Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

Advanced Subsidiary
Unit 1: Physics on the Go

Friday 11 January 2013 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6PH01/01

You must have:
Ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 4 1 6 2 7 A 0 1 2 8

PEARSON

SECTION A

Answer ALL questions.

For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 An object of weight 7 N is raised from a height of 2 m to a height of 8 m.

The change in gravitational potential energy is

☒ **A** 42 J

☒ **B** 56 J

☒ **C** 412 J

☒ **D** 549 J

(Total for Question 1 = 1 mark)

2 Which of the following is a derived SI unit?

☒ **A** joule

☒ **B** metre

☒ **C** power

☒ **D** time

(Total for Question 2 = 1 mark)

3 A student is asked to solve the following problem:

An object is thrown upwards with a speed of 25 m s^{-1}. How high will it be when the speed is 12 m s^{-1}?

Which equation will allow the problem to be solved in a single calculation?

☒ **A** $s = ut + \frac{1}{2} at^2$

☒ **B** $s = (u + v)t/2$

☒ **C** $v = u + at$

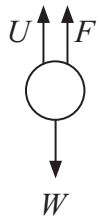
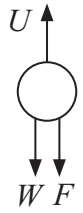
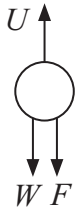
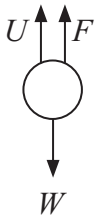
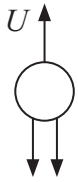
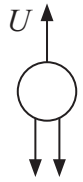
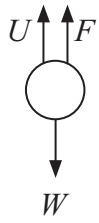
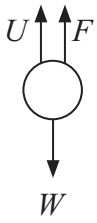
☒ **D** $v^2 = u^2 + 2as$

(Total for Question 3 = 1 mark)

4 When beer is being brewed it can contain bubbles of gas rising through it as well as solid particles, such as grain particles, falling through it.

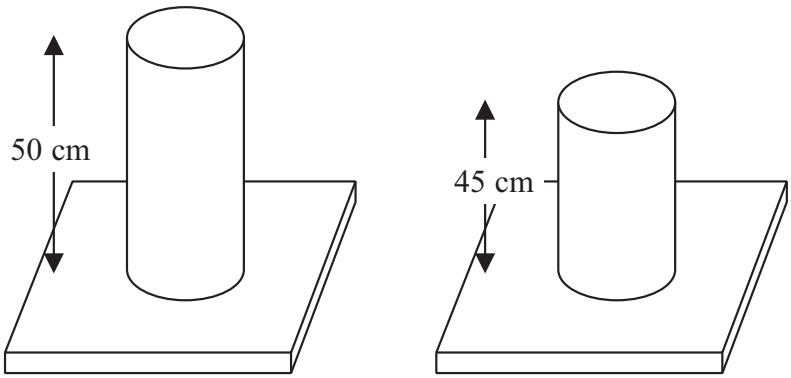
Which row of the table correctly shows the forces on a rising gas bubble and a falling solid particle?

F = viscous drag, U = upthrust, W = weight

	Gas bubble	Solid particle
☒ **A**		
☒ **B**		
☒ **C**		
☒ **D**		

(Total for Question 4 = 1 mark)

5 A cylinder of length 50 cm has a force applied to it. The new length of the cylinder is 45 cm.



The quantity determined using $\frac{5 \text{ cm}}{50 \text{ cm}}$ is

☒ **A** compressive strain.

☒ **B** compressive stress.

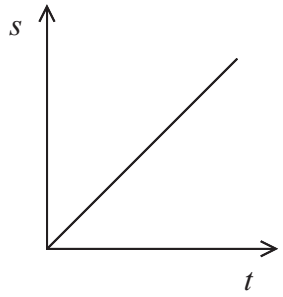
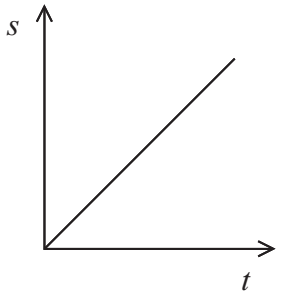
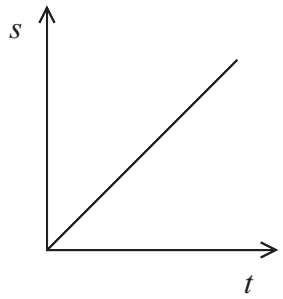
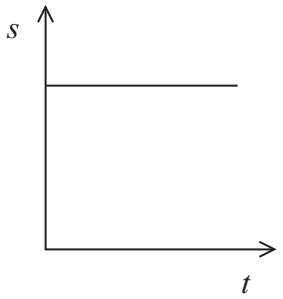
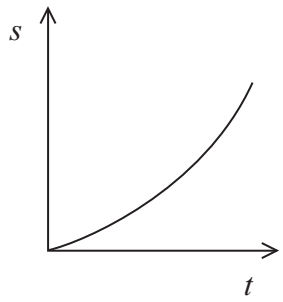
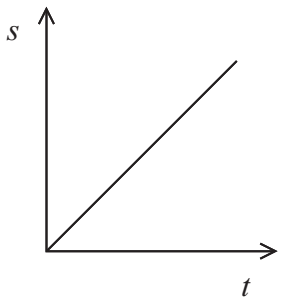
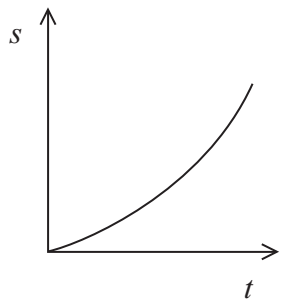
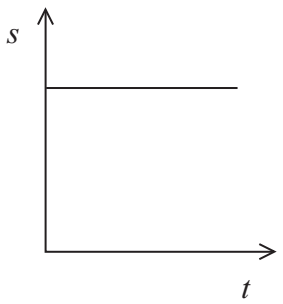
☒ **C** tensile strain.

☒ **D** tensile stress.

(Total for Question 5 = 1 mark)

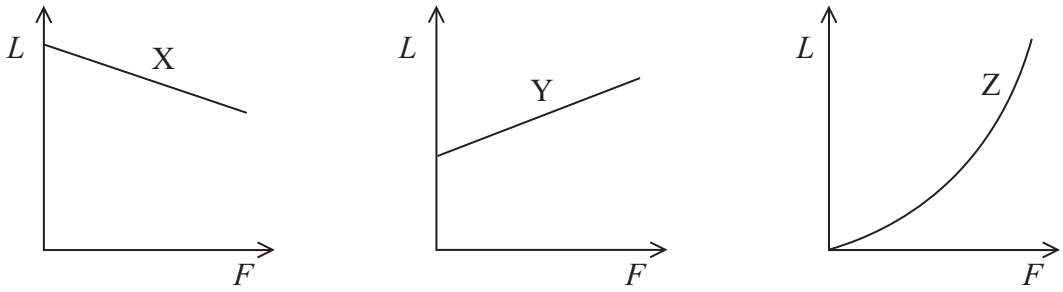
6 An object is thrown horizontally from the roof of a building.

Which pair of displacement–time graphs correctly shows the vertical and horizontal components of displacement for the object until it lands? Assume that there is no air resistance.

	Vertical	Horizontal
☒ **A**		
☒ **B**		
☒ **C**		
☒ **D**		

(Total for Question 6 = 1 mark)

7 Three springs X, Y and Z have forces applied to them. For each spring a graph is plotted of length L of the spring against force F. The graphs are shown below:



Which of the springs obey Hooke's law?

☒ **A** X and Y

☒ **B** X and Z

☒ **C** Y and Z

☒ **D** Y only

(Total for Question 7 = 1 mark)

8 A car of mass 1400 kg is travelling at 25 m s^{-1}.

The kinetic energy of the car is

☒ **A** 17.5 kJ

☒ **B** 35.0 kJ

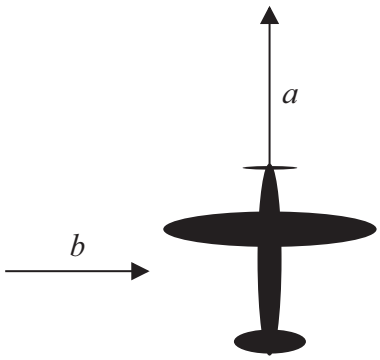
☒ **C** 438 kJ

☒ **D** 875 kJ

(Total for Question 8 = 1 mark)

Questions 9 and 10 refer to the information below.

An aeroplane is flying horizontally and heading north through the air. Its speed through the air is a and the wind is blowing east with a speed b.



9 The speed over the ground is given by

☒ **A** $a + b$

☒ **B** $a^2 + b^2$

☒ **C** $\sqrt{a + b}$

☒ **D** $\sqrt{a^2 + b^2}$

(Total for Question 9 = 1 mark)

10 The angle from north at which the plane flies over the ground is given by

☒ **A** $\cos^{-1} a/b$

☒ **B** $\sin^{-1} b/a$

☒ **C** $\tan^{-1} a/b$

☒ **D** $\tan^{-1} b/a$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 Car engines use motor oil as a lubricant. Motor oils need to operate over a range of temperatures because they may be at 0 °C or below when the engine is started but be up to 160 °C when the engine is running. At all times motor oils need to be thin enough to allow the parts to move smoothly but thick enough to remain on the moving parts.

Explain why the engine may experience difficulties if the temperature becomes too hot or cold.

(2)

(Total for Question 11 = 2 marks)

***12** A student reads the following statement in a text book:

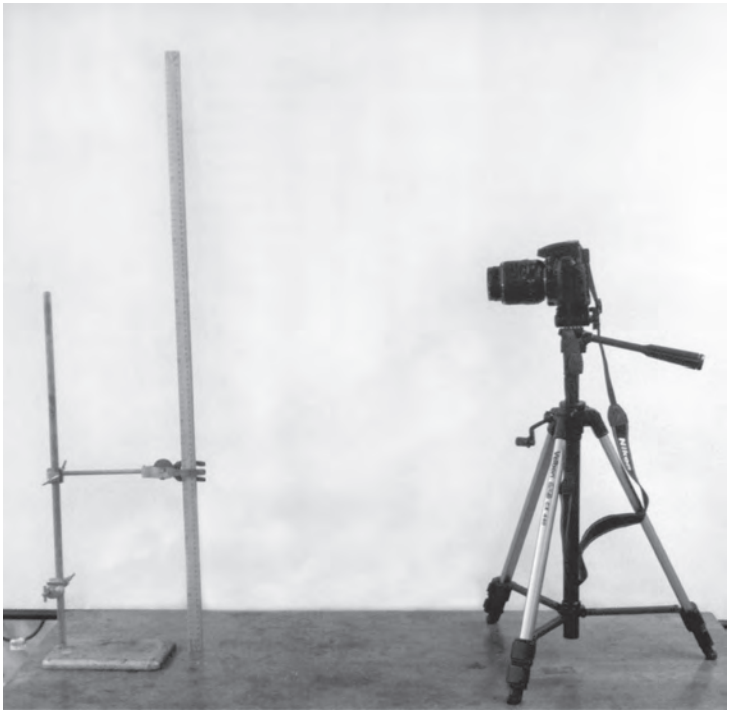
Unlike many metals, lead is malleable but not ductile.

Explain the statement.

(4)

(Total for Question 12 = 4 marks)

13 A student carries out an experiment to find the acceleration of free fall.



(a) In this experiment the student releases a small steel ball in front of a metre rule and uses a video camera to record its motion. The camera captures 30 images per second, which may be played back one image at a time.

(i) Explain how the acceleration of free fall could be determined using the recording.

(4)

(ii) Describe a systematic error which could arise.

(1)

(b) Describe one property of the steel ball that makes it suitable to use in this experiment and explain why this property makes it suitable.

(2)

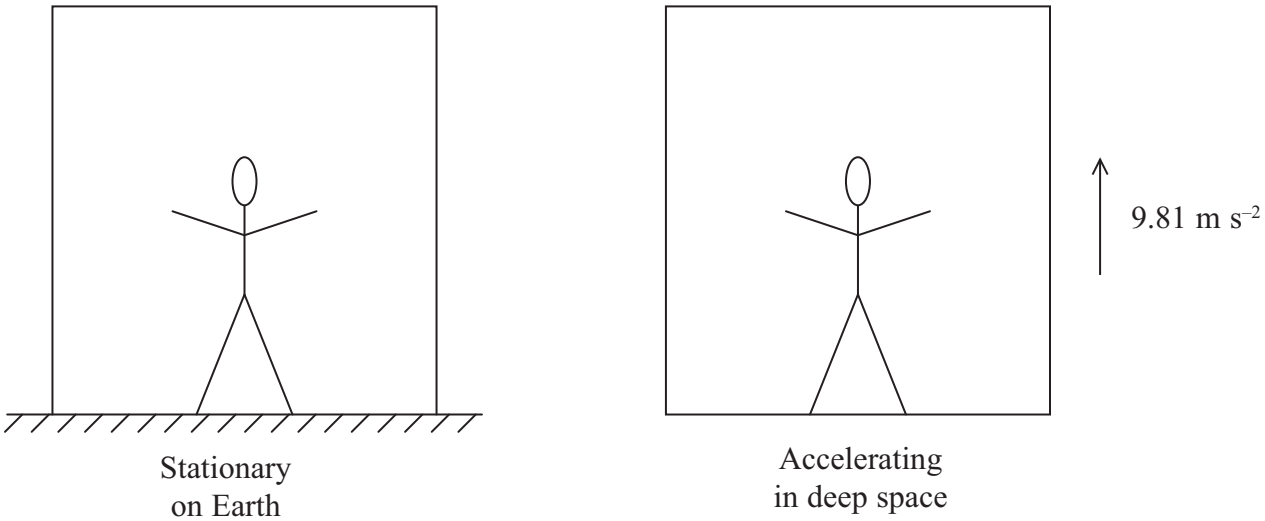
(c) Explain an advantage of using a video camera to take measurements for this experiment rather than using a stopwatch.

(2)

(Total for Question 13 = 9 marks)

***14** Einstein imagined a person in a large box without windows. He suggested that, with no way to see outside, the person could not tell whether they were:

- experiencing gravity on Earth
- in deep space far away from any effects of gravity but being accelerated at a rate of 9.81 m s^{-2}.



Stationary on Earth

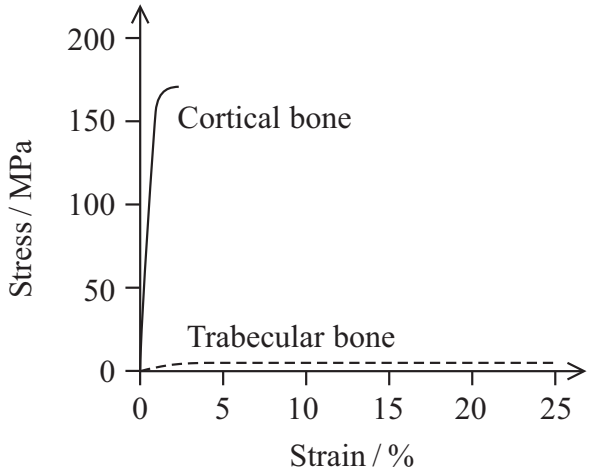
Accelerating in deep space

Account for Einstein's suggestion by explaining in each case what a person standing in the box would feel through their feet. It may help to assume the person has mass *m*.

(6)

(Total for Question 14 = 6 marks)

15 The graph shows the stress–strain curve for two types of human bone under compression.



(a) Use the graph to identify and describe **one** property of cortical bone.

(2)

.....

.....

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.....

(b) The table gives the following information for the two types of bone.

Material	Young modulus / GPa	Maximum compressive stress / MPa	Maximum tensile stress / MPa
Cortical bone	17.9	170	120
Trabecular bone	0.076	2.2	

(i) State the difference between compressive stress and tensile stress.

(1)

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(ii) State how the graph could be used to confirm the value of the Young modulus for cortical bone.

(1)

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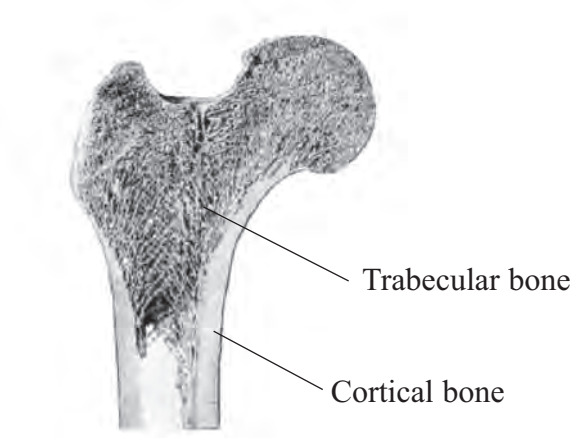
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(iii) A person of mass 90 kg stands on one foot. Show that the maximum weight which can be supported is about 70 times this person's weight. Assume all the weight is supported by the femur (thigh bone) and that it is made of cortical bone.

cross-sectional area of femur = 3.7×10^{-4} m^2

(4)

(iv) It is stated in a text book that a femur can support about 30 times a person's weight.



Explain how the structure shown in the diagram would account for the difference from the calculated value.

(2)

(Total for Question 15 = 10 marks)

16 The photograph shows a sequence of pictures of a man jumping 30 m from a cliff into the water below.

- Ignore the first picture and consider the second as representing the instant he jumps.
- Ignore the final picture (the splash), taking the tenth picture as showing the time at which he has fallen 30 m.



(a)



The diagram shows the tenth picture of the man.

It is useful to mark the centre of gravity of the man for each picture before taking measurements to analyse the motion.

State what is meant by centre of gravity and mark its approximate position on the diagram.

(2)

(b) The vertical distance between consecutive pictures increases, but the horizontal distance remains the same. Explain this observation.

(2)

(c) By considering the vertical motion for pictures 2 to 10, show that the pictures are taken at a rate of about 3 per second.

vertical height fallen = 30 m

(3)

(d) The vertical height between the second and tenth pictures is 30 m. Take measurements from the photograph and use them to show that the horizontal distance between these pictures is between 12 m and 15 m.

Record your measurements below.

(3)

(e) Calculate the horizontal velocity and vertical velocity of the man for the tenth picture.

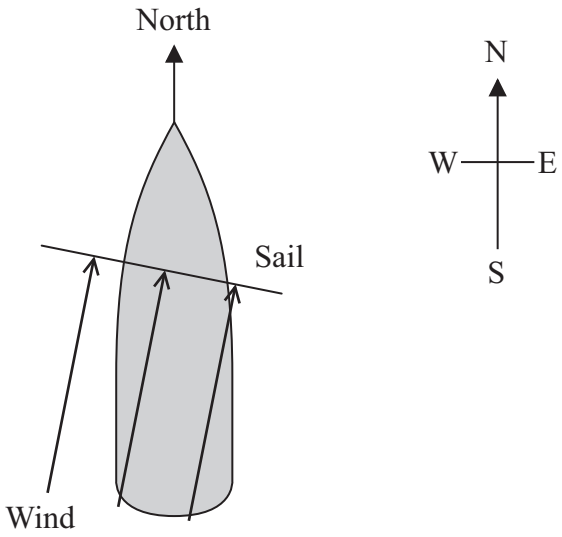
(4)

Horizontal velocity = ...

Vertical velocity = ...

(Total for Question 16 = 14 marks)

17 A stationary boat is pointing north as shown in the diagram. A wind starts blowing at 10 m s^{-1} in a direction 20° east of north against the sail. The boat starts to move northwards.



(a) (i) The wind exerts a force per unit area of 84 N m^{-2} on the sail, which is at right angles to the wind direction.

Show that the component of force in a northerly direction is about 1400 N.

area of sail = 18 m^2

(3)

(ii) When the wind starts to blow the water exerts a force on the boat to the west.

Explain why.

(2)

(iii) Draw a vector diagram showing the forces exerted on the boat by the wind and the water and the resultant force calculated in part (a)(i).

(2)

(iv) Assuming the boat is starting from rest in still water, calculate the initial acceleration of the boat.

mass of boat = 400 kg

(2)

Initial acceleration = ...

(b) Later the wind, still at a speed of 10 m s^{-1}, is blowing towards the north and the boat is travelling northwards at a steady speed of 5 m s^{-1}. The force on the sail is now 380 N towards the north.

(i) Suggest why the force on the sail is less than in part (a).

(1)

(ii) Calculate the rate at which the wind does work against the forces that resist the boat's motion.

(2)

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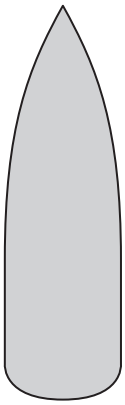
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Rate at which the wind does work = ...

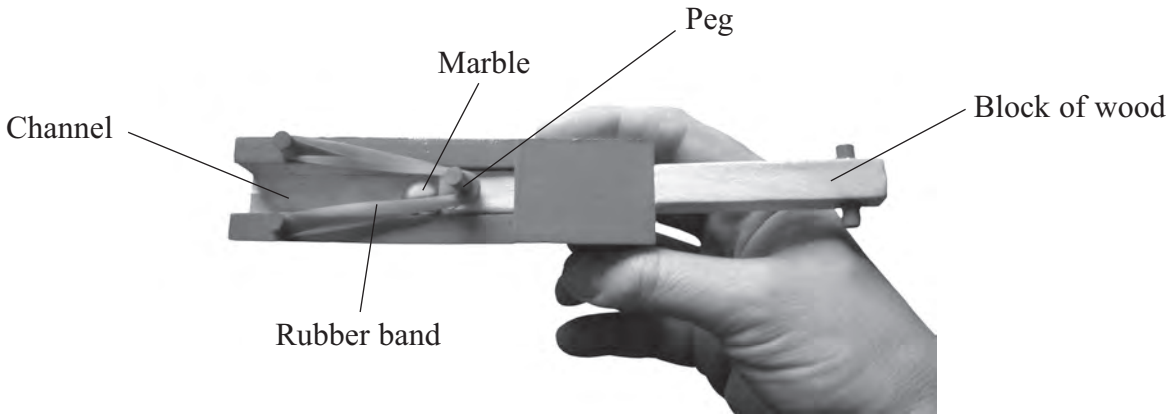
(iii) There is now a force exerted southwards on the boat. A suggested reason for this force is because of turbulence developing at the rear of the boat. Add flow lines to the diagram to show the path of water around the boat and label the regions of laminar and turbulent flow.

(2)



(Total for Question 17 = 14 marks)

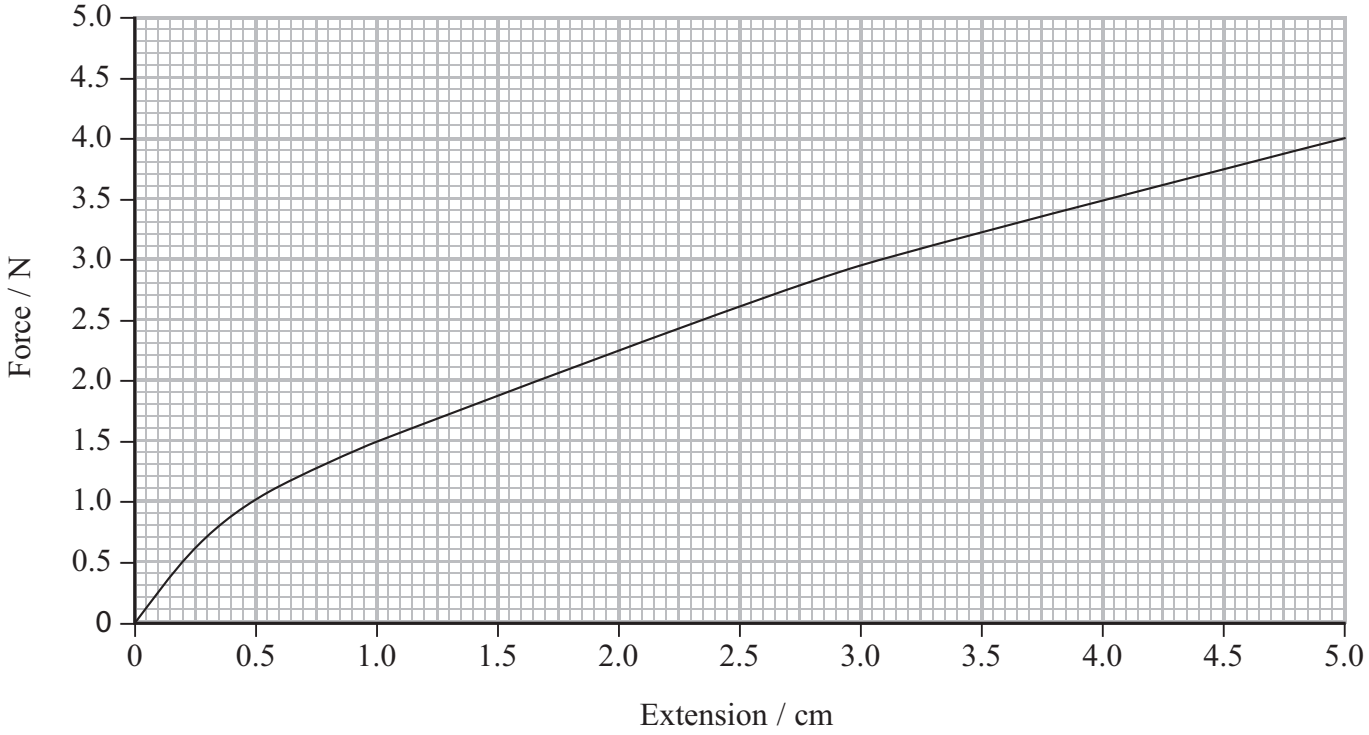
18 The photograph shows a marble launcher.



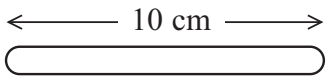
To load: pull the block of wood backwards, stretching the rubber band, place a marble into the channel.

To launch: release the block so it is pulled forward by the rubber band, pushing the marble through the channel.

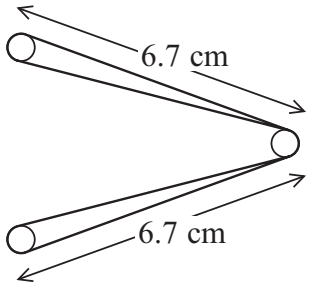
(a) The graph shows the results of an experiment to investigate the properties of the rubber band.



(i) The diagram shows the arrangement of the rubber band when it is stretched ready to launch a marble. The unstretched length of the rubber band is 10 cm.



Unstretched rubber band



Stretched rubber band

Use the graph to show that the tension is about 3 N.

(2)

(ii) A student uses the graph to obtain an approximate value of the energy stored before launching. Show that 0.06 J is a reasonable approximate value.

(2)

(iii) The student launches the marble vertically in order to determine the energy transferred to it when it is launched. Show that the maximum possible height attainable is about 2 m.

mass of marble = 3.8 g

(2)

(b) The student obtains the following set of measurements for the height reached.

30.0 cm, 30.3 cm, 25.8 cm, 29.7 cm

(i) Explain why the student obtained a value of 30.0 cm for the height reached.

(2)

.....

.....

.....

.....

(ii) Explain why the height reached is so much less than 2 m.

(2)

.....

.....

.....

.....

(iii) Suggest how the marble launcher could be adapted so that the height reached by the marble could be increased.

(1)

.....

.....

.....

(Total for Question 18 = 11 marks)

TOTAL FOR SECTION B = 70 MARKS
TOTAL FOR PAPER = 80 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Electron charge	$e = -1.60 \times 10^{-19}\ \text{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$	
Electronvolt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$	
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	

Unit 1

Mechanics

Kinematic equations of motion	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
Forces	$\Sigma F = ma$ $g = F/m$ $W = mg$
Work and energy	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{grav} = mg\Delta h$

Materials

Stokes' law	$F = 6\pi\eta rv$
Hooke's law	$F = k\Delta x$
Density	$\rho = m/V$
Pressure	$p = F/A$
Young modulus	$E = \sigma/\varepsilon$ where Stress $\sigma = F/A$ Strain $\varepsilon = \Delta x/x$
Elastic strain energy	$E_{el} = \frac{1}{2}F\Delta x$