OXFORD
INTERNATIONAL
AQA EXAMINATIONS

Please write clearly in block capitals.

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Forename(s) ____________________

Candidate signature ____________________

INTERNATIONAL AS
PHYSICS

Unit 1 Mechanics, materials and atoms

Tuesday 7 May 2019 07:00 GMT Time allowed: 2 hours

Materials
For this paper you must have:
- a Data and Formulae Booklet as a loose insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate
- a protractor.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13–26	
TOTAL	

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Section A

Answer **all** questions in this section.

0 1 An object is travelling at constant speed.

Explain how it can also be accelerating.

[3 marks]

3

0 2 Determine the unit of work done expressed in fundamental (base) units.

[2 marks]

base units of work done = ____________________

2

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0 3 Complete **Table 1** with the charge of each particle and the name of its corresponding antiparticle.

[2 marks]

Table 1

Particle	Charge / C	Antiparticle
Positron		
Neutron		

2

0 4 A proton and an antiproton are travelling in opposite directions with the same speed. They collide and annihilate.

State and explain the characteristics of the radiation produced in the annihilation.

[4 marks]

4

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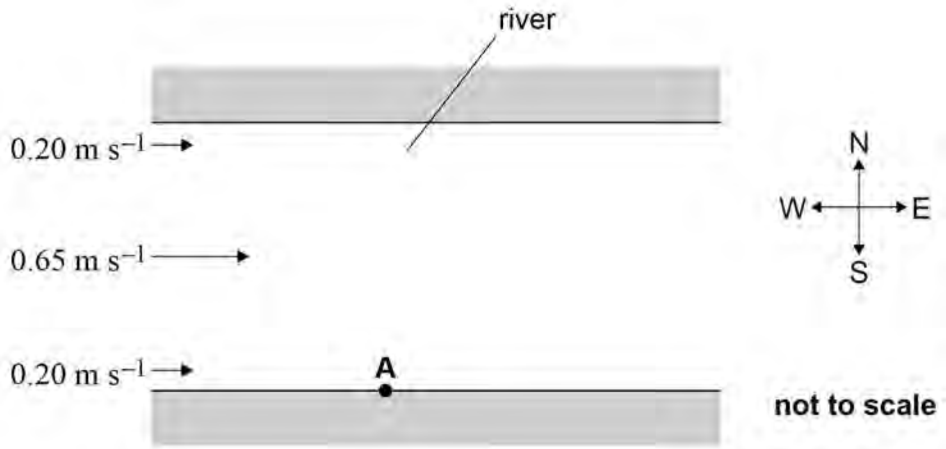
0 5 A river flows from west to east. The velocity of the current in the river varies from 0.20 m s^{-1} near the banks to a maximum of 0.65 m s^{-1} in the middle of the river, as shown in **Figure 1**. The current is always parallel to the bank.

Figure 1



A girl swims from **A** and aims due north. Her speed relative to the water is a constant 1.1 m s^{-1}.

0 5 . 1 Show that the magnitude of the girl's maximum resultant velocity is approximately 1.3 m s^{-1} as she swims across the river.

[2 marks]

0 5 . 2 On different occasions, the girl swims in the river with a speed of 0.90 m s^{-1} relative to the water and with a variety of directions.

State the magnitude and direction of the minimum possible resultant velocity that the girl can have.

[1 mark]

magnitude = ____________________ m s^{-1}

direction = ____________________

3

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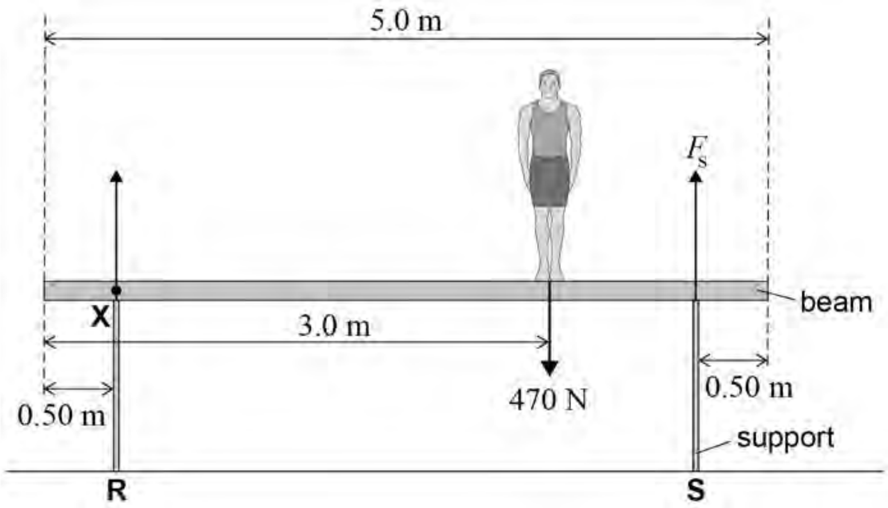
0 6 **Figure 2** shows a gymnast standing in equilibrium on a uniform beam, $3.0\ \mathrm{m}$ from one end.

Figure 2



The beam is $5.0\ \mathrm{m}$ long and the supports **R** and **S** are $0.50\ \mathrm{m}$ from each end. The weight of the beam is $700\ \mathrm{N}$. The gymnast has a weight of $470\ \mathrm{N}$.

F_s is the force exerted by **S** on the beam.

By taking moments about **X**, calculate the magnitude of F_s.

[3 marks]

magnitude of F_s = ____________________ N

3

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0 7 A nucleus of an isotope of radium decays to produce a β^- particle, a nucleus of actinium and a particle **X**.

0 7 . 1 Identify **X**.

[1 mark]

____

0 7 . 2 State **two** characteristics of **X** that make it more difficult to detect than the β^- particle.

[2 marks]

1 ____

____

2 ____

____

0 7 . 3 Explain why the specific charge on the actinium nucleus is greater than the specific charge on the radium nucleus.

[2 marks]

____

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____

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0 7 . 4 The nucleus of a different isotope of radium has a specific charge of $3.784 \times 10^{7}\ \mathrm{C\ kg^{-1}}$.
Assume that the mass of a nucleon in the nucleus is $1.661 \times 10^{-27}\ \mathrm{kg}$.

Determine the number of neutrons in the radium nucleus.

proton number of radium = 88

[3 marks]

number of neutrons = ______________________

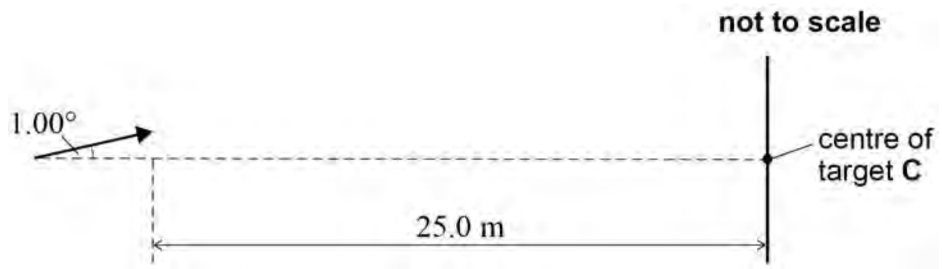
8

Turn over for the next question

0 8 An archer fires an arrow at an angle of $1.00°$ above the horizontal towards a target. The target is 25.0 m away from the point of the arrow when it is fired, as shown in **Figure 3**.

The arrow hits the target 0.260 s after it is fired.
Lift force and drag force are negligible during the flight of the arrow.

Figure 3



0 8 . 1 Show that the initial vertical component of the velocity of the arrow is approximately $1.7\ \text{m s}^{-1}$.

[2 marks]

0 8 . 2 The centre **C** of the target is at the same height as the point from which the arrow is fired. The arrow hits the target at a point **P**.

Determine the **vertical** displacement of **P** relative to **C**.

[3 marks]

displacement of **P** relative to **C** = ____________ m ____________________

5

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Turn over for the next question

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0 9 In training, an athlete runs from a starting line to a wall and back towards the starting line as shown in **Figure 4**. He starts to run at time $t = 0$

Figure 4

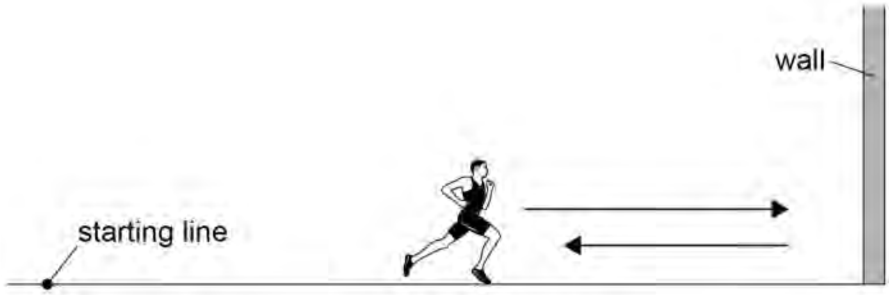
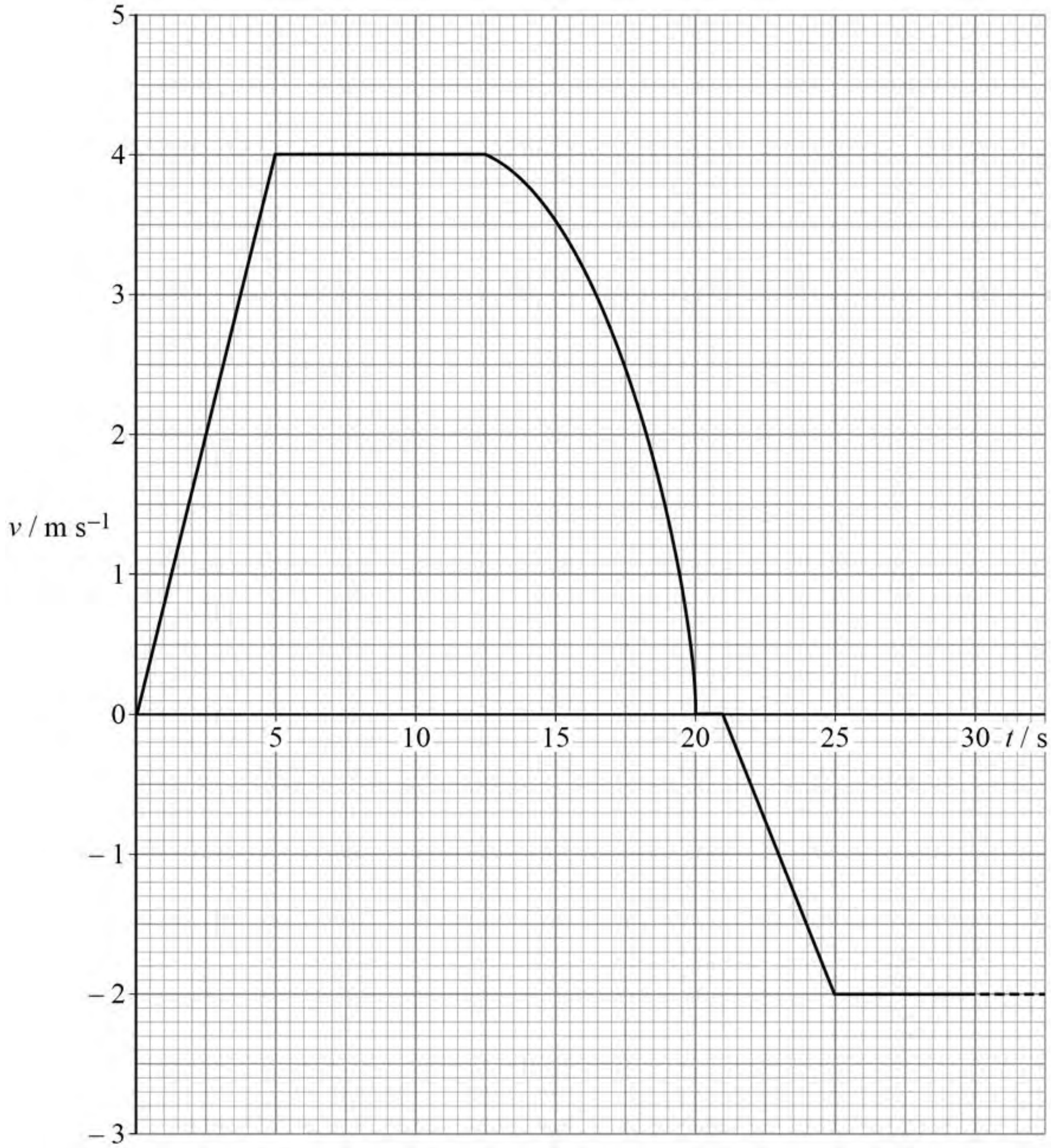


Figure 5 shows how the athlete's velocity v varies with time for the first $30\ \mathrm{s}$ of the run.

Figure 5



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0 9 . 1 Determine the acceleration of the athlete at $t = 16$ s.

[3 marks]

acceleration = ____________________ $m\ s^{-2}$

0 9 . 2 The athlete's displacement from the starting line is d.

Calculate the magnitude of d at $t = 20$ s.

[3 marks]

$d =$ ____________________ m

Question 9 continues on the next page

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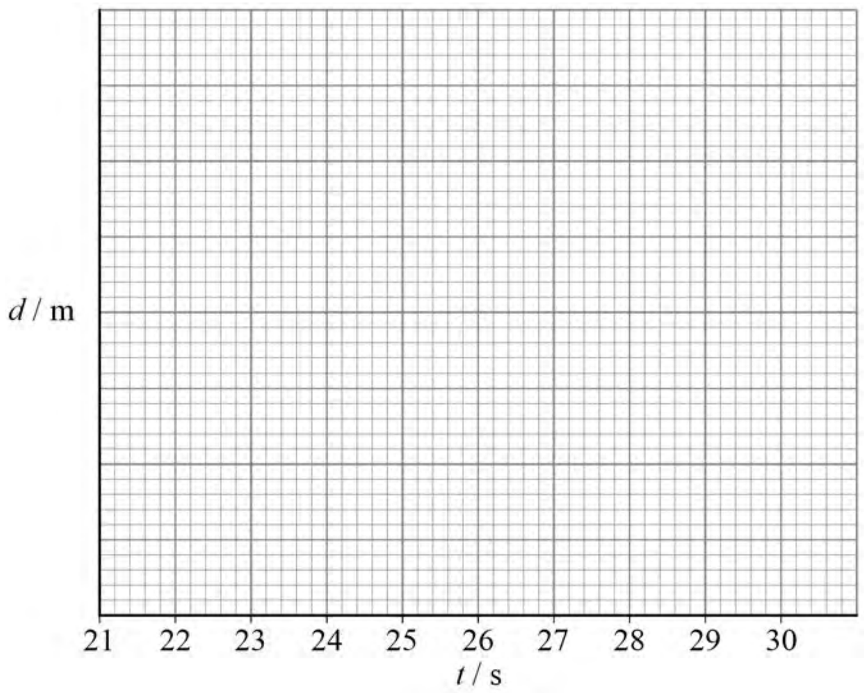
0 9 . 3 Sketch, on **Figure 6**, a graph to show the variation of d with t between $t = 21$ s and $t = 30$ s.

[3 marks]

Figure 6



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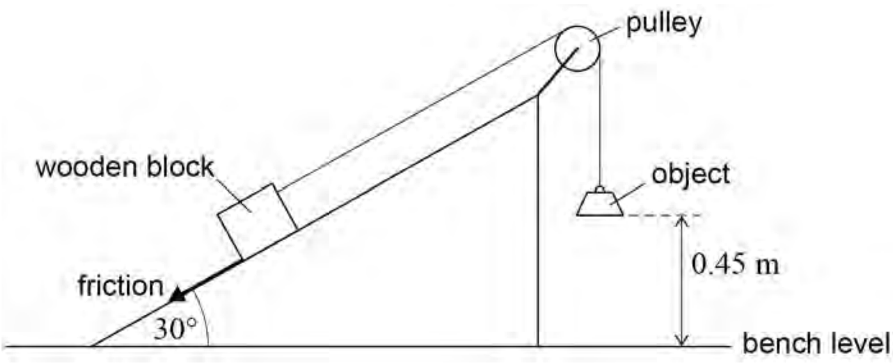
1 0 A student places a wooden block on a ramp inclined at $30°$ to the horizontal as shown in **Figure 7**. The block is pulled up the ramp by a light inextensible string connected, over a frictionless pulley, to an object of mass 0.40 kg.

Figure 7



The object is initially held at rest 0.45 m above the bench.
The wooden block has a mass of 0.25 kg and is initially at rest.

1 0 . 1 The object is released and accelerates vertically downwards at 2.23 m s^{-2}.

Explain **two** ways in which the momentum of the object is different from the momentum of the wooden block during this acceleration.

[2 marks]

1 ____

____

2 ____

____

1 0 . 2 Calculate the tension in the string as the object accelerates.

[2 marks]

tension = ______________________ N

Do not write outside the box

1 0 . 3 Show that the object is travelling at approximately $1.4\ \mathrm{m\ s^{-1}}$ just before it hits the bench.

[2 marks]

1 0 . 4 Calculate the component of the weight of the wooden block that is parallel to the ramp.

[2 marks]

component = ______________________ N

1 0 . 5 When the object hits the bench, the string becomes slack and the wooden block decelerates and stops.
There is a constant frictional force of $1.25\ \mathrm{N}$ between the wooden block and the ramp.

Calculate the distance the wooden block travels parallel to the ramp as it slows down.

[3 marks]

distance = ______________________ m

11

END OF SECTION A

Turn over ►

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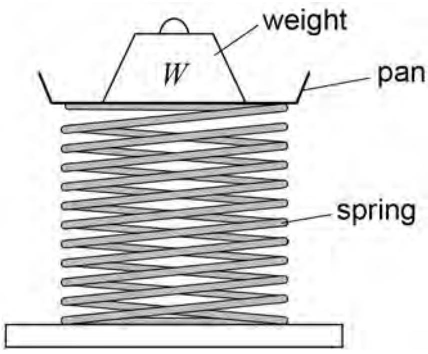
Section B

Answer **all** questions in this section.

1 1 An engineer tests a spring for a car suspension system. The engineer measures the original length of the spring and then places a pan and weight W on top of the spring as shown in **Figure 8**.

Figure 8



The engineer measures the new length of the spring each time a weight is added. For each value of W the compression ΔL of the spring is calculated.

1 1 . 1 **Table 2** shows the results of the experiment.

Table 2

W / N	50	100	150	200	250	300
ΔL / mm	5.0	7.5	9.8	12.9	15.2	17.7

Some of these data points are plotted on the grid in **Figure 9**.

Plot the remaining **two** points and draw a line of best fit.

[2 marks]

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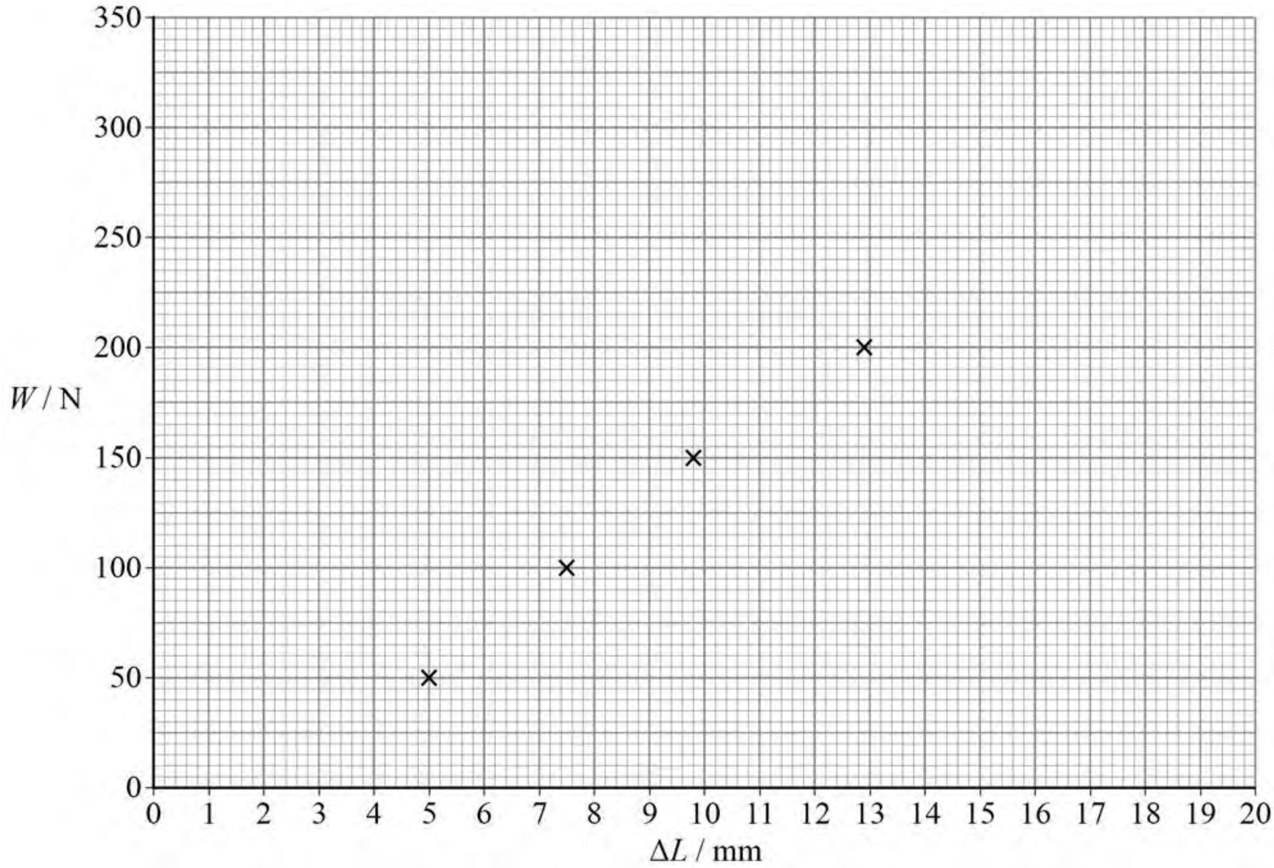
Figure 9



1 1 . 2 Theory predicts that $W = k\Delta L$.

Identify the feature of the graph that shows that it does **not** support the theory.

[1 mark]

1 1 . 3 The graph does not support the theory because of a systematic error in the experiment.

State a possible systematic error that can account for this.

[1 mark]

Question 11 continues on the next page

Turn over ►

Do not write outside the box

1 1 . 4 Determine the gradient of the graph.
State the unit for your answer.

[2 marks]

gradient = ____________________

unit = ____________________

1 1 . 5 Explain whether or not **Figure 9** can be used to find an accurate value for k in the equation $W = k\Delta L$.

[2 marks]

____

____

____

____

____

8

Turn over for the next question

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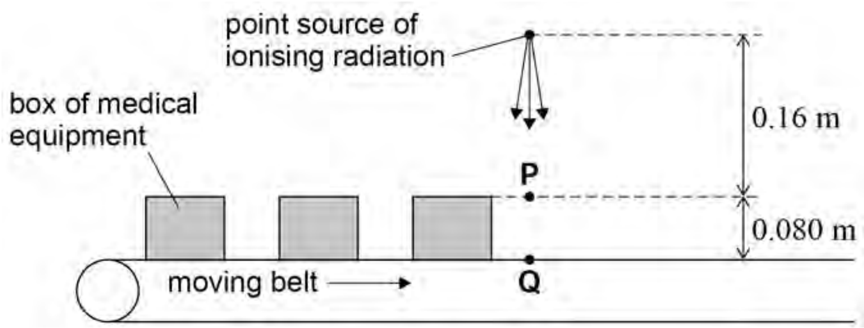
1 2 Medical equipment can be sterilised using ionising radiation. Any bacteria that absorb the ionising radiation will be killed.
Cardboard boxes of equipment to be sterilised are put on a moving belt and passed through a beam of ionising radiation from a point source as shown in **Figure 10**.

Figure 10



The boxes are $0.080\ \mathrm{m}$ high and the top of each box is $0.16\ \mathrm{m}$ below the source.

1 2 . 1 Suggest **one** advantage of using gamma radiation as the point source in this process.

[1 mark]

____

____

1 2 . 2 High-energy electrons that behave like β^- particles can also be used as the point source in this process.

Suggest **one** advantage of using high-energy electrons in this process.

[1 mark]

____

____

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1 2 . 3 One manufacturer uses gamma from a cobalt−60 source. **P** and **Q** are points vertically below the point source. For a new source, the gamma radiation intensity at **Q** is 4.0×10^{-2} W m^{-2} when there is no box under the source.

Calculate the gamma radiation intensity at **P**.

[2 marks]

gamma radiation intensity = ____________________ W m^{-2}

Question 12 continues on the next page

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1 2 . 4 Cobalt−60 has a half-life of 5.3 years. The sterilization process is ineffective if the gamma ray intensity is less than 8.0×10^{-3} W m^{-2}.

During which range of times will the intensity of the gamma radiation from the source fall to 8.0×10^{-3} W m^{-2}?
Tick **one** box.

Explain the reason for your answer.

[3 marks]

0–5.3 years ☐

5.3–10.6 years ☐

10.6–15.9 years ☐

15.9–21.2 years ☐

explanation ____

____

____

____

____

____

1 2 . 5 A different manufacturer uses high-energy electrons to sterilise the boxes of equipment. When the boxes have passed under the source, they are turned upside down and then passed under the source again.

Suggest why they are turned upside down and passed under the source again.

[1 mark]

____

____

____

8

END OF SECTION B

Section C

Each of the questions in this section is followed by four responses, **A**, **B**, **C** and **D**.

For each question select the best response.

Only **one** answer per question is allowed.
For each question completely fill in the circle alongside the appropriate answer.

CORRECT METHOD WRONG METHODS

If you want to change your answer you must cross out your original answer as shown.

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.

You may do your working in the blank space around each question but this will not be marked.
Do **not** use additional sheets for this working.

1 3 Which is a unit of power?

[1 mark]

A $kg\ m^2\ s^{-3}$

B $kg\ m^2\ s^{-2}$

C $N\ m\ s^{-2}$

D $N\ m^{-1}\ s^{-1}$

Turn over for the next question

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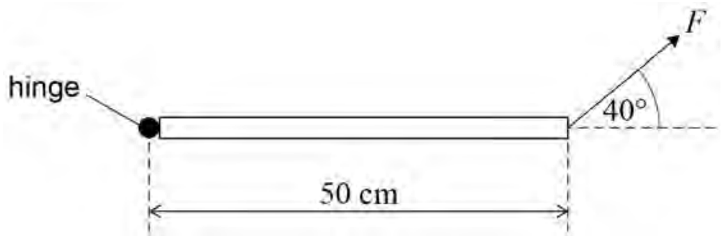
1 4 Which row shows a vector quantity and a scalar quantity?

[1 mark]

	Vector quantity	Scalar quantity	
A	distance	kinetic energy	⬭
B	force	displacement	⬭
C	temperature	charge	⬭
D	momentum	gravitational potential energy	⬭

1 5 The diagram shows a hinged uniform bar of length $50\ \text{cm}$ and weight $3.7\ \text{N}$.



The bar is held in a horizontal position by a force F that acts at $40°$ to the bar.

What is F?

[1 mark]

A $2.4\ \text{N}$ ⬭

B $2.9\ \text{N}$ ⬭

C $4.9\ \text{N}$ ⬭

D $5.8\ \text{N}$ ⬭

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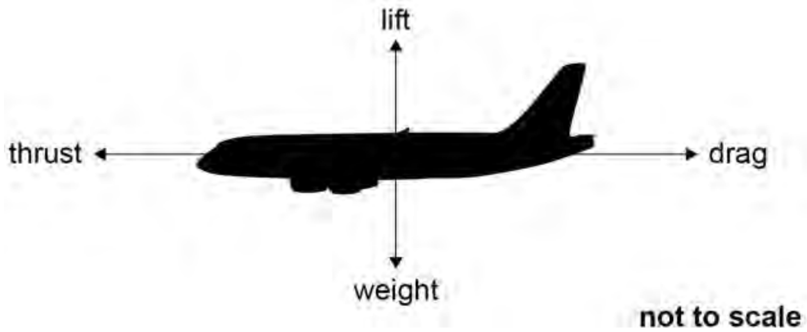
1 6 The diagram shows an aircraft that is descending at a steady speed and decelerating horizontally.



Which row shows the relationships between lift and weight and between thrust and drag?
[1 mark]

	Relationship between lift and weight	Relationship between thrust and drag	
A	lift < weight	thrust < drag	⬭
B	lift < weight	thrust = drag	⬭
C	lift = weight	thrust < drag	⬭
D	lift = weight	thrust = drag	⬭

Turn over for the next question

1 7 A rocket of mass 2.0×10^6 kg has an initial vertical thrust of 3.0×10^7 N at the Earth's surface.

What is the initial vertical acceleration of the rocket?

[1 mark]

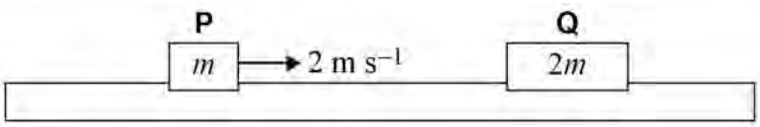
A $5.2\ \text{m s}^{-2}$ ○

B $14\ \text{m s}^{-2}$ ○

C $15\ \text{m s}^{-2}$ ○

D $25\ \text{m s}^{-2}$ ○

1 8 Trolleys **P** and **Q** are on a frictionless horizontal runway.
P has an initial velocity of $2\ \text{m s}^{-1}$ towards **Q**.
Q is initially stationary.
P has a mass of m and **Q** has a mass of $2m$.



P collides with **Q**. Immediately after the collision **Q** has a velocity of $+\frac{4}{3}\ \text{m s}^{-1}$.

What is the velocity of **P** immediately after the collision?

[1 mark]

A $+\frac{2}{3}\ \text{m s}^{-1}$ ○

B $+\frac{1}{3}\ \text{m s}^{-1}$ ○

C $-\frac{1}{3}\ \text{m s}^{-1}$ ○

D $-\frac{2}{3}\ \text{m s}^{-1}$ ○

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1 9 A car is in collision with a truck. The car experiences an impulse Δp.

When is the impulse experienced by the truck equal to $-\Delta p$?

[1 mark]

A Only when the collision is elastic.

B Only when the collision is inelastic.

C Only when the truck and the car have the same initial momentum.

D Whenever no external forces act during the collision.

2 0 An electric motor is used to lift a $120\ \mathrm{g}$ mass at a steady speed through a height of $0.15\ \mathrm{m}$.
The efficiency of the motor is 72%.

How much energy is transferred to the motor?

[1 mark]

A $0.05\ \mathrm{J}$

B $0.13\ \mathrm{J}$

C $0.25\ \mathrm{J}$

D $0.63\ \mathrm{J}$

2 1 A ball travels at speed u before colliding with a wall.
During the collision it loses 20% of its kinetic energy.

What is the speed of the ball immediately after the collision?

[1 mark]

A $0.89u$

B $0.80u$

C $0.64u$

D $0.36u$

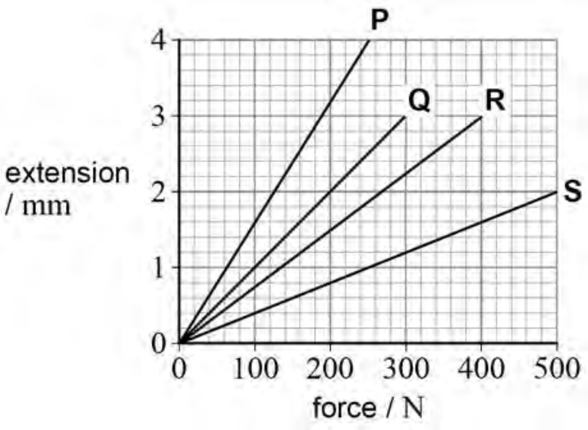
2 2 A wire **W** has mass m, radius r and is made from a material of density ρ.
The masses, radii and densities for four other wires are shown in the table.

Which has the same length as **W**?

[1 mark]

	Mass	Radius	Density	
A	$2m$	$2r$	2ρ	⬭
B	$4m$	$2r$	2ρ	⬭
C	$4m$	$2r$	4ρ	⬭
D	$8m$	$2r$	2ρ	⬭

2 3 The graph shows the variation of extension with force for four wires.



Which two wires store the same elastic strain energy at their maximum extension?

[1 mark]

A **P** and **R** ⬭

B **P** and **S** ⬭

C **Q** and **R** ⬭

D **Q** and **S** ⬭

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2 4 The half-life of a radioactive isotope is 2.0 hours.
The count rate measured from a freshly prepared sample of the isotope is 140 counts per minute.
The background count rate is 20 counts per minute.

What will be the measured count rate after 4.0 hours?

[1 mark]

A 30 counts per minute ⬭

B 35 counts per minute ⬭

C 50 counts per minute ⬭

D 55 counts per minute ⬭

2 5 A detector is placed $20\ \text{cm}$ from a source of gamma rays.
The measured count rate is C.
The background count rate is B.

What measured count rate is detected $60\ \text{cm}$ from the source?

[1 mark]

A $\dfrac{C+8B}{9}$ ⬭

B $\dfrac{C+10B}{9}$ ⬭

C $\dfrac{C+2B}{3}$ ⬭

D $\dfrac{C+4B}{3}$ ⬭

Turn over for the next question

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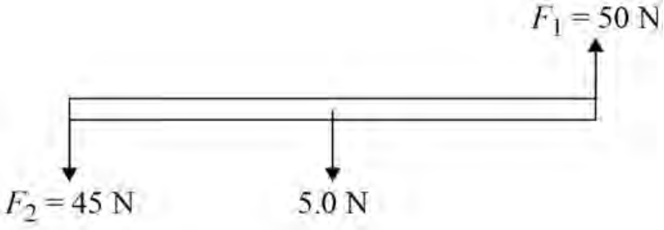
2 6 The forces F_1 and F_2 are in a vertical plane and are maintained at $90°$ to the uniform bar shown in the diagram.
The bar has a weight of 5.0 N.



The bar will rotate anticlockwise.

After rotating by less than $90°$ the bar will also accelerate

[1 mark]

A downwards and to the left.

B downwards and to the right.

C upwards and to the left.

D upwards and to the right.

END OF QUESTIONS

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