Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Thursday 11 January 2024

Afternoon (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

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 Which of the following is an SI unit for stress?

☒ **A** $\mathrm{kg\,m^{-2}}$

☒ **B** $\mathrm{m^2\,kg^{-2}}$

☒ **C** $\mathrm{m^2\,N^{-1}}$

☒ **D** $\mathrm{N\,m^{-2}}$

(Total for Question 1 = 1 mark)

2 Which row of the table only contains vector quantities?

☒ **A**	acceleration	momentum	weight
☒ **B**	density	time	work done
☒ **C**	displacement	mass	velocity
☒ **D**	force	kinetic energy	temperature

(Total for Question 2 = 1 mark)

3 A spring is stretched by applying a force of 3.0 N. The elastic strain energy stored by the spring is 0.04 J.

Which of the following expressions gives the extension, in m, of the spring?

☒ **A** $\dfrac{2 \times 0.04}{3.0}$

☒ **B** $\sqrt{\dfrac{2 \times 0.04}{3.0}}$

☒ **C** $\sqrt{\dfrac{3.0}{2 \times 0.04}}$

☒ **D** $\dfrac{3.0}{2 \times 0.04}$

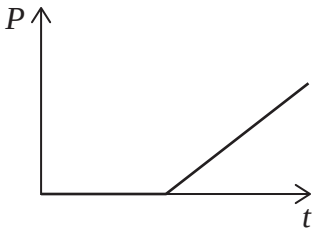
(Total for Question 3 = 1 mark)

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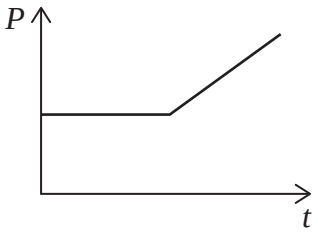
4 A cyclist moves along a horizontal road at a constant speed. She then moves at the same speed up a hill with a constant gradient.

Which of the following graphs shows how the power output P of the cyclist varies with time t?

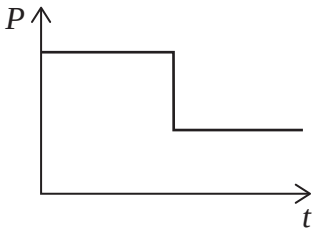
☒ **A**



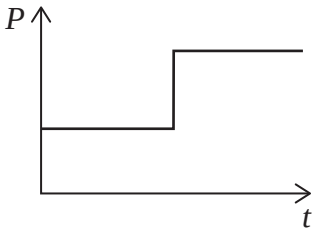
☒ **B**



☒ **C**



☒ **D**



(Total for Question 4 = 1 mark)

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5 A student dropped a table tennis ball. The ball fell for time t and had velocity v just before it hit the ground.

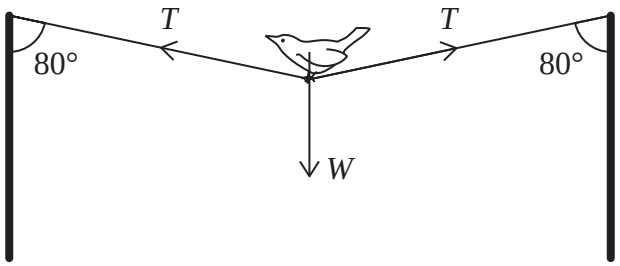
The student used the equations of motion to calculate t and v. These equations ignore air resistance.

Which row of the table shows how the actual values compared with the student's calculated values for t and v?

	t	v
☒ **A**	Less than calculated	Less than calculated
☒ **B**	Less than calculated	Greater than calculated
☒ **C**	Greater than calculated	Less than calculated
☒ **D**	Greater than calculated	Greater than calculated

(Total for Question 5 = 1 mark)

6 A length of string is attached between two vertical posts. A bird of weight W stands on the middle of the string causing tension T in the string. The string makes an angle of 80° with each post, as shown.



Which of the following expressions is correct?

☒ **A** $T = \dfrac{W}{2\sin 80°}$

☒ **B** $T = W \times 2\sin 80°$

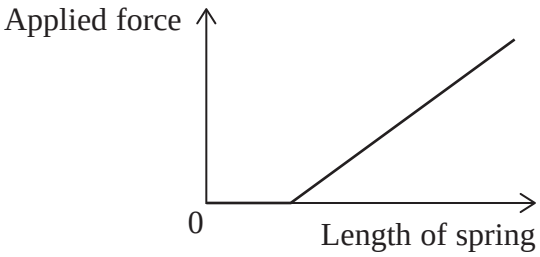
☒ **C** $T = \dfrac{W}{2\cos 80°}$

☒ **D** $T = W \times 2\cos 80°$

(Total for Question 6 = 1 mark)

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7 A force is applied to stretch a spring. The graph shows how the length of the spring varies with the applied force.



Which of the following gives the stiffness of the spring?

☒ **A** the area between the graph and the *x*-axis

☒ **B** the area between the graph and the *y*-axis

☒ **C** the gradient of the graph

☒ **D** $\dfrac{1}{\text{gradient of the graph}}$

(Total for Question 7 = 1 mark)

8 A solid cube of weight W is made from material with density ρ.

Which expression gives the length of each side of the cube?

☒ **A** $\left(\dfrac{\rho g}{W}\right)^3$

☒ **B** $\sqrt[3]{\dfrac{\rho g}{W}}$

☒ **C** $\left(\dfrac{W}{\rho g}\right)^3$

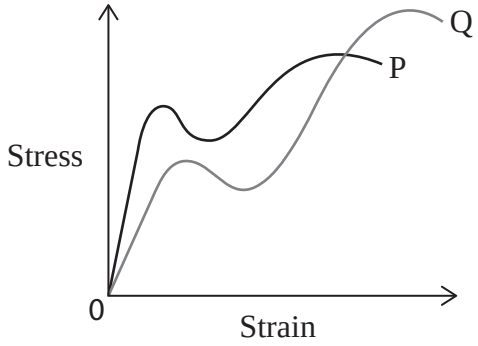
☒ **D** $\sqrt[3]{\dfrac{W}{\rho g}}$

(Total for Question 8 = 1 mark)

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9 A force is applied to stretch two wires, P and Q, until the wires break. Each wire is made of a different metal.

The stress-strain graph for each wire is shown.



Which of the following statements is correct?

☒ **A** P has a greater breaking stress than Q.

☒ **B** P has a greater breaking strain than Q.

☒ **C** P has a greater yield stress than Q.

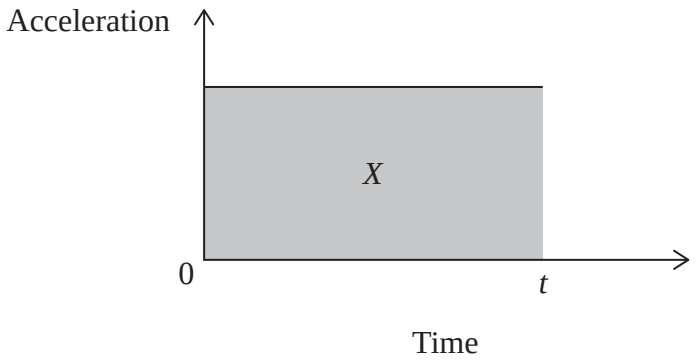
☒ **D** P has a lower Young modulus than Q.

(Total for Question 9 = 1 mark)

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10 An object moves from rest with uniform acceleration for time t.

The acceleration-time graph for the object is shown. X is the area under the graph between time 0 and time t.



Which of the following expressions gives the distance moved by the object?

☒ **A** X

☒ **B** $\frac{X}{2}$

☒ **C** Xt

☒ **D** $\frac{Xt}{2}$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

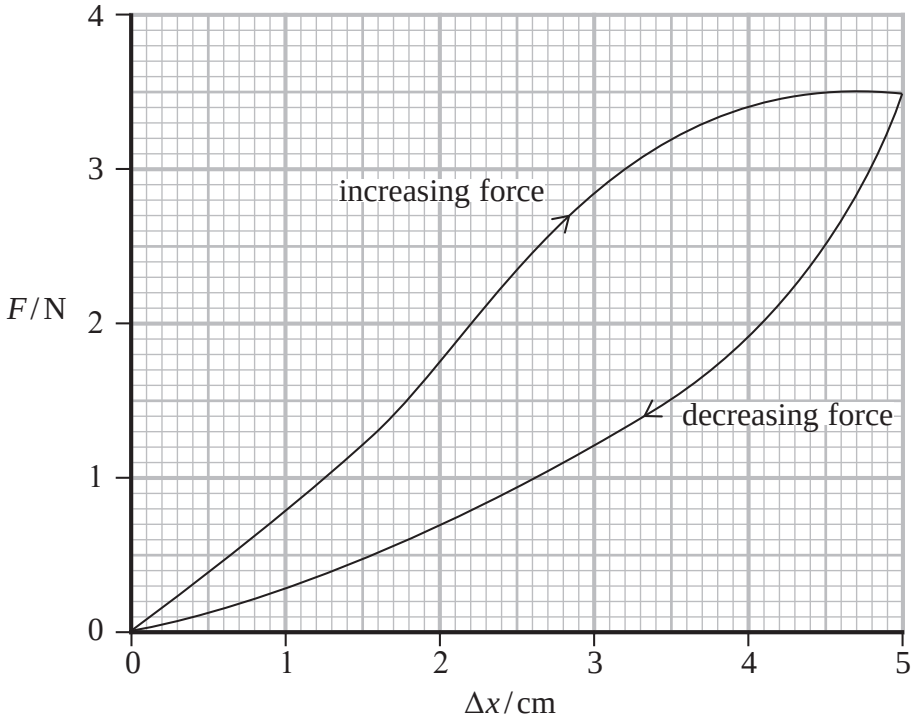
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SECTION B

Answer ALL questions in the spaces provided.

11 A student applied a force F to a rubber band. The student measured the corresponding extension, Δx, as F was increased and then decreased.

The graph shows how Δx varied as F was increased and then decreased.



(a) State how the graph shows that the rubber band deformed elastically.

(1)

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(b) The work done on the rubber band as F increased is greater than the work done by the rubber band as F was decreased.

There is a difference in these values because heating occurred.

Determine the energy that caused heating as F was increased and then decreased to zero.

(3)

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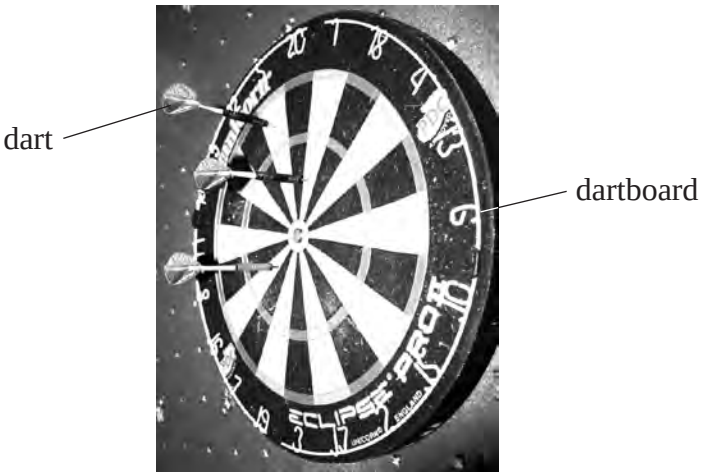
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Energy that caused heating = ...

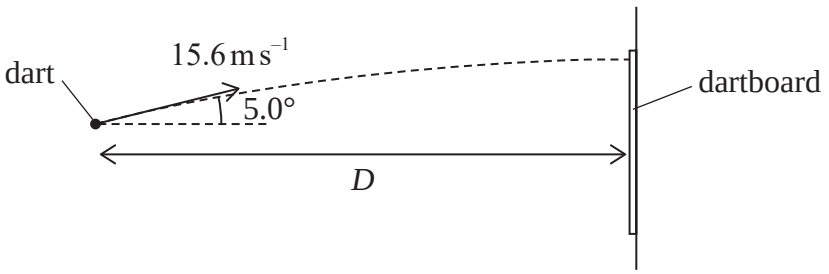
(Total for Question 11 = 4 marks)

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12 In a game called Darts, metal darts are thrown towards a dartboard. The darts hit the dartboard as shown.



A dart is thrown with a velocity of $15.6\,m\,s^{-1}$ at an angle of 5.0° to the horizontal. The dart travels a horizontal distance *D* to the dartboard, as shown.



Not to scale

Just before the dart hits the dartboard, the vertical component of the velocity of the dart is zero.

The air resistance acting on the dart is negligible.

(a) Show that the time taken for the dart to reach the dartboard is about 0.14 s.

(3)

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(b) Calculate the horizontal distance D travelled by the dart.

(2)

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D = ...

(Total for Question 12 = 5 marks)

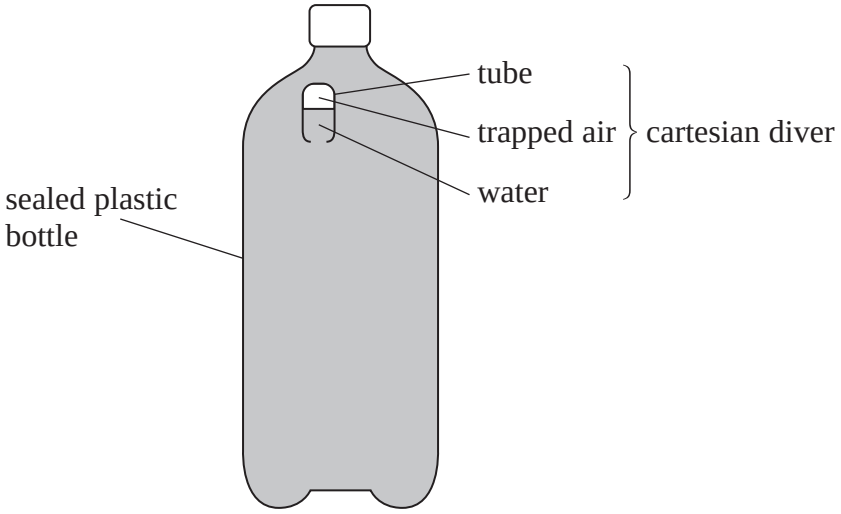
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13 A student has a toy called a 'cartesian diver' inside a sealed plastic bottle of water.

The cartesian diver consists of a tube closed at one end. Air is trapped by water inside the tube, as shown.



The student squeezes the bottle. More water is forced into the tube, and the volume of the trapped air decreases.

Explain why the cartesian diver accelerates downwards.

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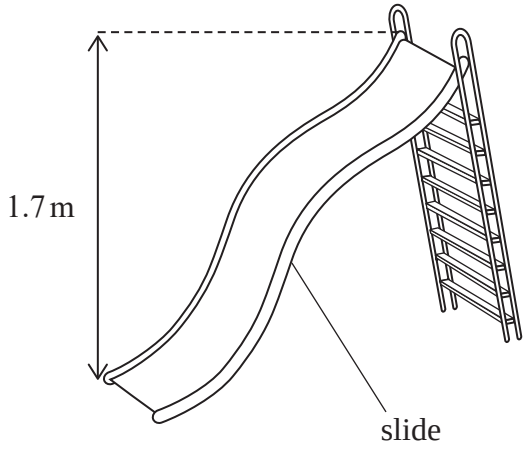
(Total for Question 13 = 3 marks)

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14 A child's slide has a vertical height of 1.7 m as shown.



(a) A child starts from rest at the top of the slide and moves down the slide. The resistive forces acting on the child can be ignored.

(i) Explain why the equations of motion should **not** be used to determine the maximum speed of the child.

You should consider the shape of the slide.

(3)

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(ii) The child has a mass of 24 kg.

Determine the maximum speed v of the child on the slide.

(3)

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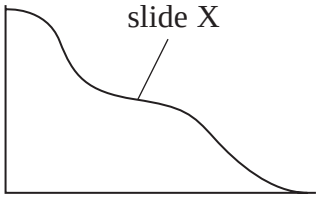
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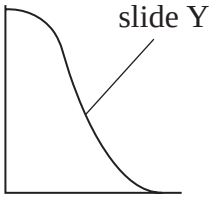
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v = ...

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(b) Two slides, X and Y, have the same height.
Slide X is longer than slide Y, as shown.





A child moves from rest down slide X and reaches a maximum speed v_X.

A second child moves from rest down slide Y and reaches a maximum speed v_Y.

The child on slide Y has a greater mass than the child on slide X.

The resistive forces acting on both children can be ignored.

Explain how v_X compares with v_Y.

(3)

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(Total for Question 14 = 9 marks)

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15 A student investigated small ball-bearings falling through a liquid to determine the viscosity of the liquid.

(a) State the conditions needed for Stokes' law to apply to this investigation.

(2)

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(b) (i) Complete the free-body force diagram for a ball-bearing when falling at terminal velocity.

(2)

drag force



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(ii) The student thought that the liquid she used might be glycerol.
She made measurements to determine the terminal velocity of a ball-bearing.

The terminal velocity of the ball-bearing was $0.0824\,m\,s^{-1}$.

Deduce whether the liquid she used was glycerol.

density of glycerol = $1.26 \times 10^{3}\,kg\,m^{-3}$
radius of ball-bearing = $2.30\,mm$
weight of ball-bearing = $4.00 \times 10^{-3}\,N$
viscosity of glycerol at room temperature = $0.934\,Pa\,s$

(6)

(Total for Question 15 = 10 marks)

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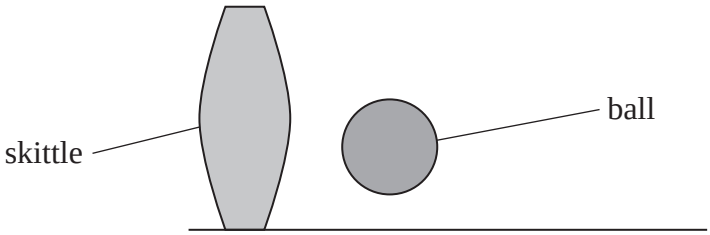
16 A skittle is a wooden object that can stand upright on one end.

In a game of Skittles, a ball is thrown at some skittles to knock them over, as shown.

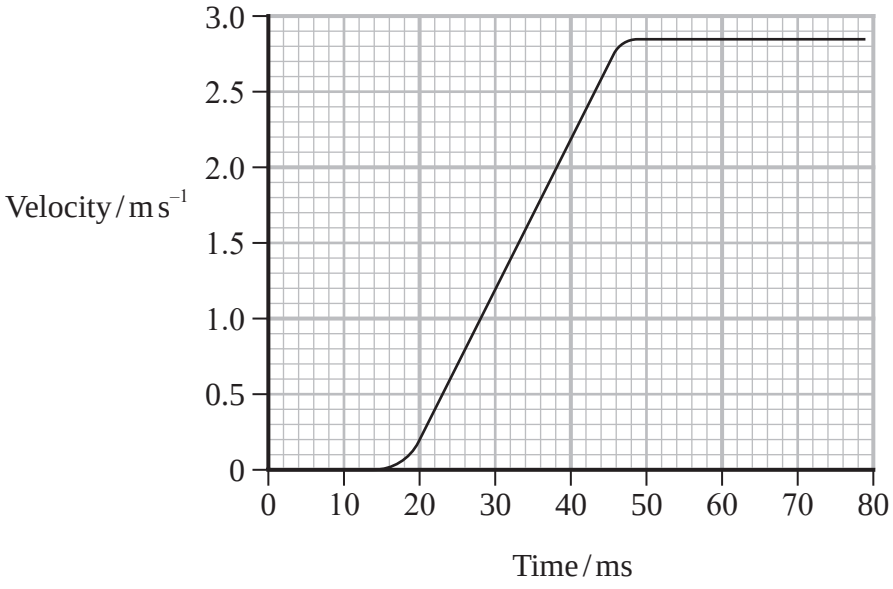


(Source: © CMBiles/Getty Images)

The diagram below shows the ball just before it collides with a skittle.



(a) The graph shows how the velocity of the skittle varies with time. The time shown on the graph starts just before the ball hits the skittle.



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Determine the average acceleration of the skittle during the collision.

(3)

Average acceleration = ...

*(b) Explain how Newton's second and third laws of motion apply to the ball and the skittle during the collision.

(6)

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(c) The ball is thrown again, and collides with another stationary skittle.

During the collision the horizontal velocity of the ball changes from $7.2\,m\,s^{-1}$ to $1.6\,m\,s^{-1}$.

The horizontal velocity of the skittle immediately after the collision is $3.1\,m\,s^{-1}$ in the same direction as the ball.

Determine the mass of the ball.

mass of skittle = 1.4 kg

(3)

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Mass of ball = ...

(Total for Question 16 = 12 marks)

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17 A student determined the Young modulus of a material in the form of a wire.

(a) The student used a micrometer to measure the diameter of the wire.

Describe how the student should

- check that the wire is uniform
- check that the wire has a circular cross-section.

(2)

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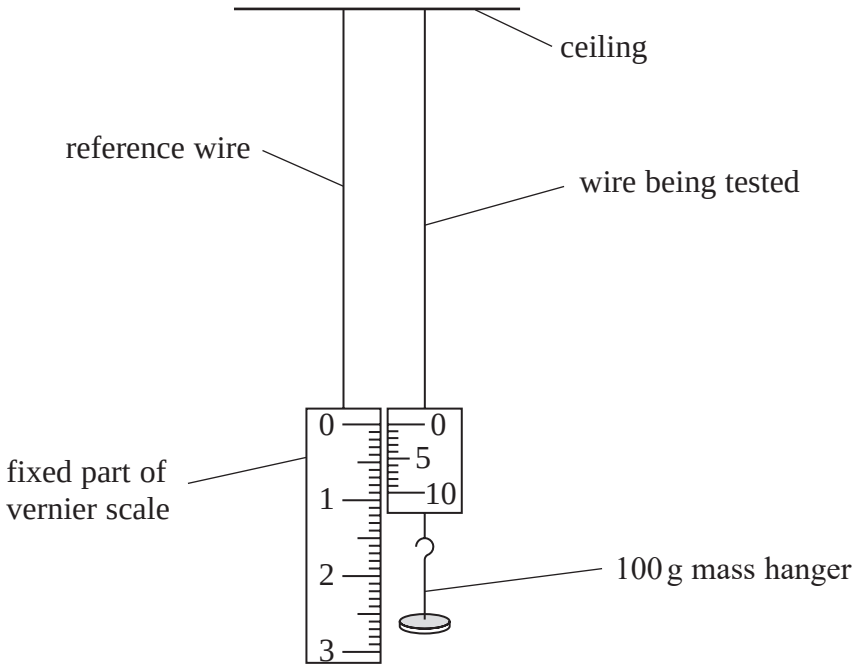
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(b) The student hung a reference wire and the wire being tested from the ceiling.

At the lower end of the reference wire he positioned the fixed part of a vernier scale.

The student attached a 100 g mass hanger to the wire being tested. The initial reading on the vernier scale was 0.0 mm, as shown.

He added masses to the mass hanger and measured the corresponding extension Δx of the wire using the vernier scale.



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(i) The student kept his feet away from the apparatus so that the masses could not fall on his feet.

Explain one other safety precaution.

(2)

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(ii) Each time the student added more mass, Δx increased by a few mm.

Explain why he should measure Δx using a vernier scale, instead of a metre rule.

(2)

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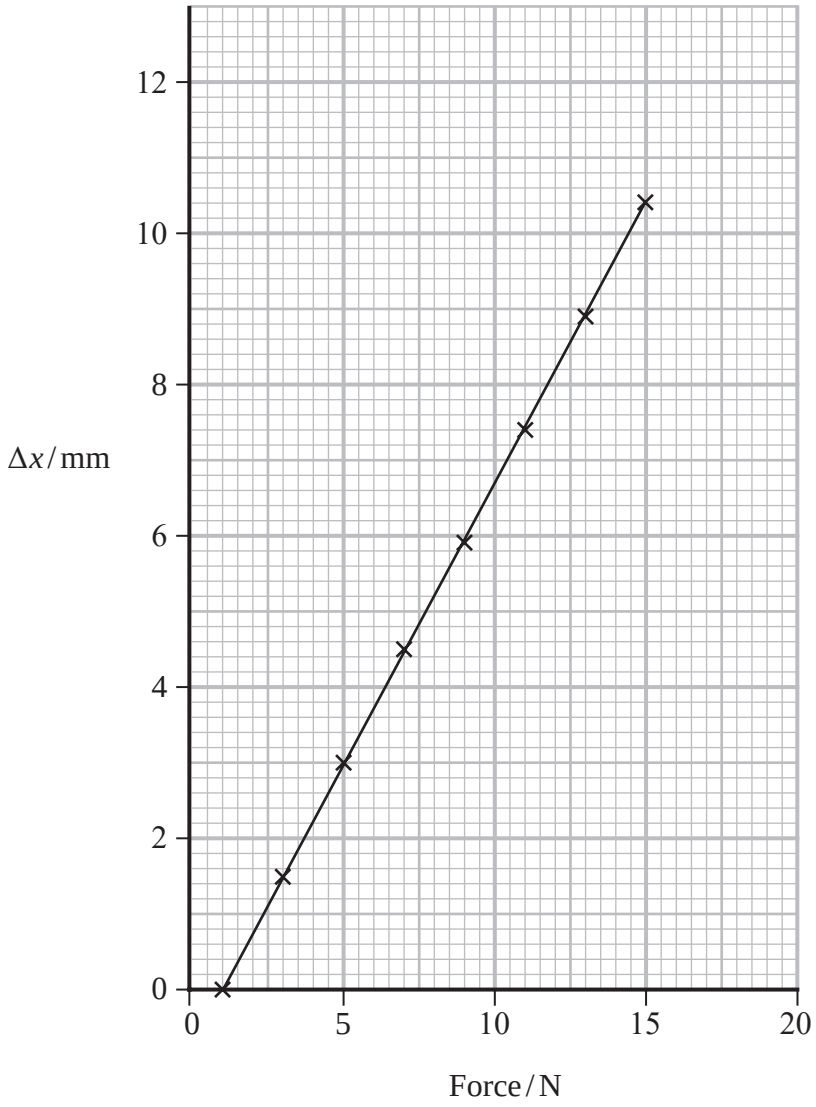
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(c) For each mass added, the student determined the force on the wire. The student plotted the graph shown.



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The table gives the Young modulus for some materials.

Material	Young modulus / GPa
Aluminium	68
Brass	106
Steel	200

Deduce which material the wire was made from.

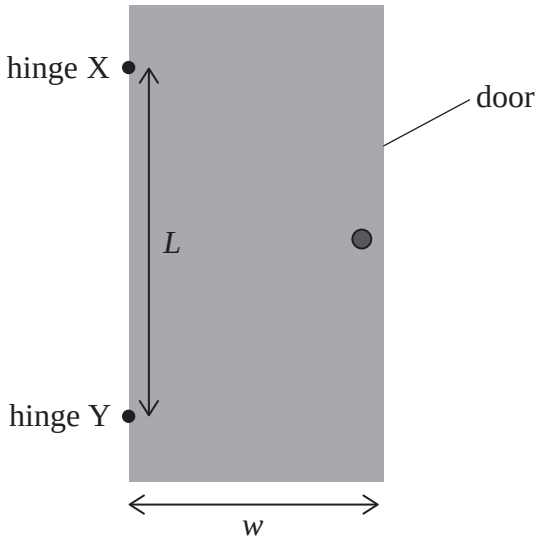
original length of wire = 1.80 m
diameter of wire = 0.17 mm

(5)

(Total for Question 17 = 11 marks)

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18 A uniform door of width w is supported by two hinges, X and Y.
X and Y are a vertical distance L apart as shown.



(a) State the conditions needed for the door to be in equilibrium.

(2)

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(b) Give the meaning of the term centre of gravity.

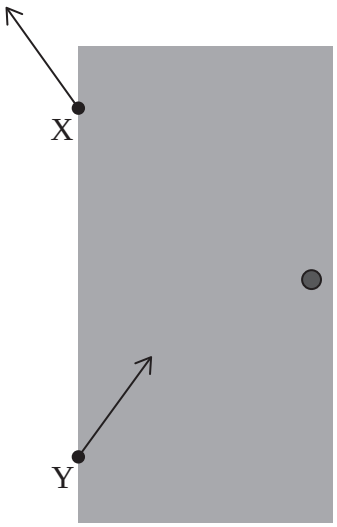
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(c) The diagram shows the force acting on the door at each hinge.



Not to scale

The mass of the door is 14.4 kg.

The weight of the door causes a moment about each hinge.

(i) Show that the horizontal component of the force of hinge Y on the door is about 40 N.

$L = 1.60\,\text{m}$
$w = 0.85\,\text{m}$

(5)

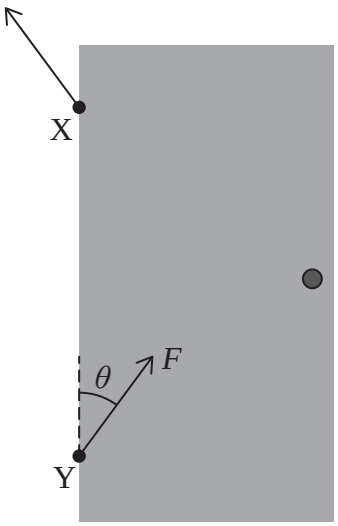
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(ii) The vertical component of the force of each hinge on the door is equal to half the weight of the door.

Hinge Y exerts a force F on the door at an angle θ to the vertical, as shown.



Not to scale

Determine the force F and the angle θ.

(4)

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F = ...

θ = ...

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(iii) An identical door is supported by hinges that are much closer together.

Explain how a smaller value of L affects F and θ.

You should consider moments about point X.

(4)

(Total for Question 18 = 16 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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