

PHYSICS

9702/11

Paper 1 Multiple Choice

May/June 2014

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 **23** 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 pair of units contains one derived unit and one SI base unit?

- A ampere coulomb
- B kilogram kelvin
- C metre second
- D newton pascal

2 What is equivalent to 2000 microvolts?

- A $2\mu\text{J C}^{-1}$
- B 2 mV
- C 2 pV
- D 2000 mV

3 The speed v of a liquid leaving a tube depends on the change in pressure ΔP and the density ρ of the liquid. The speed is given by the equation

$$v = k \left(\frac{\Delta P}{\rho} \right)^n$$

where k is a constant that has no units.

What is the value of n ?

- A $\frac{1}{2}$
- B 1
- C $\frac{3}{2}$
- D 2

Space for working

- 4 An experiment is carried out to measure the resistance of a wire.

The current in the wire is $(1.0 \pm 0.2)\text{A}$ and the potential difference across the wire is $(8.0 \pm 0.4)\text{V}$.

What is the resistance of the wire and its uncertainty?

- A $(8.0 \pm 0.2)\Omega$
 B $(8.0 \pm 0.6)\Omega$
 C $(8 \pm 1)\Omega$
 D $(8 \pm 2)\Omega$
- 5 The Young modulus of the material of a wire is to be found. The Young modulus E is given by the equation below.

$$E = \frac{4Fl}{\pi d^2 x}$$

The wire is extended by a known force and the following measurements are made.

Which measurement has the largest effect on the uncertainty in the value of the calculated Young modulus?

	measurement	symbol	value
A	length of wire before force applied	l	$2.043 \pm 0.002\text{ m}$
B	diameter of wire	d	$0.54 \pm 0.02\text{ mm}$
C	force applied	F	$19.62 \pm 0.01\text{ N}$
D	extension of wire with force applied	x	$5.2 \pm 0.2\text{ mm}$

Space for working

- 6 A tennis ball is thrown horizontally in air from the top of a tall building.

If the effect of air resistance is **not** negligible, what happens to the horizontal and vertical components of the ball's velocity?

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

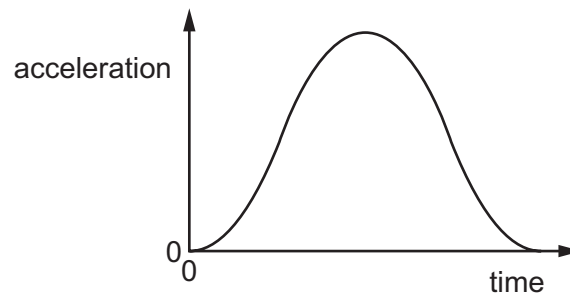
- 7 An object is thrown with velocity 5.2 ms^{-1} vertically upwards on the Moon. The acceleration due to gravity on the Moon is 1.62 ms^{-2} .

What is the time taken for the object to return to its starting point?

- A** 2.5 s **B** 3.2 s **C** 4.5 s **D** 6.4 s

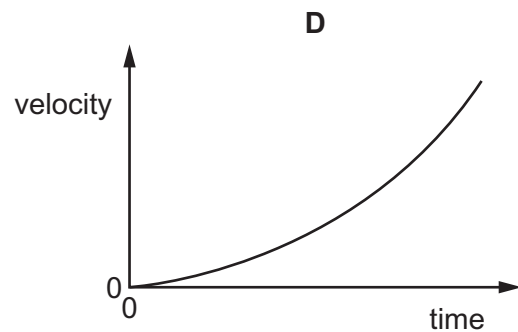
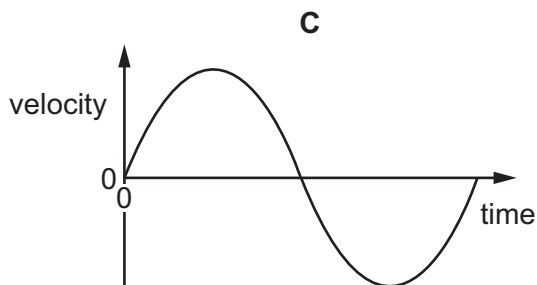
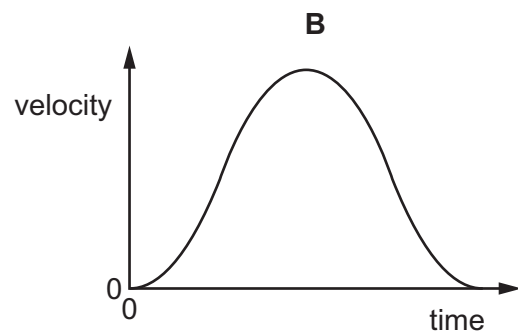
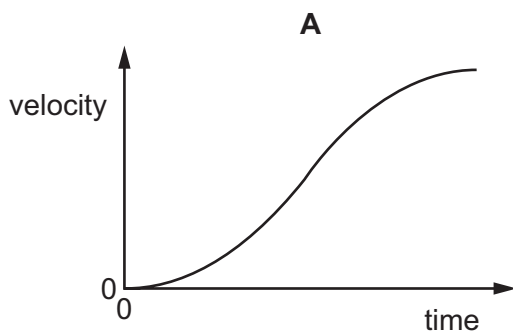
Space for working

- 8 The graph shows how the acceleration of an object moving in a straight line varies with time.



The object starts from rest.

Which graph shows the variation with time of the velocity of the object over the same time interval?

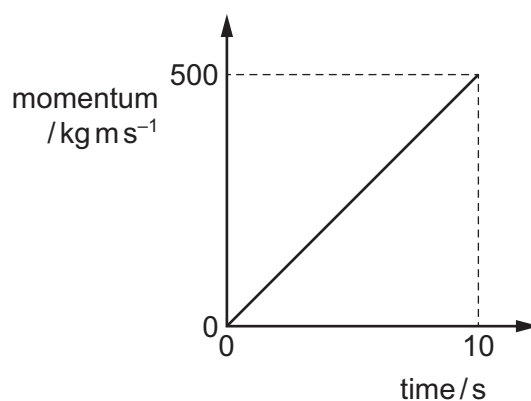


Space for working

- 9 An object of mass 4.0 kg moving with a speed of 3.0 ms^{-1} strikes a stationary object in an inelastic collision.

Which statement is correct?

- A After collision, the total kinetic energy is 18 J .
B After collision, the total kinetic energy is less than 18 J .
C Before collision, the total kinetic energy is 12 J .
D Before collision, the total kinetic energy is less than 12 J .
- 10 The graph shows how the momentum of a motorcycle changes with time.

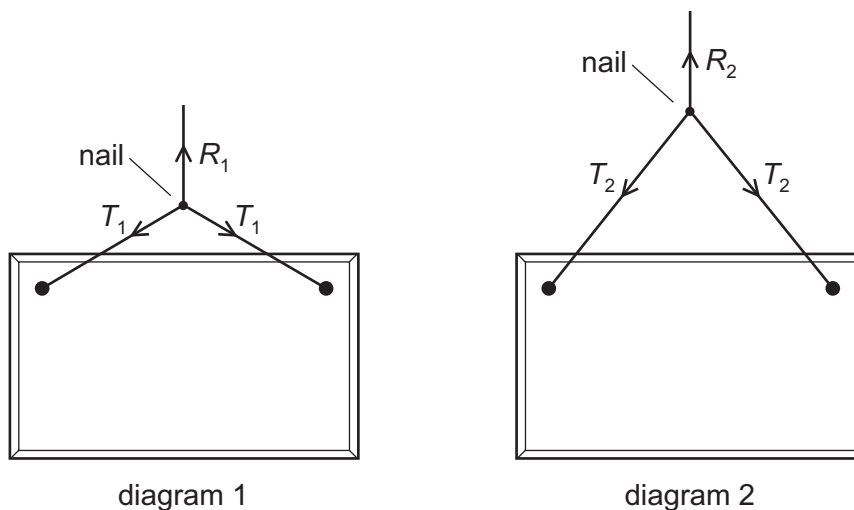


What is the resultant force on the motorcycle?

- A 50 N B 500 N C 2500 N D 5000 N

Space for working

11 The diagrams show two ways of hanging the same picture.



In both cases, a string is attached to the same points on the picture and looped symmetrically over a nail in a wall. The forces shown are those that act on the nail.

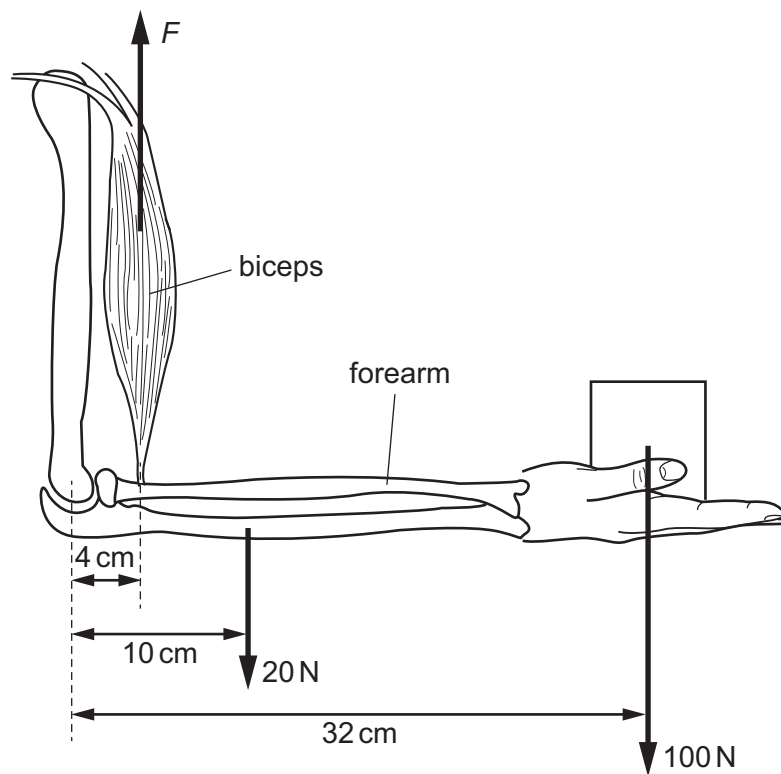
In diagram 1, the string loop is shorter than in diagram 2.

Which information about the magnitude of the forces is correct?

- A** $R_1 = R_2$ $T_1 = T_2$
- B** $R_1 = R_2$ $T_1 > T_2$
- C** $R_1 > R_2$ $T_1 < T_2$
- D** $R_1 < R_2$ $T_1 = T_2$

Space for working

- 12 A man holds a 100 N load stationary in his hand. The combined weight of the forearm and hand is 20 N. The forearm is held horizontal, as shown.

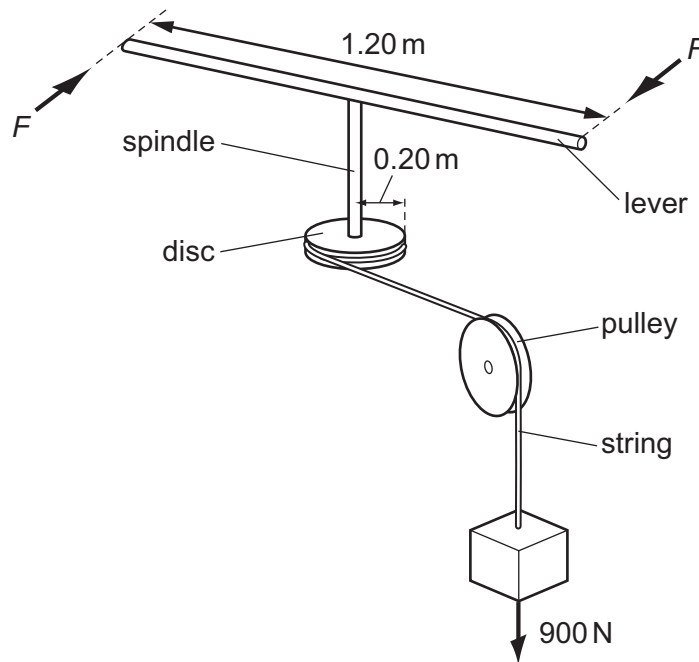


What is the vertical force F needed in the biceps?

- A 750 N B 800 N C 850 N D 900 N

Space for working

- 13 A spindle is attached at one end to the centre of a lever of length 1.20 m and at its other end to the centre of a disc of radius 0.20 m. A string is wrapped round the disc, passes over a pulley and is attached to a 900 N weight.



What is the minimum force F , applied to each end of the lever, that could lift the weight?

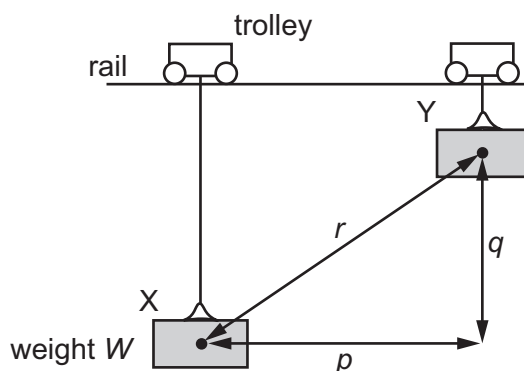
- A** 75 N **B** 150 N **C** 300 N **D** 950 N

Space for working

14 What is the average power output of a laser that can deliver 0.20 J of energy in 10 ns?

- A 2 nW B 20 mW C 200 kW D 20 MW

15 A weight W hangs from a trolley that runs along a rail. The trolley moves horizontally through a distance p and simultaneously raises the weight through a height q .



As a result, the weight moves through a distance r from X to Y. It starts and finishes at rest.

How much work is done on the weight during this process?

- A Wp B $W(p + q)$ C Wq D Wr

16 The engine of a car exerts a force of 600 N in moving the car 1.0 km in 150 seconds.

What is the average output power of the engine?

- A 4.0 W B 4.0 kW C 90 kW D 90 MW

17 Which statement about boiling and evaporation is correct?

- A Boiling can only occur at the surface of a liquid.
 B Evaporation can only occur at a fixed temperature.
 C Only boiling involves a change of phase.
 D When some of a liquid evaporates, the rest of the liquid becomes cooler.

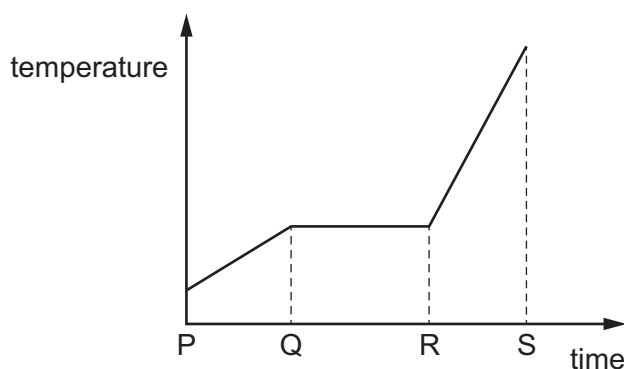
Space for working

- 18 There is one temperature, about 0.01°C , at which water, water vapour and ice can co-exist in equilibrium.

Which statement about the properties of the molecules at this temperature is correct?

- A Ice molecules are closer to one another than water molecules.
- B The mean kinetic energy of water molecules is greater than the mean kinetic energy of ice molecules.
- C Water vapour molecules are less massive than water molecules.
- D Water vapour molecules have the same mean speed as both ice and water molecules.

- 19 A crystalline solid is heated at a constant rate and the change of temperature with time is shown in the graph below.

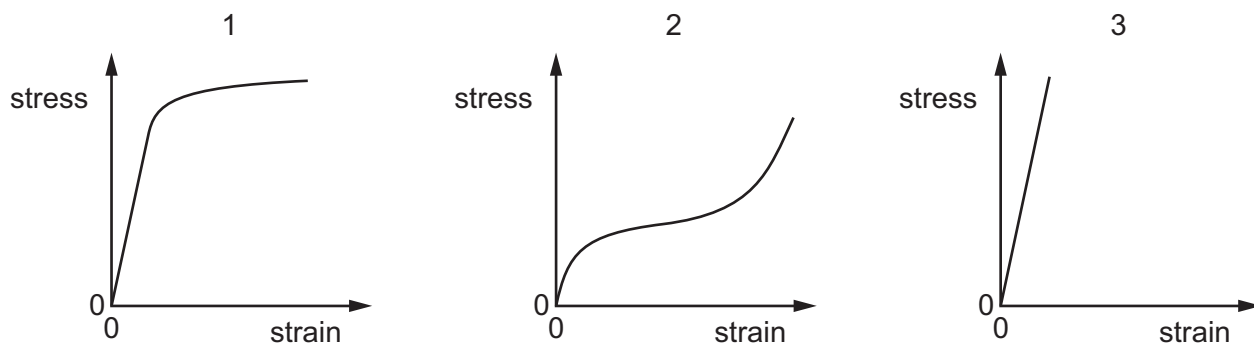


Which statement about the particles in the material is correct?

- A In the time from P to Q, the particles are arranged randomly.
- B In the time from Q to R, some particles are arranged regularly and some particles are arranged randomly.
- C In the time from R to S, the particles are widely spaced.
- D The arrangement of the particles is the same in the time from P to S.

Space for working

20 The stress-strain graphs for three different materials are shown, not drawn to the same scales.



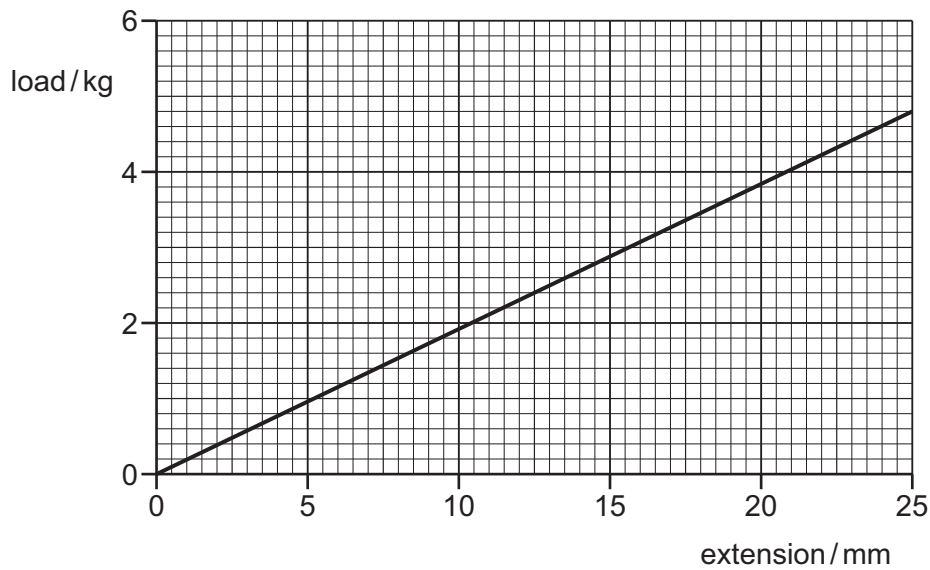
The three materials are copper, rubber and glass.

Which materials are represented by the graphs?

	1	2	3
A	copper	glass	rubber
B	copper	rubber	glass
C	glass	copper	rubber
D	glass	rubber	copper

Space for working

21 The graph is a load-extension graph for a wire undergoing elastic deformation.



How much work is done on the wire to increase the extension from 10 mm to 20 mm?

- A** 0.028 J **B** 0.184 J **C** 0.28 J **D** 0.37 J

22 Which statement about longitudinal waves is correct?

- A** Longitudinal waves include radio waves travelling through air.
B Particles in a longitudinal wave vibrate at right-angles to the direction of transfer of wave energy.
C Some types of longitudinal wave can be polarised.
D Stationary waves can be produced by the superposition of longitudinal waves.

23 The order of magnitude of the frequency of the longest-wavelength ultraviolet waves can be expressed as 10^x Hz.

What is the value of x ?

- A** 13 **B** 15 **C** 17 **D** 19

Space for working

- 24 The speed v of waves in deep water is given by the equation

$$v^2 = \frac{g\lambda}{2\pi}$$

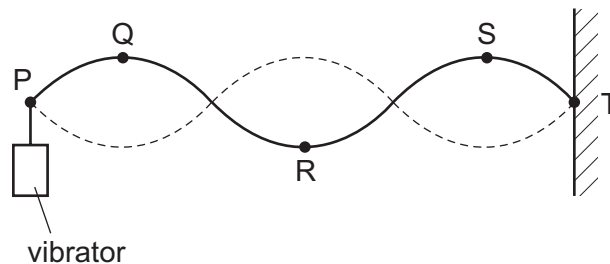
where λ is the wavelength of the waves and g is the acceleration of free fall.

A student measures the wavelength λ and the frequency f of a number of these waves.

Which graph should he plot to give a straight line through the origin?

- A f^2 against λ
- B f against λ^2
- C f against $\frac{1}{\lambda}$
- D f^2 against $\frac{1}{\lambda}$

- 25 A stationary wave on a stretched string is set up between two points P and T.



Which statement about the wave is correct?

- A Point R is at a node.
- B Points Q and S vibrate in phase.
- C The distance between P and T is three wavelengths.
- D The wave shown has the lowest possible frequency.

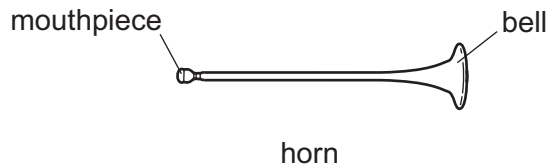
Space for working

- 26** A parallel beam of white light passes through a diffraction grating. Orange light of wavelength 600 nm in the fourth order diffraction maximum coincides with blue light in the fifth order diffraction maximum.

What is the wavelength of the blue light?

- A** 450 nm **B** 480 nm **C** 500 nm **D** 750 nm

- 27** The basic principle of note production in a horn is to set up a stationary wave in an air column.



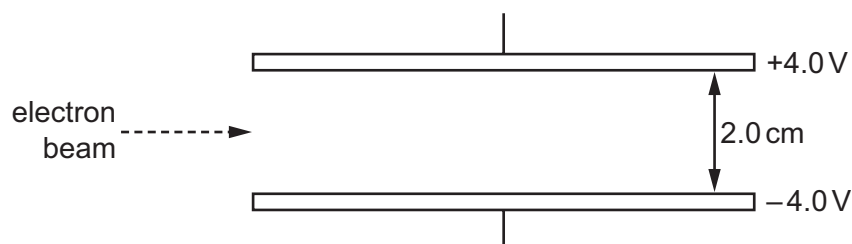
For any note produced by the horn, a node is formed at the mouthpiece and an antinode is formed at the bell. The frequency of the lowest note is 75 Hz.

What are the frequencies of the next two higher notes for this air column?

	first higher note / Hz	second higher note / Hz
A	113	150
B	150	225
C	150	300
D	225	375

Space for working

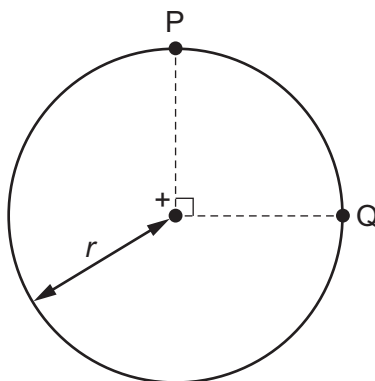
- 28 A horizontal beam of electrons is passed between two horizontal parallel plates, 2.0 cm apart, as shown.



The upper plate has an electrical potential of $+4.0\text{ V}$, and the lower plate has an electrical potential of -4.0 V .

What is the force on each electron when between the plates?

- A $3.2 \times 10^{-17}\text{ N}$ downwards
 - B $3.2 \times 10^{-19}\text{ N}$ upwards
 - C $6.4 \times 10^{-19}\text{ N}$ downwards
 - D $6.4 \times 10^{-17}\text{ N}$ upwards
- 29 The diagram shows two points P and Q which lie 90° apart on a circle of radius r .



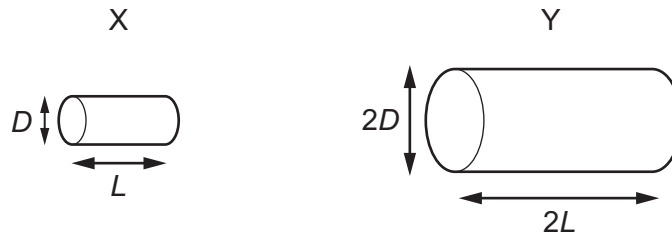
Which expression gives the work done in moving a unit positive charge from P to Q?

- A 0
- B $E \times r$
- C $E \times \left(\frac{\pi r}{2}\right)$
- D $E \times (\pi r)$

Space for working

- 30 Two electrically-conducting cylinders X and Y are made from the same material.

Their dimensions are as shown.

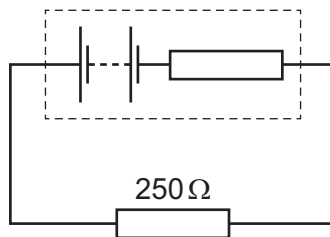


The resistance between the ends of each cylinder is measured.

What is the ratio $\frac{\text{resistance of X}}{\text{resistance of Y}}$?

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

- 31 A battery, with a constant internal resistance, is connected to a resistor of resistance $250\ \Omega$, as shown.



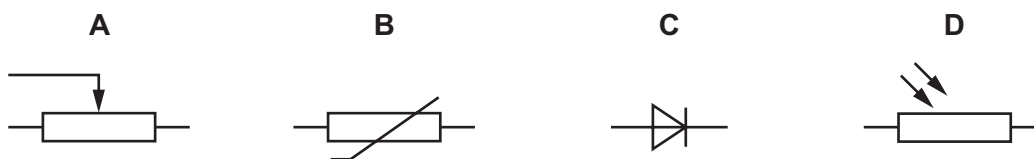
The current in the resistor is $40\ \text{mA}$ for a time of $60\ \text{s}$. During this time $6.0\ \text{J}$ of energy is lost in the internal resistance.

What are the energy supplied to the external resistor during the $60\ \text{s}$ and the e.m.f. of the battery?

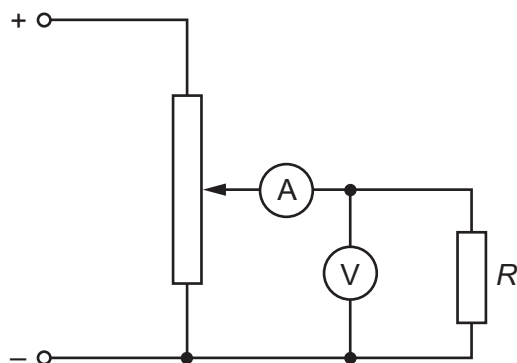
	energy / J	e.m.f. / V
A	2.4	2.4
B	2.4	7.5
C	24	10.0
D	24	12.5

Space for working

- 32 Which symbol represents a component whose resistance is designed to change with temperature?



- 33 In the circuit below, a voltmeter of resistance R_V and an ammeter of resistance R_A are used to measure the resistance R of the fixed resistor.

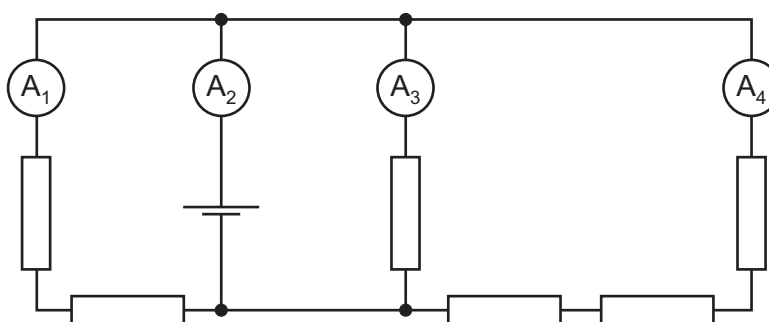


Which condition is necessary for an accurate value to be obtained for R ?

- A R is much smaller than R_V .
 B R is much smaller than R_A .
 C R is much greater than R_V .
 D R is much greater than R_A .

Space for working

- 34 In the circuit shown, all the resistors are identical and all the ammeters have negligible resistance.



The reading on ammeter A_1 is 0.6 A.

What are the readings on the other ammeters?

	reading on ammeter A_2 / A	reading on ammeter A_3 / A	reading on ammeter A_4 / A
A	1.0	0.3	0.1
B	1.4	0.6	0.2
C	1.8	0.9	0.3
D	2.2	1.2	0.4

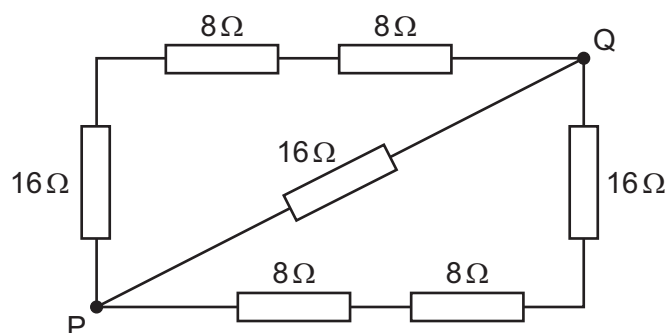
- 35 The potential difference across a component in a circuit is 2.0 V.

How many electrons must flow through this component in order for it to be supplied with 4.8 J of energy?

- A** 2.6×10^{18} **B** 1.5×10^{19} **C** 3.0×10^{19} **D** 6.0×10^{19}

Space for working

36 What is the total resistance between points P and Q in this network of resistors?



- A** 8Ω **B** 16Ω **C** 24Ω **D** 32Ω

37 Alpha, beta and gamma radiations have various depths of penetration in matter and different charges.

Which row best summarises the penetration and charge of each radiation?

	alpha	beta	gamma
A	absorbed by a sheet of card negative charge	absorbed by several mm of aluminium no charge	not fully absorbed by several cm of lead no charge
B	absorbed by a sheet of card negative charge	absorbed by several mm of aluminium positive charge	not fully absorbed by several cm of lead no charge
C	absorbed by a sheet of card positive charge	absorbed by several mm of aluminium negative charge	not fully absorbed by several cm of lead no charge
D	absorbed by several mm of aluminium positive charge	not fully absorbed by several cm of lead negative charge	absorbed by a sheet of card no charge

Space for working

- 38 In 2002, two-proton radioactive decay of an isotope of iron, ${}^{45}_{26}\text{Fe}$, was observed.

What could be the resulting product?

- A ${}^{43}_{26}\text{Fe}$ B ${}^{43}_{24}\text{Cr}$ C ${}^{45}_{24}\text{Cr}$ D ${}^{47}_{28}\text{Ni}$

- 39 U^{++} is a doubly-ionised uranium atom. The uranium atom has a nucleon number of 235 and a proton number of 92.

In a simple model of the atom, how many particles are in this ionised atom?

- A 235 B 325 C 327 D 329

- 40 The grid shows a number of nuclides arranged according to the number of protons and the number of neutrons in each.

A nucleus of the nuclide ${}^8_3\text{Li}$ decays by emitting a β -particle.

What is the resulting nuclide?

number of protons	4					A	B	
	3				${}^6_3\text{Li}$	${}^7_3\text{Li}$	${}^8_3\text{Li}$	
	2		${}^3_2\text{He}$	${}^4_2\text{He}$			C	D
	1	${}^1_1\text{H}$	${}^2_1\text{H}$					
		0	1	2	3	4	5	6
		number of neutrons						

Space for working

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PHYSICS

9702/12

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pressure of an ideal gas,

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velocity of particle in s.h.m.,

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

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

radioactive decay,

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

decay constant,

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

- 1 The maximum theoretical power P of a wind turbine is given by the equation

$$P = k\rho Av^n$$

where ρ is the density of air, A is the area swept by the turbine blades, v is the speed of the air and k is a constant with no units.

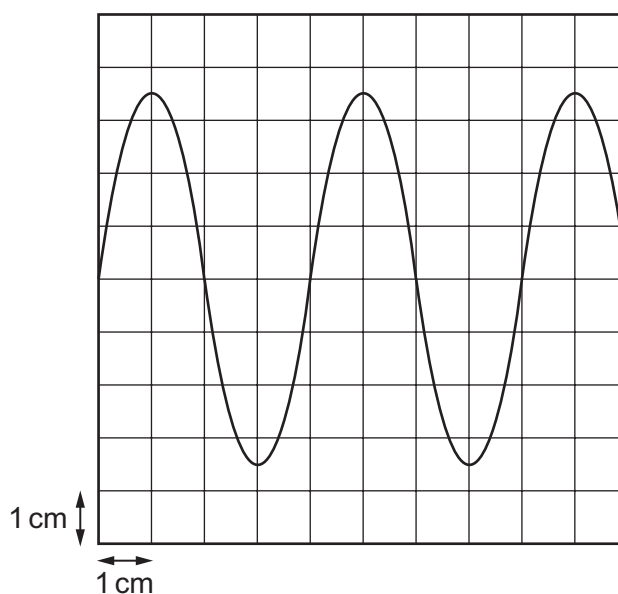
What is the value of n ?

- A** 1 **B** 2 **C** 3 **D** 4
- 2 What is the unit of resistance when expressed in SI base units?

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

Space for working

- 3 A cathode-ray oscilloscope (c.r.o.) is connected to an alternating voltage. The following trace is produced on the screen.



The oscilloscope time-base setting is 0.5 ms cm^{-1} and the Y-plate sensitivity is 2 V cm^{-1} .

Which statement about the alternating voltage is correct?

- A The amplitude is 3.5 cm.
- B The frequency is 0.5 kHz.
- C The period is 1 ms.
- D The wavelength is 4 cm.

Space for working

- 4 A quantity y is to be determined from the equation shown.

$$y = \frac{px}{q^2}$$

The percentage uncertainties in p , x and q are shown.

	percentage uncertainty
p	6%
x	2%
q	4%

What is the percentage uncertainty in y ?

- A** 0.5 % **B** 1 % **C** 16 % **D** 192 %
- 5 A thermometer can be read to an accuracy of $\pm 0.5^\circ\text{C}$. This thermometer is used to measure a temperature rise from 40°C to 100°C .

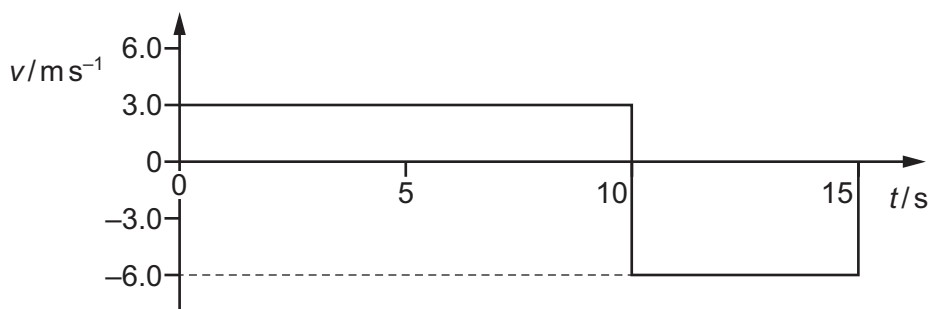
What is the percentage uncertainty in the measurement of the temperature rise?

- A** 0.5 % **B** 0.8 % **C** 1.3 % **D** 1.7 %

Space for working

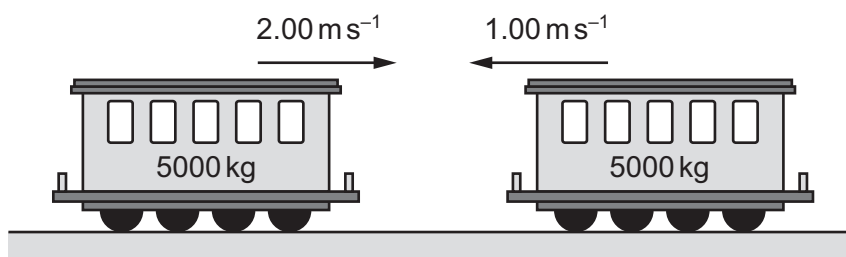
- 6 A radio-controlled toy car travels along a straight line for a time of 15 s.

The variation with time t of the velocity v of the car is shown below.



What is the average velocity of the toy car for the journey shown by the graph?

- A -1.5 m s^{-1} B 0.0 m s^{-1} C 4.0 m s^{-1} D 4.5 m s^{-1}
- 7 Two train carriages each of mass 5000 kg roll toward one another on a level track. One is travelling at 2.00 m s^{-1} and the other at 1.00 m s^{-1} , as shown.



They collide and join together.

What is the kinetic energy lost during the collision?

- A 1250 J B 7500 J C 11250 J D 12500 J

Space for working

- 8 A resultant force causes a body to accelerate.

What is equal to the resultant force?

- A the acceleration of the body per unit mass
- B the change in kinetic energy of the body per unit time
- C the change in momentum of the body per unit time
- D the change in velocity of the body per unit time

- 9 A ship of mass $8.4 \times 10^7 \text{ kg}$ is approaching a harbour with speed 16.4 ms^{-1} . By using reverse thrust it can maintain a constant total stopping force of $920\,000 \text{ N}$.

How long will it take to stop?

- A 15 seconds
- B 150 seconds
- C 25 minutes
- D 250 minutes

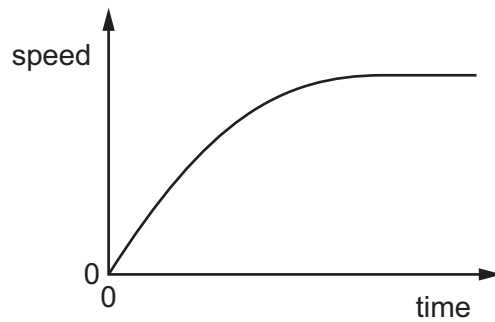
- 10 A tractor of mass 1000 kg is connected by a tow-bar to a trailer of mass 1000 kg . The total resistance to motion has a constant value of 4000 N . One quarter of this resistance acts on the trailer.

When the tractor and trailer are moving along horizontal ground at a constant speed of 6 ms^{-1} , what is the force exerted on the tractor by the tow-bar?

- A 0 N B 1000 N C 3000 N D 4000 N

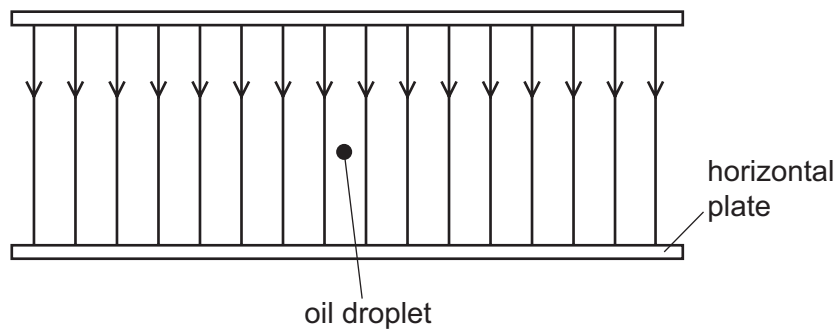
Space for working

- 11 The graph shows the variation with time of the speed of a raindrop falling vertically through air.



Which statement is correct?

- A The acceleration decreases to produce a steady speed.
 - B The acceleration increases as the speed increases.
 - C The air resistance decreases as the speed increases.
 - D The resultant force increases as the speed increases.
- 12 A tiny oil droplet with mass $6.9 \times 10^{-13} \text{ kg}$ is at rest in an electric field of electric field strength $2.1 \times 10^7 \text{ NC}^{-1}$, as shown.



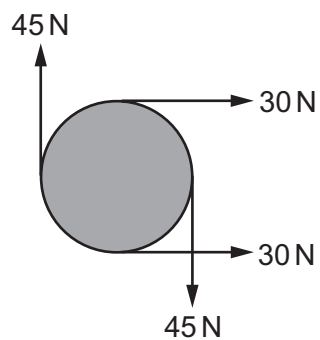
The weight of the droplet is exactly balanced by the electrical force on the droplet.

What is the charge on the droplet?

- A $3.3 \times 10^{-20} \text{ C}$
- B $-3.3 \times 10^{-20} \text{ C}$
- C $3.2 \times 10^{-19} \text{ C}$
- D $-3.2 \times 10^{-19} \text{ C}$

Space for working

13 The diagram shows four forces applied to a circular object.

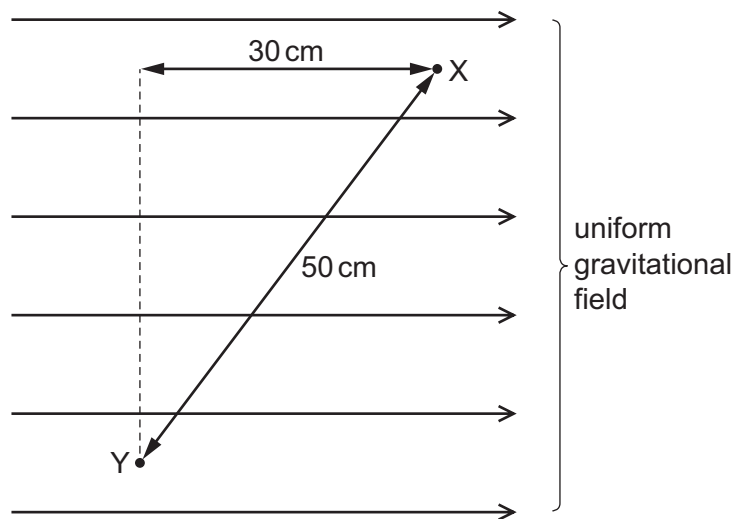


Which of the following describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	non-zero	non-zero
B	non-zero	zero
C	zero	non-zero
D	zero	zero

Space for working

- 14 A mass at point X inside a uniform gravitational field experiences a gravitational force of 0.200 N. It has 1.00 J of gravitational potential energy.



The mass is then moved to point Y.

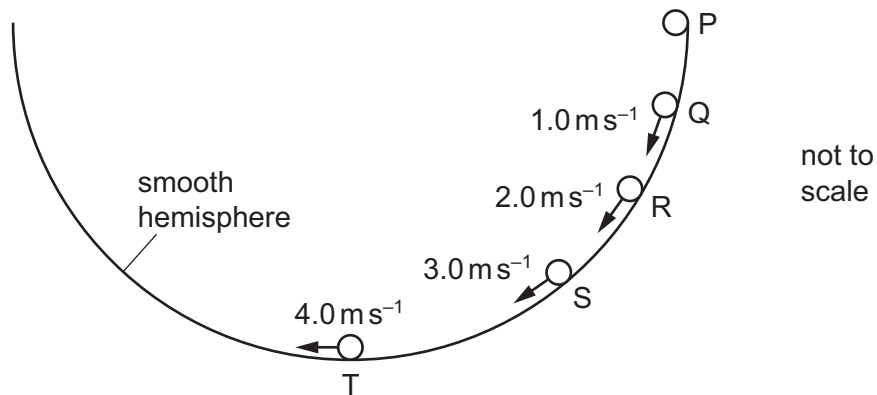
What is its new gravitational potential energy?

- A** 0.90 J **B** 0.94 J **C** 1.06 J **D** 1.10 J

Space for working

- 15 A small mass is placed at point P on the inside surface of a smooth hemisphere. It is then released from rest. When it reaches the lowest point T, its speed is 4.0 m s^{-1} .

The diagram (not to scale) shows the speed of the mass at other points Q, R and S as it slides down. Air resistance is negligible.



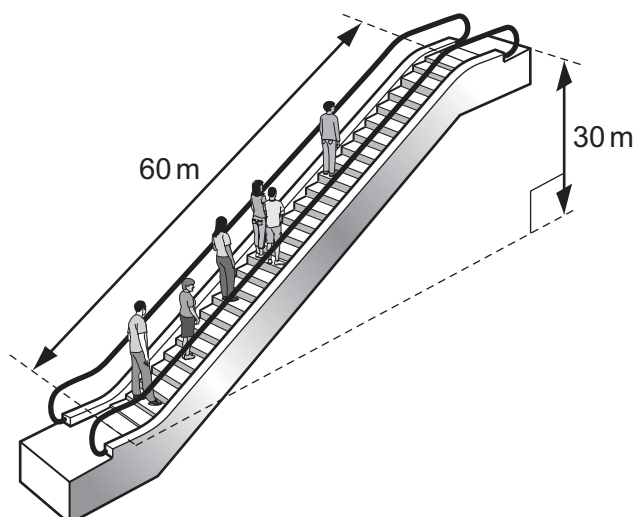
The mass loses potential energy E in falling from P to T.

At which point has the mass lost potential energy $\frac{E}{4}$?

- A Q
- B R
- C S
- D none of these

Space for working

- 16 An escalator is 60 m long and lifts passengers through a vertical height of 30 m, as shown.



To drive the escalator against the forces of friction when there are no passengers requires a power of 2.0 kW.

The escalator is used by passengers of average mass 60 kg and the power to overcome friction remains constant.

How much power is required to drive the escalator when it is carrying 20 passengers and is travelling at 0.75 m s^{-1} ?

- A 4.4 kW B 6.4 kW C 8.8 kW D 10.8 kW

- 17 If the Universe was such that the speed of the molecules in a substance increased with temperature but at any particular temperature the speed of all the molecules in a substance was the same, which process would **not** occur?

- A boiling
B condensation
C evaporation
D melting

Space for working

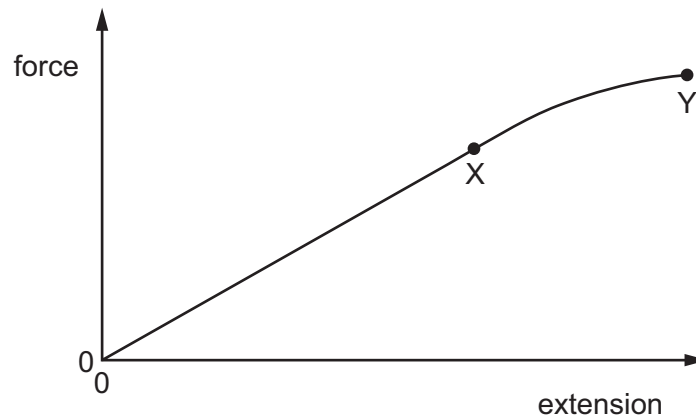
- 18 Liquid Q has twice the density of liquid R.

At depth x in liquid R, the pressure due to the liquid is 4 kPa.

At what depth in liquid Q is the pressure due to the liquid 7 kPa?

- A $\frac{2x}{7}$ B $\frac{7x}{8}$ C $\frac{8x}{7}$ D $\frac{7x}{2}$

- 19 A sample of metal is subjected to a force which increases to a maximum value and then decreases back to zero. A force-extension graph for the sample is shown.



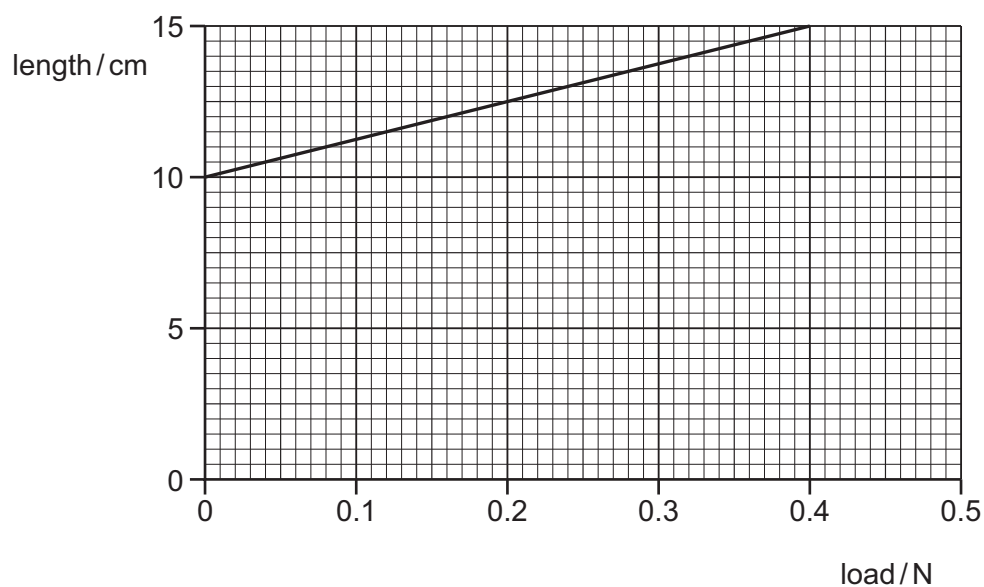
When the sample contracts it follows the same force-extension curve as when it was being stretched.

What is the behaviour of the metal between X and Y?

- A both elastic and plastic
B not elastic and not plastic
C plastic but not elastic
D elastic but not plastic

Space for working

20 The graph shows the length of a spring as it is stretched by an increasing load.

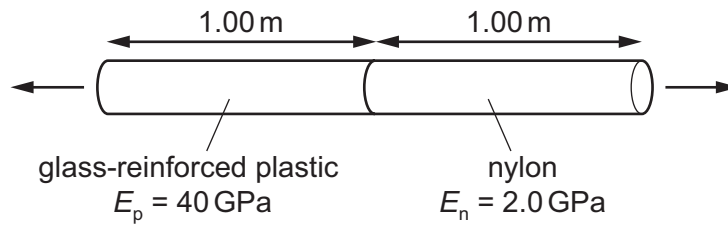


What is the spring constant?

- A** 8.0 Nm^{-1} **B** 2.7 Nm^{-1} **C** 0.13 Nm^{-1} **D** 0.080 Nm^{-1}

Space for working

- 21 A composite rod is made by attaching a glass-reinforced plastic rod and a nylon rod end to end, as shown.



The rods have the same cross-sectional area and each rod is 1.00 m in length. The Young modulus E_p of the plastic is 40 GPa and the Young modulus E_n of the nylon is 2.0 GPa.

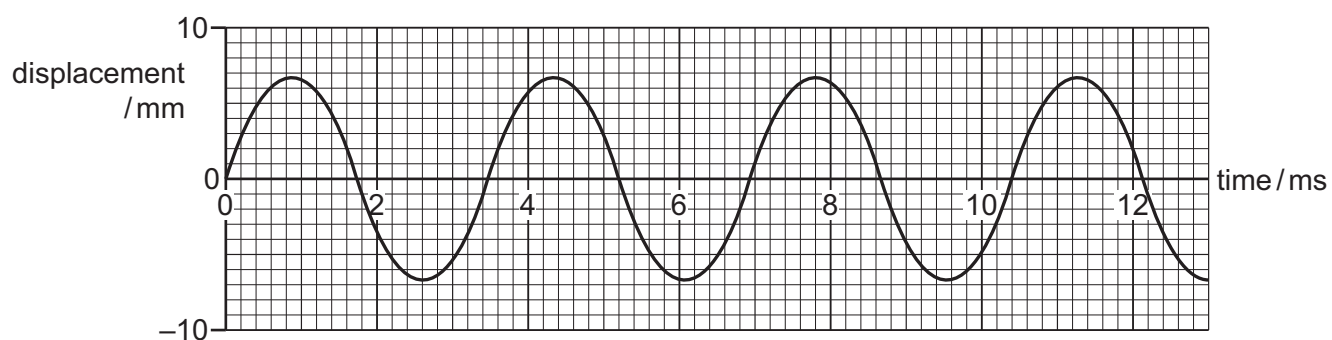
The composite rod will break when its total extension reaches 3.0 mm.

What is the greatest tensile stress that can be applied to the composite rod before it breaks?

- A $7.1 \times 10^{-14} \text{ Pa}$
- B $7.1 \times 10^{-2} \text{ Pa}$
- C $5.7 \times 10^6 \text{ Pa}$
- D $5.7 \times 10^9 \text{ Pa}$

Space for working

- 22 What, to two significant figures, are the period, the frequency and the amplitude of the wave represented by the graph?

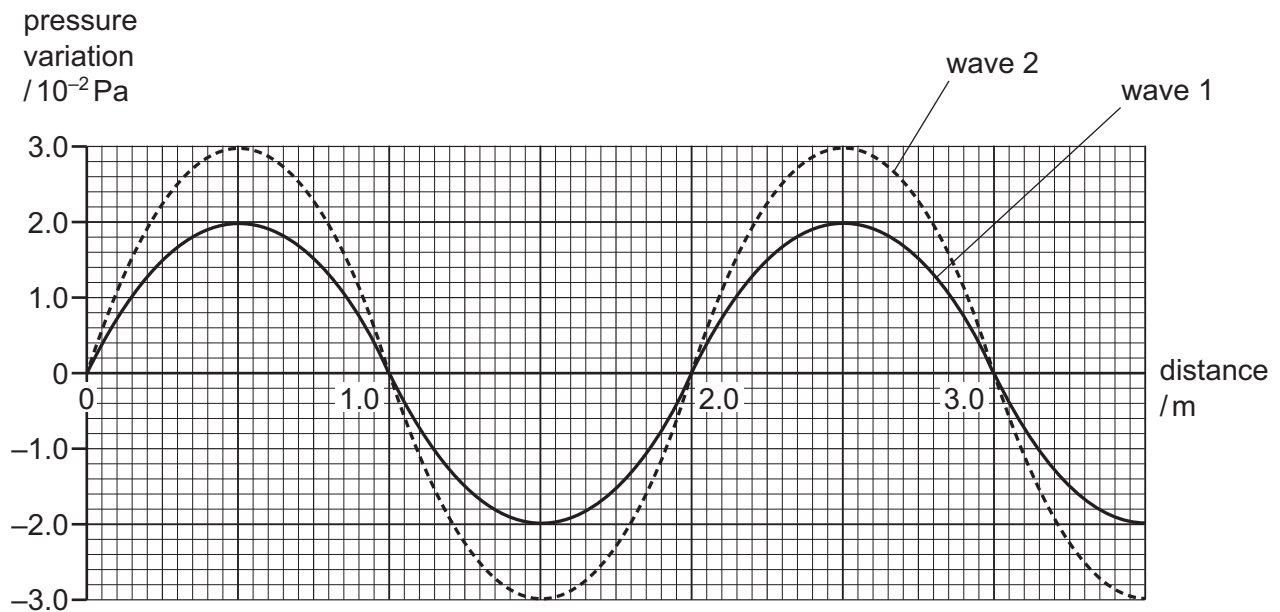


	period /s	frequency /Hz	amplitude /m
A	0.0027	370	0.0067
B	0.0031	320	0.013
C	0.0035	290	0.0067
D	0.0042	240	0.013

Space for working

- 23 A sound wave consists of a series of moving pressure variations from the normal, constant air pressure.

The graph shows these pressure variations for two waves at one instant in time.



Wave 1 has an intensity of $1.6 \times 10^{-6} \text{ W m}^{-2}$.

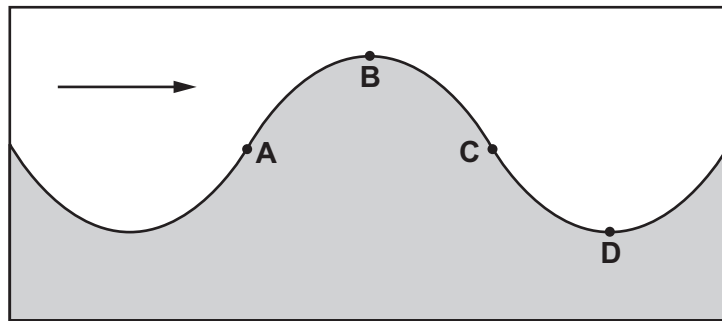
What is the intensity of wave 2?

- A $2.4 \times 10^{-6} \text{ W m}^{-2}$
- B $3.0 \times 10^{-6} \text{ W m}^{-2}$
- C $3.6 \times 10^{-6} \text{ W m}^{-2}$
- D $4.5 \times 10^{-6} \text{ W m}^{-2}$

Space for working

- 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?



- 25** The principle of superposition states that a certain quantity is added when two or more waves meet at a point.

What is this quantity?

- A** amplitude
- B** displacement
- C** intensity
- D** wavelength

Space for working

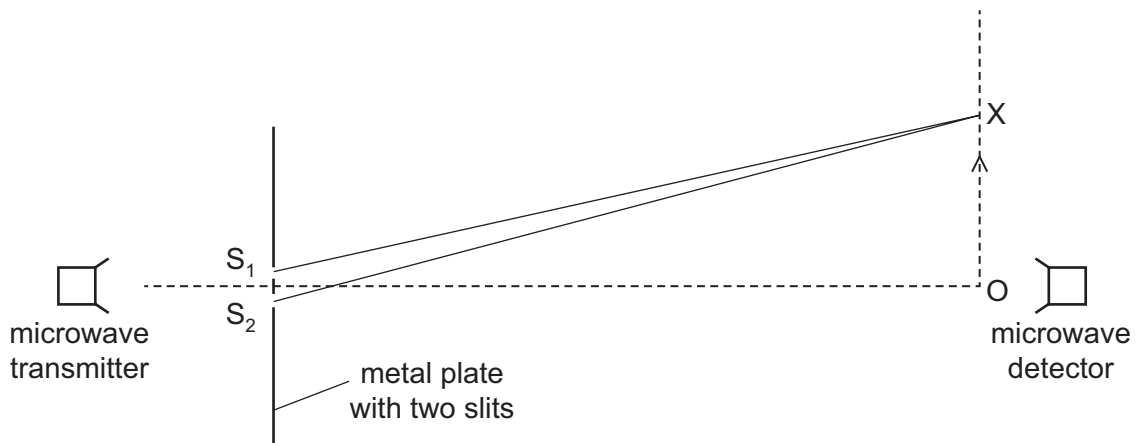
- 26** Light passes through a diffraction grating ruled at 1000 lines per cm and the same wavelength of light also passes through two narrow slits 0.5 mm apart. Both situations produce intensity maxima and minima on a screen.

Which statement about the separation of the maxima on the screen and the sharpness of the maxima is correct?

- A** The diffraction grating maxima are less widely spaced and are less sharp than the two-slit maxima.
- B** The diffraction grating maxima are less widely spaced and are sharper than the two-slit maxima.
- C** The diffraction grating maxima are more widely spaced and are less sharp than the two-slit maxima.
- D** The diffraction grating maxima are more widely spaced and are sharper than the two-slit maxima.

Space for working

- 27 The diagram shows an experiment which has been set up to demonstrate two-source interference. Microwaves of wavelength λ pass through two slits S_1 and S_2 .



The detector is moved from point O in the direction of the arrow. The signal detected decreases until the detector reaches point X, and then starts to increase again as the detector moves beyond X.

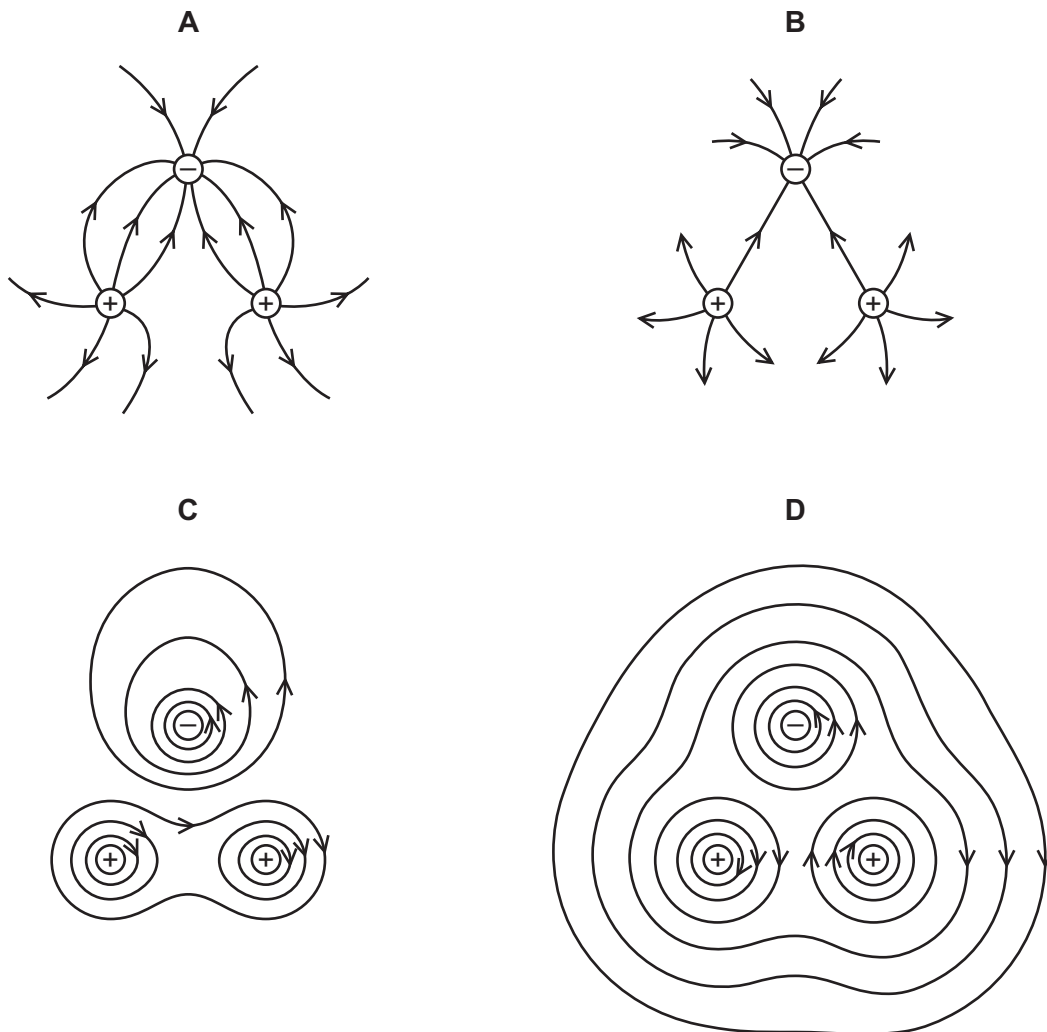
Which equation correctly determines the position of X?

- A $OX = \lambda$
- B $OX = \lambda/2$
- C $S_2X - S_1X = \lambda$
- D $S_2X - S_1X = \lambda/2$

Space for working

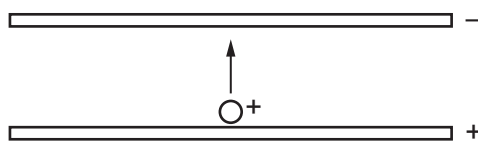
- 28 Two positive charges and one negative charge, all of equal magnitude, are set at the corners of an equilateral triangle.

Which diagram best represents the electric field surrounding the charges?

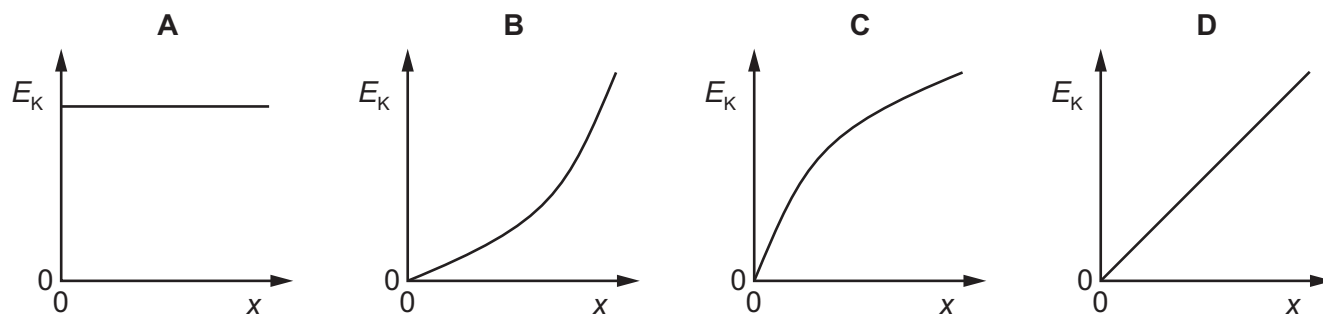


Space for working

- 29 Two oppositely-charged horizontal metal plates are placed in a vacuum. A positively-charged particle starts from rest and moves from one plate to the other plate, as shown.

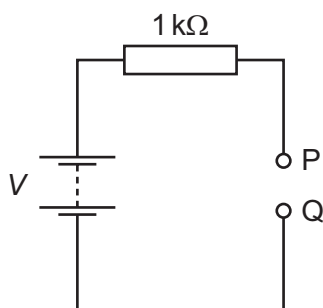


Which graph shows how the kinetic energy E_K of the particle varies with the distance x moved from the positive plate?



Space for working

- 30 A battery of electromotive force (e.m.f.) V and negligible internal resistance is connected to a $1\text{ k}\Omega$ resistor, as shown.



A student attempts to measure the potential difference (p.d.) between points P and Q using two voltmeters, one at a time. The first voltmeter has a resistance of $1\text{ k}\Omega$ and the second voltmeter has a resistance of $1\text{ M}\Omega$.

What are the readings of the voltmeters?

	reading on voltmeter with $1\text{ k}\Omega$ resistance	reading on voltmeter with $1\text{ M}\Omega$ resistance
A	$\frac{V}{2}$	$\frac{V}{2}$
B	$\frac{V}{2}$	V
C	V	$\frac{V}{2}$
D	V	V

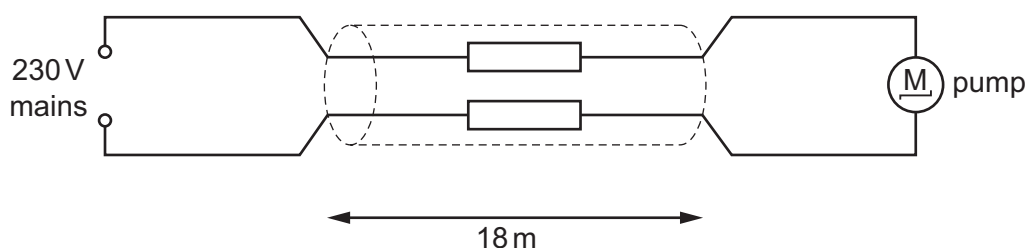
- 31 A copper wire is to be replaced by an aluminium alloy wire of the same length and resistance. Copper has half the resistivity of the alloy.

What is the ratio $\frac{\text{diameter of alloy wire}}{\text{diameter of copper wire}}$?

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

Space for working

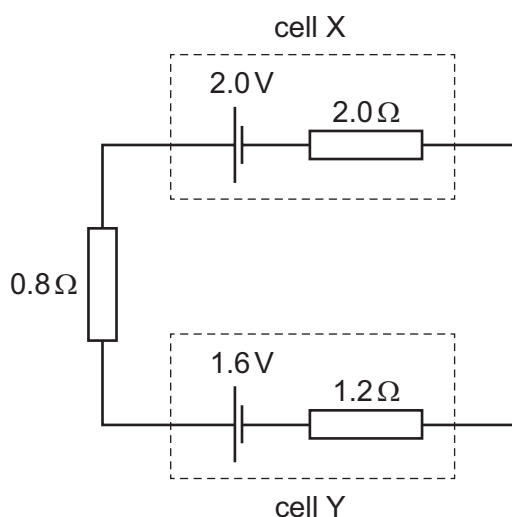
- 32 The diagram shows an electric pump for a garden fountain connected by an 18 m cable to a 230 V mains electrical supply.



The performance of the pump is acceptable if the potential difference (p.d.) across it is at least 218 V. The current through it is then 0.83 A.

What is the maximum resistance per metre of each of the two wires in the cable if the pump is to perform acceptably?

- A $0.40 \Omega \text{ m}^{-1}$ B $0.80 \Omega \text{ m}^{-1}$ C $1.3 \Omega \text{ m}^{-1}$ D $1.4 \Omega \text{ m}^{-1}$
- 33 Cell X has an e.m.f. of 2.0 V and an internal resistance of 2.0Ω . Cell Y has an e.m.f. of 1.6 V and an internal resistance of 1.2Ω . These two cells are connected to a resistor of resistance 0.8Ω , as shown.

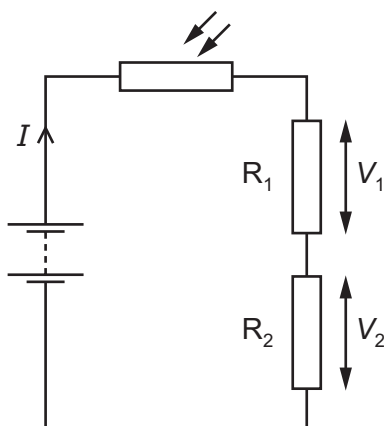


What is the current in cell X?

- A 0.10 A B 0.50 A C 0.90 A D 1.0 A

Space for working

- 34 In the circuit shown, a light-dependent resistor (LDR) is connected to two resistors R_1 and R_2 . The potential difference (p.d.) across R_1 is V_1 and the p.d. across R_2 is V_2 . The current in the circuit is I .

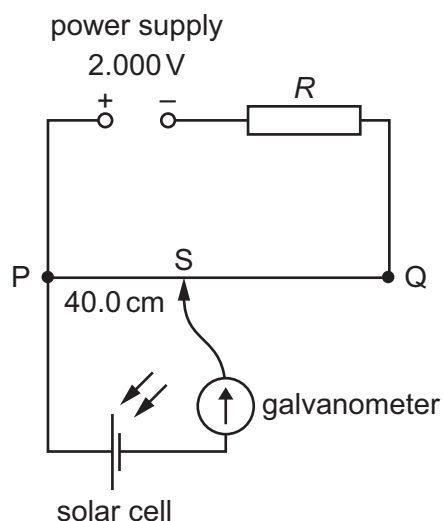


Which statement about this circuit is correct?

- A The current I increases when the light intensity decreases.
- B The LDR is an ohmic conductor.
- C The p.d. V_2 increases when the light intensity decreases.
- D The ratio $\frac{V_1}{V_2}$ is independent of light intensity.

Space for working

35 A power supply and a solar cell are compared using the potentiometer circuit shown.



The e.m.f. produced by the solar cell is measured on the potentiometer.

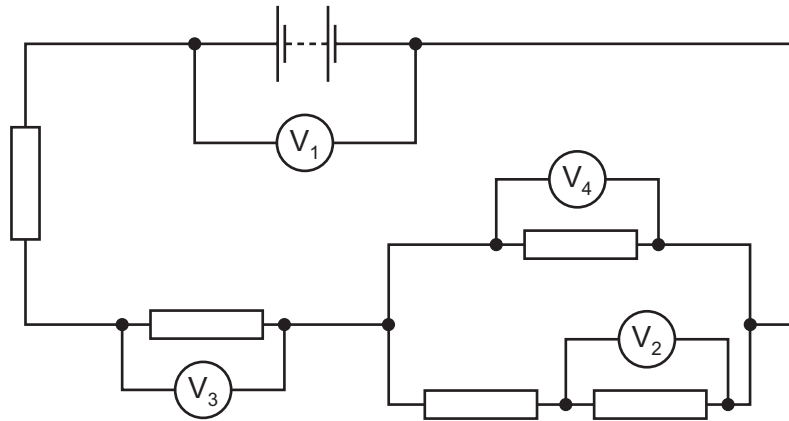
The potentiometer wire PQ is 100.0 cm long and has a resistance of $5.00\ \Omega$. The power supply has an e.m.f. of 2.000 V and the solar cell has an e.m.f. of 5.00 mV.

Which resistance R must be used so that the galvanometer reads zero when $PS = 40.0\text{ cm}$?

- A** $395\ \Omega$ **B** $795\ \Omega$ **C** $995\ \Omega$ **D** $1055\ \Omega$

Space for working

36 In the circuit shown, all the resistors are identical.



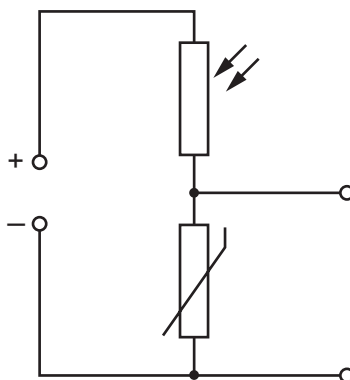
The reading on voltmeter V_1 is 8.0 V and the reading on voltmeter V_2 is 1.0 V.

What are the readings on the other voltmeters?

	reading on voltmeter V_3 / V	reading on voltmeter V_4 / V
A	1.5	1.0
B	3.0	2.0
C	4.5	3.0
D	6.0	4.0

Space for working

- 37 The diagram shows a light-dependent resistor (LDR) and a thermistor forming a potential divider.



Under which set of conditions will the potential difference across the thermistor have the greatest value?

	illumination	temperature
A	low	low
B	high	low
C	low	high
D	high	high

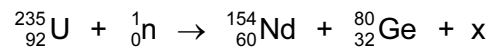
- 38 A nucleus X decays into a nucleus Y by emitting an alpha particle followed by two beta particles.

Which statement about this nuclear decay is correct?

- A** Beta particle decay occurs when a proton changes into a neutron.
- B** Nucleus Y has the same nucleon number as nucleus X.
- C** Nucleus Y is an isotope of nucleus X.
- D** The total mass of the products is equal to the mass of the initial nucleus X.

Space for working

- 39 A slow-moving neutron collides with a nucleus of uranium-235. This results in a nuclear reaction that is represented by the following nuclear equation



where x represents one or more particles.

What does x represent?

- A one neutron
 - B two electrons
 - C two neutrons
 - D two protons
- 40 The first artificial radioactive substance was made by bombarding aluminium, ${}_{13}^{27}\text{Al}$, with α -particles. This produced an unstable isotope of phosphorus, ${}_{15}^{30}\text{P}$.

What was the by-product of this reaction?

- A an α -particle
- B a β -particle
- C a neutron
- D a proton

Space for working

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PHYSICS

9702/13

Paper 1 Multiple Choice

May/June 2014

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 **22** printed pages and **2** 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 Which quantity can be measured in electronvolts (eV)?

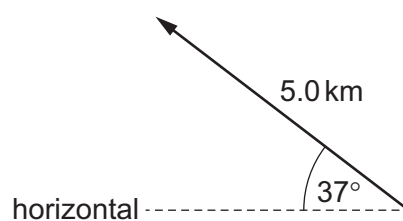
- A electric charge
- B electric potential
- C energy
- D power

2 The unit of specific heat capacity is $\text{J kg}^{-1} \text{K}^{-1}$.

What is its equivalent in terms of SI base units?

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

3 What is the vertical component of this displacement vector?



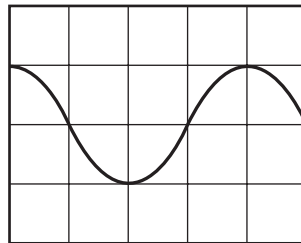
- A 3.0 km B 3.8 km C 4.0 km D 5.0 km

Space for working

- 4 The resistance of a lamp is calculated from the value of the potential difference (p.d.) across it and the value of the current passing through it.

Which statement correctly describes how to combine the uncertainties in the p.d. and in the current?

- A Add together the actual uncertainty in the p.d. and the actual uncertainty in the current.
 - B Add together the percentage uncertainty in the p.d. and the percentage uncertainty in the current.
 - C Subtract the actual uncertainty in the current from the actual uncertainty in the p.d.
 - D Subtract the percentage uncertainty in the current from the percentage uncertainty in the p.d.
- 5 The display on a cathode-ray oscilloscope shows the signal produced by an electronic circuit. The time-base is set at 5.0 ns per division and the Y-gain at 10 V per division.



What is the frequency of the signal?

- A $2.0 \times 10^{-8} \text{ Hz}$
- B $2.5 \times 10^{-2} \text{ Hz}$
- C $5.0 \times 10^7 \text{ Hz}$
- D $3.1 \times 10^8 \text{ Hz}$

Space for working

- 6 A digital caliper is used to measure the 28.50 mm width of a plastic ruler. The digital caliper reads to the nearest 0.01 mm.

What is the correct way to record this reading?

- A $0.02850 \pm 0.01 \text{ m}$
 - B $0.0285 \pm 0.001 \text{ m}$
 - C $(2.850 \pm 0.001) \times 10^{-2} \text{ m}$
 - D $(2.850 \pm 0.001) \times 10^{-3} \text{ m}$
- 7 An experiment is performed to measure the acceleration of free fall g . A body falls between two fixed points. The four measurements shown below are taken.

Which measurement is **not** required for the calculation of g ?

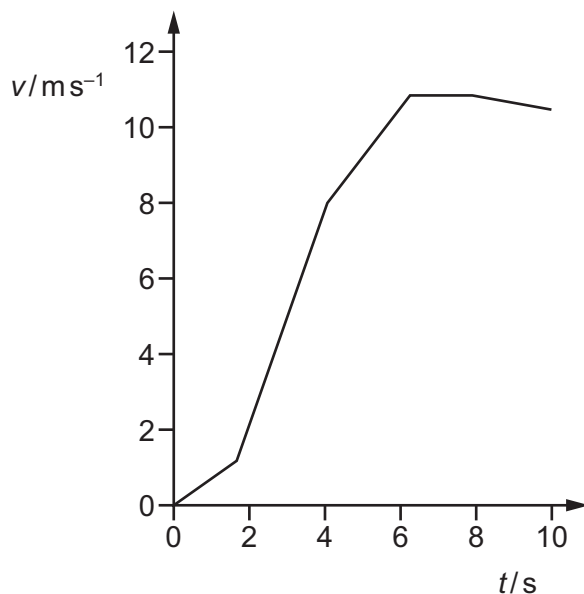
- A the distance fallen by the body
 - B the initial velocity of the body
 - C the mass of the body
 - D the time taken for the body to fall
- 8 In a cathode-ray tube, an electron is accelerated uniformly in a straight line from a speed of $4 \times 10^3 \text{ m s}^{-1}$ to $2 \times 10^7 \text{ m s}^{-1}$ over a distance of 10 mm.

What is the acceleration of the electron?

- A $2 \times 10^3 \text{ m s}^{-2}$
- B $2 \times 10^6 \text{ m s}^{-2}$
- C $2 \times 10^{13} \text{ m s}^{-2}$
- D $2 \times 10^{16} \text{ m s}^{-2}$

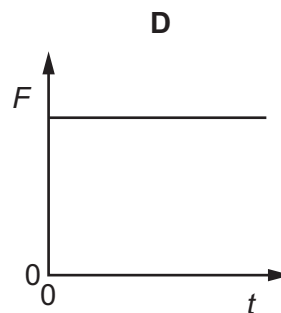
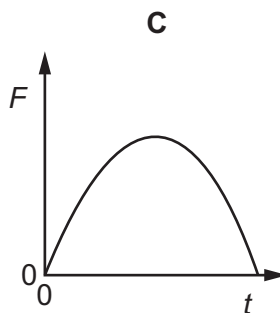
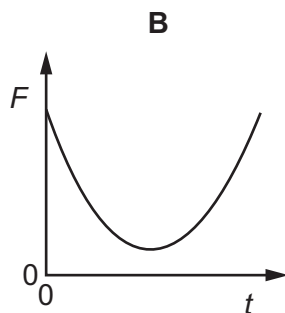
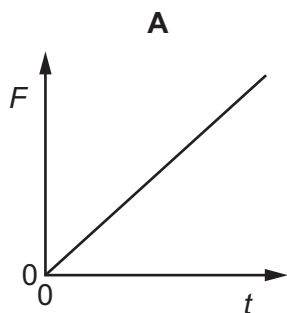
Space for working

- 9 The graph shows how the speed v of a sprinter changes with time t during a 100 m race.



What is the best estimate of the maximum acceleration of the sprinter?

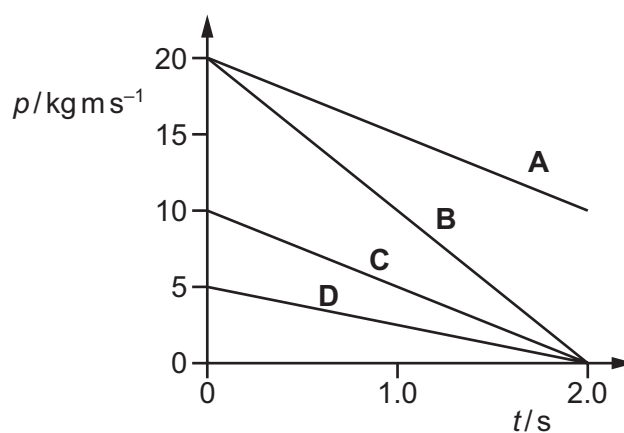
- A** 0.5 ms^{-2} **B** 1 ms^{-2} **C** 3 ms^{-2} **D** 10 ms^{-2}
- 10 A tennis ball is dropped onto a table and bounces back up. The table exerts a force F on the ball.
- Which graph best shows the variation with time t of the force F while the ball is in contact with the table?



Space for working

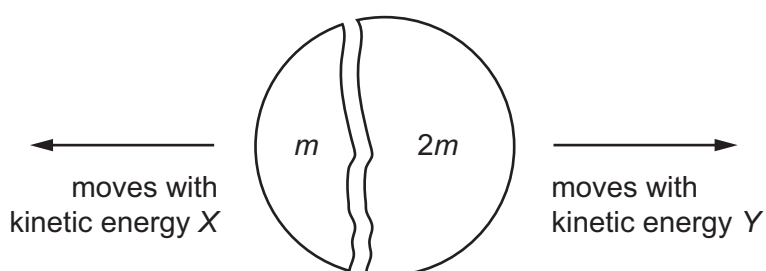
- 11 A resultant force of 10 N acts on a body for a time of 2.0 s.

Which graph could show the variation with time t of the momentum p of the body?



- 12 A stationary body explodes into two components of masses m and $2m$.

The components gain kinetic energies X and Y respectively.



What is the value of the ratio $\frac{X}{Y}$?

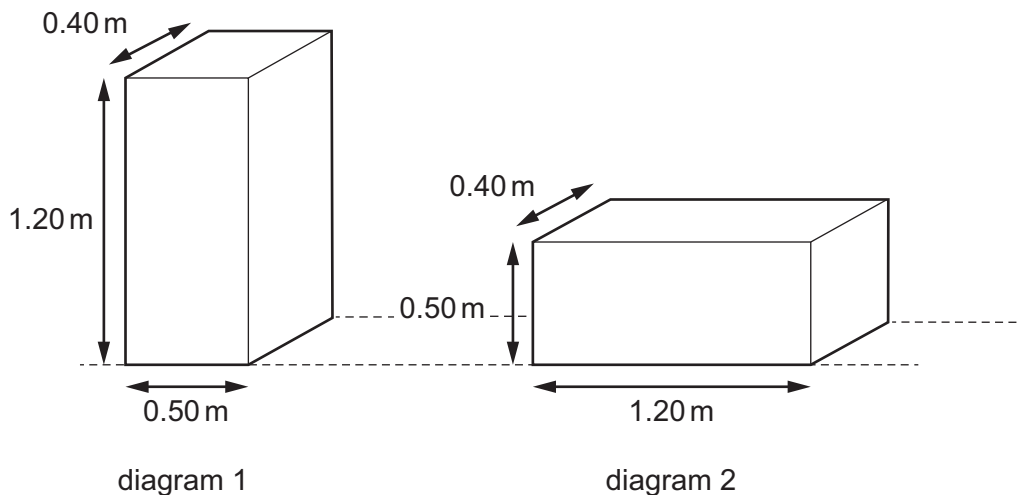
- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** $\frac{2}{1}$ **D** $\frac{4}{1}$

Space for working

13 What is the condition for an object to be in equilibrium?

- A The object's velocity and the resultant torque on it must both be zero.
- B The object's velocity must be zero.
- C The resultant force and the resultant torque on the object must both be zero.
- D The resultant force on the object must be zero.

14 A uniform solid cuboid of concrete of dimensions $0.50\text{ m} \times 1.20\text{ m} \times 0.40\text{ m}$ and weight 4000 N rests on a flat surface with the 1.20 m edge vertical as shown in diagram 1.

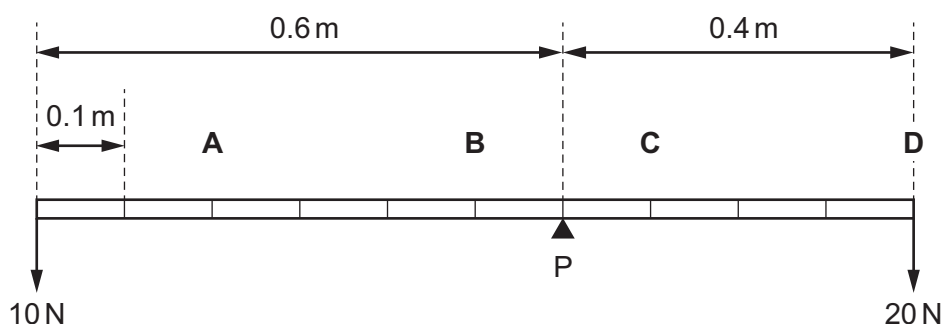


What is the minimum energy required to roll the cuboid through 90° to the position shown in diagram 2 with the 0.50 m edge vertical?

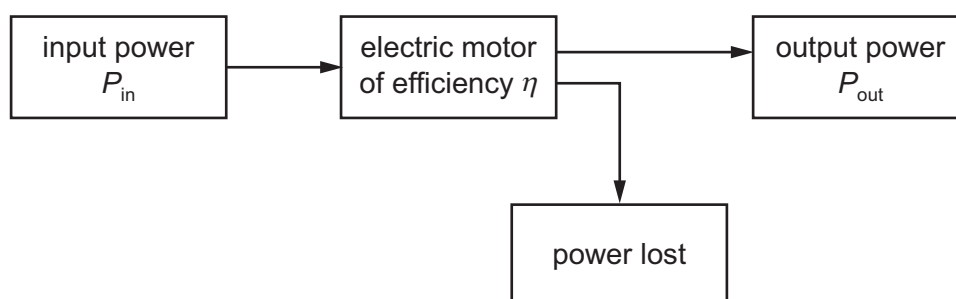
- A 200 J
- B 400 J
- C 1400 J
- D 2600 J

Space for working

- 15** A uniform beam is pivoted at P as shown. Weights of 10 N and 20 N are attached to its ends. The length of the beam is marked at 0.1 m intervals. The weight of the beam is 100 N. At which point should a further weight of 20 N be attached to achieve equilibrium?



- 16** An electric motor has an input power P_{in} , useful output power P_{out} and efficiency η .



How much power is lost by the motor?

- A** ηP_{in} **B** $\left(\frac{1}{\eta} - 1\right) P_{\text{in}}$ **C** ηP_{out} **D** $\left(\frac{1}{\eta} - 1\right) P_{\text{out}}$
- 17** A shot-put champion accelerates a 7.0 kg metal ball in a straight line. The ball moves from rest to a speed of 12 m s^{-1} in a distance of 1.2 m.

What is the average resultant force on the metal ball?

- A** 70 N **B** 210 N **C** 420 N **D** 840 N

Space for working

- 18 A ball drops onto a horizontal surface and bounces elastically.

What happens to the kinetic energy of the ball during the very short time that it is in contact with the surface?

- A Most of the kinetic energy is lost as heat and sound energy.
- B The kinetic energy decreases to zero and then returns to its original value.
- C The kinetic energy remains constant because it is an elastic collision.
- D The kinetic energy remains constant in magnitude but changes direction.

- 19 When the water in a pond freezes, it changes from a liquid to a solid. When this occurs, it changes volume and exchanges energy with the surroundings.

Which row is correct?

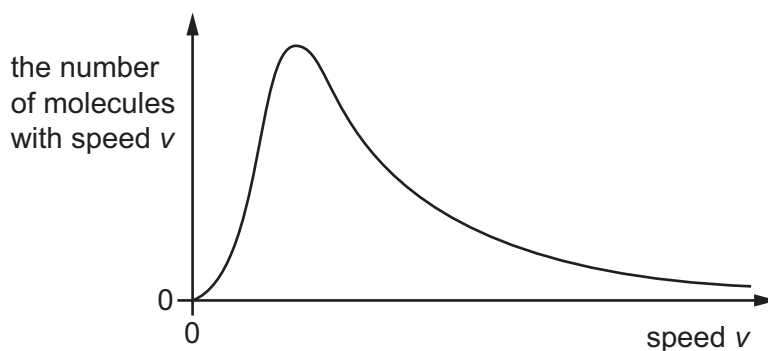
	change of volume	energy exchange
A	contracts	gives out energy to the surroundings
B	contracts	takes in energy from the surroundings
C	expands	gives out energy to the surroundings
D	expands	takes in energy from the surroundings

- 20 Which process does **not** require energy to be supplied?

- A boiling
- B evaporation
- C freezing
- D melting

Space for working

- 21 The graph shows the distribution of speeds for the molecules of a gas at a particular temperature.



Which statement is correct?

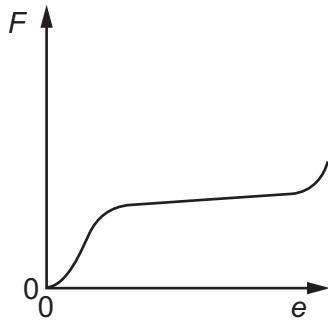
- A All the molecules have the same kinetic energy.
 - B The commonest value of speed is also the average speed.
 - C The graph shows that the molecules of a gas are widely spaced apart.
 - D The peak value of the graph would move to the right if the temperature is increased.
- 22 The Mariana Trench 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
- 23 An elastic material with a Young modulus E is subjected to a tensile stress S . Hooke's Law is obeyed.

What is the expression for the elastic energy stored per unit volume of the material?

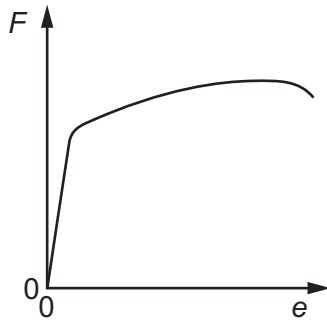
- A $\frac{S^2}{2E}$
- B $\frac{S^2}{E}$
- C $\frac{E}{2S^2}$
- D $\frac{2E}{S^2}$

Space for working

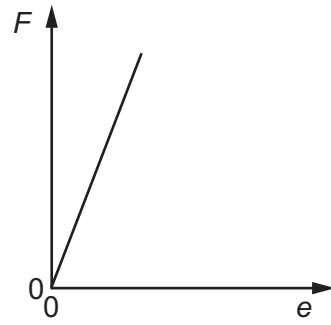
- 24** Cylindrical samples of steel, glass and rubber are each subjected to a gradually increasing tensile force F . The extensions e are measured and graphs are plotted as shown below.



graph X



graph Y



graph Z

Which row correctly relates the graphs to the materials?

	steel	glass	rubber
A	X	Y	Z
B	X	Z	Y
C	Y	X	Z
D	Y	Z	X

- 25** A cathode-ray oscilloscope (c.r.o.) displays a waveform corresponding to a sound wave.

In order to determine the frequency of the sound wave, which part of the displayed waveform must be measured and which c.r.o. setting must be known?

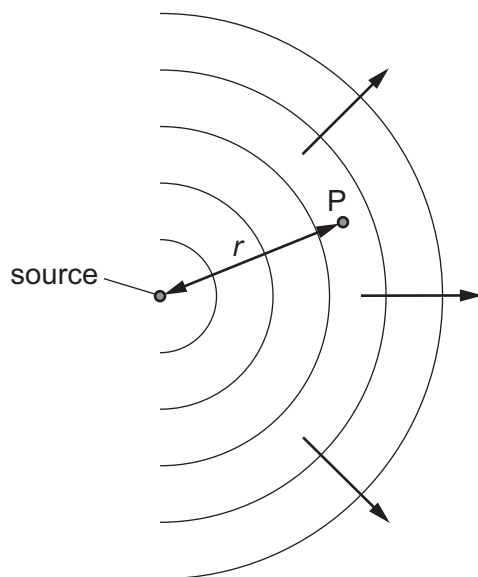
	on-screen measurement	c.r.o. setting
A	amplitude	time-base
B	amplitude	Y-gain
C	wavelength	time-base
D	wavelength	Y-gain

Space for working

26 What is the approximate range of frequencies of infra-red radiation?

- A $1 \times 10^3 \text{ Hz}$ to $1 \times 10^9 \text{ Hz}$
 B $1 \times 10^9 \text{ Hz}$ to $1 \times 10^{11} \text{ Hz}$
 C $1 \times 10^{11} \text{ Hz}$ to $1 \times 10^{14} \text{ Hz}$
 D $1 \times 10^{14} \text{ Hz}$ to $1 \times 10^{17} \text{ Hz}$

27 A small source emits spherical waves.



The wave intensity I at any point P, a distance r from the source, is inversely proportional to r^2 .

What is the relationship between the wave amplitude a and the distance r ?

- A $a^2 \propto \frac{1}{r}$ B $a \propto \frac{1}{r}$ C $a \propto \frac{1}{r^2}$ D $a \propto \frac{1}{r^4}$

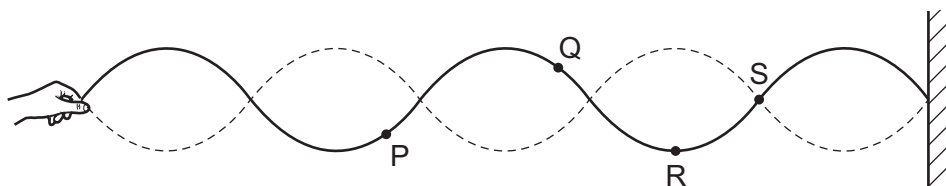
Space for working

- 28 A student attempts to show the interference of light using two identical green LEDs.

Which statement explains why the experiment will **not** succeed?

- A The light waves from the sources are not coherent.
- B The light waves from the sources do not have the same amplitude.
- C The light waves from the sources have a range of wavelengths.
- D The light waves from the sources are not monochromatic.

- 29 A stationary wave is set up on a stretched string, as shown.



Which statement about the points on the string is correct?

- A Point Q vibrates with the largest amplitude.
- B Points P and R vibrate in phase.
- C Point S is an antinode.
- D The horizontal distance between R and S is half the wavelength.

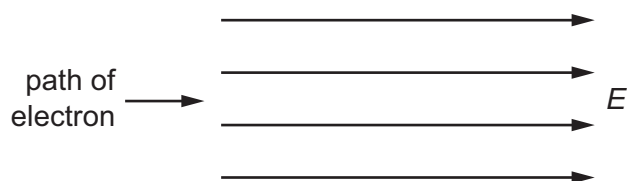
- 30 Monochromatic light is incident on a diffraction grating and a diffraction pattern is observed.

Which line of the table gives the effect of replacing the grating with one that has more lines per metre?

	number of orders of diffraction visible	angle between first and second orders of diffraction
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Space for working

- 31 An electron enters a region of space where there is a uniform electric field E as shown.



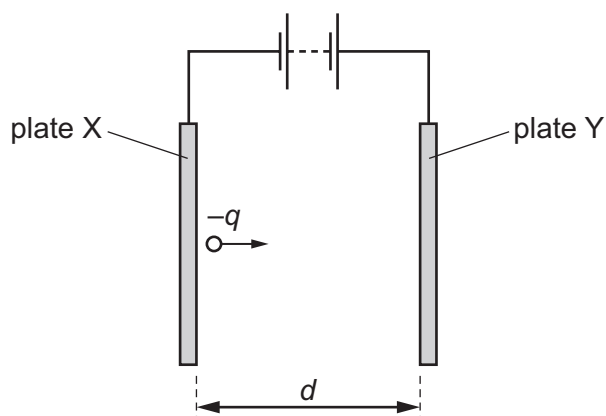
Initially, the electron is moving parallel to, and in the direction of, the electric field.

What is the subsequent path and change of speed of the electron?

	path of electron	speed of electron
A	linear	decreases
B	linear	increases
C	parabolic	decreases
D	parabolic	increases

Space for working

- 32 Two parallel plates X and Y are separated by a distance d in a vacuum. There is a potential difference between the plates so that a uniform electric field is produced.



A charge $-q$ moves from rest from the surface of plate X and travels towards plate Y.

When the charge reaches plate Y it has kinetic energy K .

Which expression gives the electric field strength between the plates?

- A** $\frac{q}{Kd}$ **B** $\frac{qd}{K}$ **C** $\frac{K}{qd}$ **D** $\frac{Kd}{q}$

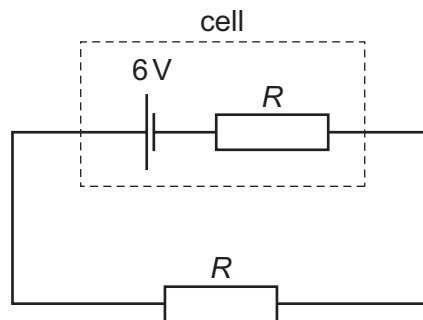
Space for working

- 33 Two wires P and Q made of the same material and of the same length are connected in parallel to the same voltage supply. Wire P has diameter 2 mm and wire Q has diameter 1 mm.

What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

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

- 34 A cell has an electromotive force (e.m.f.) of 6 V and internal resistance R . An external resistor, also of resistance R , is connected across this cell, as shown.



Power P is dissipated by the external resistor.

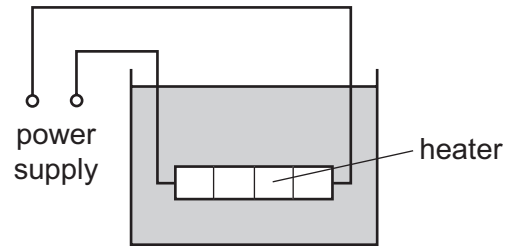
The cell is replaced by a different cell that has an e.m.f. of 6 V and negligible internal resistance.

What is the new power that is dissipated in the external resistor?

- A $0.5P$ B P C $2P$ D $4P$

Space for working

35 The diagram shows a low-voltage circuit for heating the water in a fish tank.



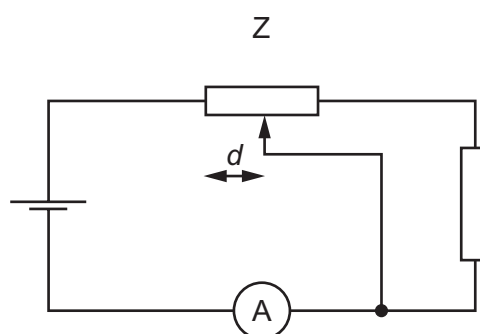
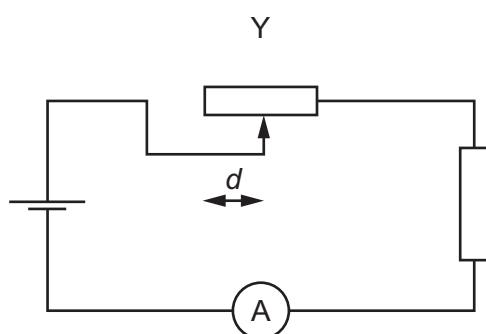
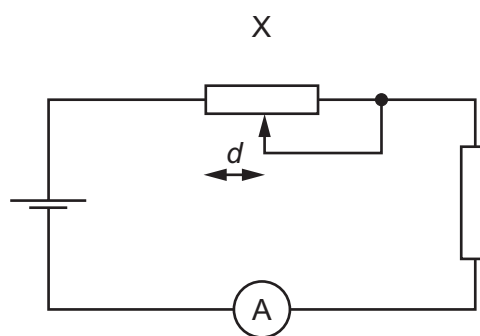
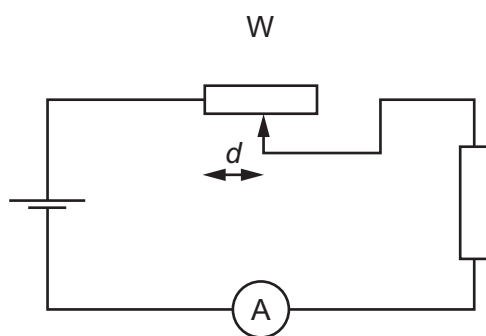
The heater has a resistance of 3.0Ω . The power supply has an e.m.f. of 12V and an internal resistance of 1.0Ω .

At which rate is energy supplied to the heater?

- A** 27W **B** 36W **C** 48W **D** 64W

Space for working

- 36 The diagrams show the same cell, ammeter, potentiometer and fixed resistor connected in different ways.



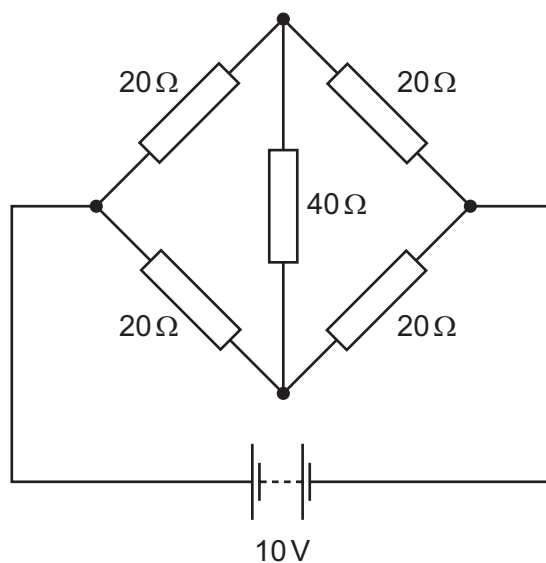
The distance d between the sliding contact and a particular end of the potentiometer is varied. The current measured is then plotted against the distance d .

For which two circuits will the graphs be identical?

- A** W and X **B** W and Y **C** X and Y **D** Y and Z

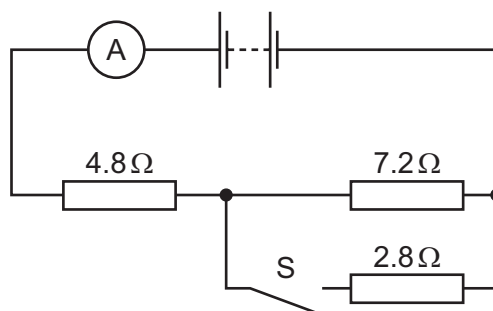
Space for working

37 What is the current in the 40Ω resistor of the circuit shown?



- A** zero **B** 0.13 A **C** 0.25 A **D** 0.50 A

38 A battery of negligible internal resistance is connected to a resistor network, an ammeter and a switch S, as shown.



When S is open, the reading on the ammeter is 250 mA.

When S is closed, what is the **change** in the reading on the ammeter?

- A** 1.07 A **B** 1.32 A **C** 190 mA **D** 440 mA

Space for working

- 39** An isotope of thorium has a nucleon number of 232 and a proton number of 90. It decays to form another isotope of thorium with a nucleon number of 228.

How many alpha particles and beta particles are emitted by a nucleus of thorium during this decay?

	alpha particles	beta particles
A	0	4
B	1	0
C	1	2
D	2	1

- 40** Four nuclei are represented below.



Which statement about these nuclei is correct?

- A** An uncharged atom of element Q has 24 orbital electrons.
- B** Nucleus M could transform into Q by emitting a beta particle.
- C** Nuclei G and M are isotopes of the same element.
- D** When E absorbs a neutron and then emits an alpha particle, nucleus E transforms into M.

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