OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname _____

Forename(s) _____

Candidate signature _____

INTERNATIONAL AS

PHYSICS

Unit 1 Mechanics, materials and atoms

Tuesday 22 May 2018   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.

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.
- 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	
12–25	
TOTAL	

Section A

Answer **all** questions in this section.

| 0 | 1 |.| 1 | What is 1.0 km h^{-1} in m s^{-1} ?

[1 mark]

_____ m s^{-1}

| 0 | 1 |.| 2 | What is 1.0 g cm^{-3} in kg m^{-3} ?

[1 mark]

_____ kg m^{-3}

2

0 2 A cyclist travels at constant speed round a circular track of radius 42 m.
She completes one circuit of the track every 24 s.

0 2 . 1 Calculate the speed of the cyclist.

[2 marks]

speed = _____ m s^{-1}

0 2 . 2 Deduce the magnitude of her average velocity over a 24 s period while travelling once round the track.

[1 mark]

magnitude of average velocity = _____ m s^{-1}

0 2 . 3 Calculate the magnitude of her average velocity over a 12 s period while she travels halfway round the circular track.

[2 marks]

magnitude of average velocity = _____ m s^{-1}

5

Turn over ►
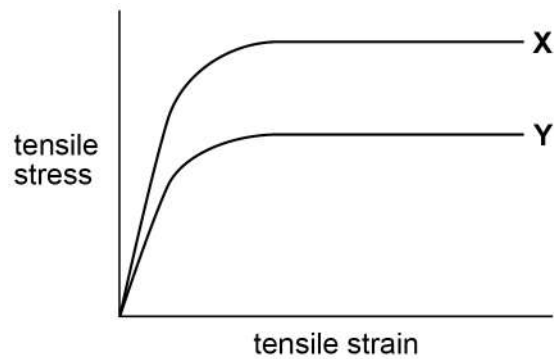
0 3 . 1 Complete **Table 1** to show some of the properties of an antiproton.

[2 marks]

Table 1

Charge / C	Rest mass / kg	Specific charge / C kg^{-1}

0 3 . 2 Antiprotons can be annihilated.

Describe annihilation.
Include the circumstances under which it can occur and its outcome.

[4 marks]

_____

_____

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6

0 4   **Figure 1** shows the stress–strain relationship for two types of steel, **X** and **Y**.

Figure 1

0 4 . 1   State what is meant by tensile strain.

[1 mark]

_____

_____

0 4 . 2   Identify on **Figure 1** the limit of proportionality of steel **Y**. Label it **L**.

[1 mark]

0 4 . 3   An engineer plans to make a brake cable for a bicycle.

Explain why **X** is more suitable than **Y**.

[3 marks]

_____

_____

_____

_____

_____

_____

5

Turn over ▶

0 5 Fluorine–18 ($_9^{18}$F) is a β^+ emitter used in medicine. Its half-life is 110 minutes.
Fluorine–18 decays to oxygen–18 ($_8^{18}$O) which is stable.

A fluorine–18 compound is injected into a patient and gamma radiation arising from the decay is detected outside the body.
A sample of pure $_9^{18}$F is prepared and then stored for 220 minutes.

0 5 . 1 The decay equation for $_9^{18}$F is

$$_9^{18}\text{F} \rightarrow {_8^{18}}\text{O} + \beta^+ + \text{X}$$
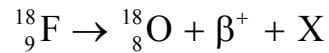
Identify X.

[2 marks]

0 5 . 2 Calculate the ratio $\dfrac{\text{number of } _9^{18}\text{F nuclei in the sample}}{\text{number of } _8^{18}\text{O nuclei in the sample}}$ after 220 minutes.

[2 marks]

ratio = _____

0 5 . 3 Explain why the $_9^{18}$F sample must be used soon after it is produced.

[2 marks]

6

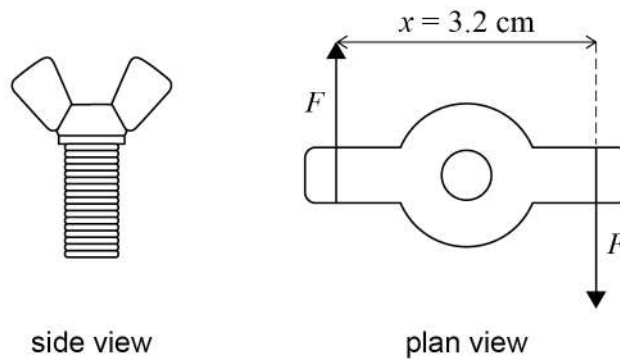**Turn over for the next question**

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Turn over ▶

0 6 A wing-screw is tightened using a thumb and finger. The thumb and finger each apply a force F as shown in **Figure 2**.

Figure 2

side view   plan view

0 6 . 1 Explain why the pair of forces shown in **Figure 2** is a couple.

[1 mark]

0 6 . 2 The perpendicular distance x between the lines of action of the forces is 3.2 cm as shown in **Figure 2**.

Calculate the force F required to produce a couple of 1.2 N m.

[1 mark]

force = _____ N

0 6 . 3 The percentage uncertainty in the couple required to turn the wing-screw is $\pm 10\%$. The absolute uncertainty in x is ± 0.2 cm.

Calculate the percentage uncertainty in your value of F.

[2 marks]

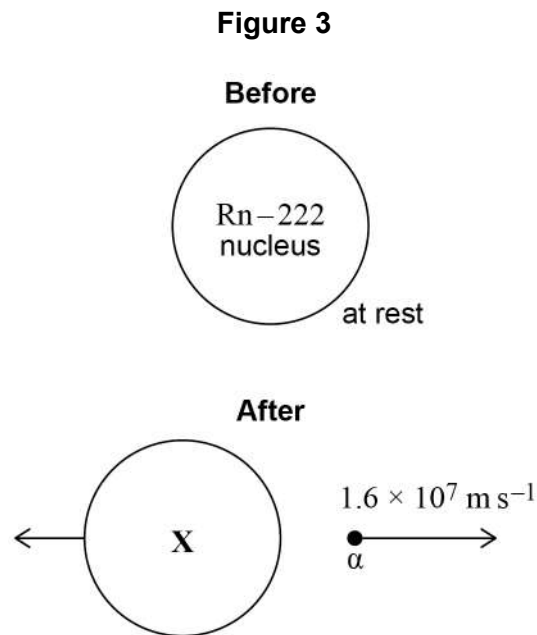percentage uncertainty = _____

4

Turn over for the next question

Turn over ▶

0 7 A stationary radon–222 (Rn–222) nucleus decays and emits an α particle of energy 5.5 MeV.
This causes the daughter nucleus **X** to move in the opposite direction as shown in **Figure 3**.

Figure 3

0 7 . 1 The α particle has mass 6.6×10^{-27} kg.

Show that the initial speed of the α particle is approximately 1.6×10^7 m s^{-1}.

[3 marks]

| 0 | 7 | . | 2 | Calculate the recoil speed of **X**.

mass of **X** = 3.6×10^{-25} kg

[2 marks]

recoil speed = _____ m s^{-1}

| 0 | 7 | . | 3 | When scientists studied beta decay they observed that

- the beta particle and the daughter nucleus did not travel in opposite directions
- beta particles from the decay of a particular nuclide had a range of energies.

Explain how these observations led to the prediction of a previously undiscovered particle.

[3 marks]

_____

_____

_____

_____

_____

_____

Turn over for the next question

8

Turn over ▶

0 8 **Figure 4** shows a golf ball hit from a mound of height 12 m.

Figure 4
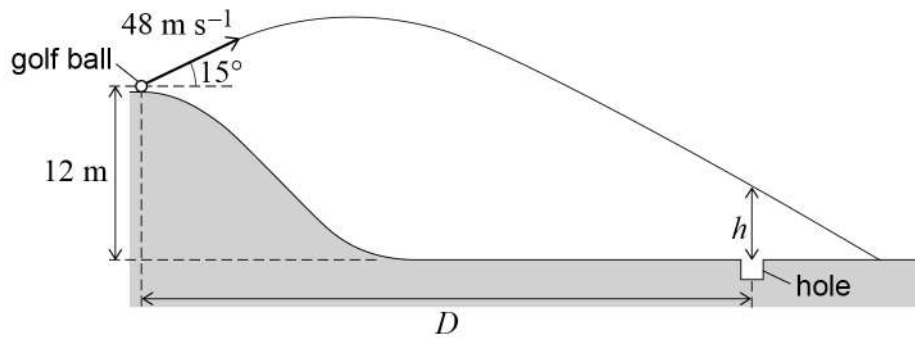
The initial velocity of the ball is 48 m s^{-1} at $15°$ to the horizontal.
The golf ball takes 3.0 s to reach a position at vertical height h above the hole.
D is the horizontal distance from the point where the ball is hit to the hole.
Ignore the effects of air resistance for this question.

0 8 . 1 Calculate D.

[2 marks]

$D =$ _____ m

0 8 . 2 Show that the initial vertical component of the ball is approximately 12 m s^{-1}.

[1 mark]

0 8 . 3 Calculate h.

[3 marks]

$h =$ _____ m

Turn over for the next question

6

Turn over ▶

0 9 **Figure 5** shows a child on a sled sliding down a slope. The total mass of the child and the sled is 75 kg. She starts from rest at **A** and descends through a vertical height of 5.5 m to **B**.

Figure 5
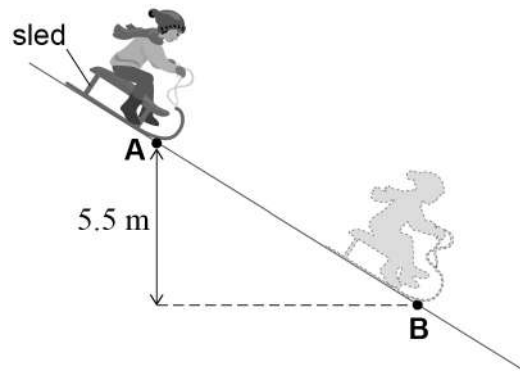
0 9 . 1 State how to calculate the work done by a force.

[2 marks]

0 9 . 2 Show that the speed of the sled at **B** would be approximately 10 m s^{-1} in the absence of friction.

[2 marks]

0 9 . 3 The actual speed of the sled at **B** is 5.8 m s^{-1}.
The distance **AB** is 17.2 m.

Calculate using energy considerations the average frictional force experienced by the sled.
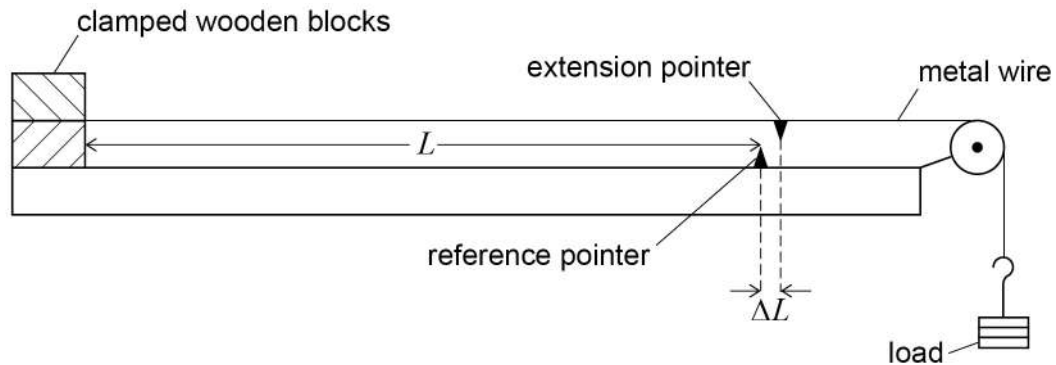
[4 marks]

average frictional force = _____ N

END OF SECTION A

8

Turn over ▶

Section B

Answer **all** questions in this section.

1 0   **Figure 6** shows an apparatus used to measure the Young modulus of a metal.

Figure 6

The initial length L of a wire made from the metal was measured using a metre ruler.
The mass of the load was increased in $50\,\text{g}$ steps and the extension ΔL measured using vernier calipers.
The experiment was carried out three times.

1 0 . 1   **Table 2** shows some of the results of this experiment.

Complete **Table 2**.

[1 mark]

Table 2

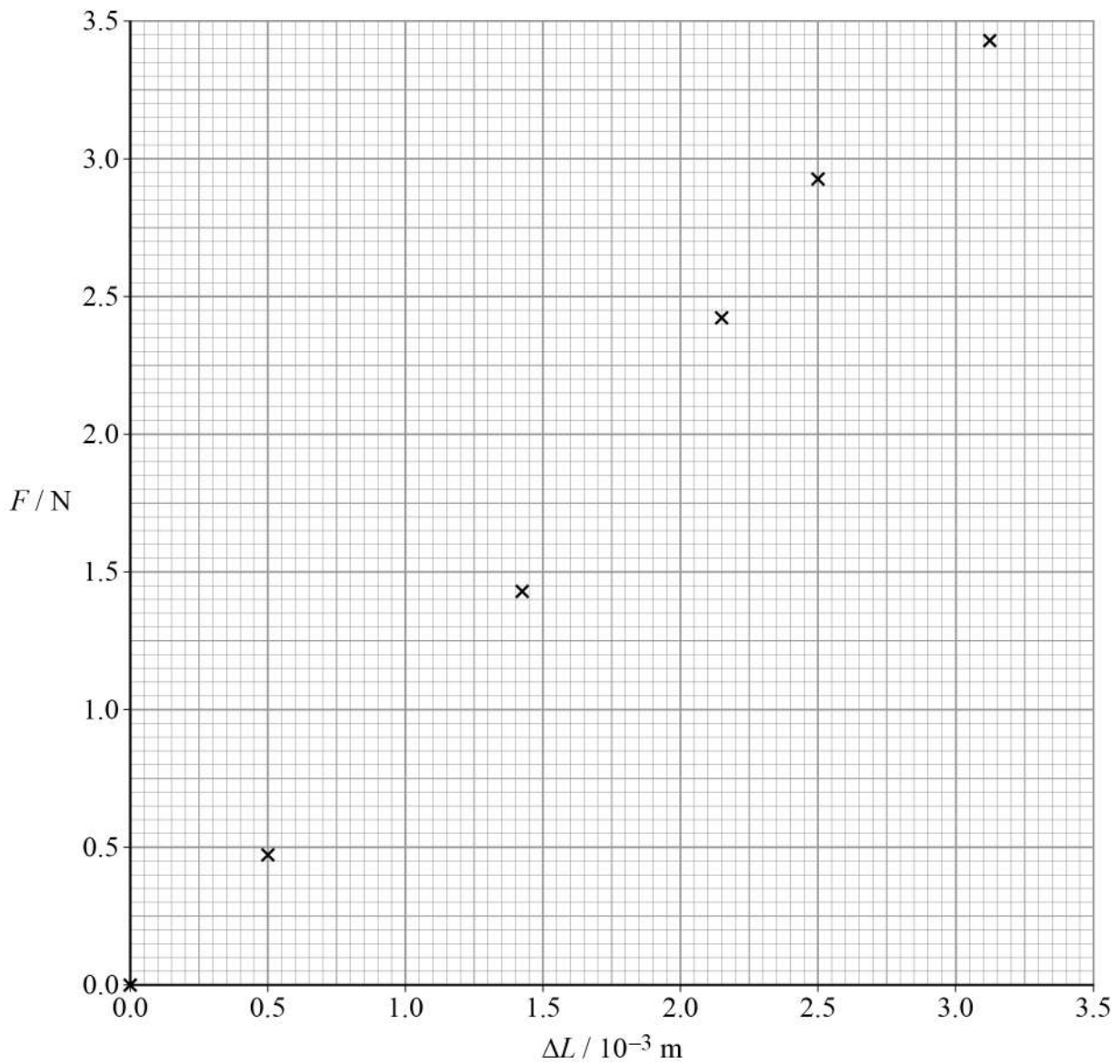| Tension F in the wire / N	ΔL / 10^{-3} m			
	First reading	Second reading	Third reading	Mean
0.00	0.0	0.0	0.0	0.0
0.49	0.5	0.5	0.5	0.5
0.98	0.8	0.7	0.9	
1.47	1.4	1.4	1.5	1.4
1.96	1.8	1.9	1.9	
2.45	2.2	2.1	2.3	2.2
2.94	2.5	2.5	2.5	2.5
3.43	3.1	3.1	3.2	3.1

1 0 . 2 Plot on **Figure 7** the two missing points.
Draw a best fit line.

[2 marks]

Figure 7

1 0 . 3 Determine the stiffness of the wire.

[2 marks]

stiffness = _____ N m^{-1}

Question 10 continues on the next page

Turn over ▶

IB/M/Jun18/PH01

1 0 . **4** The cross-sectional area of the wire was 1.8×10^{-8} m^2.
L was 1.800 m.

Calculate the Young modulus of the metal.

[2 marks]

Young modulus = _____ Pa

```
 7
```

1 1 A student measures the count rate from a gamma source to determine its half-life.

1 1 . 1 State and explain **one** precaution the student should take to limit his exposure to ionising radiation.

[2 marks]

Precaution

Explanation

Question 11 continues on the next page

| 1 | 1 | . | 2 | **Figure 8** is a plot of the results.

Figure 8
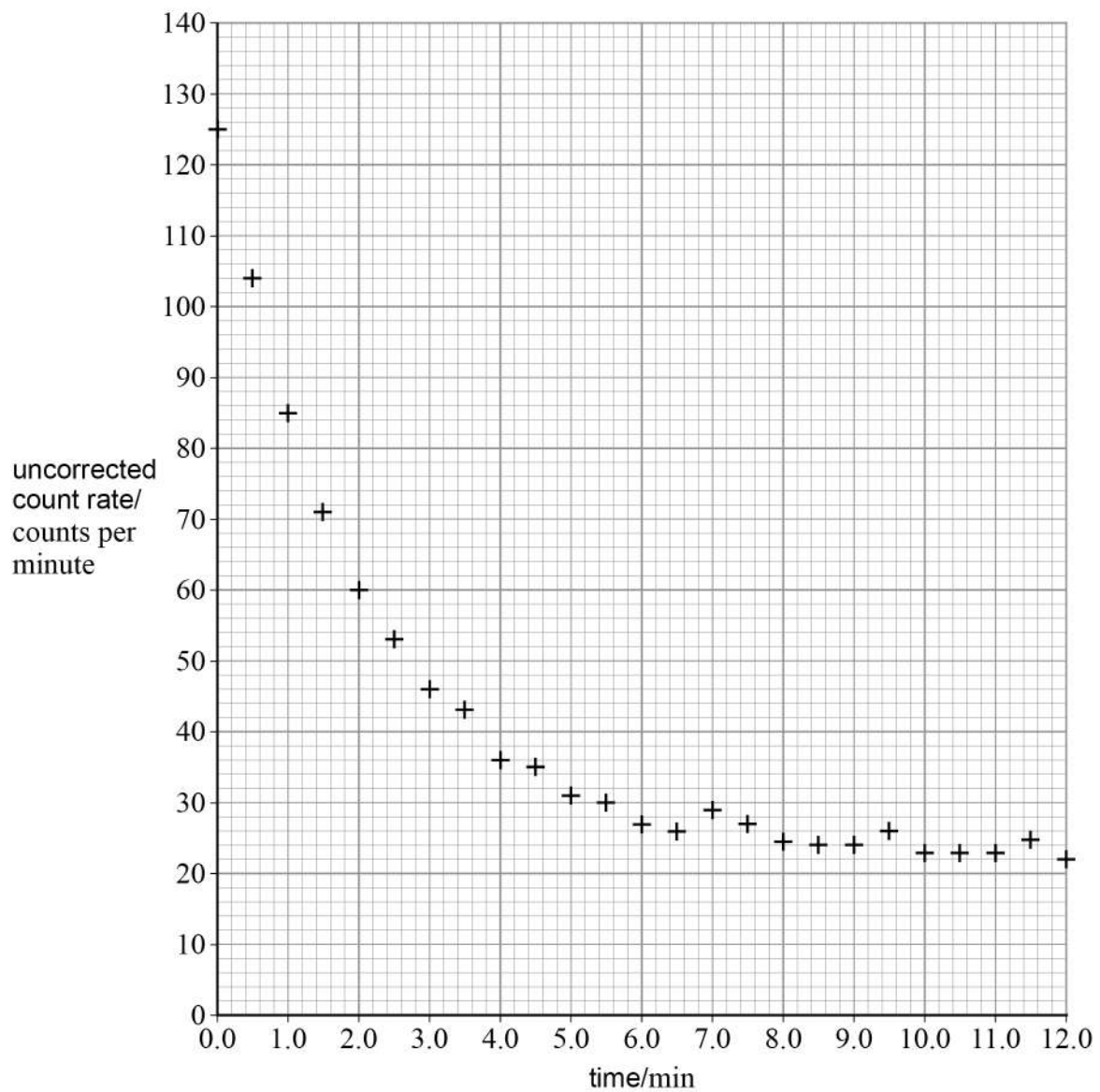
Estimate the background count rate.

[1 mark]

background count rate = _____ counts per minute

| 1 | 1 |.| 3 | Determine the half-life of the source.

[3 marks]

half-life = _____ min

| 1 | 1 |.| 4 | The student decides to measure the background count rate directly.

Describe how he should do this.
In your answer, explain how he should ensure the accuracy in his measurement.

[3 marks]

_____

_____

_____

_____

_____

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_____

_____

_____

_____

9

END OF SECTION B

Turn over ▶

Section C

Each of Questions **12** to **25** 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 2 Which quantity has a unit of kg m s^{-1}?

[1 mark]

A force ⬭

B impulse ⬭

C moment ⬭

D work done ⬭

---

1 3 Which is a unit for tensile stress?

[1 mark]

A $\text{kg m}^{-2}\,\text{s}^{-2}$ ⬭

B $\text{kg m}^{-1}\,\text{s}^{-2}$ ⬭

C kg m s^{-2} ⬭

D $\text{kg m}^2\,\text{s}^{-2}$ ⬭

1 4 A student uses a micrometer to measure the diameter of a wire at several places along its length. These are the measurements he obtains:

0.58 mm   0.52 mm   0.50 mm   0.51 mm   0.56 mm

Which diameter should he quote for the mean value of the wire?

[1 mark]

A (0.5 ± 0.01) mm ⬭

B (0.5 ± 0.1) mm ⬭

C (0.53 ± 0.04) mm ⬭

D (0.53 ± 0.08) mm ⬭

1 5 An apple falls from a tree.

What is the best estimate of its kinetic energy just before it hits the ground?

[1 mark]

A 30 mJ ⬭

B 300 mJ ⬭

C 3 J ⬭

D 30 J ⬭

Turn over for the next question

Turn over ▶

1 6 The graph shows the variation with time of the velocity of a bouncing ball.
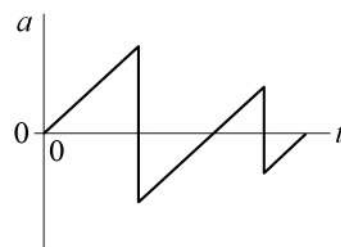The downward direction has been chosen to be positive.

velocity

0
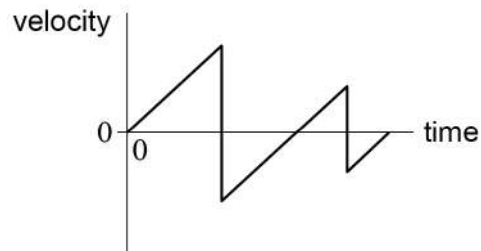
time

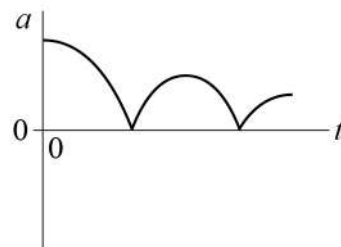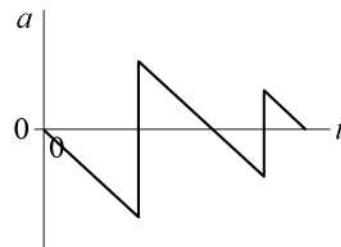Which graph shows the variation of acceleration a with time t for the ball?

[1 mark]

A

a

0

t

B

a

0

t

C
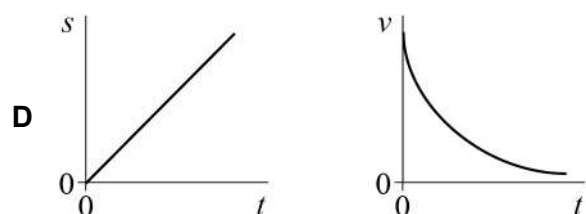
a

0

t

D

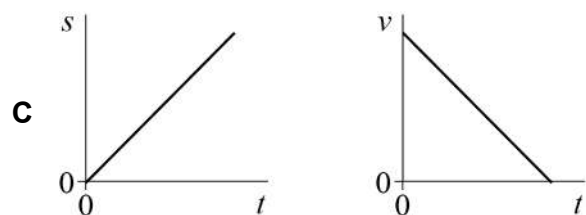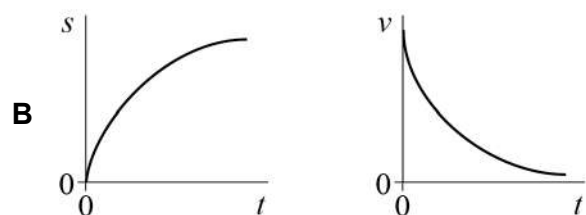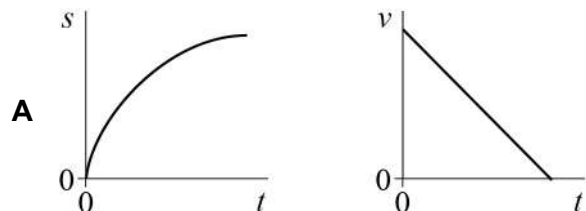a

0

t
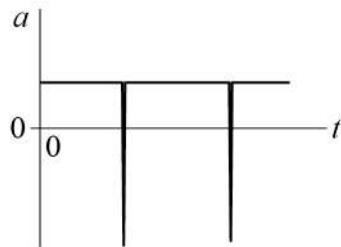
A ⬭

B ⬭

C ⬭

D ⬭

1 7 Brakes apply a constant force to a moving car starting from time $t = 0$

Which pair of graphs shows the variation with time t of displacement s and velocity v?

[1 mark]

A

B

C

D

A ⬭

B ⬭

C ⬭

D ⬭

Turn over ▶

1 8 When a ball is thrown into the air at an angle to the vertical

[1 mark]

A the forces on the ball are balanced when it is at its highest point. ▢

B the vertical velocity of the ball is zero when it is at its highest point. ▢

C the ball's acceleration increases when it starts to descend. ▢

D the ball's horizontal velocity is maximum when it is at its highest point. ▢

1 9 Which is a statement of Newton's Third Law of Motion?

[1 mark]

A Every force on an object is balanced by an equal and opposite force on the same object. ▢

B When a force acts on an object there is always a second force also acting on it in the opposite direction, but they do not balance. ▢

C Whenever an object **X** moves forwards, another object **Y** in that system must move backwards with equal and opposite velocity. ▢

D When object **X** exerts a force on object **Y**, object **Y** must exert an equal and opposite force on object **X**. ▢

2 0 What is the relationship between the momentum p of a ball falling freely from rest and time t ?

[1 mark]

A p is constant ▢

B p is proportional to $t^{\frac{1}{2}}$ ▢

C p is proportional to t ▢

D p is proportional to t^2 ▢

2 1 A conveyor belt raises 20 boxes, each of mass 60 kg, through a vertical height of 12 m every 30 s. The conveyor belt operates at a steady speed.

What is the useful output power of the conveyor belt?

[1 mark]

A 0.47 kW ⬯

B 4.7 kW ⬯

C 14 kW ⬯

D 140 kW ⬯

2 2 A lamp has a useful output power of 8.0 W and an efficiency of 12%.

What is the input power to the lamp?

[1 mark]

A 0.67 W ⬯

B 0.96 W ⬯

C 67 W ⬯

D 96 W ⬯

2 3 Spring **P** of spring constant k is stretched until the tension is T and the energy stored is E.
Spring **Q** of spring constant $2k$ is stretched until the tension is also T.

What is the energy stored in **Q**?

[1 mark]

A $2E$ ⬯

B E ⬯

C $\dfrac{E}{2}$ ⬯

D $\dfrac{E}{4}$ ⬯

Turn over ▶

2 4 In the Rutherford scattering experiment, most of the alpha particles

[1 mark]

A were deflected by an angle of more than 90°. ⬭

B were attracted to the gold nuclei. ⬭

C were stopped by the gold foil. ⬭

D passed straight through the gold foil undeflected. ⬭

2 5 A Geiger counter is used to measure the corrected count rate C from a gamma source in a vacuum.

What is the relationship between C and the distance x between the Geiger counter and the source?

[1 mark]

A C is directly proportional to x^2 ⬭

B C is directly proportional to x ⬭

C C is inversely proportional to x ⬭

D C is inversely proportional to x^2 ⬭

14

END OF QUESTIONS