shown. The water drop is **stationary**.

(i) Use Fig. 2.1 to determine the component of the weight of the water drop

1 perpendicular to the windscreen

component = ... N

2 parallel to the windscreen.

component = ... N
[2]

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(ii) Determine the magnitude of *F*. Explain your answer.

.....

.....

.....

..... **[2]**

[Total: 5]

Question 3 begins on page 6

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3 **(a)** Define the *force constant* of a spring.

.....

..... **[1]**

(b) Fig. 3.1 shows a trolley attached by two **stretched** springs **A** and **B** to fixed supports.

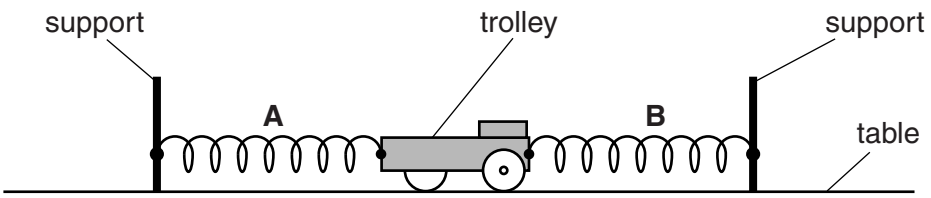


Fig. 3.1

The trolley is on a horizontal table and at rest. The springs **A** and **B** are identical.

(i) On Fig. 3.1, draw an arrow to show the direction of the force exerted by spring **A** on the trolley. Label this arrow **F**. **[1]**

(ii) The mass of the trolley is 0.80 kg. The force constant of each spring is 14 N m^{-1}. A student pulls the trolley to the left as shown in Fig. 3.2.

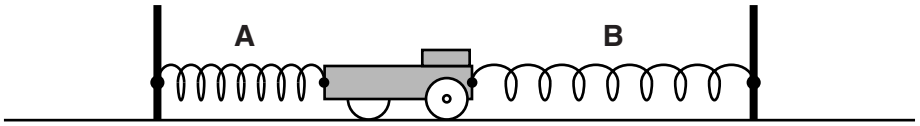


Fig. 3.2

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The extension of spring **A** is 0.30 m and the extension of spring **B** is 0.50 m. The student releases the trolley. Calculate the **initial** values of

1 the acceleration of the trolley

acceleration = ... $m\,s^{-2}$ **[3]**

2 the ratio

$$\frac{\text{elastic potential energy for spring } \mathbf{B}}{\text{elastic potential energy for spring } \mathbf{A}}.$$

ratio = ... **[2]**

(iii) Explain why the acceleration of the trolley decreases as it travels a small distance to the right.

.....

..... **[1]**

(iv) State and explain how the acceleration in your answer to **(ii)1** would be different when a heavy object is fixed to the trolley.

.....

.....

.....

..... **[2]**

[Total: 10]

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4 Fig. 4.1 shows a metal ball held stationary above a tube containing oil.

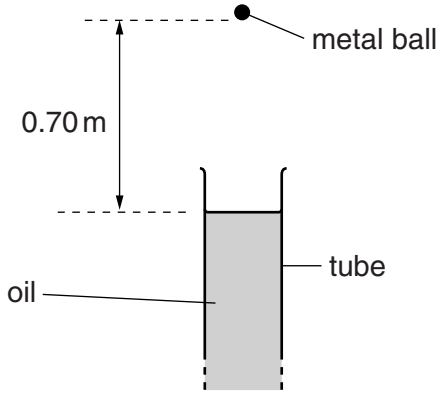


Fig. 4.1

(a) The ball is 0.70 m above the surface of the oil in the tube. Calculate the time taken for the ball to reach the surface of the oil when it is dropped from this height. Assume air resistance has negligible effect on the motion of the ball.

time = ... s **[3]**

(b) Fig. 4.2 shows the graph of velocity v against time t for the ball as it travels through the oil. The ball enters the oil at time $t = 0$.

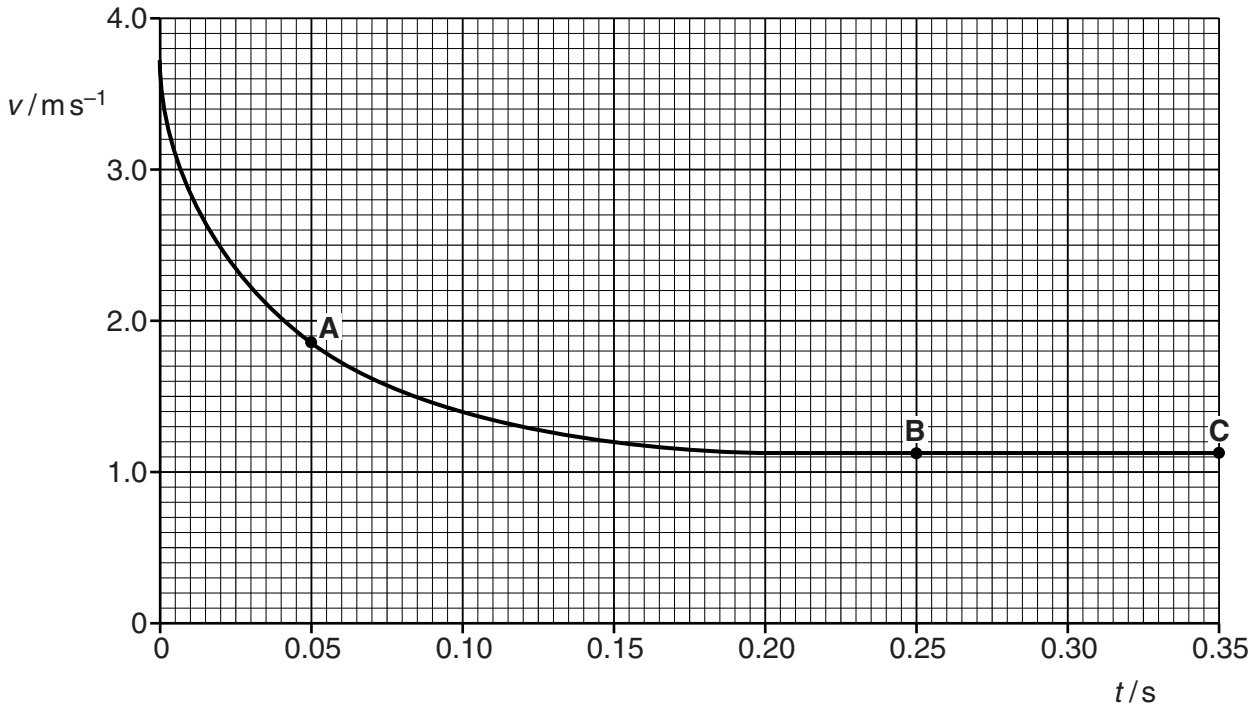


Fig. 4.2

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(i) Complete the sentence below.

The gradient of the graph is equal to the ..... of the ball and

the area under the graph is equal to the ..... . **[1]**

(ii) Use Fig. 4.2 to determine the magnitude of the deceleration of the ball at time $t = 0.05\,s$ (point **A**). Show your working.

deceleration = ... $m\,s^{-2}$ **[3]**

(iii) In terms of the **forces** acting on the ball, describe and explain its motion when

1 time $t = 0.05\,s$ (point **A**)

.....

.....

.....

.....

.....

2 time $t = 0.25\,s$ (point **B**).

.....

.....

.....

.....

.....

[4]

(iv) Describe the energy transfers taking place between $t = 0.25\,s$ and $t = 0.35\,s$ (point **B** to **C**).

.....

.....

..... **[1]**

[Total: 12]

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5 **(a)** State what is meant by the *centre of gravity* of an object.

.....

..... **[1]**

(b) Define *moment of a force*.

.....

..... **[1]**

(c) Fig. 5.1 shows a baby's mobile toy.

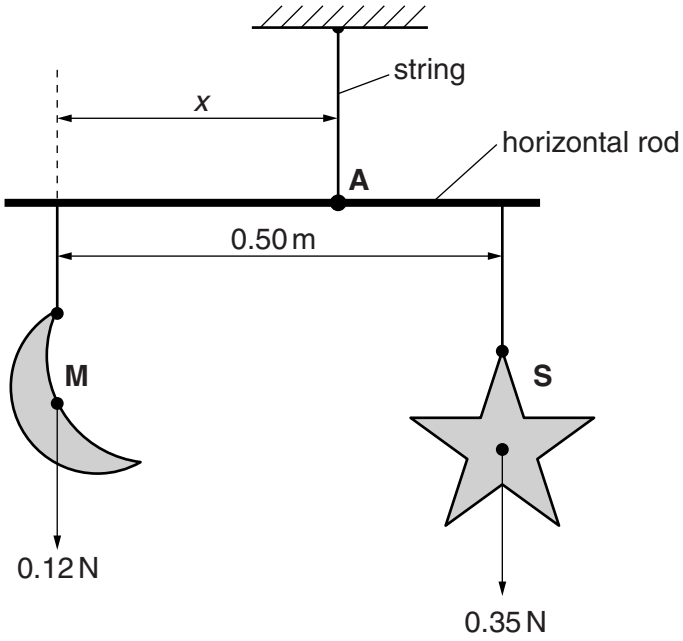


Fig. 5.1

The toy consists of a horizontal rod from which two objects shaped as a crescent moon **M** and a star **S** are suspended from lengths of string. The weight of the rod is negligible and it is pivoted about an axis passing through point **A** perpendicular to the plane of the diagram. The weights of **M** and **S** and the separation between the strings are shown in Fig. 5.1. The distance between the string on the left and point **A** is *x*. The arrangement shown in Fig. 5.1 is in equilibrium.

(i) State **two** conditions necessary for the rod to be in equilibrium.

.....

.....

..... **[2]**

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(ii) By taking moments about **A** determine the distance x.

$x =$ ..... m **[3]**

(iii) Determine the magnitude of the tension in the string attached to **A**.

tension = ... N **[1]**

[Total: 8]

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6 **(a)** Power can be measured in watts. Define the *watt*.

.....

..... **[1]**

(b) An electric motor-driven crane is used to raise a load of bricks of mass 700 kg through a vertical height of 8.5 m in a time of 45 s. The efficiency of the motor-driven crane is 30%. Calculate

(i) the gravitational potential energy E_p gained by the bricks

E_p = ... J **[1]**

(ii) the output power of the motor-driven crane

output power = ... W **[1]**

(iii) the input power to the motor-driven crane.

input power = ... W **[1]**

[Total: 4]

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7 **(a)** A car of mass m is at rest. A constant net force F acts on the car and it moves a distance x in the direction of the force. The final velocity of the car is v.

(i) Write down the equation

1 for the work done by the force F

2 relating force F and acceleration a.

[1]

(ii) Hence show that the kinetic energy of the car is given by the equation $E_k = \frac{1}{2}mv^2$.

[3]

(b) The braking distance of an empty van travelling at a steady speed on a level road is 50 m. The van is now fully loaded with goods and travels at the same speed on the same road.

Explain whether or not the braking distance would be the same. Assume that the driver applies the same braking force.

.....

.....

.....

.....

.....

.....

..... **[3]**

[Total: 7]

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8 **(a)** Fig. 8.1 shows the stress against strain graph obtained from a test on a sample of wire of a ductile material.

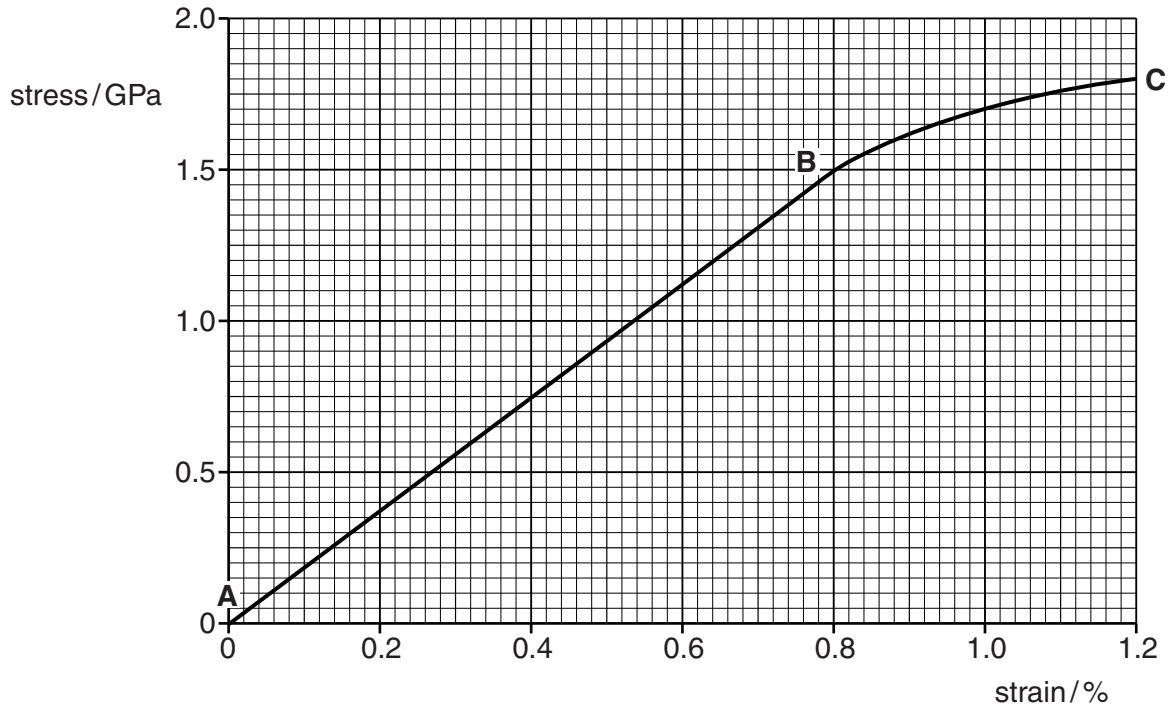


Fig. 8.1

(i) Use Fig. 8.1 to determine the Young modulus of the material.

Young modulus = ... Pa **[3]**

(ii) Use Fig. 8.1 to describe the behaviour of the material

1 in section **AB**

.....

..... **[1]**

2 in section **BC**.

.....

..... **[1]**

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(iii) State and explain the effect on the linear section **AB** of the graph when a sample of the same wire, but of twice the original length is used.

.....

.....

..... **[2]**

(b) Fig. 8.2 shows a force against extension graph for an elastic material. The work done on this material during loading (upward arrow) is equal to the energy returned by the material when the load is removed (downward arrow).

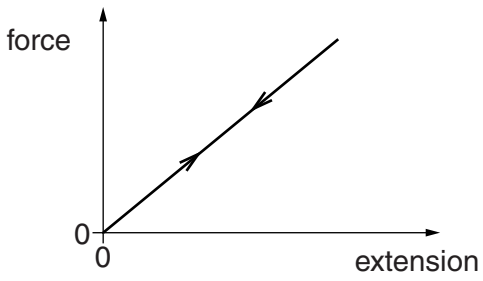


Fig. 8.2

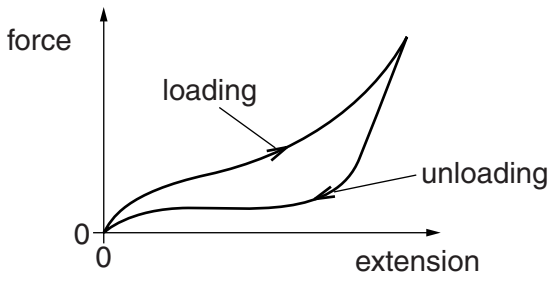


Fig. 8.3

Fig. 8.3 shows the force against extension graph for a material used to make aeroplane tyres. Aeroplane tyres experience sudden impact forces during landing.

Identify the type of material from Fig. 8.3. Describe the properties of this material and suggest why this material is suitable for aeroplane tyres.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

[Total: 10]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the lined page below. The question number(s) must be clearly shown in the margin.

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RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE

Unit **G481/01:** Mechanics

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

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1. **Annotations** available in Scoris

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect Response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct Response
	Arithmetic error
	Wrong physics or equation

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions)

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

2. The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:
One tick per mark. All questions must have appropriate annotation.

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CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures and rounding errors:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf. If an answer is given to fewer than 2 sf, then penalise once only in the entire paper. Any exception to this rule will be mentioned in the Guidance.

Penalise a rounding error once only in the entire paper.

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Question			Answer	Marks	Guidance
1	(a)		N m^{-2} or N/m^2 or Pa m s^{-2} or m/s^2 or (kg) m s^{-2} 1000	B2	**Allow** any prefix given **Allow**: 2 marks if all three correct; 1 mark if one is correct or two are correct
	(b)		(volume =) 82 - 75 (cm^3) or 7 (cm^3) density = $\frac{1.6\times10^{-2}}{7\times10^{-6}}$ density = 2.3 × 10^3 (kg m^{-3})	C1 A1	 **Allow**: 1 mark for 2.3 × 10^n, $n \neq 3$
			Total	**4**	

Question			Answer	Marks	Guidance
2	(a)		It has **direction** (and magnitude/size)	B1	**Note:** ✍ ***direction*** must be spelled correctly for the mark
	(b)	(i)	perpendicular component = 8.0 × 10^{-5} cos30 perpendicular component = 6.9 × 10^{-5} (N) parallel component = 8.0 × 10^{-5} sin30 parallel component = 4.0 × 10^{-5} (N) or 4 × 10^{-5} (N)	B1 B1	**Allow**: 1 mark if the correct numerical values of the components have been swapped **Note**: Penalise POT error once only; eg 6.9 and 4 respectively scores 1 mark **Note**: Calculator in radian mode gives 1.23 × 10^{-5} and (-) 7.90 × 10^{-5} (N); this scores 1 mark
		(ii)	(*F* =) 4.0 × 10^{-5} (N) The net force parallel to windscreen = 0 or *F* is equal to the parallel component (of the weight down the windscreen) or parallel forces must be equal and opposite or *F* = 8.0 × 10^{-5} sin30	B1 B1	Possible ecf from **(b)(i)** **Allow**: Total force down/up the windscreen/slope is zero **Not**: 'net force = 0' – this is an incomplete answer
			Total	**5**	

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Question			Answer	Marks	Guidance
3	(a)		force/extension or force per (unit) extension	B1	**Allow**: force/compression **Not**: $F = kx$ and the labels are defined, because k is not the subject
	(b)	(i)	Arrow showing the force exerted by **A** is to the <u>left</u> on Fig.3.1	B1	**Allow** an unlabelled arrow
		(ii)	**1** (F_A =) 14 × 0.30 (= 4.2 N) or (F_B =) 14 × 0.50 (= 7.0 N) or (net force =) 2.8 (N) a = 2.8/0.80 acceleration = 3.5 (m s^{-2})	C1 C1 A1	**Allow**: (net force =) 14 × [0.50 – 0.30] = 2.8 (N) **Allow**: acceleration of either 5.25 (m s^{-2}) or 8.75 (m s^{-2}) **Allow** this C1 mark for a = 8.75 – 5.25 **Note**: $a = \frac{7.0 + 4.2}{0.80} = 14$ (m s^{-2}) scores 1 mark **Note**: $a = \frac{14 \times 0.80}{0.80} = 14$ (m s^{-2}) scores zero
			2 $E = ½ Fx$ or $E = ½ kx^2$ or 1.75 (J) or 0.63 (J) ratio = $\left(\frac{0.50}{0.30}\right)^2 = 2.8$	C1 A1	**Note**: Using $E = Fx$ scores zero because of wrong physics **Note**: Answer to 3 sf is 2.78 **Allow** fractions (Ignore any units given for the ratio)
		(iii)	The <u>resultant</u> force (on the trolley) is smaller (AW)	B1	
		(iv)	The acceleration decreases Correct reasoning, eg: For the same (net force) F, a = F/m (therefore a is smaller) For the same (net force) F, $a \propto 1/m$ (therefore a is smaller)	M1 A1	**Allow**: $F = ma$. As m increases then a must decrease because F is constant
			Total	**10**	

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Question			Answer	Marks	Guidance
4	(a)		$(s = \frac{1}{2}at^2)$; 0.700 = ½ × 9.81 × t^2 $t^2 = \frac{2 \times 0.700}{9.81} (= 0.1427)$ t = 0.378 (s) or 0.38 (s)	C1 C1 A1	**Allow**: a = 9.8 (m s^{-2}) **Note**: Using a = 10 (m s^{-2}) gives 0.374 (s) or 0.37 (s); this scores 2 marks **Allow** full credit for correct use of $v^2 = 2as$ and $v = at$
	(b)	(i)	acceleration or deceleration displacement or distance	B1	
		(ii)	A tangent drawn on Fig. 4.2 at point **A** Determine the gradient of the tangent Deceleration value in the range 13.0 to 17.0 (m s^{-2})	B1 M1 A1	**Note**: This is an independent mark **Note**: Ignore sign **Special case**: Allow 1 mark for using a chord about t = 0.05 seconds to determine the deceleration and the value lies in the range 13.0 to 17.0 (m s^{-2})
		(iii)	At **A:** Drag > weight The ball is decelerating/'slowing down' At **B**: Drag = weight The ball has zero acceleration/has reached terminal velocity/has reached constant velocity	 B1 B1 B1 B1	 **Allow**: 'friction'/'resistive force' for drag **Allow**: upward/negative acceleration **Note:** Allow full credit if *upthrust* and *drag* are both mentioned and applied correctly at points **A** and/or **B**
		(iv)	The (gravitational) potential energy/(G)PE (of the ball) is converted into heat/thermal (energy)	B1	
			Total	**12**	

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Question			Answer	Marks	Guidance
5	(a)		A point where the (entire) weight of the object (appears to) act	B1	**Not**: 'where the weight of an object acts'
	(b)		moment of force = force × perpendicular distance (of line of force) from point/axis/pivot/fulcrum	B1	
	(c)	(i)	net force = 0 net moment = 0 or net torque = 0	B1 B1	**Allow**: (For this rod) upward force = (sum of the) forces down **Allow**: (For this rod sum of) clockwise moment(s) = (sum of) anticlockwise moment(s)
		(ii)	Evidence of $0.12x$ or $0.35(0.50 - x)$ $0.12x = 0.35(0.50 - x)$ $x = \frac{0.35 \times 0.50}{0.12 + 0.35}$ $x = 0.37$ (m)	C1 C1 A1	
		(iii)	force = 0.47 (N)	B1	
			Total	**8**	

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Question			Answer	Marks	Guidance
6	(a)		(1 watt is equal to) 1 joule (of energy transferred) per second	B1	**Allow**: (1) J s^{-1} **Not**: '1 J (of energy transferred) in 1 s' because the per or rate idea is not clear **Note**: Do not allow mixture of quantity and unit. Eg: '1 J per unit time' or 'energy per second'
	(b)	(i)	$E_p = 700 \times 9.81 \times 8.5$ $E_p = 5.8(4) \times 10^4$ (J)	B1	
		(ii)	output power = $\frac{5.84 \times 10^4}{45}$ output power = 1.3×10^3 (W)	B1	Possible ecf from **(i)**
		(iii)	input power = $1.3 \times 10^3 / 0.3$ input power = 4.3×10^3 (W)	B1	Possible ecf from **(ii)**
			Total	**4**	

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Question			Answer	Marks	Guidance
7	(a)	(i)	(work done =) Fx and $F = ma$ (Allow any subject)	B1	**Allow**: d or s instead of x
		(ii)	(E_k =) max or (work done =) max (Allow any subject)	B1	**Note**: This mark is for substituting 'ma' into the equation 'Fx'
			$v^2 = 2ax$	B1	
			Use of $v^2 = 2ax$ and $E_k = max$ to show KE = ½ mv^2	B1	**Note**: This B1 mark is for manipulation of equations leading to KE = ½ mv^2 **Allow** full credit for alternative approaches
	(b)		The (braking) distance is more (than 50m)	B1	
			KE = Fx	B1	Alternative: Fx = ½ mv^2 B1
			Correct reasoning for longer braking distance, eg: (KE increases and) $x \propto$ KE	B1	*Correct reasoning for longer braking distance, eg:* $x \propto m$ B1
			Or		
			The (braking) distance is more (than 50m)	B1	
			The van has smaller deceleration (for the same force)	B1	**Allow**: smaller acceleration
			Correct reasoning for longer braking distance in terms of $v^2 = u^2 + 2as$	B1	**Allow**: Correct reasoning for longer distance in terms of equations of motion
			Total	**7**	

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Question			Answer	Marks	Guidance
8	(a)	(i)	Young modulus = gradient (in the linear region) $E = 1.5 \times 10^9/0.008$ $E = 1.9 \times 10^{11}$ (Pa)	C1 C1 A1	**Allow**: (E =) stress/strain for this C1 mark **Note**: Deduct 1 mark for incorrect value or omission of the prefix G. Also deduct another mark for incorrect conversion of 0.80% strain.
		(ii)	**1** Obeys Hooke's law/elastic (behaviour) (AW)	B1	**Allow**: stress $\propto$ strain
		(ii)	**2** Plastic (deformation) (AW)	B1	
		(iii)	No change (to the linear section)/gradient is the same because the Young modulus is the same (and independent of length)	M1 A1	
	(b)		Polymer or polymeric or rubber Any <u>one</u> from: • The material is elastic/there is no strain when the stress is removed/material returns to its original size or shape when forces are removed (AW) • The work done on the material > energy returned back by the material or area under loading graph > area under unloading graph (AW) The aeroplane/tyres do not bounce (too much on landing)	B1 B1 B1	✎ ***polymer/polymeric/rubber*** must be spelled correctly to gain the first B1 mark **Not**: 'Monomer' **Allow**: material/graph shows 'hysteresis' **Allow**: Material 'absorbs' energy/material gets hot (AW)
			Total	**10**	

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Appendix – Additional Guidance

Question	Additional Guidance
1b	**Allow:** 1 mark for 2.3 g/cm^3 **Note**: The **volume** mark is for seeing '7' – ignore any POT (Do not allow 7^3)
2a	If only F=ma is used they need to state acceleration has direction **and** mass is a scalar/has no direction
2bii	**Allow**: $F = W\sin30$ or $F = mg\sin30$ for the last option No credit for 'forces are balanced' or 'forces are in equilibrium'
3bi	Ignore any arrows on Fig 3.2 If the arrow to the left on Fig 3.1 starts from the support/is to the left of the support this scores 0.
3bii1	**Allow** (net force =) $14 \times 0.2 = 2.8$ (N) for the first C1 mark
3biii	**Note** ' force on B decreases and force on A increases' is **not** sufficient to gain a mark **Allow**: net/total/sum of/overall/Σ
4a	The first C1 mark is for substitution, the second C1 mark is for rearrangement **Alternative**: $v^2 = 2as$ $v^2 = 2 \times 9.81 \times 0.70$ or $v = 3.7(06$ m s^{-1}) C1 $t = 3.706/9.81$ C1 time = 0.378 (s) or 0.38 (s) A1
4bii	A mark is lost for a graph mis-read, so please check the co-ordinates (± 1 small square). This may lead to an ECF falling outside the range but do not penalise twice. A mark will also be lost for any AE in the calculation.
4biii	**Note**: Do not allow 'gravity' for weight. 'Force of gravity' is OK In 4biii2, allow constant speed for constant velocity
4biv	**Do not allow:** potential energy **to kinetic energy** to heat **Allow**: potential energy to kinetic energy **of oil**
5a	**Do not allow:** place, position, where, location
5ci	**Do not allow:** ΣF = 0 and ΣM = 0 **Allow**: ΣForces = 0 and ΣMoments = 0
6a	**Allow**: base units, kgm^{2}s^{-3} or other alternatives.
7aii	**Allow**: W for KE in the final stage of the derivation
7b	For the second answer route and the third B1 mark: **Allow**: correct reasoning for longer distance in terms of equations of motion: $a = \Delta v/\Delta t$ to explain more t and $s = ½(u + v)t$ to explain more s. **Allow**: explanation in terms of momentum including the equation. **IF THE CANDIDATE ANSWERS VIA BOTH ROUTES THEN AWARD THE HIGHER MARK.**
8aii1	**Allow**: force ∝ extension, elastic in words i.e. returns to original length when **unloaded**.
8aii2	**Allow:** inelastic, plastic in words i.e. does not return to original length when **unloaded** **Allow**: permanently deformed
8aiii	For the A1 mark allow the 'ratio of stress to strain is the same'
8b	**Allow**: Elastomer for the first B1 mark if spelled correctly. Watch for CONs, e.g 'the material is elastic and ductile' cannot score the second B1 mark. **QWC** - Allow the mark if one spelling word is incorrectly spelled and another is correctly spelled.

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RECOGNISING ACHIEVEMENT

Friday 11 January 2013 – Afternoon

AS GCE PHYSICS A

G481/01 Mechanics

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Duration: 1 hour

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

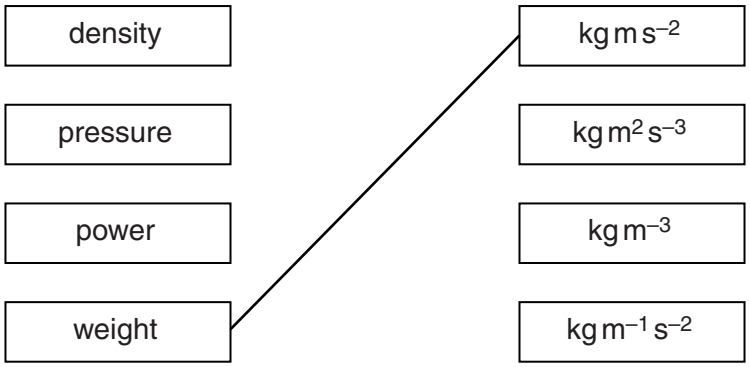
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Draw a line from each quantity on the left-hand side to the correct unit on the right-hand side. One quantity (weight) has already been matched to its unit.



[2]

[Total: 2]

2 **(a)** Speed is a scalar quantity and velocity is a vector quantity. State one difference and one similarity between speed and velocity.

difference: .....

.....

similarity: .....

..... **[2]**

(b) Fig. 2.1 shows a toy locomotive on a circular track.

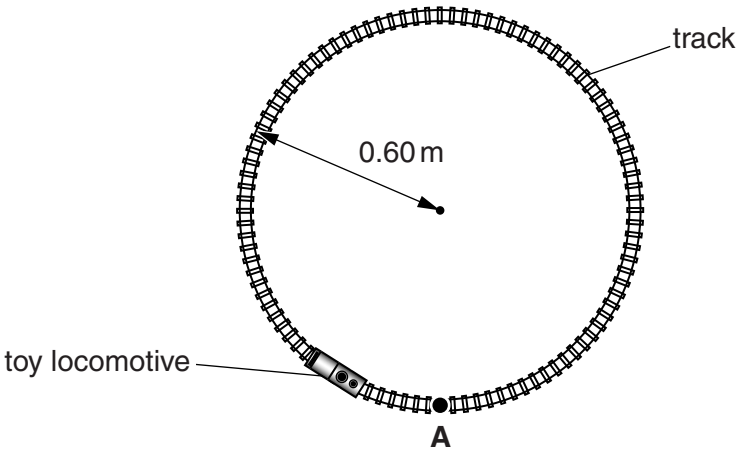


Fig. 2.1

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The locomotive travels at constant speed round the track in a clockwise direction. It takes 12 s to travel completely round the track. At time $t = 0$, the locomotive is at point **A**.

(i) Calculate the speed of the locomotive.

speed = ... $m\,s^{-1}$ **[2]**

(ii) Calculate the magnitude of the displacement s of the locomotive from point **A** after it has travelled one quarter of the way round the track.

s = ... m **[2]**

(iii) Explain why the average velocity of the locomotive is zero after a time of 12 s.

.....

..... **[1]**

(iv) Explain why the velocity of the locomotive changes even though its speed is constant.

.....

..... **[1]**

[Total: 8]

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3 A car of mass 1200 kg is travelling at 18 m s^{-1} along a horizontal road. A constant braking force of 3600 N brings it to rest.

(a) Calculate the magnitude of the deceleration of the car.

deceleration = ... m s^{-2} **[1]**

(b) Calculate the distance travelled by the car during the deceleration.

distance = ... m **[3]**

(c) The same car travels **down** a slope at the same speed of 18 m s^{-1}, see Fig. 3.1.

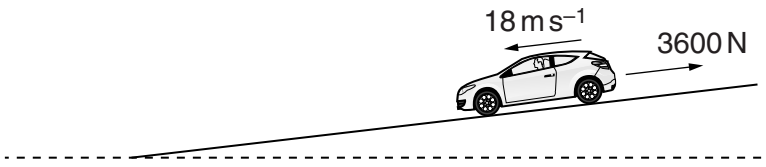


Fig. 3.1

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The car is brought to rest by applying the brakes. The same resistive force of 3600 N acts on the car. Explain whether the distance travelled by the car before it stops is greater than, smaller than or the same as your answer to **(b)**.

.....

.....

.....

.....

.....

.....

..... **[3]**

(d) Many cars are fitted with Global Positioning System (GPS) devices.

Describe how geostationary satellites are used to track the location of cars on the Earth's surface.



In your answer, you should use appropriate technical terms, spelled correctly.

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..... **[4]**

[Total: 11]

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4 **(a)** Define *acceleration*.

.....

..... **[1]**

(b) State the **two** factors that affect the acceleration of an object.

.....

..... **[1]**

(c) Fig. 4.1 shows the variation of velocity v with time t for a small rocket.

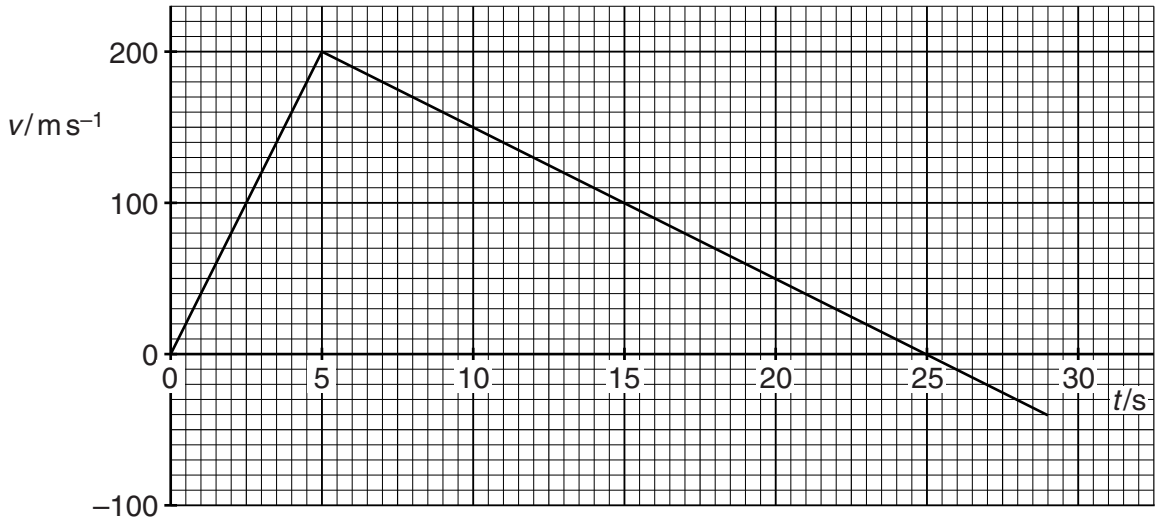


Fig. 4.1

The rocket is initially at rest and is fired vertically upwards from the ground. All the rocket fuel is burnt after a time of 5.0 s when the rocket has a vertical velocity of 200 m s^{-1}. Assume that air resistance has a negligible effect on the motion of the rocket.

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(i) Without doing any calculations, describe the motion of the rocket

1 from $t = 0$ to $t = 5.0\,s$

.....

.....

2 from $t = 5.0\,s$ to $t = 25\,s$.

.....

.....

..... **[3]**

(ii) Calculate the maximum height reached by the rocket.

height = ... m **[3]**

(iii) Explain why the rocket has a speed greater than $200\,m\,s^{-1}$ as it hits the ground.

.....

.....

.....

..... **[1]**

[Total: 9]

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5 **(a)** State how the magnitude of the drag force on an object is affected by its speed.

.....

..... **[1]**

(b) Describe the experiments Galileo carried out which overturned Aristotle's ideas of motion.

.....

.....

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.....

.....

..... **[3]**

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(c) A skydiver is falling towards the ground at a terminal velocity of $50\,m\,s^{-1}$.

(i) State the **two** main forces acting on the skydiver and how they are related at terminal velocity.

.....

..... **[1]**

(ii) The skydiver opens her parachute. After some time, the skydiver reaches a lower terminal velocity of $4.0\,m\,s^{-1}$. Describe and explain how the magnitude of the deceleration of the skydiver changes as her velocity reduces from $50\,m\,s^{-1}$ to $4.0\,m\,s^{-1}$.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

[Total: 9]

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6 **(a)** Define *work done* by a force.

.....

..... **[1]**

(b) Fig. 6.1 shows a water slide.

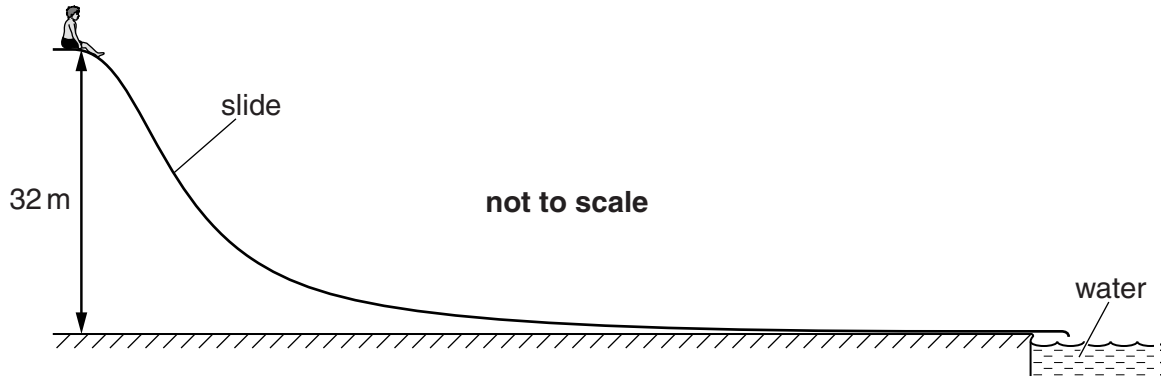


Fig. 6.1

The top of the slide is 32 m above the bottom of the slide. The total distance along the slide is 120 m. A person of weight 700 N, initially at rest at the top, slides down. His speed at the end of the slide is 15 m s^{-1}.

(i) Calculate his kinetic energy at the end of the slide.

kinetic energy = ... J **[2]**

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(ii) Calculate the average resistive force acting on him as he travels down to the end of the slide.

average resistive force = ... N **[3]**

[Total: 6]

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7 **(a)** Fig. 7.1 shows several forces acting on an object that is free to move.

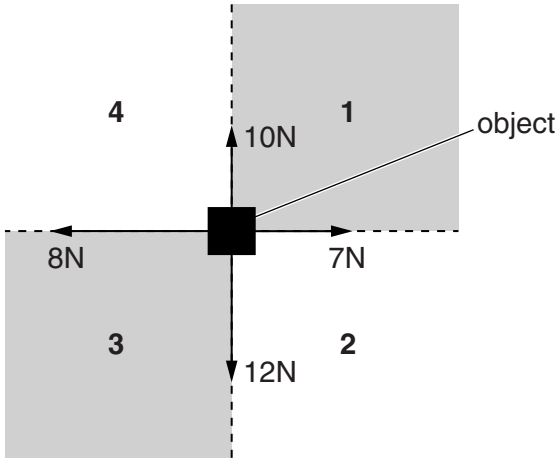


Fig. 7.1

Using simple calculations, deduce whether the object will move into region **1**, **2**, **3** or **4**. Briefly explain your reasoning.

.....

.....

..... **[2]**

(b) State the *principle of moments*.

.....

.....

..... **[1]**

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(c) Fig. 7.2 shows the forces acting on a suitcase with wheels as it is held stationary.

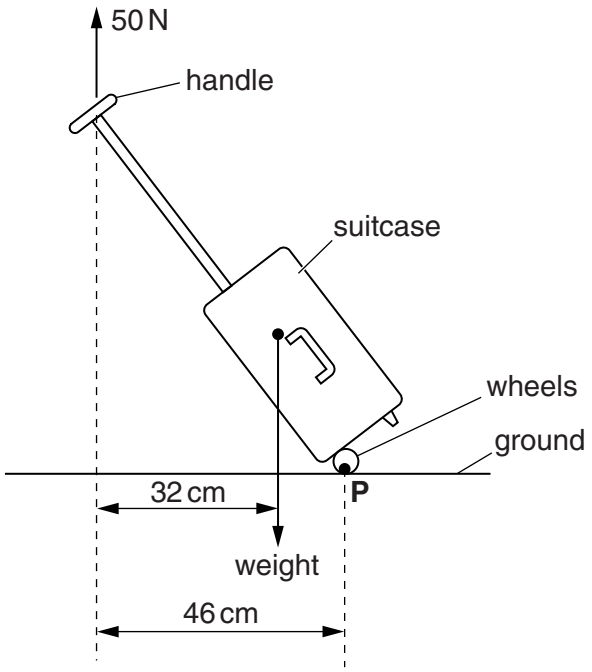


Fig. 7.2

A vertical force of 50 N is applied to the top of the handle in order to keep the suitcase stationary in the position shown in Fig. 7.2. The line of action of this force acts at a perpendicular distance of 46 cm from **P**, the point of contact with the ground. The line of action of the weight of the suitcase acts at a perpendicular distance of 32 cm from the top of the handle.

By taking moments about **P**, calculate the mass *m* of the suitcase.

m = ... kg **[3]**

[Total: 6]

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8 A sample of wire is tested in the laboratory. Fig. 8.1 shows the force, F against extension, x graph for this wire.

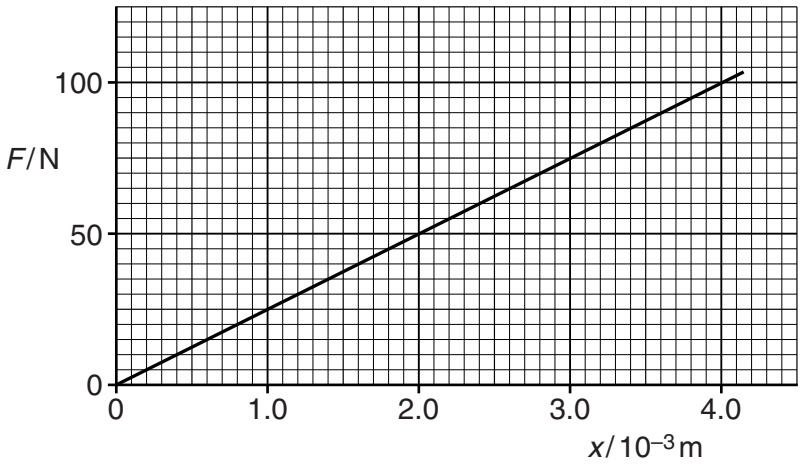


Fig. 8.1

(a) Explain how the graph shows that the wire obeys Hooke's law.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(b) State what the gradient of the graph represents.

..... **[1]**

(c) The initial length of the wire is 1.60 m. The radius of the wire is 2.8×10^{-4} m. Use the graph and this information to determine the Young modulus of the material of the wire.

Young modulus = ... Pa **[3]**

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(d) The test is repeated for another wire made from the same material, having the same length but **half** the diameter. Explain how the force against extension graph for this wire will differ from the graph of Fig. 8.1.

.....

.....

.....

.....

..... **[2]**

(e) It is very dangerous if the wire under stress suddenly breaks. The elastic potential energy of the strained wire is converted into kinetic energy. Show that the 'whiplash' speed v of the wire is directly proportional to the extension x of the wire.

.....

.....

..... **[2]**

[Total: 9]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page. The question number(s) must be clearly shown in the margin.

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GCE

Physics A

Advanced Subsidiary GCE

Unit **G481/01:** Mechanics

Mark Scheme for January 2013

Oxford Cambridge and RSA Examinations

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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Annotations

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation

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Abbreviations used in detailed mark scheme

Abbreviation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text.

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Note about significant figures and rounding errors:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf. If an answer is given to fewer than 2 sf, then penalise once only in the entire paper. Any exception to this rule will be mentioned in the Guidance.

Penalise a rounding error once only in the entire paper.

Question			Answer	Marks	Guidance
1			Lines joining density to 'kg m^{-3}' pressure to 'kg m^{-1} s^{-2}' power to 'kg m^{2} s^{-3}'	B1×2	**Note**: All correct – 2 marks, deduct 1 mark for each error or omission. (Minimum score = 0)
			Total	**2**	

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Question			Answer	Marks	Guidance
2	(a)		Difference: Velocity / vector has direction (and speed does not) or speed / scalar does not have direction (velocity has) Similarity: Both have the same unit / both have m s^{-1} (as the unit) / both have magnitudes	B1 B1	**Not** 'velocity is a vector / speed is a scalar' since it is stated in the question
	(b)	(i)	distance = $2 \times \pi \times 0.60$ (= 3.77 m) / speed = $\frac{3.77}{12}$ speed = 0.31 (m s^{-1})	C1 A1	**Note**: Answer to 3 sf is 0.314 (m s^{-1})
		(ii)	$s^2 = 0.60^2 + 0.60^2$ s = 0.85 (m)	C1 A1	**Note**: Answer to 3 sf is 0.849 (m) **Note**: 0.72 scores 1 mark (square root omitted)
		(iii)	The (change in) displacement is zero	B1	
		(iv)	The direction changes (even though the magnitude is the same)	B1	
			Total	**8**	

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Question			Answer	Marks	Guidance
3	(a)		a = 3600/1200 a = 3.0 (m s^{-2})	B1	**Allow** 1 sf answer (Ignore sign)
	(b)		$v^2 = u^2 + 2as$ $0 = 18^2 + (2 \times -3.0 \times s)$ / $s = \frac{18^2}{6.0}$ s = 54 (m)	C1 C1 A1	Possible ecf **Allow** '$v^2 = 2as$, $18^2 = 2 \times 3.0 \times s$' **Allow** other approaches, examples: t = 6 (s) C1 $s = (18 \times 6.0) + ½ \times (-3.0) \times 6.0^2$ C1 s = 54 (m) A1 Or $½ mv^2 = Fs$ C1 $½ \times 1200 \times 18^2 = 3600 \times s$ C1 s = 54 (m) A1
	(c)		(The distance is) greater There is a <u>component</u> of the weight of the car acting down the slope / <u>component</u> of weight against the resistive force / reference to $W \sin\theta$ (AW) <u>Net</u> force is less / reference to 3600 – $W \sin\theta$ / (magnitude of) deceleration is smaller	B1 B1 B1	**Allow** the following for the last two B1 marks: • The same force has to do more work • Work done is the sum of initial kinetic energy and change in GPE (due to vertical downward movement)
	(d)		Reference to radio waves or microwaves (transmitted from satellites) There is a 'delay time' of signal from satellite to GPS device / car Distance (between satellite and GPS device / car) calculated using 'delay time $\times$ c' **Trilateration** / intersecting **shells** / **circles** / **spheres** (used to locate position of car)	B1 B1 B1 B1	**Use ticks on Scoris to show where the marks are awarded** **Allow**: 'delay time' of signal between satellite and GPS device / car (**Not** from GPS device / car to satellite) ***Trilateration*** / ***shell(s)*** / ***circle(s)*** / ***sphere(s)*** must be spelled correctly to gain the mark. **Note**: Allow full range of marks for other sensible alternative approaches
			Total	**11**	

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Question			Answer	Marks	Guidance
4	(a)		acceleration = rate of <u>change of velocity</u> (or acceleration = <u>change in velocity</u> / time)	B1	**Allow** '$a = (v - u)/t$' *or* $\Delta v/t$ if v, u and t or Δv and t are defined
	(b)		Mass and (net) force	B1	
	(c)	(i)	**1** acceleration **2** deceleration / negative acceleration Detail mark: Constant used in either 1 or 2 or reaches maximum height at 25 (s) or stops at 25 (s)	B1 B1 B1	**Allow**: velocity / speed increases **Allow**: velocity / speed decreases **Allow**: 'uniform / same' for 'constant'
		(ii)	height = area under graph from 0 to 25 (s) height = ½ × 25 × 200 height = 2500 (m)	C1 C1 A1	**Allow** 1 mark for either 500 (m) or 2000 (m)
		(iii)	A sensible suggestion, for example: • $v^2 = 2 \times g \times 2500$, $v = 220$ (m s^{-1}) – allow $g = 10$ (m s^{-2}) • For 200 (m s^{-1}) at ground, the (maximum) height would only be 2040 (m) (with $g = 9.81$ m s^{-2}) or 2000 (m) (with $g = 10$ m s^{-2}) • (Burning) rocket fuel does work on the rocket (AW)	B1	
			Total	**9**	

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Question			Answer	Marks	Guidance
5	(a)		Drag increases with speed (ORA) / drag $\propto$ speed^2	B1	
	(b)		Galileo dropped different mass balls / rolled different mass balls (down a ramp) Balls hit the ground / reached the bottom (of ramp) at the same time (Galileo -) All objects fall with the same acceleration and (Aristotle -) Heavy / massive objects fall faster / quicker (than light objects)	B1 B1 B1	**Allow** object / trolley instead of ball
	(c)	(i)	(The two forces are weight and drag) weight = drag	B1	**Not** 'gravity' for weight **Allow**: weight = drag + upthrust
		(ii)	When the parachute is opened, drag increases / drag is greater than the weight Drag decreases as the speed decreases / net force decreases The (magnitude of the) deceleration decreases (between 50 m s^{-1} and 4 m s^{-1}) (At 4 m s^{-1}) deceleration or acceleration = 0	B1 B1 B1 B1	
			Total	**9**	

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Question			Answer	Marks	Guidance
6	(a)		work done = force × distance <u>moved</u> in the direction of force	B1	**Allow**: work done = force × displacement in direction of force
	(b)	(i)	mass = 700/9.81 or mass = 71.4 (kg) kinetic energy = ½ × 71.4 × 15^2 kinetic energy = 8.0 × 10^3 (J)	C1 A1	 **Note**: Answer to 3 sf is 8.03 × 10^3 (J) **Note**: '½ × 700 × 15^2 = 7.9 × 10^4' scores zero **Allow**: 1 sf answer
		(ii)	GPE = *mgh* 700 × 32 / 2.24 × 10^4 (J) work done = 2.24 × 10^4 – 8.03 × 10^3 resistive force = $\frac{1.44 \times 10^4}{120}$ resistive force = 120 (N)	 C1 C1 A1	 Possible ecf **Note**: Dividing the work done by 32 (m) gives 450 (N). This answer scores 2 marks.
			Total	**6**	

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Question			Answer	Marks	Guidance
7	(a)		Object moves into region 3 (net) force to left / 1 (N) to the left / 8 (N) > 7 (N) and (net) force down / 2 (N) down / 12 (N) > 10 (N)	M1 A1	 **Allow** use of labelled arrows, e.g ↓ 2 (N)
	(b)		(When an object is in equilibrium the) sum of clockwise moments (about a point) = sum of anticlockwise moments (about the same point)	B1	**Allow**: summation sign Σ
	(c)		50 × 46 = weight × 14 weight = 164 (N) mass = 164/9.81 mass = 16.7 (kg) or 17 (kg)	C1 C1 A1	 Possible ecf for weight calculated. **Note**: Using '50 × 46 = weight × 32' gives an incorrect weight of 71.9 (N). However, 1 mark can be scored through ecf for a mass of 7.3 (kg) **Allow**: 3 marks for 'weight = 160 N, mass = 16.3 kg or 16 kg'
			Total	**6**	

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Question			Answer	Marks	Guidance
8	(a)		The graph is a straight line through the origin / *F* proportional to *x* / force is proportional to extension	B1	**Use ticks on Scoris to show where the marks are awarded** ✎ ***origin / proportional*** must be spelled correctly to gain the mark **Not**: $F \propto x$
	(b)		force constant	B1	**Allow**: spring constant
	(c)		stress = $\frac{100}{\pi \times (2.8\times10^{-4})^2}$ (= 4.06×10^8 Pa) strain = $\frac{4.0\times10^{-3}}{1.60}$ (= 2.5×10^{-3}) $E = \frac{4.06\times10^{8}}{2.5\times10^{-3}}$ Young modulus = 1.6×10^{11} (Pa)	C1 C1 A1	**Allow** use of any other point on the graph. **Alternative method:** $E = \frac{FL}{Ax}$ C1 (Any subject) $E = \frac{100\times1.60}{\pi\times(2.8\times10^{-4})^2\times4.0\times10^{-3}}$ C1 $E = 1.6 \times 10^{11}$ (Pa) A1 **Allow** 2 marks for 1.6×10^n, $n \neq 11$ (POT error)
	(d)		(Straight line) with quarter gradient Correct reasoning, for example: • gradient = *EA*/*L* and *A* decreases by a factor of 4 • *A* decreases by a factor of 4 and the same force gives 4 times the extension	B1 B1	**Note**: No need to define the labels
	(e)		½ kx^2 = ½ mv^2 Manipulation leading to $v \propto x$, for example: • taking square root of both sides (gives $v \propto x$) • $v^2 \propto x^2$ (hence $v \propto x$) • $v = (\sqrt{k/m})x$ (and therefore $v \propto x$)	M1 A1	**Note**: No need to define the labels
			Total	**9**	

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Thursday 17 May 2012 – Morning

AS GCE PHYSICS A

G481 Mechanics

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Ruler (cm/mm)
- Protractor

Duration: 1 hour

G411700612

G 4 8 1

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 **(a)** State **one** difference between a scalar quantity and a vector quantity.

.....

..... **[1]**

(b) Fig. 1.1 shows two sets of quantities listed as 'scalars' and 'vectors' by a student.

scalars	vectors
acceleration	displacement
pressure	energy
stress	power
time	velocity
volume	weight

Fig. 1.1

(i) State the one quantity that has been incorrectly listed as a scalar.

..... **[1]**

(ii) State two quantities that have been incorrectly listed as vectors.

1. .....

2. ..... **[1]**

(iii) State two quantities listed as scalars that have the same unit. Name this unit.

1. .....

2. .....

unit: ..... **[2]**

(c) Circle the correct value for the prefix tera (T) in the list below.

10^6 10^9 10^{12} 10^{15} **[1]**

(d) Rearrange the following prefixes in the order of smallest to largest.

μ c p k

..... **[1]**

[Total: 7]

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2 Fig. 2.1 shows the path of a metal ball fired at a velocity of $24\,m\,s^{-1}$ at an angle of 30° to the horizontal.

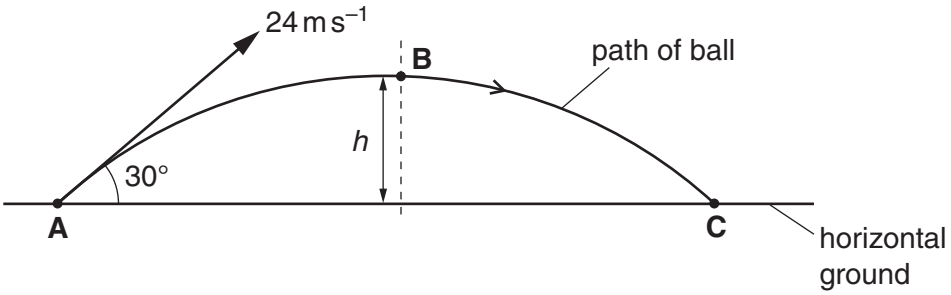


Fig. 2.1

Air resistance has negligible effect on the motion of the metal ball. The ball is fired from point **A** and it reaches its maximum height at point **B**. The mass of the ball is 450 g.

(a) State the direction of the acceleration of the ball during its flight.

..... **[1]**

(b) Calculate the horizontal and vertical components of the velocity of the ball at **A**.

horizontal velocity = ... $m\,s^{-1}$

vertical velocity = ... $m\,s^{-1}$ **[2]**

(c) Explain why the gravitational potential energy gained by the ball as it moves from **A** to **B** is not equal to its initial kinetic energy at **A**.

.....

.....

..... **[1]**

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(d) Calculate the maximum vertical height h of the ball.

h = ... m **[3]**

[Total: 7]

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3 **(a)** Define *velocity*.

.....

..... **[1]**

(b) Define *work done* by a force.

.....

..... **[2]**

(c) Fig. 3.1 shows a rider on a sledge sliding down an icy slope.

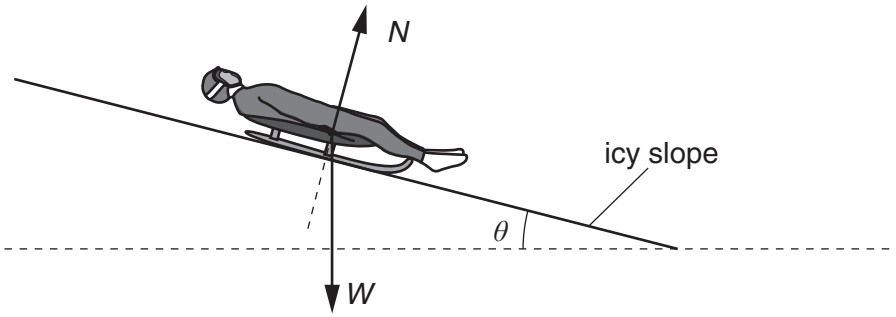


Fig. 3.1

The frictional forces acting on the sledge and the rider are negligible. The normal contact force *N* and the total weight *W* of the sledge and rider are shown.

(i) Explain why the force *N* does no work on the sledge as it slides down the slope.

.....

..... **[1]**

(ii) State and explain the force that causes the sledge and rider to accelerate down the slope.

.....

..... **[1]**

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(d) Fig. 3.2 shows the velocity against time graph for the sledge and rider in **(c)** sliding down the icy slope.

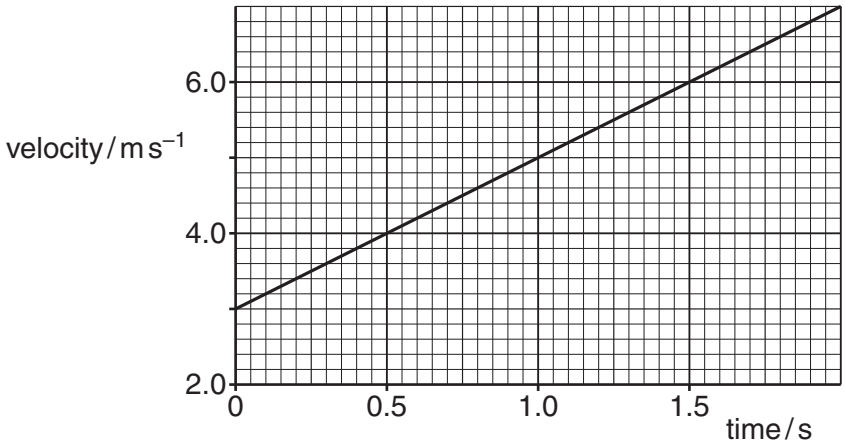


Fig. 3.2

(i) Use Fig. 3.2 to determine

1 the acceleration of the sledge and rider down the slope

acceleration = ... m s^{-2} **[2]**

2 the angle made by the slope to the horizontal.

angle = ...° **[2]**

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(ii) The sledge crashes into a foam barrier at the bottom of the slope.

The velocity of the sledge just before the impact is $15\,m\,s^{-1}$. The sledge and rider take 3.5 s to stop. The average decelerating force on the sledge and rider is 510 N.

Calculate the total mass of the sledge and rider.

mass = ... kg **[3]**

[Total: 12]

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4 **(a)** Define the following terms:

(i) *couple*

.....

..... **[1]**

(ii) *torque of a couple*.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(b) Fig. 4.1 shows a satellite in space moving from left to right.

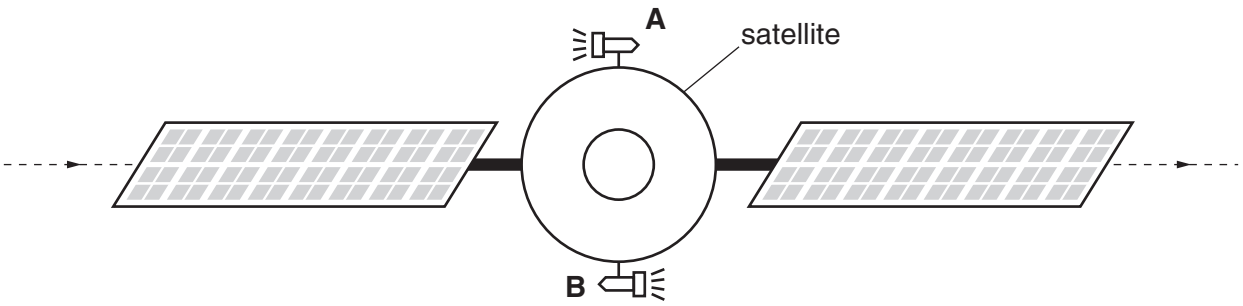


Fig. 4.1

The satellite has two small rockets **A** and **B** mounted at opposite ends of a diameter. When fired, each rocket motor provides the **same** constant force, but in **opposite** directions.

Describe the change in the motion of the satellite when

(i) both rocket motors are fired

.....

.....

..... **[2]**

(ii) only rocket motor **A** is fired.

.....

.....

..... **[2]**

[Total: 6]

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5 Fig. 5.1 shows the vertical forces acting on a helium-filled weather balloon just before lift off.

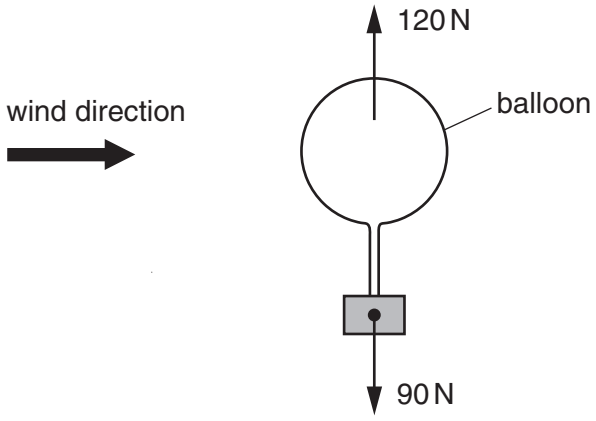


Fig. 5.1

The balloon experiences an upward vertical force (upthrust) equal to 120 N. The weight of the balloon and its contents is 90 N. The magnitude of the horizontal force provided by the wind is 18 N.

(a) Determine the magnitude of the resultant force acting on the balloon and the angle this resultant force makes with the horizontal.

net force = ... N

angle = ... °

[4]

(b) As the balloon rises through the air, it experiences a drag force. State two factors that affect the magnitude of the drag force on this balloon.

1. .....

2. ..... **[2]**

[Total: 6]

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6 **(a)** Fig. 6.1 shows the stress against strain graphs of two materials **X** and **Y**.

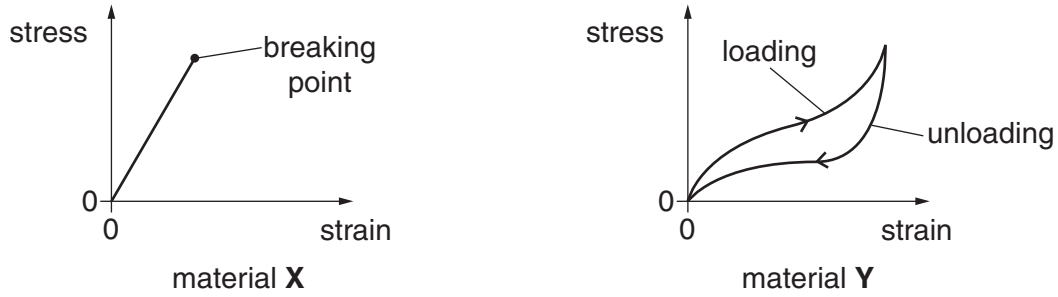


Fig. 6.1

Describe the properties of materials **X** and **Y**.

In your answer, you should use appropriate technical terms, spelled correctly.

material **X** .....

.....

.....

.....

.....

material **Y** .....

.....

.....

.....

..... **[5]**

(b) You are given a spring, a metre rule and a 100 g mass. Describe how you would determine the force constant *k* of the spring.

.....

.....

.....

.....

..... **[3]**

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(c) A glider of mass 0.180 kg is placed on a horizontal frictionless air track. One end of the glider is attached to a compressible spring of force constant 50 N m^{-1}. The glider is pushed against a fixed support so that the spring compresses by 0.070 m, see Fig. 6.2. The glider is then released.

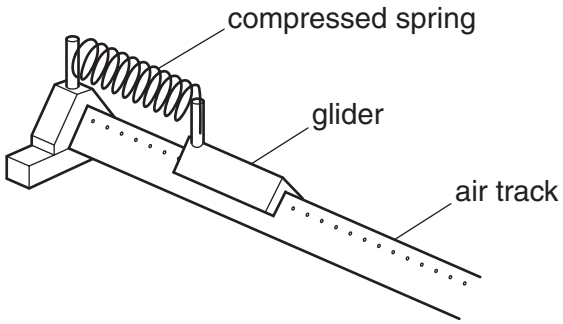


Fig. 6.2

(i) Calculate the horizontal acceleration of the glider **immediately** after release.

acceleration = ... m s^{-2} **[3]**

(ii) After release, the spring exerts a force on the glider for a time of 0.094 s. Calculate the average rate of work done by the spring on the glider.

average rate of work done = ... J s^{-1} **[2]**

[Total: 13]

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7 Fossil fuels will eventually run out. This has led to scientists looking for alternative sources of energy. Tidal stream systems use the kinetic energy of seawater to generate electrical energy during the incoming and outgoing tides. Fig. 7.1 shows a twin-turbine system in which flowing seawater turns the turbine blades.

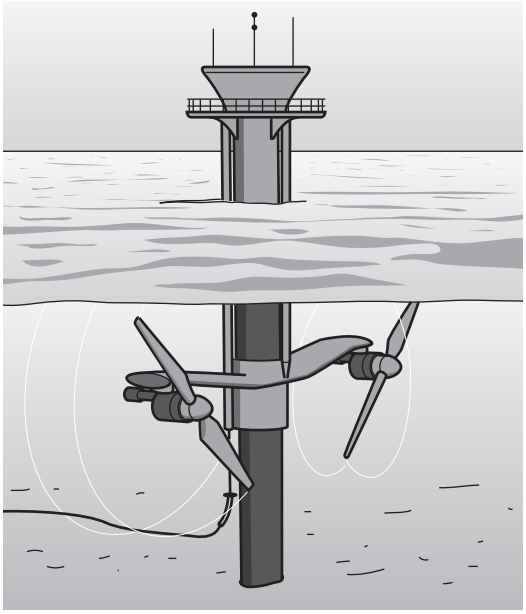


Fig. 7.1

When operating, 9.7×10^5 kg of seawater travelling at a speed of $3.0\,m\,s^{-1}$ passes through each turbine every second. Each turbine generates 1.2×10^6 W of electrical power.

(a) Define *power*.

.....

..... **[1]**

(b) The input power to each turbine is the kinetic energy of the seawater that flows through each turbine in one second.

Show that the input power to each turbine is 4.4×10^6 W.

[2]

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(c) Calculate the percentage efficiency of each turbine.

efficiency = ... % **[1]**

(d) In one second, a cylinder of seawater of mass 9.7×10^5 kg passes through each turbine at a speed of 3.0 m s^{-1}. Calculate the radius of each turbine. The density of seawater is 1030 kg m^{-3}.

radius = ... m **[3]**

(e) Tidal stream systems require less space than conventional wind turbines that are found in windy regions of this country.

(i) Explain why a tidal stream turbine system of identical size to a wind turbine system will produce greater power for the same water or wind speed.

.....

.....

..... **[1]**

(ii) Suggest one further advantage of tidal stream systems over conventional wind farms.

.....

..... **[1]**

[Total: 9]

END OF QUESTION PAPER

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ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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GCE

Physics A

Advanced Subsidiary GCE

Unit **G481:** Mechanics

Mark Scheme for June 2012

Oxford Cambridge and RSA Examinations

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations available in scoris

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation

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The abbreviations, annotations and conventions used in the detailed mark scheme are:

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

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CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

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Note about significant figures:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

Question			Answer	Marks	Guidance
1	(a)		A vector quantity has direction / scalar quantity does not have direction	B1	**Not**: 'Scalar only has magnitude' because there is no mention of direction
	(b)	(i)	acceleration	B1	
		(ii)	power and energy	B1	
		(iii)	stress and pressure unit: pascal / Pa / N m^{-2} / kg m^{-1} s^{-2}	M1 A1	 **Note**: The A1 mark can only be scored if M1 is awarded
	(c)		10^{12}	B1	
	(d)		*p μ c k*	B1	
			Total	**7**	

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Question			Answer	Marks	Guidance
2	(a)		vertically down(wards) / vertically towards the ground	B1	**Not**: vertical / down
	(b)		horizontal velocity = 24 × cos30 = 21 (m s^{-1}) vertical component = 24 × sin30 = 12 (m s^{-1})	B1 B1	**Note**: Answer to 3 sf is 20.8 (m s^{-1}) **Allow**: 12√3 **Allow**: 1 mark if the answers have been swapped. **Allow**: 1 mark for answers of '3.7 and -23.7' obtained using '30 rad'
	(c)		The ball is (still) moving at **B** / has horizontal motion at **B** / has horizontal velocity (of 20.8 m s^{-1}) at **B** / has KE at **B**	B1	**Allow**: 'The ball has KE at the top / peak / maximum point'
	(d)		$v^2 = u^2 + 2as$ Using the vertical component 12 (m s^1) 0 = 12^2 – 2 × 9.81 × *h* *h* = 7.3 (m)	C1 C1 A1	Possible ecf from **(b)** **Note**: Answer to 3sf is 7.34 (m) **Allow**: $mgh = \frac{1}{2}mv^2$ Using 12 (m s^1) C1 $h = 12^2/(2 \times 9.81)$ C1 *h* = 7.3 (m) A1 **Allow**: *m* × 9.81 × *h* = ½ × *m* × 24^2 - ½ × *m* × 20.8^2 C1 *h* = (24^2 – 20.8^2)/2 × 9.81 C1 *h* = 7.3 (m) A1
			Total	**7**	

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Question			Answer	Marks	Guidance
3	(a)		velocity = rate of change of <u>displacement</u>	B1	**Allow**: Equation if labels are defined **Not**: velocity = displacement/time **Not**: A mixture of quantity and unit, e.g: 'change in displacement per second'
	(b)		work done = force × distance <u>moved</u> in direction of force	M1 A1	**Allow**: 'force × displacement' for the M1 mark
	(c)	(i)	It is at right angles to motion	B1	**Allow:** It is at right angles to slope / sledge
		(ii)	The component of the weight / *W* / *mg* (down the slope)	B1	**Allow:** *W* sinθ or *mg*sinθ **Not**: 'component of gravity' **Allow**: <u>Resultant</u> of *W* and *N*
	(d)	(i)	1 acceleration = gradient / $a = (v-u)/t$ *a* = 3.0/1.5 *a* = 2.0 (m s^{-2}) 2 $a = g\sin\theta$ $\sin\theta = 2.0/9.81$ θ = 12°	C1 A1 C1 A1	 **Allow**: 1 sf answer Possible ecf from incorrect value of acceleration *a* Answer to 3 sf is 11.8° **Note**: Using 10 m s^{-2} gives an answer of 11.5° - award 2 marks
		(ii)	*a* = (-) 15/3.5 or *a* = (-) 4.29 (m s^{-2}) $m = 510/4.29$ mass = 120 (kg)	C1 C1 A1	**Ignore** sign Answer to 3 sf is 119 (kg)
			Total	**12**	

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Question			Answer	Marks	Guidance
4	(a)	(i)	Two equal but opposite forces	B1	
		(ii)	torque = one of the forces × <u>perpendicular</u> distance between the forces	B1	**Use tick or cross on Scoris** ✎ ***perpendicular*** must be spelled correctly to gain the mark
	(b)	(i)	It will rotate / spin / turn Rotation is clockwise / (continue) to travel from left to right/ the rotational speed increases (with time)	B1 B1	
		(ii)	It will accelerate The idea that acceleration is to the right / Suggestion that satellite will 'turn'	B1 B1	**Allow**: 'speed up' / 'speed increases' / 'velocity increases' / 'move faster'
			Total	**6**	

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Question			Answer	Marks	Guidance
5	(a)		(net vertical force =) 120 – 90 $F^2 = 30^2 + 18^2$ net force = 35 (N)	C1 C1 A1	**Allow**: 2 marks for 1224 (N) - answer not square-rooted **Allow**: 1 mark for resultant of 18 and 90; equal to 91.8 (N) **Allow**: 1 mark for resultant of 18 and 120; equal to 121.3 (N) **Alternative for scale drawing:** (net vertical force =) 30 (N) C1 Correct 'triangle'; at least one of the sides labelled C1 *F* in the range 34 to 36 (N) A1
			$\tan\theta = 30/18$ angle = 59°	B1	Possible ecf from net force
	(b)		Any <u>two</u> from: • speed of balloon • (frontal) area • texture of balloon • temperature of air / density of air / viscosity (of air)	B1×2	**Not**: size / shape of balloon
			Total	**6**	

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Question			Answer	Marks	Guidance
6	(a)		Material **X** It is a ***brittle*** material No plastic deformation / It is elastic / It returns to same length when stress / force is removed Material **Y** It is a polymeric / polymer (material) It is elastic / It returns to same length when stress / force is removed **X** obeys Hooke's law / **Y** does not obey Hooke's law	 B1 B1 B1 B1 B1	**Use ticks on Scoris to show where the marks are awarded** ✎ ***Brittle*** must be spelled correctly to gain the mark. **Allow**: rubber / 'elastic band' **Allow**: energy 'lost' (when unloaded)
	(b)		Place the 100 g mass on the spring / hang the 100 g mass from the spring Determine the extension / compression of the spring (using a ruler) force constant = 0.98(1)/extension	B1 B1 B1	 **Allow**: k = (0.1 × 9.8)/extension **Allow**: k = 1.0 (N)/extension
	(c)	(i)	$F = kx$ $F = 50 \times 0.070$ / F = 3.5 (N) a = 3.5/0.180 acceleration = 19 (m s^{-2})	 C1 C1 A1	 Answer to 3 sf is 19.4 (m s^{-2})
		(ii)	average work done = <u>average</u> force × displacement = 1.75 × 0.070 (= 0.1225) av rate of work done = 0.1225/0.094 av rate of work done = 1.3 (J s^{-1})	 C1 A1	 **Aternative** (allow full credit for other correct methods) $E = \frac{1}{2} \times 50 \times 0.070^2 (= 0.1225)$ C1 power = 0.1225/ 0.094 power = 1.3 (J s^{-1}) A1
			Total	**13**	

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Question			Answer	Marks	Guidance
7	(a)		power = work done/ time or energy/time or 'rate of work done'	B1	
	(b)		power = KE/time Using $\frac{1}{2}mv^2$ (power =) ½ × 9.7 × 10^5 (kg s^{-1}) × 3.0^2 (power =) 4.365 × 10^6 (W)	C1 C1 A0	**Allow**: 1 mark for a bald answer of 4.37 × 10^6 since this is a 'show' question
	(c)		efficiency = $\frac{1.2}{4.4} \times 100$ efficiency = 27 %	B1	**Note**: Answer to 3 sf is 27.3% if 4.4 × 10^6 is used **Note**: Answer is 27.5% if 4.365 × 10^6 is used **Not**: 0.27
	(d)		(volume per second =) 9.7 × 10^5/1030 or 941.7 mass per second = density × volume per second 9.7 × 10^5 = 1030 × (3.0 × π × r^2) $r^2 = \frac{9.7 \times 10^5}{1030 \times 3\pi}$ radius = 10 (m)	C1 C1 A1	**Allow** any subject **Allow**: 2 marks for 100 (m); answer not square rooted
	(e)	(i)	water has greater density or water has greater mass / KE for the same volume	B1	
		(ii)	Any one from: • Not an eyesore / cannot be seen • Not noisy • Predictable energy (with in and out tides) • Do not occupy space on the land	B1	**Allow** other sensible suggestions
			Total	**9**	

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Thursday 12 January 2012 – Afternoon

AS GCE PHYSICS A

G481 Mechanics

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Duration: 1 hour

G481

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 **(a)** Define *acceleration*.

.....

..... **[1]**

(b) A super-tanker cruising at an initial velocity of $6.0\,m\,s^{-1}$ takes 40 minutes (2400 s) to come to a stop. The super-tanker has a constant deceleration.

(i) Calculate the magnitude of the deceleration.

deceleration = ... $m\,s^{-2}$ **[3]**

(ii) Calculate the distance travelled in the 40 minutes it takes the tanker to stop.

distance = ... m **[2]**

(iii) On Fig. 1.1, sketch a graph to show the variation of distance *x* travelled by the super-tanker with time *t* as it decelerates to a stop.

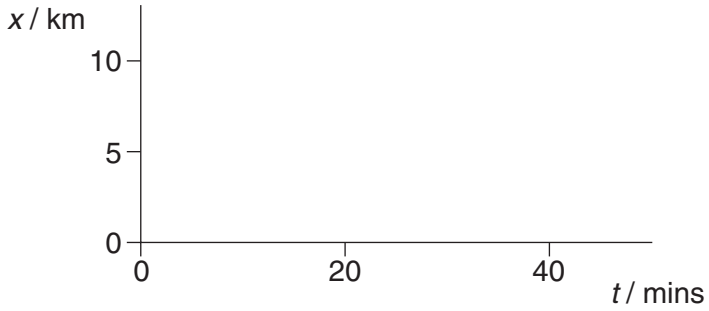


Fig. 1.1 **[2]**

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(c) A student repeats one of Galileo's classic experiments from the sixteenth century. Fig. 1.2 shows the arrangement of this experiment.

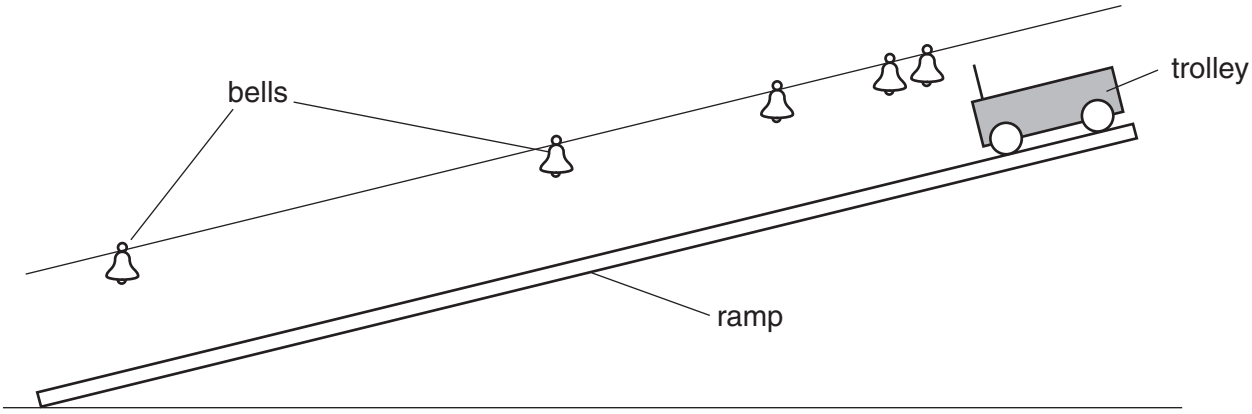


Fig. 1.2

A number of tiny bells are hung above a ramp. A trolley is released from rest from the top of the ramp. It rings each bell on its journey down the ramp. The procedure is repeated several times. The separations between the bells are adjusted until the time taken by the trolley to travel between successive bells is the **same**. This means that the bells ring at regular intervals. The distance between successive bells increases down the ramp.

(i) State what you can deduce about the motion of the trolley as it travels down the ramp.

.....

..... **[1]**

(ii) The positions of the bells are unchanged. The mass of the trolley is increased. This heavier trolley is released from rest from the top of the ramp. State and explain the observations made by the student for this trolley.

.....

.....

.....

.....

..... **[2]**

[Total: 11]

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2 **(a)** State the *principle of conservation of energy*.

.....

..... **[1]**

(b) Define *work done* by a force and state its unit.

definition .....

.....

.....

unit ..... **[3]**

(c) Fig. 2.1 shows a crater on the surface of the Earth.



Fig. 2.1

The crater was formed by a meteor impact about 50,000 years ago. The meteor was estimated to have a mass of 3.0×10^8 kg with an initial kinetic energy of 8.4×10^{16} J just before impact.

(i) State one major energy transformation that took place during the impact of the meteor with the Earth.

.....

..... **[1]**

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(ii) Show that the initial impact speed of the meteor was about $2.0 \times 10^4\,\text{m}\,\text{s}^{-1}$.

[2]

(iii) The crater is about 200 m deep. Estimate the average force acting on the meteor during the impact.

force = ... N **[3]**

[Total: 10]

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3 Thinking and braking distances are important quantities when considering road safety.

(a) The driver of a car travelling at constant speed sees a hazard ahead at time $t = 0$. The reaction time of the driver is 0.5 s. On Fig. 3.1, sketch a graph of distance travelled by the car against time t during this interval of 0.5 s.

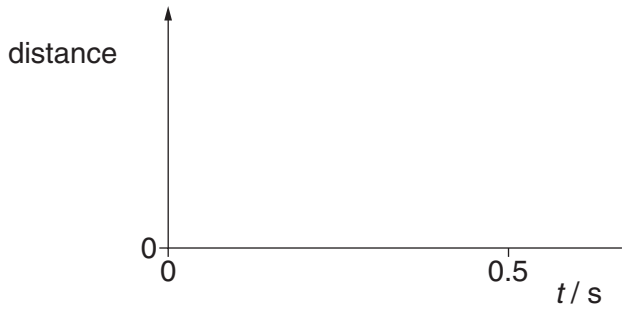


Fig. 3.1 **[1]**

(b) Explain the shape of your graph in Fig. 3.1.

.....

..... **[1]**

(c) Define *braking distance*.

.....

..... **[1]**

(d) Apart from the conditions of the tyres, brakes, road surface and weather, state two other factors that affect the **braking distance** of a car. For each factor, discuss how it affects the braking distance.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

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(e) Describe and explain how seat belts reduce the forces on a driver during the impact in an accident.

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

[Total: 10]

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4 **(a)** Define *moment of a force*.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(b) State the two conditions that apply when an object is in equilibrium.

1. .....

2. ..... **[2]**

(c) Fig. 4.1 is a diagram of a human arm lifting an object.

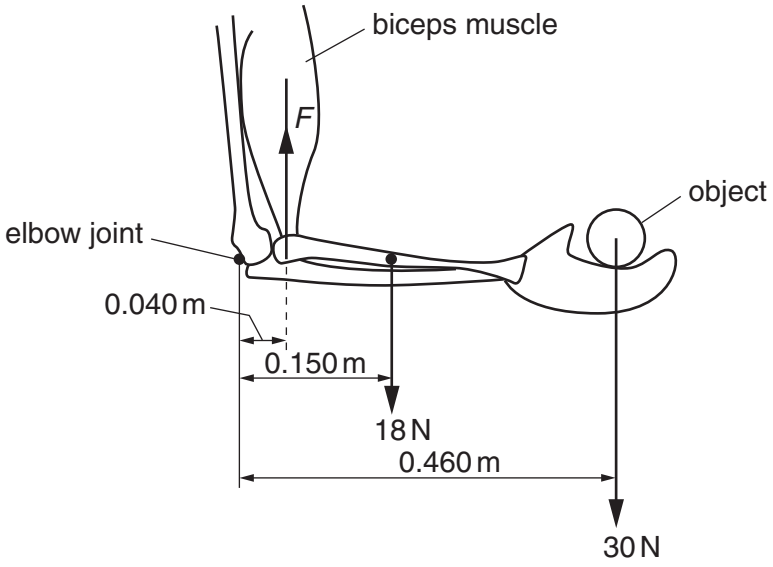


Fig. 4.1

The lower arm is horizontal and its centre of gravity is 0.150 m from the elbow joint. The weight of the lower arm is 18 N. The biceps muscle exerts a vertical force *F* on the arm. The horizontal distance between the elbow joint and the point of attachment of the muscle to the lower arm bone is 0.040 m. The weight of the object held in the hand is 30 N and its centre of gravity is 0.460 m from the elbow joint. The arm is in equilibrium.

(i) Define *centre of gravity.*

.....

..... **[1]**

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(ii) Calculate the total clockwise moment about the elbow joint.

total clockwise moment = ... N m **[2]**

(iii) As the lower arm is moved away from the body, the force *F* exerted by the biceps muscles acts at an angle θ to the vertical as shown in Fig. 4.2.

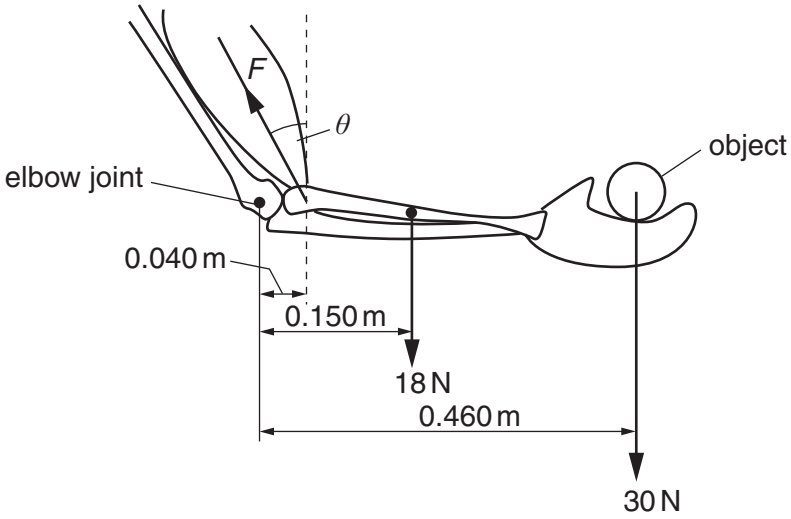


Fig. 4.2

The lower arm remains horizontal and in equilibrium. Describe and explain what happens to each of the following quantities as the angle θ is increased

1 the anticlockwise moment about the elbow joint

.....

.....

2 the magnitude of the force *F*.

.....

.....

.....

..... **[3]**

[Total: 9]

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5 Fig. 5.1 shows a person standing in a stationary lift.

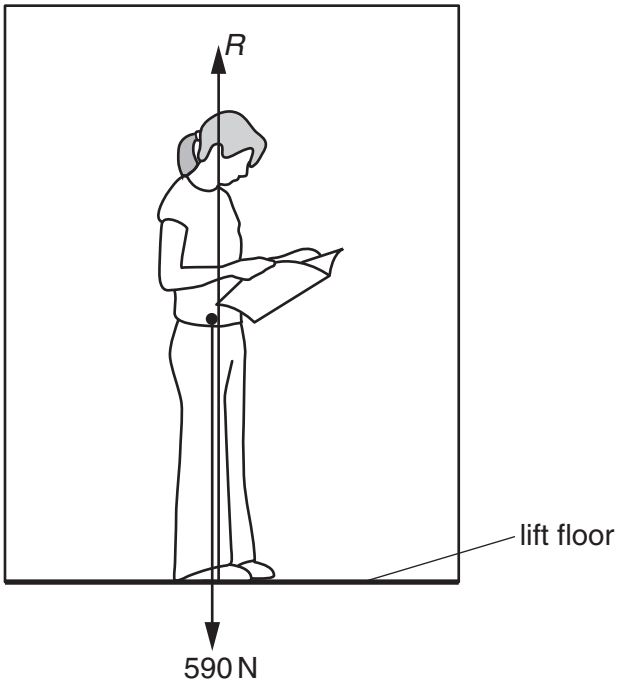


Fig. 5.1

There are only two forces acting on the person. The weight of the person is 590 N. The vertical contact force acting on the person from the floor of the lift is *R*.

(a) Show that the mass of the person is 60 kg.

[1]

(b) The lift starts from rest. It has a constant upward acceleration of 0.50 m s^{-2}. Calculate the magnitude of the contact force *R*.

R = ... N **[2]**

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(c) After a short period of acceleration, the lift travels upwards at a constant velocity. Explain why the force *R* is equal to the weight of the person when the lift travels at a constant velocity.

.....

.....

..... **[1]**

(d) State and explain how the force *R* changes at the instant the lift starts to decelerate.

.....

.....

.....

..... **[2]**

[Total: 6]

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6 **(a)** State *Hooke's law*.

.....

..... **[1]**

(b) Fig. 6.1 shows a force against extension graph for a spring.

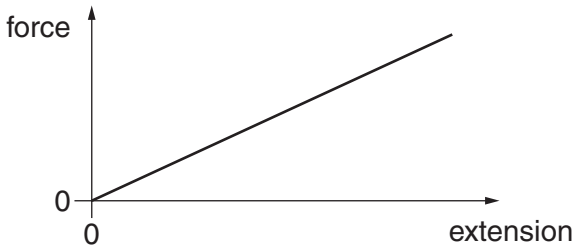


Fig. 6.1

Describe how such a force against extension graph can be used to determine

(i) the *force constant* of the spring

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(ii) the *work done* on the spring.

.....

..... **[1]**

(c) Two identical springs are connected end-to-end (series). The force constant of each spring is *k*. The free ends of the springs are pulled apart as shown in Fig. 6.2.

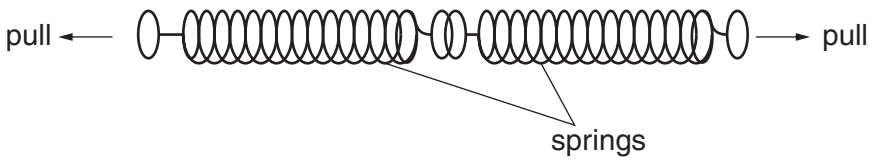


Fig. 6.2

Explain why the force constant of this combination of two springs in series is $\frac{k}{2}$.

.....

.....

..... **[2]**

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(d) (i) Define the *Young modulus* of a material and state the condition when it applies.

.....

.....

..... **[2]**

(ii) A guitar string has length 0.70 m and cross-sectional area 0.20 mm^2. A constant tension of 4.2 N is applied to the string causing a strain of 0.015. Calculate

1 the stress in the string

stress = ... Pa **[2]**

2 the Young modulus of the material of the string

Young modulus = ... Pa **[2]**

3 the elastic potential energy (stored energy) in the string.

energy = ... J **[3]**

[Total: 14]

END OF QUESTION PAPER

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ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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ADDITIONAL PAGE

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GCE

Physics A

Advanced Subsidiary GCE

Unit **G481:** Mechanics

Mark Scheme for January 2012

Oxford Cambridge and RSA Examinations

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Annotations available in scoris

Annotation	Meaning
	correct response
	incorrect response
	benefit of the doubt (where professional judgement has been used)
	benefit of the doubt **not** given
	error carried forward
	information omitted
	contradiction (in cases where candidates contradict themselves in the same response)
	follow through
	error in number of significant figures
	error in the power of 10 in calculation
	arithmetic or calculation error
	not answered question
	wrong physics
	reading error

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Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
allow	=	answers that can be accepted
not	=	answers which are not worthy of credit
reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant
( )	=	words which are not essential to gain credit
__	=	underlined word (or the equivalent) must be present in answer to score a mark
ecf	=	error carried forward
AW	=	alternative wording
ora	=	or reverse argument

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CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow answers to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.
(Significant figures are rigorously assessed in the practical skills.)

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Question			Answers	Marks	Guidance
1	(a)		acceleration = rate of <u>change</u> of <u>velocity</u>	B1	**Allow**: $a = \frac{v-u}{t}$ where *v* = final velocity, *u* = initial velocity and *t* = time **Allow**: 'acceleration = change in <u>velocity</u> over time' **Not**: 'acceleration = rate of change of <u>speed</u>' **Not**: mixture of quantity and unit, e.g. 'change of velocity per second'
	(b)	(i)	$a = \frac{v-u}{t}$ (Any subject) $a = \frac{0-6.0}{2400}$ *a* = (-) 2.5 × 10^{-3} (m s^{-2})	C1 C1 A1	**Allow**: $a = 6.0/2400$ Ignore sign
		(ii)	distance = <u>av speed</u> × time or $v^2 = u^2 + 2as$ distance = 3.0 × 2400 or $0 = 6.0^2 - (2 \times 2.5 \times 10^{-3} \times s)$ distance = 7200 (m)	C1 A1	Possible ecf. from **(b)(i)** **Allow**: $v^2 = u^2 + 2as$ with *v* = 6.0, *u* = 0 and *a* = 0.0025 **Allow**: Full credit for correct use of $s = ut + ½ at^2$ **Note**: Bald 7200 (m) scores 2 marks **Allow**: 1 mark for '*s* = (6 × 2400) + ½ × 0.0025 × 2400^2 = 21600 (m)'
		(iii)	Correct shape of curve of <u>decreasing</u> gradient starting from 0,0 Graph passes through 40, 7.2	M1 A1	Possible e.c.f. from **(b)(ii)** **Allow** the A1 mark if *x* is between 5-10 km at 40 min
	(c)	(i)	It has (constant) acceleration / It accelerates (down the ramp)	B1	**Allow**: Its velocity / speed increases
		(ii)	The time taken by ball to travel between (successive) bells is the same / 'same as first trolley' / 'there is no change' (AW) Acceleration is independent of mass / acceleration is the same (for the heavier trolley) (AW)	B1 B1	
			Total	**11**	

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Question			Answers	Marks	Guidance
2	(a)		total energy of a (closed) system remains constant or Energy cannot be created or destroyed (it can only be transferred into other forms) or total initial energy = total final energy	B1	**Not**: 'Energy cannot be created / destroyed / lost'
	(b)		work done = force × distance moved in the direction of the force Unit: N m or J	M1 A1 B1	**Allow**: 'force × displacement' for the M1 mark **Note**: The unit mark is an independent mark
	(c)	(i)	kinetic energy → heat	B1	**Not**: friction / deformation / sound / KE of dust / KE of Earth
		(ii)	($E = \frac{1}{2}mv^2$) $8.4 \times 10^{16} = \frac{1}{2} \times 3.0 \times 10^8 \times v^2$ $v^2 = \frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}$ or $v = \sqrt{\frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}}$ ($v = 2.37 \times 10^4$ m s^{-1})	C1 C1 A0	**Note**: This mark is for correct substitution **Allow**: 2 marks for $v^2 = 5.6 \times 10^8$ **Allow**: 1 mark for a bald answer of 2.4×10^4
		(iii)	$8.4 \times 10^{16} = F \times 200$ $F = \frac{8.4 \times 10^{16}}{200}$ force = 4.2×10^{14} (N)	C1 C1 A1	Possible ecf **Allow**: $a = (-)\frac{u^2}{2s}$ $a = (-)\frac{(2.37 \times 10^4)^2}{2 \times 200}$ or $a = (-)\frac{(2 \times 10^4)^2}{2 \times 200}$ C1 $a = 1.4 \times 10^6$ (m s^{-2}) or $a = 1.0 \times 10^6$ (m s^{-2}) C1 $F = 3.0 \times 10^8 \times 1.4 \times 10^6$ or $F = 3.0 \times 10^8 \times 1.0 \times 10^6$ force = 4.2×10^{14} (N) or force = 3.0×10^{14} (N) A1
			Total	**10**	

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Question			Answers	Marks	Guidance
3	(a)		A straight line through the origin	B1	**Ignore** graph after 0.5 s.
	(b)		The speed (of the car) is constant	B1	**Note**: This can only be scored if **(a)** is correct
	(c)		The distance travelled by the car after the brakes are applied until the car stops	B1	**Note**: Must have reference to car 'stopping' to score the mark
	(d)		Mass (of car) ($\frac{1}{2}$ $mv^2 = Fx$, hence braking) distance $\propto$ mass Speed / velocity (of car) ($\frac{1}{2}$ $mv^2 = Fx$, hence braking) distance $\propto$ speed^2	M1 A1 M1 A1	**Must use tick or cross on Scoris to show if the mark is awarded** **Allow**: weight (of car) **Not**: 'distance increases with mass' **Allow**: distance $\propto m$ **Not**: 'distance increases with speed' **Allow**: distance $\propto v^2$
	(e)		Increases time (of impact / to slow down) / increases the distance (travelled by the driver) Smaller deceleration / acceleration Force is smaller because $F = ma$ and a is smaller or force is smaller because $F = E_k/x$ and x is bigger or force is smaller because $F = \frac{\Delta p}{\Delta t}$ and Δt is bigger	B1 B1 B1	**Must use tick or cross on Scoris to show if the mark is awarded** **Not**: 'slow down acceleration' **Allow**: $E_k = Fx$ and x is bigger **Not**: Prevent crashing into windscreen / steering wheel
			Total	**10**	

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Question			Answers	Marks	Guidance
4	(a)		moment = force × perpendicular distance from point / pivot ✎**The term *perpendicular* to be included and spelled correctly to gain the B1 mark**	B1	**Must use tick or cross on Scoris to show if the mark is awarded**
	(b)		Net force = 0 Net moment / torque = 0	B1 B1	**Not**: 'All forces are equal' or 'forces are balanced' or 'total forces up = total forces down' **Allow**: 'sum of clockwise moments = sum of anticlockwise moments'
	(c)	(i)	The point where the weight (appears) to act	B1	**Not**: 'The point where gravity acts' or 'point where mass acts/is concentrated'
		(ii)	moment = (0.150 × 18) + (0.460 × 30) moment = 16.5 (N m)	C1 A1	**Allow**: 2 sf answer of 17 N
		(iii)	1 Same / equal to 16.5 (N m) / equal to clockwise moment 2 (perpendicular) distance between elbow and (the line of action of) *F* decreases or (the vertical force) $F\cos\theta$ is the same or $F\cos\theta$ = 412.5 or $F \propto \frac{1}{\cos\theta}$ Hence the force increases	B1 M1 A1	Possible ecf
			Total	**9**	

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Question			Answers	Marks	Guidance
5	(a)		mass = $\frac{590}{9.8(1)}$ (= 60 kg)	B1	**Allow**: weight = 60 × 9.8(1) **Allow**: 60 × 9.8(1) = 588 (N) or 60 × 9.8(1) = 590 (N)
	(b)		net force = 60 × 0.50 (= 30 N) *R* = 590 + 30 *R* = 620 (N)	 C1 A1	 **Allow**: 1 mark for '590 – 30 = 560 (N)'
	(c)		resultant force = 0 / '*a* = 0 and *F* = *ma* = 0'	B1	**Not**: Acceleration = 0 or 'forces are balanced'
	(d)		weight > *R* (for deceleration) / *R* = 590 – 60*a* / *R* = *mg* -*ma* Hence *R* decreases	M1 A1	**Allow**: *W* or *mg* for 'weight'
			Total	**6**	

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Question			Answers	Marks	Guidance
6	(a)		The extension ∝ (applied) force (on spring) (as long as the elastic limit is not exceeded)	B1	
	(b)	(i)	Gradient / slope (of line / graph) / force divided by extension ✎ **The term *gradient /slope / divided* to be included and spelled correctly to gain the B1 mark**	B1	**Must use tick or cross on Scoris to show if the mark is awarded**
		(ii)	Area (under the graph / line)	B1	**Allow**: ½ × force × extension **Allow**: ½ × force constant × extension^2 if **(b)(i)** is correct
	(c)		The extension (for the combination) is doubled Force (for each spring) is the same / constant (force constant = force/extension, hence it is halved)	B1 B1	**Allow**: 1 mark for '*F* is the same, *x* is doubled' **Allow**: 2 marks for 'the springs need half the force to give the same (total) extension'
	(d)	(i)	Young modulus = stress/strain As long as the elastic limit is not exceeded / in the linear region of stress against strain graph / Hooke's law is obeyed	M1 A1	
		(ii) 1	stress = $\frac{4.2}{0.20\times10^{-6}}$ stress = 2.1×10^7 (Pa)	C1 A1	**Allow**: 1 mark for 2.1×10^n, $n \neq 7$
		(ii) 2	Young modulus = $\frac{2.1\times10^7}{0.015}$ Young modulus = 1.4×10^9 (Pa)	C1 A1	Possible ecf from **(ii)1**
		(ii) 3	energy = $\frac{1}{2}Fx$ $x = 0.70 \times 0.015$ / $x = 0.0105$ (m) energy = $\frac{1}{2}\times4.2\times(0.70\times0.015)$ energy = 2.2×10^{-2} (J)	C1 C1 A1	
			Total	**14**	

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ADVANCED SUBSIDIARY GCE

PHYSICS A

Mechanics

G481

Candidates answer on the question paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet

Other materials required:
- Electronic calculator
- Ruler (cm/mm)
- Protractor

Tuesday 24 May 2011
Morning

Duration: 1 hour

G 4 8 1

OCE/26232

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

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Turn over

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Answer **all** the questions.

1 **(a)** The areas under the graphs below are physical quantities.

(i) Fig. 1.1 shows a force against extension graph for a rubber band.

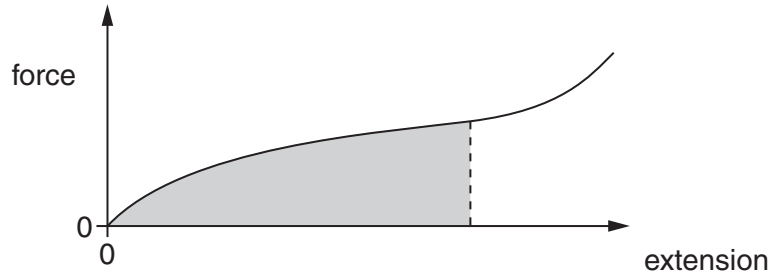


Fig. 1.1

State the quantity represented by the area under the force against extension graph.

..... **[1]**

(ii) Fig. 1.2 shows the velocity against time graph for an accelerating car.

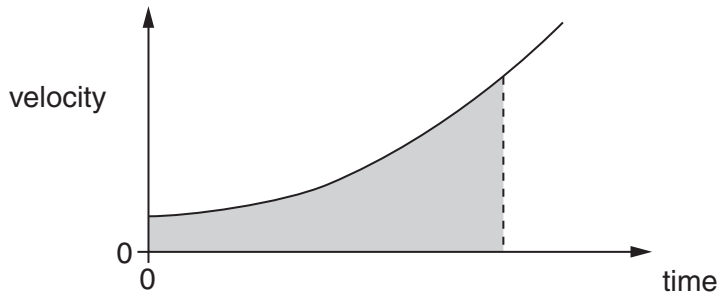


Fig. 1.2

State the quantity represented by the area under the velocity against time graph.

..... **[1]**

(b) State two quantities in physics that have the **same** unit of newton metre (N m).

quantity 1 ..... **[1]**

quantity 2 ..... **[1]**

[Total: 4]

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2 **(a)** Define *density*.

.....

..... **[1]**

(b) Fig. 2.1 shows the variation of density of the Earth with **depth** from the surface.

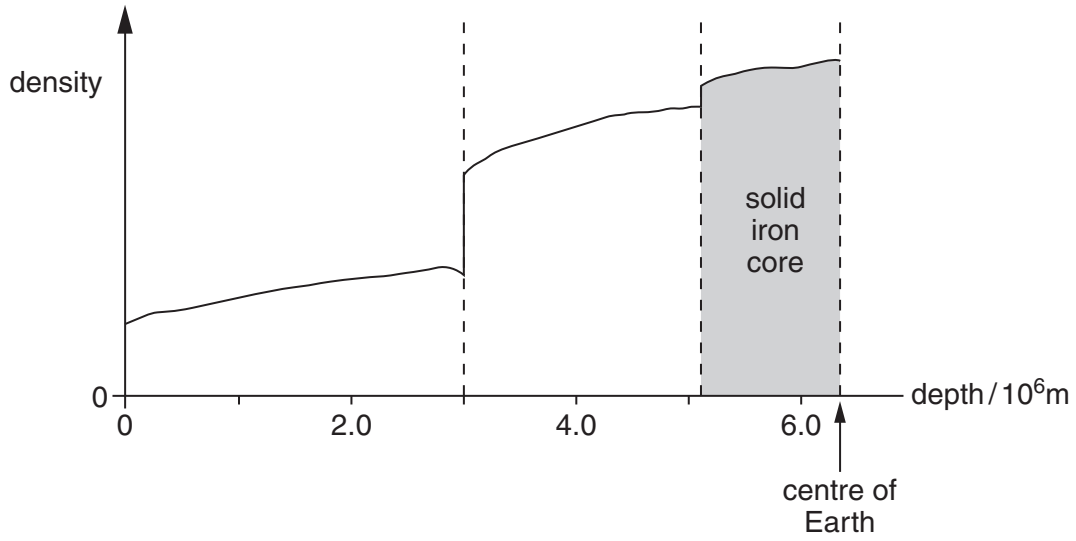


Fig. 2.1

(i) Suggest how Fig. 2.1 shows that the Earth consists of a number of distinct layers.

.....

..... **[1]**

(ii) Geophysicists believe that the central core of the Earth is solid iron. This central core is surrounded by a layer of molten metal. The central core starts at a **depth** of 5.1×10^6 m. The solid iron core accounts for 18% of the mass of the Earth. The mass of the Earth is 6.0×10^{24} kg and its radius is 6.4×10^6 m. Calculate the mean density of the central core of the Earth.

volume of a sphere = $\frac{4}{3}\pi r^3$

density = ... $kg\,m^{-3}$ **[3]**

[Total: 5]

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3 **(a)** Define a *vector* quantity and give one example.

.....

..... **[2]**

(b) Fig. 3.1 shows a force *F* at an angle of 30° to the horizontal direction.



Fig. 3.1

(i) The **horizontal component** of the force *F* is 7.0 N. Calculate the magnitude of the force *F*.

F = ... N **[2]**

(ii) The force *F* moves an object in the horizontal direction. In a time of 4.2 s, the object moves a horizontal distance of 5.0 m. Calculate

1 the work done by the force

work done = ... J **[2]**

2 the rate of work done by the force.

rate of work done = ... W **[1]**

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(c) Fig. 3.2 shows the forces acting on a stage light of weight 120 N held stationary by two separate cables.

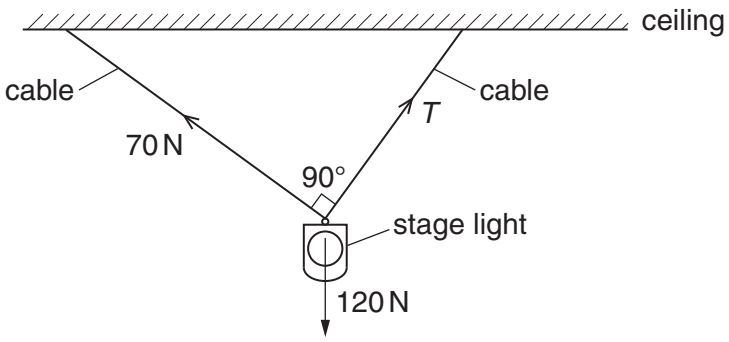


Fig. 3.2

The angle between the two cables is 90°. One cable has tension 70 N and the other has tension *T*.

(i) State the magnitude and the direction of the **resultant** of the tensions in the two cables.

magnitude .....

direction ..... **[2]**

(ii) Sketch a labelled vector triangle for the forces acting on the stage light. Hence, determine the magnitude of the tension *T*.

T = ... N **[4]**

[Total: 13]

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4 **(a)** State two factors that affect the magnitude of the drag force acting on an object falling through air.

1. .....

2. ..... **[2]**

(b) Fig. 4.1 shows a skydiver of total mass 75 kg falling vertically towards the ground.



Fig. 4.1

The air resistance, or drag force, D in newtons (N) acting on the skydiver falling through the air is given by the equation

$$D = 0.3v^2$$

where v is the speed in $m\,s^{-1}$ of the skydiver.

(i) On Fig. 4.1, draw arrows to represent the weight (labelled W) and drag force (labelled D). **[1]**

(ii) Calculate the weight of the skydiver.

weight = ... N **[1]**

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(iii) At a particular instant, the speed of the skydiver is $20\,m\,s^{-1}$. Calculate the instantaneous acceleration of the skydiver.

acceleration = ... $m\,s^{-2}$ **[3]**

(iv) State the relationship between the forces *W* and *D* when the skydiver reaches terminal velocity.

.....

..... **[1]**

(v) Determine the terminal velocity of the skydiver.

terminal velocity = ... $m\,s^{-1}$ **[2]**

[Total: 10]

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5 **(a)** A student conducts an experiment to estimate the acceleration *g* of free fall by dropping a heavy metal ball from a high wall into a sandpit below. Describe how this student can estimate the acceleration *g* of free fall. Your description should include:

- the measurements taken
- the instruments used to take the measurements
- how the measurements are used to estimate *g*
- an explanation of why the value for *g* is only an estimate



In your answer, you should use appropriate technical terms, spelled correctly.

.....

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..... **[7]**

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(b) The global positioning system (GPS) is used to locate accurately the position of cars on the Earth's surface.

(i) Name the electromagnetic waves used by GPS.

..... **[1]**

(ii) Explain how GPS determines the distance between the car and satellite.

.....

.....

.....

..... **[2]**

(iii) Briefly describe how the distances from two or more satellites are used to locate the position of a car.

.....

.....

.....

..... **[2]**

[Total: 12]

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6 **(a)** State the principle of *conservation of energy*.

.....

.....

..... **[1]**

(b) Fig. 6.1 shows a glider on a horizontal frictionless track.

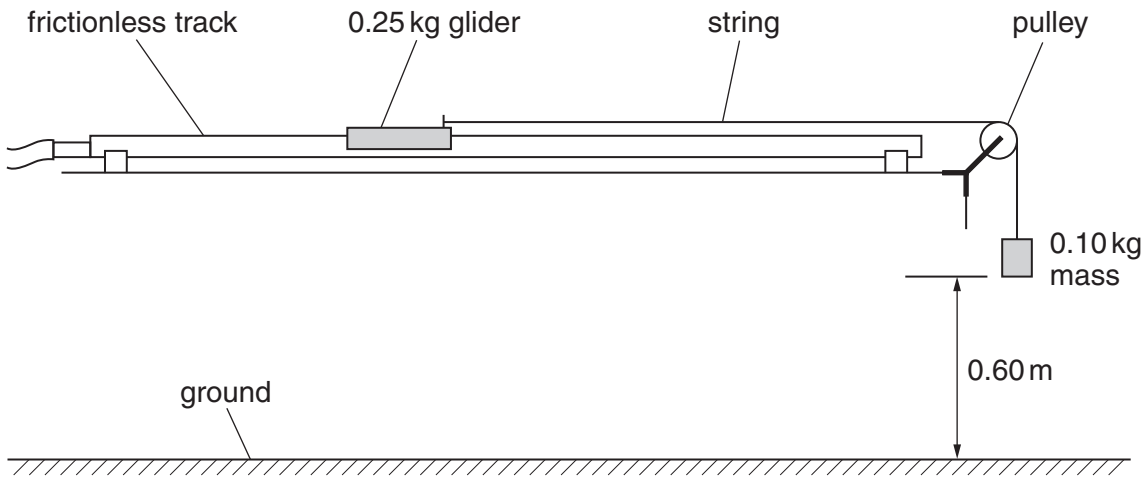


Fig. 6.1

The mass of the glider is 0.25 kg. One end of a string is fixed to the glider and the other end to a 0.10 kg mass. The 0.10 kg mass is held stationary at a height of 0.60 m from the ground. The pulley is more than 0.60 m away from the front of the glider. When the 0.10 kg mass is released, the glider has a constant acceleration of 2.8 m s^{-2} towards the pulley. The 0.10 kg mass instantaneously comes to rest when it hits the ground.

(i) Calculate the loss in potential energy of the 0.10 kg mass as it falls through the distance of 0.60 m.

loss in potential energy = ... J **[1]**

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(ii) The glider starts from rest. Show that the velocity of the **glider** after travelling a distance of 0.60 m is about 1.8 m s^{-1}.

[2]

(iii) Calculate the kinetic energy of the **glider** at this velocity of 1.8 m s^{-1}.

kinetic energy = ... J **[2]**

(iv) Explain why the answer to **(b)(iii)** is not the same as **(b)(i)**.

.....

..... **[1]**

[Total: 7]

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7 **(a)** Atoms in a solid are held in position by electrical forces. These electrical forces can be represented by an imaginary 'interatomic spring' between neighbouring atoms, see Fig. 7.1.

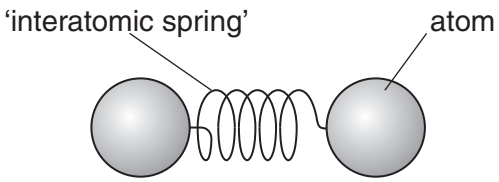


Fig. 7.1

The interatomic spring obeys *Hooke's law* and has a *force constant* just as a normal spring in the laboratory. Researchers in America have recently managed to determine the force experienced by an individual atom of cobalt when the atoms are squeezed together. The researchers found that a force of 210 pN changed the separation between a pair of atoms by a distance of 0.16 nm.

(i) State *Hooke's law*.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

..... **[1]**

(ii) Calculate the force constant of the interatomic spring for a pair of cobalt atoms.

force constant = ... $N\,m^{-1}$ **[3]**

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(b) Fig. 7.2 shows a stress against strain graph for a metal wire up to its breaking point.

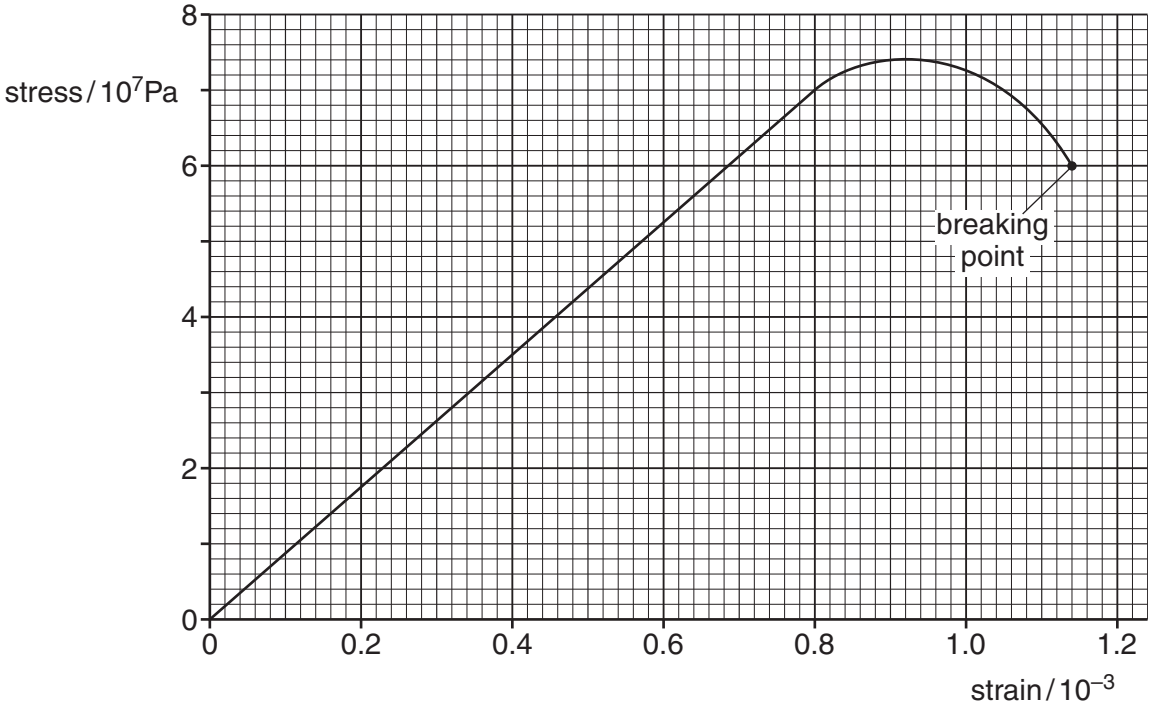


Fig. 7.2

(i) Use the graph to determine the Young modulus of the metal.

Young modulus = ... unit .....**[3]**

(ii) The wire breaks when a force of 19 N is applied. Use the graph to determine the cross-sectional area of the wire at the breaking point.

area = ... m^2 **[2]**

[Total: 9]

END OF QUESTION PAPER

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ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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ADDITIONAL PAGE

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ADDITIONAL PAGE

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GCE

Physics A

Advanced Subsidiary GCE

Unit **G481:** Mechanics

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

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All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

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Note about significant figures:

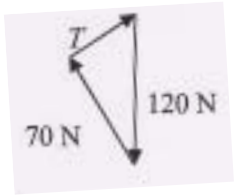
Significant figures are rigorously assessed in the practical skills.
If the data given in a question is to 2 sf, then allow answers to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

Question			Expected Answers	Marks	Additional Guidance
1	a	i	work (done) / (elastic potential) energy	B1	**Not:** heat / gravitational potential energy / kinetic energy
		ii	displacement / distance	B1	
	b		Any two from: • Torque (of a couple) • Moment (of a force) • Work (done) / energy	B1×2	**Not**: 'Couple' for 'torque' **Allow**: PE / KE
			Total	**4**	

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Question			Expected Answers	Marks	Additional Guidance
2	a		density = mass/volume or 'density is mass <u>per</u> (unit) volume'	B1	**Allow**: $\rho = \frac{M}{V}$, where M = mass and V = volume **Not**: mass per m^3
	b	i	Dramatic change(s) in <u>density</u> (at 3.0 Mm and 5.1 Mm) (AW)	B1	**Not**: There are three (distinct) layers / Each layer has different density
		ii	mass = $0.18 \times 6.0 \times 10^{24}$ ($=1.08 \times 10^{24}$ kg) or radius = 1.3×10^6 (m)	C1	**Note**: The first C1 mark is for determining the mass or the radius of core
			volume = $\frac{4}{3}\pi \times (1.3 \times 10^6)^3$		
			density = $\frac{1.08 \times 10^{24}}{9.20 \times 10^{18}}$	C1	Possible 10^n errors
			density = 1.2×10^5 (kg m^{-3})	A1	**Bald** answer of 1.2×10^5 (kg m^{-3}) or 1.17×10^5 (kg m^{-3}) scores 3 marks **Allow**: 2 marks for $\frac{6.0 \times 10^{24}}{9.20 \times 10^{18}} = 6.5 \times 10^5$ (factor of 0.18 missed out) **Note**: The <u>last</u> <u>two</u> C1 and A1 marks cannot be scored if incorrect radius is used. Hence no further marks for $\frac{1.08 \times 10^{24}}{\frac{4}{3}\pi \times (6.4 \times 10^6)^3}$ or $\frac{1.08 \times 10^{24}}{\frac{4}{3}\pi \times (5.1 \times 10^6)^3}$, etc
			Total	**5**	

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Question			Expected Answers	Marks	Additional Guidance
3	a		A quantity with magnitude / size <u>and</u> direction Suitable example: displacement / velocity / acceleration / force / weight etc	B1 B1	
	b	i	$F_x = F\cos\theta$ $7.0 = F \times \cos 30$ $F = 8.1$ (N) or 8.08 (N)	C1 A1	**Allow**: 1 mark for 'radian' error; answer is 45.3 (N) **Note**: No marks for '7.0 × cos30 = 6.06 N'
		ii	**1** $W = 7.0 \times 5.0$ or $W = 8.08 \times 5.0 \times$ <u>cos30</u> work done = 35 (J) **2** 'power' = 35/4.2 = 8.3 (W)	C1 A1 B1	Possible ecf **Note**: If answer for **(b)(i)** is 6.06 (N), then '6.06 × 5.0 × <u>cos30</u> = 26.2 (J)' scores 2/2 because of ecf Possible ecf
	c	i	Magnitude is 120 (N) / equal to weight Direction is (vertically) up / opposite to weight	B1 B1	
		ii	Correct diagram Correct detail on diagram  $120^2 = 70^2 + T^2$ $T = 97$ (N) or 97.5 (N)	M1 A1 C1 A1	**Note**: For the M1 mark, the basic diagram must have all sides labelled (70, 120 and T) <u>and</u> the angle between 70 (N) and T is judged by eye to be 90° **Note**: For the A1 mark, all the arrows are marked and cyclic **Note**: For the C1 A1 marks, $T = \sqrt{120^2 + 70^2} = 140$ scores zero **Allow:** 2 marks for T in the range of 94 (N) to 100 (N) if scale drawing is done
			Total	**13**	

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Question			Expected Answers	Marks	Additional Guidance
4	a		Any <u>two</u> from: • area • speed / velocity • viscosity (of air) / temperature / density • (surface) texture / 'aerodynamic' (shape)	B1×2	**Not**: shape / size **Allow**: 'streamlining'
	b	i	Correct <u>directions</u> of arrows *W* and *D*	B1	Award the mark for two arrows in opposite directions as long as <u>one</u> of them is labelled
		ii	weight = 75 × 9.81 weight = 736 (N) or 740 (N)	 B1	**Reminder**: weight can be quoted to more than 2 sf (e.g: 735.75) **Not**: '75 × 10 = 750 N'
		iii	$D = 0.30 \times 20^2$ (= 120 N) $736 - 120 = 75a$ $a = 8.2$ (m s^{-2})	C1 C1 A1	 **Allow**: Answer to 2sf or more **Bald** answer of 8.2 or 8.21 scores 3 marks **Note**: Using 740 (N) gives an answer 8.3 (m s^{-2})
		iv	(*D* and *W* are) equal	B1	**Not**: *D* and *W* are 'balanced/equilibrium'
		v	drag = weight $736 = 0.30 \times v^2$ $v = 49.5$ (m s^{-1}) or 50 (m s^{-1})	 C1 A1	 **Bald** answer of 49.5 (m s^{-1}) or 50 (m s^{-1}) scores 2 marks
			Total	**10**	

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Question			Expected Answers	Marks	Additional Guidance
5	a		**Measurements**: height (of wall) time (of fall) **Instruments**: ruler / tape (measure) stopwatch / timer / clock /video $g = \frac{2s}{t^2}$ / $g = 2 \times$ gradient of s-t^2 graph **Note**: Allow full credit if candidate has used alternative approaches using $v^2 = u^2 + 2as$ or $v = u + at$. Any <u>two</u> from: g is an estimate because • air resistance / drag ignored • parallax problems with 'landing time' • starting / stopping the clock	 B1 B1 B1 B1 B1 B1×2	**Must use tick or cross on Scoris to show if the mark is awarded** **Allow:** 'distance (of fall)' instead of 'height' ✎ **The 4th B1 can only be scored if *stopwatch* / *timer* / *clock* / *video* (camera) is spelled correctly** **Allow:** Use of 'a' instead of 'g' **Note**: a must be the subject **Allow:** 'wind resistance'/'resistive force' for first bullet point **Allow**: 'reaction time' but **not** 'human error' for the third bullet point
	b	i	Radio (waves) / microwaves	B1	
		ii	Time taken for the signal to travel from satellite to car is determined / 'delay' time for signal is determined distance = $c \times$ (delay) time	M1 A1	 **Allow**: speed of light / 3.0×10^8 <u>m s^{-1}</u> instead of c **Note:** Distance must be the subject for the second B1 mark

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Question			Expected Answers	Marks	Additional Guidance
		iii	Mention of circles / spheres / shells	B1	**Note**: This mark can be scored if a diagram shows circles / arcs (no label required)
			The position of the car is where the circles intersect / trilateration mentioned	B1	**Note**: This mark can be scored on a diagram if it shows intersecting circles / arcs and the intersection point is marked 'car'
			Total	**12**	

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Question			Expected Answers	Marks	Additional Guidance
6	a		Energy can neither be created nor destroyed (but it can be transformed from one form to another) or Total energy of a closed system remains constant	B1	
	b	i	loss in PE = $0.10 \times 9.81 \times 0.60$ $= 0.59$ (J) or 0.589 (J)	 B1	
		ii	$v^2 = 2as$ / $v^2 = 2 \times 2.8 \times 0.60$ / $v^2 = 3.36$ $v = \sqrt{2 \times 2.8 \times 0.60}$ or $v = 1.8\underline{33}$ or $v = 1.8\underline{3}$ $v = 1.8$ (m s^{-1})	M1 M1 A0	
		iii	(KE =) $\frac{1}{2}mv^2$ / (KE =) $\frac{1}{2} \times 0.25 \times 1.8^2$ kinetic energy = 0.405 (J) or 0.41 (J)	C1 A1	Possible ecf from **(b)(ii)** **Note**: The answer is 0.42 (J) when 1.83 m s^{-1} is used **Allow:** 1 mark for 0.162 (J) if 0.10 kg mass is used or for 0.567 (J) if 0.35 kg is used
		iv	KE of 0.10 kg mass is not taken into account (AW)	B1	**Not:** 'There is friction'
			Total	**7**	

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Question			Expected Answers	Marks	Additional Guidance
7	a	i	Extension is proportional to force (applied as long as the elastic limit is not exceeded)	B1	**Must use tick or cross on Scoris to show if the mark is awarded** ✎ This B1 can only be scored when '***extension'*** is spelled correctly **Note:** If '*change in length'* or 'Δ *length'* used instead of '*extension'*, then ***length*** must be spelled correctly **Allow:** stress $\propto$ strain as BOD (stress or stain must be spelled correctly)
		ii	p $\rightarrow 10^{-12}$ n $\rightarrow 10^{-9}$ $k = \frac{F}{x}$ / $k = \frac{210\times10^{-12}}{0.16\times10^{-9}}$ force constant = 1.3 (N m^{-1}) or 1.31 (N m^{-1})	C1 C1 A1	Possible ecf **Allow:** 1 mark for '210/0.16 =1312.5'
	b	i	E = gradient / E = stress/strain (linear section) $E = \frac{70\times10^{6}}{0.8\times10^{-3}}$ E = 8.8 × 10^{10} (Pa) or 8.75 × 10^{10} (Pa) unit: N m^{-2} or Pa	C1 A1 B1	**Allow**: An answer in the range (8.3 to 9.1) × 10^{10} (Pa) **Allow**: 1 mark for an answer 8.75 × 10^{n}, n ≠ 10 **Note**: This is an independent mark
		ii	breaking stress = 6.0 × 10^{7} (Pa) $A = \frac{19}{6.0\times10^{7}}$ (Any subject) A = 3.2 × 10^{-7} (m^2) or 3.17 × 10^{-7} (m^2)	 C1 A1	 **Allow:** 1 mark 3.17 × 10^{n} (m^2) , n ≠ -7 **Note:** No marks if breaking stress of <u>6.0</u> × 10^{n} is not used
			Total	**9**	

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ADVANCED SUBSIDIARY GCE

PHYSICS A

Mechanics

G481

Candidates answer on the question paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet

Other materials required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Wednesday 12 January 2011
Morning

Duration: 1 hour

*G 4 8 1 *

OCE/17466

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.



Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means for example you should:
- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
- organise information clearly and coherently, using specialist vocabulary when appropriate.

- This document consists of **16** pages. Any blank pages are indicated.

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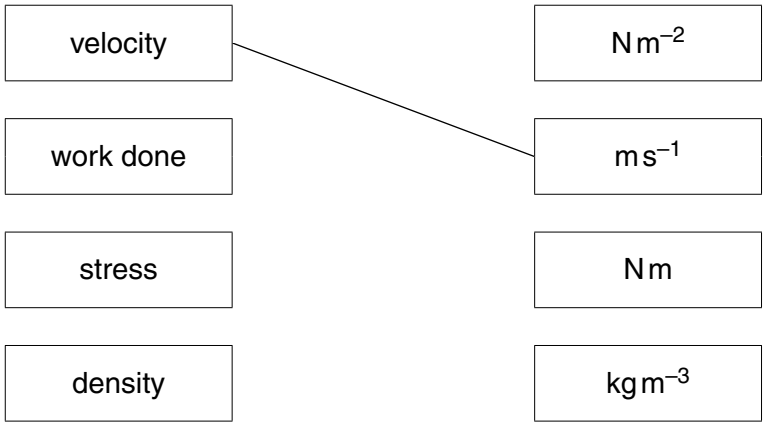
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Turn over

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Answer **all** the questions.

1 **(a)** Draw a straight line from each quantity on the left hand side to its correct unit on the right hand side; one has already been done for you.



[2]

(b) Fig. 1.1 shows a metal cube which rests on a table.

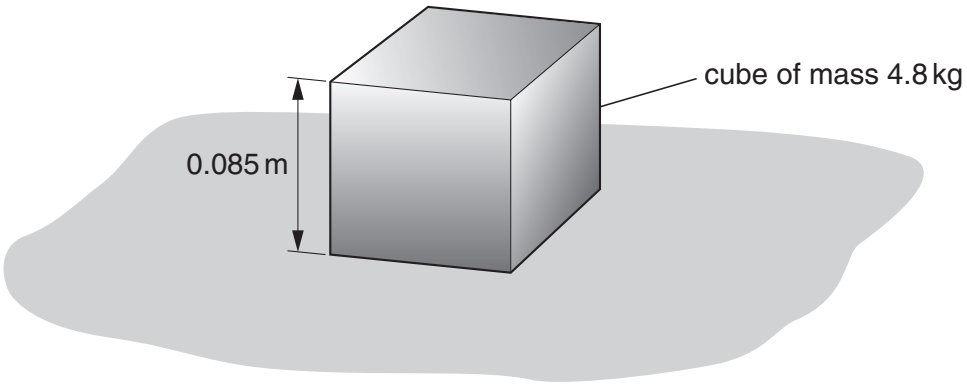


Fig. 1.1

The mass of the metal cube is 4.8 kg. Each side of the cube has length 0.085 m. The cube exerts pressure on the table.

(i) Complete the sentence below:

The force acting on the table is due to the …… of the metal cube. **[1]**

(ii) Calculate the pressure exerted on the table by the metal cube.

pressure = ... Pa **[2]**

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(iii) The metal cube shown is replaced by a second cube made of the same material but with each side of double the length of the original cube.

Complete the sentences below for the second cube when compared with the original cube.

The mass of the second cube is …… times greater than the original cube.

The cross-sectional area of the base is …… times greater than the original cube.

Hence, the pressure exerted by this cube is …… times greater than the original cube.

[3]

[Total: 8]

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2 A driver travelling in a car on a straight and level road sees an obstacle in the road ahead and applies the brakes until the car stops. The initial speed of the car is 20 m s^{-1}. The reaction time of the driver is 0.50 s.

Fig. 2.1 shows the velocity against time graph for the car.

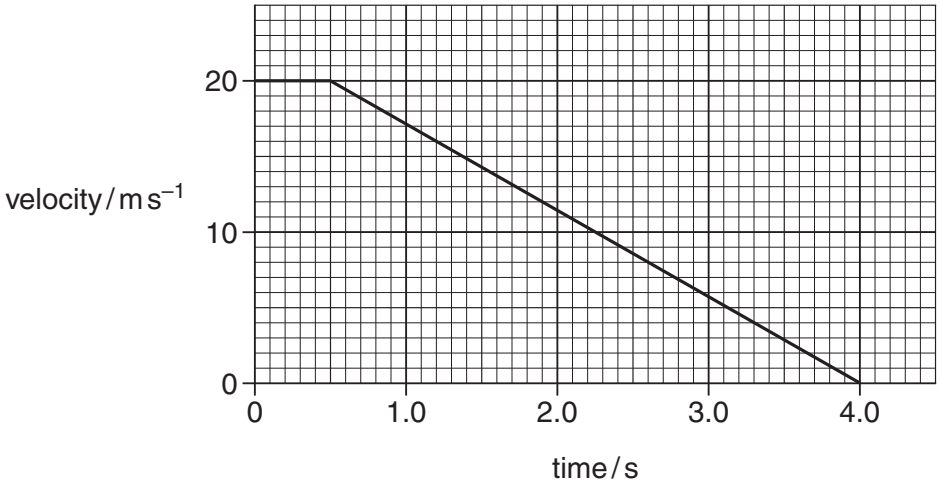


Fig. 2.1

(a) Define *thinking distance*.

.....

..... **[1]**

(b) What does the area under a velocity against time graph represent?

..... **[1]**

(c) Use your answer to **(b)** and Fig. 2.1 to determine

(i) the thinking distance

thinking distance = ... m **[1]**

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(ii) the braking distance.

braking distance = ... m **[2]**

(d) The total mass of the car is 910 kg. Use Fig. 2.1 to determine

(i) the magnitude of the deceleration of the car

deceleration = ... $m\,s^{-2}$ **[2]**

(ii) the braking force acting on the car as it decelerates.

force = ... N **[2]**

(e) Suppose the initial speed of the car is twice that shown in Fig. 2.1. The braking force remains the same. State and explain by what factor the **braking** distance would increase.

.....

.....

.....

..... **[2]**

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(f) One of the safety features in a car is the air bag for the driver. Briefly describe how the air bag is triggered and how it minimises the impact force on the driver.

.....

.....

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.....

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.....

.....

..... **[4]**

[Total: 15]

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3 **(a)** Define *work done* by a force.

.....

..... **[1]**

(b) Fig. 3.1 shows a car travelling up a slope at a constant speed.

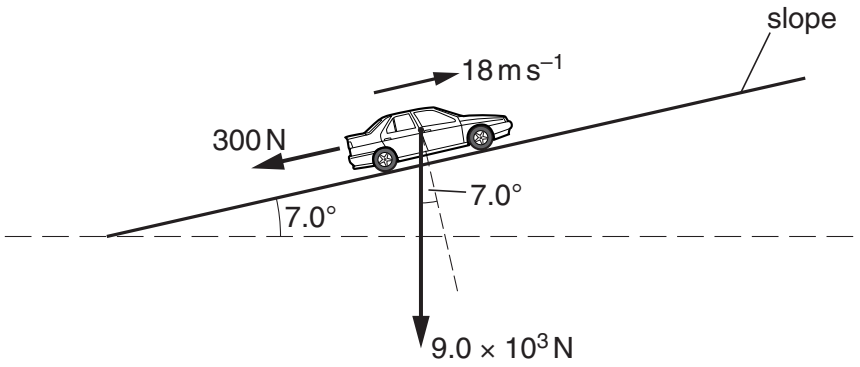


Fig. 3.1

The angle between the slope and the horizontal is 7.0°. The weight of the car is 9.0 × 10^3 N. The car travels up the slope at a constant speed of 18 m s^{-1}. A resistive force of 300 N acts on the car down the slope.

(i) What is the net force acting on the car? Explain your answer.

.....

.....

..... **[2]**

(ii) Calculate the component of the weight of the car acting down the slope.

component of weight = ... N **[2]**

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(iii) Calculate the work done per second against the resistive force.

work done per second = ... Js^{-1} **[1]**

(iv) Calculate the power developed by the car as it travels up the slope.

power = ... W **[3]**

[Total: 9]

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4 **(a)** Write a word equation for *kinetic energy*.

kinetic energy =

[1]

(b) A bullet of mass 3.0×10^{-2} kg is fired at a sheet of plastic of thickness 0.015 m. The bullet enters the plastic with a speed of 200 m s^{-1} and emerges from the other side with a speed of 50 m s^{-1}.

Calculate

(i) the loss of kinetic energy of the bullet as it passes through the plastic

loss of kinetic energy = ... J **[3]**

(ii) the average frictional force exerted by the plastic on the bullet.

frictional force = ... N **[2]**

[Total: 6]

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5 Use your knowledge of physics to state if each statement is correct or incorrect. You then need to explain the reason for your answer. An example has been done for you:

In a vacuum, a 2.0 kg object will fall faster towards the ground than an object of mass 1.0 kg.

This statement is **incorrect**.
Explanation: **All objects falling towards the Earth in a vacuum have the same acceleration**.

(a) The mass of a particle (e.g. electron) remains constant as its speed approaches the speed of light.

This statement is .....

Explanation: .....

.....

..... **[2]**

(b) A ball is thrown vertically upwards. Air resistance has negligible effect on its motion. During the flight, the total energy of the ball remains constant.

This statement is .....

Explanation: .....

.....

..... **[2]**

(c) An object falling through air has a terminal velocity of 30 m s^{-1}. At terminal velocity, the weight of the object is equal to the acceleration of free fall.

This statement is .....

Explanation: .....

.....

..... **[2]**

(d) The technique of 'triangle of vectors' is used by a global positioning system (GPS) to locate the position of cars.



In your answer, you should use appropriate technical terms, spelled correctly.

This statement is .....

Explanation: .....

.....

..... **[2]**

[Total: 8]

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6 **(a)** Explain in terms of forces what is meant by a *couple*.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

..... **[1]**

(b) **(i)** Define *moment of a force*.

.....

..... **[1]**

(ii) Fig. 6.1 shows three forces acting on a rod.

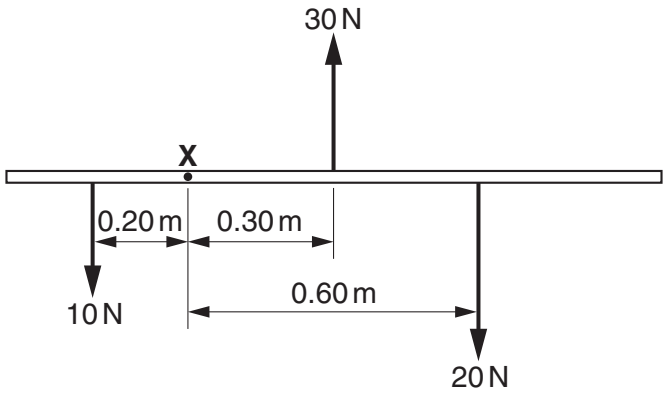


Fig. 6.1

By taking moments about point **X**, show that the rod is not in equilibrium when acted upon by these forces.

.....

..... **[2]**

[Total: 4]

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7 **(a)** Fig. 7.1 shows stress against strain graphs for materials **X**, **Y** and **Z** up to their breaking points.

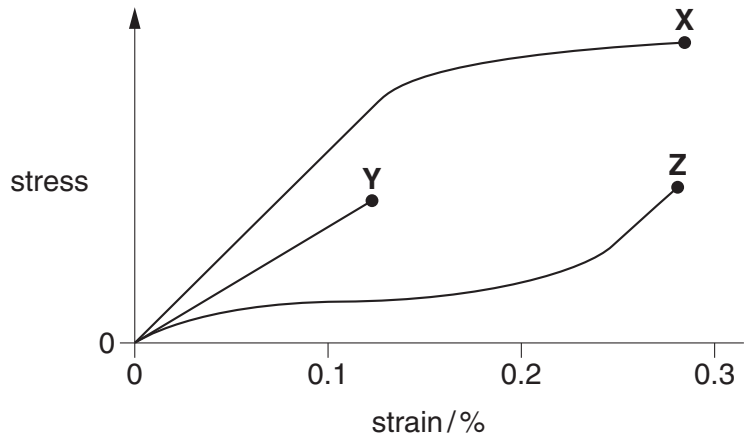


Fig. 7.1

(i) State which of these three materials is brittle.

..... **[1]**

(ii) State one similarity between the properties of materials **X** and **Y** for strains less than 0.05%.

.....

..... **[1]**

(iii) State and explain which material has the greatest value for the Young modulus.

.....

.....

..... **[2]**

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(b) Engineers are testing a new material to be used as support cables for a bridge. In a laboratory test, the breaking force for a sample of the material of diameter 0.50 mm is 240 N. Estimate the breaking force for a cable of diameter 15 mm made from the same material.

breaking force = ... N **[2]**

[Total: 6]

Please turnover for Question 8.

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8 A small block of wood is held at a horizontal distance of 1.2 m from a metal ball. The metal ball is fired horizontally towards the block at a speed of 8.0 m s^{-1}. At the same instant the ball is fired, the block is released and it falls vertically under gravity.

Fig. 8.1 shows the paths of the metal ball and the block. The ball collides with the block. Air resistance is negligible.

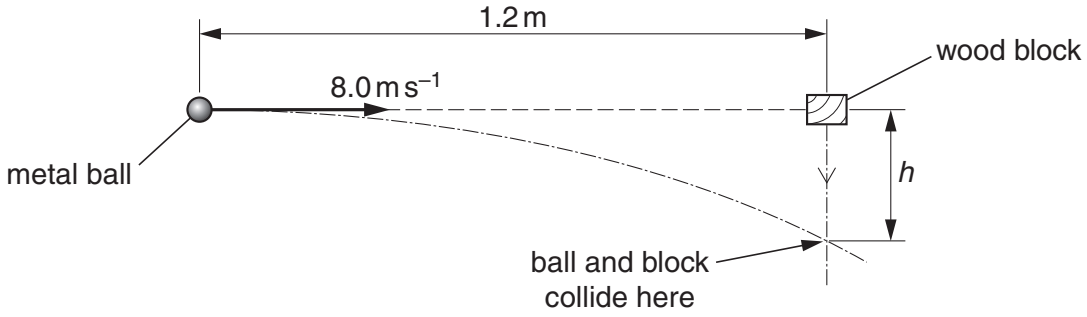


Fig. 8.1

(a) Show that the time between firing the ball and it colliding with the block is 0.15 s.

[1]

(b) Calculate the vertical distance *h* fallen by the wooden block when it collides with the metal ball.

h = ... m **[2]**

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(c) Briefly explain why the metal ball will always collide with the wood block, even if the speed of the ball or the horizontal distance is changed.

.....

.....

..... **[1]**

[Total: 4]

END OF QUESTION PAPER

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GCE

Physics A

Advanced Subsidiary GCE

Unit **G481:** Mechanics

Mark Scheme for January 2011

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1. Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
allow	=	answers that can be accepted
not	=	answers which are not worthy of credit
reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant
( )	=	words which are not essential to gain credit
__	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW	=	alternative wording
ora	=	or reverse argument

2. Annotations: the following annotations are available on SCORIS.

✓	=	correct response
✗	=	incorrect response
AE	=	arithmetic error
BOD	=	benefit of the doubt (where professional judgement has been used)
NBOD	=	benefit of the doubt **not** given
ECF	=	error carried forward
^	=	information omitted
CON	=	contradiction (in cases where candidates contradict themselves in the same response)
RE	=	rounding error
SF	=	error in the number of significant figures
POT	=	error in the power of 10 in a calculation
?	=	wrong physics or equation
NAQ	=	not answered question
FT	=	follow through

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CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

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Q 1	Expected Answers	Marks	Additional Guidance
a	work done $\rightarrow$ N m stress $\rightarrow$ N m^{-2} density $\rightarrow$ kg m^{-3}	B2	**Allow** 2 marks if all correct **Allow** 1 mark if one or two responses are correct
b(i)	weight / gravitational force	B1	**Not** 'gravity'
b(ii)	(force =) 4.8×9.81 (= 47.1 N) pressure = $\frac{4.8 \times 9.81}{0.085 \times 0.085}$ pressure = 6.52×10^3 (Pa)	C1 A1	**Note:** 2 marks for bald 2 sf answer of 6.5×10^3 (Pa) **Allow** 1 mark for '$48/0.085^2 = 6.64 \times 10^3$'; *g* taken as 10 (N kg^{-1}) **Allow** 1 mark for '$4.8 \times 9.81/8.5^2 = 0.65$' **Not** 'mass/area' since it is 'wrong physics'.
b(iii)	8 4 2	B1 B1 B1	 This must be consistent with the values for mass and cross-sectional area.
	Total	**8**	

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Q2	Expected Answers	Marks	Additional Guidance
a	The distance travelled (by the car) from when the driver sees a problem and the brakes are applied	B1	**Note**: There must be reference to 'stimulus' and brakes. **Not**: 'speed × reaction time'
b	Distance / displacement	B1	
c(i)	distance = 20 × 0.5 distance = 10 (m)	B1	
c(ii)	distance = area under graph distance = ½ × 20 × 3.5 distance = 35 (m)	 C1 A1	 **Allow** 1 mark if stopping distance of 45 m quoted No marks for an answer of '20 × 3.5 = 70 (m)'
d(i)	gradient = 'acceleration' / $a = \frac{v-u}{t}$ / $a = \frac{\Delta v}{\Delta t}$ $a = (-)\frac{20}{3.5}$ deceleration = 5.71(4) ≈ 5.7 (m s^2)	C1 A1	The first mark is for selecting correct equation or stating a = gradient **Note**: Ignore negative sign
d(ii)	force = 910 × 5.71 force ≈ 5200 (N)	C1 A1	 Possible ecf from **(d)(i)**
e	Increases by a factor of 4 Braking distance ∝ speed^2 / '$Fx = ½ mv^2$' / speed doubles and time doubles	B1 B1	

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Q2	Expected Answers	Marks	Additional Guidance
f			**Must use ticks on Scoris to show where the marks are awarded**
	Large deceleration / rapid decrease in speed (triggers the air bag)	B1	**Not** 'quick / sudden / rapid deceleration' **Not** 'large acceleration'
	Prevent collision with steering wheel / windscreen / dashboard	B1	
	Time (for stopping) is more / distance (for stopping) is more	B1	
	Smaller deceleration / acceleration (of person)	B1	**Allow**: 'smaller rate of change of momentum' **Not** 'smaller rate of deceleration'
	Total	**15**	

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Q3	Expected Answers	Marks	Additional Guidance
a	work (done) = force × distance moved in the direction of force	B1	**Allow**: work = force × displacement in direction of force **Not**: work (done) = energy transfer
b(i)	(Net /total /resultant force is) zero The acceleration is zero	B1 B1	 **Not** 'a = 0'
b(ii)	$9.0 \times 10^3 \cos 83°$ or $9.0 \times 10^3 \sin 7°$ 1.1×10^3 (N)	C1 A1	 **Not** '$9.0 \times 10^3 \cos 7°$'
b(iii)	work done per second = 300 × 18 work done per second = 5400 (J s^{-1})	 B1	
b(iv)	(total force down slope =) 1100 + 300 (N) (power =) 1400 × 18 (power =) 2.52×10^4 (W) or 2.5×10^4 (W) or rate of work done against weight = $1.1 \times 10^3 \times 18$ (= 19800 W) power = 19800+ 5400 power = 2.52×10^4 (W) or 2.5×10^4 (W)	C1 C1 A1 C1 C1 A1	**Allow**: 1400 (N) Possible ecf from **(b)(ii)** **Allow**: '$Fx\cos\theta = 9.0 \times 10^3 \times 18 \times \cos 83°$' Possible ecf from **(b)(ii)** and **(b)(iii)**
	Total	**9**	

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Q4	Expected Answers	Marks	Additional Guidance
a	kinetic energy = ½ × mass × speed^2	B1	**Allow** KE = ½ mv^2, where m = mass and v = speed **Allow** velocity instead of speed **Not**: KE = ½ mv^2 on its own
b(i)	initial KE = ½ × 3.0 × 10^{-2} × 200^2 (= 600 J) final KE = ½ × 3.0 × 10^{-2} × 50^2 (= 37.5 J) Loss in KE = 600 – 37.5 Loss in KE = 562.5 (J) ≈ 560 (J)	C1 C1 A1	 **Special case**: 1 mark for 'KE = ½ mv^2 ... loss in KE = (½ × 3.0 × 10^{-2} × 200 - ½ × 3.0 × 10^{-2} × 50 =) 2.25 (J)' **Note:** No marks for 337.5 (J) when Δv used in the KE equation (½ × 3.0 × 10^{-2} × 150^2 = 337.5 J)
b(ii)	work done = (loss in) KE / $a = (v^2 - u^2)/2s$ F × 1.5 × 10^{-2} = 562.5 / a = (-) 1.25 × 10^6 force = 3.75 × 10^4 (N)	 C1 A1	 Possible ecf from **(b)(i)** **Allow**: A 2 sf answer of either 3.8 × 10^4 (N) or 3.7 × 10^4 (N)
	Total	**6**	

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Q5	Expected Answers	Marks	Additional Guidance
a	…incorrect Mass (of the particle) increases (as it approaches speed of light)	M1 A1	**In question 5, use tick or cross on Scoris to show if the mark is awarded** **Not**: mass *changes*
b	….correct KE is changed into (G)PE or (G)PE is changed into KE or change in KE = change in (G)PE (AW)	M1 A1	 **Note**: This mark is for stating the transfer of energy between kinetic and (gravitational) potential
c	…incorrect Weight is equal to drag / air resistance / friction (and not acceleration of free fall)	M1 A1	Allow **alternative** response: ……. incorrect M1 Acceleration and weight are not the same quantities (AW) A1
d	…incorrect The technique is trilateration ✍ **The term *trilateration* to be included and spelled correctly to gain the A1 mark**	M1 A1	 **Note** 1 mark if 'trilateration' is misspelled but candidate has mentioned that the statement is incorrect
	Total	**8**	

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Q6	Expected Answers	Marks	Additional Guidance
a	A pair of <u>equal</u> and <u>opposite</u> forces (with their lines of action separated by a distance) ✎ **The term *opposite* to be included and spelled correctly to gain mark**	B1	**Must use tick or cross on Scoris to show if the mark is awarded** No mark can be scored if there is no reference 'opposite'. (Allow 'opposing')
b(i)	moment = force × <u>perpendicular</u> distance from pivot / axis / point	B1	
b(ii)	(clockwise moment =) 20 × 0.60 <u>and</u> (anticlockwise moments =) 10 × 0.20 + 30 × 0.30 (Not in equilibrium because) clockwise moment ≠ anticlockwise moment / clockwise moment > anticlockwise moment / 12 (Nm) > 11 (Nm) / 12 (Nm) ≠ 11 (Nm)	M1 A1	**Allow** a correct moments equation involving all three forces
	Total	**4**	

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Q7	Expected Answers	Marks	Additional Guidance
a(i)	**Y** (is brittle)	B1	
a(ii)	(Both) obey Hooke's law	B1	**Allow** (For both) stress ∝ strain / elastic (behaviour) / 'not plastic (behaviour)' / force ∝ extension **Not**: 'straight line(s)'
a(iii)	Gradient (of the linear section) is equal to Young Modulus / gradient is largest **X** (has largest Young modulus)	B1 B1	**Allow**: 'slope' for 'gradient'
b	(force increases by a factor of) 30^2 force = 240×30^2 force = 2.16×10^5 (N)	C1 A1	 **Allow**: 1 mark for value of breaking stress of $1.2(2) \times 10^9$ (Pa)
	Total	**6**	

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Q8	Expected Answers	Marks	Additional Guidance
a	time = 1.2/8.0 time = 0.15 (s)	M1 A0	**Note**: The mark is for dividing the distance by the speed – hence must be seen
b	$s = ut + \frac{1}{2}at^2$ and $u = 0$ / $s = \frac{1}{2}at^2$ / $h = \frac{1}{2} \times 9.81 \times 0.15^2$ $h = 0.11$ (m)	C1 A1	
c	They both have same (vertical) acceleration / same acceleration of free fall / acceleration of 9.8 ms^{-2} (and zero initial vertical velocity)	B1	**Note**: Must have reference to both objects
	Total	**4**	

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ADVANCED SUBSIDIARY GCE
PHYSICS A
Mechanics

G481

Candidates answer on the Question Paper

OCR Supplied Materials:
- Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator
- Ruler (cm/mm)
- Protractor

Thursday 27 May 2010
Afternoon

Duration: 1 hour

OCE/23014

G4831

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but must clearly show your Candidate Number, Centre Number and question number(s).

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

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Turn over

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Answer **all** the questions.

1 **(a)** Complete the table of Fig. 1.1 by stating the value or name of each of the remaining three prefixes.

prefix	value
micro (μ)	10^{-6}
mega (M)	
	10^{-9}
tera (T)	

Fig. 1.1

[3]

(b) Circle all the scalar quantities in the list below.

density **weight** **velocity** **volume** **acceleration**

[1]

(c) The distance between the Sun and the Earth is 1.5×10^{11} m. Calculate the time in minutes for light to travel from the Sun to the Earth. The speed of light is $3.0 \times 10^{8}\,m\,s^{-1}$.

time = ... min **[2]**

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(d) The terminal velocity of a raindrop falling vertically through air is $4.0\,m\,s^{-1}$.

(i) In terms of the forces acting on the raindrop, explain why it is at terminal velocity.

.....

.....

..... **[2]**

(ii) Fig. 1.2 shows a velocity vector diagram for the falling raindrop in a horizontal crosswind of speed $1.5\,m\,s^{-1}$.

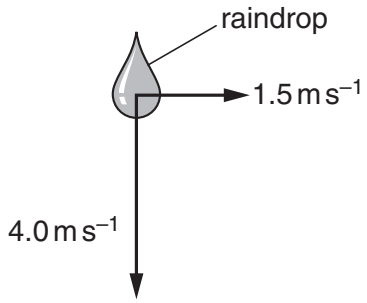


Fig. 1.2

1 On Fig. 1.2, draw an arrow on the raindrop to show the **direction** in which it will travel.

2 Calculate the magnitude of the resultant velocity of the raindrop. Use the space below for your working.

resultant velocity = ... $m\,s^{-1}$ **[3]**

[Total: 11]

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2 **(a)** According to Aristotle (384 – 322 B.C.)

'heavier objects fall faster than lighter ones'.

Explain how one experiment carried out by Galileo (1564 – 1642) overturned Aristotle's ideas of motion.

.....

.....

.....

.....

.....

..... **[3]**

(b) Fig. 2.1 shows an arrangement used in the laboratory to determine the acceleration *g* of free fall.

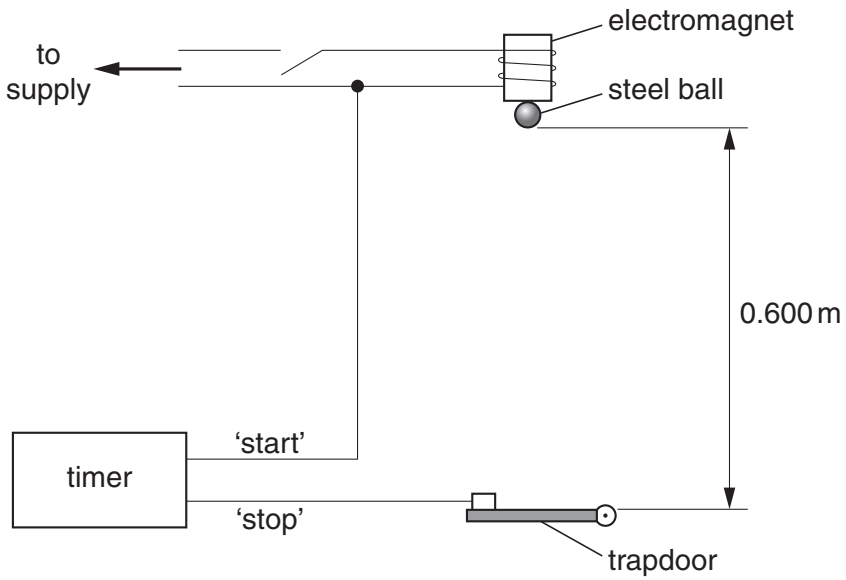


Fig. 2.1

The steel ball is held at rest by an electromagnet. When the electromagnet is switched off, the electronic timer is started and the ball falls. The timer is stopped when the ball opens the trapdoor. The distance between the bottom of the ball and the top of the trapdoor is 0.600 m. The timer records a time of fall of 0.356 s.

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(i) Show that the value for the acceleration g of free fall obtained from this experiment is $9.47\,m\,s^{-2}$.

[2]

(ii) State **one** reason why the experimental value in **(i)** is less than $9.81\,m\,s^{-2}$.

.....

.....

..... **[1]**

(iii) On Fig. 2.2 sketch a graph to show the variation of the vertical distance s fallen by the ball with time t.

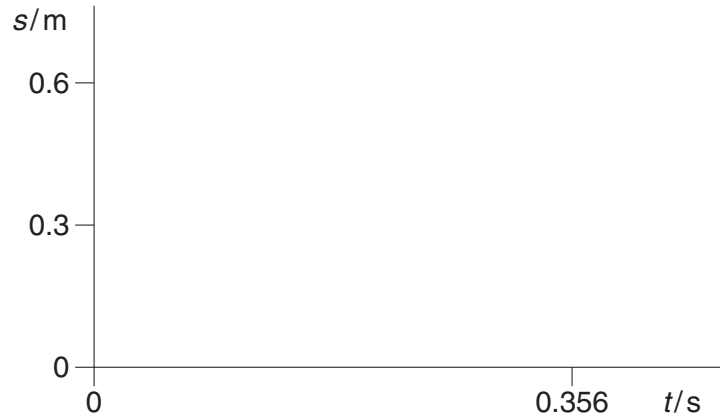


Fig. 2.2

[1]

[Total: 7]

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3 **(a)** Define the *newton*.

.....

..... **[1]**

(b) Fig. 3.1 shows a spaceship on the surface of the Earth.

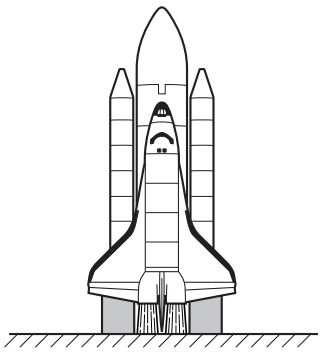


Fig. 3.1

The mass of the spaceship is 1.9×10^6 kg. During lift off, the spaceship rockets produce a vertical upward force of 3.1×10^7 N.

(i) Calculate the weight of the spaceship.

weight = ... N **[1]**

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(ii) Calculate the initial vertical acceleration as the spaceship lifts off.

acceleration = ... $m\,s^{-2}$ **[2]**

(iii) The vertical upward force on the spaceship stays constant. Explain why the acceleration of the spaceship increases after lift off.

.....

.....

.....

..... **[1]**

[Total: 5]

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4 **(a)** Define *work done* by a force.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(b) Fig. 4.1 shows a side view of a roller coaster.

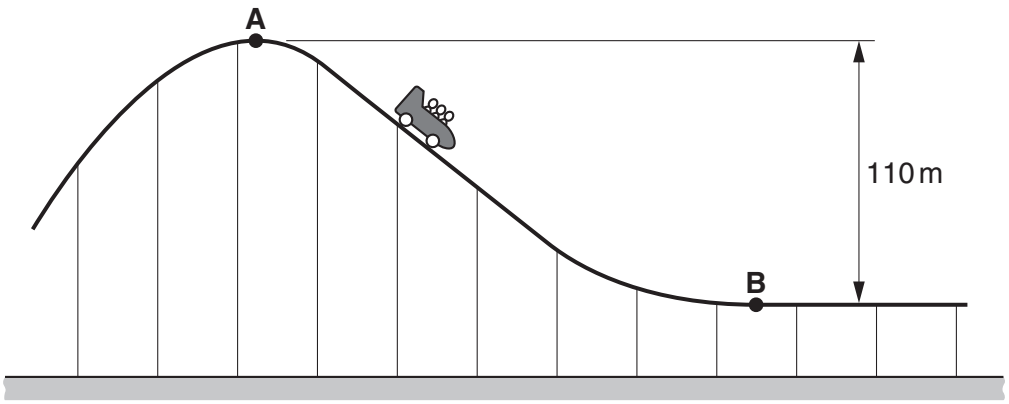


Fig. 4.1

The carriage and its passengers start at rest at **A**. At **B**, the bottom of the ride, the maximum speed of the carriage is $20\,m\,s^{-1}$. The vertical distance between **A** and **B** is 110 m. The length of the track between **A** and **B** is 510 m. The mass of the carriage and the passengers is 4000 kg.

(i) Complete the sentence below.

In your answer, you should use appropriate technical terms, spelled correctly.

As the carriage travels from **A** to **B**, ……..…… energy

is transferred to …… energy and heat. **[2]**

(ii) By considering this energy transfer from **A** to **B**, determine the average frictional force acting on the carriage and passengers between **A** and **B**.

force = ... N **[3]**

[Total: 6]

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5 **(a)** Define *braking distance* of a car.

.....

.....

..... **[1]**

(b) Other than the speed of the car, state two factors that affect the braking distance of a car. Describe how the braking distance is affected by each factor.

1. .....

.....

.....

.....

2. .....

.....

.....

..... **[4]**

(c) Describe and explain how seat belts in cars reduce impact forces on the driver in an accident.

.....

.....

.....

.....

.....

.....

..... **[3]**

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(d) Fig. 5.1 shows the variation of braking distance with speed v of a car.

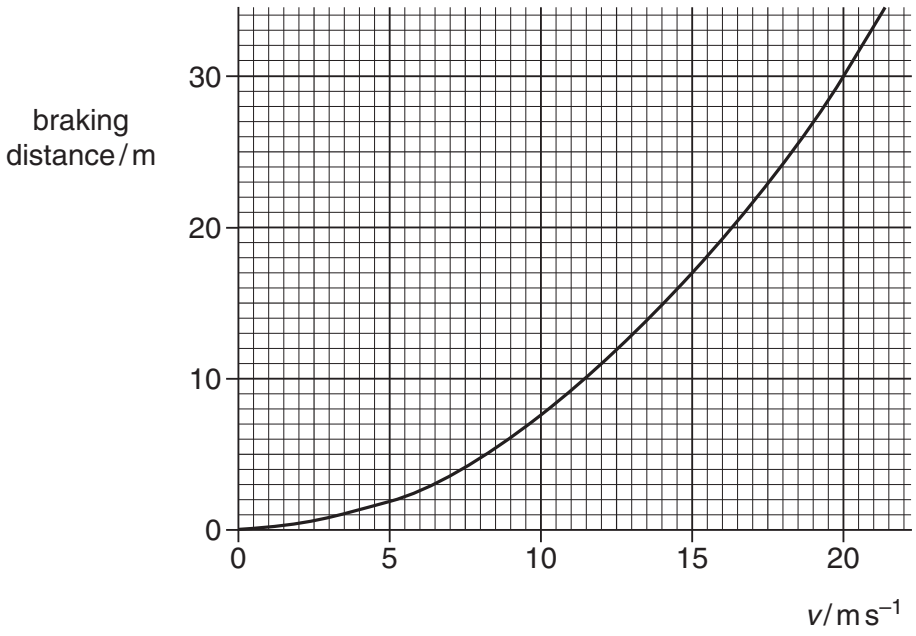


Fig. 5.1

(i) The car is travelling on a level straight road at a speed of $20\,m\,s^{-1}$. The reaction time of the driver is 0.50 s.

1 Calculate the thinking distance.

thinking distance = ... m

2 Hence, determine the stopping distance of the car.

stopping distance = ... m
[3]

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(ii) In Fig. 5.1, the braking distance is directly proportional to the square of the speed. Determine the braking distance of the car when travelling at a speed of $32\,m\,s^{-1}$.

braking distance = ... m **[2]**

[Total: 13]

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6 **(a)** Fig. 6.1 shows two equal but opposite forces acting on an object.

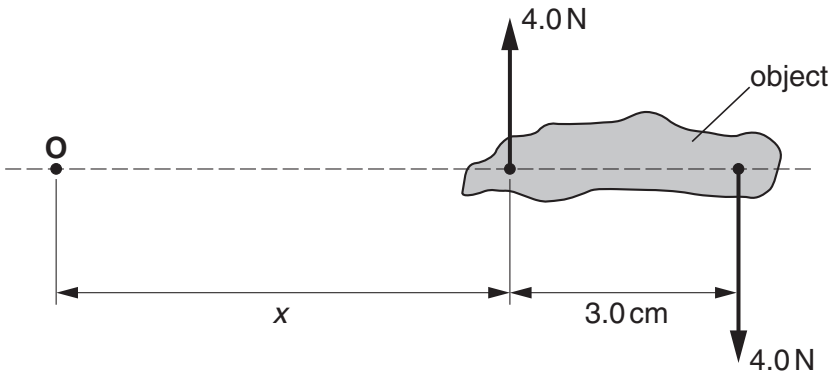


Fig. 6.1

The point **O** is at a distance *x* from the nearer of the two forces.

(i) The separation between the two parallel forces is 3.0 cm. Determine the torque of the couple exerted on the object.

torque = ... N m **[2]**

(ii) Calculate the total moment of the forces about the point **O** and state the significance of this value.

.....

..... **[3]**

(b) State two conditions necessary for an object to be in equilibrium.

.....

.....

..... **[2]**

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(c) A concrete paving slab has mass 45 kg and dimensions 0.600 m × 0.600 m × 0.050 m.

(i) Calculate the density of the concrete.

density = ... kg m^{-3} **[2]**

(ii) Fig. 6.2 shows the concrete paving slab in equilibrium.

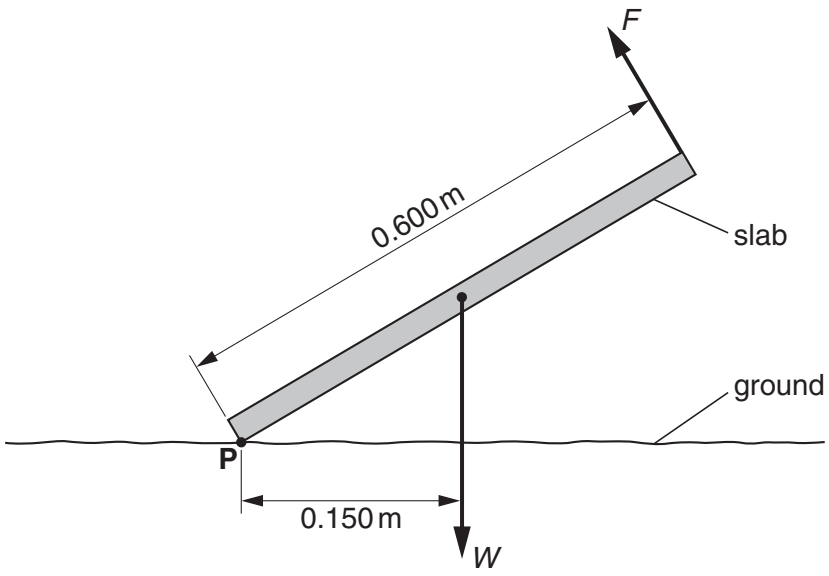


Fig. 6.2

Two forces acting on the slab are shown. The weight of the slab is *W*. The force *F* is applied at right angles to the end of the slab. By taking moments about **P**, determine the size of the force *F*.

F = ... N **[3]**

[Total: 12]

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7 **(a)** Fig. 7.1 shows stress against strain graphs for two materials **X** and **Y** up to their breaking points.

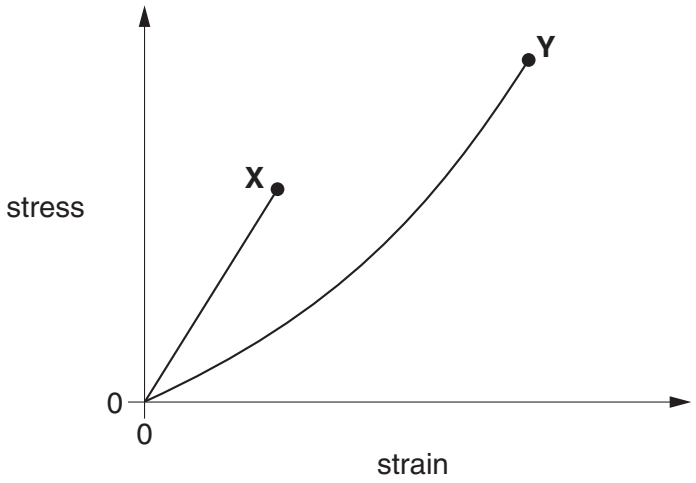


Fig. 7.1

Put a tick (✓) in the appropriate column if the statement applies to the material.

Statement	**X**	**Y**
This material is brittle.		
This material has greater breaking stress.		
This material obeys Hooke's Law.		

[1]

(b) Kevlar is one of the strongest man-made materials. It is used in reinforcing boat hulls, aircraft, tyres and bullet-proof vests. Sudden impacts cause this material to undergo plastic deformation.

(i) Explain what is meant by *plastic deformation*.

.....

.....

..... **[1]**

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(ii) One particular type of Kevlar has breaking stress 3.00×10^9 Pa and Young modulus 1.30×10^{11} Pa. For a Kevlar thread of cross-sectional area 1.02×10^{-7} m^2 and length 0.500 m, calculate

1 the maximum breaking force

force = ... N

2 the extension of the thread when the stress is 1.20×10^9 Pa.

extension = ... m
[4]

[Total: 6]

END OF QUESTION PAPER

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

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Convention used when marking scripts

WRONG PHYSICS OR EQUATION – indicate by **?** on scoris
No credit is given for correct substitution, or subsequent arithmetic, in a physically incorrect equation.

ERROR CARRIED FORWARD – indicate by **ECF** on scoris
Answers to later sections of numerical questions may be awarded up to full credit provided they are consistent with earlier incorrect answers.

ARITHMETIC ERROR – indicate by **AE** on scoris
Deduct 1 mark for the error and then follow through the working/calculation giving full credit for subsequent marks if there are no further errors. The ruling also includes power of ten (POT).

TRANSCRIPTION ERROR – indicate by ^ on scoris
This error is when there is incorrect transcription of data from the question, formulae booklet or previous answer. For example 1.6×10^{-19} has been written down as 6.1×10^{-19} or 1.6×10^{19}. Deduct the relevant mark and then follow through the working giving full credit for subsequent marks.

SIGNIFICANT FIGURES – indicate by **SF** on scoris
Where more SFs are given than is justified by the question, do not penalise. Fewer significant figures than necessary will be considered within the mark scheme. An error in significant figures is penalised only once per paper.

BENEFIT OF DOUBT – indicate by **BOD** on scoris
This mark is awarded where the candidate provides an answer that is not totally satisfactory, but the examiner feels that sufficient work has been done.

RUBRIC INFRINGEMENT
If the candidate crosses out an answer but does not make any other attempt, then the work that is crossed out should be marked and the marks awarded without penalty.

CONTRADICTION – indicate by **CON** on scoris
No mark can be awarded if the candidate contradicts himself or herself in the same response. For example, '… t*he mass of the particle increases and decreases*.'

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Q 1	Expected Answers	Marks	Additional Guidance
a	10^6 nano (n) 10^{12}	B1 B1 B1	**Allow**: 1000 000 **Allow**: nano / n / nano (N) as BOD **Allow**: 1000 000 000 000
b	Circled quantities: density and volume	B1	
c	$1.5\times10^{11} = 3.0\times10^{8}\times t$ time = $\frac{1.5\times10^{11}}{3.0\times10^{8}}$ / 500 (s) time = 8.33 (min) ≈ 8.3 (min)	C1 A1	**Allow**: Any subject **Note**: Bald 500 (s) scores 1 mark **Allow**: 2 marks for a bald answer of 8.3 **Allow**: Answer as a fraction – 25/3 (min) / 8 min 20 s **Allow**: 1 mark for '(500/3600 =) 0.139'
d(i)	Mention of weight or drag Net / total / resultant force (on drop) is zero 'upward force = downward force' / 'weight = drag' / 'weight balances drag'	B1 B1	**Allow:** (air) resistance / (air) friction for 'drag' **Not:** 'gravity' for 'weight' **but** 'force of gravity' is fine **Not**: 'acceleration = 0' since question requires answer in terms of forces **Not**: 'All forces are equal' **Note**: 'weight = drag' / 'weight balances drag' scores 2 marks
d(ii)1	A downward line / arrow (from the raindrop) leaning to the right	B1	**Note**: Answer **must** be on Fig. 1.2 Judge by eye – the angle is not important
d(ii)2	$v^2 = 1.5^2 + 4.0^2$ velocity = 4.27 (m s^{-1}) ≈ 4.3 (m s^{-1})	C1 A1	**Allow**: 2 marks for a scale drawing with value in the range 4.1 to 4.5. If value in the range 4.0 to 4.1 or 4.5 to 4.6 then give 1 mark **Allow**: 2 marks for a bald answer of 4.3 (m s^{-1})
	Total	**11**	

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Q 2	Expected Answers	Marks	Additional Guidance
a	'heavy' and 'light' objects / different weights / different masses dropped (from leaning tower of Pisa) / rolled down incline plane Objects have the same <u>acceleration</u> (of free fall) Objects hit ground at same time	B1 B1 B1	**Must use ticks on Scoris to show where the marks are awarded** **Not**: 'dropping feather' / 'vacuum' / 'experiment on the Moon' for this first B1 mark but can score subsequent B1 marks **Not**: 'fall at the same rate / accelerates at the same rate / same speed'
b(i)	$s = ut + \frac{1}{2}at^2$ <u>and</u> $u = 0$ / $0.600 = \frac{1}{2} \times a \times (0.356)^2$ $a = \frac{2 \times 0.600}{0.356^2}$ $a = 9.47$ (m s^{-2})	C1 C1 A0	**Note**: There are no marks for just an answer, since this is a **'show'** question **Allow**: 2 marks for correct substitution with 'a' the subject or $0.600 = \frac{1}{2} \times a \times (0.356)^2$ followed by $a = 9.469$ (more than 3 sf) **Note:** Using 'v =.600/0.356' followed by $a = \Delta v / \Delta t = 4.73$ scores zero. (Watch out for $4.734 \times 2 = 9.47$)
b(ii)	Air resistance or drag / residual magnetism or 'sticky' electromagnet / trapdoor takes time to open	B1	**Not**: 'Experiment is not done in a vacuum' / 'friction/resistance'
b(iii)	A 'parabola shape' / graph of increasing positive gradient starting from <u>origin</u> and going through 0.356,0.6	B1	Judge the shape of the graph by eye. A horizontal line from 0.6 must cut the graph within the 'vertical zone provided by 0.356 s ' on the time axis
	Total	**7**	

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Q 3	Expected Answers	Marks	Additional Guidance
a	The (net) force (is a newton) when a 1 kg mass has acceleration of 1 m s^{-2}	B1	**Not**: 1 N = 1 kg m s^{-2} because this is too brief for a definition
b(i)	weight = $1.9 \times 10^6 \times 9.81$ weight = 1.86×10^7 (N)	 B1	**Allow**: 9.8 (m s^{-2}) for *g* but not 10 (m s^{-2}) **Allow**: A bald answer of 1.9×10^7 N, but **not** if 10 (m s^{-2}) is seen
b(ii)	net force = 1.24×10^7 (N) or 1.2×10^7 (N) $a = \frac{F}{m} = \frac{1.24 \times 10^7}{1.9 \times 10^6}$ acceleration = 6.53 (m s^{-2}) or 6.5 (m s^{-2})	C1 A1	**Allow**: The C1 mark for "(net force) = $(3.1 - 1.86) \times 10^7$ (N)" **Allow**: 2 marks for a bald answer **Allow**: Answer of 6.3 (m s^{-2}) if 1.9×10^7 (N) is used for weight or net force of 1.2×10^7 (N) is used **Allow**: 1 mark for '$3.1 \times 10^7 / 1.9 \times 10^6 = 16.3$' **Not:** '$1.86 \times 10^7 / 1.9 \times 10^6 = 9.8$'
b(iii)	The mass / weight (of spaceship) decreases (as it loses fuel)	B1	**Allow**: 'g' / acceleration of free fall / gravitational field strength decreases (but **not** gravity decreases) **Not**: 'less drag / air resistance'
	Total	**5**	

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Q 4	Expected Answers	Marks	Additional Guidance
a	✍work done = force × distance <u>moved</u> / <u>travelled</u> (in direction of force) **The term *distance* / *displacement* to be included and spelled correctly to gain mark**	B1	**Note**: Must have reference to 'distance moved / travelled' **Allow**: 'work done = force × displacement' **Must use tick or cross on Scoris to show if the mark is awarded**
b(i)	<u>gravitational</u> potential ✍ kinetic **The term *kinetic* to be included and spelled correctly to gain the second B1 mark**	B1 B1	**Not**: 'potential' on its own **Note**: Ignore any reference to sound **Must use ticks on Scoris to show where the marks are awarded**
b(ii)	(GPE =) $4000 \times 9.81 \times 110$ / (GPE =) 4.32×10^6 **or** (KE =) $\frac{1}{2} \times 4000 \times 20^2$ / (KE =) 8.0×10^5 Work done = $(4000 \times 9.81 \times 110) - (\frac{1}{2} \times 4000 \times 20^2)$ force = $\frac{3.516 \times 10^6}{510}$ force = 6.9×10^3 (N)	C1 C1 A1	 **Allow**: 2 marks if second line is written or $3.5(16) \times 10^6$ (J) is quoted **Allow**: 3 marks for a bald answer of 6.9×10^3 (N)
	Total	**6**	

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Q 5	Expected Answers	Marks	Additional Guidance
a	The distance travelled (by the car) whilst the brakes are applied and the car stops (wtte)	B1	**Note**: The answer must have reference to car stopping
b	Any <u>two</u> factors from: mass, brakes, tyres / tread, road (surface) and 'slope' of road Correct description for each factor; see below: 1. Greater mass increases distance / distance ∝ mass 2. Worn brakes increases distance 3. Bald tyres increases distance (when wet) 4. Wet / icy /gravel road increases distance 5. An uphill road will decrease the distance (ora)	B1×2 B1×2	**Must use ticks on Scoris to show where the marks are awarded** **Allow:** Reference to just 'distance' since '<u>braking</u> distance' is in the question **Note**: For point 3, allow 'less tread increases (braking) distance (when wet)'.
c	Any <u>three</u> from: 1. Prevent collision with steering wheel / windscreen /dashboard 2. Time for stopping is more / distance for stopping is more / seat belt 'stretches' 3. Smaller deceleration / acceleration (of person) 4. Reference to '$KE = Fs$' or '$\frac{1}{2}mv^2 = Fs$'	B1×3	**Must use ticks on Scoris to show where the marks are awarded** **Allow**: Smaller 'rate of change of momentum' for the third B1 point **Not**: Less pressure (on driver because of larger area of belt)

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Q 5	Expected Answers	Marks	Additional Guidance
d(i)1	thinking distance = 0.50 × 20 thinking distance = 10 (m)	B1	
d(i)2	braking distance = 30 (m) stopping distance = (30 + 10 =) 40 (m)	C1 A1	 **Allow**: 2 marks for a bald answer of 40 (m) **Allow**: 1 mark for 'answer to **(d)(i)1** + candidate's braking distance' if braking distance ≠ 30 (m) Possible ecf from **(d)(i)1**
d(ii)	$\frac{s}{32^2} = \frac{30}{20^2}$ / '$k = 0.075$' / '$k = 13.3$' (distance =) 77 (m) ---------- Or ---------- At speed of 16 (m s^{-1}), distance = 19 (m) (distance = $2^2 \times 19$ =) 76 (m)	C1 A1 ------- C1 A1	**Allow**: For the C1 any other equivalent and correct substitution into similar equation **Allow**: An answer in the range 76 - 78. Note bald answer in this range can score 2 marks **Allow**: distance in the range 19 to 19.5 (m) Possible ecf
	Total	**13**	

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Q 6	Expected Answers	Marks	Additional Guidance
a(i)	torque = 4.0×0.03 torque = 0.12 (N m)	C1 A1	**Note**: An answer of 12 scores 1 mark (because cm not converted into m) **Allow**: Full marks for if the centi prefix added; that is 12 N cm **Allow**: 2 marks for a bald 0.12 (N m)
a(ii)	 (total moment =) $(x + 0.03) \times 4.0 - 4.0x$ (total) moment = 0.12 (N m) It is the same as the torque (of the couple) / same as **(a)(i)**	 M1 A1 B1	**Condone** the use of 'N cm' in **a(ii)** **Allow**: Equation with x value of 0.06 (m) or 6 cm **Special case**: 1 mark for (anticlockwise moment =) $4.0x$ or (clockwise moment =) $[x + 0.03] \times 4.0$ seen anywhere on the script **Not**: '0.12 (N m)'
b	Net / total / resultant force = 0 Net / total torque / moment = 0	B1 B1	**Not**: 'forces are balanced' or 'force up = force down' **Allow**: clockwise moment(s) = anticlockwise moment(s)
c(i)	$\rho = \frac{M}{V}$ / density = $\frac{45}{0.600 \times 0.600 \times 0.050}$ density = 2.5×10^3 (kg m^{-3})	C1 A1	 **Allow**: 2 marks for a bald answer of 2.5×10^3 (kg m^{-3})
c(ii)	clockwise moment = anticlockwise moment **or** (weight =) 45×9.81 / (weight =) 441.45 $(45 \times 9.81) \times 0.150 = F \times 0.600$ F = 110 (N)	C1 C1 A1	 **Allow**: 3 marks for a bald 110 (N) **Allow**: 2 marks for 11.25 – mass of 45 kg not changed to N
	Total	**12**	

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<table>
<tr><th>Q 7</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td>a</td><td><table><tr><th>X</th><th>Y</th></tr><tr><td>✓</td><td></td></tr><tr><td></td><td>✓</td></tr><tr><td>✓</td><td></td></tr></table></td><td>B1</td><td>All 3 ticks correctly placed for 1 mark</td></tr>
<tr><td>b(i)</td><td>Material is permanently deformed / longer when stress / force is removed (wtte)</td><td>B1</td><td>Note: The answer must make reference to stress or forces <u>removed</u></td></tr>
<tr><td>b(ii)1</td><td>(stress = force/area)
force = $3.00 \times 10^{9} \times 1.02 \times 10^{-7}$

force = 306 (N) or 310 (N)</td><td>C1

A1</td><td>Allow: Any subject

Allow: 2 marks for a bald 306 (N) or 310 (N)</td></tr>
<tr><td>b(ii)2</td><td>(E = stress/strain)
strain = $\frac{1.20 \times 10^{9}}{1.30 \times 10^{11}}$ / strain = 9.23×10^{-3}
extension = $9.23 \times 10^{-3} \times 0.500$

extension = $4.6(15) \times 10^{-3}$ (m)</td><td>C1

A1</td><td>Allow: 4.6×10^{-3}, 4.61×10^{-3}, 4.62×10^{-3}
Allow: 2 marks for a bald $4.6(15) \times 10^{-3}$ (m)
Allow: 1 mark for using breaking stress of 3.0×10^{9} Pa; this gives an extension of 0.0115 (m)

Alternative answer:
$x = (1.20 \times 10^{9} \times 0.500)/1.30 \times 10^{11}$ C1 (Any subject)
extension = $4.6(15) \times 10^{-3}$ (m) A1</td></tr>
<tr><td></td><td>Total</td><td>6</td><td></td></tr>
</table>

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THIS IS A NEW SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE
PHYSICS A
Mechanics

G481

Candidates answer on the Question Paper

OCR Supplied Materials:
Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator
- Ruler (cm/mm)
- Protractor

Wednesday 13 January 2010
Morning

Duration: 1 hour

OCE/19073

G4811

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.

Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means for example you should:
- ensure that text is legible and that spelling, punctuation and grammar are accurate so that the meaning is clear;
- organise information clearly and coherently, using specialist vocabulary when appropriate.

- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **16** pages. Any blank pages are indicated.

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Turn over

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Answer **all** the questions.

1 **(a)** Draw a line from each unit on the left-hand side to the correct equivalent unit on the right-hand side.

joule (J)	kg m s^{-2}
watt (W)	N m
newton (N)	J s^{-1}

[2]

(b) This question is about estimating the pressure exerted by a person wearing shoes standing on a floor, see Fig. 1.1.

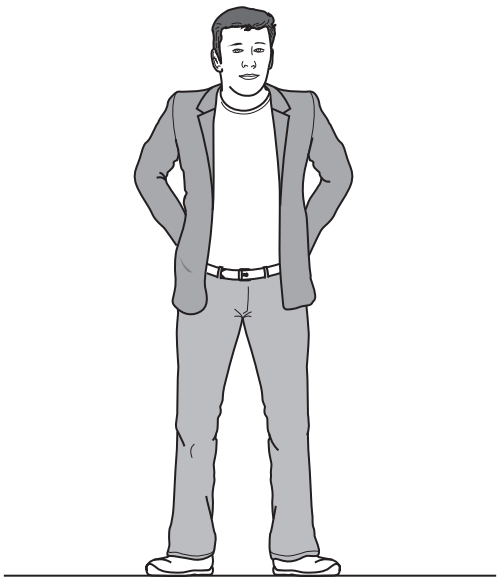


Fig. 1.1

(i) Estimate the weight in newtons of a person.

weight = ... N **[1]**

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(ii) Estimate the total area of contact in square metres between the shoes of this person and the floor.

area = ... m^2 **[1]**

(iii) Hence estimate the pressure in pascals exerted by this person standing on the floor.

pressure = ... Pa **[1]**

[Total: 5]

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2 Fig. 2.1 shows two masses **A** and **B** tied to the ends of a length of string. The string passes over a pulley. The mass **A** is held at rest on the floor.

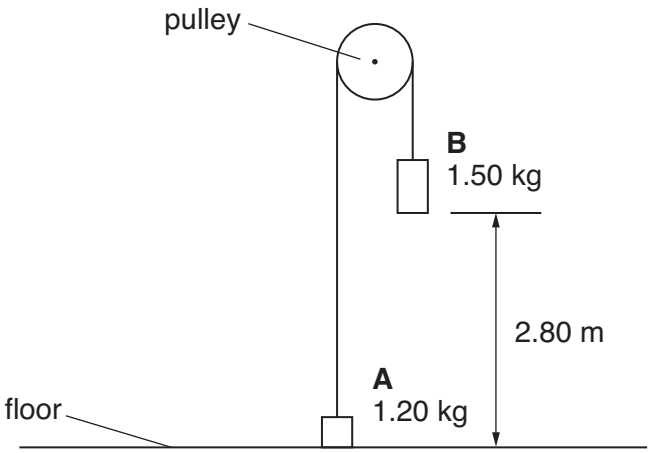


Fig. 2.1

The mass **A** is 1.20 kg and the mass **B** is 1.50 kg.

(a) Calculate the weight of mass **B**.

weight = ... N **[1]**

(b) Mass **B** is initially at rest at a height of 2.80 m above the floor. Mass **A** is then released. Mass **B** has a constant downward acceleration of 1.09 m s^{-2}. Assume that air resistance and the friction between the pulley and the string are negligible.

(i) In terms of forces, explain why the acceleration of the mass **B** is less than the acceleration of free fall *g*.

.....

..... **[1]**

(ii) Calculate the time taken for the mass **B** to fall 1.40 m.

time = ... s **[3]**

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(iii) Calculate the velocity of mass **B** after falling 1.40 m.

velocity = ... $m\,s^{-1}$ **[2]**

(iv) Mass **B** hits the floor at a speed of $2.47\,m\,s^{-1}$. It **rebounds** with a speed of $1.50\,m\,s^{-1}$. The time of contact with the floor is 3.0×10^{-2} s. Calculate the magnitude of the average acceleration of mass **B** during its impact with the floor.

acceleration = ... $m\,s^{-2}$ **[2]**

[Total: 9]

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3 A lift has a mass of 500 kg. It is designed to carry a maximum of 8 people of total mass 560 kg. The lift is supported by a steel cable of cross-sectional area $3.8 \times 10^{-4}\,m^2$. When the lift is at ground floor level the cable is at its maximum length of 140 m, as shown in Fig. 3.1. The mass per unit length of the cable is $3.0\,kg\,m^{-1}$.

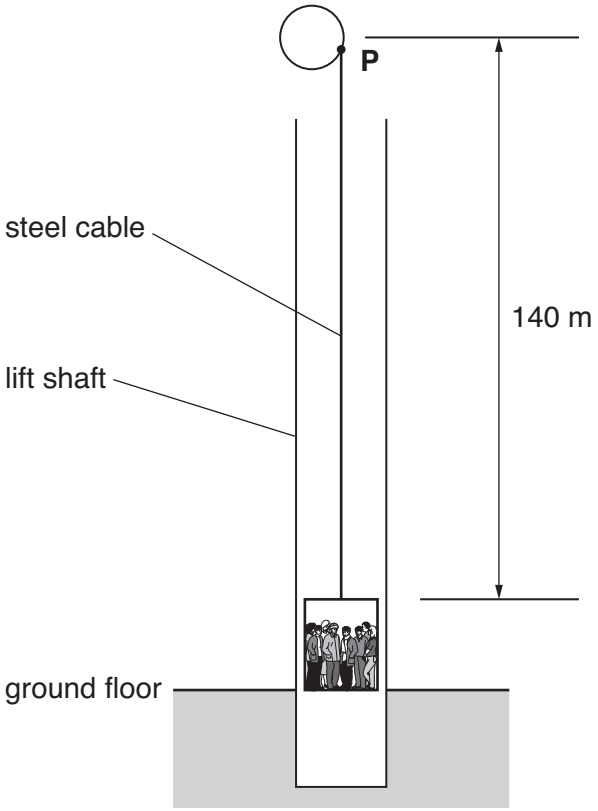


Fig. 3.1

(a) Show that the mass of the 140 m long steel cable is 420 kg.

[1]

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(b) (i) The lift with its 8 passengers is stationary at the ground floor level. The initial upward acceleration of the lift and the cable is $1.8\,m\,s^{-2}$. Show that the **maximum** tension in the cable at point **P** is $1.7 \times 10^4\,N$.

[4]

(ii) Calculate the maximum stress in the cable.

stress = ... Pa **[2]**

[Total: 7]

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4 **(a)** An electron in a particle accelerator experiences a constant force. According to one student, the acceleration of the electron should remain constant because the ratio of force to mass does not change. In reality, experiments show that the acceleration of the electron decreases as its velocity increases. Describe what can be deduced from such experiments about the nature of accelerated electrons.

.....

.....

.....

..... **[2]**

(b) Fig. 4.1 shows the velocity vector for a particle moving at an angle of 31° to the horizontal.

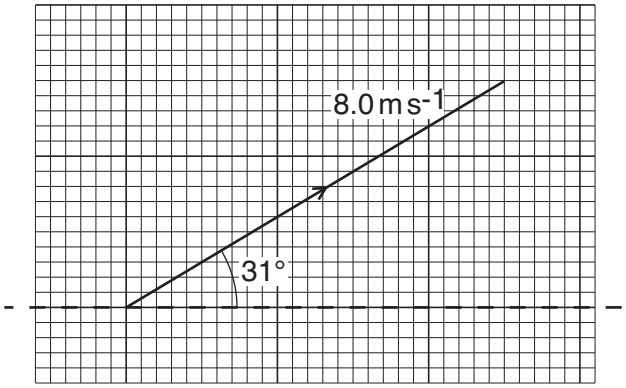


Fig. 4.1

(i) On Fig. 4.1, show the horizontal (*x*-direction) and vertical (*y*-direction) components of the velocity. **[2]**

(ii) Calculate the horizontal (*x*-direction) component of the velocity.

velocity = ... $m\,s^{-1}$ **[1]**

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(c) Fig. 4.2 shows a ship **S** being pulled by two tug-boats.

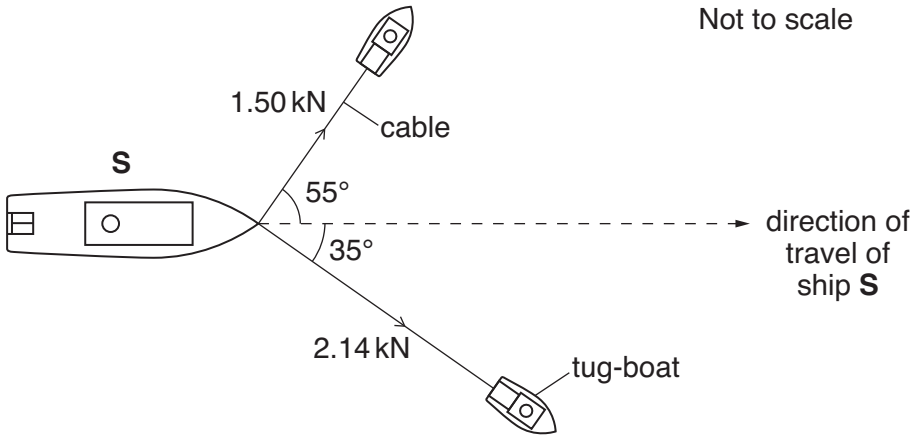


Fig. 4.2

The ship is travelling at a constant velocity. The tensions in the cables and the angles made by these cables to the direction in which the ship travels are shown in Fig. 4.2.

(i) Draw a vector triangle and determine the resultant force provided by the two cables.

resultant force = ... kN **[3]**

(ii) State the value of the drag force acting on the ship **S**. Explain your answer.

.....

.....

..... **[2]**

[Total: 10]

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5 **(a)** State the principle of conservation of energy.

.....

..... **[1]**

(b) Describe one example where elastic potential energy is stored.

..... **[1]**

(c) Fig. 5.1 shows a simple pendulum with a metal ball attached to the end of a string.

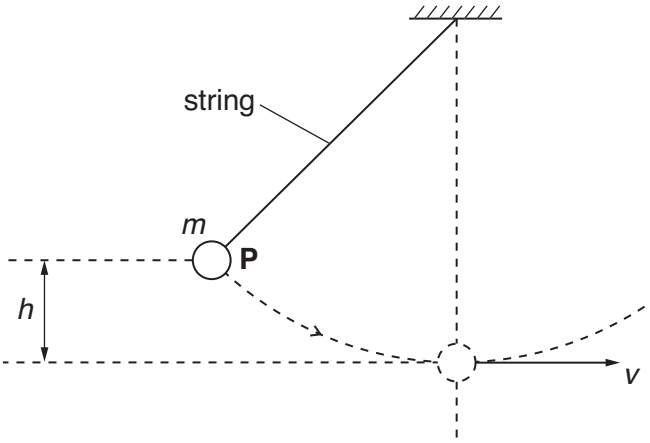


Fig. 5.1

When the ball is released from **P**, it describes a circular path. The ball has a maximum speed v at the bottom of its swing. The vertical distance between **P** and bottom of the swing is h. The mass of the ball is m.

(i) Write the equations for the change in gravitational potential energy, E_p, of the ball as it drops through the height h and for the kinetic energy, E_k, of the ball at the bottom of its swing when travelling at speed v.

E_p =

E_k = **[1]**

(ii) Use the principle of conservation of energy to derive an equation for the speed v. Assume that there are no energy losses due to air resistance.

[2]

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(d) Some countries in the world have frequent thunderstorms. A group of scientists plan to use the energy from the falling rain to generate electricity. A typical thunderstorm deposits rain to a depth of 1.2×10^{-2} m over a surface area of 2.0×10^{7} m^2 during a time of 900 s. The rain falls from an average height of 2.5×10^{3} m. The density of rainwater is 1.0×10^{3} kg m^{-3}. About 30% of the gravitational potential energy of the rain can be converted into electrical energy at the ground.

(i) Show that the total mass of water deposited in 900 s is 2.4×10^{8} kg.

[2]

(ii) Hence show that the average electrical power available from this thunderstorm is about 2 GW.

[3]

(iii) Suggest one problem with this scheme of energy production.

.....

..... **[1]**

[Total: 11]

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6 The force against length graph for a spring is shown in Fig. 6.1.

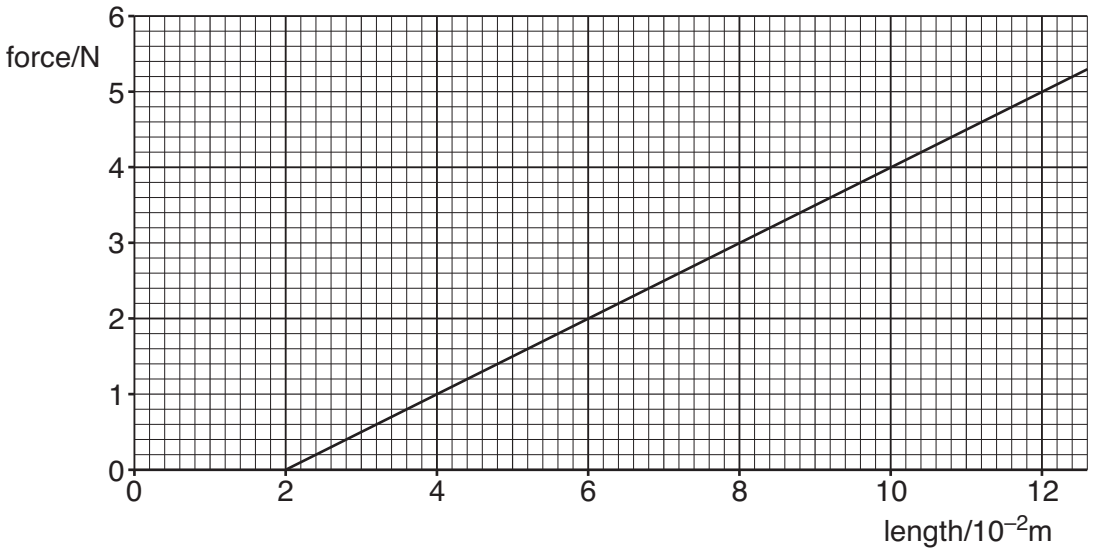


Fig. 6.1

(a) Explain why the graph does not pass through the origin.

.....

..... **[1]**

(b) State what feature of the graph shows that the spring obeys Hooke's law.

.....

..... **[1]**

(c) The gradient of the graph is equal to the force constant *k* of the spring. Determine the force constant of the spring.

force constant = ... N m^{-1} **[2]**

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(d) Calculate the work done on the spring when its length is increased from 2.0×10^{-2} m to 8.0×10^{-2} m.

work done = ... J **[2]**

(e) One end of the spring is fixed and a mass is hung vertically from the other end. The mass is pulled down and then released. The mass oscillates up and down. Fig. 6.2 shows the displacement *s* against time *t* graph for the mass.

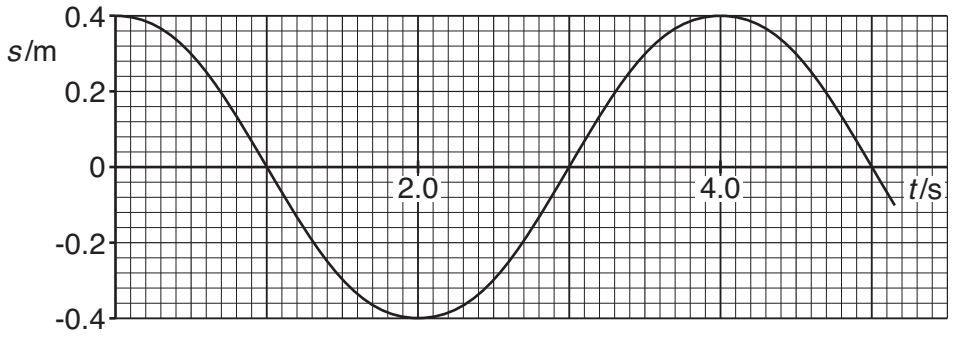


Fig. 6.2

Explain how you can use Fig. 6.2 to determine the **maximum** speed of the mass. You are not expected to do the calculations.

.....

.....

.....

..... **[2]**

[Total: 8]

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7 **(a)** Fig. 7.1 shows a length of tape under tension.

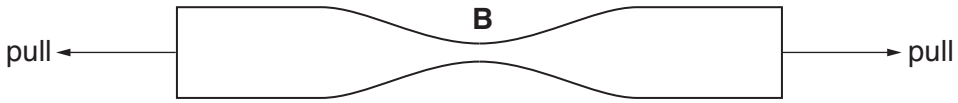


Fig. 7.1

(i) Explain why the tape is most likely to break at point **B**.

.....

..... **[1]**

(ii) Explain what is meant by the statement:

'the tape has gone beyond its elastic limit'.

.....

.....

..... **[1]**

(b) Fig. 7.2 shows one possible method for determining the Young modulus of a metal in the form of a wire.

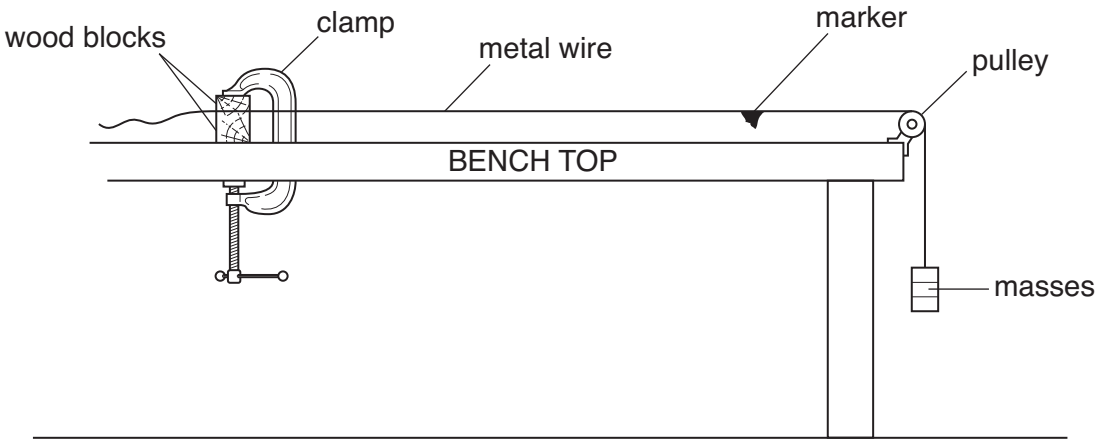


Fig. 7.2

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Describe how you can use this apparatus to determine the Young modulus of the metal. The sections below should be helpful when writing your answers.



The **measurements** to be taken:

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....



The **equipment** used to take the measurements:

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

How you would **determine** Young modulus from your measurements:

.....

.....

.....

.....

.....

.....

[8]

[Total: 10]

END OF QUESTION PAPER

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G481 Mechanics

Question			Expected Answers	Marks	Additional Guidance
1	(a)		Correct lines from: • joule (J) to N m • watt (W) to J s^{-1} • newton (N) to kg m s^{-2}	B2	**Note**: 2 marks for all correct 1 mark for two correct 0 marks for none or one correct
	(b)	(i)	weight in the range 200 to 1200 (N)	B1	
		(ii)	area in the range 0.01 to 0.08 (m^2)	B1	
		(iii)	pressure = (b)(i)/b(ii)	B1	**Allow**: 1 sf answer
			Total	**5**	

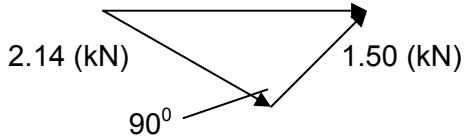
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Question			Expected Answers	Marks	Additional Guidance
2	(a)		$W = mg$ weight $= 1.50 \times 9.81 = 14.72$ (N) or 14. 7 (N) or 15 (N)	B1	**Allow**: Use of 9.8 (m s^{-2}) **Allow**: Bald 15 (N); but **not** '1.50 × 10 = 15(N)'
	(b)	**(i)**	Net / resultant force (on **B**) is less / (net) force (on **B**) is less than its weight / there is tension (in the string) / there is a vertical / upward / opposing force (on **B**)	B1	**Note**: Must have reference to force
		(ii)	$s = ut + \frac{1}{2}at^2$ and u = 0 $1.40 = \frac{1}{2} \times 1.09 \times t^2$ t = 1.60 (s)	C1 C1 A1	**Allow**: 2 marks for 1.75/1.09' if answer from **(iii)** is used **Allow**: 2 sf answer **Allow**: 2 marks if **2.80 m** is used; time = 2.27 (s)
		(iii)	$v^2 = 2 \times 1.09 \times 1.40$ / $v = 0 + 1.09 \times 1.60$ v = 1.75 (m s^{-1}) / v = 1.74 (m s^{-1})	C1 A1	Possible ecf **Allow**: 1.7 or 1.8 (m s^{-1})
		(iv)	change in velocity = 2.47 + 1.50 (= 3.97 m s^{-1}) acceleration = $\frac{3.97}{0.030}$ acceleration = 132 (m s^{-2})	C1 A1	Ignore sign for change in velocity **Allow**: 130 (m s^{-2}) --- **Special case:** acceleration = $\frac{2.47 - 1.50}{0.030} = 32.3$ or 32 (m s^{-2}) scores 1 mark
			Total	**9**	

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Question			Expected Answers	Marks	Additional Guidance
3	(a)		mass = $\underline{140 \times 3.0}$ (= 420 kg)	B1	**Allow**: $\frac{420}{3.0} = 140$ (reverse argument)
	(b)	(i)	total mass = 500 + 560 + 420 (= 1480 kg) total weight = 1480 × 9.8(1) / total weight = 14520 (N) net force = 1480 × 1.8 / net force = 2664 (N) tension = 14520 + 2664 tension = 1.7(2) × 10^4 (N)	C1 C1 C1 C1 A0	**Note**: Omitting one of the masses – can score maximum of 3 Omitting two masses – can score maximum of 2 **Examples:** 3 marks if mass of cable is omitted tension = 1908 +10400 = 1.23 × 10^4 (N) 2 marks if mass of cable and people are omitted tension = 900 + 4905 = 5.8 × 10^3 (N) **Note**: 4 marks for 'tension = $(m(g+a)=)$ 1480 × (9.81 + 1.8)'
		(ii)	stress = $\frac{1.72\times10^4}{3.8\times10^{-4}}$ / stress = $\frac{(b)(i)}{3.8\times10^{-4}}$ stress = 4.5(3) × 10^7 (Pa)	C1 A1	Possible ecf from **(i)** **Note**: A tension of 1.7 × 10^4 (N) gives an answer of 4.4(7) × 10^7 (Pa)
			Total	**7**	

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Question			Expected Answers	Marks	Additional Guidance
4	(a)		The mass (of the electron) increases as its speed approaches *c* / speed of light / 3×10^8 m s^{-1}	M1 A1	**Not**: mass 'changes' / 'electron becomes heavier'
	(b)	(i)	A line with correct arrow in the *y* direction has length of 14 to 16 'small squares' A line with correct arrow in the *x* direction has length of 24 to 26 'small squares'	B1 B1	 **Note**: If correct arrows are not shown, then maximum mark is 1
		(ii)	component = $(8.0\cos 31 =)6.86$ (m s^{-1}) or 6.9 (m s^{-1})	B1	**Allow**: 6.85 as BOD
	(c)	(i)	Correct vector triangle drawn  (resultant force)^2 = $2.14^2 + 1.50^2$ resultant force = 2.61 (kN)	B1 C1 A1	**Note**: Expect at least one 'label' on the sketch, eg: 2.14, 1.5, 90^0 The 'orientation' of the triangle is not important The directions of all three arrows are required **Allow**: 2 sf answer of 2.6 (kN) **Allow** a scale drawing; 2 marks if answer is within $\pm$0.1 kN and 1 mark if $\pm$ 0.2 kN **Alternative** for the C1 A1 marks: 1.50cos(55) or 2.14cos(35) C1 resultant force = 1.50cos(55) + 2.14cos(35) resultant force = 2.61 (kN) A1
		(ii)	2.6(1) (kN) (Constant velocity implies) zero net force / zero acceleration	B1 B1	Possible ecf **Not**: '*resultant force* = *drag*' since the first B1 assumes this
			Total	**10**	

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Question			Expected Answers	Marks	Additional Guidance
5	(a)		Energy cannot be created or destroyed; it can only be transferred/transformed into other forms or The (total) energy of a system remains constant or (total) initial energy = (total) final energy (AW)	B1	**Allow**: 'Energy cannot be created / destroyed / lost'
	(b)		Any suitable example of something strained (eg: stretched elastic band)	B1	
	(c)	(i)	$E_{p=}\ mgh$ and $E_k = \frac{1}{2}mv^2$ (Allow Δh for h)	B1	**Not**: $E_k = mgh$
		(ii)	$mgh = \frac{1}{2}mv^2$ $v^2 = 2gh$ or $v = \sqrt{2gh}$	B1 B1	
	(d)	(i)	$m = \rho V$ $m = 1.0\times10^3 \times (1.2\times10^{-2} \times 2.0\times10^7)$ mass of water = 2.4×10^8 (kg)	C1 C1 A0	**Allow** any subject for the density equation
		(ii)	loss in potential energy = $2.4\times10^8 \times 9.81 \times 2.5\times10^3$ 30% of GPE = $0.3 \times 5.89 \times 10^{12}$ ($=1.77 \times 10^{12}$) power = $\frac{1.77\times10^{12}}{900}$ power = 1.9(63) $\times 10^9$ (W) ($\approx$ 2 GW)	C1 C1 C1 A0	**Allow** 1 mark for '5.89×10^{12} (J)' **Allow** 2 marks for '1.77×10^{12} (J)' **Note**: $\frac{5.89\times10^{12}}{900} (= 6.5\ \text{GW})$ scores 2 marks
		(iii)	Any correct suitable suggestion; eg: the energy supply is not constant/ cannot capture all the rain water / large area (for collection)	B1	**Note**: Do not allow reference to 'inefficiency' / 'cost'
			Total	**11**	

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Question			Expected Answers	Marks	Additional Guidance
6	(a)		The graph shows length and not extension of the spring / spring has original length (of 2.0 cm) (AW)	B1	**Allow**: 'length cannot be zero'
	(b)		Straight line (graph) / linear graph / force $\propto$ extension / constant gradient (graph)	B1	**Not** 'force $\propto$ length'
	(c)		force constant = $\frac{2.0}{0.04}$ force constant = 50 (N m^{-1})	C1 A1	**Note**: The mark is for any correct substitution **Allow**: 1 mark for 0.5 (N m^{-1}) – 10^{n} error **Allow** 1 mark for 5/12 $\times$ 10^{-2} = 41.7 or 4/10 $\times$ 10^{-2} = 40 or 3/8 $\times$ 10^{-2} = 37.5 or 2/6 $\times$ 10^{-2} = 33.3 or 1/4 $\times$ 10^{-2} = 25
	(d)		work done = $\frac{1}{2}Fx$ or $\frac{1}{2}kx^2$ or 'area under graph' work done = $\frac{1}{2}\times 3.0\times 0.06$ or $\frac{1}{2}\times 50\times 0.06^2$ work done = 0.09 (J)	C1 A1	 Possible ecf **Note**: 1 sf answer is allowed
	(e)		Find the gradient / slope (of the tangent / graph) Maximum speed at 1.0s / 3.0s / 5.0s / steepest 'part' of graph / displacement = 0	B1 B1	 **Allow**:2 marks for 'steepest / maximum gradient'
			Total	**8**	

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Question			Expected Answers	Marks	Additional Guidance
7	(a)	(i)	It has maximum / large / increased <u>stress</u> at this point	B1	**Allow**: it has 'same force but thinner/smaller area' **Not**: Thin / small area
		(ii)	The tape has (permanent) extension / deformation when the force / stress is removed (AW)	B1	**Note**: Need reference to force or stress removed **Allow**: '.. does not return to original size / shape / length when force / stress is removed'
	(b)		**Measurement:** ✎ Diameter Any <u>two</u> from: • original / initial length (**Not**: final length) • extension / initial <u>and</u> final lengths • weight / mass **Equipment:** ✎ Micrometer / vernier (calliper) (for the diameter of the wire) Any <u>two</u> from: • Ruler / (metre) rule / tape measure (for measuring the original length / extension) • Travelling microscope (for measuring extension) • Scales / balance (for measuring the mass & *mg* equation is used or for measuring weight) / Newtonmeter (for the weight of hanging masses) / 'known' weights used **Determining Young modulus:** • stress = force/(cross-sectional) area <u>and</u> strain = extension/original length • Young modulus = stress/strain / Young modulus is equal to the gradient from stress-strain graph (in the linear region)	B1 B1 X 2 B1 B1 × 2 B1 B1	**The term *diameter* to be included and spelled correctly to gain the mark** **The term *micrometer* / *vernier* (*calliper*) to be included and spelled correctly to the gain mark. (ALLOW: Micrometer is used to measure area / radius / thickness – as BOD)** **Allow**: 'known masses & *mg* equation' but **not** 'known masses' **Allow:** stress = *F*/*A* <u>and</u> strain = *x*/*L* **Special case for determining Young modulus:** Gradient from force-extension graph is $\frac{EA}{L}$ B1 Young modulus = gradient × *L*/*A* B1
			Total	**10**	

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THIS IS A NEW SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE
PHYSICS A
Mechanics

G481

Candidates answer on the question paper

OCR Supplied Materials:
- Formulae, Data and Relationships Booklet

Other Materials Required:
- Electronic calculator
- Ruler
- Protractor

Thursday 21 May 2009
Afternoon

Duration: 1 hour

OCE/T69962

G 4 8 1

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example, you should
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use an electronic calculator.
- This document consists of **16** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	6	
2	7	
3	9	
4	11	
5	11	
6	5	
7	11	
TOTAL	**60**	

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Answer **all** the questions.

1 **(a)** State a similarity and a difference between *distance* and *displacement*.

(i) similarity: .....

..... **[1]**

(ii) difference: .....

..... **[1]**

(b) Fig. 1.1 shows two airports **A** and **C**.

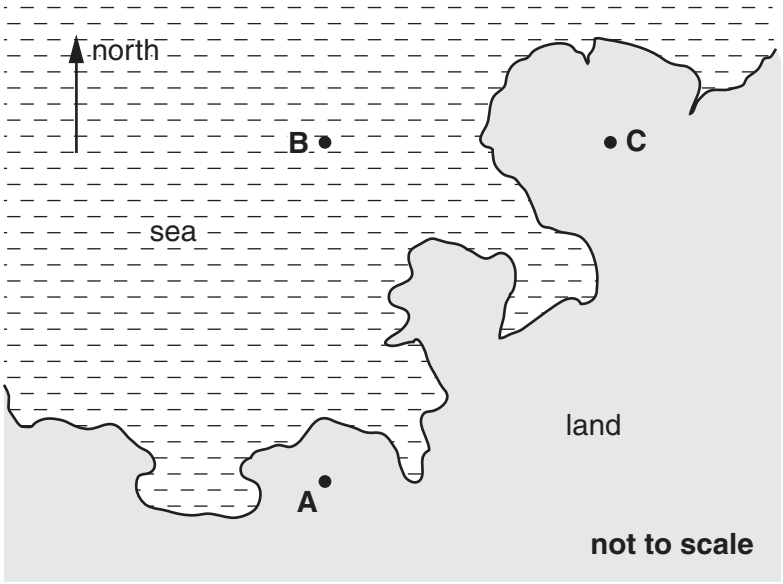


Fig. 1.1

An aircraft flies due north from **A** for a distance of 360 km (3.6×10^5 m) to point **B**.
Its average speed between **A** and **B** is 170 m s^{-1}. At **B** the aircraft is forced to change course and flies due east for a distance of 100 km to arrive at **C**.

(i) Calculate the time of the journey from **A** to **B**.

time = ... s **[1]**

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(ii) Draw a labelled displacement vector triangle below. Use it to determine the magnitude of the displacement in km of the aircraft at **C** from **A**.

displacement = ... km **[3]**

[Total: 6]

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2 Fig. 2.1 shows a graph of velocity against time for an object travelling in a straight line.

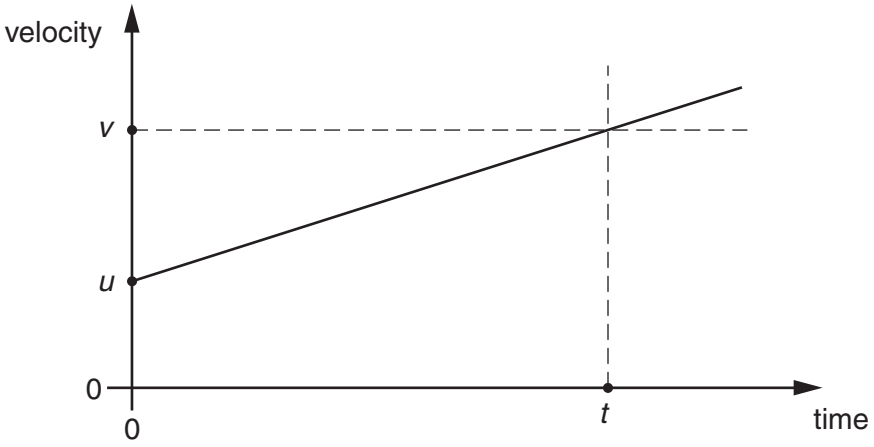


Fig. 2.1

The object has a constant acceleration *a*. In a time *t* its velocity increases from *u* to *v*.

(a) Describe how the graph of Fig. 2.1 can be used to determine

(i) the acceleration *a* of the object

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(ii) the displacement *s* of the object.

.....

..... **[1]**

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(b) Use the graph of Fig. 2.1 to show that the displacement s of the object is given by the equation:

$$s = ut + \frac{1}{2}at^2$$

[2]

(c) In order to estimate the acceleration g of free fall, a student drops a large stone from a tall building. The height of the building is known to be 32 m. Using a stopwatch, the time taken for the stone to fall to the ground is 2.8 s.

(i) Use this information to determine the acceleration of free fall.

acceleration = ... $m\,s^{-2}$ **[2]**

(ii) One possible reason why your answer to **(c)(i)** is smaller than the accepted value of 9.81 $m\,s^{-2}$ is the reaction time of the student. State another reason why the answer is smaller than 9.81 $m\,s^{-2}$.

.....

..... **[1]**

[Total: 7]

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3 A skydiver jumps from a stationary hot-air balloon several kilometres above the ground.

(a) In terms of acceleration and forces, explain the motion of the skydiver

immediately after jumping .....

.....

.....

.....

.....

.....

at a time **before** terminal velocity is reached .....

.....

.....

.....

.....

.....

at terminal velocity. .....

.....

.....

.....

.....

..... **[6]**

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(b) In the final stage of the fall, the skydiver is falling through air at a constant speed. The skydiver's kinetic energy does not change even though there is a decrease in the gravitational potential energy. State what happens to this loss of gravitational potential energy.

.....

..... **[1]**

(c) Fig. 3.1 shows a sketch graph of the variation of the velocity v of the skydiver with time t.

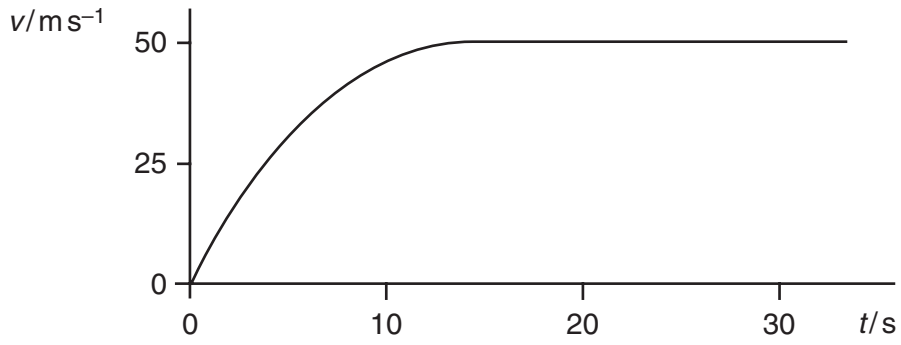


Fig. 3.1

Suggest the changes to the graph of Fig. 3.1, if any, for a more massive (heavier) skydiver of the same shape.

.....

.....

.....

..... **[2]**

[Total: 9]

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4 **(a)** Define *work done* by a force.

.....

..... **[2]**

(b) Define *power*.

.....

..... **[1]**

(c) Explain why the efficiency of a mechanical device can never be 100%.

.....

..... **[1]**

(d) A car has a total mass of 810 kg. Its speed changes from zero to 30 m s^{-1} in a time of 12 s.

(i) Calculate the change in the kinetic energy of the car.

change in kinetic energy = ... J **[2]**

(ii) Calculate the average power generated by the car engine. Assume that the power generated by the engine of the car is entirely used in increasing the kinetic energy of the car.

power = ...W **[1]**

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(iii) The actual efficiency of the car is 25%. The car takes 18 kg of petrol to fill its tank. The energy provided per kilogram of petrol is 46 MJ kg^{-1}. The drag force acting on the car at a constant speed of 30 m s^{-1} is 500 N.

1 Calculate the work done against the drag force per second.

work done per second = ... J s^{-1} **[1]**

2 Calculate the total distance the car can travel on a full tank of petrol when travelling at a constant speed of 30 m s^{-1}.

distance = ... m **[3]**

[Total: 11]

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5 **(a)** Fig. 5.1 shows a wooden block motionless on an inclined ramp.

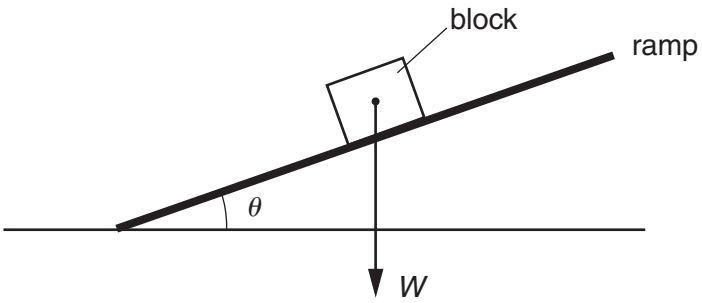


Fig. 5.1

The angle between the ramp and the horizontal is θ.

(i) The weight W of the block is already shown on Fig. 5.1. Complete the diagram by showing the normal contact (reaction) force N and the frictional force F acting on the block. **[2]**

(ii) Write an equation to show how F is related to W and θ.

.....

..... **[1]**

(b) Fig. 5.2 shows a kitchen cupboard securely mounted to a vertical wall. The cupboard rests on a support at **A**.

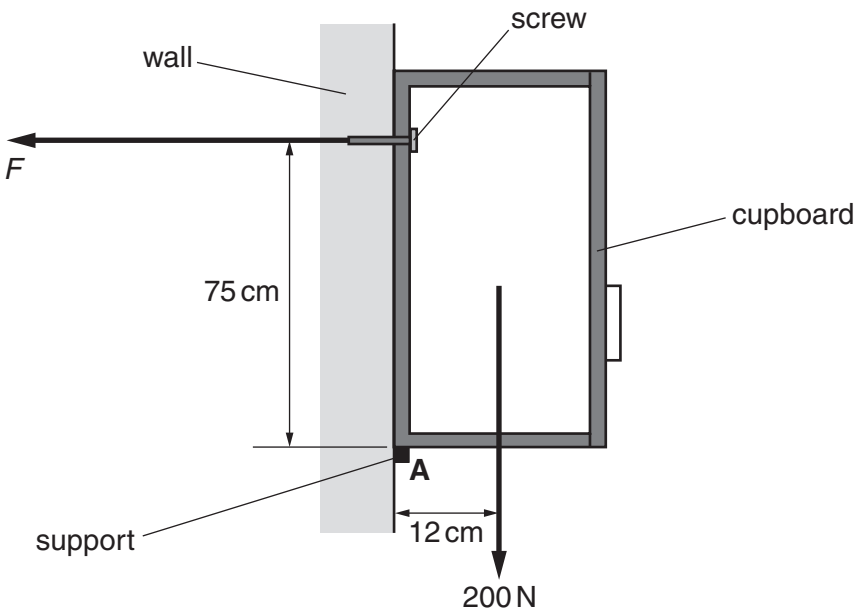


Fig. 5.2

The total weight of the cupboard and its contents is 200 N. The line of action of its weight is at a distance of 12 cm from **A**. The screw securing the cupboard to the wall is at a vertical distance of 75 cm from **A**.

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(i) State the principle of moments.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

..... **[2]**

(ii) The direction of the force *F* provided by the screw on the cupboard is horizontal as shown in Fig. 5.2. Take moments about **A**. Determine the value of *F*.

F = ...N **[2]**

(iii) The cross-sectional area under the head of the screw in contact with the cupboard is $6.0 \times 10^{-5}\,m^2$. Calculate the pressure on the cupboard under the screw head.

pressure = ...Pa **[2]**

(iv) State and explain how your answer to **(iii)** would change, if at all, if the same screw was secured much closer to **A**.

.....

.....

..... **[2]**

[Total: 11]

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6 In February 1999 NASA launched its Stardust spacecraft on a mission to collect dust particles from the comet Tempel 1. After a journey of 5.0×10^{12} m that took 6.9 years, Stardust returned to Earth with samples of the dust particles embedded in a special low-density gel. When a dust particle hits the gel, it buries itself in the gel creating a cone-shaped track as shown in Fig. 6.1. The length of the track is typically 200 times the diameter of the dust particle.

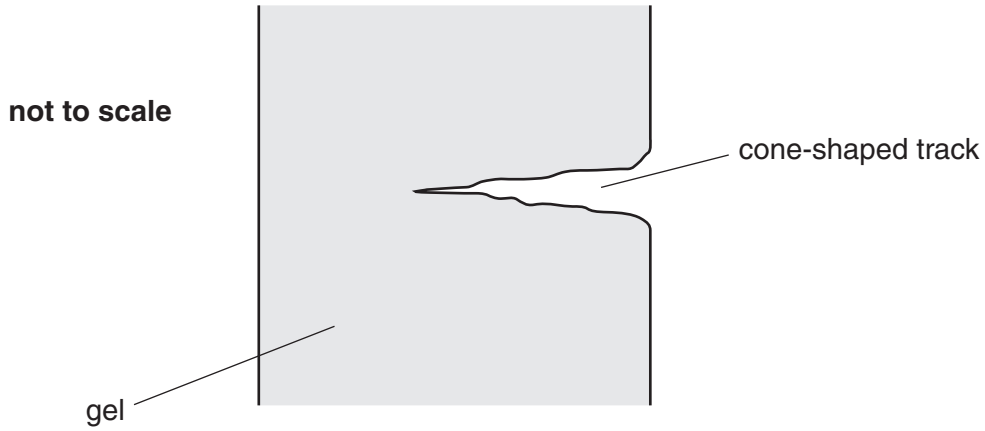


Fig. 6.1

(a) Calculate the average speed in m s^{-1} of Stardust during its voyage.

speed = ... m s^{-1} **[2]**

(b) Calculate the average stopping force produced by the gel for a dust particle of diameter 0.70 mm and mass 4.0×10^{-6} kg travelling at a velocity of 6.1×10^{3} m s^{-1} relative to Stardust.

force = ...N **[3]**

[Total: 5]

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7 **(a)** On the axes of Fig. 7.1, sketch a stress against strain graph for a typical ductile material.



Fig. 7.1

[2]

(b) Circle from the list below a material that is ductile.

jelly copper ceramic glass **[1]**

(c) Define *ultimate tensile strength* of a material.

.....

..... **[1]**

(d) State *Hooke's law*.

.....

..... **[1]**

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(e) Fig. 7.2 shows a mechanism for firing a table tennis ball vertically into the air.

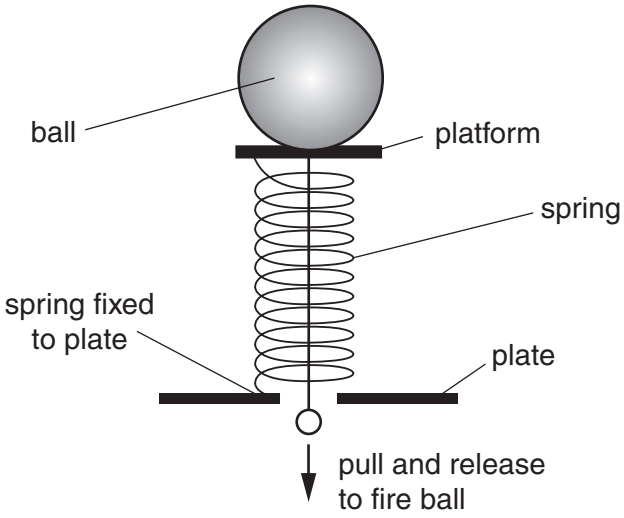


Fig. 7.2

The spring has a force constant of $75\,N\,m^{-1}$. The ball is placed on the platform at the top of the spring.

(i) The spring is compressed by 0.085 m by pulling the platform. Calculate the force exerted by the compressed spring on the ball **immediately** after the spring is released. Assume both the spring and the platform have negligible mass.

force = ...N **[2]**

(ii) The mass of the ball is 2.5×10^{-3} kg. Calculate the initial acceleration of the ball.

acceleration = ... $m\,s^{-2}$ **[1]**

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(iii) Calculate the maximum height that could be gained by the ball. Assume all the elastic potential energy of the spring is converted into gravitational potential energy of the ball.

height = ... m **[3]**

[Total: 11]

END OF QUESTION PAPER

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G481 Mechanics

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

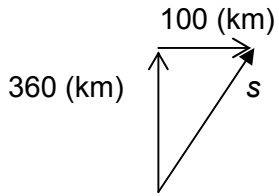
C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

SIGNIFICANT FIGURES

In general, there is no penalty when the candidate's answer is more than the sf of the data given in the question.
For example, in a question where the data is given to 2 sf, the answer can be 2 sf or more. An answer given to 1 sf may be penalised.

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Question			Expected Answers	Marks	Additional Guidance
1	(a)	(i)	Both measured in metre/m	B1	**Allow**: Both have the same unit/Both have 'magnitude' **Not**: Both are distance/length
		(ii)	Distance is a scalar/does not have direction or Displacement is a vector/has direction	B1	**Not**: One is a vector and the other a scalar
	(b)	(i)	time = $\frac{3.6\times10^5}{170}$ time = 2.1(18) $\times$ 10^3 (s) or 2.1 $\times$ 10^3 (s)	B1	**Note**: Answer to 2sf or more is required
		(ii)	Correct vector triangle Eg:  $s^2 = 360^2 + 100^2$ / $s = \sqrt{(360^2 + 100^2)}$ *s* = 373.6 (km) / 370 (km)	B1 C1 A1	The vector triangle must have at least two labels (360, 100 and *s* – allow *x* or *d* for *s*). The 'orientation' of the triangle must be as shown. Ignore the direction of the arrows. **Allow**: Full credit can be given for a scale drawing 2 marks if answer in the range (370 – 380) 1 mark if answer in the range (360 – 370) or (380 - 390) **Note**: Bald answer to 2sf or more and no diagram scores 2/3 marks.
			Total	**6**	

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Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	*a* = gradient/slope (of the line)	B1	**Allow**: *a* = change in velocity/time or 'rate of change of velocity' **Allow**: Correct equation plus labels; $a = (v-u)/t$; *v* = final velocity, *u* = initial velocity and *t* = time **Note**: The term *gradient*/*slope*/*change*/ *initial* to be included and spelled correctly to gain mark
		(ii)	*s* = area (under the graph)	B1	
	(b)		area of 'rectangle' = '*ut*' area of 'triangle' = $\frac{1}{2} \times t \times (v-u)$ area of 'triangle' = $\frac{1}{2} \times t \times at$	M1 M1	**Note**: The second M1 mark is **not** for '½ at^2' but for ' ½ × *t* × *at*' **Allow**: 'Area of trapezium method': $s = \frac{1}{2}(u+v)t$ and $v = u + at$ M1 Correct substitution leading to correct answer M1 **Note**: Substitution method starting with $v^2 = u^2 + 2as$ scores zero
	(c)	(i)	$32 = \frac{1}{2} \times a \times 2.8^2$ $a = \frac{32 \times 2}{2.8^2}$ *a* = 8.16 (m s^{-2}) or 8.2 (m s^{-2})	C1 A1	**Note**: The C1 mark is for substitution into the equation given in **(b)** with *u* = 0 **Note**: Bald answer of 8.16 (m s^{-2}) or 8.2 (m s^{-2}) scores 2/2 marks Bald 8 (m s^{-2}) scores 1/2
		(ii)	Drag/air resistance/air friction (makes the time longer)	B1	**Not:** 'Reaction time'/'wind'
			Total	**7**	

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Question			Expected Answers	Marks	Additional Guidance
3	(a)		… ***immediately*** *after jumping* Only force is the weight/drag = 0/net force = weight acceleration = *g*/9.8(1 m s^{-2}) (Allow '*mg*' for weight. Do not allow 'gravity' for weight.) … ***before*** *terminal velocity is reached* Any **<u>two</u>** from: Drag increases (with speed) /drag $\propto$ $speed^2$ Net or resultant or total force decreases / weight > drag Acceleration is less than *g* … ***at*** *terminal velocity* weight = drag / net force = 0 acceleration = 0 /<u>constant</u> speed or velocity (AW)	B1 B1 B1 B1 B1 B1 B1	**Alternatives** accepted for *drag* are: friction/air resistance **Allow**: 'Has acceleration of free-fall/due to gravity' as alternative for second B1 mark **Allow**: velocity instead of speed. **Allow**: 'drag $\propto$ speed' as BOD. **Allow**: Acceleration decreases **Allow**: upward force(s) = downward force/'forces balanced'
	(b)		(Transformed to) heat/thermal (energy)	B1	**Not**: 'Friction'/sound
	(c)		Any **<u>two</u>** from: 1. The terminal velocity increases 2. Initial gradient/slope is the same/equal to *g* 3. Time taken to reach terminal velocity is longer	B1 × 2	 **Allow**: Initial acceleration is the same/*g*/9.8(1 m s^{-2})
			Total	**9**	

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Question			Expected Answers	Marks	Additional Guidance
4	(a)		work done = force × distance <u>moved</u> in the direction of the force	M1 A1	**Allow**: 'displacement' instead of 'distance' **Allow**: 1 mark for 'force × distance in the direction of the force' **Not**: work done = energy transfer
	(b)		power = work (done)/time or power = energy/time or power = rate of work done	B1	**Not**: Mixture of quantities and units, e.g: 'energy per second'
	(c)		This is because of heat/thermal energy/friction	B1	**Not**: sound/vibrations
	(d)	(i)	$E_k = \frac{1}{2}mv^2$ / $E_k = \frac{1}{2} \times 810 \times 30^2$ $E_k = 3.645 \times 10^5$ (J) or 3.65×10^5 (J)	C1 A1	**Note**: Bald answer 3.645×10^5 (J) or 3.6×10^5 (J) scores 2/2 marks **Allow**: 1 mark for wrongly rounded answer of 3.7×10^5 (J)
		(ii)	power = $\frac{3.65 \times 10^5}{12}$ power = 3.04×10^4 (W) ≈ 3.0×10^4 (W)	B1	Possible ecf
		(iii) 1.	work done = 500 × 30 work done = 15000 (J s^{-1})	B1	
		2.	'output energy' = $18 \times 46 \times 10^6 \times 0.25$ (= 2.07×10^8 J)	C1	**Allow**: 'input energy' = $18 \times 46 \times 10^6$ (= 8.28×10^8 J)
			total drive time = $\frac{18 \times 46 \times 10^6 \times 0.25}{15000}$ (= 1.38×10^4s)	C1	This C1 mark can also be scored using: 'distance = $2.07 \times 10^8/500$' Possible ecf from **iii 1.**
			total drive distance = $1.38 \times 10^4 \times 30$ = 4.1×10^5 (m)	A1	**Allow**: Bald 4.1×10^5 (m) scores 3/3 2/3 for 1.66×10^6 m if 25% efficiency is not used 2/3 if 30 kW from **ii** is used; answer 2.0 or 2.1×10^5 (m)
			Total	**11**	

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Question			Expected Answers	Marks	Additional Guidance
5	(a)	(i)	*N* is normal to the ramp (judged by eye) *F* is parallel and up the ramp	B1 B1	Allow marks even if the labels *N* and *F* are omitted
		(ii)	$F = W\sin\theta$	B1	
	(b)	(i)	Expected answer: '*For equilibrium of an object the sum of clockwise moments about a point = sum of anticlockwise moments about the same point*.' clockwise moment(s) = anticlockwise moment(s) Reference to one of the moments taken about a point/'equilibrium'/sum (or total or net or Σ) mentioned once	 M1 A1	**Note**: The term '*clockwise*' to be included and spelled correctly to gain the M1 mark **Note**: 'net moment = 0' is equivalent to the M1 mark **Note**: If M1 is lost for incorrect spelling of 'clockwise', then allow this A1 mark
		(ii)	$200\times12 = F\times75$ $F = 32$ (N)	C1 A1	**Note**: Bald answer of 32 (N) scores 2/2 marks
		(iii)	$p = \frac{32}{6.0\times10^{-5}}$ pressure = 5.3×10^{5} (Pa)	C1 A1	Possible ecf **Note**: Bald answer of 5.3×10^{5} (Pa) scores 2/2 marks
		(iv)	(Pressure is) greater because the force/*F* is larger (to provide the same moment)	B1 B1	
			Total	**11**	

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Question			Expected Answers	Marks	Additional Guidance
6	(a)		time = $6.9 \times 3.16 \times 10^7$ (= 2.18×10^8 s) average speed = $\frac{5.0 \times 10^{12}}{6.9 \times 3.16 \times 10^7}$ average speed = 2.29×10^4 or 2.3×10^4 (m s^{-1})	C1 A1	**Allow**: 1 mark for $5.0 \times 10^{12}/6.9 = 7.2(46) \times 10^{11}$ (m y^{-1}) **Allow**: 1 mark for $\frac{5.0 \times 10^{12}}{3.16 \times 10^7} = 1.58 \times 10^5$ (m s^{-1})
	(b)		distance = 0.70×200 (= 140 mm) or KE = ½ × $4.0 \times 10^{-6} \times 6100^2$ (= 74.4 J) work done = change in KE $F \times (0.70 \times 10^{-3} \times 200) = \frac{1}{2} \times 4.0 \times 10^{-6} \times 6100^2$ *F* = 530 (N) ---------- or ---------- *F* = *ma* $a = \frac{6100^2}{2 \times (0.70 \times 10^{-3} \times 200)}$ (=1.33×10^8) *F* = $4.0 \times 10^{-6} \times 1.33 \times 10^8$ *F* = 530 (N)	C1 C1 A1 C1 C1 A1	**Note**: Bald answer scores 3/3 marks **Note**: 0.53 (N) scores 2/3 because of 10^n error in distance 1.06×10^5 (N) scores 2/3 because '200' not taken into account 106 (N) scores 1/3 because '200' missed out and 10^n error
			Total	**5**	

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Question			Expected Answers	Marks	Additional Guidance
7	(a)		Straight line through origin (judge by eye) Correct shape of curve in the plastic region	B1 B1	
	(b)		Copper	B1	
	(c)		Maximum stress material can withstand (before fracture)	B1	**Allow**: UTS = breaking stress **Allow**: UTS = breaking force /(cross-sectional) area
	(d)		extension (or compression) $\propto$ force (as long as elastic limit is not exceeded)	B1	**Allow**: 'load' instead of force **Not**: $x \propto F$, unless the labels are defined
	(e)	(i)	force = 75×0.085 F = 6.38 (N) $\approx$ 6.4 (N)	C1 A1	
		(ii)	acceleration = $\frac{6.38}{2.5\times10^{-3}}$ acceleration = 2550 (m s^{-2})	B1	**Note**: $a = \frac{kx - mg}{m}$ gives 2540 (m s^{-2}) Possible ecf
		(iii)	Correct selection of equation: mgh / $\frac{1}{2}kx^2$ / $\frac{1}{2}Fx$ $0.0025\times9.81\times h = \frac{1}{2}\times75\times0.085^2$ height = 11 (m)	C1 C1 A1	 **Note**: Bald answer of 11 (m) scores 3/3 marks
			Total	**11**	

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ADVANCED SUBSIDIARY GCE
PHYSICS A
Mechanics

G481

Candidates answer on the question paper

OCR Supplied Materials:
- Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Tuesday 13 January 2009
Afternoon

Duration: 1 hour

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Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.

Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means for example you should:
- ensure that text is legible and that spelling, punctuation and grammar are accurate so that the meaning is clear;
- organise information clearly and coherently, using specialist vocabulary when appropriate.

- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **16** pages. Any blank pages are indicated.

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Qu.	**Max.**	**Mark**
1	9	
2	8	
3	8	
4	10	
5	7	
6	9	
7	9	
TOTAL	**60**	

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Answer **all** the questions.

1 **(a)** Define a *vector quantity*.

.....

..... **[1]**

(b) Circle all the vector quantities in the list below.

acceleration speed time displacement weight **[1]**

(c) Fig. 1.1 shows graphs of velocity v against time t for two cars **A** and **B** travelling along a straight level road in the same direction.

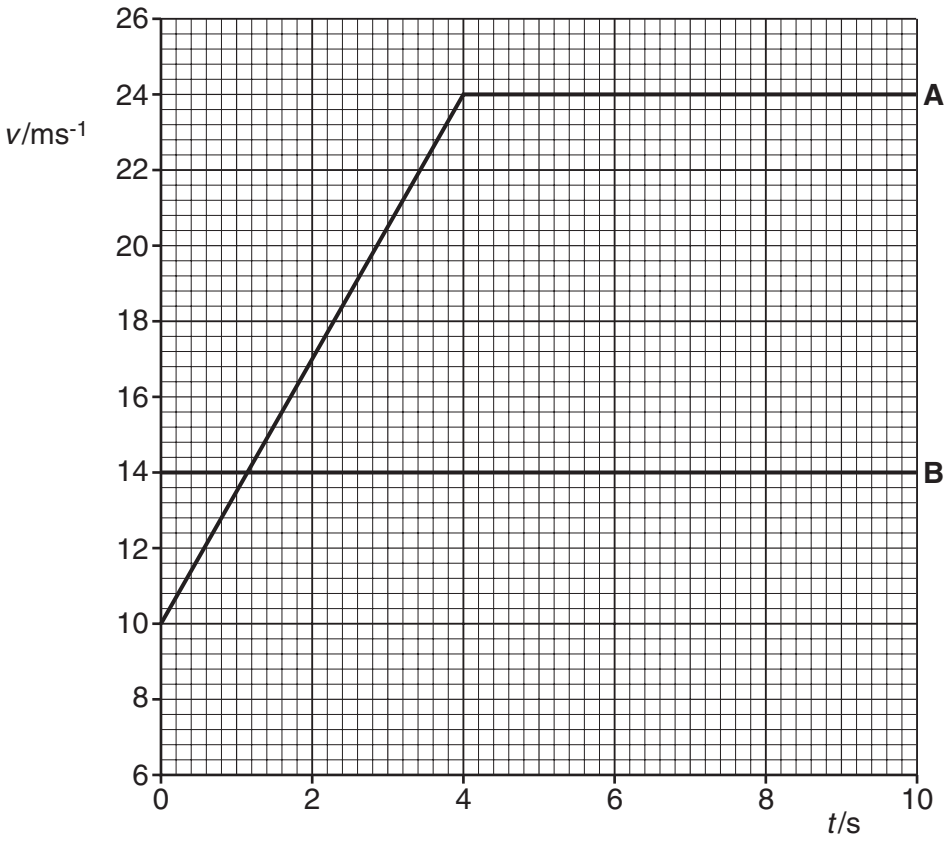


Fig. 1.1

At time $t = 0$, both cars are side-by-side.

(i) Describe the motion of car **A** from $t = 0$ to $t = 10$ s.

.....

.....

..... **[2]**

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(ii) Calculate the distance travelled by car **A** in the first 4.0 s.

distance = ... m **[2]**

(iii) Use Fig. 1.1 to find

1 the time at which both cars have the same velocity

time = ... s **[1]**

2 the time *t* at which car **A** overtakes car **B**.

t = ... s **[2]**

[Total: 9]

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2 Fig. 2.1 shows the path of water from a hose pipe.

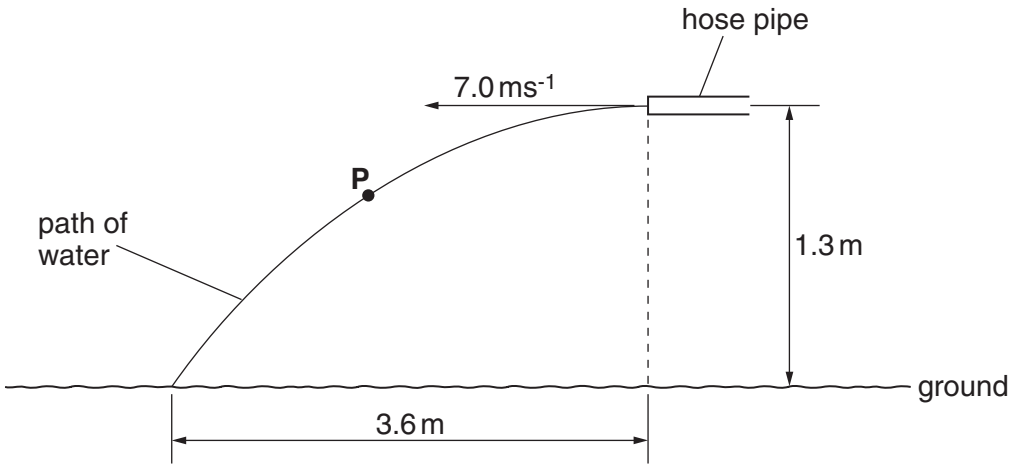


Fig. 2.1

The end of the horizontal hose pipe is at a height of 1.3 m from the ground. The initial horizontal velocity of the water is 7.0 m s^{-1}. The horizontal distance from the end of the hose pipe to the point where the water hits the ground is 3.6 m. You may assume that air resistance has negligible effect on the motion of the water jet.

(a) On Fig. 2.1, draw an arrow to show the direction of the acceleration of the water at point **P**. (Mark this arrow **A**). **[1]**

(b) Describe the energy conversion that takes place as the water travels from the end of the hose pipe to the ground.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

..... **[2]**

(c) Explain why the horizontal component of the velocity remains constant at 7.0 m s^{-1}.

.....

..... **[1]**

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(d) Show that the water takes about 0.5 s to travel from the end of the pipe to the ground.

[1]

(e) Show that the speed of the water when it hits the ground is 8.6 m s^{-1}.

[3]

[Total: 8]

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3 **(a)** Define the *newton*.

.....

..... **[1]**

(b) State why the equation '$F = ma$' cannot be applied to particles travelling at speeds very close to the speed of light.

.....

..... **[1]**

(c) Fig. 3.1 shows the horizontal forces acting on a car of mass 900 kg when it is travelling at a particular velocity on a level-road.



Fig. 3.1

The total forward force between the tyres and the road is 200 N and the air resistance (drag) is 80 N.

(i) Calculate the acceleration of the car.

acceleration = ... $m\,s^{-2}$ **[2]**

(ii) Explain why we cannot use the equation $v = u + at$ to predict the velocity of the car at a later time even when the forward force is constant.

.....

..... **[1]**

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(d) Fig. 3.2 shows a person being lifted vertically upwards by a rope.

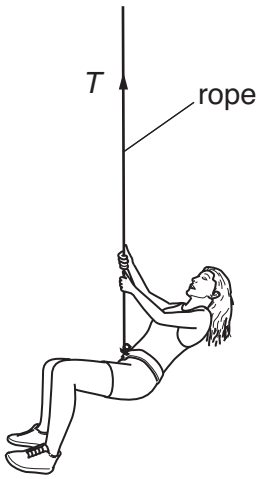


Fig. 3.2

The mass of the person is 72 kg. The upward vertical acceleration of the person is 1.4 m s^{-2}. Calculate the tension T in the rope.

T = ... N **[3]**

[Total: 8]

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4 **(a)** Define *torque of a couple*.

.....

..... **[1]**

(b) Explain why *moment of a force* and *torque of a couple* have the same unit N m.

.....

..... **[1]**

(c) Fig. 4.1 shows an irregular shaped metal plate of constant thickness that can swing freely about point **P**.

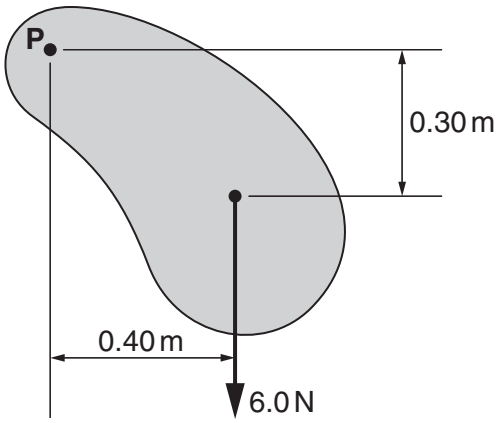


Fig. 4.1

(i) The weight of the plate is 6.0 N. With the plate in the position as shown in Fig. 4.1, calculate the clockwise moment of the weight of the plate about an axis through point **P**.

moment = ... N m **[1]**

(ii) Explain why the moment of the weight reduces to zero when the plate reaches the bottom of the swing.

.....

..... **[1]**

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(d) Describe an experiment to determine the centre of gravity of the metal plate shown in Fig. 4.1.

.....

.....

.....

.....

..... **[3]**

(e) Fig. 4.2 shows a section of the human forearm in equilibrium.

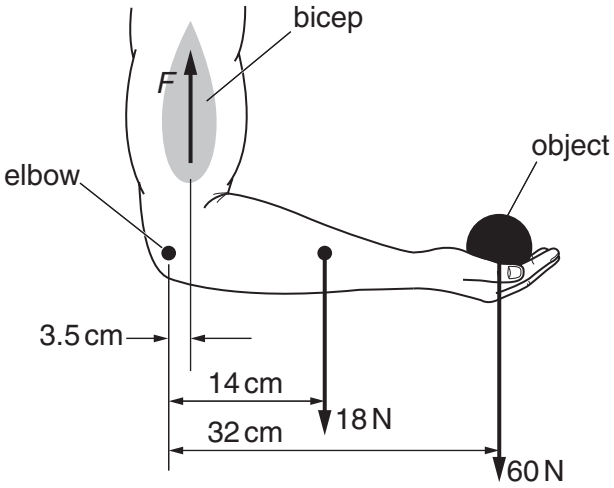


Fig. 4.2

The weight of the object in the hand is 60 N. The centre of gravity of this object is 32 cm from the elbow. The bicep provides an upward force of magnitude *F*. The distance between the line of action of this force and the elbow is 3.5 cm. The weight of the forearm is 18 N. The distance between the centre of gravity of the forearm and the elbow is 14 cm.

By taking moments about the elbow, determine the magnitude of the force *F* provided by the bicep.

F = ... N **[3]**

[Total: 10]

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5 **(a)** Fig. 5.1 shows a 20 N force acting at an angle of 38° to the horizontal.

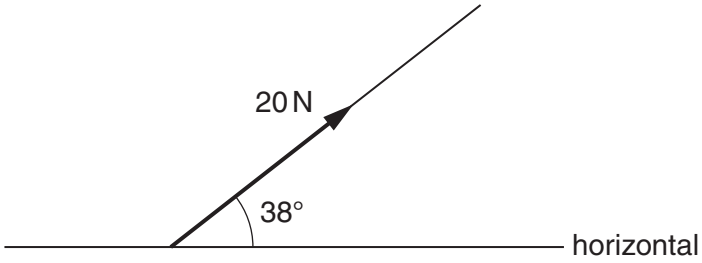


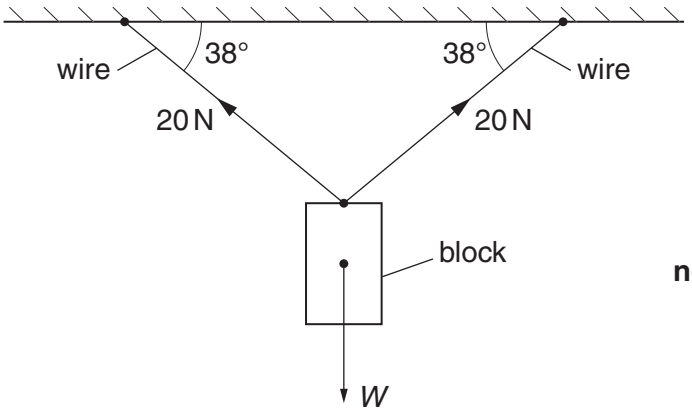
Fig. 5.1

Determine the horizontal and vertical components of this force.

horizontal component = ... N **[1]**

vertical component = ... N **[1]**

(b) Fig. 5.2 shows a metal block held in equilibrium by two wires.



not to scale

Fig. 5.2

The tension in each wire is 20 N.

(i) Show that the weight *W* of the metal block is about 25 N.

[2]

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(ii) The metal block has a volume of $2.9 \times 10^{-4}\,m^3$. Calculate the density of the metal.

density = ... $kg\,m^{-3}$ **[3]**

[Total: 7]

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6 **(a)** Define *stopping distance* of a car.

.....

..... **[1]**

(b) State two factors that affect the braking distance of a car. Describe how each factor affects the braking distance.

.....

.....

.....

.....

..... **[4]**

(c) Describe how Global Positioning System (GPS) is used to locate the position of a car on the Earth's surface.
In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

..... **[4]**

[Total: 9]

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7 **(a)** In what form is energy stored when a metal wire is extended by a force?

..... **[1]**

(b) A metal wire of length 1.2 m is clamped vertically. A weight is hung from the lower end of the wire. The extension of the wire is 0.35 mm. The cross-sectional area of the wire is $1.4 \times 10^{-7}\,m^2$ and the Young modulus of the metal is 1.9×10^{11} Pa.

Calculate

(i) the strain of the wire

strain = ... **[1]**

(ii) the tension in the wire.

tension = ... N **[2]**

Question 7 is continued over the page.

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(c) There is great excitement at the moment about structures known as carbon nanotubes (CNTs). CNTs are cylindrical tubes of carbon atoms. These cylindrical tubes have diameter of a few nanometres and can be several millimetres in length. Carbon nanotubes are one of the strongest and stiffest materials known. Recently a carbon nanotube was tested to have an ultimate tensile strength of about 60 GPa. In comparison, high-carbon steel has an ultimate tensile strength of about 1.2 GPa. Under excessive tensile stress, the carbon nanotubes undergo plastic deformation. This deformation begins at a strain of about 5%. Carbon nanotubes have a low density for a solid. Carbon nanotubes have recently been used in high-quality racing bicycles.

(i) **1** The diameter of CNTs is a *few nanometres*. What is one nanometre in metres?

..... **[1]**

2 Explain what is meant by *plastic deformation*.

.....

.....

..... **[1]**

(ii) How many times stronger are CNTs than high-carbon steel?

.....

..... **[1]**

(iii) State two advantages of making a bicycle frame using CNT technology rather than high-carbon steel.

.....

.....

..... **[2]**

[Total: 9]

END OF QUESTION PAPER

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RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE **H558**

Advanced Subsidiary GCE **H158**

Mark Scheme for the Units

January 2009

H158/H558/MS/R/09J

Oxford Cambridge and RSA Examinations

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All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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MARK SCHEMES FOR THE UNITS

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Question			Expected Answers	Marks	Additional Guidance
2	(a)		Downward arrow at **P**	**B1**	Arrow must be close to or at point **P**
	(b)		From gravitational potential (energy) to kinetic (energy) / KE / E_k (wtte) Any further detail: KE maximum at bottom / Zero (G)PE at bottom / (G)PE is maximum at top / (G)PE and KE at top (wtte)	**B1** **B1**	The term gravitational to be included and spelled correctly in **(b)** to gain the first B1 mark **Not**: Heat / sound at ground
	(c)		The acceleration / force / weight is at right angles to horizontal motion / velocity (wtte)	**B1**	**Allow**: 'In this direction the force / acceleration is zero'
	(d)		time = $\frac{3.6}{7.0}$ (= 0.514 s)	**B1**	**Allow**: time = $\sqrt{(1.3\times 2)/9.81}$ (= 0.515 s) **Allow**: Use of 9.8 (m s^{-2})
	(e)		u = 0 and $v = u + at$ or $v^2 = u^2 + 2as$ 'vertical' velocity = 9.81× 0.5(14) or 'vertical' velocity = $\sqrt{2\times 9.81\times 1.3}$ 'vertical' velocity = 5.0 (m s^{-1}) $v^2 = 7.0^2 + 5.0^2$ $v = 8.6$ (m s^{-1})	**C1** **C1** **A0**	**Watch out for**: '$v^2 = u^2 + 2as = 7^2 + (2\times 9.81\times 1.3) = 8.6$' – this scores **no** marks because of **wrong** physics. **Note**: Getting an answer 5.0 (m s^{-1}) scores the first 2 marks **Note**: Using t = 0.5 (s) gives 8.55 (m s^{-1}) **Note**: Bald answer scores zero marks – since this is a 'show' question (Allow full marks for correct analysis using the principle of conservation of energy.)
			Total	**8**	

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Question			Expected Answers	Marks	Additional Guidance
3	(a)		(Force is 1 N) when a **1 kg** mass has an acceleration of **1 m s^{-2}**	B1	**Not**: '1 kg and 1 m **s^{-1}**' **Allow**: (1 N =) **1 kg** × **1 m s^{-2}**
	(b)		The mass of particles increases (at its speed gets closer to the speed of light)	B1	**Not**: 'weight of particle increases' **Not**: 'mass changes / different'
	(c)	(i)	net force = 120 (N) $a = \frac{120}{900}$ a = 0.13 (m s^{-2})	C1 A1	 **Note**: Bald answer scores 2 marks; answer must be 2 sf or more
		(ii)	The drag force changes with speed / acceleration is not constant	B1	
	(d)		$F = 72 \times 1.4$ (= 100.8 N) / weight = 72 × 9.81 (= 706.32 N) T = (72 × 9.81) + (72 × 1.4) T = 807 (N) or 810 (N)	C1 C1 A1	**Note**: Bald 101 (N) or 706 (N) scores 1 mark **Note**: Bald answer scores 3 marks Bald 605.52 to at least 2 sf scores 1 mark
			Total	8	

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Question			Expected Answers	Marks	Additional Guidance
4	(a)		torque of a couple = one of forces × perpendicular distance (between forces)	B1	**Not**: 'force × perpendicular distance'
	(b)		Torque and moment are to do with 'distance multiplied by force'	B1	
	(c)	(i)	moment = 6.0 × 0.40 moment = 2.4 (N m)	B1	
		(ii)	Weight / force acts through the pivot Or (perpendicular) distance from pivot is (reduced to) zero (wtte)	B1	**Allow**: weight is 'vertically below' / 'directly below' the pivot Reference to pivot / point **P** (wtte) is essential
	(d)		Any three from: 1. (Suspend plate from a point and then) mark a vertical line on the plate (wtte) 2. Plumb line / 'pendulum' (used to find the vertical line) 3. Hang from another point / place (and draw another vertical line) (wtte) 4. Where the lines intersect gives position of centre of gravity (wtte)	B1×3	**Note**: For 1st point accept 'mark line of string' **Allow**: 1 mark for 'By trial and error find a position where the plate balances'
	(e)		(sum of) clockwise moment(s) = (sum of) anticlockwise moment(s) $(18 \times 0.14) + (60 \times 0.32) = 0.035F$ $F \approx 620$ (N)	C1 C1 A1	**Not**: 'CWM = ACWM' **Allow**: working in consistently in cm **Note**: Bald answer scores 3 marks **Allow**: 1 mark for 21.72 (N m) or 2172 (N cm)
			Total	10	

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Question			Expected Answers	Marks	Additional Guidance
5	(a)		$F_H = 20\cos 38 = 15.76 \approx 15.8$ (N) $F_V = 20\sin 38 = 12.31 \approx 12.3$ (N)	B1 B1	**Allow**: 2 sf answers of 16 (N) and 12 (N) **Allow**: 1 mark if vertical and horizontal components have been interchanged
	(b)	(i)	net force vertically = 0 / weight = upward forces weight = 12.3 + 12.3 weight = 24.6 (N) ≈ 25 (N) ---------- Or ---------- correct triangle of forces diagram correct determination of weight weight = 24.6 (N) ≈ 25 (N)	C1 C1 A0 C1 C1 A0	 Possible ecf from F_V value from **(a)** At least one label needed (e.g: 20, correct angle, etc) – arrows not needed Weight in the range 22 – 27 (N)
		(ii)	mass = $\frac{25}{9.81} = 2.55$ (kg) density = $\frac{2.55}{2.9\times10^{-4}}$ density = 8.8×10^3 (kg m^{-3})	C1 C1 A1	**Note**: 2.51 kg if 24.6 N is used **Note**: 'weight/volume' scores zero **Note**: Answer is 8.7×10^3 if 2.51 kg is used **Allow**: 2 marks if g = 10 used and 25 N → 2.5 kg $\therefore \rho$ = 8620 (kg m^{-3}) **Note**: Bald 8.7×10^3 or 8.8×10^3 scores 3 marks **Allow**: 1 mark if 20 N is used instead of 25 N – this gives 7030 (kg m^{-3})
			Total	**7**	

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Question			Expected Answers	Marks	Additional Guidance
6	(a)		stopping distance = thinking distance + braking distance	B1	
	(b)		Any <u>two</u> factors from: speed, mass, condition of tyres, condition of brakes, condition of road, gradient of road For each factor, correct description of how braking distance is affected E.g: • Greater speed means greater distance Or distance ∝ speed^2 (ora) • Greater mass means greater distance Or distance ∝ mass (ora) • Worn tyres / brakes implies less friction therefore greater distance (ora) • Wet / slippery / icy road means less friction therefore greater distance (ora) • Uphill means shorter distance (ora)	B1×2 B1×2	**Allow**: KE if neither mass nor speed is mentioned. For description marks, reference to 'distance' instead of 'braking distance' is fine For 1st bullet point allow reference to kinetic energy **Allow**: 'more' or 'longer' instead of 'greater' when referring to distance Do not allow 'grip' for friction for 3rd and 4th bullet points
	(c)		1. (Several) <u>satellites</u> used 2. Distance from (each) satellite is determined 3. Position / distance is determined using *c* / speed of e.m waves / radio waves / microwaves and delay time (wtte) 4. Trilateration is used to locate the position of the car Or position of car is where circles / spheres cross (wtte)	B1 B1 B1 B1	**Note**: The term 'satellite(s)' to be included and spelled correctly, on all occasions, to gain this first (or second) B1 mark (Deduct this mark only <u>once</u>.) Do not allow this 4th mark for just a diagram of intersecting spheres / circles
			Total	9	

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Question			Expected Answers	Marks	Additional Guidance
7	(a)		elastic potential (energy) / strain (energy)	B1	**Note**: The candidates do not need to include 'energy' since it is in the stem of the question **Not**: 'stored energy' / 'elastic energy'
	(b)	(i)	strain = $\frac{0.35\times10^{-3}}{1.2} = 2.9(2)\times10^{-4}$	B1	
		(ii)	stress = $1.9 \times 10^{11} \times 2.92 \times 10^{-4}$ (= 5.55×10^{7} Pa) tension = $5.55 \times 10^{7} \times 1.4 \times 10^{-7}$ tension = 7.8 (N)	C1 A1	Possible ecf from **b(i)** **Allow**: Bald answer scores 2 marks
	(c)	(i) 1	10^{-9} (m)	B1	
		(i) 2	Material does not return to original length / shape/ size when the force / stress is removed	B1	There must be reference to stress / force removed to score this mark **Note**: If there is no reference to unloading then allow 'material is <u>permanently</u> deformed'
		(ii)	50 times (stronger)	B1	
		(iii)	Less mass / less weight / lighter Stronger / greater tensile strength	B1 B1	
			Total	9	

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