



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

PHYSICS

9702/11

Paper 1 Multiple Choice

October/November 2010

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, highlighters, 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.

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.

This document consists of **24** printed 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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
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 A signal has a frequency of 2.0 MHz.

What is the period of the signal?

- A $2\ \mu\text{s}$ B $5\ \mu\text{s}$ C 200 ns D 500 ns

- 2 A metal sphere of radius r is dropped into a tank of water. As it sinks at speed v , it experiences a drag force F given by $F = krv$, where k is a constant.

What are the SI base units of k ?

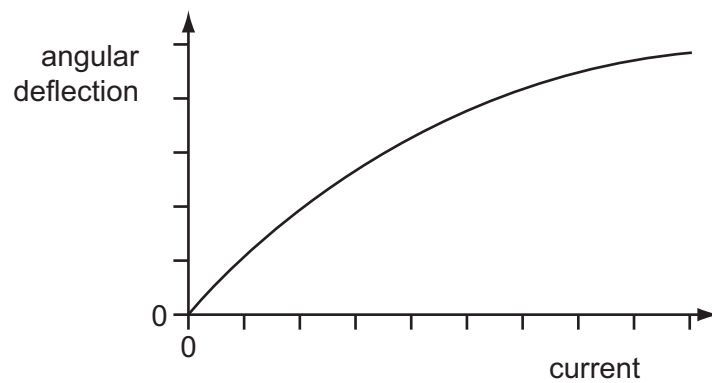
- A $\text{kg m}^2 \text{s}^{-1}$ B $\text{kg m}^{-2} \text{s}^{-2}$ C $\text{kg m}^{-1} \text{s}^{-1}$ D kg m s^{-2}

- 3 Which physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge?

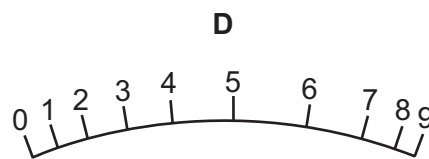
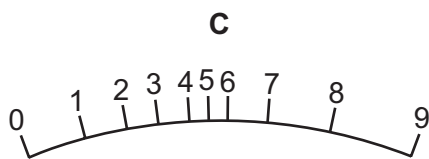
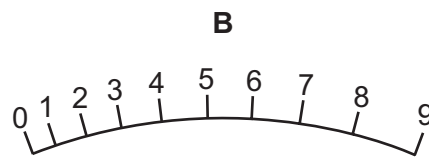
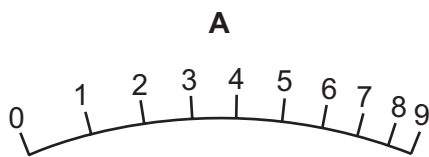
- A electric current
B electric energy
C electric field strength
D electric power

Space for working

- 4 The angular deflection of the needle of an ammeter varies with the current passing through the ammeter as shown in the graph.

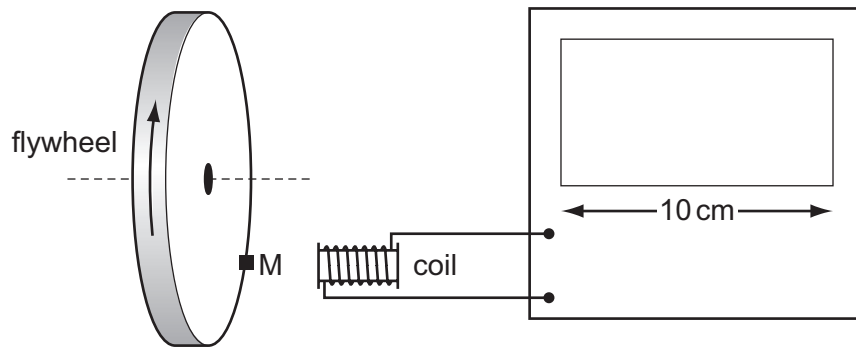


Which diagram could represent the appearance of the scale on this meter?



Space for working

- 5 The diagram shows a cathode-ray oscilloscope (c.r.o.) being used to measure the rate of rotation of a flywheel.



The flywheel has a small magnet M mounted on it. Each time the magnet passes the coil, a voltage pulse is generated, which is passed to the c.r.o. The display of the c.r.o. is 10 cm wide. The flywheel is rotating at a rate of about 3000 revolutions per minute.

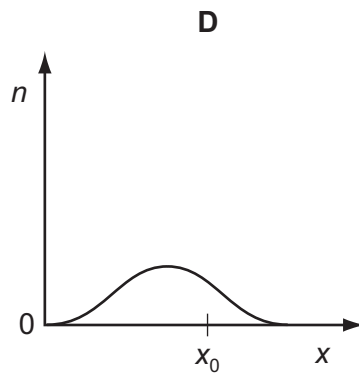
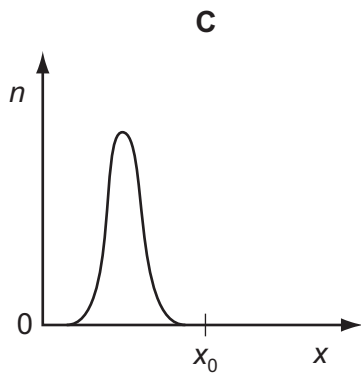
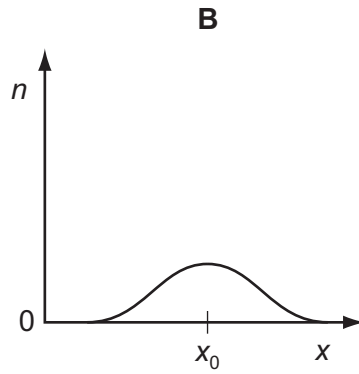
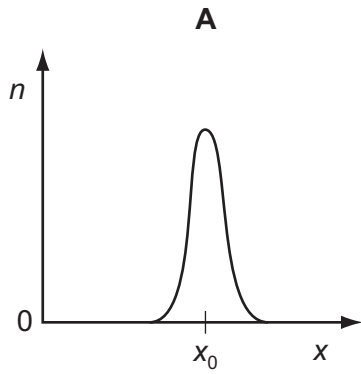
Which time-base setting will display clearly separate pulses on the screen?

- A** 1 s cm^{-1} **B** 10 ms cm^{-1} **C** $100 \mu\text{s cm}^{-1}$ **D** $1 \mu\text{s cm}^{-1}$

Space for working

- 6 A fixed quantity x_0 is measured many times in an experiment that has experimental uncertainty. A graph is plotted to show the number n of times that a particular value x is obtained.

Which graph could be obtained if the measurement of x_0 has a large systematic error but a small random error?



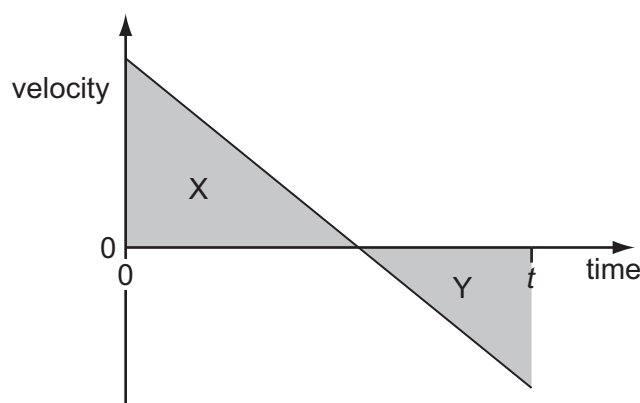
Space for working

- 7 A ball is thrown horizontally in still air from the top of a very tall building. The ball is affected by air resistance.

What happens to the horizontal and to the vertical components of the ball's velocity?

	horizontal component of velocity	vertical component of velocity
A	decreases to zero	increases at a constant rate
B	decreases to zero	increases to a constant value
C	remains constant	increases at a constant rate
D	remains constant	increases to a constant value

- 8 The velocity-time graph below is for a stone thrown vertically up into the air. Air resistance is negligible.



The stone is thrown up at time zero.

Area X represents a distance of 5 m. Area Y represents a distance of 3 m.

What is the displacement of the stone from its initial position at time t ?

- A** 2 m **B** 3 m **C** 5 m **D** 8 m

Space for working

- 9 In order that a train can stop safely, it will always pass a signal showing a yellow light before it reaches a signal showing a red light. Drivers apply the brake at the yellow light and this results in a uniform deceleration to stop exactly at the red light.

The distance between the red and yellow lights is x .

What must be the minimum distance between the lights if the train speed is increased by 20 %, without changing the deceleration of the trains?

- A** $1.20x$ **B** $1.25x$ **C** $1.44x$ **D** $1.56x$

- 10 The gravitational field strength on the surface of planet P is one tenth of that on the surface of planet Q.

On the surface of P, a body has a mass of 1.0 kg and a weight of 1.0 N.

What are the mass and weight of the same body on the surface of planet Q?

	mass on Q / kg	weight on Q / N
A	1.0	0.1
B	1.0	10
C	10	10
D	10	100

- 11 A body, initially at rest, explodes into two masses M_1 and M_2 that move apart with speeds v_1 and v_2 respectively.

What is the ratio $\frac{v_1}{v_2}$?

- A** $\frac{M_1}{M_2}$ **B** $\frac{M_2}{M_1}$ **C** $\sqrt{\frac{M_1}{M_2}}$ **D** $\sqrt{\frac{M_2}{M_1}}$

Space for working

- 12** Two experiments are carried out using two trolleys of equal mass. All moving parts of the trolleys are frictionless, as is the surface that the trolleys move over. In both experiments, trolley X moves towards trolley Y, which is initially stationary.



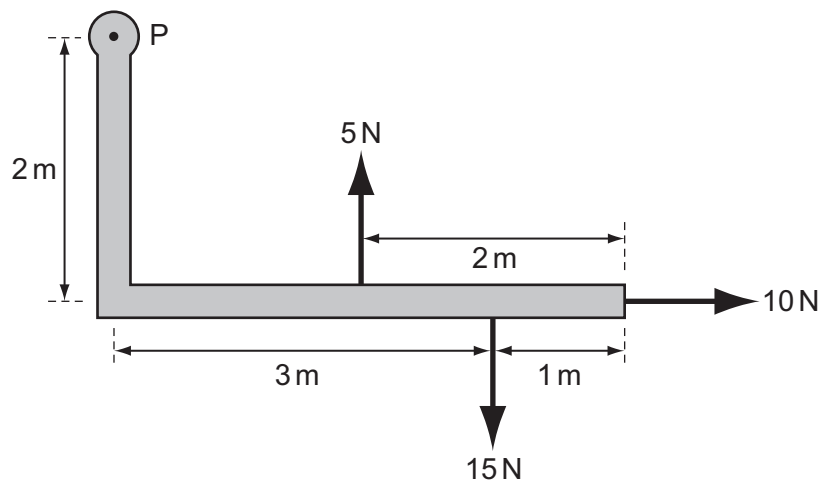
After the collision in experiment 1, X is stationary and Y moves off to the right.

After the collision in experiment 2, the trolleys join and move off together.

What types of collision occur in these experiments?

	experiment 1	experiment 2
A	elastic	elastic
B	elastic	inelastic
C	inelastic	elastic
D	inelastic	inelastic

- 13** A rigid L-shaped lever arm is pivoted at point P.



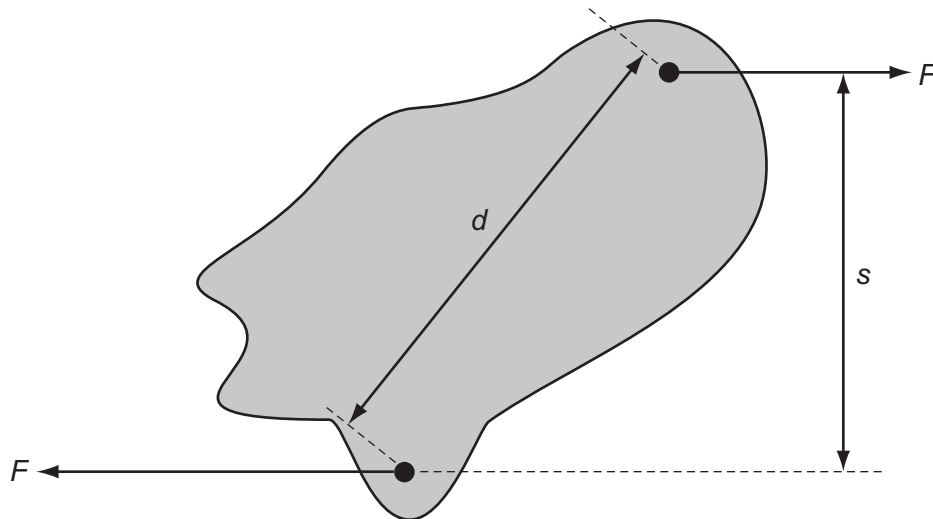
Three forces act on the lever arm, as shown in the diagram.

What is the magnitude of the resultant moment of these forces about point P?

- A** 15 Nm **B** 20 Nm **C** 35 Nm **D** 75 Nm

Space for working

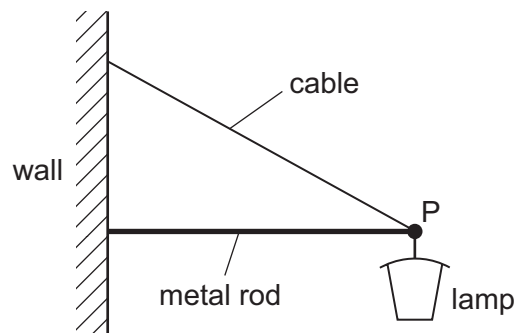
- 14 Two parallel forces, each of magnitude F , act on a body as shown.



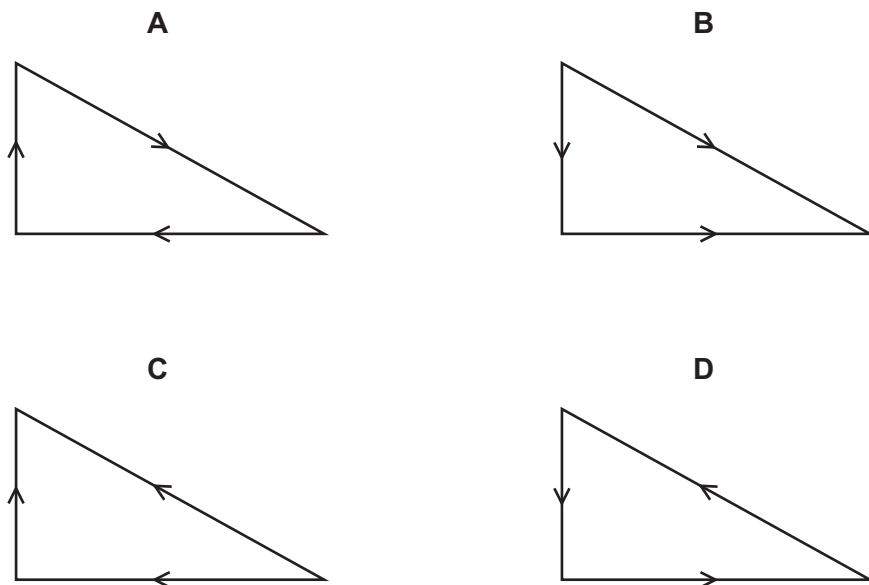
What is the magnitude of the torque on the body produced by these forces?

- A** Fd **B** Fs **C** $2Fd$ **D** $2Fs$

- 15 A street lamp is fixed to a wall by a metal rod and a cable.



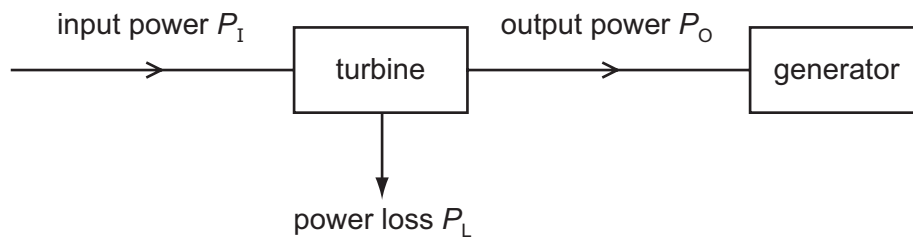
Which vector triangle represents the forces acting at point P?



16 What is the internal energy of a system?

- A the amount of heat supplied to the system
- B the energy of the atoms of the system
- C the total kinetic energy of the system
- D the total potential energy of the system

17 A steam turbine is used to drive a generator. The input power to the turbine is P_I and the output power P_O . The power loss in the turbine is P_L , as shown below.

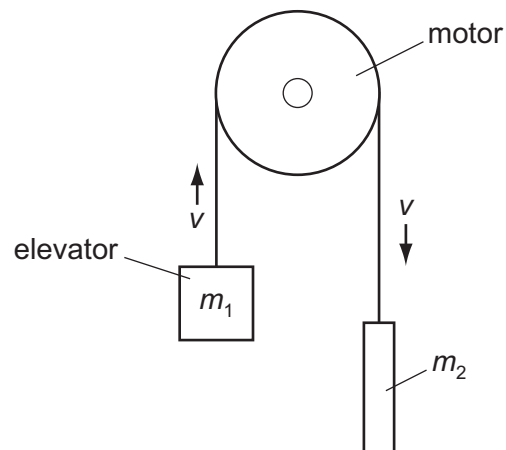


What is the efficiency of the turbine?

- A $\frac{P_L}{P_O}$
- B $\frac{P_I}{P_O}$
- C $\frac{P_L}{P_I}$
- D $\frac{P_O}{P_I}$

Space for working

- 18 The diagram shows a lift system in which the elevator (mass m_1) is partly counterbalanced by a heavy weight (mass m_2).



At what rate does the motor provide energy to the system when the elevator is rising at a steady speed v ? (g = acceleration of free fall)

- A** $\frac{1}{2} m_1 v^2$
B $\frac{1}{2} (m_1 - m_2) v^2$
C $m_1 g v$
D $(m_1 - m_2) g v$
- 19 The Mariana Trench in the Pacific Ocean has a depth of about 10 km.
- Assuming that sea water is incompressible and has a density of about 1020 kg m^{-3} , what would be the approximate pressure at that depth?

- A** 10^5 Pa **B** 10^6 Pa **C** 10^7 Pa **D** 10^8 Pa

Space for working

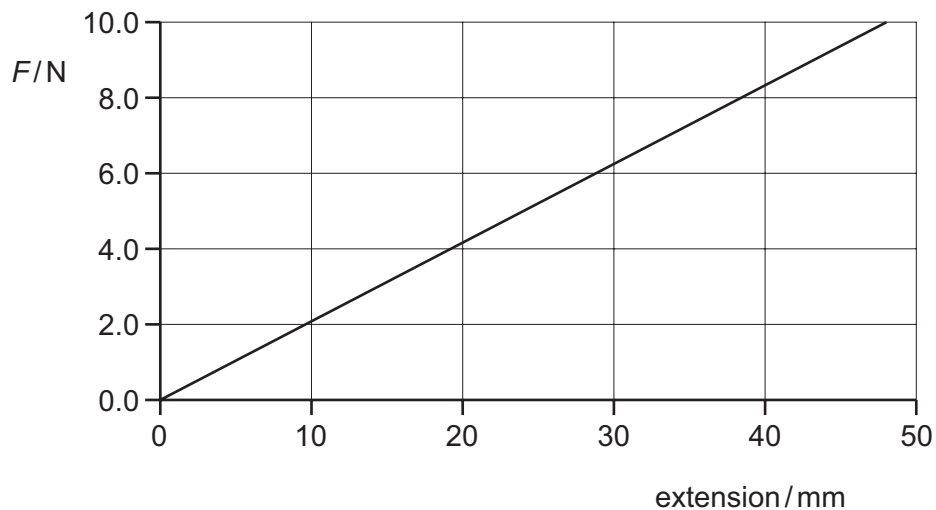
20 A student writes some statements about solids, liquids and gases.

- 1 Solids are rigid because the molecules in a solid vibrate.
- 2 Liquids flow because the molecules in a liquid are closer than in a gas.
- 3 Gases are less dense than liquids because the molecules in a gas move randomly.

Which statements are correct?

- A** 1 only
B 1 and 3 only
C 2 and 3 only
D none of the above

21 The graph shows how force depends on extension for a certain spring.



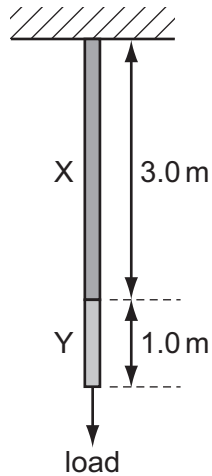
What is the energy stored in the spring when the extension is 30 mm?

- A** 0.095 J **B** 0.19 J **C** 0.25 J **D** 0.95 J

Space for working

22 A wire consists of a 3.0 m length of metal X joined to a 1.0 m length of metal Y.

The cross-sectional area of the wire is uniform.



A load hung from the wire causes metal X to stretch by 1.5 mm and metal Y to stretch by 1.0 mm.

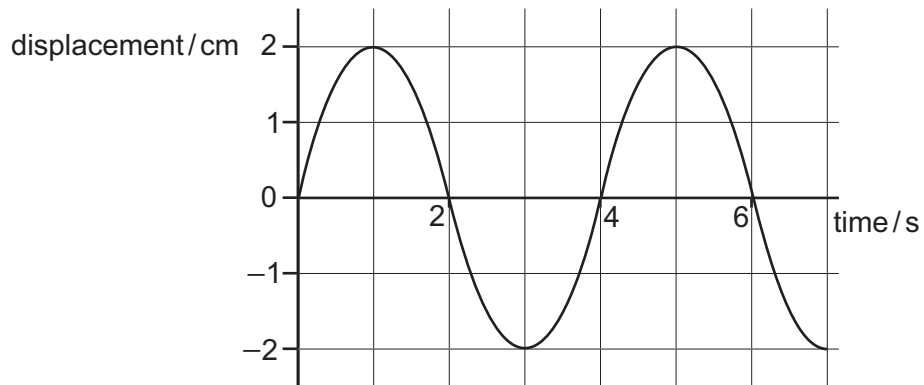
The same load is then hung from a second wire of the same cross-section, consisting of 1.0 m of metal X and 3.0 m of metal Y.

What is the total extension of this second wire?

- A** 2.5 mm **B** 3.5 mm **C** 4.8 mm **D** 5.0 mm

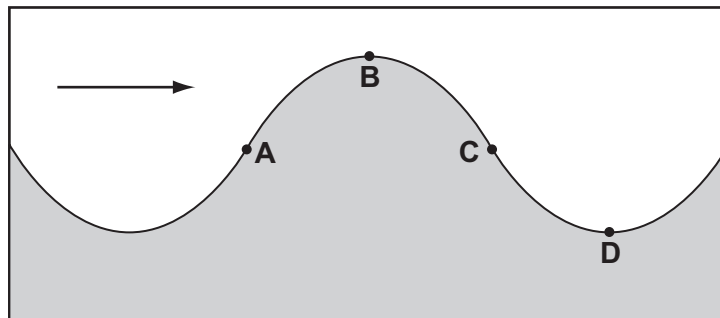
Space for working

- 23** The graph shows how the displacement of a particle in a wave varies with time.



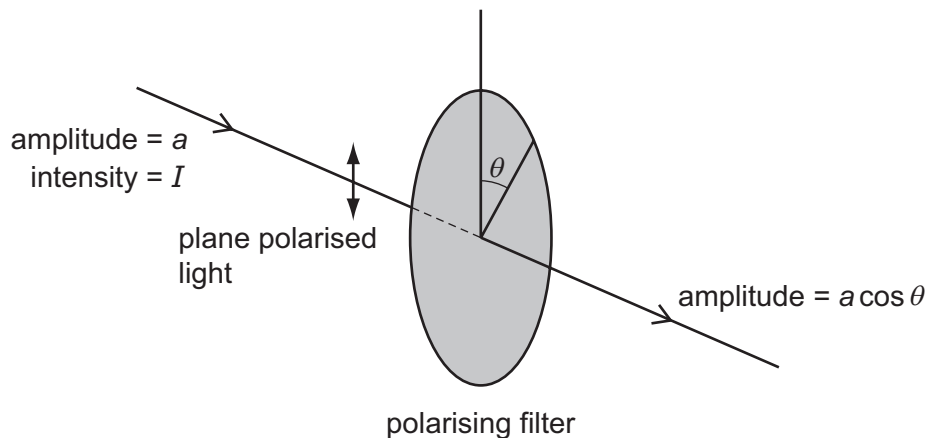
Which statement is correct?

- A** The wave has an amplitude of 2 cm and could be either transverse or longitudinal.
 - B** The wave has an amplitude of 2 cm and must be transverse.
 - C** The wave has an amplitude of 4 cm and could be either transverse or longitudinal.
 - D** The wave has an amplitude of 4 cm and must be transverse.
- 24** The diagram shows a vertical cross-section through a water wave moving from left to right.
- At which point is the water moving upwards with maximum speed?



Space for working

- 25 When plane-polarised light of amplitude a is passed through a polarising filter as shown, the amplitude of the light emerging is $a \cos \theta$.

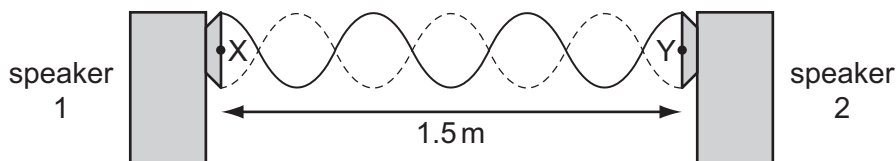


The intensity of the initial beam is I .

What is the intensity of the emerging light when θ is 60.0° ?

- A** $0.250I$ **B** $0.500I$ **C** $0.750I$ **D** $0.866I$

- 26 A stationary wave is produced by two loudspeakers emitting sound of the same frequency.



When a microphone is moved between X and Y, a distance of 1.5 m, six nodes and seven antinodes are detected.

What is the wavelength of the sound?

- A** 0.50 m **B** 0.43 m **C** 0.25 m **D** 0.21 m

Space for working

- 27 Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around 10^{-10} m?
- A infra-red
 - B microwave
 - C ultraviolet
 - D X-ray
- 28 An electron is in an electric field of strength $5 \times 10^4 \text{ V m}^{-1}$. The field is the only influence on the electron.

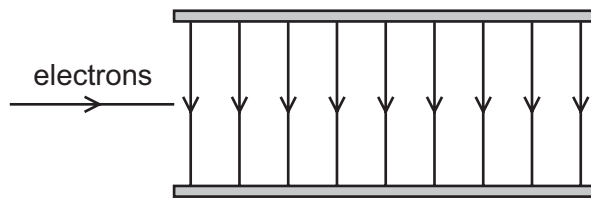
The mass and charge of an electron are known.

Which quantity can be calculated without any more information?

- A the force on the electron
- B the momentum of the electron
- C the kinetic energy of the electron
- D the speed of the electron

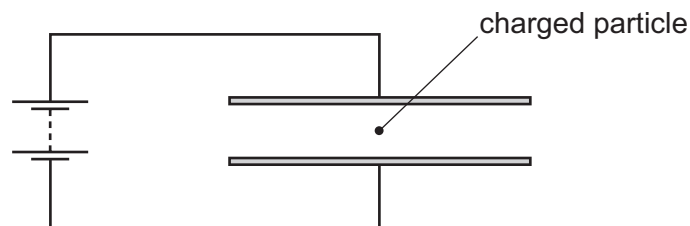
Space for working

- 29 Electrons are accelerated and then directed into the uniform electric field between two parallel plates in a vacuum.



What best describes the shape of the path followed by the electrons in the field?

- A a downwards curve along a line that is part of a circle
 - B a downwards curve along a line that is **not** part of a circle
 - C an upwards curve along a line that is part of a circle
 - D an upwards curve along a line that is **not** part of a circle
- 30 A charged particle is in the electric field between two horizontal metal plates connected to a source of constant potential difference, as shown. There is a force F on the particle due to the electric field.



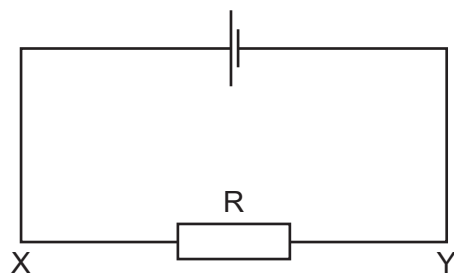
The separation of the plates is doubled.

What will be the new force on the particle?

- A $\frac{F}{4}$
- B $\frac{F}{2}$
- C F
- D $2F$

Space for working

31 The current in the circuit shown is 4.8 A.

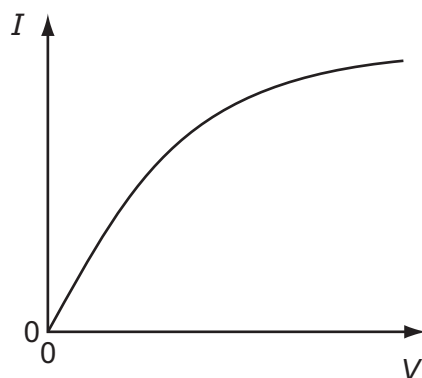


What is the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow
A	X to Y	$3.0 \times 10^{19} \text{ s}^{-1}$
B	X to Y	$6.0 \times 10^{18} \text{ s}^{-1}$
C	Y to X	$3.0 \times 10^{19} \text{ s}^{-1}$
D	Y to X	$6.0 \times 10^{18} \text{ s}^{-1}$

Space for working

32 Which component has the I - V graph shown?



- A filament lamp
- B light-dependent resistor
- C semiconductor diode
- D thermistor

33 A copper wire is cylindrical and has resistance R .

What will be the resistance of a copper wire of twice the length and twice the radius?

- A $\frac{R}{4}$
- B $\frac{R}{2}$
- C R
- D $2R$

34 A relay is required to operate 800 m from its power supply. The power supply has negligible internal resistance. The relay requires 16.0 V and a current of 0.60 A to operate.

A cable connects the relay to the power supply and two of the wires in the cable are used to supply power to the relay.

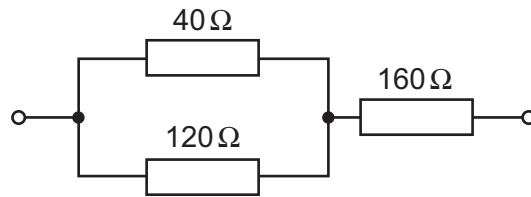
The resistance of each of these wires is $0.0050\ \Omega$ per metre.

What is the minimum output e.m.f. of the power supply?

- A 16.6 V
- B 18.4 V
- C 20.8 V
- D 29.3 V

Space for working

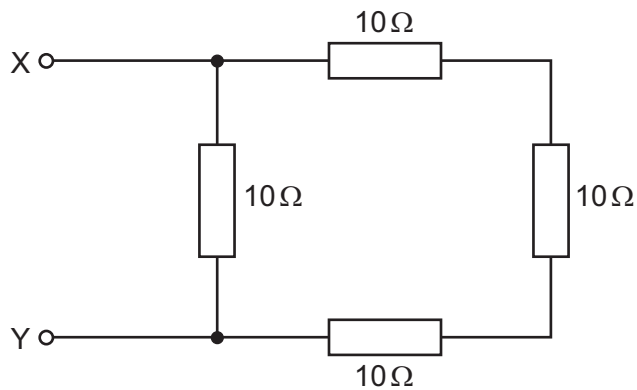
35 The diagram shows part of a circuit.



What is the total resistance of the combination of the three resistors?

- A** $320\ \Omega$ **B** $240\ \Omega$ **C** $190\ \Omega$ **D** $80\ \Omega$

36 The diagram shows an arrangement of resistors.

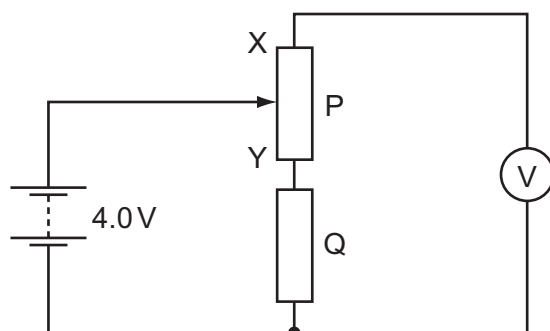


What is the total electrical resistance between X and Y?

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

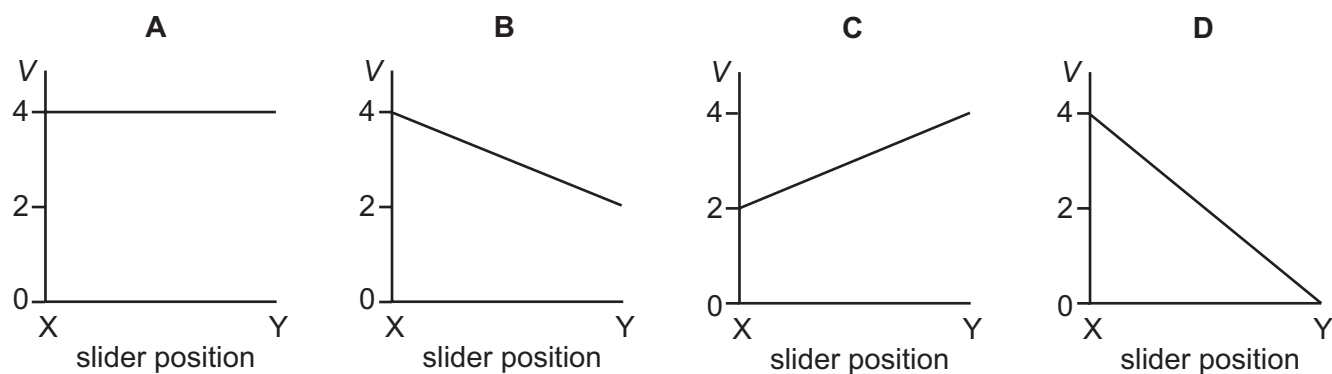
Space for working

- 37 In the circuit below, P is a potentiometer of total resistance $10\ \Omega$ and Q is a fixed resistor of resistance $10\ \Omega$. The battery has an e.m.f. of $4.0\ \text{V}$ and negligible internal resistance. The voltmeter has a very high resistance.



The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph would be obtained?



Space for working

38 Uranium-235 may be represented by the symbol ${}_{92}^{235}\text{U}$.

Which row shows the numbers of nucleons, protons and neutrons in a ${}_{92}^{235}\text{U}$ nucleus?

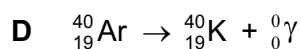
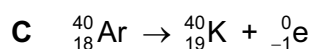
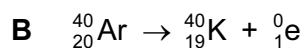
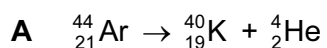
	nucleons	protons	neutrons
A	92	235	143
B	143	92	235
C	235	92	143
D	235	143	92

39 When a magnesium nucleus ${}_{12}^{25}\text{Mg}$ is hit by a gamma ray, a sodium nucleus ${}_{11}^{24}\text{Na}$ is formed and another particle is emitted.

What are the nucleon number (mass number) and proton number (atomic number) of the other particle produced in this nuclear reaction?

	nucleon number	proton number
A	0	-1
B	0	1
C	1	-1
D	1	1

40 Which nuclear equation shows the beta decay of a nucleus of argon (Ar) into potassium (K)?



Space for working

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.

University of 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.



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

PHYSICS

9702/12

Paper 1 Multiple Choice

October/November 2010

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, highlighters, 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.

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.

This document consists of **24** printed 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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
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 row shows a base quantity with its correct SI unit?

	quantity	unit
A	current	A
B	mass	g
C	temperature	°C
D	weight	N

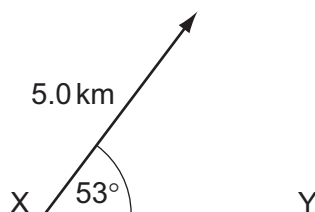
- 2 The frictional force F on a sphere falling through a fluid is given by the formula

$$F = 6\pi a\eta v$$

where a is the radius of the sphere, η is a constant relating to the fluid and v is the velocity of the sphere.

What are the units of η ?

- A** kg m s^{-1} **B** $\text{kg m}^{-1} \text{s}^{-1}$ **C** kg m s^{-3} **D** $\text{kg m}^3 \text{s}^{-3}$
- 3 What is the component of this displacement vector in the direction XY?



- A** 3.0 km **B** 4.0 km **C** 5.0 km **D** 6.6 km

Space for working

- 4 A metre rule is used to measure the length of a piece of wire. It is found to be 70 cm long to the nearest millimetre.

How should this result be recorded in a table of results?

- A 0.7 m B 0.70 m C 0.700 m D 0.7000 m

- 5 A quantity x is to be determined from the equation

$$x = P - Q.$$

P is measured as 1.27 ± 0.02 m.

Q is measured as 0.83 ± 0.01 m.

What is the percentage uncertainty in x to one significant figure?

- A 0.4 % B 2 % C 3 % D 7 %

- 6 A football is dropped from the top of a three-storey building. It falls through air until it reaches the ground.

What remains constant throughout the fall?

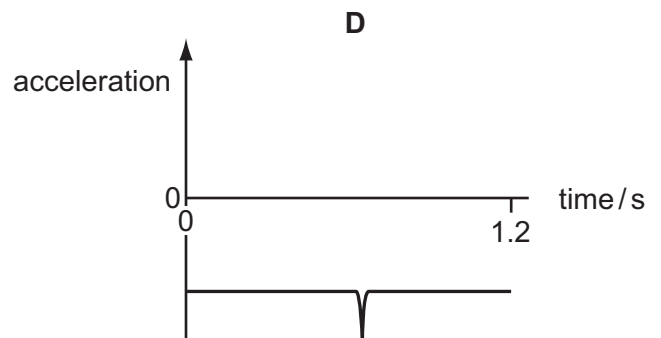
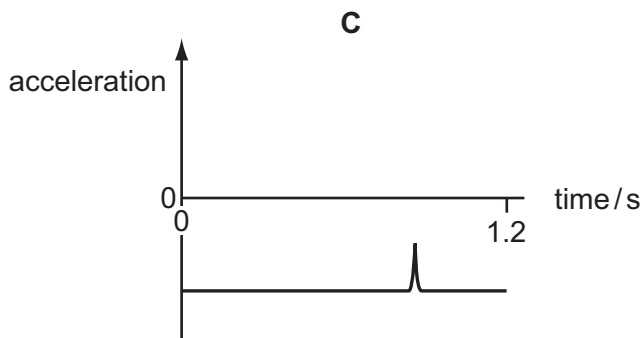
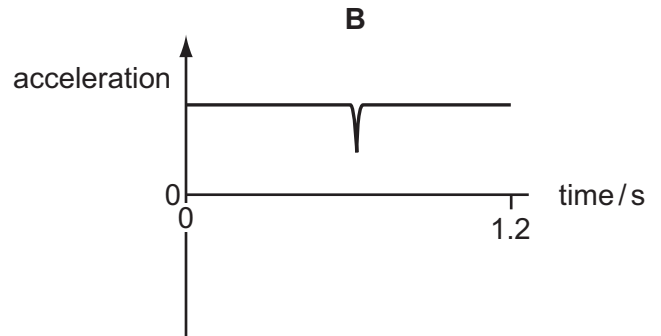
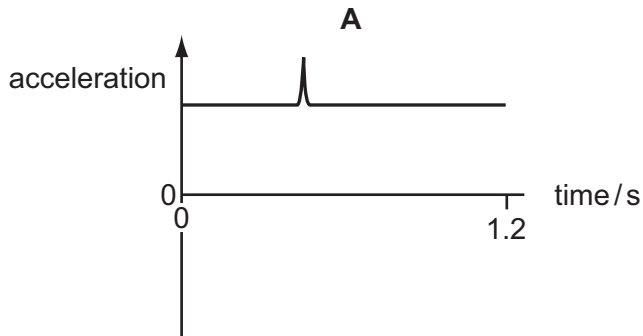
- A acceleration of the football
B air resistance on the football
C velocity of the football
D weight of the football

Space for working

- 7 A student throws a ball in the positive direction vertically upwards.

The ball makes an elastic collision with the ceiling, rebounds and accelerates back to the student's hand in a time of 1.2 s.

Which graph best represents the acceleration of the ball from the moment it leaves the hand to the instant just before it returns to the hand?



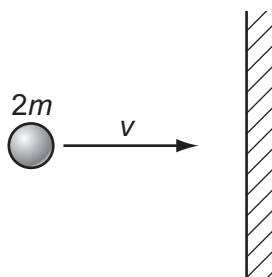
Space for working

- 8 A moving body undergoes uniform acceleration while travelling in a straight line between points X, Y and Z. The distances XY and YZ are both 40 m. The time to travel from X to Y is 12 s and from Y to Z is 6.0 s.

What is the acceleration of the body?

- A 0.37 m s^{-2} B 0.49 m s^{-2} C 0.56 m s^{-2} D 1.1 m s^{-2}

- 9 A particle of mass $2m$ and velocity v strikes a wall.



The particle rebounds along the same path after colliding with the wall. The collision is inelastic.

What is a possible change in the momentum of the ball during the collision?

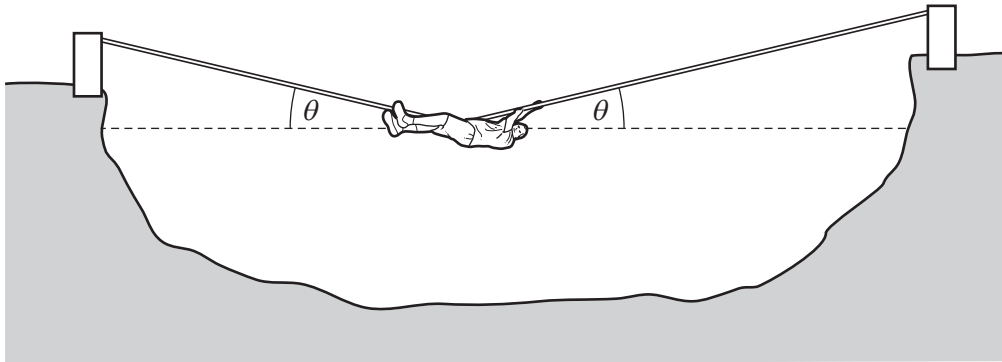
- A mv B $2mv$ C $3mv$ D $4mv$

- 10 Which defines the weight of a body?

- A the amount of matter in the body
B the force of gravity on the body
C the number of particles in the body
D the product of the body's volume and density

Space for working

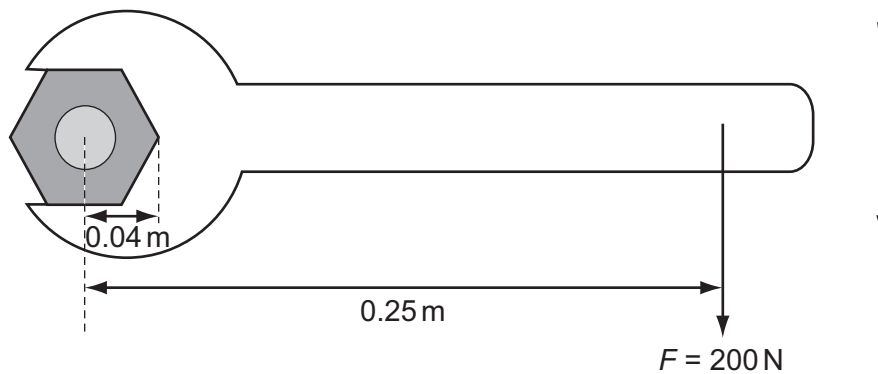
- 11 The diagram shows a rope bridge that a student makes on an adventure training course. The student has a weight W .



Which formula gives the tension T in the rope?

- A $T = \frac{W}{2\cos\theta}$ B $T = \frac{W}{2\sin\theta}$ C $T = \frac{W}{\cos\theta}$ D $T = \frac{W}{\sin\theta}$

- 12 A spanner is used to tighten a nut as shown.



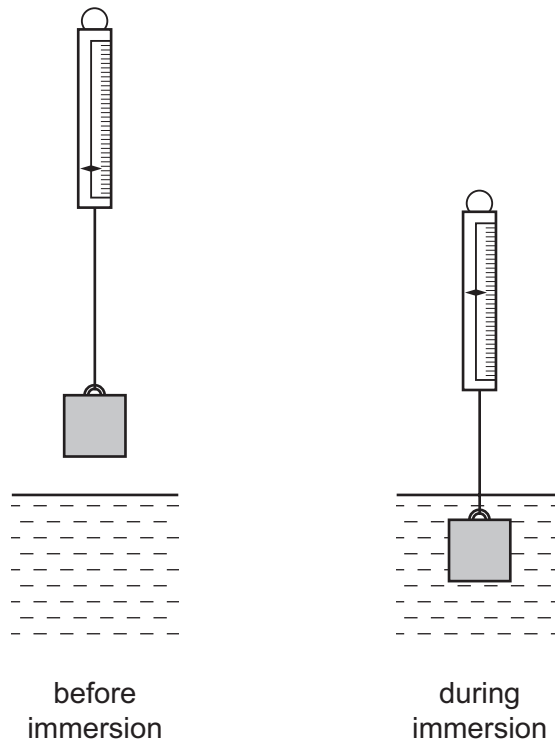
A force F is applied at right-angles to the spanner at a distance of 0.25 m from the centre of the nut. When the nut is fully tightened, the applied force is 200 N.

What is the resistive torque, in an anticlockwise direction, preventing further tightening?

- A 8 N m B 42 N m C 50 N m D 1250 N m

Space for working

- 13 The diagrams show a metal cube suspended from a spring balance before and during immersion in water.



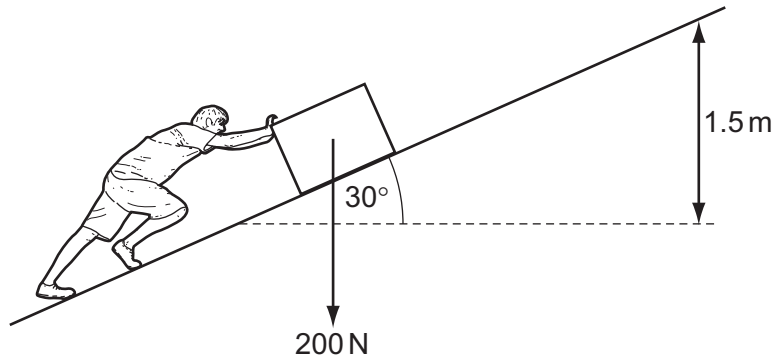
A reduction in the balance reading occurs as a consequence of the immersion.

Which statement is correct?

- A** The balance reading will be further reduced if the cube is lowered further into the water.
- B** The balance reading during immersion corresponds to the upthrust of the water on the cube.
- C** The forces acting on the vertical sides of the cube contribute to the change in the balance reading.
- D** The gravitational pull on the cube is unchanged by the immersion.

Space for working

- 14** A box of weight 200 N is pushed so that it moves at a steady speed along a ramp, through a height of 1.5 m. The ramp makes an angle of 30° with the ground. The frictional force on the box is 150 N while the box is moving.



What is the work done by the person?

- A** 150 J **B** 300 J **C** 450 J **D** 750 J
- 15** A raindrop of mass m is falling vertically through the air with a steady speed v . The raindrop experiences a retarding force kv due to the air, where k is a constant. The acceleration of free fall is g .

Which expression gives the kinetic energy of the raindrop?

- A** $\frac{mg}{k}$ **B** $\frac{mg^2}{2k^2}$ **C** $\frac{m^3g^2}{k^2}$ **D** $\frac{m^3g^2}{2k^2}$

Space for working

- 16** The kinetic energy of a vehicle of mass 1000 kg is 4.5×10^5 J. It is stopped by applying a constant braking force of 6000 N.

What is its stopping distance?

- A** 37 m **B** 75 m **C** 150 m **D** 300 m

- 17** What are units of work, energy and power?

	work	energy	power
A	J	Nm	J
B	J s^{-1}	J	J s^{-1}
C	Nm	Nm	W
D	Nm	W	W

- 18** Below are four short paragraphs describing the molecules in a beaker of water at 50°C.

Which paragraph correctly describes the molecules?

- A** The molecules all travel at the same speed. This speed is not large enough for any of the molecules to leave the surface of the water. There are attractive forces between the molecules.
- B** The molecules have a range of speeds. Some molecules travel sufficiently fast to leave the surface of the water. There are no forces between the molecules.
- C** The molecules have a range of speeds. Some molecules travel sufficiently fast to leave the surface of the water. There are attractive forces between the molecules.
- D** The molecules have a range of speeds. The fastest molecules are unable to leave the surface of the water. There are attractive forces between the molecules.

Space for working

19 Which group of materials contains two polymers?

- A** copper sand polystyrene
- B** glass wood aluminium
- C** nylon sugar rubber
- D** stone diamond steel

20 The pressure at sea level is approximately 100 000 Pa. The density of sea water is 1030 kg m^{-3} .

What is the approximate pressure 80 m below the surface of the sea?

- A** 100 000 Pa **B** 180 000 Pa **C** 800 000 Pa **D** 900 000 Pa

21 Two wires P and Q are made from the same material.

Wire P is initially twice the diameter and twice the length of wire Q. The same force, applied to each wire, causes the wires to extend elastically.

What is the ratio of the extension in P to that in Q?

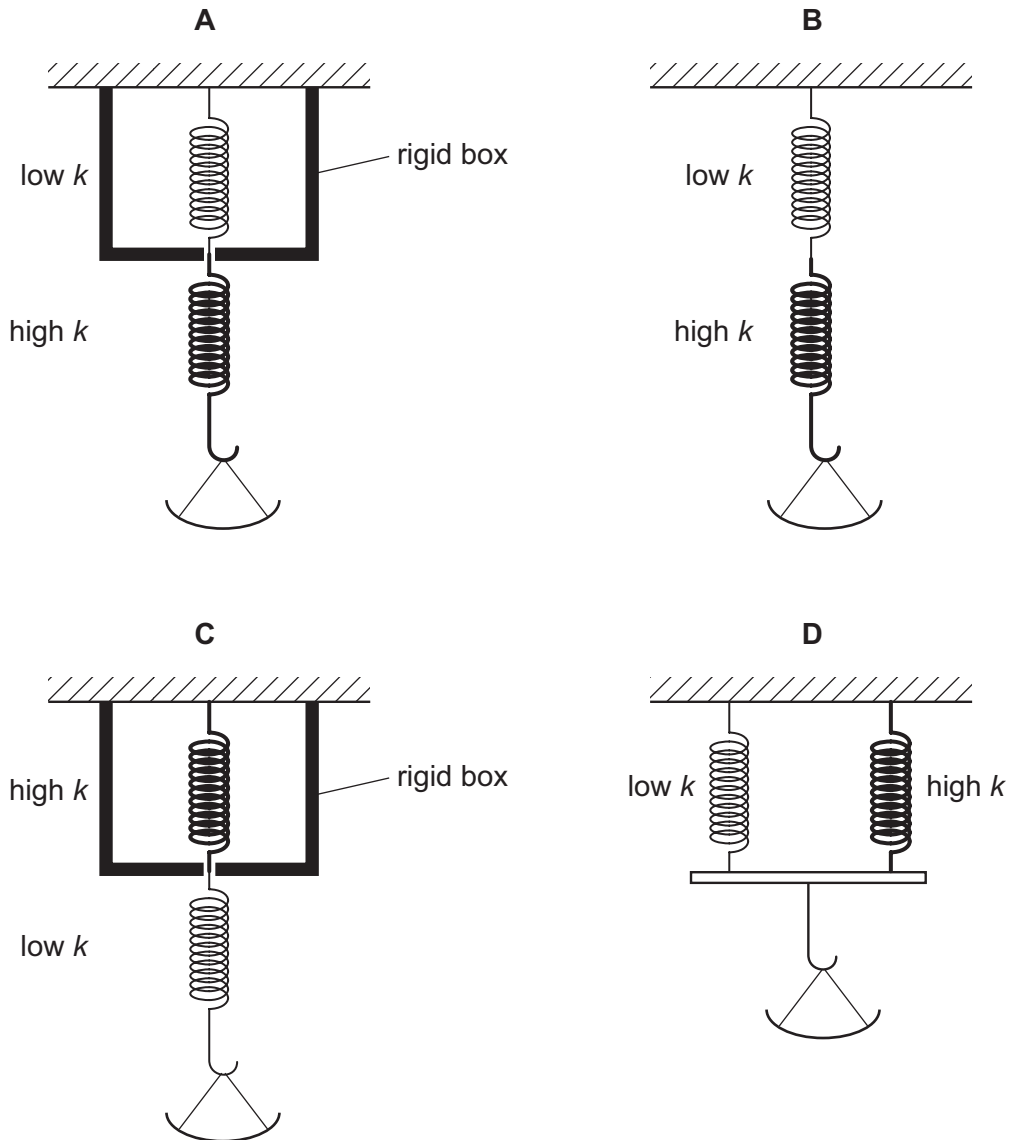
- A** $\frac{1}{2}$ **B** 1 **C** 2 **D** 4

Space for working

- 22 To determine the mass of food in a pan, a scale is used that has high sensitivity for small masses but low sensitivity for large masses.

To do this, two springs are used, each with a different spring constant k . One of the springs has a low spring constant and the other has a high spring constant.

Which arrangement of springs would be suitable?



Space for working

- 23 The amplitude of a wave is A and its intensity is I .

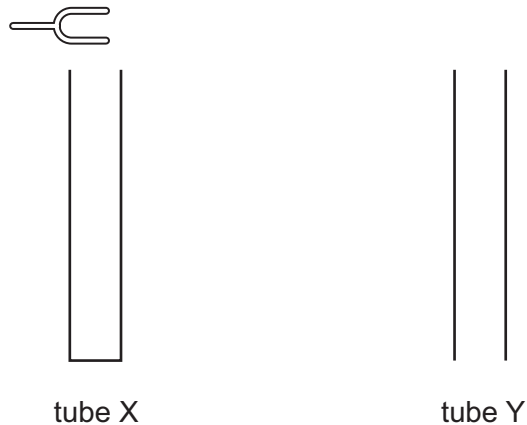
Which amplitude is necessary for the intensity to be doubled to $2I$?

- A A^2 B $\sqrt{A}$ C $\sqrt{2} A$ D $2A$

- 24 Which value is a possible wavelength for radiation in the ultra-violet region of the electromagnetic spectrum?

- A $3 \times 10^{-2} \text{ m}$ B $3 \times 10^{-5} \text{ m}$ C $3 \times 10^{-8} \text{ m}$ D $3 \times 10^{-10} \text{ m}$

- 25 The diagram shows two tubes.



The tubes are identical except tube X is closed at its lower end while tube Y is open at its lower end. Both tubes have open upper ends.

A tuning fork placed above tube X causes resonance of the air at frequency f . No resonance is found at any **lower** frequency than f with tube X.

Which tuning fork will produce resonance when placed just above tube Y?

- A a fork of frequency $\frac{f}{2}$
- B a fork of frequency $\frac{2f}{3}$
- C a fork of frequency $\frac{3f}{2}$
- D a fork of frequency $2f$

Space for working

- 26 A microwave transmitter emits waves towards a metal plate. The waves strike the plate and are reflected back along their original path.



A microwave detector is moved along the line PT.

Points P, Q, R, S and T are the positions where minima of intensity are observed. These points are found to be 15 mm apart.

What is the frequency of the microwaves?

- A** 5.0 GHz **B** 6.7 GHz **C** 10 GHz **D** 20 GHz
- 27 A double slit experiment, using light of wavelength 600 nm, results in fringes being produced on a screen. The fringe separation is found to be 1.0 mm.

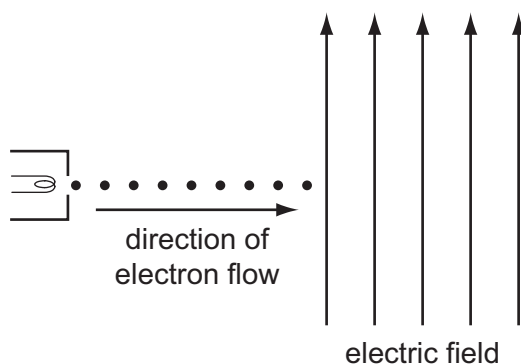
When the distance between the double slits and the viewing screen is increased **by** 2.0 m, the fringe separation increases **to** 3.0 mm.

What is the separation of the double slits producing the fringes?

- A** 0.4 mm **B** 0.6 mm **C** 0.9 mm **D** 1.2 mm

Space for working

28 The diagram shows a vertical uniform electric field in a vacuum.



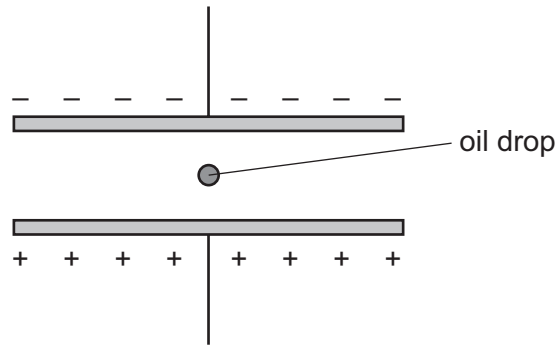
An electron gun injects a beam of electrons horizontally into the field.

Which changes, if any, have occurred to the path and speed of the electrons by the time the beam leaves the field?

	path of electrons	speed of electrons
A	deflected downwards	increased
B	deflected downwards	unchanged
C	deflected upwards	increased
D	deflected upwards	unchanged

Space for working

- 29 A very small oil drop of mass m carries a charge $+q$.



The potential difference across the plates is V and the separation is d .

The weight of the drop is balanced by the electric force. (Buoyancy forces may be considered to be negligible.)

Which formula gives the charge on the drop?

- A** $q = \frac{mgd}{V}$
 B $q = \frac{mgV}{d}$
 C $q = \frac{Vd}{mg}$
 D $q = \frac{V}{mgd}$

- 30 Which electrical component is represented by the following symbol?



- A** a diode
B a potentiometer
C a resistor
D a thermistor

Space for working

- 31 When there is **no current** in a wire, which statement about the conduction electrons in that wire is correct?
- A Electrons in the wire are moving totally randomly within the wire.
 - B Equal numbers of electrons move at the same speed, but in opposite directions, along the wire.
 - C No current is flowing therefore the electrons in the wire are stationary.
 - D No current is flowing therefore the electrons in the wire are vibrating around a fixed point.

- 32 A high-resistance voltmeter connected across a battery reads 6.0 V.

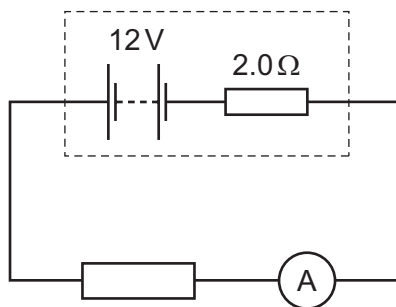
When the battery is connected in series with a lamp of resistance of $10\ \Omega$, the voltmeter reading falls to 5.6 V.

Which statement explains this observation?

- A The electromotive force (e.m.f.) of the battery decreases because more work is done across its internal resistance.
- B The e.m.f. of the battery decreases because work is done across the lamp.
- C The potential difference (p.d.) across the battery decreases because more work is done across its internal resistance.
- D The p.d. across the battery decreases because work is done across the lamp.

Space for working

- 33 A battery of e.m.f. 12 V and internal resistance $2.0\ \Omega$ is connected in series with an ammeter of negligible resistance and an external resistor. External resistors of various different values are used.

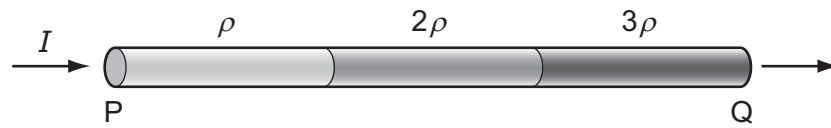


Which combination of current and resistor value is **not** correct?

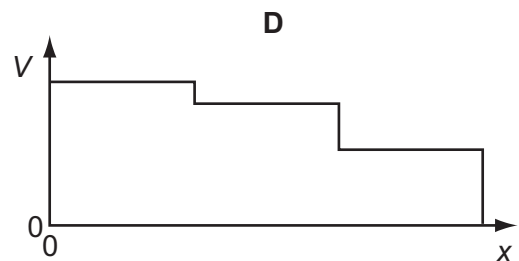
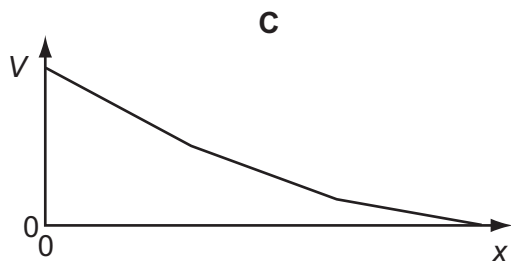
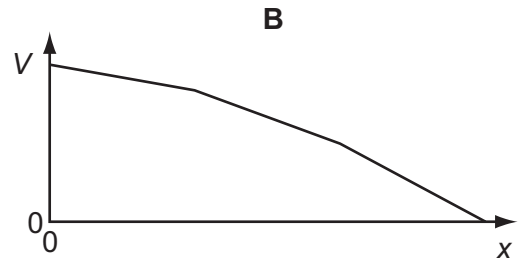
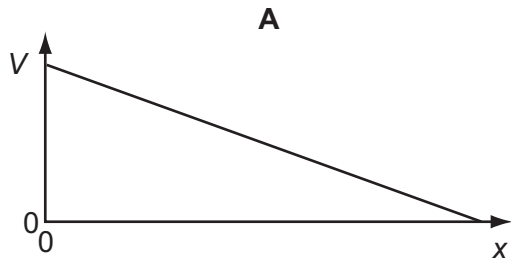
	current / A	external resistor value / Ω
A	1.0	10
B	1.2	8
C	1.5	6
D	1.8	4

Space for working

- 34 A wire PQ is made of three different materials, with resistivities ρ , 2ρ and 3ρ . There is a current I in this composite wire, as shown.

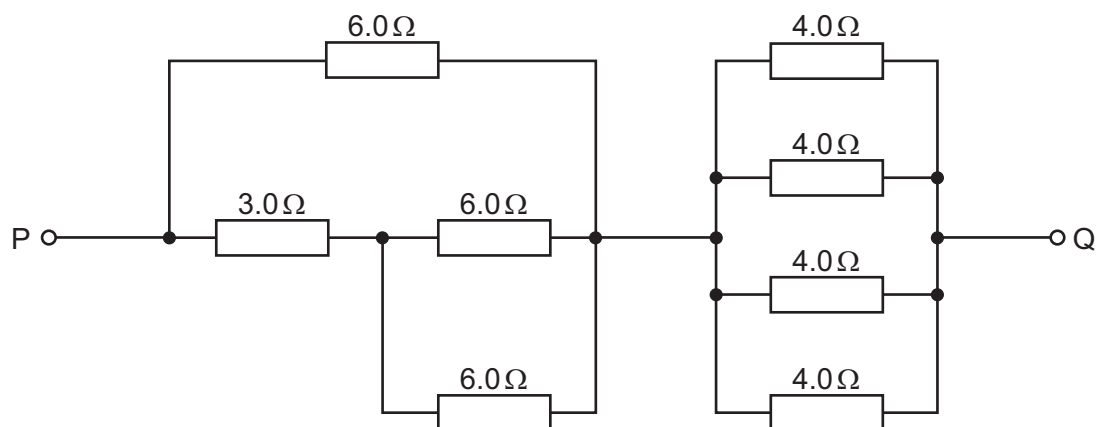


Which graph best shows how the potential V along the wire varies with distance x from P?



Space for working

35 The diagram shows part of a circuit.

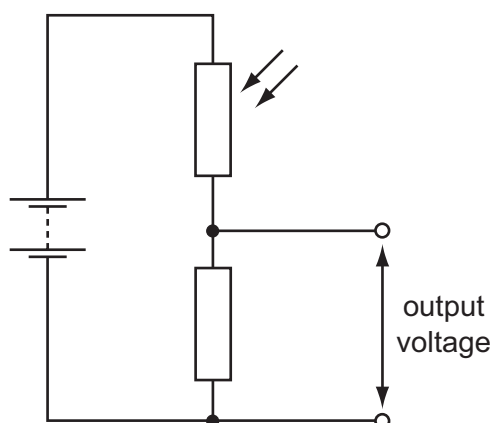


What is the resistance between the points P and Q due to the resistance network?

- A** 1.3Ω **B** 4.0Ω **C** 10Ω **D** 37Ω

Space for working

36 The diagram shows a potential divider circuit.



The light level increases.

What is the effect on the resistance of the light-dependent resistor (LDR) and on the output voltage?

	resistance of the LDR	output voltage
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

37 Three resistors, with resistances R_1 , R_2 and R_3 , are connected in series and are found to have a combined resistance of $500\ \Omega$. When connected in parallel, the combined resistance is found to be $50\ \Omega$.

Which values will correspond to these results?

	R_1/Ω	R_2/Ω	R_3/Ω
A	160	160	80
B	200	200	100
C	225	225	50
D	230	230	40

Space for working

- 38** In the Rutherford scattering experiment, α -particles were fired at a thin gold foil. A small proportion of the α -particles were deflected through large angles.

Which statement gives the correct conclusion that could be drawn directly from these results?

- A** The atom is made up of electrons, protons and neutrons.
 - B** The nucleus is at the centre of the atom.
 - C** The nucleus is made up of protons and neutrons.
 - D** The atom contains a very small, charged nucleus.
- 39** Which statement about the nuclei of the atoms of an element is correct?
- A** Every nucleus of an element contains an equal number of neutrons and protons.
 - B** Every nucleus of an element contains the same number of neutrons as all others of that element, but the number of protons may differ.
 - C** Every nucleus of an element contains the same number of protons as all others of that element, but the number of neutrons may differ.
 - D** The number of protons in a nucleus differs from isotope to isotope of an element, as do the number of neutrons.

Space for working

- 40** A counter recording radioactive decays from a radioactive source gives the following counts in equal intervals of time.

time / min	counts
0–10	424
10–20	395
20–30	413
30–40	363
40–50	366
50–60	294
60–70	301
70–80	253
80–90	212

What can be deduced from these readings?

- A** that radioactivity is random and that the half-life is 90 minutes
- B** that radioactivity is random and that the half-life is uncertain
- C** that radioactivity is spontaneous and that the half-life is 90 minutes
- D** that radioactivity is spontaneous and that the half-life is uncertain

Space for working



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

PHYSICS

9702/13

Paper 1 Multiple Choice

October/November 2010

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, highlighters, 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.

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.

This document consists of **24** printed 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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
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,

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

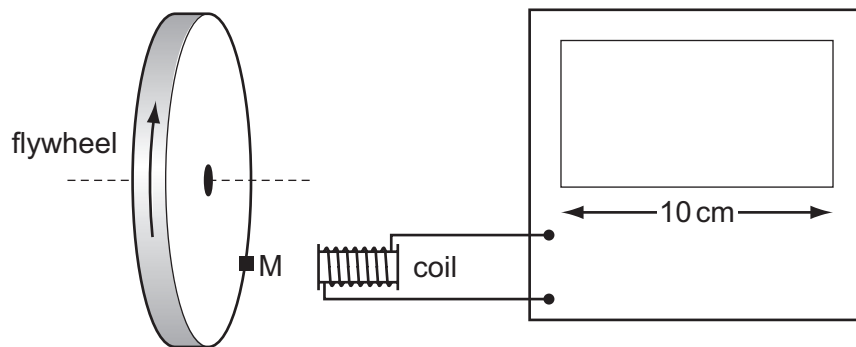
radioactive decay,

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

decay constant,

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

- 1 Which physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge?
- A electric current
B electric energy
C electric field strength
D electric power
- 2 The diagram shows a cathode-ray oscilloscope (c.r.o.) being used to measure the rate of rotation of a flywheel.



The flywheel has a small magnet M mounted on it. Each time the magnet passes the coil, a voltage pulse is generated, which is passed to the c.r.o. The display of the c.r.o. is 10 cm wide. The flywheel is rotating at a rate of about 3000 revolutions per minute.

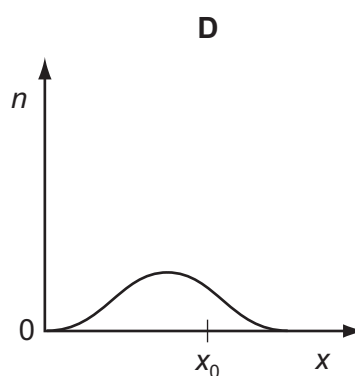
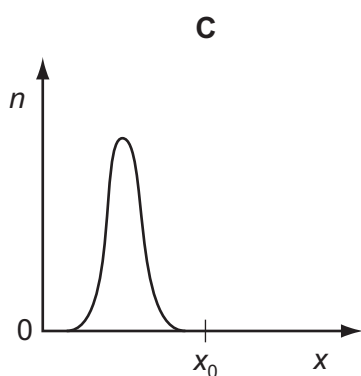
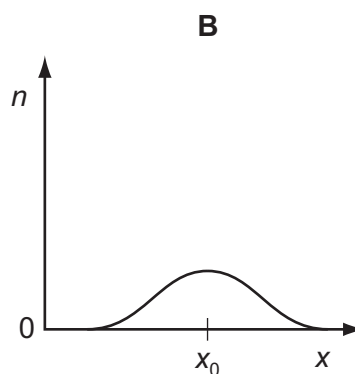
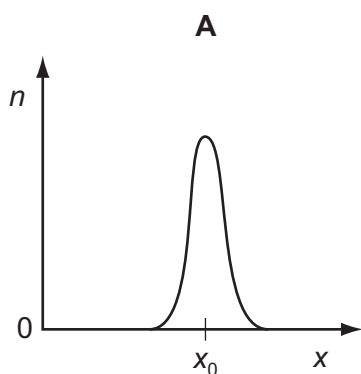
Which time-base setting will display clearly separate pulses on the screen?

- A 1 s cm^{-1} B 10 ms cm^{-1} C $100 \mu\text{s cm}^{-1}$ D $1 \mu\text{s cm}^{-1}$

Space for working

- 3 A fixed quantity x_0 is measured many times in an experiment that has experimental uncertainty. A graph is plotted to show the number n of times that a particular value x is obtained.

Which graph could be obtained if the measurement of x_0 has a large systematic error but a small random error?



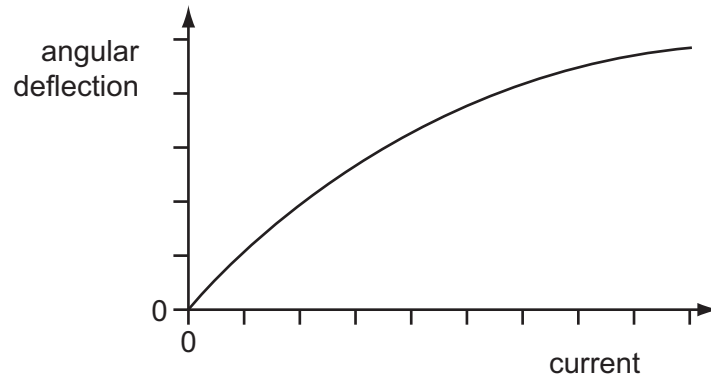
Space for working

- 4 A signal has a frequency of 2.0 MHz.

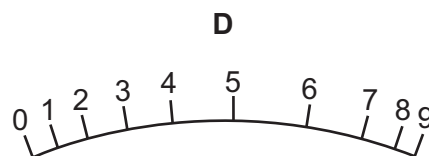
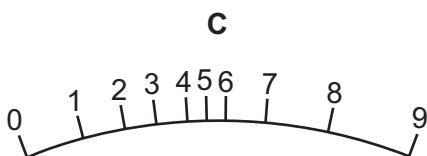
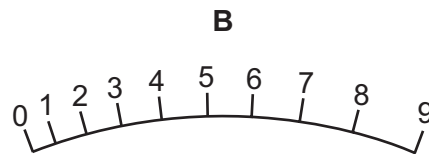
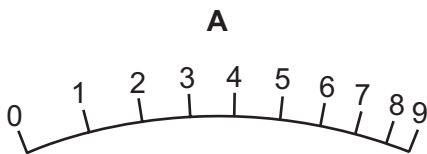
What is the period of the signal?

- A $2\ \mu\text{s}$ B $5\ \mu\text{s}$ C 200 ns D 500 ns

- 5 The angular deflection of the needle of an ammeter varies with the current passing through the ammeter as shown in the graph.

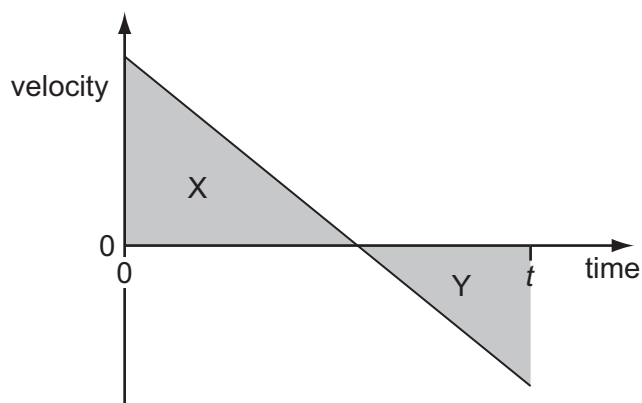


Which diagram could represent the appearance of the scale on this meter?



Space for working

- 6 The velocity-time graph below is for a stone thrown vertically up into the air. Air resistance is negligible.



The stone is thrown up at time zero.

Area X represents a distance of 5 m. Area Y represents a distance of 3 m.

What is the displacement of the stone from its initial position at time t ?

- A** 2 m **B** 3 m **C** 5 m **D** 8 m
- 7 A metal sphere of radius r is dropped into a tank of water. As it sinks at speed v , it experiences a drag force F given by $F = krv$, where k is a constant.

What are the SI base units of k ?

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

Space for working

- 8 The gravitational field strength on the surface of planet P is one tenth of that on the surface of planet Q.

On the surface of P, a body has a mass of 1.0 kg and a weight of 1.0 N.

What are the mass and weight of the same body on the surface of planet Q?

	mass on Q / kg	weight on Q / N
A	1.0	0.1
B	1.0	10
C	10	10
D	10	100

- 9 A body, initially at rest, explodes into two masses M_1 and M_2 that move apart with speeds v_1 and v_2 respectively.

What is the ratio $\frac{v_1}{v_2}$?

A $\frac{M_1}{M_2}$

B $\frac{M_2}{M_1}$

C $\sqrt{\frac{M_1}{M_2}}$

D $\sqrt{\frac{M_2}{M_1}}$

Space for working

- 10** Two experiments are carried out using two trolleys of equal mass. All moving parts of the trolleys are frictionless, as is the surface that the trolleys move over. In both experiments, trolley X moves towards trolley Y, which is initially stationary.



After the collision in experiment 1, X is stationary and Y moves off to the right.

After the collision in experiment 2, the trolleys join and move off together.

What types of collision occur in these experiments?

	experiment 1	experiment 2
A	elastic	elastic
B	elastic	inelastic
C	inelastic	elastic
D	inelastic	inelastic

- 11** A ball is thrown horizontally in still air from the top of a very tall building. The ball is affected by air resistance.

What happens to the horizontal and to the vertical components of the ball's velocity?

	horizontal component of velocity	vertical component of velocity
A	decreases to zero	increases at a constant rate
B	decreases to zero	increases to a constant value
C	remains constant	increases at a constant rate
D	remains constant	increases to a constant value

Space for working

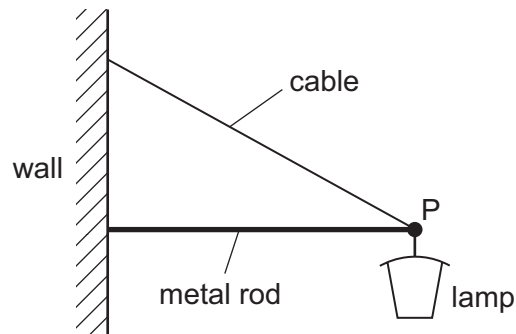
- 12** In order that a train can stop safely, it will always pass a signal showing a yellow light before it reaches a signal showing a red light. Drivers apply the brake at the yellow light and this results in a uniform deceleration to stop exactly at the red light.

The distance between the red and yellow lights is x .

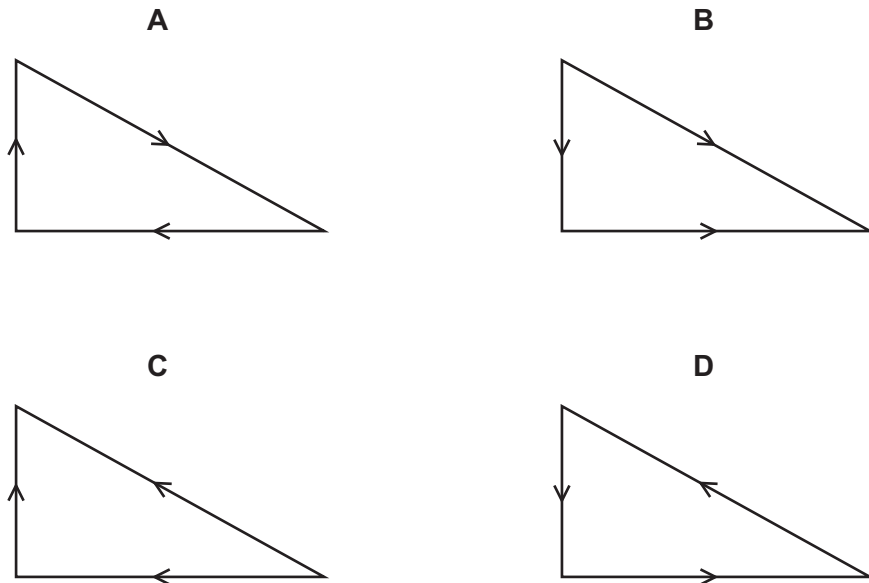
What must be the minimum distance between the lights if the train speed is increased by 20 %, without changing the deceleration of the trains?

- A** $1.20x$ **B** $1.25x$ **C** $1.44x$ **D** $1.56x$

- 13** A street lamp is fixed to a wall by a metal rod and a cable.

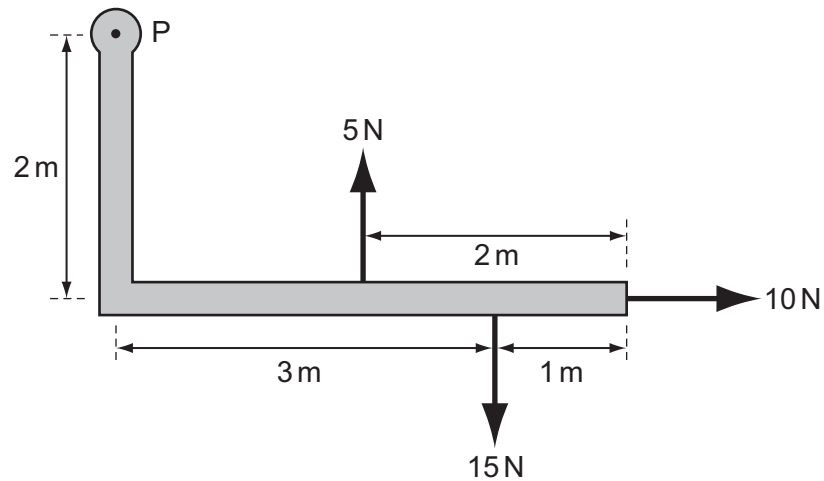


Which vector triangle represents the forces acting at point P?



Space for working

- 14 A rigid L-shaped lever arm is pivoted at point P.

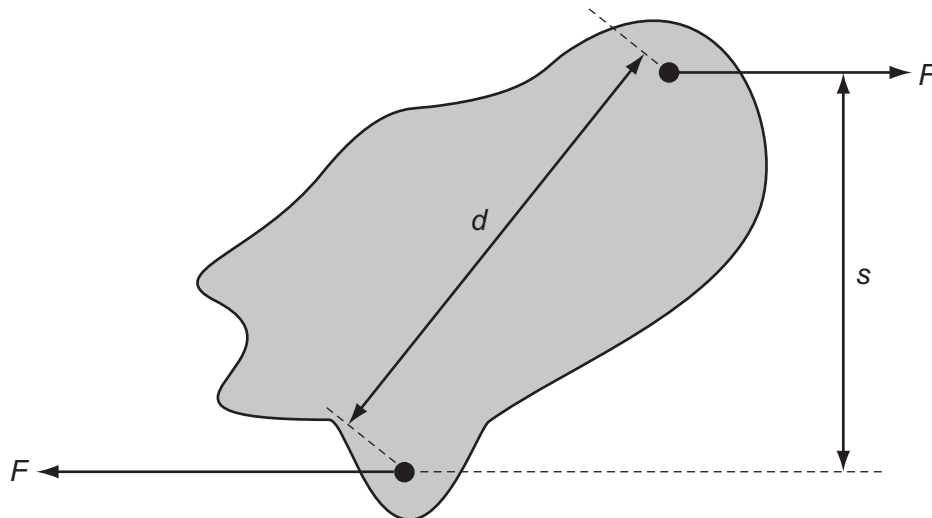


Three forces act on the lever arm, as shown in the diagram.

What is the magnitude of the resultant moment of these forces about point P?

- A 15 Nm B 20 Nm C 35 Nm D 75 Nm

- 15 Two parallel forces, each of magnitude F , act on a body as shown.

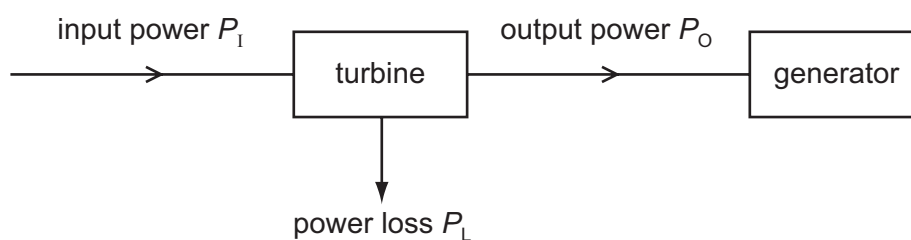


What is the magnitude of the torque on the body produced by these forces?

- A Fd B Fs C $2Fd$ D $2Fs$

Space for working

- 16 A steam turbine is used to drive a generator. The input power to the turbine is P_I and the output power P_O . The power loss in the turbine is P_L , as shown below.



What is the efficiency of the turbine?

A $\frac{P_L}{P_O}$

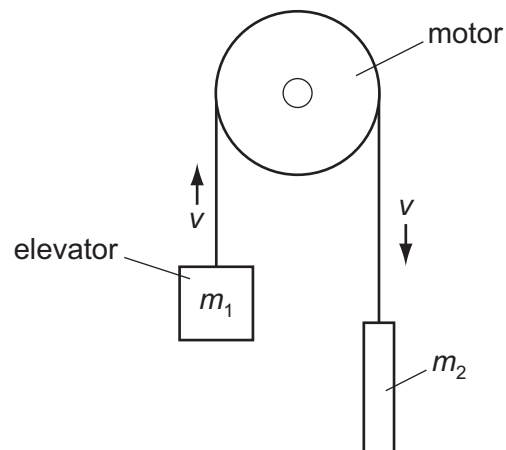
B $\frac{P_I}{P_O}$

C $\frac{P_L}{P_I}$

D $\frac{P_O}{P_I}$

Space for working

- 17 The diagram shows a lift system in which the elevator (mass m_1) is partly counterbalanced by a heavy weight (mass m_2).

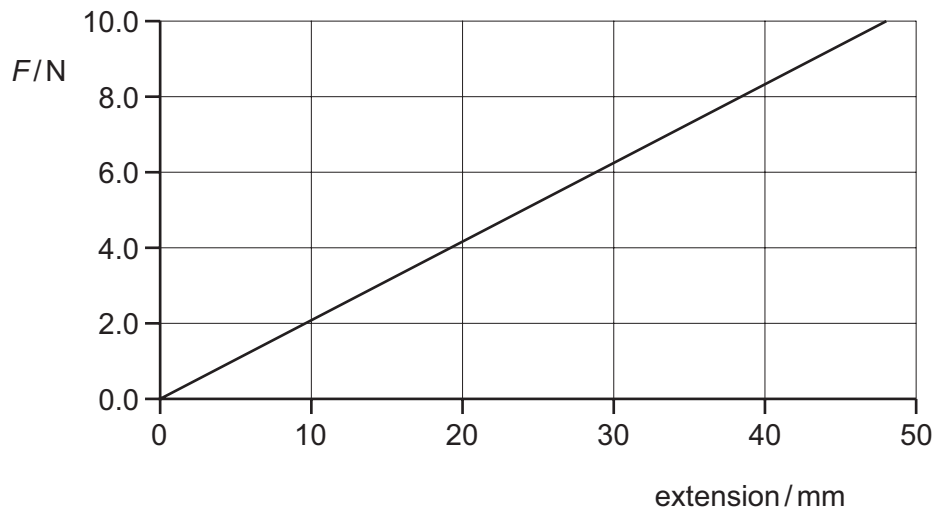


At what rate does the motor provide energy to the system when the elevator is rising at a steady speed v ? (g = acceleration of free fall)

- A $\frac{1}{2} m_1 v^2$
 - B $\frac{1}{2} (m_1 - m_2) v^2$
 - C $m_1 g v$
 - D $(m_1 - m_2) g v$
- 18 What is the internal energy of a system?
- A the amount of heat supplied to the system
 - B the energy of the atoms of the system
 - C the total kinetic energy of the system
 - D the total potential energy of the system

Space for working

- 19 The graph shows how force depends on extension for a certain spring.



What is the energy stored in the spring when the extension is 30 mm?

- A 0.095 J B 0.19 J C 0.25 J D 0.95 J
- 20 The Mariana Trench in the Pacific Ocean has a depth of about 10 km.

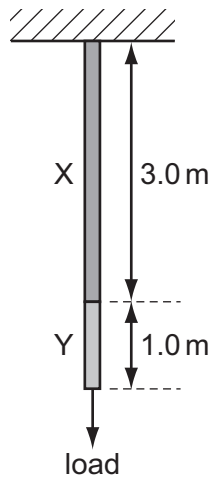
Assuming that sea water is incompressible and has a density of about 1020 kg m^{-3} , what would be the approximate pressure at that depth?

- A 10^5 Pa B 10^6 Pa C 10^7 Pa D 10^8 Pa

Space for working

- 21** A wire consists of a 3.0 m length of metal X joined to a 1.0 m length of metal Y.

The cross-sectional area of the wire is uniform.



A load hung from the wire causes metal X to stretch by 1.5 mm and metal Y to stretch by 1.0 mm.

The same load is then hung from a second wire of the same cross-section, consisting of 1.0 m of metal X and 3.0 m of metal Y.

What is the total extension of this second wire?

- A** 2.5 mm **B** 3.5 mm **C** 4.8 mm **D** 5.0 mm

Space for working

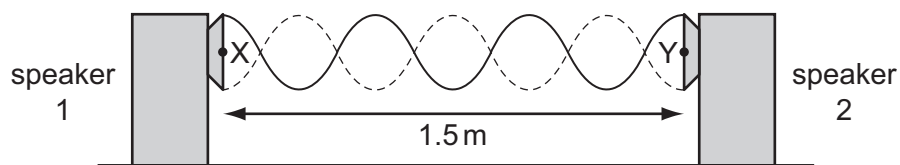
22 A student writes some statements about solids, liquids and gases.

- 1 Solids are rigid because the molecules in a solid vibrate.
- 2 Liquids flow because the molecules in a liquid are closer than in a gas.
- 3 Gases are less dense than liquids because the molecules in a gas move randomly.

Which statements are correct?

- A** 1 only
B 1 and 3 only
C 2 and 3 only
D none of the above

23 A stationary wave is produced by two loudspeakers emitting sound of the same frequency.



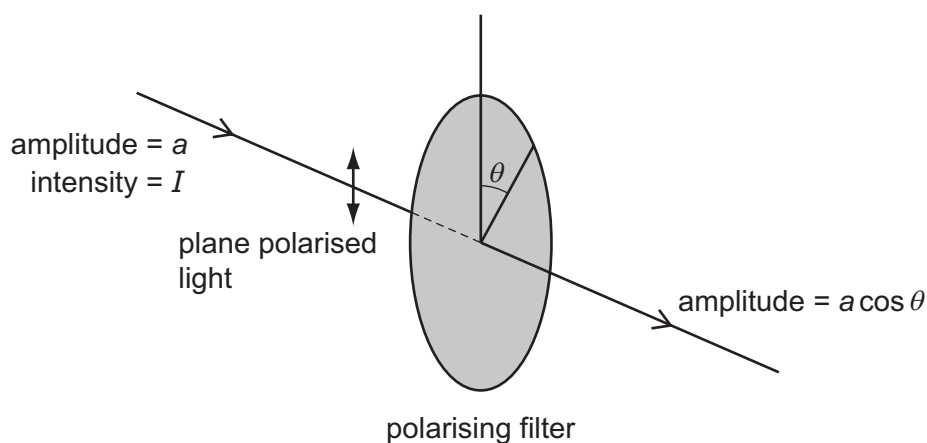
When a microphone is moved between X and Y, a distance of 1.5 m, six nodes and seven antinodes are detected.

What is the wavelength of the sound?

- A** 0.50 m **B** 0.43 m **C** 0.25 m **D** 0.21 m

Space for working

- 24 When plane-polarised light of amplitude a is passed through a polarising filter as shown, the amplitude of the light emerging is $a \cos \theta$.



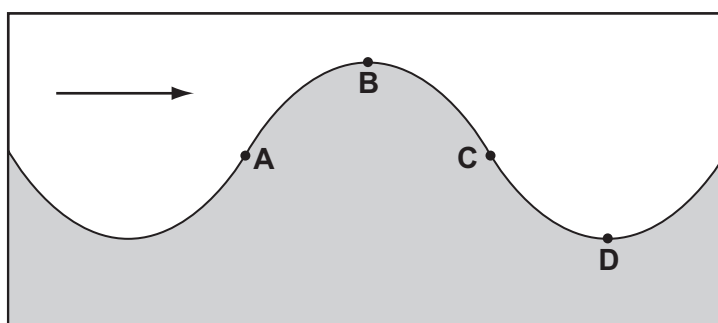
The intensity of the initial beam is I .

What is the intensity of the emerging light when θ is 60.0° ?

- A** $0.250 I$ **B** $0.500 I$ **C** $0.750 I$ **D** $0.866 I$

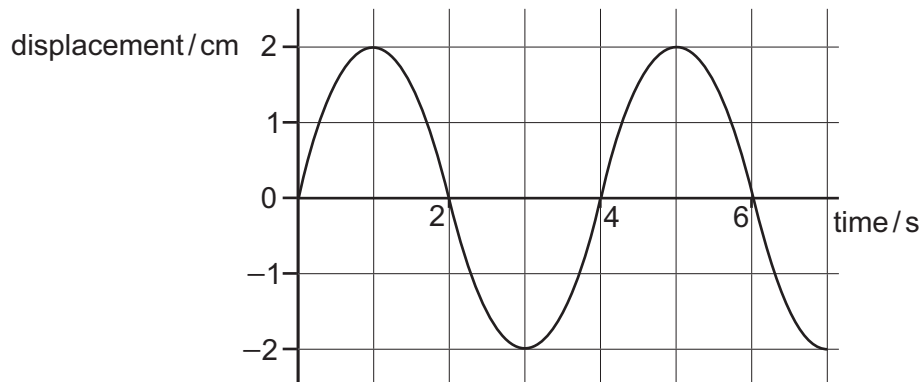
- 25 The diagram shows a vertical cross-section through a water wave moving from left to right.

At which point is the water moving upwards with maximum speed?



Space for working

- 26 Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around 10^{-10} m?
- A infra-red
 - B microwave
 - C ultraviolet
 - D X-ray
- 27 The graph shows how the displacement of a particle in a wave varies with time.

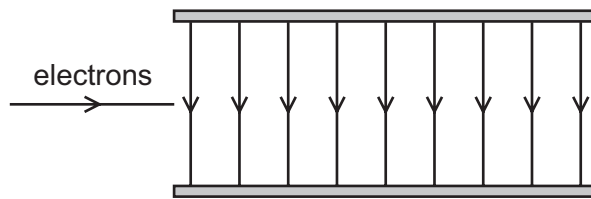


Which statement is correct?

- A The wave has an amplitude of 2 cm and could be either transverse or longitudinal.
- B The wave has an amplitude of 2 cm and must be transverse.
- C The wave has an amplitude of 4 cm and could be either transverse or longitudinal.
- D The wave has an amplitude of 4 cm and must be transverse.

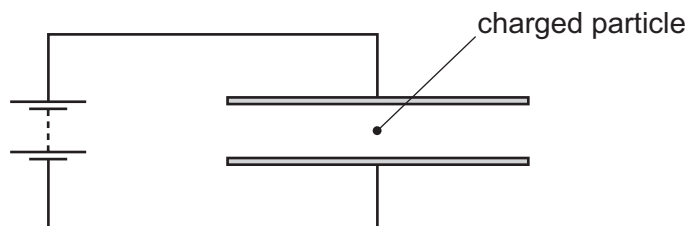
Space for working

- 28 Electrons are accelerated and then directed into the uniform electric field between two parallel plates in a vacuum.



What best describes the shape of the path followed by the electrons in the field?

- A a downwards curve along a line that is part of a circle
 - B a downwards curve along a line that is **not** part of a circle
 - C an upwards curve along a line that is part of a circle
 - D an upwards curve along a line that is **not** part of a circle
- 29 A charged particle is in the electric field between two horizontal metal plates connected to a source of constant potential difference, as shown. There is a force F on the particle due to the electric field.



The separation of the plates is doubled.

What will be the new force on the particle?

- A $\frac{F}{4}$
- B $\frac{F}{2}$
- C F
- D $2F$

Space for working

- 30** An electron is in an electric field of strength $5 \times 10^4 \text{ V m}^{-1}$. The field is the only influence on the electron.

The mass and charge of an electron are known.

Which quantity can be calculated without any more information?

- A** the force on the electron
 - B** the momentum of the electron
 - C** the kinetic energy of the electron
 - D** the speed of the electron
- 31** A relay is required to operate 800 m from its power supply. The power supply has negligible internal resistance. The relay requires 16.0 V and a current of 0.60 A to operate.

A cable connects the relay to the power supply and two of the wires in the cable are used to supply power to the relay.

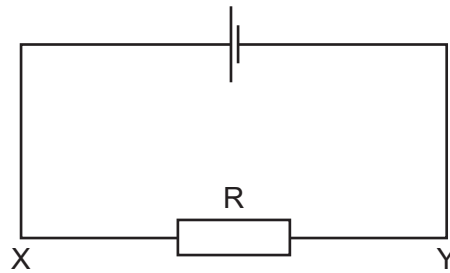
The resistance of each of these wires is 0.0050Ω per metre.

What is the minimum output e.m.f. of the power supply?

- A** 16.6 V **B** 18.4 V **C** 20.8 V **D** 29.3 V

Space for working

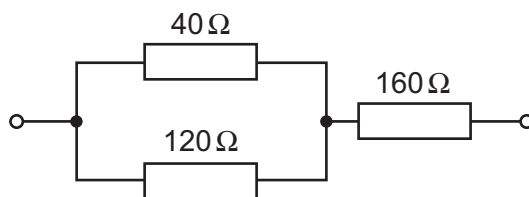
32 The current in the circuit shown is 4.8 A.



What is the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow
A	X to Y	$3.0 \times 10^{19} \text{ s}^{-1}$
B	X to Y	$6.0 \times 10^{18} \text{ s}^{-1}$
C	Y to X	$3.0 \times 10^{19} \text{ s}^{-1}$
D	Y to X	$6.0 \times 10^{18} \text{ s}^{-1}$

33 The diagram shows part of a circuit.



What is the total resistance of the combination of the three resistors?

- A** 320Ω **B** 240Ω **C** 190Ω **D** 80Ω

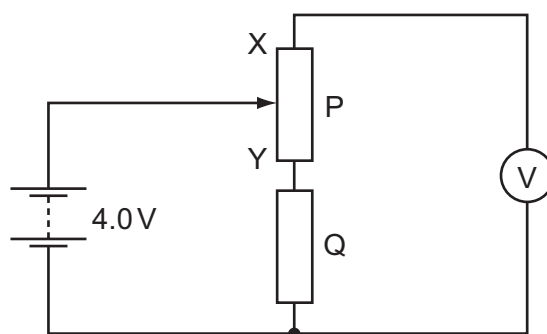
Space for working

- 34** A copper wire is cylindrical and has resistance R .

What will be the resistance of a copper wire of twice the length and twice the radius?

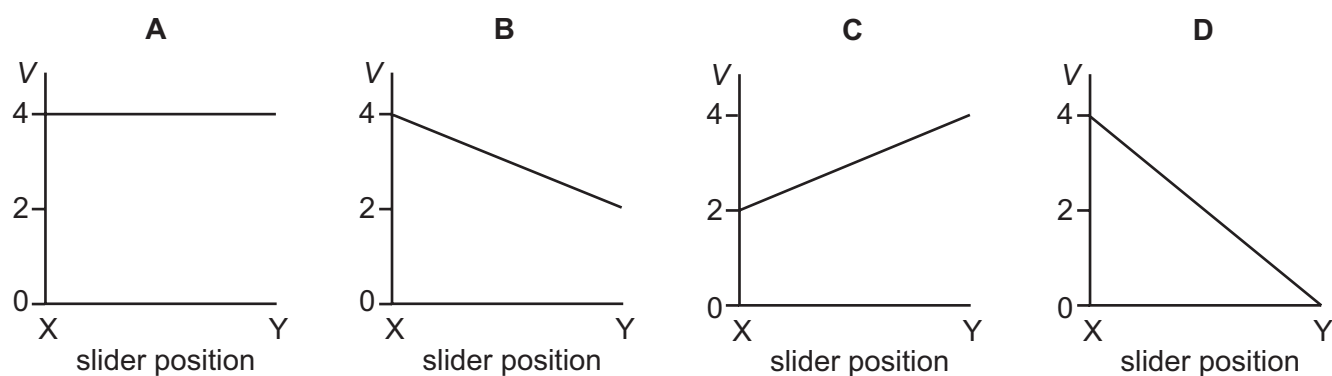
- A** $\frac{R}{4}$ **B** $\frac{R}{2}$ **C** R **D** $2R$

- 35** In the circuit below, P is a potentiometer of total resistance $10\ \Omega$ and Q is a fixed resistor of resistance $10\ \Omega$. The battery has an e.m.f. of 4.0 V and negligible internal resistance. The voltmeter has a very high resistance.



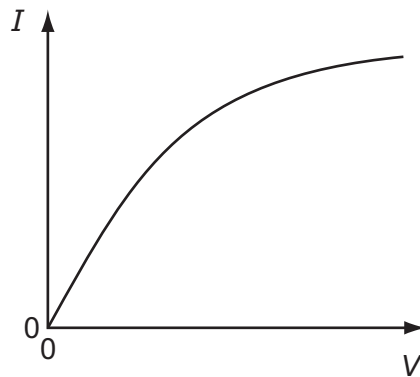
The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph would be obtained?



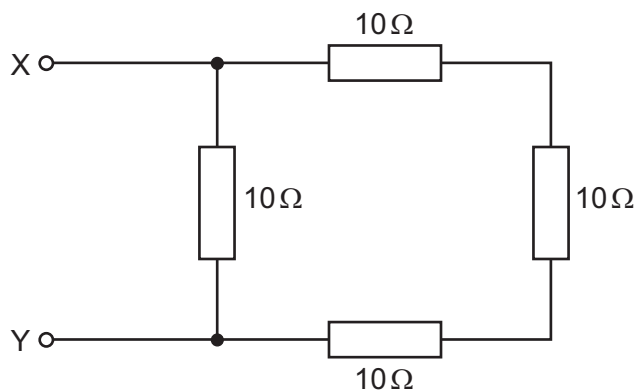
Space for working

36 Which component has the I - V graph shown?



- A filament lamp
- B light-dependent resistor
- C semiconductor diode
- D thermistor

37 The diagram shows an arrangement of resistors.

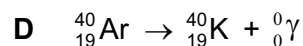
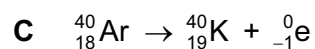
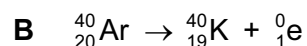
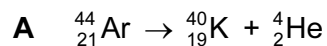


What is the total electrical resistance between X and Y?

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

Space for working

38 Which nuclear equation shows the beta decay of a nucleus of argon (Ar) into potassium (K)?



39 Uranium-235 may be represented by the symbol ${}_{92}^{235}\text{U}$.

Which row shows the numbers of nucleons, protons and neutrons in a ${}_{92}^{235}\text{U}$ nucleus?

	nucleons	protons	neutrons
A	92	235	143
B	143	92	235
C	235	92	143
D	235	143	92

40 When a magnesium nucleus ${}_{12}^{25}\text{Mg}$ is hit by a gamma ray, a sodium nucleus ${}_{11}^{24}\text{Na}$ is formed and another particle is emitted.

What are the nucleon number (mass number) and proton number (atomic number) of the other particle produced in this nuclear reaction?

	nucleon number	proton number
A	0	-1
B	0	1
C	1	-1
D	1	1

Space for working