Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Friday 10 May 2024

Morning (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, ruler, protractor

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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 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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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 engine is used to remove water from a mine. The engine transfers energy to the water at a rate of 180 kW and wastes energy at a rate of 60 kW.

Which of the following expressions gives the efficiency of the engine?

☒ **A** $\frac{180}{240}$

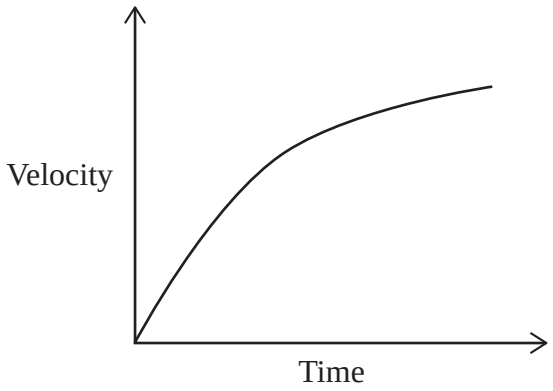
☒ **B** $\frac{60}{240}$

☒ **C** $\frac{60}{180}$

☒ **D** $\frac{180}{300}$

(Total for Question 1 = 1 mark)

2 The graph shows how the velocity of an object varies with time.



Which of the following describes the motion of the object?

☒ **A** constant acceleration

☒ **B** constant displacement

☒ **C** decreasing acceleration

☒ **D** decreasing displacement

(Total for Question 2 = 1 mark)

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3 An object is moving through a fluid.

Which row of the table states the conditions which must be met for Stokes' law to apply?

	Size of object	Shape of object	Type of flow
☒ **A**	any	any	turbulent
☒ **B**	any	spherical	turbulent
☒ **C**	small	spherical	laminar
☒ **D**	small	any	laminar

(Total for Question 3 = 1 mark)

4 Which of the following expressions gives a vector quantity?

☒ **A** density × volume

☒ **B** force × distance moved in direction of force

☒ **C** mass × velocity

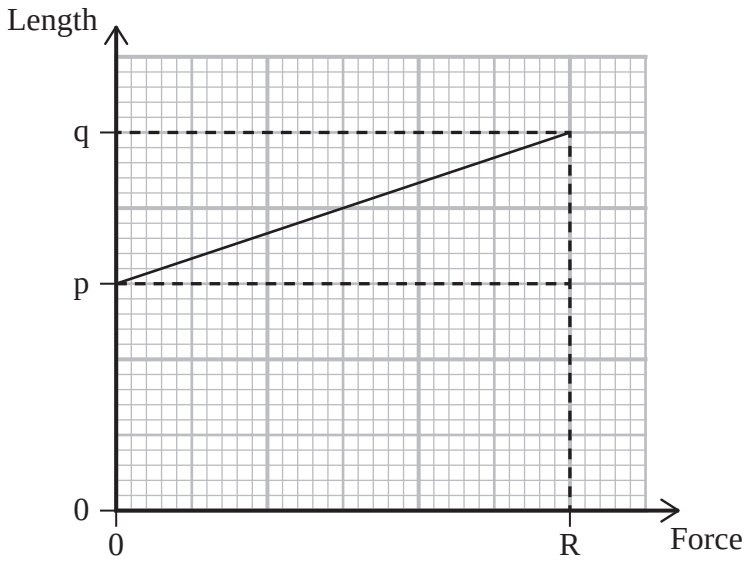
☒ **D** power × time

(Total for Question 4 = 1 mark)

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Questions 5 and 6 refer to the information below.

A student stretches a spring of original length p to a length q by applying an increasing force. The graph shows how the length of the spring changes as the student increases the force from zero to a magnitude R.



5 Which of the following expressions gives the stiffness of the spring?

- ☒ **A** $\frac{q - p}{R}$
- ☒ **B** $\frac{q}{R}$
- ☒ **C** $\frac{R}{q}$
- ☒ **D** $\frac{R}{q - p}$

(Total for Question 5 = 1 mark)

6 Which of the following expressions gives the work done stretching the spring from its original length p to length q?

- ☒ **A** $\frac{p \times R}{2}$
- ☒ **B** $\frac{(q - p) \times R}{2}$
- ☒ **C** $\frac{(q + p) \times R}{2}$
- ☒ **D** $(q - p) \times R$

(Total for Question 6 = 1 mark)

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7 Which of the following describes the centre of gravity of an object?

- ☒ **A** the point where the mass of the object is located
- ☒ **B** the point where the mass of the object is concentrated
- ☒ **C** the point where the weight of the object is located
- ☒ **D** the point where the weight of the object may be considered to act

(Total for Question 7 = 1 mark)

8 A student is determining the acceleration of free-fall, g.

The student uses a stopwatch to measure the time taken for a ball bearing to fall a measured distance.

The student calculates a value of g that is greater than $9.81\,m\,s^{-2}$.

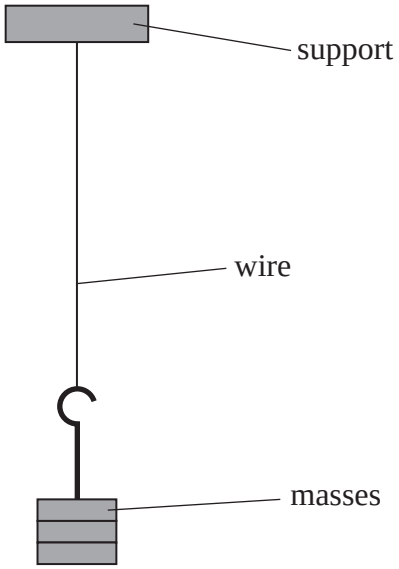
Which of the following could be an explanation for the student's result?

- ☒ **A** The ball bearing is moving downwards when the student starts the stopwatch.
- ☒ **B** The ball bearing is moving upwards when the student starts the stopwatch.
- ☒ **C** The student starts the stopwatch before the ball bearing is dropped.
- ☒ **D** The student stops the stopwatch after the ball bearing lands.

(Total for Question 8 = 1 mark)

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9 A student attached one end of a wire to a support. The student added masses to the other end of the wire, as shown. The student measured the corresponding extension for each added mass.



The wire broke when the extension was small.

The student replaced the wire with a second wire made of the same material. The second wire had a larger extension before breaking.

Which of the following produced this result?

☒ **A** The second wire had a greater diameter.

☒ **B** The second wire had a longer length.

☒ **C** The second wire had a smaller diameter.

☒ **D** The second wire had a shorter length.

(Total for Question 9 = 1 mark)

10 A ship has a mass of 1.2×10^7 kg and has an acceleration of $0.03\,m\,s^{-2}$. The force produced by the ship's engine is 8.0×10^5 N.

Which of the following expressions gives the magnitude of the drag force, in N, on the ship?

☒ **A** $8.0 \times 10^5 - (0.03 \times 1.2 \times 10^7)$

☒ **B** $8.0 \times 10^5 + (0.03 \times 1.2 \times 10^7)$

☒ **C** $8.0 \times 10^5 \div (0.03 \times 1.2 \times 10^7)$

☒ **D** $8.0 \times 10^5 \times (0.03 \times 1.2 \times 10^7)$

(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 train moves up an inclined track at constant velocity. The train moves through a vertical height of 25 m.

(a) Show that the gravitational potential energy gained by the train is about 400 MJ.

mass of train = 1.7×10^6 kg

(2)

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(b) The train's engine has an output power of 20 MW. The train takes a time of 35 s to move through the vertical height of 25 m.

Calculate the work done by the engine against resistive forces.

(3)

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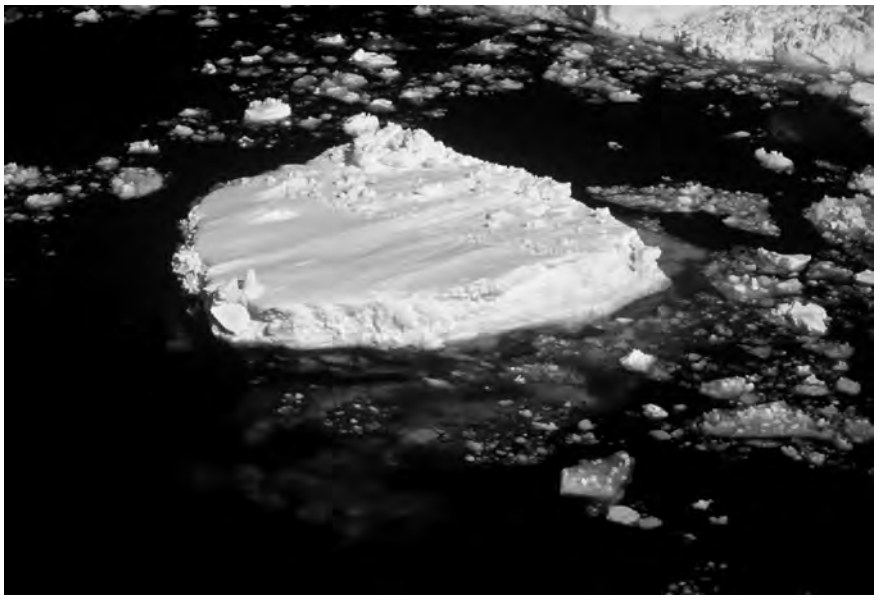
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Work done = ...

(Total for Question 11 = 5 marks)

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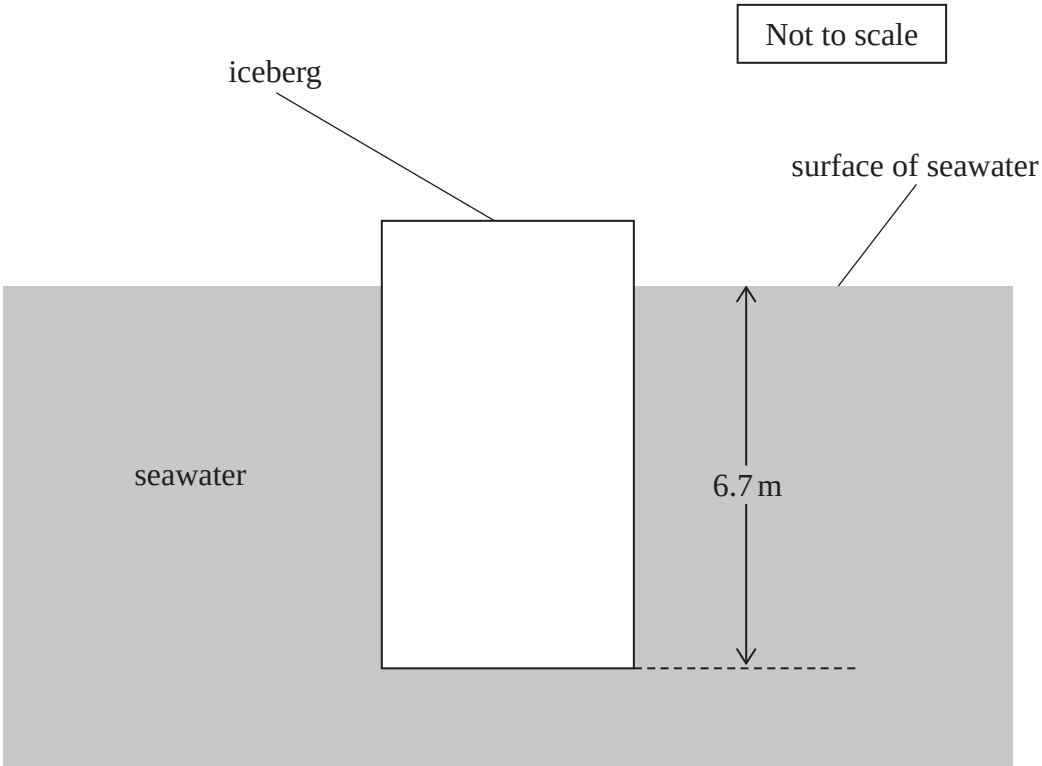
12 An iceberg is a large mass of ice that floats in seawater with most of its volume below the surface of the seawater. The photograph shows a typical iceberg.



(Source: © Doug Allan / Science Photo Library)

An iceberg can be modelled as a rectangular block of ice.

A particular iceberg has 6.7 m of its total height below the surface of the water, as shown.



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The block of ice has a horizontal cross-sectional area of $3500\,m^2$.

(a) Calculate the weight of the block of ice.

density of seawater = $1.03 \times 10^3\,kg\,m^{-3}$

(3)

Weight of block = ...

(b) An identical block of ice floats in water of a lower density than the seawater in (a). A larger volume of this block is below the surface of the water.

Explain why.

(2)

(Total for Question 12 = 5 marks)

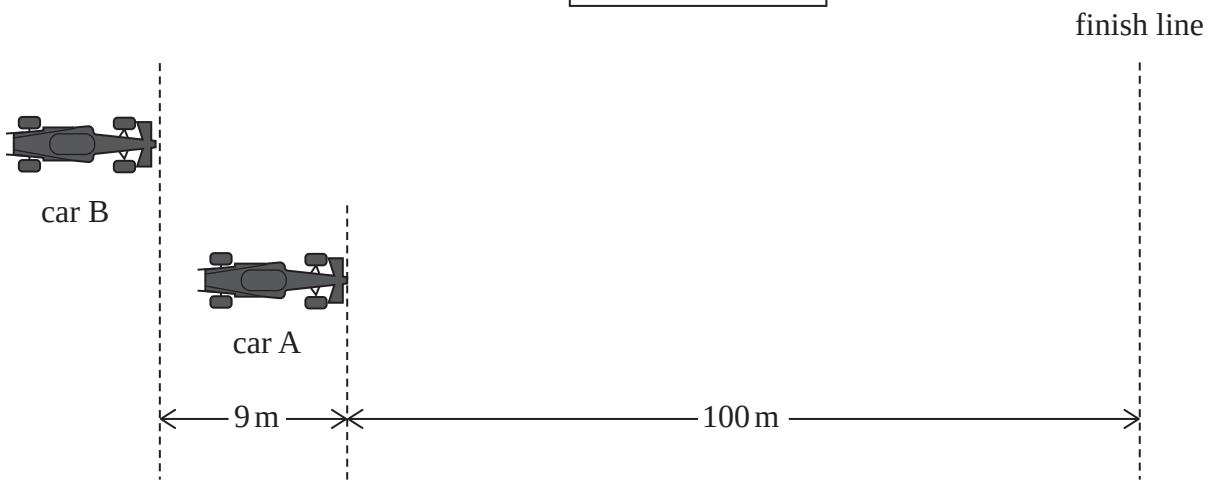
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13 Two cars, A and B, are racing along a track.

Car A has a constant velocity of $93\,m\,s^{-1}$. At a particular instant, car A is 9 m ahead of car B, as shown.

Not to scale

View from above



At this instant, car B has a velocity of $93\,m\,s^{-1}$. Car B is accelerating with a constant acceleration of $14\,m\,s^{-2}$.

(a) Show that car A and car B are side by side after a time of about 1.1 s.

(3)

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(b) At the instant shown, car A is 100 m from the finish line.

Deduce whether car A reaches the finish line before car B.

(3)

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(Total for Question 13 = 6 marks)

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14 A grain of sand quickly reaches terminal velocity when it falls into water.

(a) State why the grain of sand reaches terminal velocity.

(1)

(b) A spherical grain of sand has a weight of 4.3×10^{-5} N. The grain of sand displaces water with a weight of 1.5×10^{-5} N.

The terminal velocity of the grain of sand as it falls through the water is about $0.050\,m\,s^{-1}$.

Deduce whether Stokes' law applies to the grain of sand as it falls at terminal velocity.

viscosity of water = 1.2×10^{-3} Pa s
diameter of grain of sand = 1.5×10^{-3} m

(3)

(c) Explain how the temperature of the water affects the terminal velocity of a grain of sand if Stokes' law does apply.

(2)

(Total for Question 14 = 6 marks)

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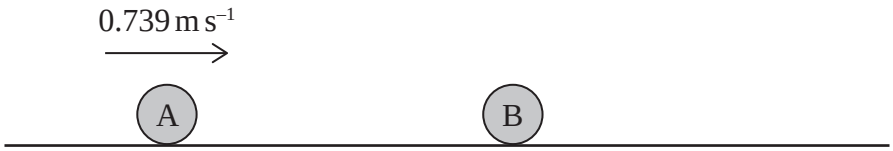
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15 Two identical balls, A and B, collide. Ball B is initially at rest. After the collision, ball B moves off in the same direction as ball A.

The mass of each ball is 0.165 kg.

The initial velocity of ball A is $0.739\,m\,s^{-1}$. After the collision, the velocity of ball B is $0.691\,m\,s^{-1}$, as shown.

Before collision



After collision



(a) Show that the velocity of ball A immediately after the collision is about $0.05\,m\,s^{-1}$.

(3)

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(b) Before the collision, the kinetic energy of ball A is 4.5×10^{-2} J, and the kinetic energy of ball B is zero.

Determine the decrease in total kinetic energy during the collision.

(2)

Decrease in total kinetic energy = ... J

(c) During the collision there is a resultant force on ball B from ball A.

Explain, in terms of Newton's laws, why ball A decelerates during the collision.

(2)

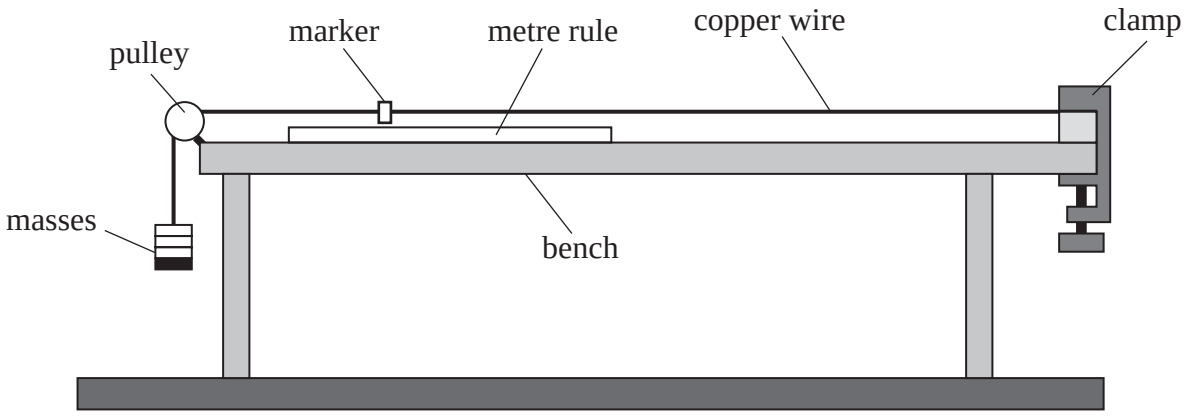
(Total for Question 15 = 7 marks)

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16 A student carried out an experiment to determine the Young modulus of copper.

*(a) The student clamped one end of a copper wire to the bench. The wire passed over a pulley and masses were added to the other end of the wire.

A metre rule was fixed to the bench and a marker fixed to the wire, as shown.



The student measured the diameter of the copper wire.

Describe the other measurements that need to be made using this apparatus and how they will be used to determine the Young modulus of copper.

You should define the meanings of any symbols you use.

(6)

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(b) Another student attaches a weight of 5.0 N to a copper wire of diameter 0.56 mm.

Calculate the extension of the wire.

length of wire = 2.5 m
Young modulus of copper = 1.1×10^{11} Pa

(4)

Extension = ...

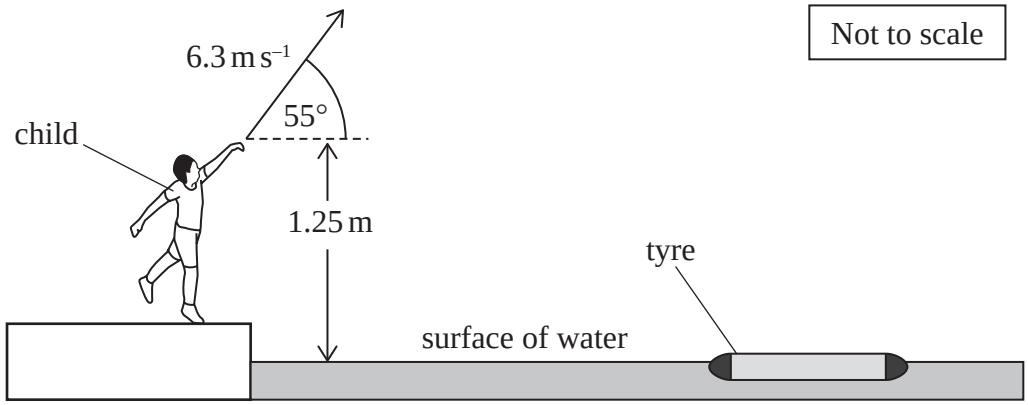
(Total for Question 16 = 10 marks)

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17 A child is playing a game. The child is trying to get stones to land inside an old tyre floating on the water.

The child throws a stone at a speed of $6.3\,m\,s^{-1}$ and at an angle of 55° to the horizontal.

The stone leaves the child's hand at a height of 1.25 m above the surface of the water, as shown.



(a) Show that the vertical component of the stone's initial velocity is about $5\,m\,s^{-1}$ and that the horizontal component is about $4\,m\,s^{-1}$.

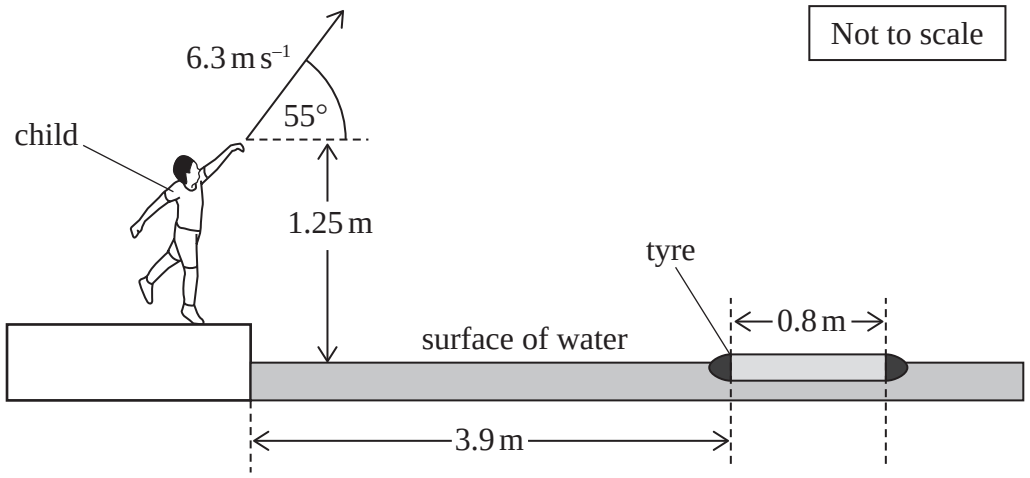
(2)

(b) Show that the greatest height above the surface of the water reached by the stone is about 3 m.

(3)

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(c) The inside of the tyre is 0.8 m in diameter and is 3.9 m from the side of the water, as shown.



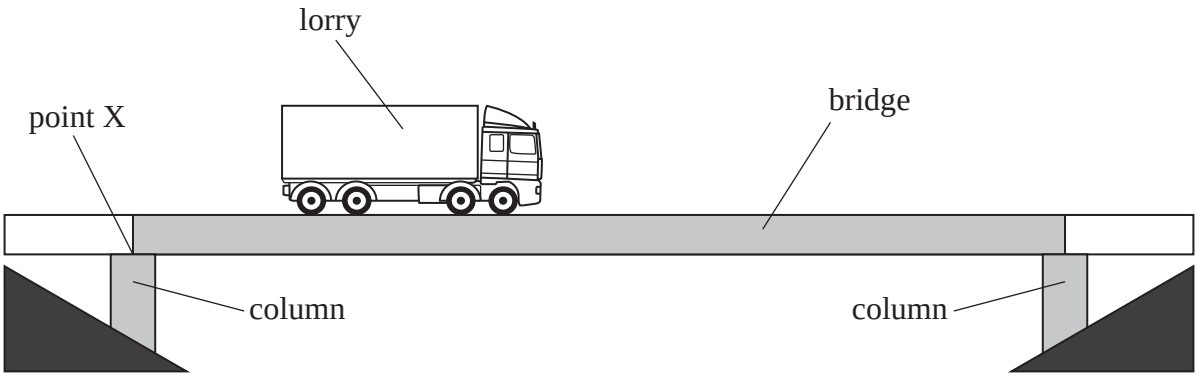
Deduce whether the stone thrown by the child lands inside the tyre.

(4)

(Total for Question 17 = 9 marks)

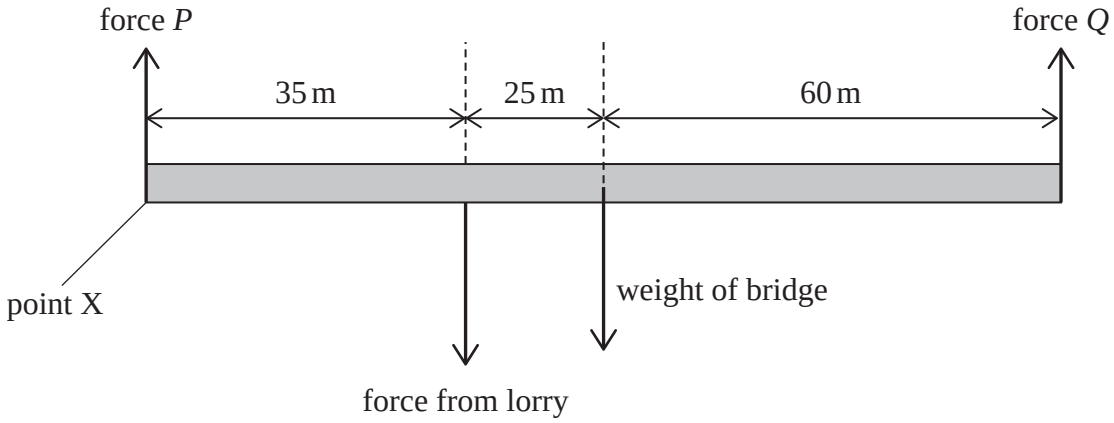
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18 A lorry is crossing a bridge. The bridge is supported by two columns, as shown.



Forces *P* and *Q* act on the bridge from the columns. The centre of gravity of the bridge is at its centre. At a particular time the lorry is 35 m from point X.

A simplified diagram showing the positions of the forces on the bridge is shown below.



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(a) Calculate the magnitudes of the forces P and Q.

You should take moments about point X.

force from lorry = 4.2×10^5 N
weight of bridge = 9.8×10^5 N

(5)

P = ...

Q = ...

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(b) Explain why force *Q* increases as the lorry moves across the bridge.

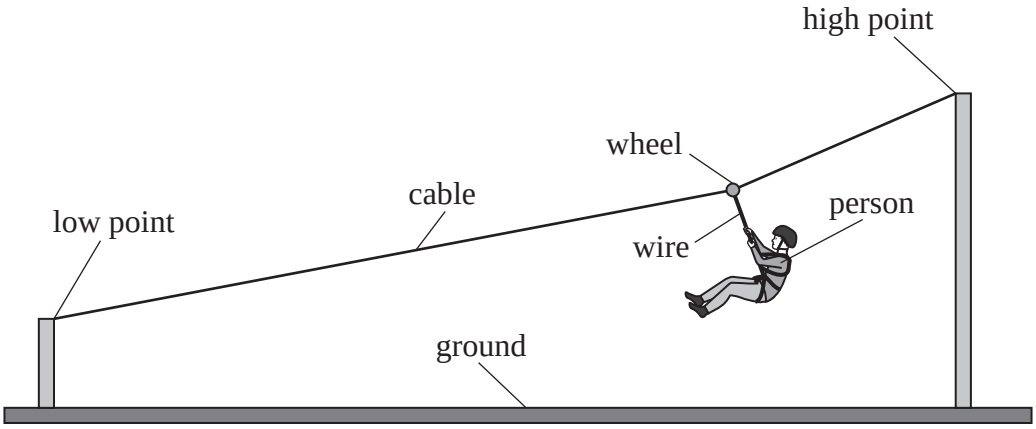
(5)

(Total for Question 18 = 10 marks)

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19 A ‘zip-line’ consists of a cable fixed at two points, one higher than the other.

A person hangs from a wire attached to a wheel, as shown. The wheel can move along the cable. The wheel moves the person along the cable.



(a) In the position shown, the person is accelerating.

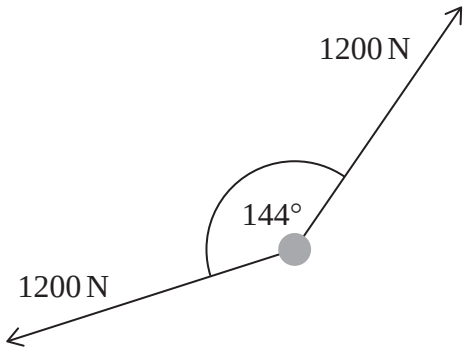
Complete the free-body force diagram below to show the three forces acting on the person in this position.

(3)

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(b) At a particular instant, the tension in the cable is 1200 N and the angle formed by the cable at the wheel is 144°, as shown.

Not to scale



(i) Show, by calculation, that the force on the wheel from the cable is about 740 N.

(2)

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(ii) There is a force on the wheel from the wire of 800 N.

The angle between the force from the cable and the 800 N force from the wire is 150°.

Determine the magnitude of the resultant force on the wheel using a scaled vector diagram.

You should ignore the weight of the wheel.

(4)

Resultant force on the wheel = ...

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(c) People take turns at moving along the zip-line from the high point to the low point. The people are initially at rest at the high point.

Explain why the speeds of people with different masses are always about the same when they reach the low point.

(3)

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(Total for Question 19 = 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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