Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Thursday 10 October 2019

Afternoon (Time: 1 hour 30 minutes) | Paper Reference **WPH11/01**

Physics

International Advanced Subsidiary
Unit 1: Mechanics and Materials

You must have:
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or **black** 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.*
- **Show all your working in calculations and include units where appropriate**.

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.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

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

Turn over ▶

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P 6 2 7 8 6 A 0 1 2 8

Pearson

SECTION A

Answer ALL questions.

For questions 1–10, 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 Which row of the table gives the meaning of the stated unit prefixes?

	micro	centi
☒ **A**	10^{-6}	10^{-2}
☒ **B**	10^{-9}	10^{2}
☒ **C**	10^{-9}	10^{-2}
☒ **D**	10^{-6}	10^{2}

(Total for Question 1 = 1 mark)

2 All quantities may be expressed in terms of SI base units.

Which of the following are the base units for the moment of a force?

☒ **A** $\mathrm{kg\,m\,s^{-2}}$

☒ **B** $\mathrm{kg\,m^2\,s^{-2}}$

☒ **C** $\mathrm{kg\,m\,s^{-1}}$

☒ **D** $\mathrm{kg\,m^2\,s^{-3}}$

(Total for Question 2 = 1 mark)

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3 A student measured the diameter of a length of wire in order to determine its cross-sectional area.

The following measurements were taken at various positions along the wire and at various orientations around the wire. All measurements are in mm.

1.57	1.36	1.54	1.55	1.58

Which of the following expressions should the student use to determine the cross-sectional area of the wire in mm^2?

☒ **A** $\pi(1.56)^2$

☒ **B** $\pi(1.52)^2$

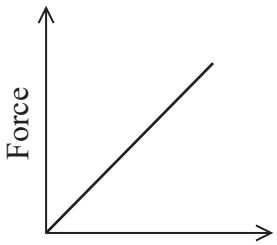
☒ **C** $\pi(0.78)^2$

☒ **D** $\pi(0.76)^2$

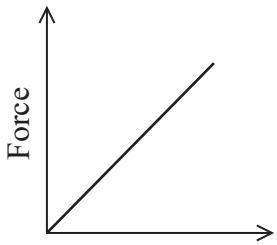
(Total for Question 3 = 1 mark)

4 The area under each of the following graphs represents a physical quantity.

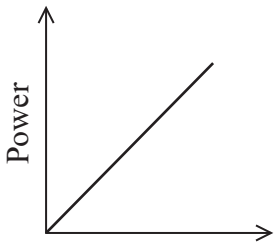
For which graph is the area under the graph **not** equal to work done?



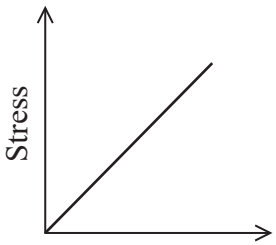
☒ **A**



☒ **B**



☒ **C**

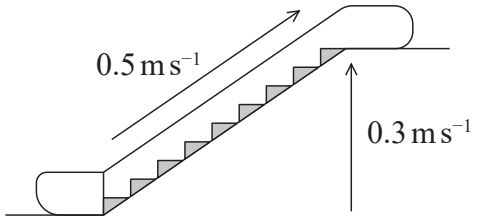


☒ **D**

(Total for Question 4 = 1 mark)

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5 The steps on an escalator move with a speed of $0.5\,m\,s^{-1}$. The vertical component of their velocity is $0.3\,m\,s^{-1}$ upwards.



Which of the following is the horizontal component of velocity for the escalator steps?

☒ **A** $0.2\,m\,s^{-1}$

☒ **B** $0.4\,m\,s^{-1}$

☒ **C** $0.5\,m\,s^{-1}$

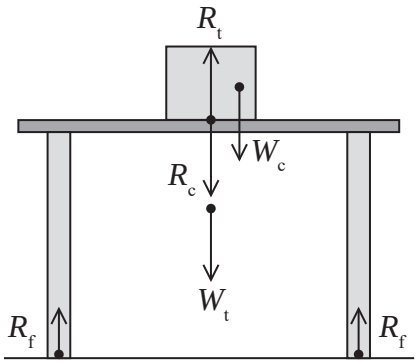
☒ **D** $0.8\,m\,s^{-1}$

(Total for Question 5 = 1 mark)

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Questions 6 and 7 refer to the diagram below.

A uniform solid cube is placed on a table. The diagram shows the forces acting on the table and on the cube.



R_c = reaction force of cube on table
R_f = reaction force of floor on table
R_t = reaction force of table on cube
W_c = weight of cube
W_t = weight of table

6 The dot at the start of every arrowed line indicates the point at which the force can be considered to act.

Which of the following forces has been drawn in the wrong position?

☒ **A** R_c

☒ **B** R_t

☒ **C** W_c

☒ **D** W_t

(Total for Question 6 = 1 mark)

7 The table has four legs.

Which of the following statements is correct according to Newton's third law?

☒ **A** $4R_f = R_c + R_t$

☒ **B** $4R_f = R_c + W_t$

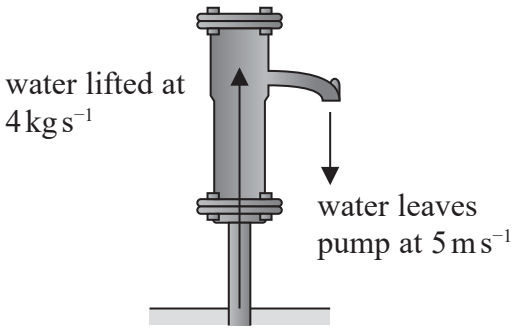
☒ **C** $R_c = R_t$

☒ **D** $R_t = W_c$

(Total for Question 7 = 1 mark)

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8 An electric pump lifts water from a well through a height of 10 m at a rate of $4\,kg\,s^{-1}$. The water leaves the pump with a velocity of $5\,m\,s^{-1}$ as shown.



Which of the following expressions could be used to determine the minimum power output of the pump in watts?

☒ **A** $\frac{1}{2}(4 \times 5^2)$

☒ **B** $(4 \times 9.81 \times 10)$

☒ **C** $(4 \times 9.81 \times 10) + \frac{1}{2}(4 \times 5^2)$

☒ **D** $(4 \times 9.81 \times 10) - \frac{1}{2}(4 \times 5^2)$

(Total for Question 8 = 1 mark)

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9 A student used a falling sphere to determine the acceleration of free fall.

A camera produced images of the sphere at constant time intervals as it fell.

The positions of the sphere in the first two images are shown. Image 1 shows the sphere's position at the instant it was released.

Image 1

Image 2

P

Q

R

S

Which of the positions P, Q, R or S will the sphere be at in Image 3?

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(Total for Question 9 = 1 mark)

10 A force F was applied to compress a spring by a distance x.

A second spring of double the stiffness was compressed by the same distance x.

Which of the following gives the magnitude of the force applied to the second spring?

☒ **A** $4F$

☒ **B** $2F$

☒ **C** F

☒ **D** $\frac{F}{2}$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

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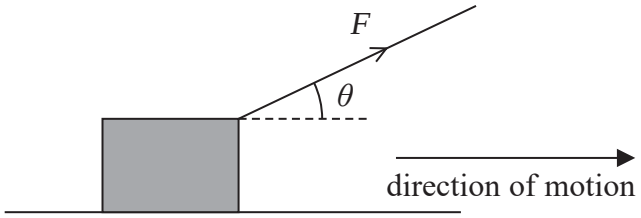
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SECTION B

Answer ALL questions in the spaces provided.

11 A rope is used to pull a box a fixed distance s along a horizontal surface. The rope is at an angle θ to the horizontal and a constant force F is applied to the rope as shown.



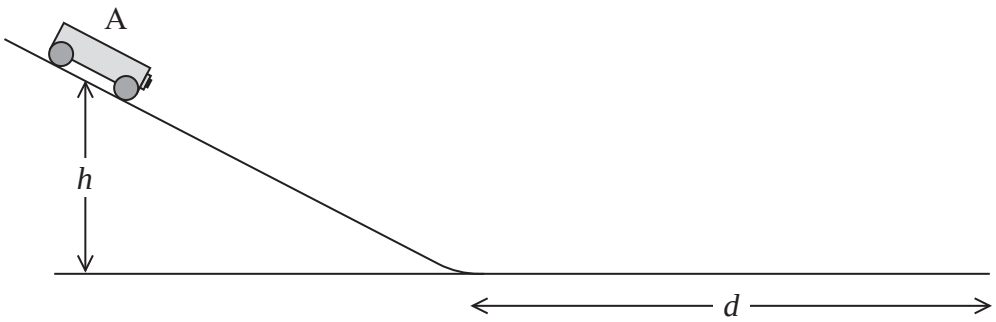
Explain how the work done on the box by F varies as θ varies.

(3)

(Total for Question 11 = 3 marks)

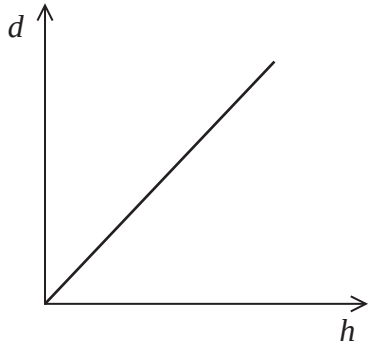
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12 A student set up the apparatus shown.



(a) When released from a height h, trolley A ran down the slope and then continued to move horizontally. On the horizontal part of the track a frictional force F brought the trolley to rest over a short distance d. The trolley has a mass m. The student measured d for a range of heights h.

The student plotted the following graph of d against h.

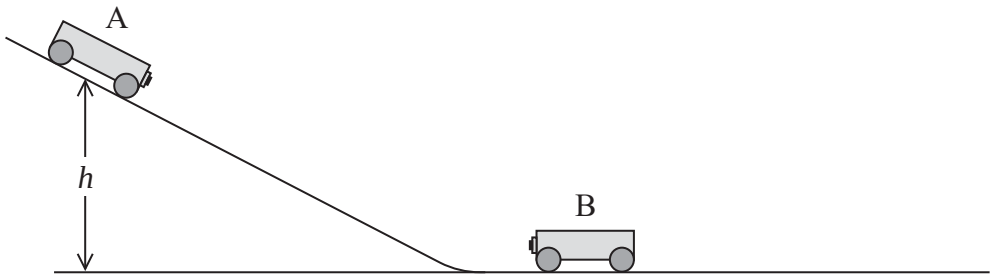


Derive an expression for the gradient of the graph, in terms of F, m and g.

(2)

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(b) In a second experiment, an identical trolley B was placed at rest at the bottom of the slope. When trolley A was released as before, it rolled down and collided with trolley B. After the collision the two trolleys joined together and moved off to the right with a velocity v.



The student predicted that, provided friction was ignored, $v = \sqrt{\frac{gh}{2}}$.

Assess whether the student was correct.

(4)

(Total for Question 12 = 6 marks)

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13 The photograph shows an area of land where golfers can practise their golf shots. Distances are marked out along the land in front of where the golfer stands, to measure the distance travelled by the ball.

Two levels are available. If the lower level is used, the ball lands at the same height from which it was hit. If the higher level is used, this enables the ball to be hit further.



Source: www.golfnews.co.uk

(a) A ball is given an initial velocity of $33\,m\,s^{-1}$ at an angle of 28° to the horizontal.

When hit from the lower level, this ball travels a horizontal distance of 92 m before landing. Use of the higher level increases the horizontal distance travelled before landing by 10 m.

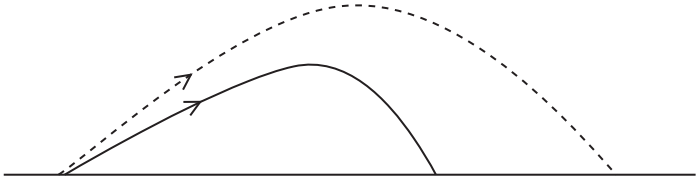
Deduce whether an upper level at a height of 4.5 m would be sufficient to produce this increase. You should ignore air resistance.

(5)

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*(b) Your answer to part (a) did not consider the effect of air resistance.

The trajectories of the motion of the golf ball with air resistance and without air resistance are shown.



Trajectory without air resistance ----------

Trajectory with air resistance _____

Explain the differences between the two paths.

(6)

(Total for Question 13 = 11 marks)

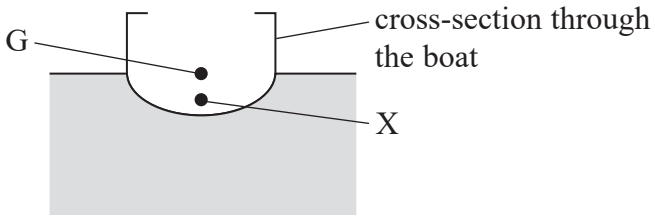
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14 For a boat to maintain a constant upright position in the water, the weight W and upthrust U should have the same line of action.

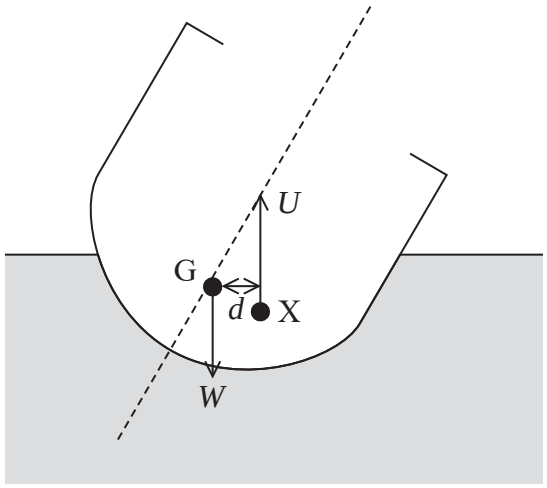
W acts through G, the centre of gravity of the boat.

U acts through X, the centre of gravity of the volume of water displaced by the boat.

G and X are shown on the diagram.



(a) A sudden gust of wind applies a force to the side of the boat, causing it to tilt. The lines of action of W and U move apart a distance d, as shown below.



(i) Explain the effect of the moment Ud.

(2)

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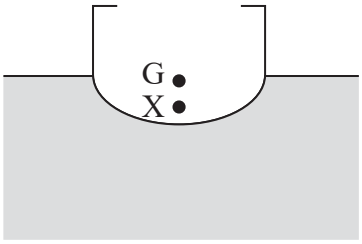
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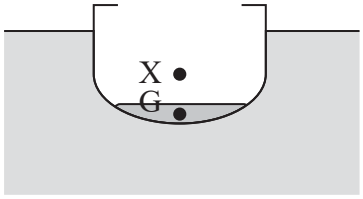
(ii) Explain what would happen to the boat in windy weather if the centre of gravity G were higher.

(3)

(b) Some boats use a ballast tank, which is a refillable tank of water in the base of the boat, to improve stability.



Ballast tank empty



Ballast tank full

(i) Explain why the position of X for the ship when it has a full ballast tank is lower than when the ship has an empty ballast tank.

(4)

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(ii) Explain a disadvantage of using a full ballast tank when the boat is moving through the water.

(2)

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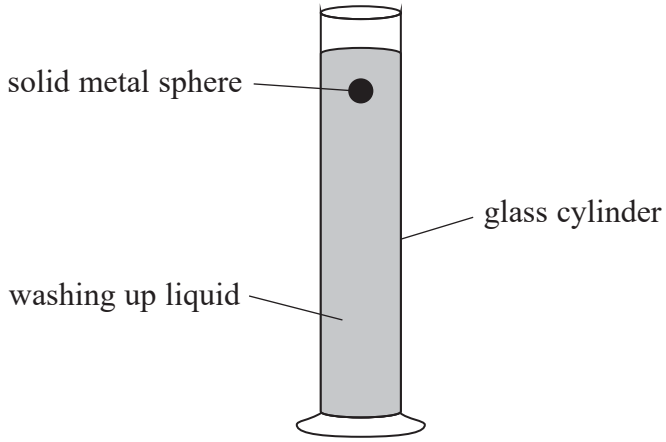
(Total for Question 14 = 11 marks)

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15 A student carried out an experiment to determine the viscosity of washing up liquid using the apparatus shown.



(a) The student released the sphere at the top of the cylinder and made measurements, using a stopwatch and metre rule, so the terminal velocity of the sphere could be determined.

(i) Describe a method that the student could use to determine an accurate value for the terminal velocity of the sphere. You may add to the diagram above.

(5)

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(ii) Explain why the use of a larger sphere would increase the percentage uncertainty in the calculated value of the terminal velocity.

(4)

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(b) (i) Complete the free-body force diagram for the sphere when travelling at terminal velocity.

(3)



(ii) The student obtained a value of $0.16\,m\,s^{-1}$ for the terminal velocity of the sphere.

Calculate the viscosity η of the washing up liquid in Pa s.

radius of sphere = 4.8×10^{-3} m
weight of sphere = 3.5×10^{-2} N
density of washing up liquid = $1.1 \times 10^{3}\,kg\,m^{-3}$

(4)

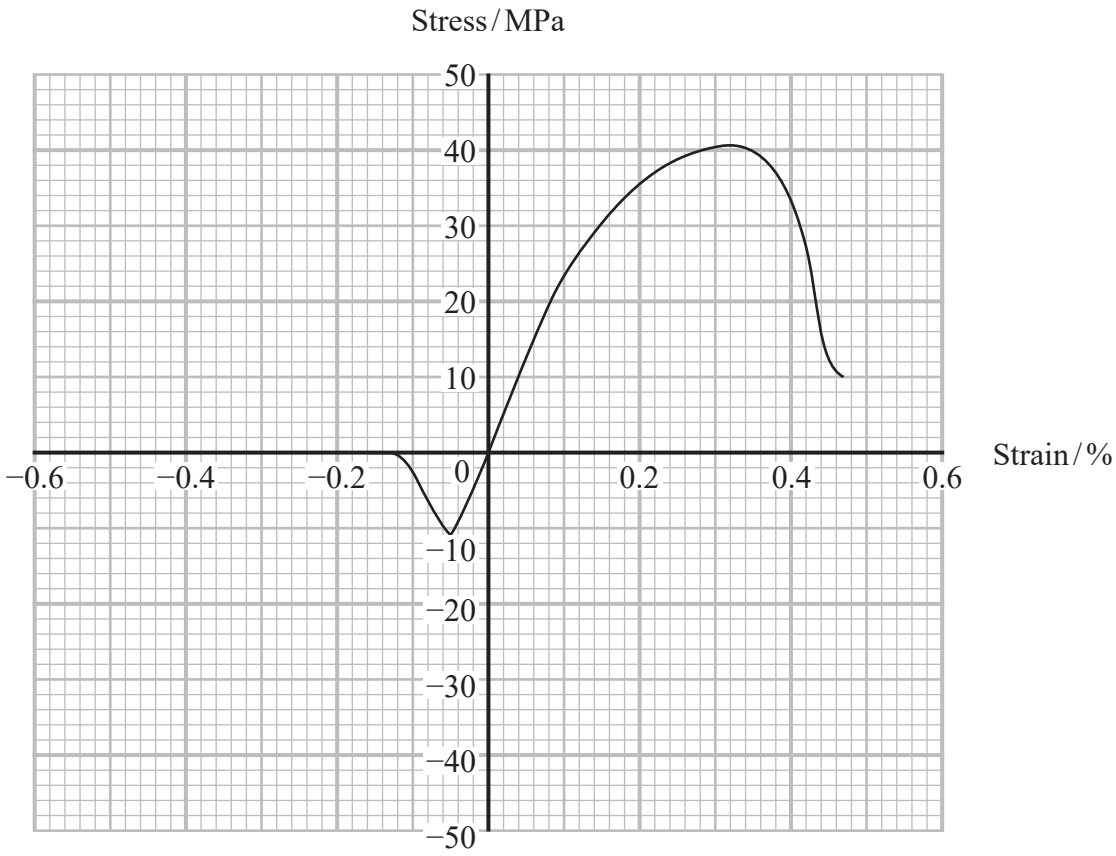
η = ... Pa s

(Total for Question 15 = 16 marks)

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16 Concrete is a material often used for building.

A stress-strain graph for one type of concrete is shown. Positive values of strain represent compression and negative values of strain represent tension.

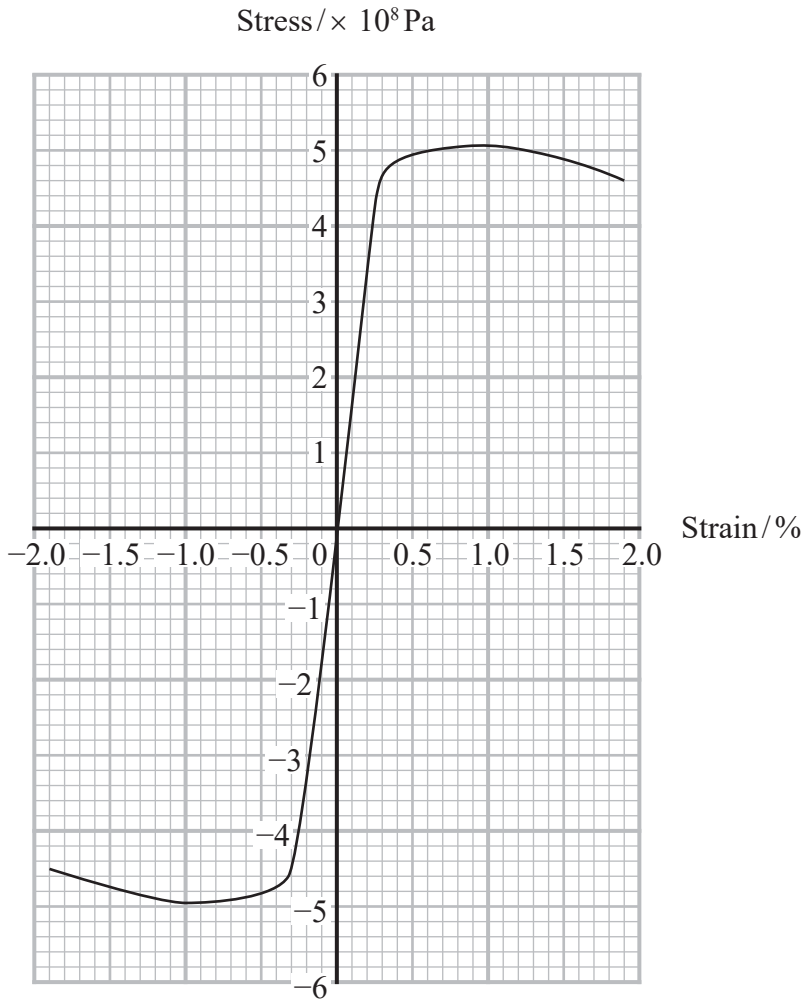


(a) Explain how the stress-strain graph shows that concrete is more suitable for use under compression than under tension.

(2)

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(b) Steel is a metal often used in building. The stress-strain graph for steel is shown.



A steel rod has a diameter of 45 mm.

Calculate the maximum force that could be applied to the steel rod before it fractures.

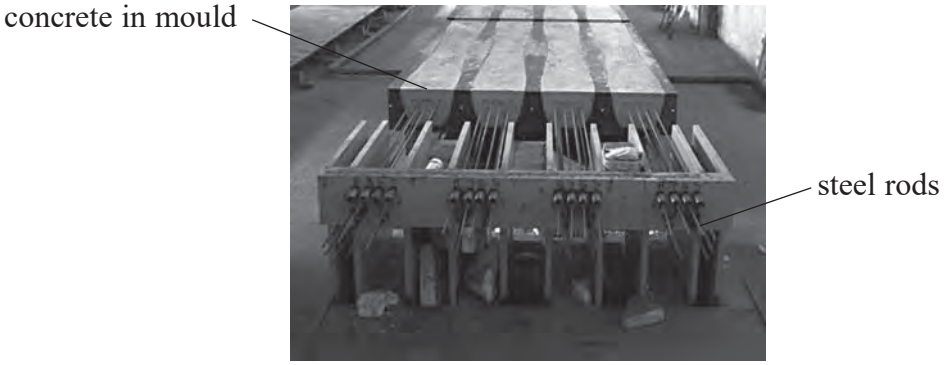
(3)

Maximum force = ...

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(c) To make concrete suitable for use under large forces steel rods are sometimes embedded in the concrete.

An external tensile force is applied to the steel rods. Concrete is poured into a mould around the rods. Once the concrete has set the external force is removed from the steel rods, placing the concrete in compression.



Source: www.designingbuildings.co.uk

(i) Explain how this process increases the maximum tensile force that the concrete can withstand before fracture.

(4)

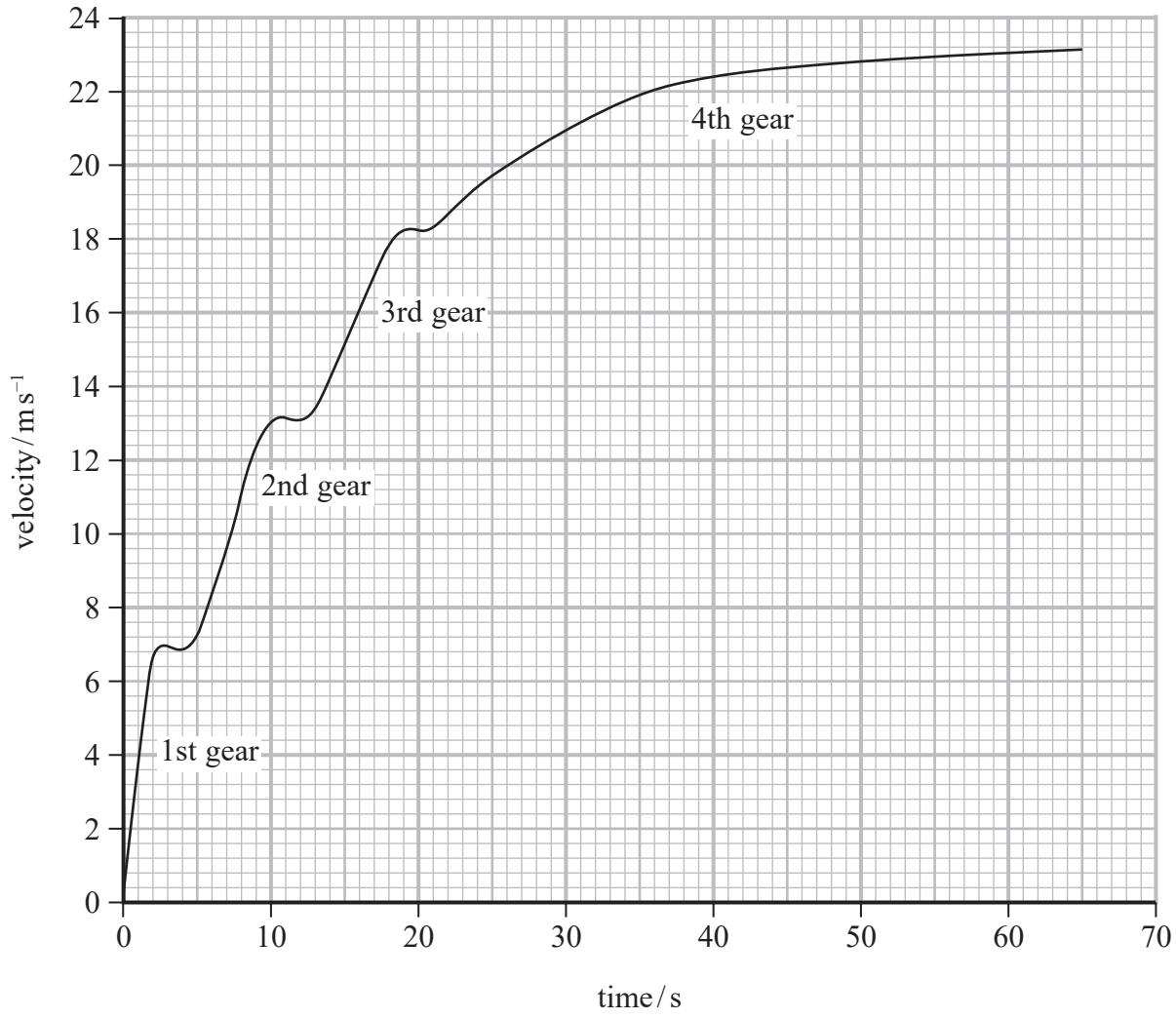
(ii) Explain why the external tensile force in the rods must not take the steel beyond its elastic limit.

(2)

(Total for Question 16 = 11 marks)

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17 The velocity-time graph for a car for the first part of a journey is shown.



(a) As the velocity of the car increased, the driver changed gear. Each change in gear produced a small decrease in velocity.

(i) State how the graph shows that in 3rd gear the car has a smaller acceleration than in 1st gear.

(1)

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.....

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(ii) Determine the average acceleration when the car is accelerating in 2nd gear.

(2)

Average acceleration in 2nd gear = ...

(iii) The equation that links the power P of a car engine to the forward force F on the car and the velocity v of the car is

$$P = Fv$$

Comment on the magnitude of F when the car is in higher gears, assuming P remains constant.

(2)

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(b) The manufacturer of a different car gives the following information.

Gear	Maximum velocity / m s^{-1}	Maximum acceleration / m s^{-2}
1st	18	2.9
2nd	32	1.2
3rd	46	0.83
4th	74	0.72

(i) Calculate the minimum time taken for the car to accelerate from rest to 60 miles per hour. You may assume that the time taken to change gears is negligible.

1 mile = 1600 m

(4)

Time = ...

(ii) Explain why there will be a maximum speed at which the car can travel.

(3)

(Total for Question 17 = 12 marks)

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

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List of data, formulae and relationships

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to Earth's surface)
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)

Unit 1

Mechanics

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Materials

Density

$$\rho = \frac{m}{V}$$

Stokes' law

$$F = 6\pi\eta rv$$

Hooke's law

$$\Delta F = k\Delta x$$

Elastic strain energy

$$\Delta E_{el} = \frac{1}{2}F\Delta x$$

Young modulus

$$E = \frac{\sigma}{\varepsilon} \text{ where}$$

$$\text{Stress } \sigma = \frac{F}{A}$$

$$\text{Strain } \varepsilon = \frac{\Delta x}{x}$$

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