

PHYSICS

9702/11

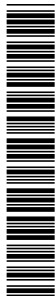
Paper 1 Multiple Choice

October/November 2015

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

* 8 1 2 5 0 8 4 6 3 1 *



READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

DO NOT WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any working should be done in this booklet.

Electronic calculators may be used.

This document consists of **19** printed pages and **1** blank page.



Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

work done on/by a gas,

$$W = p\Delta V$$

gravitational potential,

$$\phi = -\frac{Gm}{r}$$

hydrostatic pressure,

$$p = \rho gh$$

pressure of an ideal gas,

$$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$$

simple harmonic motion,

$$a = -\omega^2 x$$

velocity of particle in s.h.m.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{(x_0^2 - x^2)}$$

electric potential,

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

capacitors in series,

$$1/C = 1/C_1 + 1/C_2 + \dots$$

capacitors in parallel,

$$C = C_1 + C_2 + \dots$$

energy of charged capacitor,

$$W = \frac{1}{2}QV$$

resistors in series,

$$R = R_1 + R_2 + \dots$$

resistors in parallel,

$$1/R = 1/R_1 + 1/R_2 + \dots$$

alternating current/voltage,

$$x = x_0 \sin \omega t$$

radioactive decay,

$$x = x_0 \exp(-\lambda t)$$

decay constant,

$$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$$

1 What is the unit of weight in terms of SI base unit(s)?

- A kg m s^{-1} B kg m s^{-2} C N D J m^{-1}

2 At temperatures close to 0 K, the specific heat capacity c of a particular solid is given by $c = bT^3$, where T is the thermodynamic temperature and b is a constant characteristic of the solid. The SI unit of specific heat capacity is $\text{J kg}^{-1} \text{K}^{-1}$.

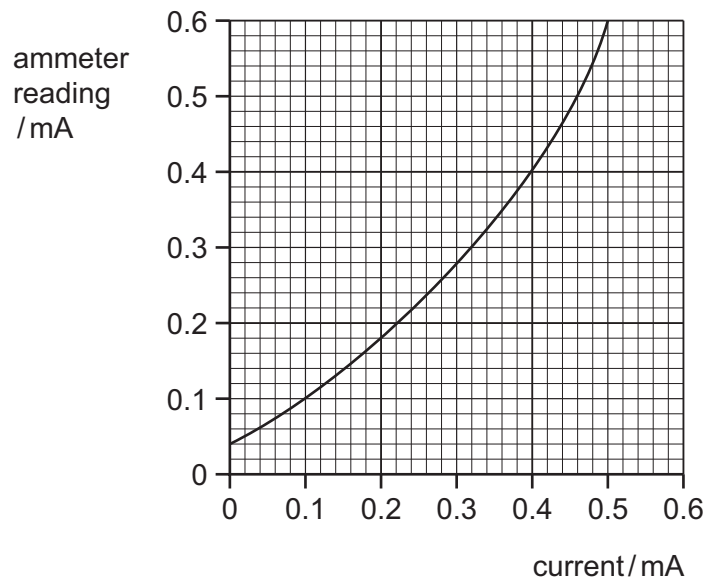
What is the unit of constant b , expressed in SI base units?

- A $\text{m}^2 \text{s}^{-2} \text{K}^{-3}$
 B $\text{m}^2 \text{s}^{-2} \text{K}^{-4}$
 C $\text{kg m}^2 \text{s}^{-2} \text{K}^{-3}$
 D $\text{kg m}^2 \text{s}^{-2} \text{K}^{-4}$

3 In making reasonable estimates of physical quantities, which statement is **not** correct?

- A The frequency of sound can be of the order of GHz.
 B The wavelength of light can be of the order of 600 nm.
 C The Young modulus of a metal can be of the order of 10^{11} Pa .
 D Beta particles are associated with one unit of negative charge.

4 A calibration graph is shown for an ammeter whose scale is inaccurate.

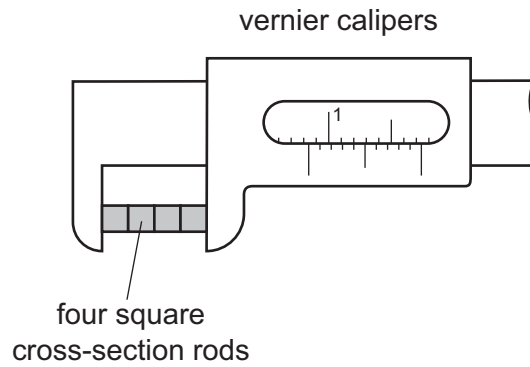


Two readings taken on the meter at different times during an experiment are 0.13 mA and 0.47 mA.

By how much did the current really increase between taking the two readings?

- A 0.30 mA B 0.35 mA C 0.40 mA D 0.44 mA

- 5 Four identical rods have a square cross-section. The rods are placed side by side and their total width is measured with vernier calipers, as shown.

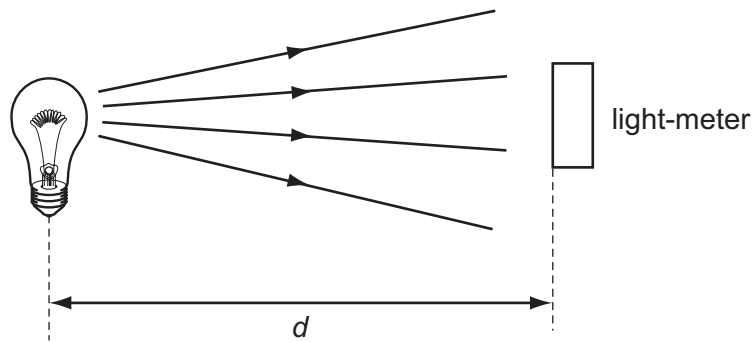


The measurement is (8.4 ± 0.1) mm and the zero reading on the calipers is (0.0 ± 0.1) mm.

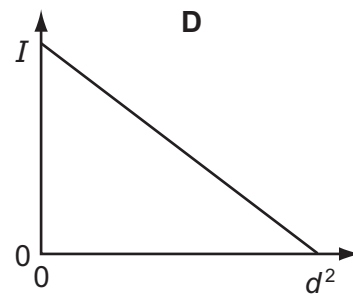
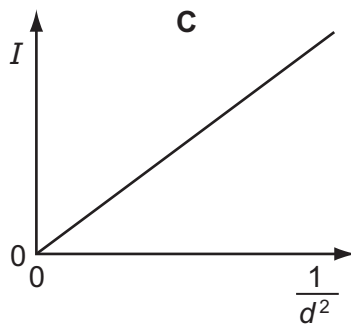
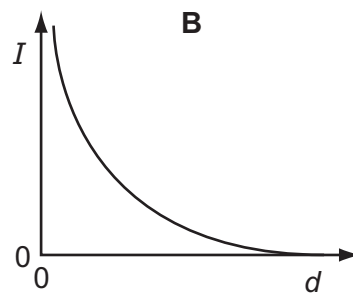
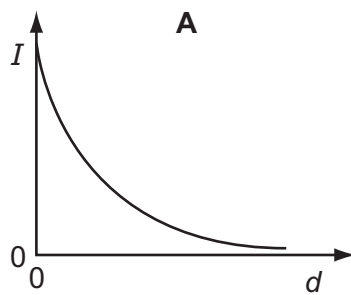
What is the width of one rod?

- A (2.10 ± 0.025) mm
- B (2.10 ± 0.05) mm
- C (2.1 ± 0.1) mm
- D (2.1 ± 0.2) mm

- 6 A light-meter measures the intensity I of the light incident on it. Theory suggests that I varies inversely as the square of the distance d .



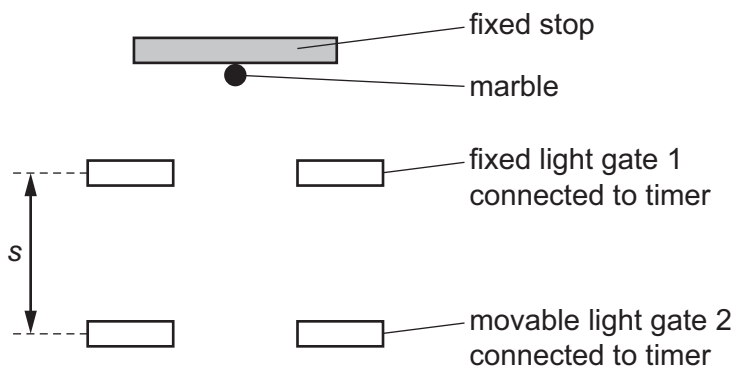
Which graph of the results supports this theory?



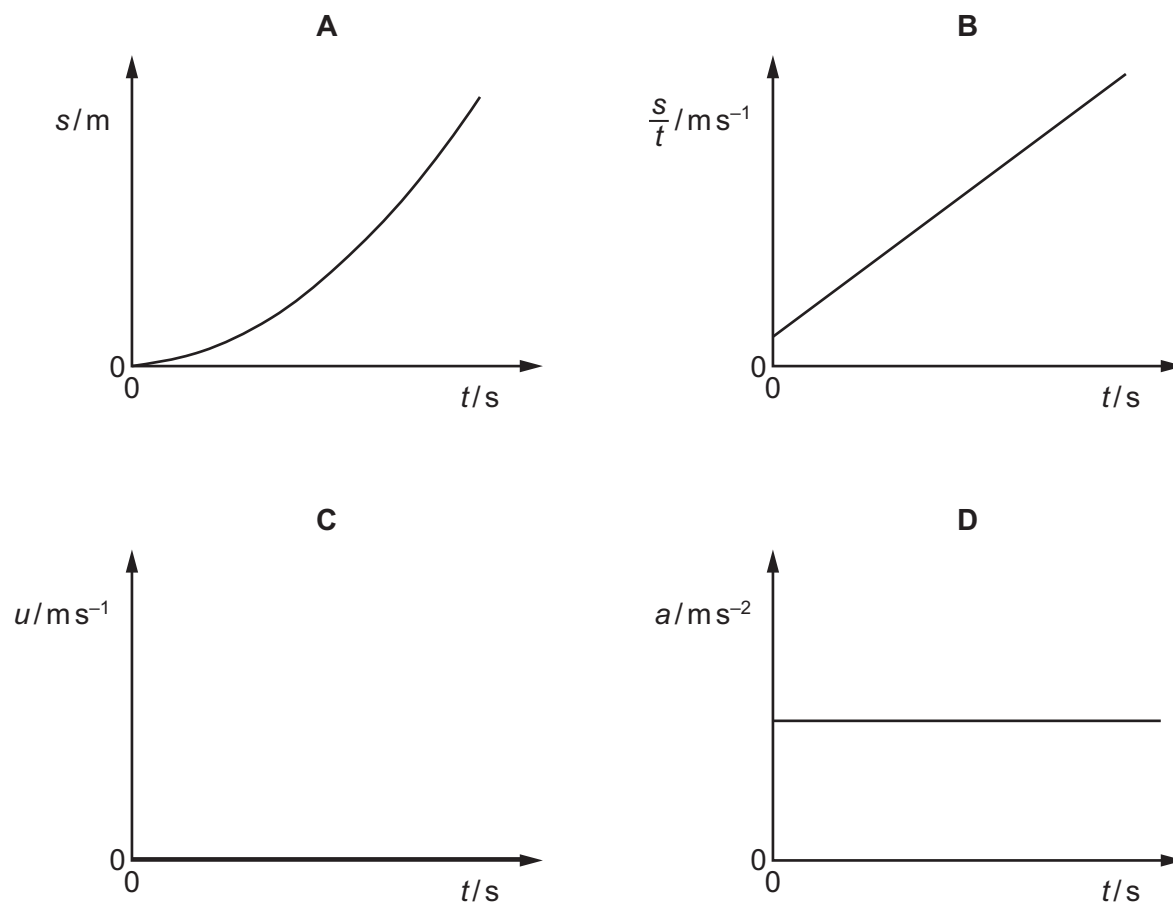
7 One of the equations of uniformly accelerated motion is shown.

$$s = ut + \frac{1}{2}at^2$$

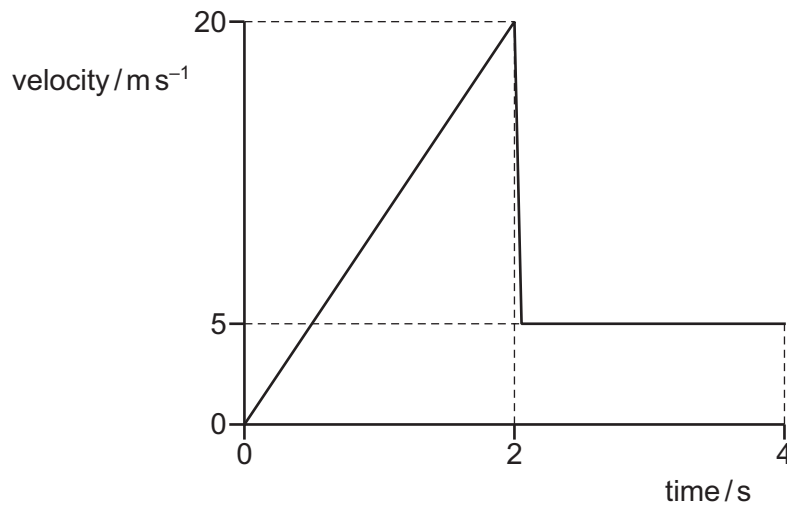
Apparatus is arranged to record the time t taken for a marble to fall between two light gates connected to timers. The marble touches the stop before it is released. The vertical distance s between the light gates is measured.



Which graph does **not** show a correct relationship when light gate 2 moves up to light gate 1 which is fixed?



- 8 A stone is dropped from a height of 20 m above water. The graph shows the variation with time of the velocity of the stone.



Which statement describes the approximate position of the stone four seconds after it is dropped?

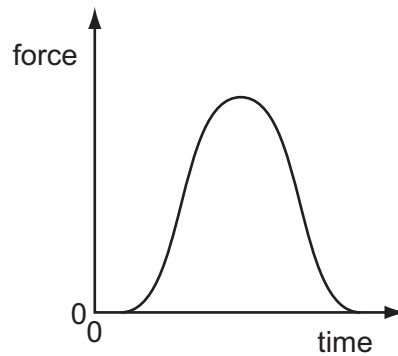
- A** It is at a distance of 10 m above the surface of the water.
 - B** It is at a distance of 10 m below the surface of the water.
 - C** It is at a distance of 20 m below the surface of the water.
 - D** It is at a distance of 30 m below the surface of the water.
- 9 The water surface in a deep well is 78.0 m below the top of the well. A person at the top of the well drops a heavy stone down the well.

Air resistance is negligible. The speed of sound in the air is 330 m s^{-1} .

What is the time interval between the person dropping the stone and hearing it hitting the water?

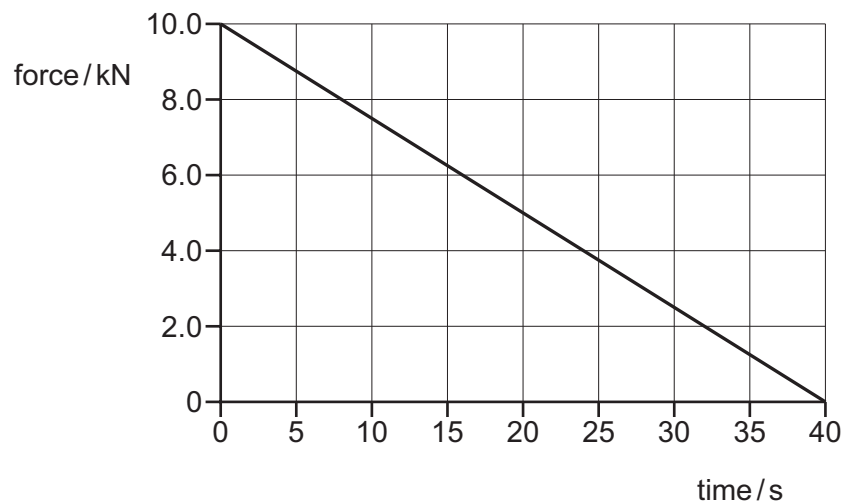
- A** 3.75 s **B** 3.99 s **C** 4.19 s **D** 4.22 s

- 10 A golf ball is hit by a club. The graph shows the variation with time of the force exerted on the ball by the club.



Which quantity, for the time of contact, **cannot** be found from the graph?

- A the average force on the ball
 - B the change in momentum of the ball
 - C the contact time between the ball and the club
 - D the maximum acceleration of the ball
- 11 A glider of mass 1500 kg is launched from rest on a straight and level track using a catapult. The graph shows the variation with time of the resultant force.



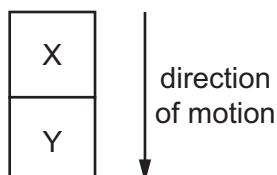
What is the speed of the glider when the resultant force acting on it reaches zero?

- A 133 ms^{-1}
 - B 200 ms^{-1}
 - C 250 ms^{-1}
 - D 267 ms^{-1}
- 12 Which statement about a ball that strikes a tennis racket and rebounds is **always** correct?
- A The total kinetic energy of the ball is conserved.
 - B The total kinetic energy of the system is conserved.
 - C The total momentum of the ball is conserved.
 - D The total momentum of the system is conserved.

13 In which example is it **not** possible for the underlined body to be in equilibrium?

- A an aeroplane climbs at a steady rate
- B an aeroplane tows a glider at a constant altitude
- C a speedboat changes direction at a constant speed
- D two tug boats tow a ship into harbour

14 Two blocks X and Y are falling through a vacuum in a uniform gravitational field, as shown.



Block X has weight $2w$.

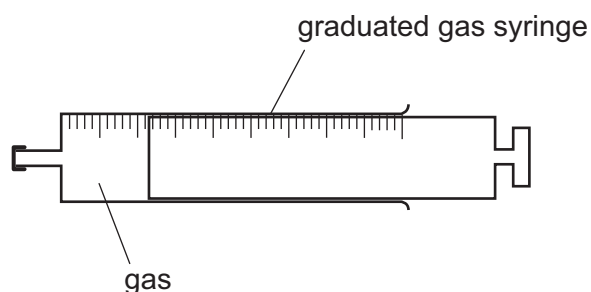
Block Y has weight w .

The blocks do not move apart.

Which value best represents the force exerted by block X on block Y?

- A 0
- B w
- C $1.5w$
- D $2w$

15 A gas is contained inside a sealed syringe, as shown.



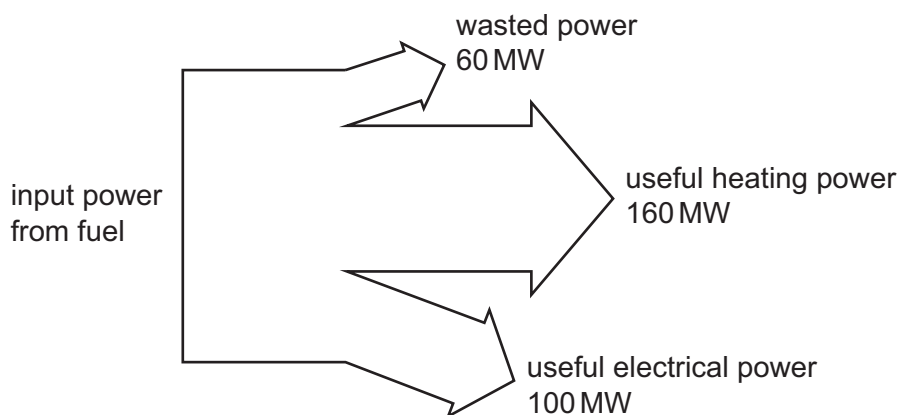
The volume of gas at room temperature is 2.0 cm^3 .

Atmospheric pressure is 101 kPa .

What is the work done by the gas when it is heated and expands to a volume of 6.0 cm^3 ?

- A $404 \mu\text{J}$
- B 404 mJ
- C 404 J
- D 404 kJ

- 16 A combined heat and power (CHP) station generates electrical power and useful heat. The diagram shows the input and output for a CHP station.



What is the efficiency of the CHP station for producing useful power?

- A** 31% **B** 38% **C** 50% **D** 81%
- 17 In 'normal driving conditions', an electric car has a range of 150 km. This uses all of the 200 MJ energy stored in its batteries.

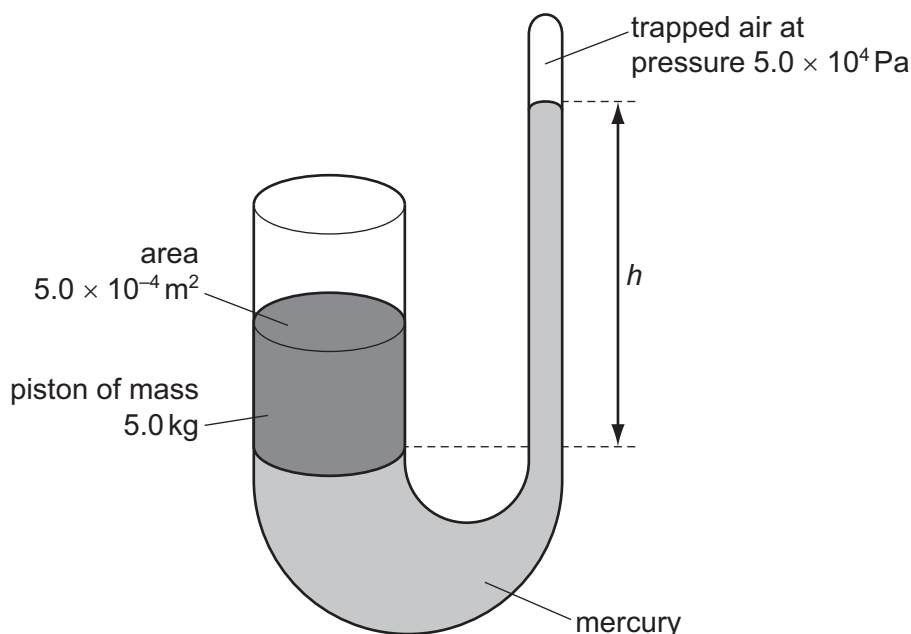
With the batteries initially fully charged, the car is driven 100 km in 'normal driving conditions'. The batteries are then recharged from a household electrical supply delivering a constant current of 13.0 A at a potential difference (p.d.) of 230 V.

What is the minimum time required to recharge the batteries?

- A** 0.95 hours
B 12.4 hours
C 18.6 hours
D 27.9 hours
- 18 A fixed amount of gas is reduced in volume at a constant temperature.
- What is the reason for the increase in pressure of the gas?
- A** The average distance travelled between collisions by the gas molecules is increased.
B The average intermolecular attractive force between the gas molecules is decreased.
C The average speed of the gas molecules is increased.
D The frequency of the collisions of the gas molecules with the walls of the container is increased.

- 19 A U-tube closed at one end contains mercury. Air at a pressure of $5.0 \times 10^4 \text{ Pa}$ is trapped at the closed end. The other end is open to the atmosphere and is fitted with a piston of mass 5.0 kg and cross-sectional area $5.0 \times 10^{-4} \text{ m}^2$.

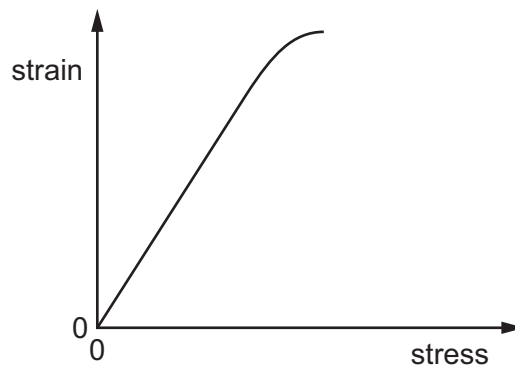
The density of mercury is $13\,600 \text{ kg m}^{-3}$ and atmospheric pressure is $1.01 \times 10^5 \text{ Pa}$.



What is the height h of the mercury column?

- A** 37 cm **B** 44 cm **C** 74 cm **D** 110 cm
- 20 A known tensile force acts on a wire. The wire does not exceed its elastic limit.
- Which two measurements enable the strain of the wire to be calculated?
- A** the unstretched length of the wire and the cross-sectional area of the wire
B the unstretched length of the wire and the extension of the wire
C the Young modulus of the wire's material and the extension of the wire
D the Young modulus of the wire's material and the unstretched length of the wire
- 21 The Young modulus of steel is determined using a length of steel wire and is found to have the value E .
- Another experiment is carried out using a wire of the same steel, but of half the length and half the diameter.
- Which value is obtained for the Young modulus in the second experiment?
- A** $\frac{1}{2}E$ **B** E **C** $2E$ **D** $4E$

- 22 The graph shows the variation with stress of the strain of a material as it is extended elastically.

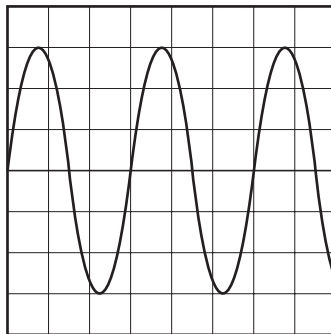


Why is the strain energy per unit volume of the material **not** the area under the graph?

- A The axes are the wrong way round.
 - B The graph is not a straight line.
 - C The graph is strain-stress instead of extension-force.
 - D The material is polymeric.
- 23 A wire has a final length of 6.0 m after undergoing a strain of 200%.

What is the original length of the wire?

- A 1.5 m
 - B 2.0 m
 - C 3.0 m
 - D 4.0 m
- 24 A sound wave is displayed on the screen of a cathode-ray oscilloscope, as shown.



The time-base setting is 0.50 ms per division.

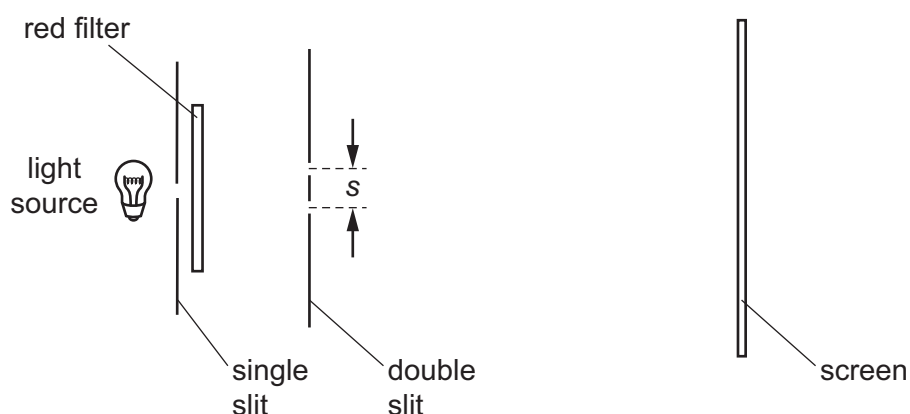
What is the frequency of the sound wave?

- A 250 Hz
- B 500 Hz
- C 670 Hz
- D 1300 Hz

- 25** Part of a car was damaged by heating when, on a sunny day, the car was left in front of a curved mirrored building which focussed reflected sunlight onto the car.

Which statement about sunlight correctly explains this observation?

- A** Sunlight contains infra-red radiation.
 - B** Sunlight contains ultraviolet radiation.
 - C** Sunlight is a longitudinal progressive wave which carries energy.
 - D** Sunlight is a transverse standing wave which carries energy.
- 26** A student sets up an experiment to investigate double-slit interference of light but finds that the interference fringes observed on the screen are too close to each other to be distinguished.



Which change would help the student to distinguish the fringes?

- A** decrease the distance s between the two slits
 - B** increase the width of each slit
 - C** move the screen closer to the light source
 - D** use a blue filter instead of a red filter
- 27** Ships have been damaged by water waves with large amplitudes. These waves could have been formed by adding the displacements of smaller waves.

Which term describes this phenomenon?

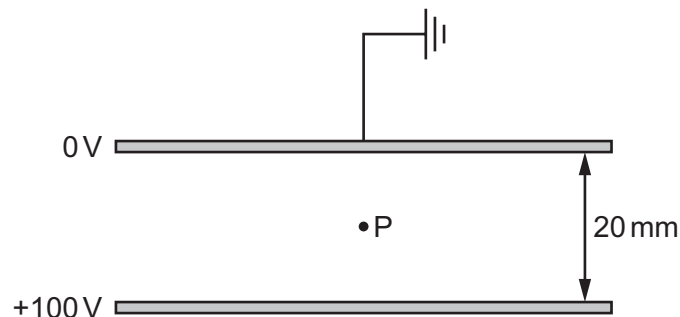
- A** diffraction
- B** polarisation
- C** refraction
- D** superposition

- 28 Water waves of wavelength λ are diffracted as they pass through a gap of width d in a barrier.

Which combination of wavelength and gap width would produce the greatest angle of diffraction?

	gap width	wavelength
A	$\frac{1}{2}d$	2λ
B	$\frac{1}{2}d$	$\frac{1}{2}\lambda$
C	$2d$	2λ
D	$2d$	$\frac{1}{2}\lambda$

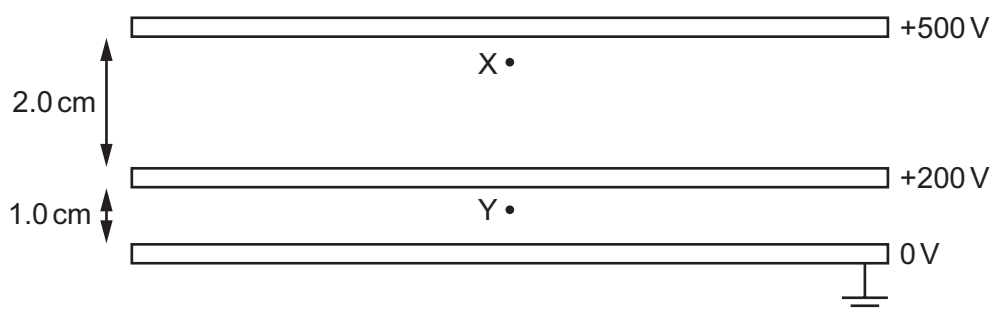
- 29 Two horizontal parallel plate conductors are separated by a distance of 20 mm in air. The upper plate is earthed and the potential of the lower plate is +100 V.



What is the electric field strength at point P midway between the plates?

- A** 5000 V m^{-1} downwards
- B** 5000 V m^{-1} upwards
- C** $10\,000 \text{ V m}^{-1}$ downwards
- D** $10\,000 \text{ V m}^{-1}$ upwards

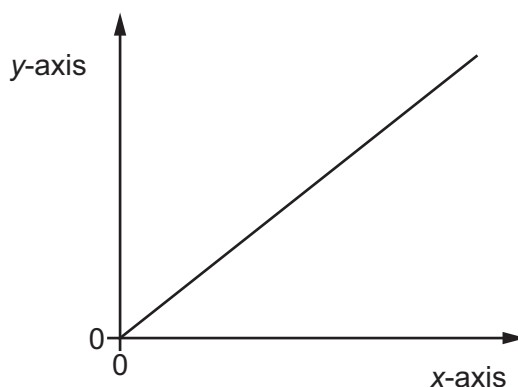
- 30 Three parallel metal plates of the same area are fixed with a separation of 2.0 cm between the top plate and the centre plate, and 1.0 cm between the centre plate and the bottom plate. The top plate is held at a potential of +500 V, the middle plate at +200 V and the bottom plate is earthed, as shown.



What is the value of the ratio $\frac{\text{magnitude of force on an electron at X}}{\text{magnitude of force on an electron at Y}}$?

- A 0.75 B 1.00 C 1.25 D 1.50

- 31 The diagram shows a graph.



For a uniform metallic wire, what could the graph **not** represent?

	y-axis	x-axis
A	current	potential difference
B	resistance	length
C	resistance	temperature in °C
D	potential difference	current

- 32 An iron wire has length 8.0 m and diameter 0.50 mm. The wire has resistance R .

A second iron wire has length 2.0 m and diameter 1.0 mm.

What is the resistance of the second wire?

- A $\frac{R}{16}$ B $\frac{R}{8}$ C $\frac{R}{2}$ D R

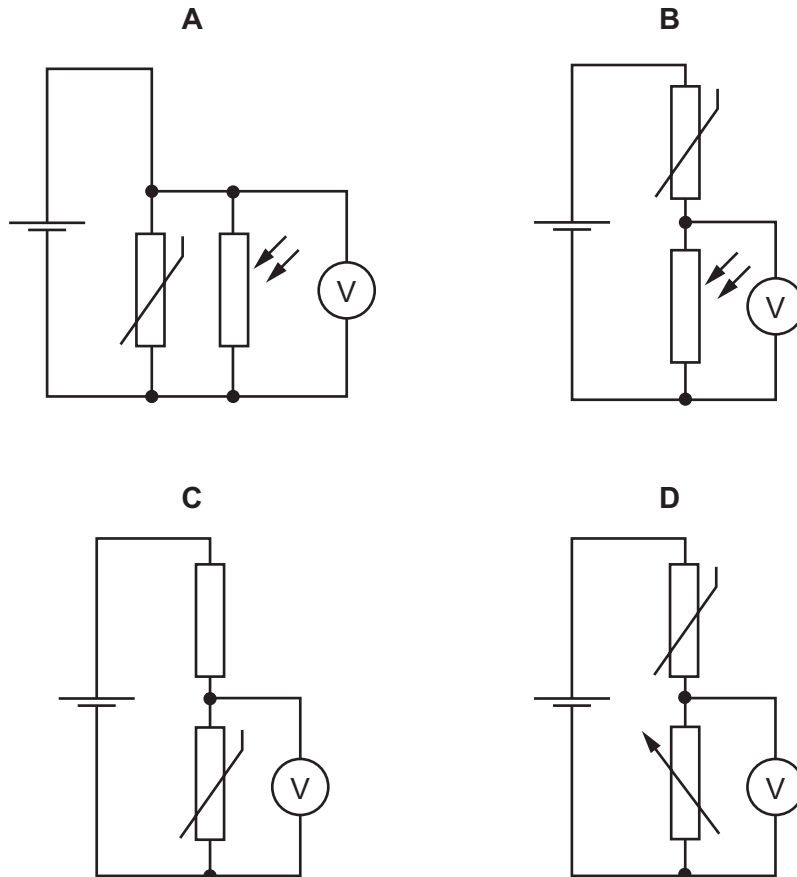
- 33** The Atlantic torpedo is a large electric fish capable of generating a voltage of 220V between its tail and its head. This drives a pulse of current of 15A lasting for a time of 2.0ms. The fish produces 200 pulses per second.

What is the average power output of the fish?

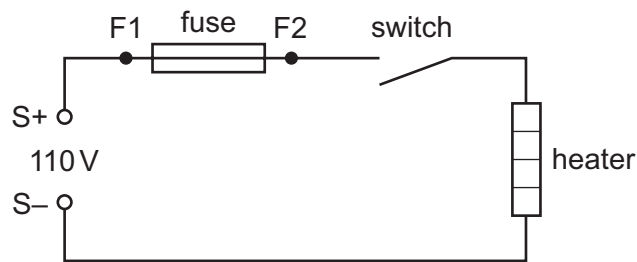
- A** 33W **B** 1.3kW **C** 3.3kW **D** 6.6kW

- 34** A thermistor and another component are connected to a constant voltage supply. A voltmeter is connected across one of the components. The temperature of the thermistor is then reduced but no other changes are made.

In which circuit will the voltmeter reading increase?



- 35 A 110 V d.c. supply is connected to a heater, a fuse and a switch, as shown.

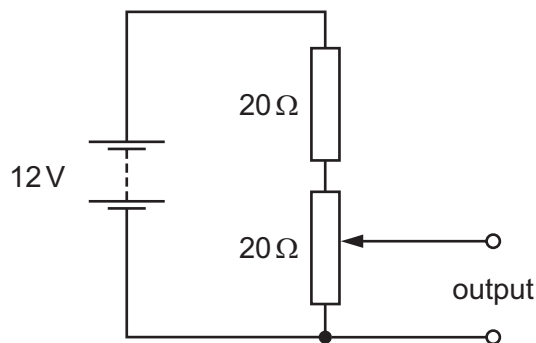


Owing to a fault in the system, power is not supplied to the heater. A technician diagnoses the fault using a voltmeter.

He closes the switch and connects his meter between the positive supply terminal S+ and the fuse terminal F2. The voltmeter reads 110 V.

Which diagnosis is correct?

- A The fuse has melted.
 - B The fuse has not melted and there is a short circuit in the heater.
 - C The fuse has not melted and there is no path for current through the heater.
 - D The fuse has not melted and the switch has operated correctly.
- 36 The diagram shows a potentiometer and a fixed resistor connected across a 12 V battery of negligible internal resistance.



The fixed resistor and the potentiometer each have resistance $20\ \Omega$. The circuit is designed to provide a variable output voltage.

What is the range of output voltages?

- A 0–6 V
- B 0–12 V
- C 6–12 V
- D 12–20 V

37 Radioactive decay is random.

What is meant by the term *random*?

- A The decay of a nucleus can be predicted.
- B The decay of a nucleus is unaffected by pressure.
- C The decay of a nucleus is unaffected by temperature.
- D The nucleus has a constant probability of decay per unit time.

38 The nuclei of the isotopes of an element all contain the same number of a certain particle.

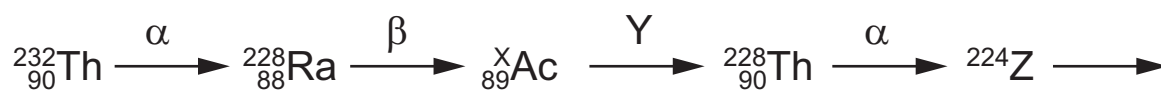
What is this particle?

- A electron
- B neutron
- C nucleon
- D proton

39 Which statement about nuclei is correct?

- A Different isotopic nuclei have different proton numbers.
- B For some nuclei, the nucleon number can be less than the proton number.
- C In some nuclear processes, mass-energy is not conserved.
- D Nucleon numbers of nuclei are unchanged by the emission of β -particles.

40 The diagram shows part of a radioactive decay chain in which the nuclide thorium-232 decays by α -emission into radium-228. This nuclide is also unstable and decays by β -emission into a nuclide of actinium. This process continues.



What are X, Y and Z?

	X	Y	Z
A	228	α	Th
B	228	β	Ra
C	232	α	Th
D	232	β	Ra

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

PHYSICS

9702/12

Paper 1 Multiple Choice

October/November 2015

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

DO NOT WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any working should be done in this booklet.

Electronic calculators may be used.

This document consists of **19** printed pages and **1** blank page.



Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

work done on/by a gas,

$$W = p\Delta V$$

gravitational potential,

$$\phi = -\frac{Gm}{r}$$

hydrostatic pressure,

$$p = \rho gh$$

pressure of an ideal gas,

$$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$$

simple harmonic motion,

$$a = -\omega^2 x$$

velocity of particle in s.h.m.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{(x_0^2 - x^2)}$$

electric potential,

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

capacitors in series,

$$1/C = 1/C_1 + 1/C_2 + \dots$$

capacitors in parallel,

$$C = C_1 + C_2 + \dots$$

energy of charged capacitor,

$$W = \frac{1}{2}QV$$

resistors in series,

$$R = R_1 + R_2 + \dots$$

resistors in parallel,

$$1/R = 1/R_1 + 1/R_2 + \dots$$

alternating current/voltage,

$$x = x_0 \sin \omega t$$

radioactive decay,

$$x = x_0 \exp(-\lambda t)$$

decay constant,

$$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$$

1 Which list shows increasing lengths from beginning to end?

A 1 cm 1 nm 1 mm 1 μm

B 1 μm 1 mm 1 nm 1 cm

C 1 nm 1 μm 1 mm 1 cm

D 1 mm 1 cm 1 μm 1 nm

2 Which equation contains only scalar quantities?

A acceleration = $\frac{\text{force}}{\text{mass}}$

B power = $\frac{\text{work}}{\text{time}}$

C pressure = $\frac{\text{force}}{\text{area}}$

D velocity = $\frac{\text{displacement}}{\text{time}}$

3 The time T taken for a satellite to orbit the Earth on a circular path is given by the equation

$$T^2 = \frac{kr^3}{M}$$

where r is the radius of the orbit, M is the mass of the Earth and k is a constant.

What are the SI base units of k ?

A $\text{kg}^{-1} \text{m}^{-3} \text{s}^2$

B $\text{kg}^{-1} \text{m}^3 \text{s}^2$

C $\text{kg} \text{m}^{-3} \text{s}^2$

D $\text{kg} \text{m}^3 \text{s}^2$

4 Which row gives reasonable estimates for the mass and the speed of an adult running?

	mass/kg	speed/ m s^{-1}
A	6×10^0	5×10^1
B	6×10^1	5×10^0
C	6×10^1	5×10^1
D	6×10^2	5×10^0

- 5 A student measures the time T for one complete oscillation of a pendulum of length l .

Her results are shown in the table.

l/m	T/s
0.420 ± 0.001	1.3 ± 0.1

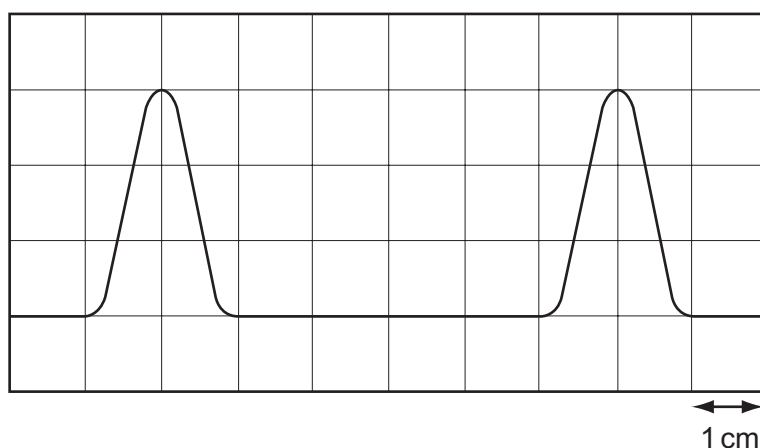
She uses the formula

$$T = 2\pi \sqrt{\frac{l}{g}}$$

to calculate the acceleration of free fall g .

What is the best estimate of the percentage uncertainty in the value of g ?

- A** 0.02% **B** 4% **C** 8% **D** 16%
- 6 The diagram shows two complete pulses on the screen of a cathode-ray oscilloscope. A grid of 1 cm squares covers the screen. The time-base setting is $1 \mu\text{s cm}^{-1}$.



How long does each pulse last?

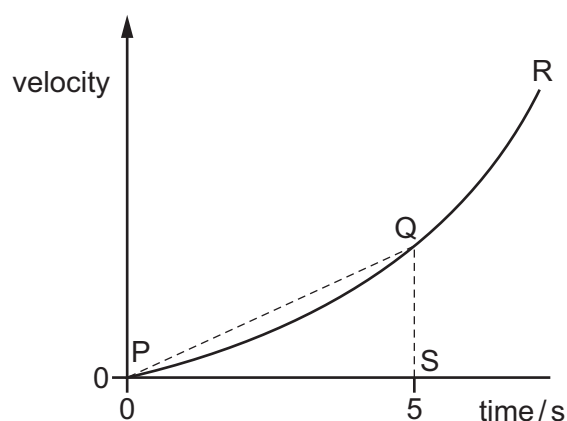
- A** $2 \mu\text{s}$ **B** $3 \mu\text{s}$ **C** $4 \mu\text{s}$ **D** $6 \mu\text{s}$

- 7 A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and then falls back to his hands.

Which row gives the acceleration of the ball at various stages in its motion? (Take vertically upwards as positive. Ignore air resistance.)

	rising	at maximum height	falling
A	-9.81 m s^{-2}	0	$+9.81 \text{ m s}^{-2}$
B	-9.81 m s^{-2}	-9.81 m s^{-2}	-9.81 m s^{-2}
C	$+9.81 \text{ m s}^{-2}$	$+9.81 \text{ m s}^{-2}$	$+9.81 \text{ m s}^{-2}$
D	$+9.81 \text{ m s}^{-2}$	0	-9.81 m s^{-2}

- 8 The curved line PQR is the velocity-time graph for a car starting from rest.

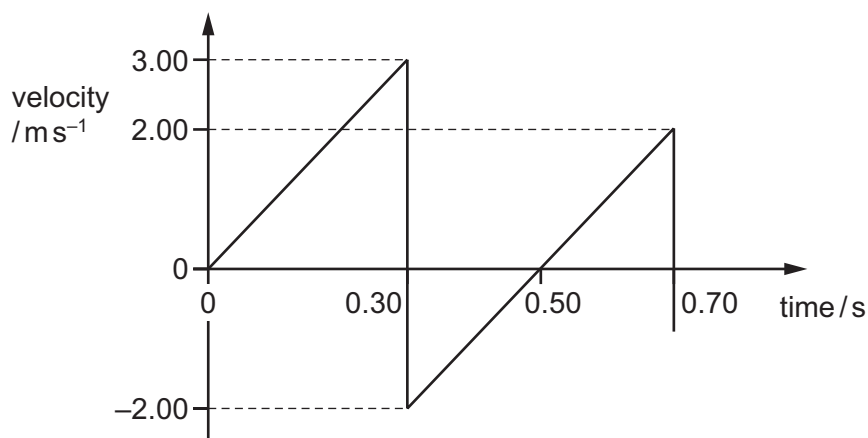


What is the average acceleration of the car over the first 5 s?

- A** the area below the curve PQ
- B** the area of the triangle PQS
- C** the gradient of the straight line PQ
- D** the gradient of the tangent at Q

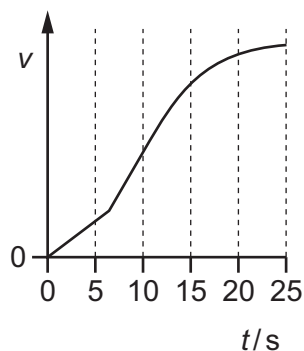
- 9 A ball is released from rest above a horizontal surface. It strikes the surface and bounces several times.

The velocity-time graph for the first two bounces is shown.

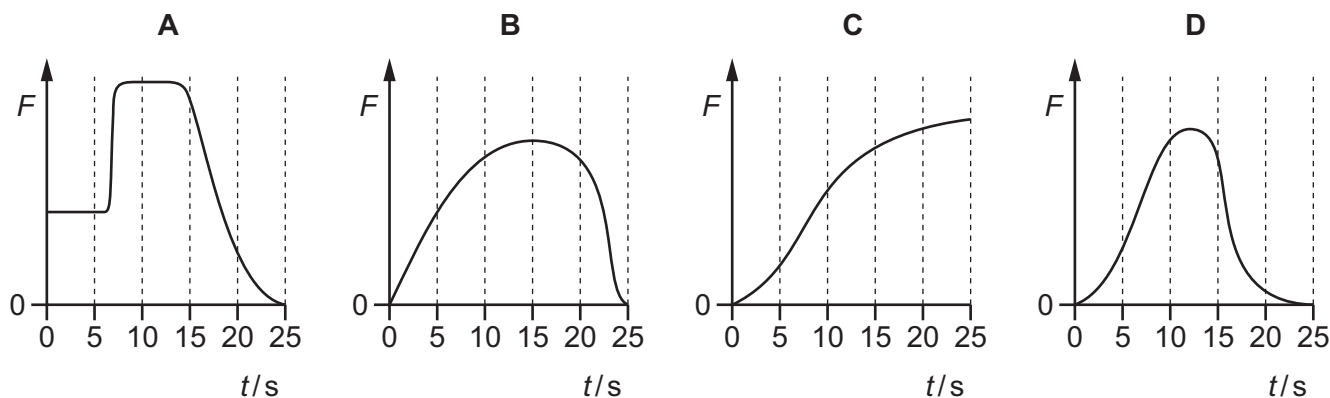


What is the maximum height of the ball after the first bounce?

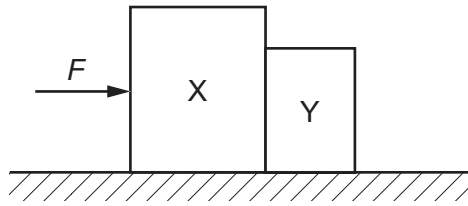
- A** 0.20 m **B** 0.25 m **C** 0.45 m **D** 0.65 m
- 10 A bus takes a time of 25 s to reach a constant speed while travelling in a straight line. A graph of speed v against time t is shown.



Which graph shows the variation with t of the resultant force F on the bus?



- 11 A single horizontal force F is applied to a block X which is in contact with a separate block Y as shown.

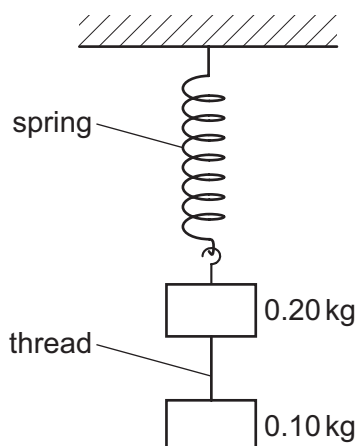


The blocks remain in contact as they accelerate along a horizontal frictionless surface. Air resistance is negligible. X has a greater mass than Y.

Which statement is correct?

- A The acceleration of X is equal to force F divided by the mass of X.
- B The force that X exerts on Y is equal to F .
- C The force that X exerts on Y is less than F .
- D The force that X exerts on Y is less than the force that Y exerts on X.

- 12 A mass of 0.20 kg is suspended from the lower end of a light spring. A second mass of 0.10 kg is suspended from the first mass by a thread. The arrangement is allowed to come into static equilibrium and then the thread is burned through.



At this instant, what is the upward acceleration of the 0.20 kg mass? (Assume $g = 10 \text{ m s}^{-2}$.)

- A 5.0 m s^{-2} B 6.7 m s^{-2} C 10 m s^{-2} D 15 m s^{-2}
- 13 An object of mass m travelling with speed v has a head-on collision with another object of mass m travelling with speed v in the opposite direction. The two objects stick together after the collision.

What is the total loss of kinetic energy in the collision?

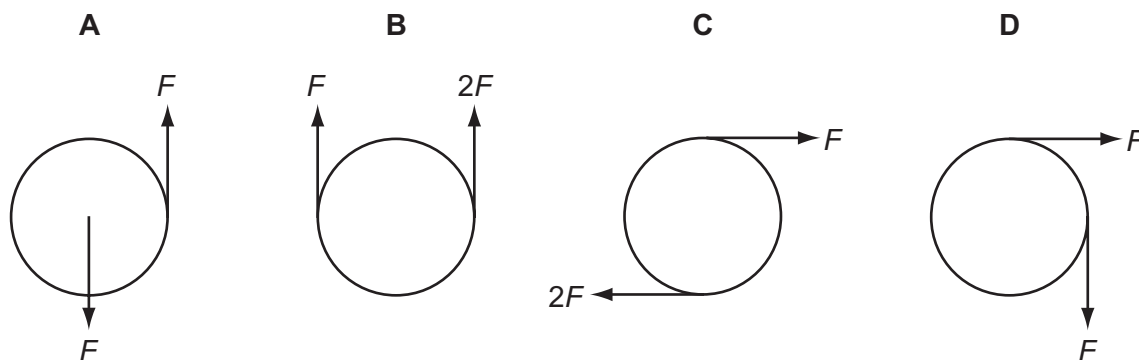
- A 0 B $\frac{1}{2}mv^2$ C mv^2 D $2mv^2$
- 14 Two identical spheres X and Y approach each other with the speeds shown and undergo a head-on elastic collision.



What are the velocities of the spheres after the collision?

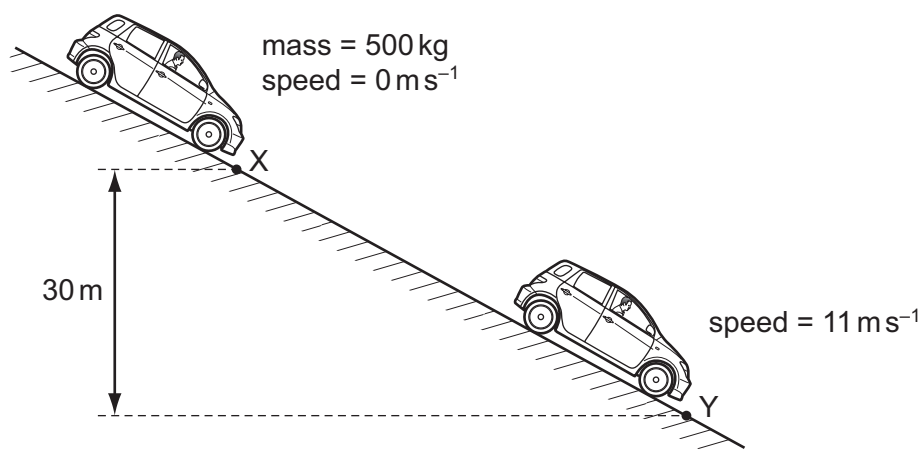
	sphere X	sphere Y
A	0 m s^{-1}	2 m s^{-1} →
B	2 m s^{-1} →	4 m s^{-1} →
C	2 m s^{-1} ←	4 m s^{-1} →
D	4 m s^{-1} ←	2 m s^{-1} →

15 Which pair of forces acts only as a couple on the circular object?



16 A car of mass 500 kg is at rest at point X on a slope, as shown.

The car's brakes are released and the car rolls down the slope with its engine switched off. At point Y the car has moved through a vertical height of 30 m and has a speed of 11 m s^{-1} .



What is the energy dissipated by frictional forces when the car moves from X to Y?

- A $3.0 \times 10^4 \text{ J}$ B $1.2 \times 10^5 \text{ J}$ C $1.5 \times 10^5 \text{ J}$ D $1.8 \times 10^5 \text{ J}$

17 In which situation is **no** work done?

- A The air in a bicycle tyre is released because of a puncture.
 B A ball is dropped and falls to the ground.
 C A box moves at constant speed across a smooth horizontal surface.
 D A crane lifts a steel girder at constant speed.

- 18 An electric railway locomotive has a maximum mechanical output power of 4.0 MW. Electrical power is delivered at 25 kV from overhead wires. The overall efficiency of the locomotive in converting electrical power to mechanical power is 80 %.

What is the current from the overhead wires when the locomotive is operating at its maximum power?

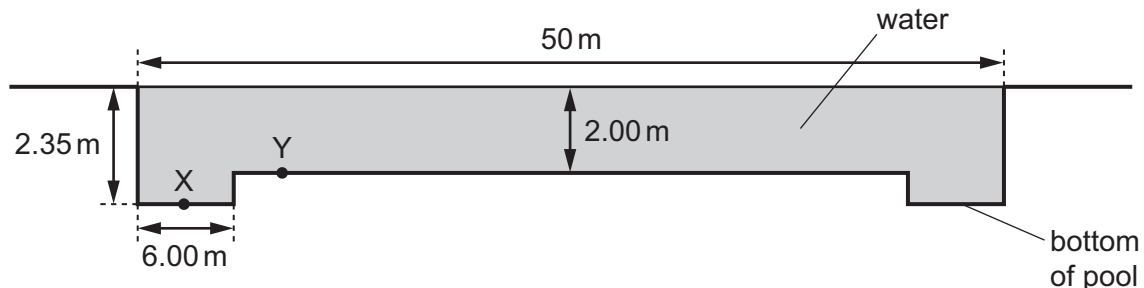
- A 130 A B 160 A C 200 A D 250 A

- 19 The table summarises some descriptions of evaporation.

Which row of the table is correct?

	involves a change in state from liquid to vapour	occurs at a fixed temperature	involves a reduction in the average kinetic energy of the remaining atoms
A	true	true	true
B	true	false	true
C	true	false	false
D	false	true	false

- 20 The diagram shows the cross-section of an Olympic-size swimming pool filled with water. It is not drawn to scale. The density of the water is 1000 kg m^{-3} .



What is the difference in pressure between X and Y?

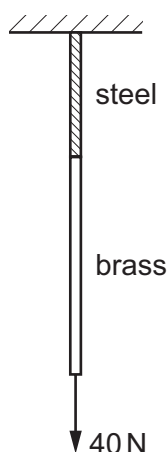
- A 0.35 kPa B 3.4 kPa C 21.3 kPa D 58.9 kPa

- 21 A force acts on a wire to produce extension e . The same force then acts on a second wire of the same material, but of half the diameter and three times the length of the first wire. Both wires obey Hooke's law.

What is the extension of the second wire?

- A $3e$ B $4e$ C $6e$ D $12e$

- 22 Which statement about elastic and plastic deformation is correct?
- A Elastic deformation and plastic deformation are proportional to the applied force.
 - B Elastic deformation and plastic deformation cause no change in volume.
 - C Elastic deformation causes heating of the material but plastic deformation does not.
 - D Elastic deformation is reversible but plastic deformation is not.
- 23 What is meant by the *ultimate tensile stress* of a ductile metal?
- A It is the maximum stress at which the material deforms elastically.
 - B It is the maximum stress at which the material obeys Hooke's law.
 - C It is the maximum stress that the material can support without breaking.
 - D It is the Young modulus multiplied by the maximum possible strain of a material.
- 24 A 0.80 m length of steel wire and a 1.4 m length of brass wire are joined together. The combined wires are suspended from a fixed support and a force of 40 N is applied, as shown.



The Young modulus of steel is 2.0×10^{11} Pa.

The Young modulus of brass is 1.0×10^{11} Pa.

Each wire has a cross-sectional area of $2.4 \times 10^{-6} \text{ m}^2$.

The wires extend without reaching their elastic limits.

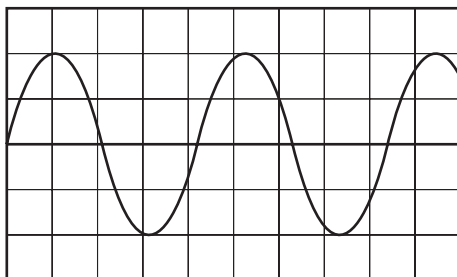
What is the total extension? Ignore the weights of the wires.

- A $1.7 \times 10^{-4} \text{ m}$ B $3.0 \times 10^{-4} \text{ m}$ C $3.9 \times 10^{-4} \text{ m}$ D $9.0 \times 10^{-4} \text{ m}$

25 Which of the following wave motions may be used to demonstrate the phenomenon of polarisation?

- A a sound wave from a thunderclap
- B a surface wave in a water ripple tank
- C a stationary wave in an organ pipe
- D a stationary wave on a stretched wire

26 The diagram shows the screen of a cathode-ray oscilloscope (c.r.o.) displaying a wave.



The time-base of the c.r.o. is set at 10 ms/div.

What is the frequency of the wave?

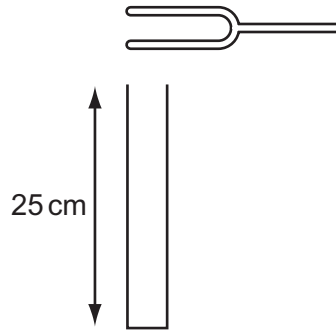
- A 0.24 Hz
- B 4.2 Hz
- C 12 Hz
- D 24 Hz

27 P is a source emitting infra-red radiation and Q is a source emitting ultra-violet radiation. The figures in the table are suggested values for the wavelengths emitted by P and Q.

Which row is correct?

	wavelength emitted by P / m	wavelength emitted by Q / m
A	5×10^{-5}	5×10^{-8}
B	5×10^{-5}	5×10^{-10}
C	5×10^{-7}	5×10^{-8}
D	5×10^{-7}	5×10^{-10}

- 28 The diagram shows a tuning fork above a tube of air of length 25 cm.



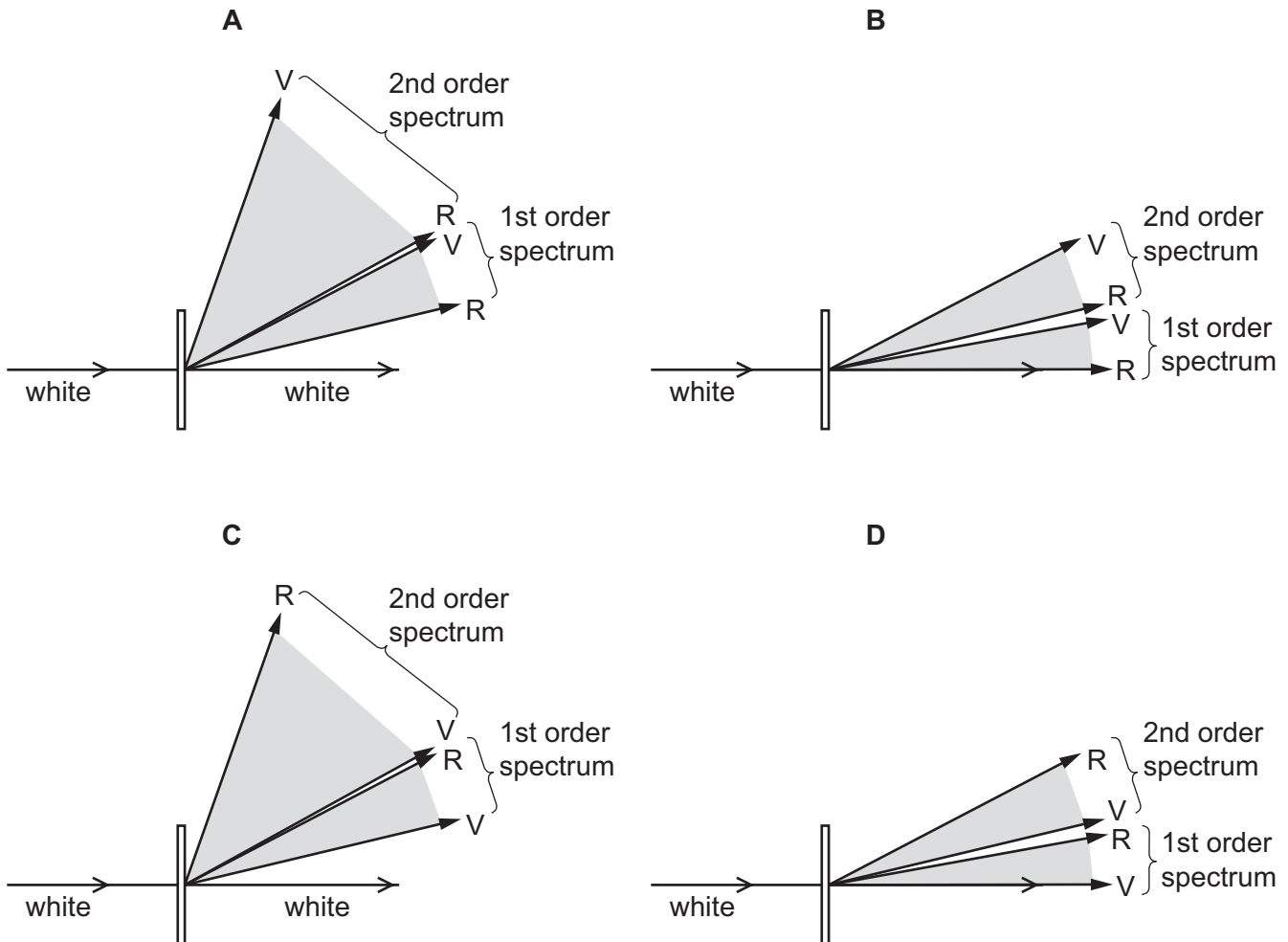
A stationary wave is set up in the tube with the same frequency as the tuning fork. The lower end of the tube is sealed. This is the minimum length of tube with the lower end sealed that creates a stationary wave.

Which other lengths of tubes, sealed at their lower end, will also create a stationary wave?

- A 37.5 cm and 50 cm
- B 50 cm and 75 cm
- C 75 cm and 100 cm
- D 75 cm and 125 cm

- 29 White light consists of many wavelengths. The wavelength of red light R is approximately twice the wavelength of violet light V. When white light is incident normally on a diffraction grating, several spectra can be formed.

Which diagram shows the possible distributions of light in the first order and the second order spectra?



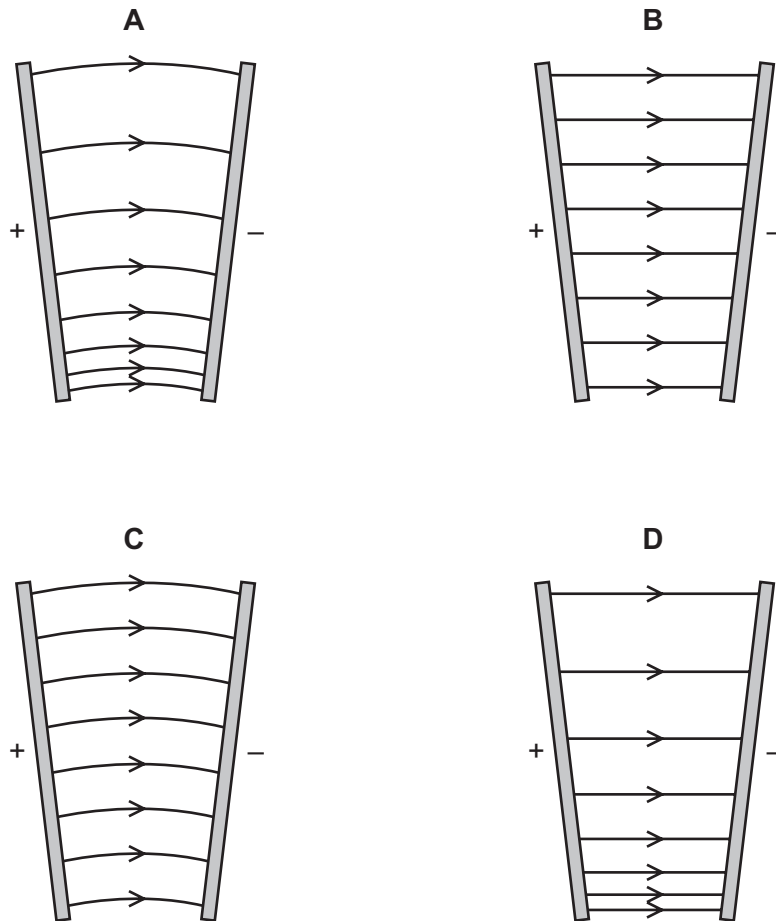
- 30 To produce a stationary wave, two waves must travel in opposite directions through the same space.

Which statement about the properties of the two waves must also be true?

- A The waves must have equal frequency, but a different speed and wavelength.
- B The waves must have equal speed, but a different wavelength and frequency.
- C The waves must have equal speed, frequency and wavelength.
- D The waves must have equal wavelength, but a different speed and frequency.

- 31 A potential difference is applied between two metal plates that are **not** parallel.

Which diagram shows the electric field between the plates?



- 32 A particle situated between two parallel metal plates carries a charge of $8 \times 10^{-19} \text{ C}$.

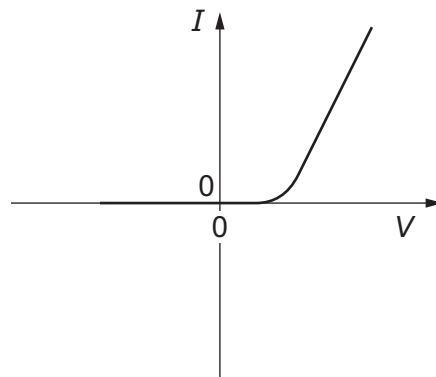
The potential difference (p.d.) between the plates is 2000 V. A force of $3.2 \times 10^{-13} \text{ N}$ due to the electric field acts on the particle.

What is the distance between the plates?

- A 5 mm B 8 mm C 5 cm D 8 cm
- 33 Which unit is equivalent to a coulomb (C)?

- A As B $\Omega \text{ s}$ C Vs D Ws

34 The graph shows the I - V characteristic of an electrical component.

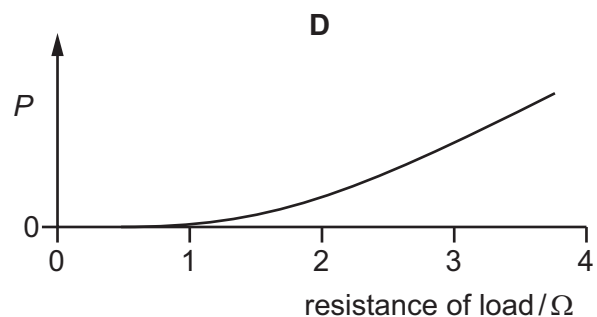
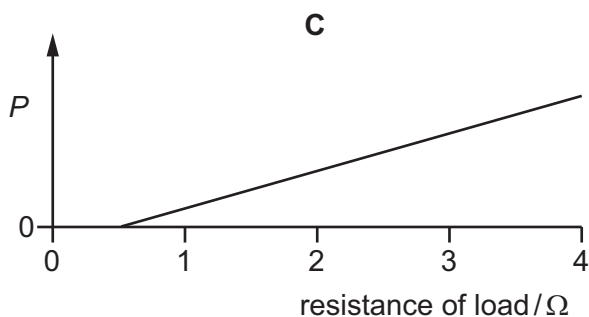
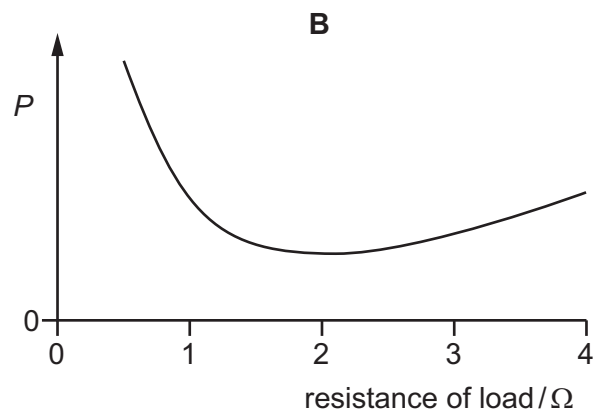
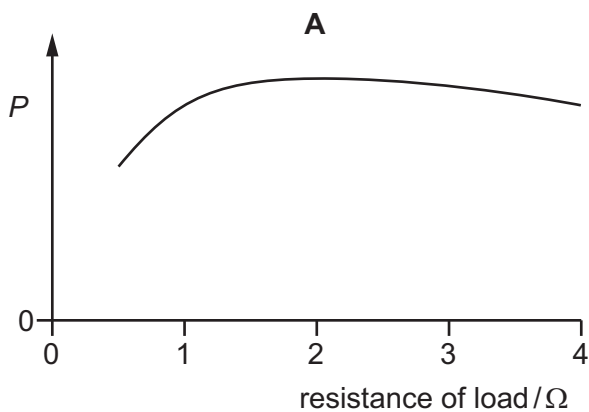


What is the component?

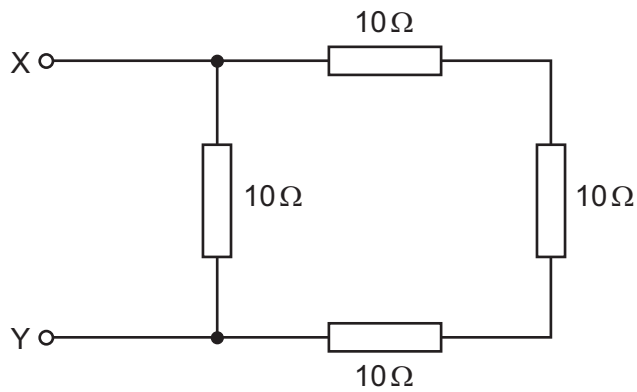
- A a filament lamp
- B a metallic conductor at constant temperature
- C a semiconductor diode
- D a thermistor

35 A power supply of electromotive force (e.m.f.) 12 V and internal resistance $2\ \Omega$ is connected in series with a load resistor. The resistance of the load resistor is varied from $0.5\ \Omega$ to $4\ \Omega$.

Which graph shows how the power P dissipated in the load resistor varies with the resistance of the load resistor?



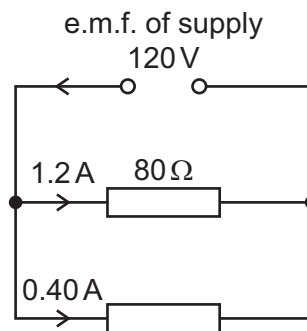
36 The diagram shows an arrangement of resistors.



What is the total electrical resistance between X and Y?

- A** less than $1\ \Omega$
- B** between $1\ \Omega$ and $10\ \Omega$
- C** between $10\ \Omega$ and $30\ \Omega$
- D** $40\ \Omega$

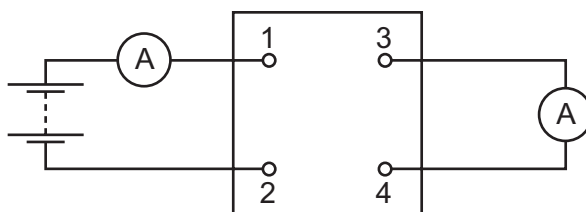
37 The electromotive force of a power supply is 120 V . It delivers a current of 1.2 A to a resistor of resistance $80\ \Omega$ and a current of 0.40 A to another resistor, as shown.



What is the internal resistance of the power supply?

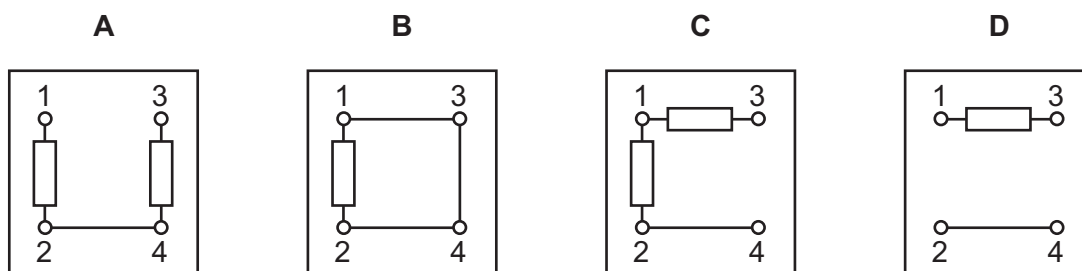
- A** $15\ \Omega$
- B** $20\ \Omega$
- C** $60\ \Omega$
- D** $75\ \Omega$

- 38 The diagram shows a four-terminal box connected to a battery and two ammeters.



The currents in the two meters are identical.

Which circuit, within the box, will give this result?



- 39 A material contains a radioactive isotope that disintegrates solely by the emission of α -particles at a rate of 100 s^{-1} .

Which statement about this material is correct?

- A** The number of atoms in the material diminishes at a rate of 100 s^{-1} .
B The number of neutrons in the material diminishes at a rate of 100 s^{-1} .
C The number of nucleons in the material diminishes at a rate of 400 s^{-1} .
D The number of protons in the material diminishes at a rate of 100 s^{-1} .
- 40 A radioactive nucleus emits an α -particle or a β -particle, creating a product nucleus.

Which decay process could create the product nucleus stated?

	radioactive nucleus	decay	product nucleus
A	$^{226}_{88}\text{Ra}$	α	$^{224}_{86}\text{Rn}$
B	$^{238}_{92}\text{U}$	α	$^{242}_{94}\text{Pu}$
C	$^{228}_{88}\text{Ra}$	β	$^{228}_{87}\text{Fr}$
D	$^{231}_{90}\text{Th}$	β	$^{231}_{91}\text{Pa}$

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

PHYSICS

9702/13

Paper 1 Multiple Choice

October/November 2015

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)



READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

DO NOT WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any working should be done in this booklet.

Electronic calculators may be used.

This document consists of **21** printed pages and **3** blank pages.



Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

work done on/by a gas,

$$W = p\Delta V$$

gravitational potential,

$$\phi = -\frac{Gm}{r}$$

hydrostatic pressure,

$$p = \rho gh$$

pressure of an ideal gas,

$$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$$

simple harmonic motion,

$$a = -\omega^2 x$$

velocity of particle in s.h.m.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{(x_0^2 - x^2)}$$

electric potential,

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

capacitors in series,

$$1/C = 1/C_1 + 1/C_2 + \dots$$

capacitors in parallel,

$$C = C_1 + C_2 + \dots$$

energy of charged capacitor,

$$W = \frac{1}{2}QV$$

resistors in series,

$$R = R_1 + R_2 + \dots$$

resistors in parallel,

$$1/R = 1/R_1 + 1/R_2 + \dots$$

alternating current/voltage,

$$x = x_0 \sin \omega t$$

radioactive decay,

$$x = x_0 \exp(-\lambda t)$$

decay constant,

$$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$$

1 What is the unit of the Young modulus when expressed in SI base units?

- A $\text{kg m}^{-1} \text{s}^{-2}$
- B $\text{kg m}^3 \text{s}^{-2}$
- C kg m^{-2}
- D $\text{kg m}^{-1} \text{s}^{-1}$

2 The Reynolds number R is a constant used in the study of liquids flowing through pipes. R is a pure number with no unit.

$$R = \frac{\rho v D}{\mu}$$

where ρ is the density of the liquid, v is the speed of the liquid and D is the diameter of the pipe through which the liquid flows.

What are the SI base units of μ ?

- A kg m s
- B $\text{kg m}^{-1} \text{s}$
- C kg m s^{-1}
- D $\text{kg m}^{-1} \text{s}^{-1}$

3 When a force F moves its point of application through a displacement s in the direction of the force, the work W done by the force is given by

$$W = Fs.$$

How many vector quantities and scalar quantities does this equation contain?

- A one scalar quantity and two vector quantities
- B one vector quantity and two scalar quantities
- C three scalar quantities
- D three vector quantities

4 Measurements are subject to systematic error and random error.

Which measurements have high accuracy and low precision?

- A high random error and high systematic error
- B high random error and low systematic error
- C low random error and high systematic error
- D low random error and low systematic error

- 5 The density of the material of a coil of thin wire is to be found.

Which set of instruments could be used to do this most accurately?

- A** metre rule, protractor, spring balance
B micrometer, metre rule, top-pan balance
C stopwatch, newton-meter, vernier calipers
D tape measure, vernier calipers, lever balance
- 6 A cylindrical tube rolling down a slope of inclination θ moves a distance L in time T . The equation relating these quantities is

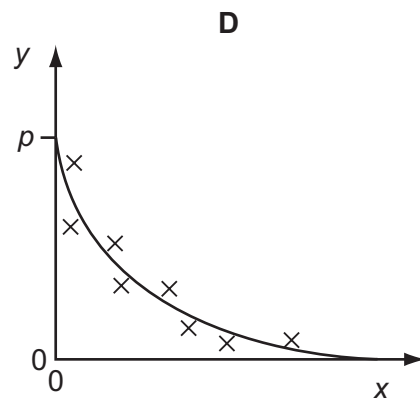
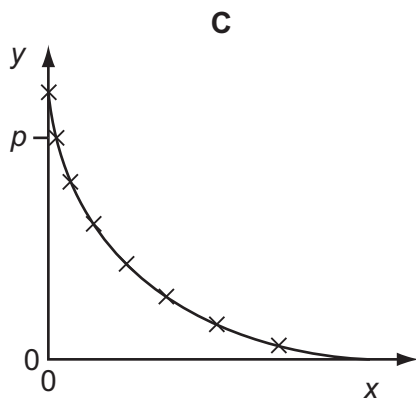
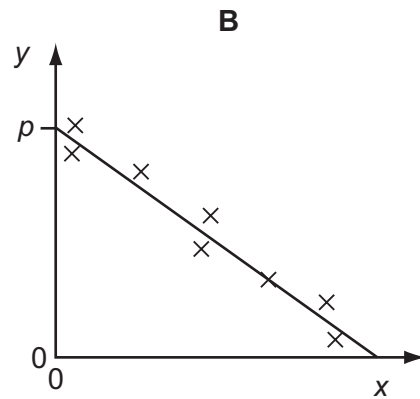
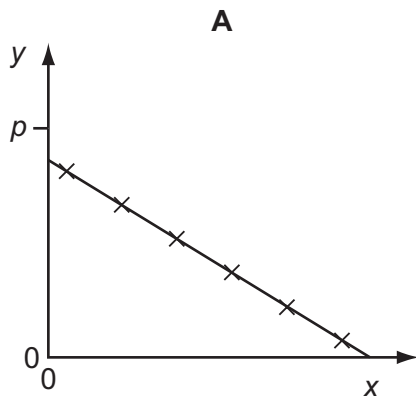
$$L \left(3 + \frac{a^2}{P} \right) = QT^2 \sin \theta$$

where a is the internal radius of the tube and P and Q are constants.

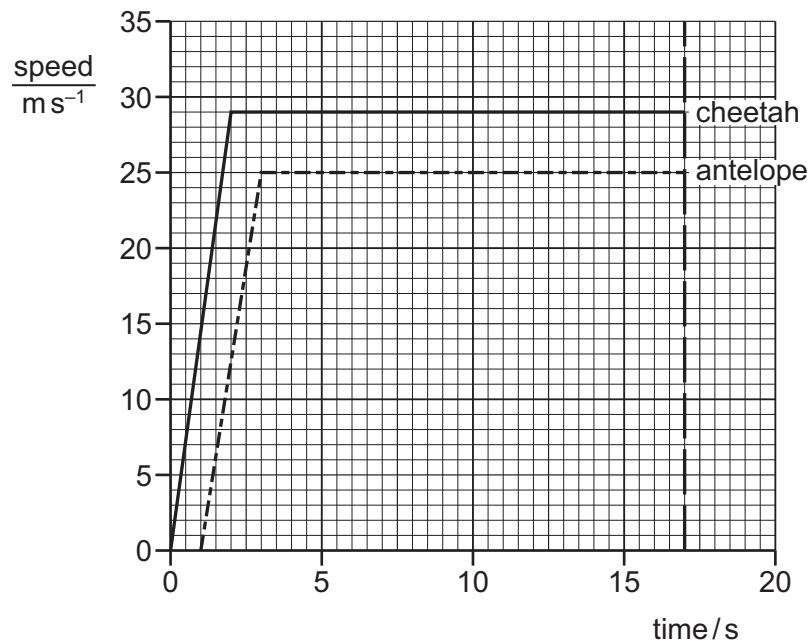
Which row gives the correct units for P and for Q ?

	P	Q
A	m^2	$\text{m}^2 \text{s}^{-2}$
B	m^2	m s^{-2}
C	m^2	$\text{m}^3 \text{s}^{-2}$
D	m^3	m s^{-2}

- 7 Variables x and y are related by the equation $y = p - qx$ where p and q are constants. Values of x and y are measured experimentally. The results contain a systematic error. Which graph best represents these results?

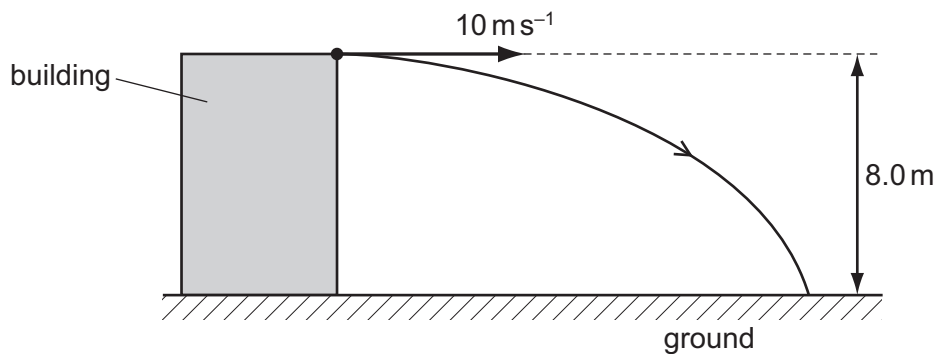


- 8 A cheetah and an antelope are 100 m apart. The cheetah spots the antelope and runs towards it. The antelope reacts to the cheetah after one second and runs directly away from the cheetah. Both animals take 2 seconds to reach their top speeds. The graph shows how the speeds of the two animals vary with time.



How far apart are the animals, 17 seconds after the cheetah began running?

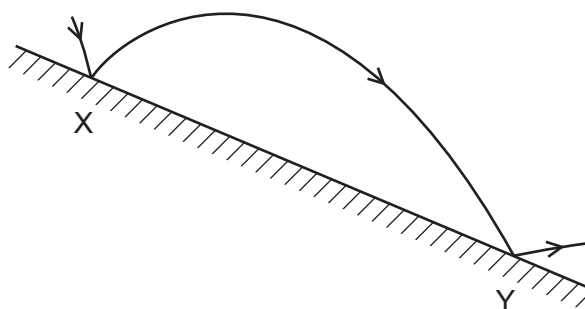
- A** 4 m **B** 11 m **C** 54 m **D** 89 m
- 9 A boy throws a stone with a horizontal velocity of 10 m s^{-1} from the top of a building. The height of the building is 8.0 m. The stone travels along a curved path until it hits the ground, as shown in the diagram.



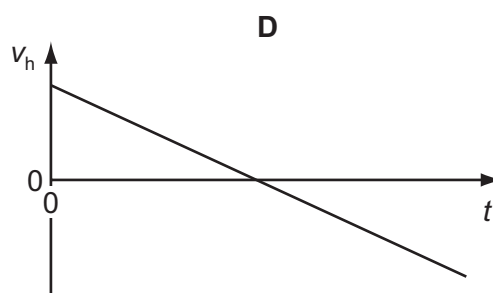
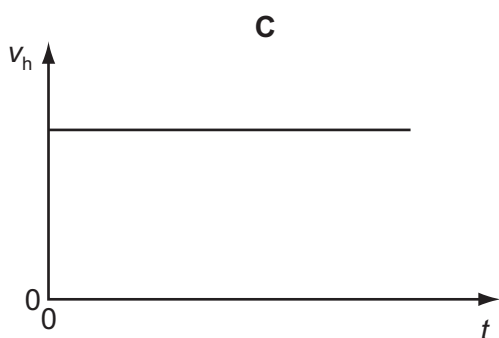
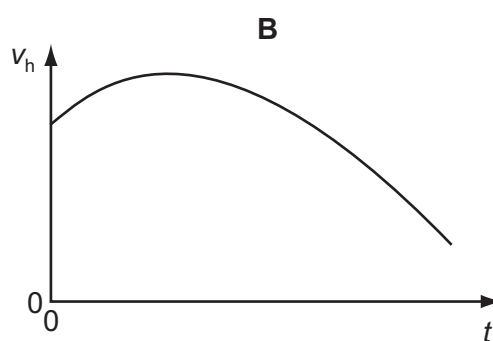
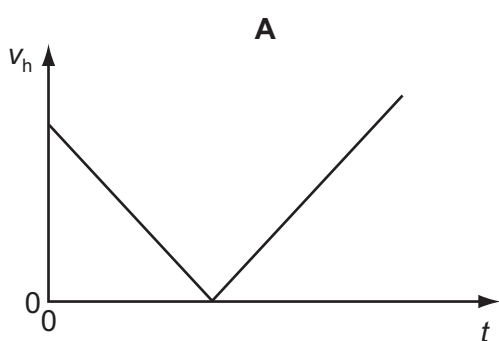
How long does it take the stone to reach the ground? (Air resistance can be neglected.)

- A** 0.61 s **B** 0.80 s **C** 1.3 s **D** 1.6 s

- 10 A football is released above a plane, sloping surface and bounces several times. The diagram shows its path between its bounces at X and at Y. Assume that there is no air resistance.



Which graph correctly shows the variation with time t of the horizontal component of its velocity v_h between X and Y?

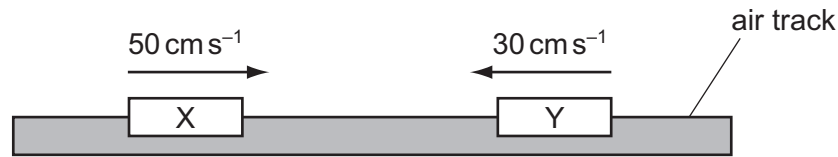


- 11 A rocket of mass 30 000 kg sits on a launch pad on the Earth's surface. The rocket motors provide an upward force of 330 kN on the rocket.

What is the initial acceleration of the rocket?

- A** 0.12 ms^{-2}
- B** 1.1 ms^{-2}
- C** 1.2 ms^{-2}
- D** 11 ms^{-2}

- 12 Two equal masses X and Y are moving towards each other on a frictionless air track as shown. The masses make an elastic collision.

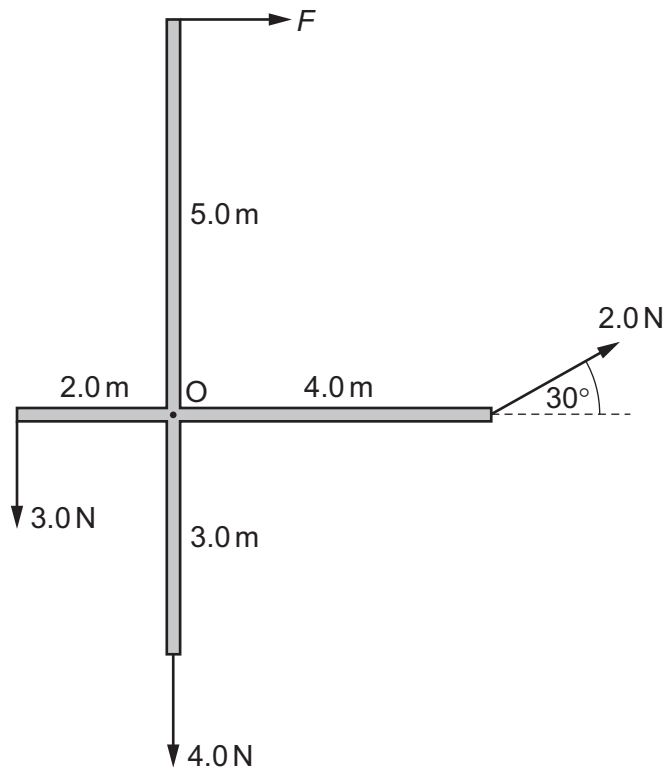


Which row gives possible velocities for the two masses after the collision?

	velocity of X	velocity of Y
A	zero	20 cm s^{-1} to the right
B	10 cm s^{-1} to the right	10 cm s^{-1} to the right
C	20 cm s^{-1} to the left	zero
D	30 cm s^{-1} to the left	50 cm s^{-1} to the right

- 13 Which statement is correct with reference to perfectly elastic collisions between two bodies?
- A** Neither total momentum nor total kinetic energy need be conserved but total energy must be conserved.
 - B** Total momentum and total energy are conserved but total kinetic energy may be changed into some other form of energy.
 - C** Total kinetic energy and total energy are both conserved but total momentum is conserved only if the two bodies have equal masses.
 - D** Total momentum, total kinetic energy and total energy are all conserved.
- 14 Which statement best describes a couple?
- A** a pair of forces of equal magnitude acting in opposite directions which produce rotational motion but not translational motion
 - B** a pair of forces of equal magnitude acting in opposite directions which produce translational motion but not rotational motion
 - C** a pair of forces of equal magnitude acting in the same direction which produce rotational motion but not translational motion
 - D** a pair of forces of equal magnitude acting in the same direction which produce translational motion but not rotational motion

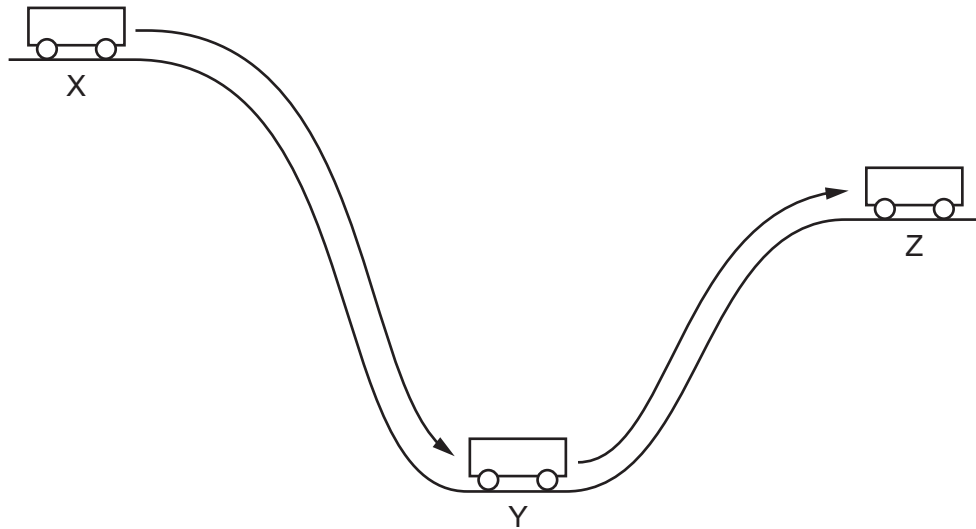
- 15 A cross-shaped structure, freely pivoted at O, has arms of lengths 5.0 m, 4.0 m, 3.0 m and 2.0 m. It is acted on by forces of 2.0 N, 3.0 N, 4.0 N and an unknown force F . The structure is in rotational equilibrium.



What is the magnitude of force F ?

- A** 0.40 N **B** 2.0 N **C** 2.6 N **D** 4.4 N

- 16 A trolley starts from rest at X. It rolls down to Y and eventually comes to rest at Z.



Which row is a possible summary of the energy changes during this process?

	X to Y	Y to Z
A	p.e. $\rightarrow$ k.e.	k.e. $\rightarrow$ p.e.
B	p.e. $\rightarrow$ k.e.	k.e. $\rightarrow$ p.e. + heat
C	p.e. $\rightarrow$ k.e. + heat	k.e. $\rightarrow$ p.e.
D	p.e. $\rightarrow$ k.e. + heat	k.e. $\rightarrow$ p.e. + heat

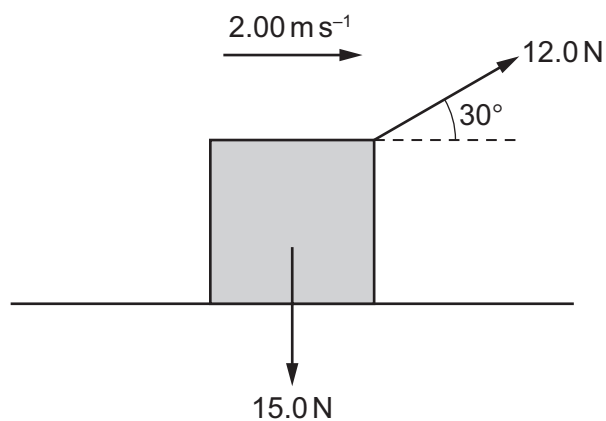
key

p.e. = potential energy

k.e. = kinetic energy

- 17 An object of weight 15.0 N is pulled along a horizontal surface at a constant velocity of 2.00 m s^{-1} .

The force pulling the object is 12.0 N at 30° to the horizontal, as shown.



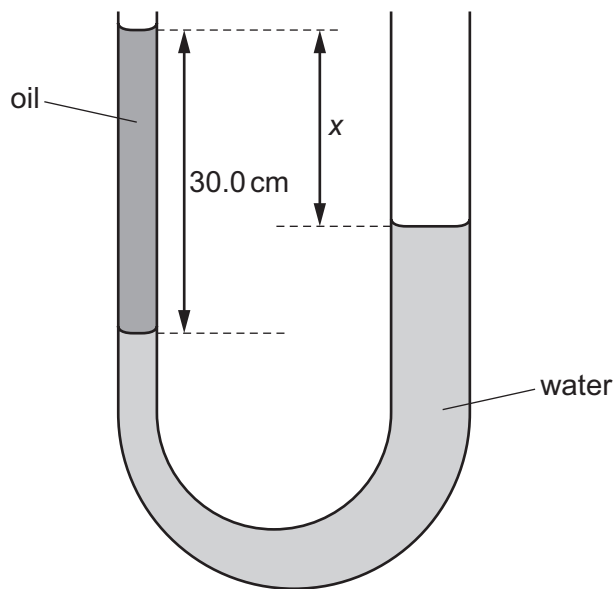
What is the power used to move the object?

- A** 12.0 W **B** 20.8 W **C** 24.0 W **D** 30.0 W

- 18 Brownian motion can be demonstrated by illuminating smoke particles inside a closed, transparent container. When the particles are viewed using a microscope, bright specks of light are observed to move with constant, random motion.

What **cannot** be inferred from this observation?

- A Air molecules are in constant motion.
 - B Air molecules are in random motion.
 - C Air pressure is due to air molecules colliding with the container.
 - D The mass of an air molecule is much less than the mass of a smoke particle.
- 19 A U-tube has one arm of area of cross-section A and the other of cross-section $4A$. The tube contains water of density 1000 kg m^{-3} and oil of density 850 kg m^{-3} , as shown.



The column of oil on top of the water in the left-hand arm is of length 30.0 cm .

What is the difference in height x between the levels in the two arms of the tube?

- A 4.5 cm
- B 6.2 cm
- C 23.8 cm
- D 25.5 cm

- 20** The Young modulus of a metal may be determined from the ratio $\frac{\text{stress}}{\text{strain}}$ when the metal is stretched elastically. This can be done by making measurements when loads are added to a wire.

Which measurements are needed to calculate the stress and strain of the wire in such an experiment?

	stress		strain	
A	wire diameter	initial and final positions of load	wire's original length	mass added
B	wire diameter	mass added	wire's original length	initial and final positions of load
C	wire's original length	initial and final positions of load	wire diameter	mass added
D	wire's original length	mass added	wire diameter	initial and final positions of load

- 21** A copper wire of length 3.6 m and diameter 1.22 mm is stretched elastically by a force of 37 N. The Young modulus of copper is 1.17×10^{11} Pa.

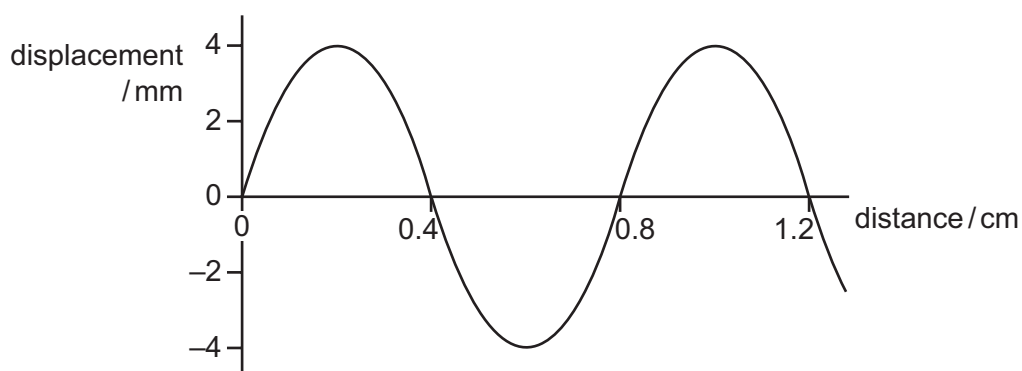
Which extension is caused by this force?

- A** 0.24 mm **B** 0.76 mm **C** 0.97 mm **D** 3.1 mm

- 22** When all the other features of a wave are constant, which relationship is correct?

- A** Amplitude is directly proportional to velocity.
B Intensity is directly proportional to amplitude.
C Velocity is directly proportional to wavelength.
D Wavelength is directly proportional to frequency.

- 23 A vibrating rod makes a water wave in a ripple tank. The graph shows the displacement of the wave at one instant as it travels away from the rod. The wave speed is 2.0 cm s^{-1} .



What is the frequency of the wave?

- A** 0.8 Hz **B** 1.6 Hz **C** 2.5 Hz **D** 5.0 Hz
- 24 Polarisation is a phenomenon associated with a certain type of wave.
- Which condition **must** be fulfilled if a wave is to be polarised?
- A** It must be a light wave.
B It must be a longitudinal wave.
C It must be a radio wave.
D It must be a transverse wave.
- 25 Monochromatic light passes through two narrow slits and produces an interference pattern on a screen some distance away. The interference fringes are very close together.
- Which change would **increase** the distance between the fringes?
- A** Increase the brightness of the light source.
B Increase the distance between the slits and the screen.
C Increase the distance between the two slits.
D Increase the frequency of the light used.
- 26 The following statements describe the diffraction of waves passing through a narrow slit.
- Which statement is **not** correct?
- A** Both transverse and longitudinal waves can be diffracted.
B Diffraction can only be seen with light when the light is monochromatic.
C Red light diffracts through a greater angle than blue light.
D The angle of diffraction increases when the width of the slit decreases.

- 27 Monochromatic light is directed onto a pair of slits. Interference fringes that are 2.0 mm apart are observed on a distant screen.

The frequency of the light used is then doubled and the slit separation is halved.

How far apart are the new interference fringes?

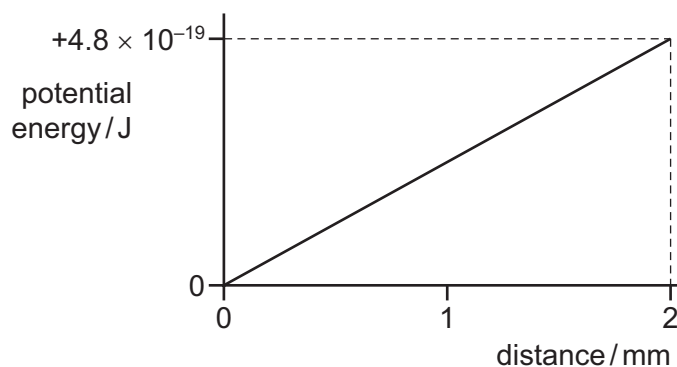
- A 0.50 mm B 2.0 mm C 4.0 mm D 8.0 mm

- 28 A diffraction grating has N lines per unit length and is placed at 90° to monochromatic light of wavelength λ .

What is the expression for θ , the angle to the normal to the grating at which the third order diffraction peak is observed?

- A $\sin \theta = \frac{1}{3N\lambda}$ B $\sin \theta = \frac{N\lambda}{3}$ C $\sin \theta = 3N\lambda$ D $\sin \theta = \frac{3\lambda}{N}$

- 29 Two parallel plates R and S are 2 mm apart in a vacuum. An electron with charge $-1.6 \times 10^{-19} \text{ C}$ moves along a straight line in the electric field between the plates. The graph shows how the potential energy of the electron varies with its distance from plate R.

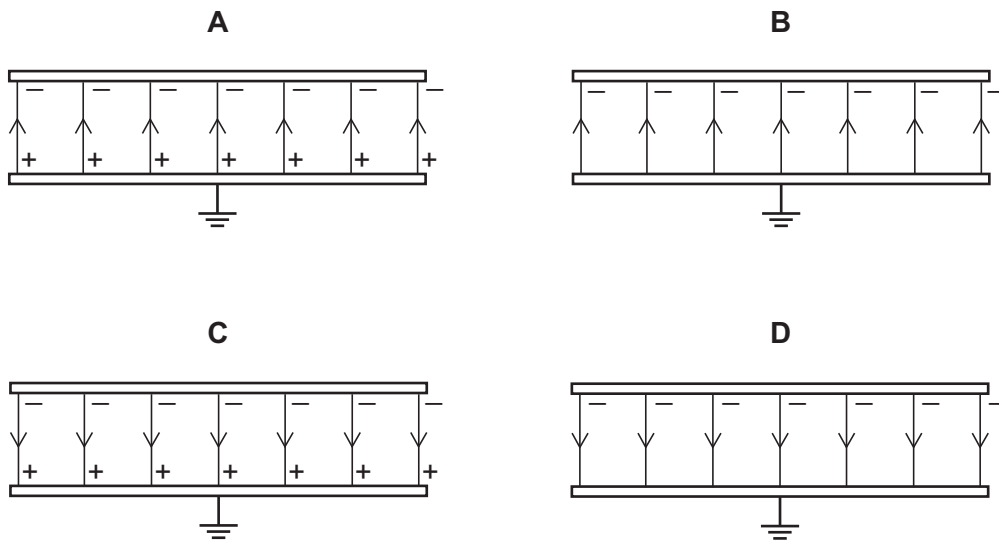


Which deduction is **not** correct?

- A The electric field between R and S is uniform.
 B The electric field strength is 3000 N C^{-1} .
 C The force on the electron is constant.
 D The magnitude of the potential difference between R and S is 3 V.

- 30 Two parallel, conducting plates with air between them are placed close to one another. The top plate is given a negative charge and the bottom one is earthed.

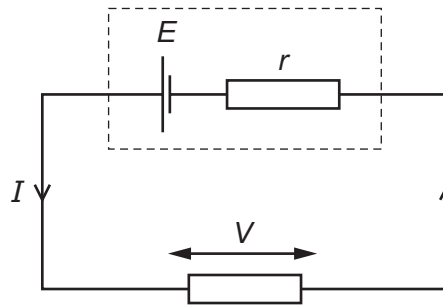
Which diagram best represents the distribution of charges and the field between the plates?



- 31 In terms of energy transfer W and charge q , what are the definitions of potential difference (p.d.) and electromotive force (e.m.f.)?

	p.d.	e.m.f.
A	$\frac{W}{q}$	$\frac{W}{q}$
B	$\frac{W}{q}$	Wq
C	Wq	$\frac{W}{q}$
D	Wq	Wq

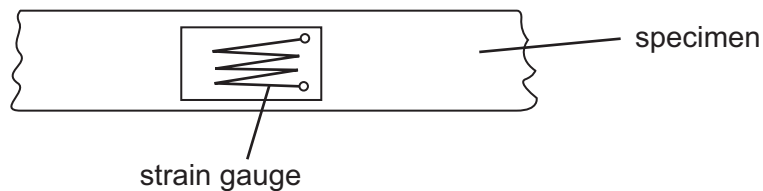
- 32 A cell of electromotive force E and internal resistance r is connected to an external resistor, as shown.



The current in the circuit is I and the potential difference (p.d.) across the external resistor is V .

In the equation $(E - V) = Ir$, what does the term $(E - V)$ represent?

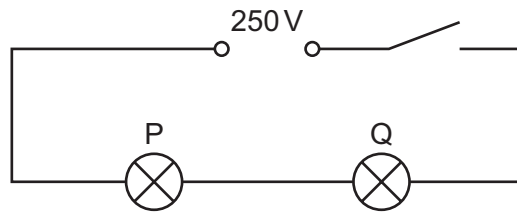
- A electrical energy per unit charge lost in the cell
 - B electrical energy per unit charge lost in the complete circuit
 - C electrical energy per unit charge lost in the connecting wire
 - D electrical energy per unit charge lost in the external resistor
- 33 Tensile strain may be measured by the change in electrical resistance of a device called a strain gauge. A strain gauge consists of folded fine metal wire mounted on a flexible insulating backing sheet. The strain gauge is firmly attached to the specimen.



When the strain in the specimen is increased, what happens to the resistance of the wire?

- A It decreases, because the length decreases and the cross-sectional area increases.
- B It decreases, because the length increases and the cross-sectional area decreases.
- C It increases, because the length decreases and the cross-sectional area increases.
- D It increases, because the length increases and the cross-sectional area decreases.

- 34** In the circuit shown, lamp P is rated 250 V, 50 W and lamp Q is rated 250 V, 200 W. The two lamps are connected in series to a 250 V power supply.



Assume that the resistance of each lamp remains constant.

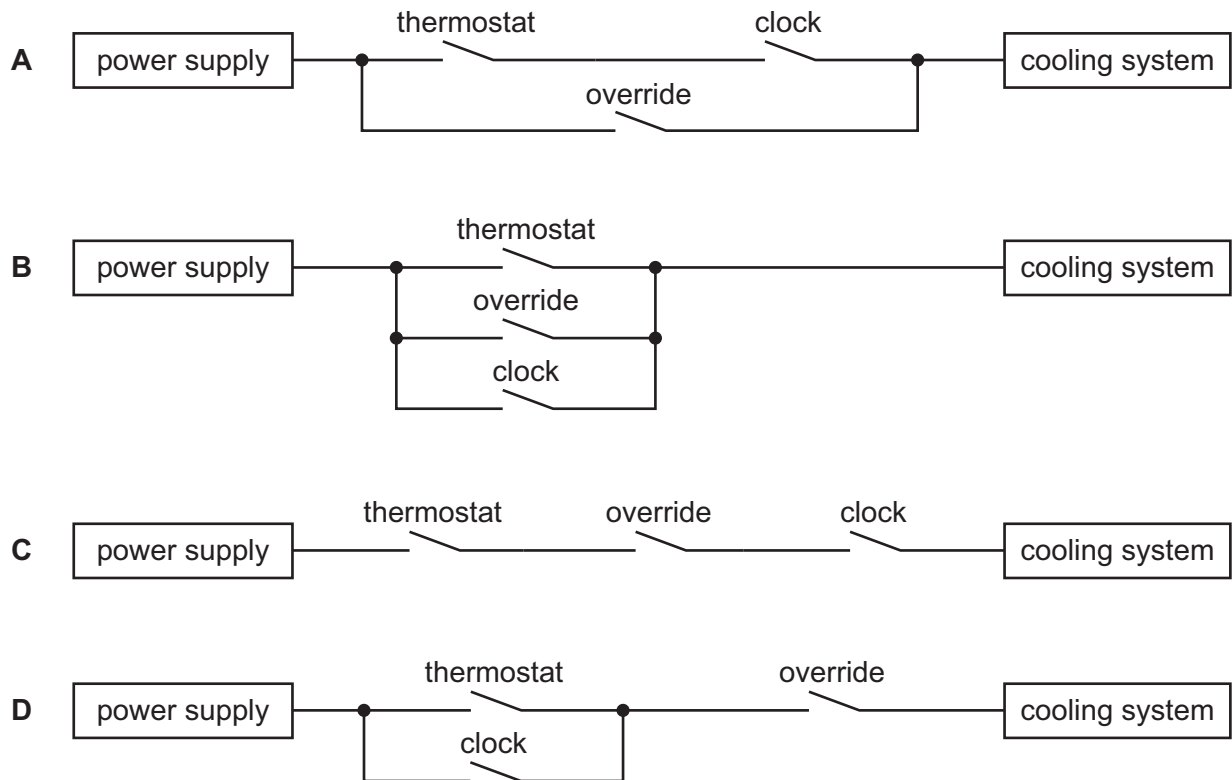
Which statement most accurately describes what happens when the switch is closed?

- A** Lamp P emits four times as much power as lamp Q.
- B** Lamp P emits twice as much power as lamp Q.
- C** Lamp Q emits four times as much power as lamp P.
- D** Lamp Q emits twice as much power as lamp P.

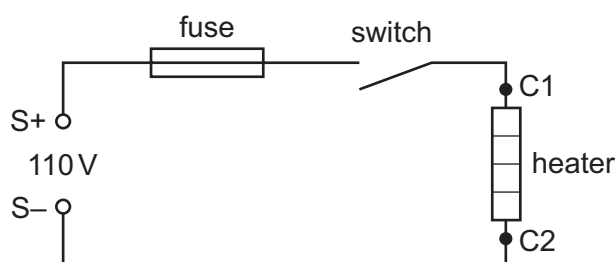
35 The cooling system in many houses is controlled by three electrical switches. These are:

- a thermostat switch that closes when the temperature rises to a given value,
- a clock switch that closes at times when cooling may be required,
- an override switch that closes to turn on the system when exceptional temperature rises occur.

Which diagram shows the switches correctly connected between the power supply and the cooling system?



- 36 A 110 V supply of negligible internal resistance is connected to a heater through a fuse and a switch.



Terminals S+ and S– are the positive and negative terminals of the supply. Points C1 and C2 at either side of the heater are accessible for fault-finding.

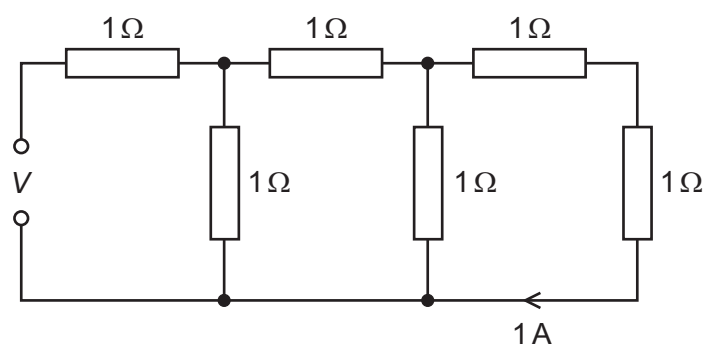
A voltmeter is connected between S– and C1.

With the circuit working correctly, the voltmeter reading is noted with the switch closed.

A fault occurs and the voltmeter is again connected between S– and C1 with the switch closed.

Which fault would result in the same two voltmeter readings?

- A a break in the wire of the heater
 - B a broken switch that cannot close correctly
 - C a melted fuse
 - D a short circuit in the heater
- 37 A network of resistors, each of resistance $1\ \Omega$, is connected as shown.



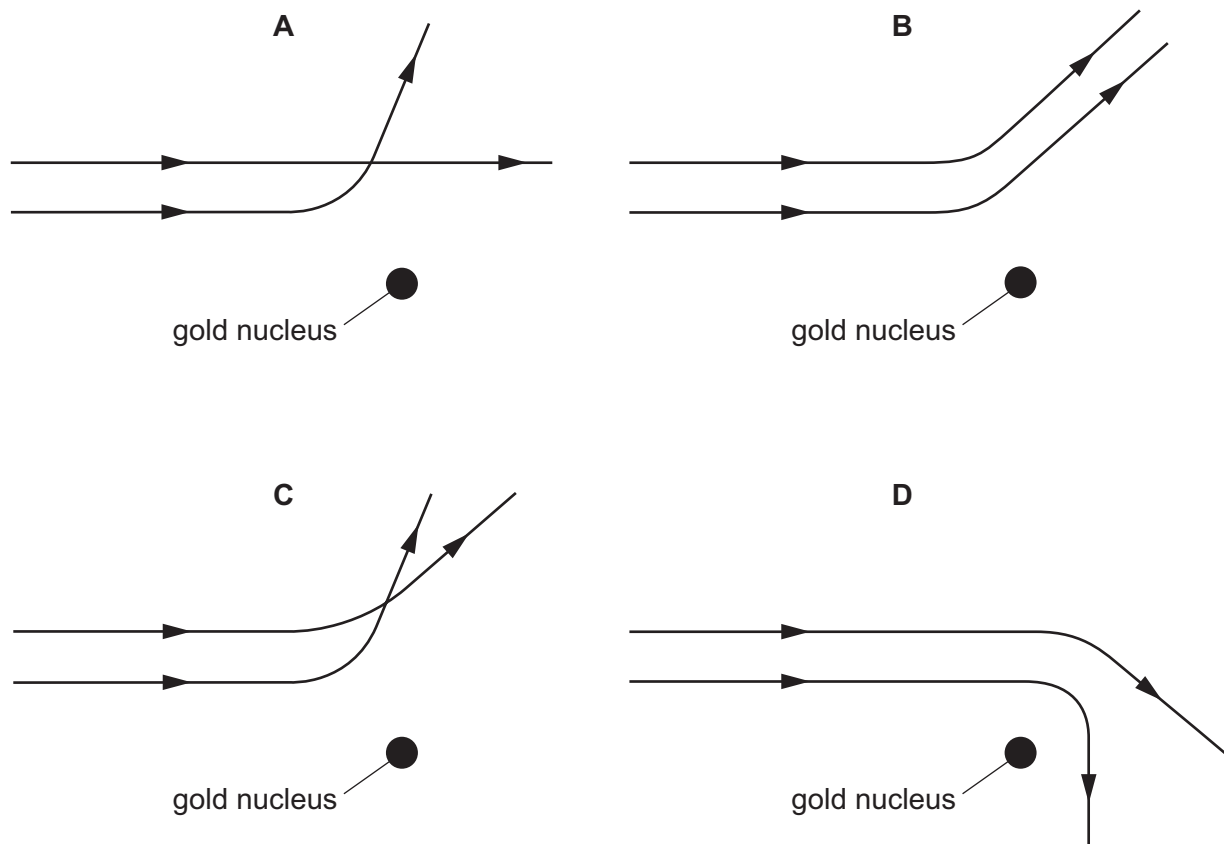
The current passing through the end resistor is 1 A.

What is the potential difference (p.d.) V across the input terminals?

- A 2 V
- B 5 V
- C 8 V
- D 13 V

- 38 Two α -particles with equal energies are fired towards the nucleus of a gold atom.

Which diagram best represents their paths?



- 39 When a nucleus emits an α -particle, how do the proton number and the nucleon number of the original nucleus change?

	proton number	nucleon number
A	-4	-2
B	-2	-2
C	-2	-4
D	+1	no change

- 40 A simple theory of α -particle scattering by a thin metal foil uses the four assumptions given below.

Which assumption is exact and is **not** an approximation?

- A** Each α -particle interacts with just one nucleus.
- B** The α -particles lose no kinetic energy when they are deflected.
- C** The metal nuclei do not recoil.
- D** Total momentum is conserved.

BLANK PAGE

BLANK PAGE

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.