Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 30 minutes

Paper reference **WPH11/01**

Physics

International Advanced Subsidiary/Advanced Level
UNIT 1: Mechanics and Materials

You must have:
Scientific calculator

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.*
- **Show all your working out** 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 the question marked with an **asterisk (*)**, marks will be awarded for your ability to structure your answers 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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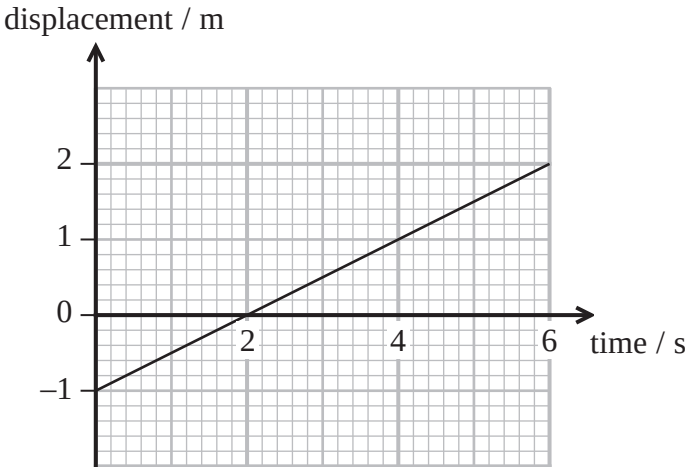
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SECTION A

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 A student walks for 6 seconds. The displacement-time graph for the student is shown.



Which row of the table shows the final displacement and velocity of the student?

		Displacement / m	Velocity / m s^{-1}
☒	**A**	2.0	0.5
☒	**B**	3.0	0.5
☒	**C**	5.0	2.0
☒	**D**	3.0	2.0

(Total for Question 1 = 1 mark)

2 Physical quantities may be vectors or scalars.

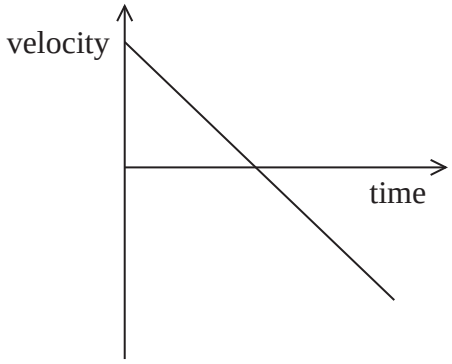
Which row of the table is correct?

		Force	Mass	Acceleration
☒	**A**	scalar	vector	scalar
☒	**B**	scalar	scalar	vector
☒	**C**	vector	vector	scalar
☒	**D**	vector	scalar	vector

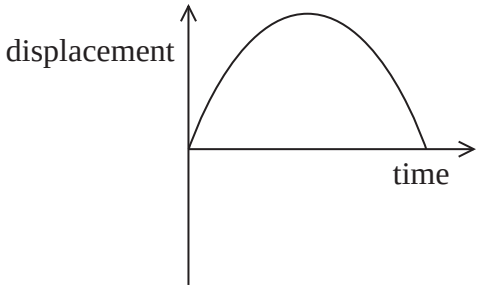
(Total for Question 2 = 1 mark)

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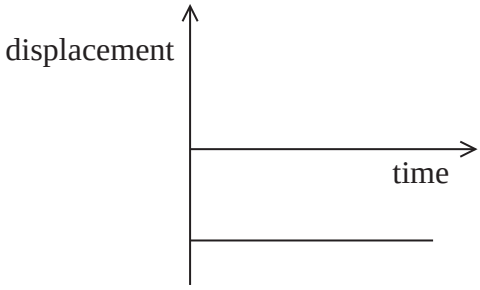
3 The velocity-time graph for a particle is shown.



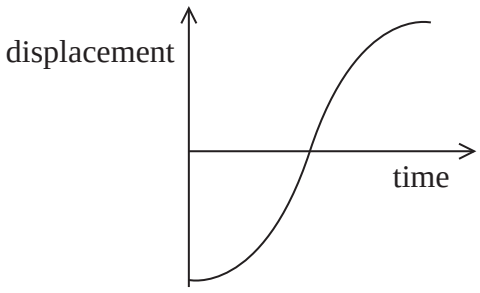
Which of the following is the displacement-time graph for this particle?



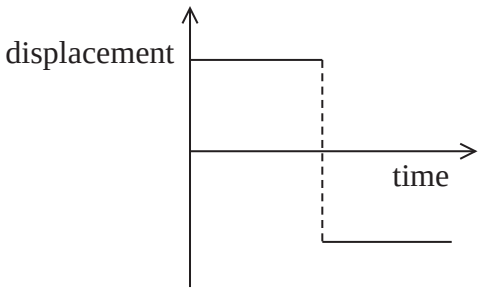
A



B



C



D

☒ **A**

☒ **B**

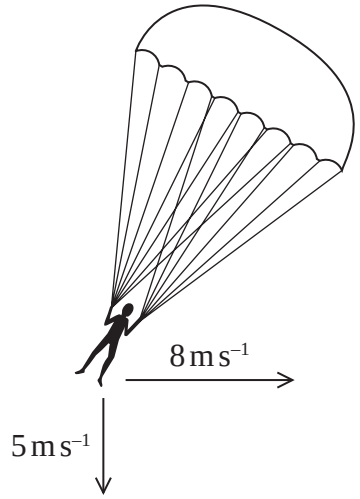
☒ **C**

☒ **D**

(Total for Question 3 = 1 mark)

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4 The diagram shows a student during a parachute jump on a windy day. The vertical component of her velocity is $5.0\,m\,s^{-1}$. The horizontal component of her velocity is $8.0\,m\,s^{-1}$. She descends at an angle θ to the vertical.



Which row of the table gives expressions for the magnitude and angle of the student's resultant velocity?

	Magnitude / $m\,s^{-1}$	θ / °
☒ **A**	$\sqrt{8^2 - 5^2}$	$\tan^{-1}\frac{8}{5}$
☒ **B**	$\sqrt{8^2 - 5^2}$	$\sin^{-1}\frac{5}{8}$
☒ **C**	$\sqrt{8^2 + 5^2}$	$\tan^{-1}\frac{8}{5}$
☒ **D**	$\sqrt{8^2 + 5^2}$	$\sin^{-1}\frac{5}{8}$

(Total for Question 4 = 1 mark)

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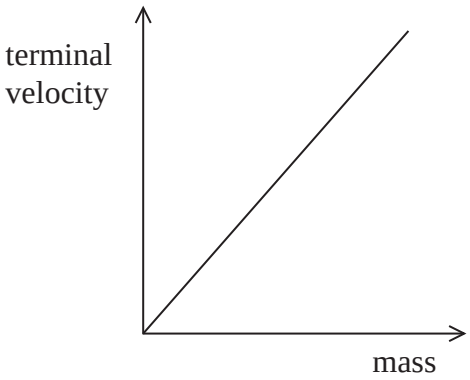
5 An object on the Moon falls a vertical distance of 0.32 m, from rest, in a time of 0.63 s.

Which of the following expressions gives the acceleration due to gravity on the Moon in $m\,s^{-2}$?

- ☒ **A** $\frac{0.32}{2 \times 0.63}$
- ☒ **B** $\frac{0.32}{2 \times 0.63^2}$
- ☒ **C** $\frac{2 \times 0.32}{0.63^2}$
- ☒ **D** $\frac{2 \times 0.32}{0.63}$

(Total for Question 5 = 1 mark)

6 The graph shows how terminal velocity varies with mass for small spheres of equal diameter falling through a viscous liquid.



Which of the following describes the gradient of the graph for a liquid of greater viscosity?

- ☒ **A** a greater gradient
- ☒ **B** a smaller gradient
- ☒ **C** a variable gradient
- ☒ **D** the same gradient

(Total for Question 6 = 1 mark)

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7 A person is pushing a trolley at a constant velocity.

The floor exerts a force *P* on the person, the person exerts a force *Q* on the trolley.

The trolley exerts a force *R* on the person and the total drag force on the trolley is *S*.



(Source: Andy Dossett / Alamy Stock Photo)

Which pair of forces is a Newton's Third Law pair?

☒ **A** *P* and *R*

☒ **B** *Q* and *R*

☒ **C** *Q* and *S*

☒ **D** *P* and *S*

(Total for Question 7 = 1 mark)

8 A wire breaks when a tensile force *T* is applied. A second wire, made of the same material, has twice the diameter.

Which of the following is the force required to break the second wire?

☒ **A** $4T$

☒ **B** $2T$

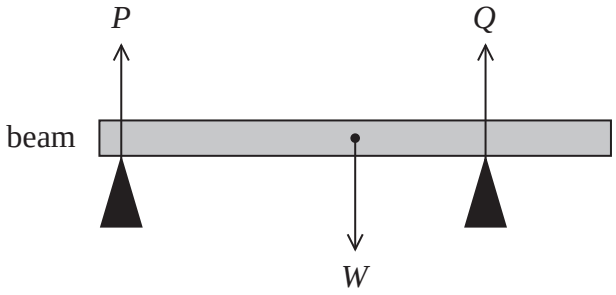
☒ **C** $\frac{T}{2}$

☒ **D** $\frac{T}{4}$

(Total for Question 8 = 1 mark)

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9 A beam is balanced on two supports as shown.



The beam has a weight W and the reaction forces at the two supports are P and Q.

Which of the following statements about the magnitudes of the forces is correct?

☒ **A** $P > Q$

☒ **B** $Q > W$

☒ **C** $Q > P$

☒ **D** $(P + Q) > W$

(Total for Question 9 = 1 mark)

10 Which row of the table contains two units that are **not** equivalent?

		Unit 1	Unit 2
☒	**A**	Js^{-1}	W
☒	**B**	$kg\,m\,s^{-2}$	N s
☒	**C**	$N\,kg^{-1}$	$m\,s^{-2}$
☒	**D**	N m	J

(Total for Question 10 = 1 mark)

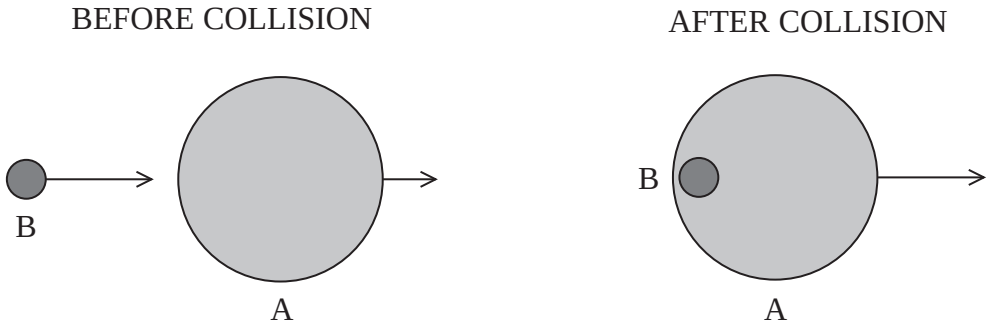
TOTAL FOR SECTION A = 10 MARKS

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SECTION B

Answer ALL questions in the spaces provided.

11 A slow moving asteroid A was hit by a faster asteroid B. Asteroid B was absorbed by asteroid A as shown.



(a) State the principle of conservation of linear momentum.

(2)

(b) Before the collision, asteroid A had a velocity of $2.19 \times 10^{3}\,m\,s^{-1}$ and a momentum of $1.80 \times 10^{17}\,kg\,m\,s^{-1}$.

(i) Show that the mass of asteroid A was about $8.2 \times 10^{13}\,kg$.

(2)

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(ii) Calculate the velocity of the asteroids after the collision.

mass of asteroid B = 5.90×10^{12} kg
velocity of asteroid B before the collision = 15.0×10^{3} m s^{-1}

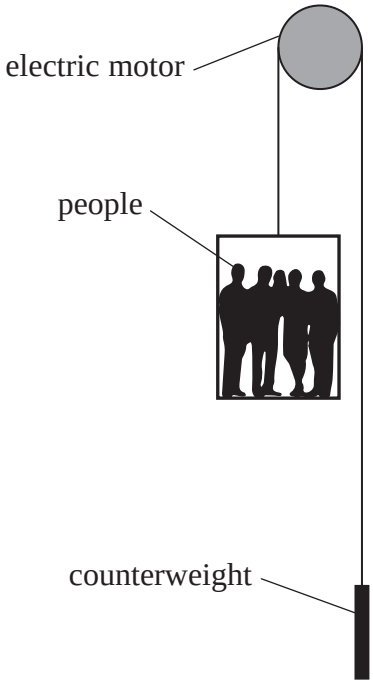
(3)

Velocity of asteroids = ...

(Total for Question 11 = 7 marks)

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12 The diagram shows a lift system for moving people up and down a tall building. There is a counterweight to balance the weight of the lift. An electric motor is used to raise and lower the lift.



(a) Explain how the counterweight affects the amount of work required from the electric motor to raise the lift.

(2)

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(b) The electric motor raises the lift through a height of 40.0 m in a time of 30.0 s.

Show that the output power of the electric motor is about 12 kW.

total mass of lift and people = 2 250 kg
mass of counterweight = 1 300 kg

(4)

(c) The electric motor dissipates energy to the surroundings at a rate of 3 600 W.

Determine the efficiency of the electric motor.

(2)

Efficiency = ...

(Total for Question 12 = 8 marks)

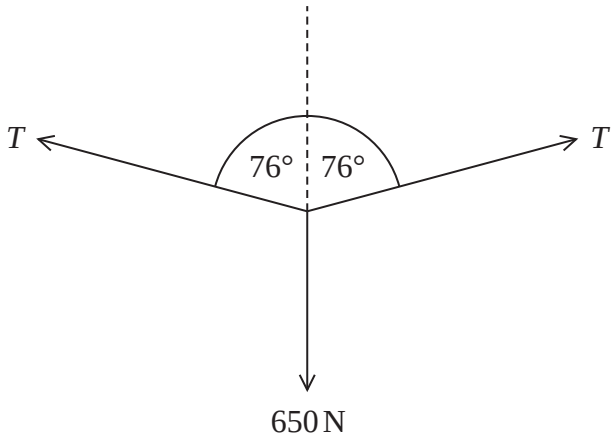
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13 The Tyrolean traverse is a technique for crossing a deep valley. The photograph shows a climber crossing a river using this technique. The climber moves along a rope suspended from the bank on either side of the river.



(Source: © Folio Images/Alamy Stock Photo)

(a) The free-body force diagram for the climber is shown below. The weight of the climber is 650 N.



Show that the tension T in the rope is about 1.3×10^3 N.

(3)

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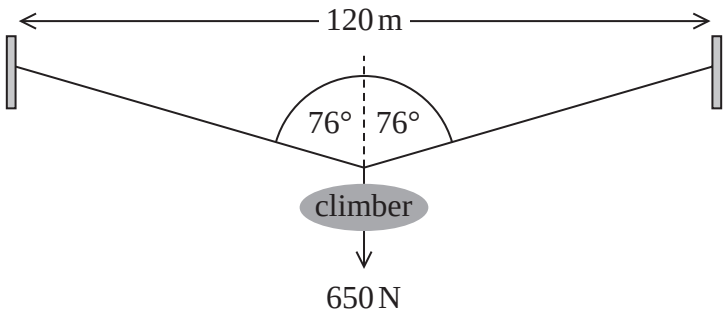
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(b) The rope has an unstretched length of 120 m as shown below.



(i) Determine the strain in the rope while it is supporting the weight of the climber.

You may ignore the weight of the rope.

(3)

Strain = ...

(ii) The rope has a cross-sectional area of $3.14 \times 10^{-4}\,m^2$.

Determine the Young modulus of the rope material.

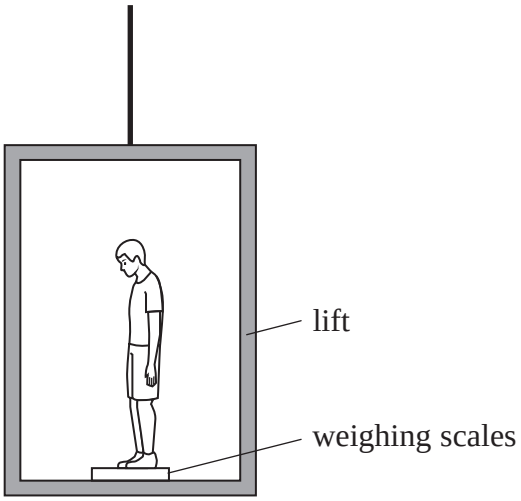
(3)

Young modulus = ...

(Total for Question 13 = 9 marks)

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***14** A student of weight 600 N is standing on weighing scales in a lift. The scales are calibrated to give readings in newtons.



The lift moves upwards at constant velocity, then decelerates to rest. As the lift moves, the student looks at the readings on the scales.

Explain the readings on the scales.

(Total for Question 14 = 6 marks)

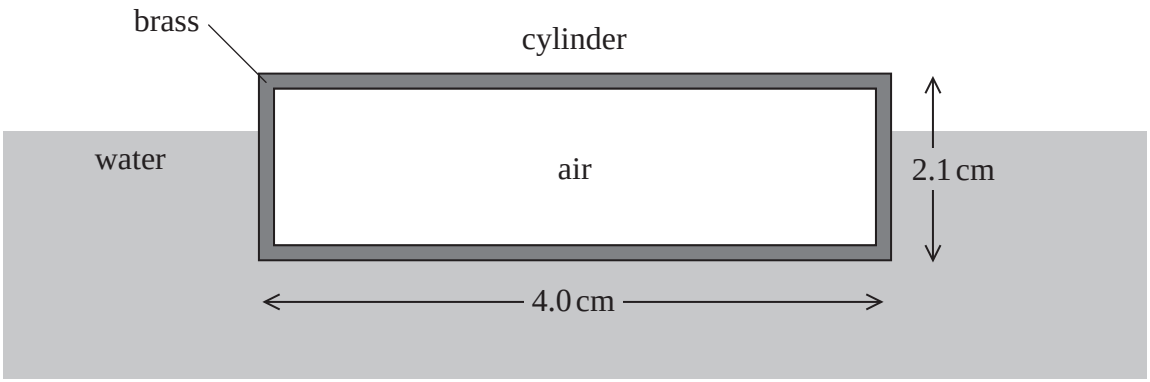
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15 A hollow brass cylinder with closed ends is floating on the surface of water.

The cylinder has a length of 4.0 cm and an external diameter of 2.1 cm as shown.



63% of the volume of the cylinder is submerged. The cylinder contains negligible weight of air.

(a) Explain why the brass cylinder floats.

(2)

(b) The density of water is $1.0 \times 10^{3}\,\text{kg}\,\text{m}^{-3}$

(i) Show that the mass of the cylinder is about $9 \times 10^{-3}\,\text{kg}$.

(4)

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(ii) Deduce whether an identical hollow cylinder made of gold would also float. Assume that the volume of gold is the same as the volume of brass.

density of gold = $19.3 \times 10^3\,\text{kg}\,\text{m}^{-3}$
density of brass = $8.7 \times 10^3\,\text{kg}\,\text{m}^{-3}$

(4)

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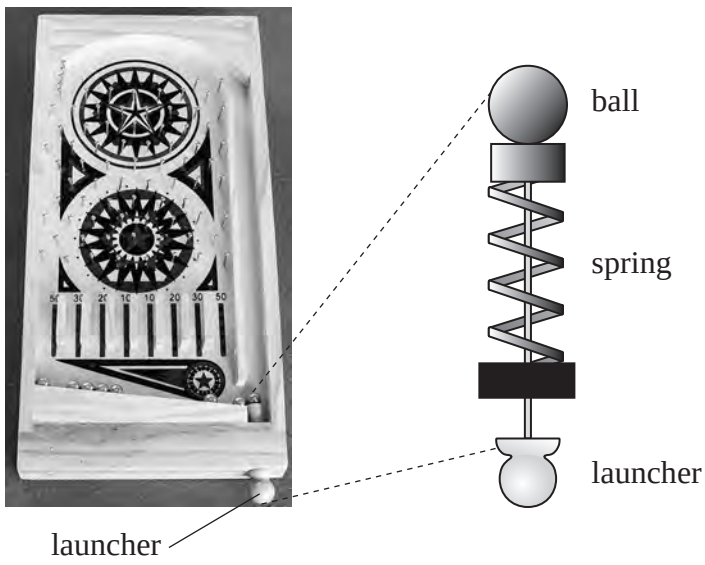
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(Total for Question 15 = 10 marks)

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16 The photograph shows a toy pinball machine. The launcher is pulled back, compressing a spring. The spring obeys Hooke's law. When the launcher is released, the spring returns to its original length and a small ball is launched horizontally into the machine.



(Source: © Valery Voennyy / Alamy Stock Photo)

When the launcher is pulled back, the spring is compressed by 5.0 cm. When the spring is released, the ball is launched at a speed of 8.0 cm s^{-1}.

(a) Show that the kinetic energy of the ball just after launching is about 4×10^{-5} J.

mass of ball = 12 g

(2)

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(b) Determine the force on the ball when the spring is released.

(2)

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Force = ...

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(c) Determine the stiffness of the spring.

(2)

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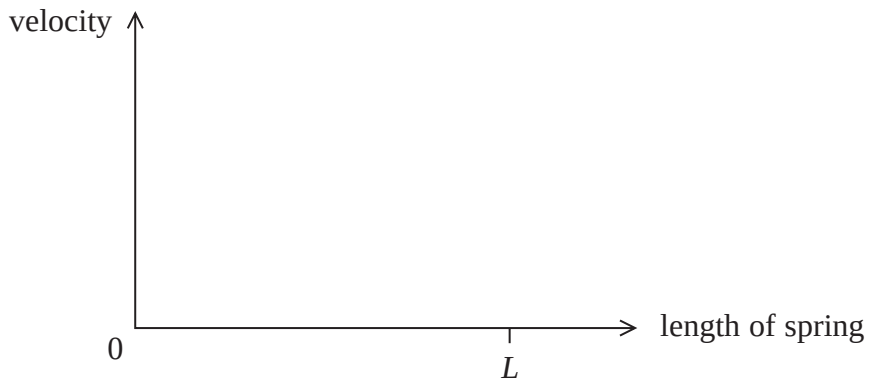
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Stiffness = ...

(d) The spring returns to its original length L.

Sketch a graph, on the axes below, to show how the velocity of the ball varies with the length of the spring.

(4)



(Total for Question 16 = 10 marks)

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17 A small sphere is moving horizontally through a viscous liquid.

(a) Stokes' law can be used to calculate the drag force on an object.

State the conditions that must apply for Stokes' law to be valid.

(2)

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(b) There is a constant force of 2.3×10^{-5} N acting horizontally on the sphere.

diameter of sphere = 4.5×10^{-3} m
viscosity of liquid = 7.1×10^{-2} Pa s

(i) At one instant, the speed of the sphere is 5.2×10^{-3} m s^{-1}.

Calculate the resultant horizontal force on the sphere.

(3)

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Resultant horizontal force = ...

(ii) Calculate the maximum speed of the sphere in the horizontal direction.

(2)

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Maximum horizontal speed = ...

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(c) A larger diameter sphere in the same liquid is acted upon by the same constant force as in (b). The liquid is at a lower temperature.

Explain the effect these changes have on the maximum speed of this sphere.

(4)

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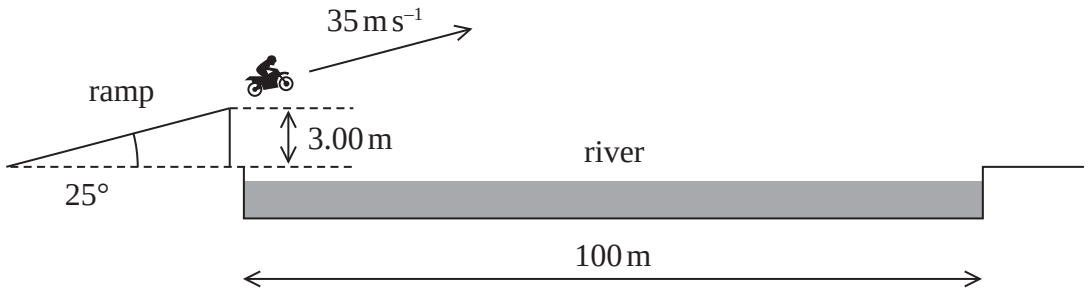
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(Total for Question 17 = 11 marks)

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18 A stunt motorcyclist wants to jump across a river to land on the other side. The diagram shows the motorcyclist driving off a ramp at the edge of a river.



The ramp is at an angle of 25° to the horizontal and the height at the end of the ramp is 3.0 m. The width of the river is 100 m. The initial velocity of the motorcyclist is 35 m s^{-1}.

(a) Calculate the horizontal and vertical components of the motorcycle's initial velocity as it leaves the ramp.

(2)

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Horizontal component = ...

Vertical component = ...

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(b) Deduce whether the rider lands on the other side of the river.

The effects of air resistance can be ignored.

(4)

(c) Explain how air resistance would affect the jump.

(3)

(Total for Question 18 = 9 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)
Boltzmann constant	$k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$	
Coulomb's law constant	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$	
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 constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$	
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$	
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
Proton mass	$m_p = 1.67 \times 10^{-27}\ \text{kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27}\ \text{kg}$	

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

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

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

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

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

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

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