



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

PHYSICS

9702/11

Paper 1 Multiple Choice

May/June 2013

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.

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 **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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
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,

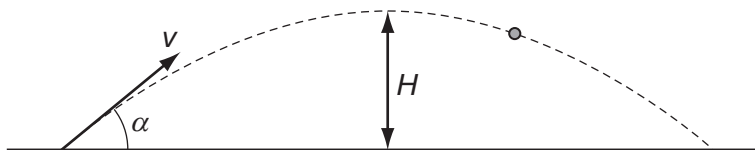
$$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$$

- 1 Which pair of quantities contains one vector and one scalar quantity?
- A** displacement; force
B kinetic energy; power
C acceleration; momentum
D velocity; distance
- 2 One property Q of a material is used to describe the behaviour of sound waves in the material. Q is defined as the pressure P of the sound wave divided by the speed v of the wave and the surface area A of the material through which the wave travels:

$$Q = \frac{P}{vA}.$$

What are the SI base units of Q ?

- A** $\text{kg m}^2 \text{s}^{-3}$ **B** $\text{kg m}^{-3} \text{s}^{-1}$ **C** $\text{kg m}^{-4} \text{s}^{-1}$ **D** $\text{kg m}^{-2} \text{s}^{-2}$
- 3 A cannon fires a cannonball with an initial speed v at an angle α to the horizontal.



Which equation is correct for the maximum height H reached?

- A** $H = \frac{v \sin \alpha}{2g}$ **B** $H = \frac{g \sin \alpha}{2v}$ **C** $H = \frac{(v \sin \alpha)^2}{2g}$ **D** $H = \frac{g^2 \sin \alpha}{2v}$

Space for working

- 4 A wave has a frequency of 5 GHz.

What is the period of the wave?

- A 20 000 μs
- B 20 ns
- C 2 ns
- D 200 ps

- 5 In an experiment to determine the acceleration of free fall g , the period of oscillation T and length l of a simple pendulum were measured. The uncertainty in the measurement of l is estimated to be 4%, and the uncertainty in the measurement of T is estimated to be 1%.

The value of g is determined using the formula

$$g = \frac{4\pi^2 l}{T^2}.$$

What is the uncertainty in the calculated value for g ?

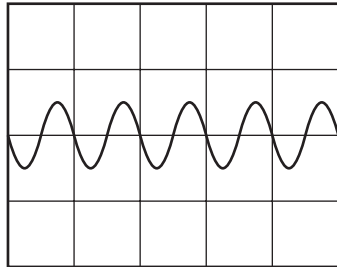
- A 2%
- B 3%
- C 5%
- D 6%

Space for working

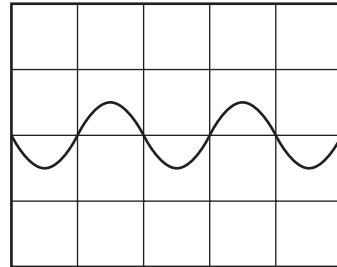
- 6 The Y-input terminals of a cathode-ray oscilloscope (c.r.o.) are connected to a supply of amplitude 5.0 V and frequency 50 Hz. The time-base is set at 10 ms per division and the Y-gain at 5.0 V per division.

Which trace is obtained?

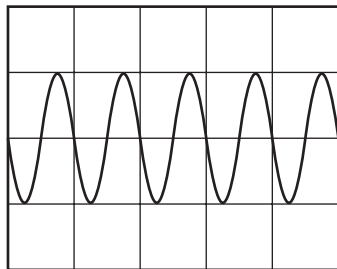
A



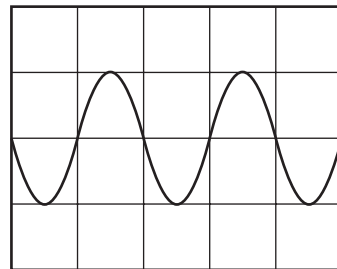
B



C



D



- 7 A body is released from rest and falls vertically in air of constant density.

Which statement about the motion of the falling body is correct?

- A** As it accelerates, its weight decreases so that its acceleration decreases until it travels with constant velocity.
- B** It accelerates initially at 9.8 m s^{-2} but the drag force increases so its acceleration decreases.
- C** Its velocity increases at a constant rate until its velocity becomes constant.
- D** The drag force of the air increases continually and eventually the velocity decreases.

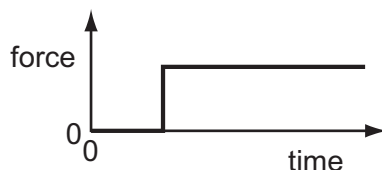
Space for working

- 8 A goods train passes through a station at a steady speed of 10 m s^{-1} . An express train is at rest at the station. The express train leaves the station with a uniform acceleration of 0.5 m s^{-2} just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks.

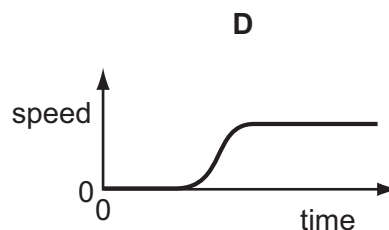
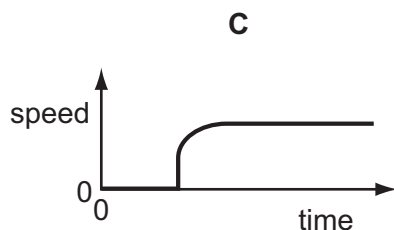
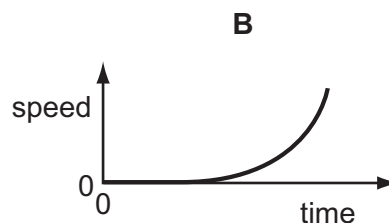
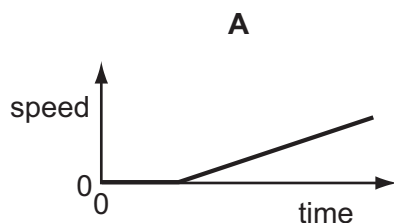
How much time passes before the express train overtakes the goods train?

- A 6 s B 10 s C 20 s D 40 s

- 9 A car is stationary at traffic lights. When the traffic lights go green, the driver presses down sharply on the accelerator. The resultant horizontal force acting on the car varies with time as shown.



Which graph shows the variation with time of the speed of the car?

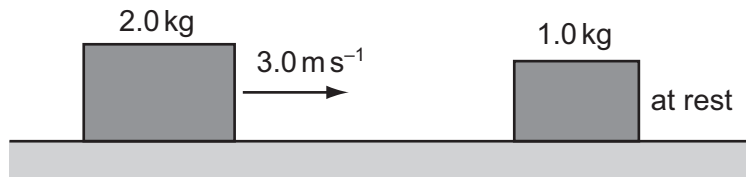


Space for working

10 Which of the following is a statement of the principle of conservation of momentum?

- A In an elastic collision momentum is constant.
- B Momentum is the product of mass and velocity.
- C The force acting on a body is proportional to its rate of change of momentum.
- D The momentum of an isolated system is constant.

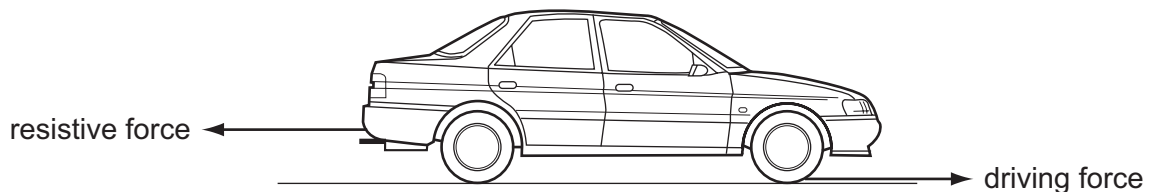
11 A 2.0 kg mass travelling at 3.0 m s^{-1} on a frictionless surface collides head-on with a stationary 1.0 kg mass. The masses stick together on impact.



How much kinetic energy is lost on impact?

- A zero
- B 2.0 J
- C 2.4 J
- D 3.0 J

12 A car of mass 750 kg has a horizontal driving force of 2.0 kN acting on it. It has a forward horizontal acceleration of 2.0 m s^{-2} .

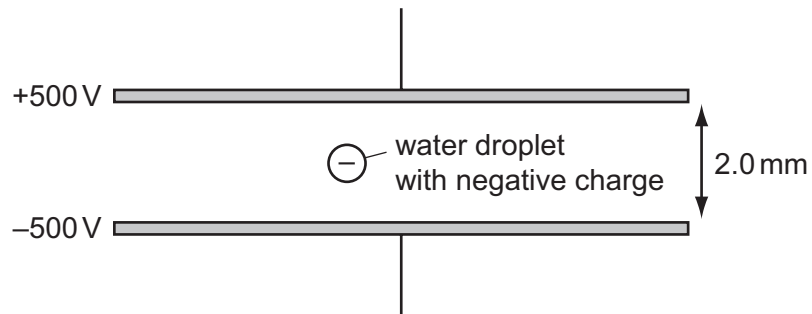


What is the resistive force acting horizontally?

- A 0.50 kN
- B 1.5 kN
- C 2.0 kN
- D 3.5 kN

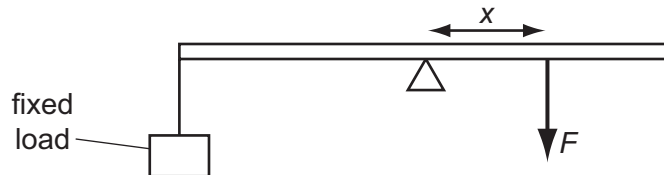
Space for working

- 13** A small water droplet of mass $3.0\ \mu\text{g}$ carries a charge of $-6.0 \times 10^{-11}\text{ C}$. The droplet is situated in the Earth's gravitational field between two horizontal metal plates. The potential of the upper plate is $+500\text{ V}$ and the potential of the lower plate is -500 V .

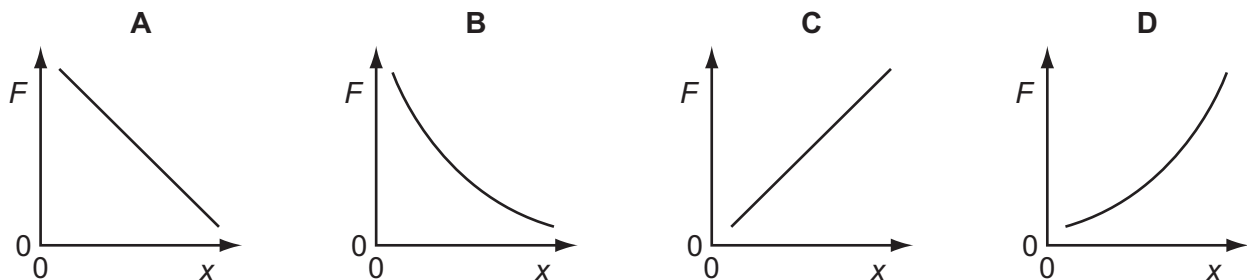


What is the motion of the droplet?

- A** It accelerates downwards.
 - B** It remains stationary.
 - C** It accelerates upwards.
 - D** It moves upwards at a constant velocity.
- 14** A horizontal bar is supported on a pivot at its centre of gravity. A fixed load is attached to one end of the bar. To keep the bar in equilibrium, a force F is applied at a distance x from the pivot.

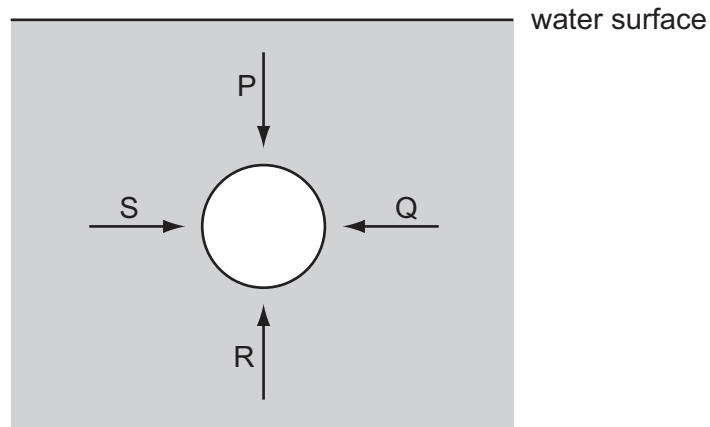


How does F vary with x ?



Space for working

- 15 The diagram represents a sphere under water. P, Q, R and S are forces acting on the sphere, due to the pressure of the water.



Each force acts perpendicularly to the sphere's surface. P and R act in opposite directions vertically. Q and S act in opposite directions horizontally.

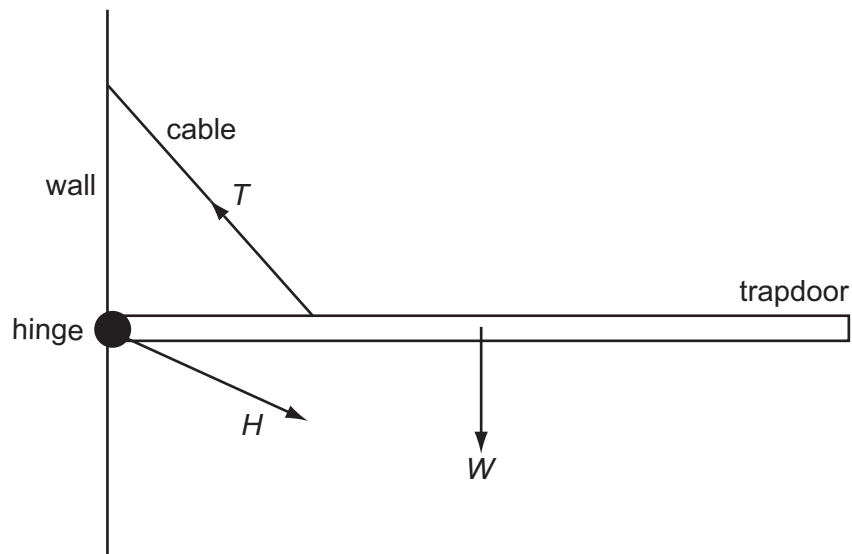
Which information about the magnitudes of the forces is correct?

- A $P < R$ and $S = Q$
- B $P > R$ and $S = Q$
- C $P = R$ and $S = Q$ and $P \neq S$
- D $P = R$ and $S = Q$ and $P = S$

Space for working

- 16 A hinged trapdoor is held closed in the horizontal position by a cable.

Three forces act on the trapdoor: the weight W of the door, the tension T in the cable and the force H at the hinge.

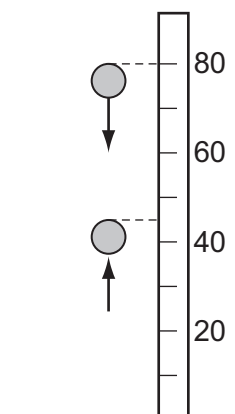


Which list gives the three forces in **increasing** order of magnitude?

- A** H, T, W **B** T, H, W **C** W, H, T **D** W, T, H

Space for working

- 17 A solid rubber ball has a diameter of 8.0 cm. It is released from rest with the top of the ball 80 cm above a horizontal surface. It falls vertically and then bounces back up so that the maximum height reached by the top of the ball is 45 cm, as shown.



If the kinetic energy of the ball is 0.75 J just before it strikes the surface, what is its kinetic energy just after it leaves the surface?

- A 0.36 J B 0.39 J C 0.40 J D 0.42 J

Space for working

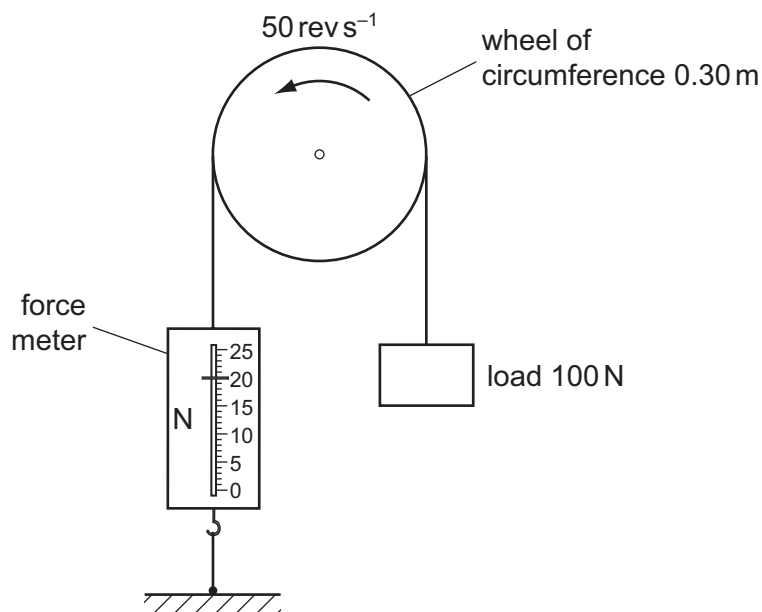
- 18 A wind turbine has blades that sweep an area of 2000 m^2 . It converts the power available in the wind to electrical power with an efficiency of 50%.

What is the electrical power generated if the wind speed is 10 m s^{-1} ? (The density of air is 1.3 kg m^{-3} .)

- A 130 kW B 650 kW C 1300 kW D 2600 kW

- 19 The diagram shows a wheel of circumference 0.30 m. A rope is fastened at one end to a force meter. The rope passes over the wheel and supports a freely hanging load of 100 N. The wheel is driven by an electric motor at a constant rate of 50 revolutions per second.

When the wheel is turning at this rate, the force meter reads 20 N.



What is the output power of the motor?

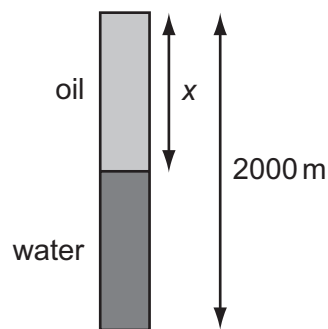
- A 0.3 kW B 1.2 kW C 1.8 kW D 3.8 kW

Space for working

20 Which row correctly states the characteristics of the process of evaporation?

	requires heat energy	occurs only at a particular temperature	can cause a change of temperature
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✗
D	✗	✗	✓

21 A bore-hole of depth 2000 m contains both oil and water as shown. The pressure due to the liquids at the bottom of the bore-hole is 17.5 MPa. The density of the oil is 830 kg m^{-3} and the density of the water is 1000 kg m^{-3} .



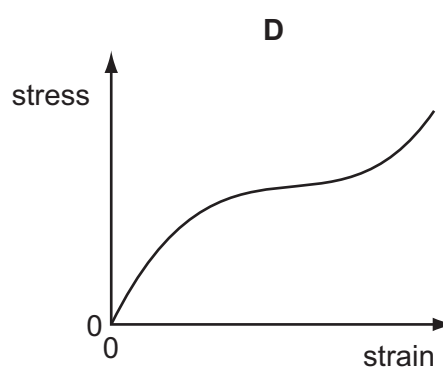
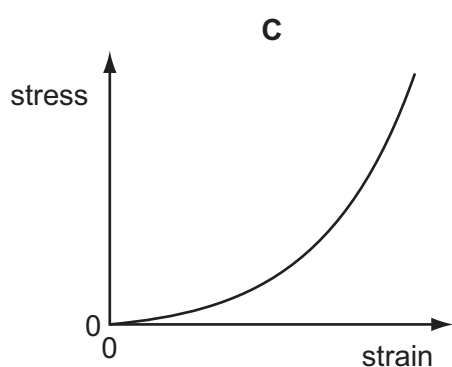
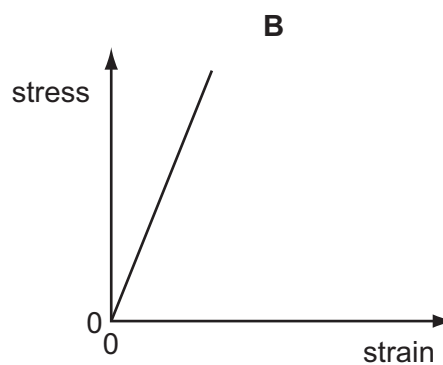
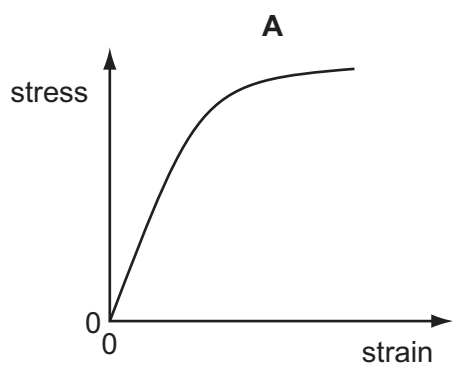
What is the depth x of the oil?

- A** 907 m **B** 1000 m **C** 1090 m **D** 1270 m

Space for working

22 The stress-strain graphs for four different materials are shown below.

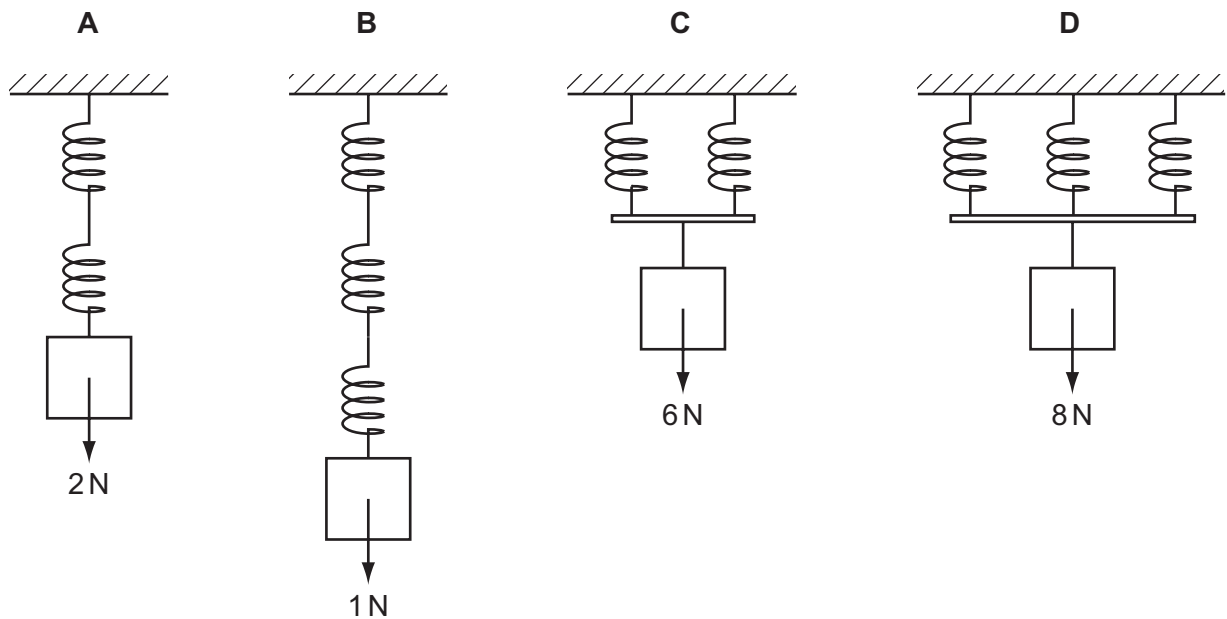
Which diagram shows the stress-strain graph for a ductile metal?



Space for working

- 23** A number of identical springs, each having the same spring constant, are joined in four arrangements. A different load is applied to each arrangement.

Which arrangement has the largest extension?



- 24** A light wave of amplitude A is incident normally on a surface of area S . The power per unit area reaching the surface is P .

The amplitude of the light wave is increased to $2A$. The light is then focussed on to a smaller area $\frac{1}{3}S$.

What is the power per unit area on this smaller area?

- A** $36P$
- B** $18P$
- C** $12P$
- D** $6P$

Space for working

- 25** A wave has a speed of 340 m s^{-1} and a period of 0.28 ms .

What is its wavelength?

- A** 0.095 m **B** 95 m **C** $1.2 \times 10^3 \text{ m}$ **D** $1.2 \times 10^6 \text{ m}$

- 26** Which line in the table summarises the change in wave characteristics on going from infra-red to ultraviolet in the electromagnetic spectrum?

	frequency	speed in a vacuum
A	decreases	decreases
B	decreases	remains constant
C	increases	remains constant
D	increases	increases

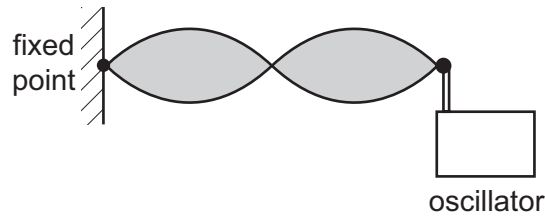
- 27** Light of wavelength 600 nm is incident on a pair of slits. Fringes with a spacing of 4.0 mm are formed on a screen.

What will be the fringe spacing when the wavelength of the light is changed to 400 nm and the separation of the slits is doubled?

- A** 1.3 mm
B 3.0 mm
C 5.3 mm
D 12 mm

Space for working

- 28 The speed of a transverse wave on a stretched string can be changed by adjusting the tension of the string. A stationary wave pattern is set up on a stretched string using an oscillator set at a frequency of 650 Hz.



How must the wave be changed to maintain the same stationary wave pattern if the applied frequency is increased to 750 Hz?

- A Decrease the speed of the wave on the string.
 - B Decrease the wavelength of the wave on the string.
 - C Increase the speed of the wave on the string.
 - D Increase the wavelength of the wave on the string.
- 29 Noise reduction headphones actively produce their own sound waves in order to cancel out external sound waves.

A microphone in the headphones receives waves of one frequency. A loudspeaker in the headphones then produces a wave of that frequency but of a different phase.

What is the phase difference between the external sound wave and the wave produced by the loudspeaker in the headphones?

- A 90° B 180° C 270° D 360°

Space for working

- 30 A beam of electrons is directed into an electric field and is deflected by it.

Diagram 1 represents an electric field in the plane of the paper.

Diagram 2 represents an electric field directed perpendicular to the plane of the paper.

The lines **A**, **B**, **C** and **D** represent possible paths of the electron beam. All paths are in the plane of the paper.

Which line best represents the path of the electrons inside the field?

diagram 1

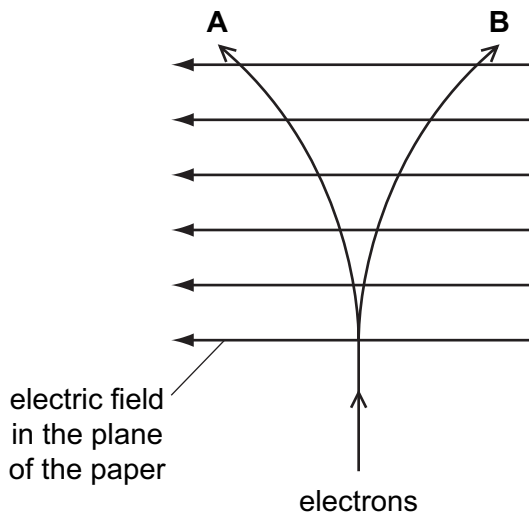
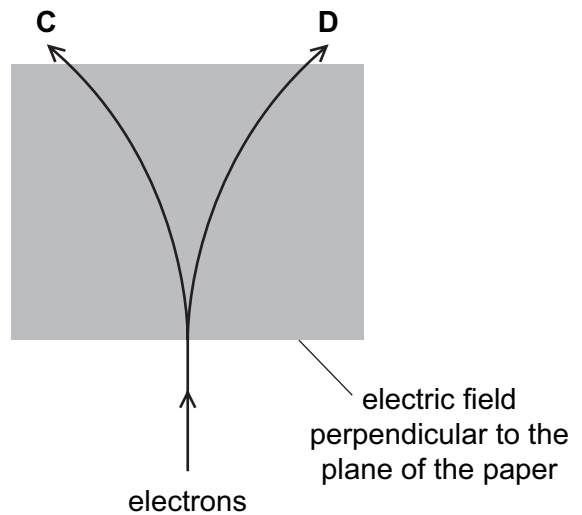
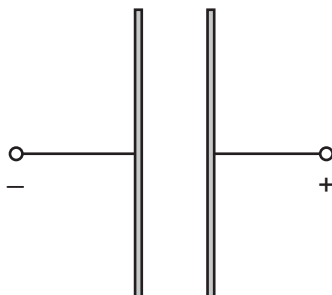


diagram 2



Space for working

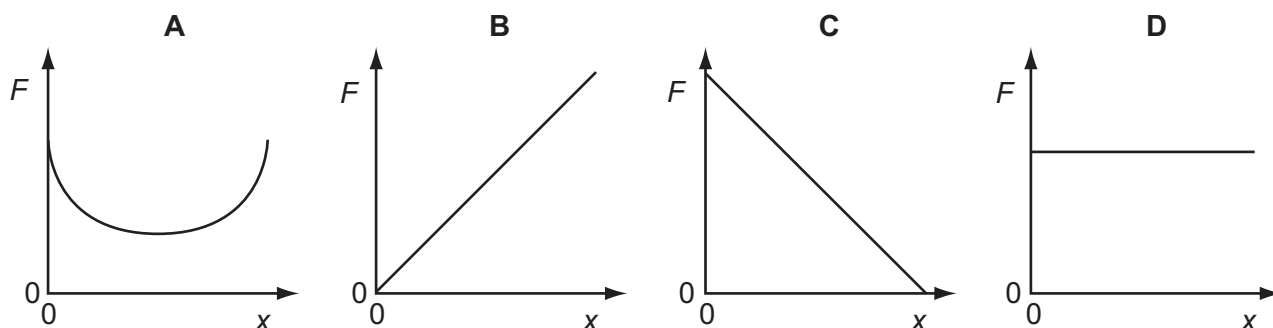
- 31 Two oppositely-charged parallel plates are arranged as shown.



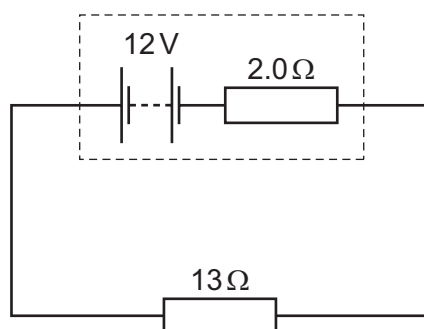
An electron is released from rest from the surface of the negatively-charged plate.

The electron travels from the negatively-charged plate towards the positively-charged plate.

Which graph shows how the force F on the electron varies with its distance x from the negative plate?



- 32 A power supply of electromotive force (e.m.f.) 12 V and internal resistance $2.0\ \Omega$ is connected in series with a $13\ \Omega$ resistor.



What is the power dissipated in the $13\ \Omega$ resistor?

- A** 8.3 W **B** 9.6 W **C** 10 W **D** 11 W

Space for working

- 33** When a battery is connected to a resistor, the battery gradually becomes warm. This causes the internal resistance of the battery to increase whilst its e.m.f. stays unchanged.

As the internal resistance of the battery increases, how do the terminal potential difference and the output power change, if at all?

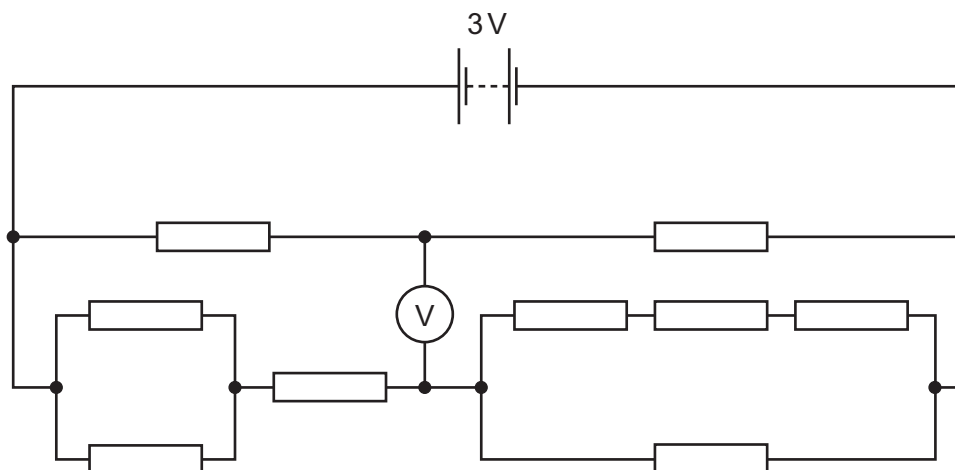
	terminal potential difference	output power
A	decrease	decrease
B	decrease	unchanged
C	unchanged	decrease
D	unchanged	unchanged

- 34** The principles of conservation of which two quantities are associated with Kirchhoff's first and second laws?

	first law	second law
A	charge	energy
B	charge	voltage
C	energy	charge
D	voltage	charge

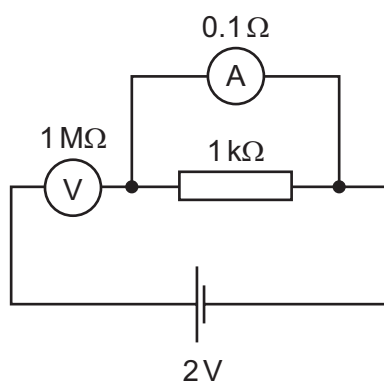
Space for working

- 35 A circuit is set up as shown, supplied by a 3 V battery. All resistances are $1\text{ k}\Omega$.



What will be the reading on the voltmeter?

- A** 0 **B** 0.5 V **C** 1.0 V **D** 1.5 V
- 36 The diagram shows an incorrectly connected circuit. The ammeter has a resistance of $0.1\text{ }\Omega$ and the voltmeter has a resistance of $1\text{ M}\Omega$.

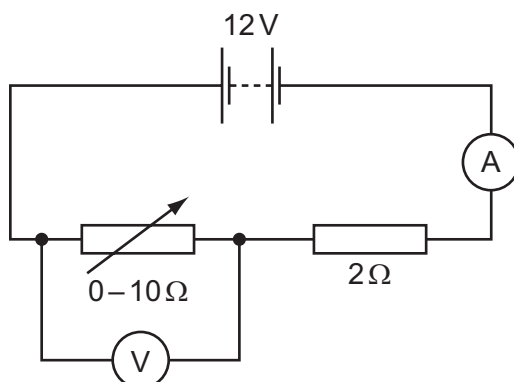


Which statement is correct?

- A** The ammeter reads 2 mA.
B The ammeter reads 20 A.
C The voltmeter reads zero.
D The voltmeter reads 2 V.

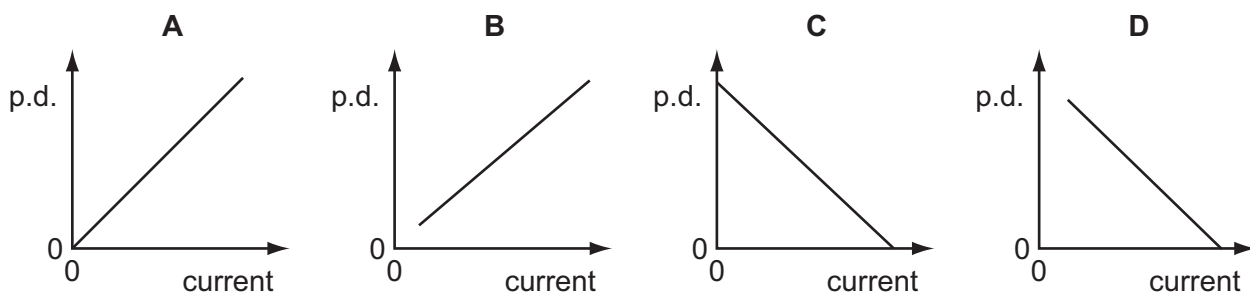
Space for working

- 37 A 12V battery is in series with an ammeter, a 2Ω fixed resistor and a $0-10\Omega$ variable resistor. A high-resistance voltmeter is connected across the variable resistor.



The resistance of the variable resistor is changed from zero to its maximum value.

Which graph shows how the potential difference (p.d.) measured by the voltmeter varies with the current measured by the ammeter?



- 38 A nickel nucleus $^{59}_{28}\text{Ni}$ can be transformed by a process termed K-capture. In this process the nucleus absorbs an orbital electron.

If no other process is involved, what is the resulting nucleus?

- A** $^{58}_{28}\text{Ni}$ **B** $^{58}_{27}\text{Co}$ **C** $^{59}_{27}\text{Co}$ **D** $^{59}_{29}\text{Cu}$

Space for working

- 39 It was once thought that the mass of an atom is spread uniformly through the volume of the atom. When α -particles are directed at a piece of gold foil, the results led scientists to believe instead that nearly all the mass of the gold atom is concentrated at a point inside the atom.

Which effect is possible **only** if nearly all the mass of the gold atom is concentrated at a point?

- A a few α -particles bounce back
- B most α -particles are only slightly deflected
- C some α -particles pass through without any deflection
- D some α -particles are absorbed

- 40 Which pair of nuclei are isotopes of one another?

	nucleon number	number of neutrons
A	186	112
	180	118
B	186	112
	182	108
C	184	110
	187	110
D	186	110
	186	112

Space for working



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

PHYSICS

9702/12

Paper 1 Multiple Choice

May/June 2013

1 hour

Additional Materials: Multiple Choice Answer Sheet
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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,

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

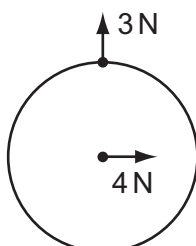
- 1 Which pair includes a vector quantity and a scalar quantity?
- A** displacement; acceleration
- B** force; kinetic energy
- C** power; speed
- D** work; potential energy
- 2 The unit of resistivity, expressed in terms of base units, is given by

$$\text{kg x}^3 \text{y}^{-2} \text{z}^{-3}.$$

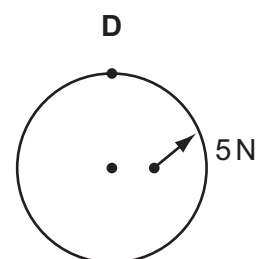
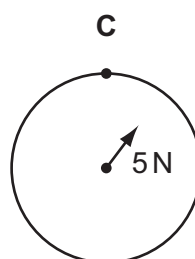
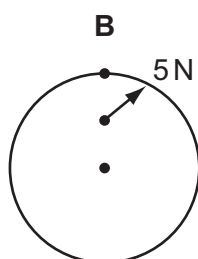
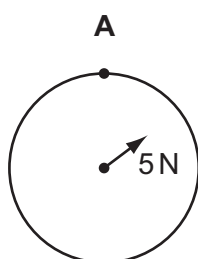
Which base units are x, y and z?

	x	y	z
A	ampere	metre	second
B	metre	ampere	second
C	metre	second	ampere
D	second	ampere	metre

- 3 Two forces act on a circular disc as shown.



Which diagram shows the line of action of the resultant force?

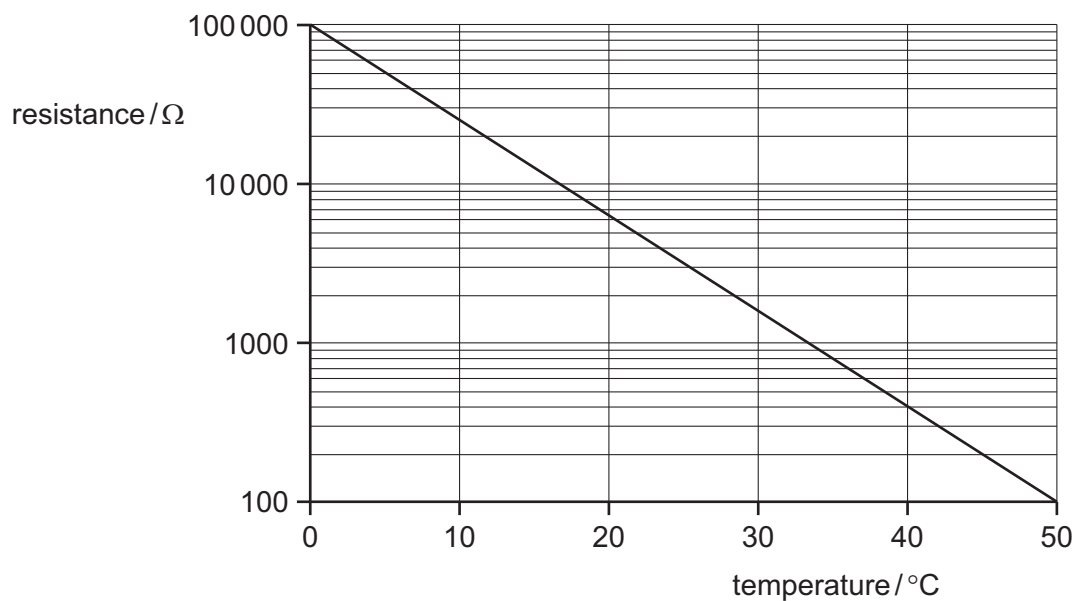


Space for working

- 4 A student carried out an experiment in which an electric current was known to decrease with time. The readings he found, from first to last, were 3.62 mA, 2.81 mA, 1.13 mA, 1.76 mA and 0.90 mA.

Which statement could **not** explain the anomalous 1.13 mA reading?

- A** He has reversed the third and fourth readings in the results table.
B He read the ammeter incorrectly; the reading should have been 2.13 mA.
C He took the current reading at the wrong time.
D There was a systematic error in the readings from the ammeter.
- 5 The diagram shows a calibration curve for a thermistor, drawn with an unusual scale on the vertical axis.



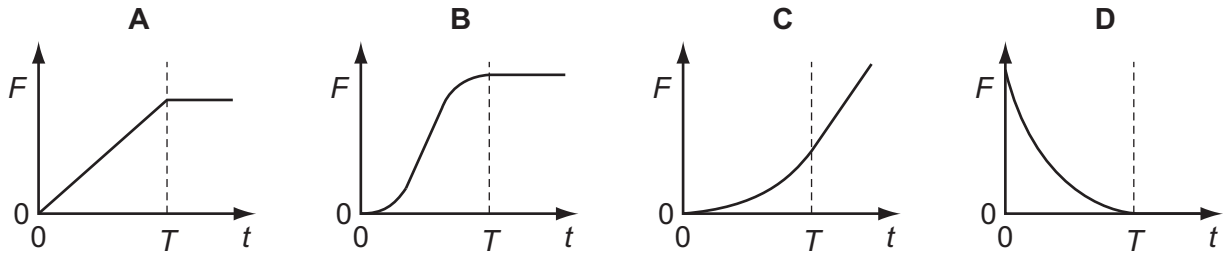
What is the thermistor resistance corresponding to a temperature of 40 °C?

- A** 130 Ω **B** 150 Ω **C** 400 Ω **D** 940 Ω

Space for working

- 6 A sky diver falls vertically from a stationary balloon. She leaves the balloon at time $t = 0$. At time $t = T$, she reaches terminal velocity. Beyond the time shown in the graphs, she opens her parachute.

Which graph shows the variation with time t of the force F due to air resistance?



- 7 The diagram shows an arrangement to stop trains that are travelling too fast.



Trains coming from the left travel at a speed of 50 m s^{-1} . At marker 1, the driver must apply the brakes so that the train decelerates uniformly in order to pass marker 2 at no more than 10 m s^{-1} .

The train carries a detector that notes the times when the train passes each marker and will apply an emergency brake if the time between passing marker 1 and marker 2 is less than 20 s.

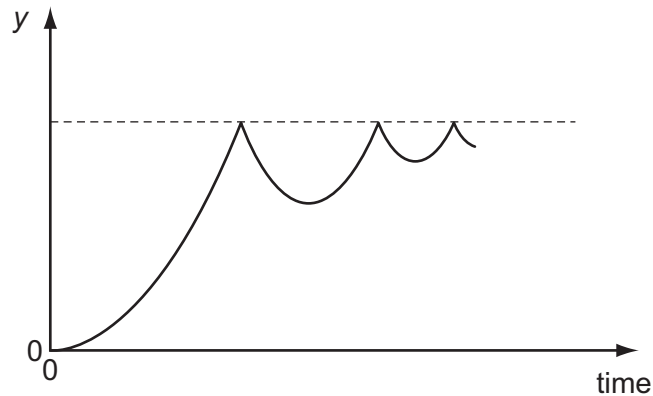
How far from marker 2 should marker 1 be placed?

- A** 200 m **B** 400 m **C** 500 m **D** 600 m

Space for working

- 8 A ball is released from rest above a horizontal surface and bounces several times.

The graph shows how, for this ball, a quantity y varies with time.



What is the quantity y ?

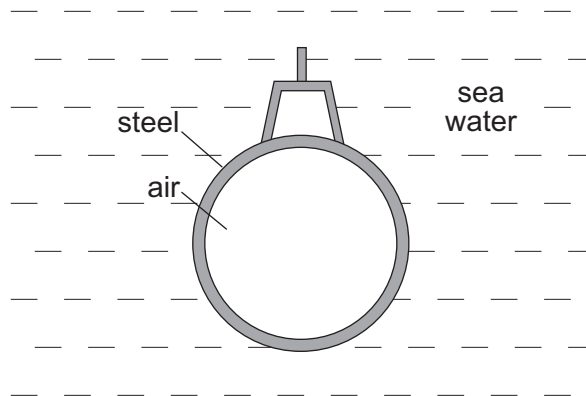
- A acceleration
 - B displacement
 - C kinetic energy
 - D velocity
- 9 A strong wind of speed 33 m s^{-1} blows against a wall. The density of the air is 1.2 kg m^{-3} . The wall has an area of 12 m^2 at right angles to the wind velocity. The air has its speed reduced to zero when it hits the wall.

What is the approximate force exerted by the air on the wall?

- A 330 N B 400 N C 480 N D 16 000 N

Space for working

- 10 Two bodies travelling in a straight line collide in a perfectly elastic collision. Which of the following statements **must** be correct?
- A The initial speed of one body will be the same as the final speed of the other body.
 - B The relative speed of approach between the two bodies equals their relative speed of separation.
 - C The total momentum is conserved but the total kinetic energy will be reduced.
 - D One of the bodies will be stationary at one instant.
- 11 A submarine is in equilibrium in a fully submerged position.



What causes the upthrust on the submarine?

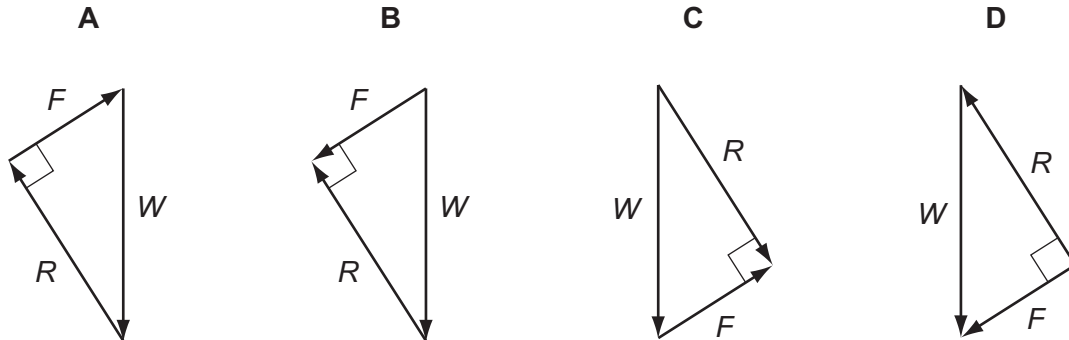
- A The air in the submarine is less dense than sea water.
- B The sea water exerts a greater upward force on the submarine than the weight of the steel.
- C The submarine displaces its own volume of sea water.
- D There is a difference in water pressure acting on the top and on the bottom of the submarine.

Space for working

- 12** A vehicle is at rest on a slope. It is considered to have three forces acting on it to keep it in equilibrium.

They are its weight W , a normal reaction force R and a frictional force F .

Which triangle of forces is correct?



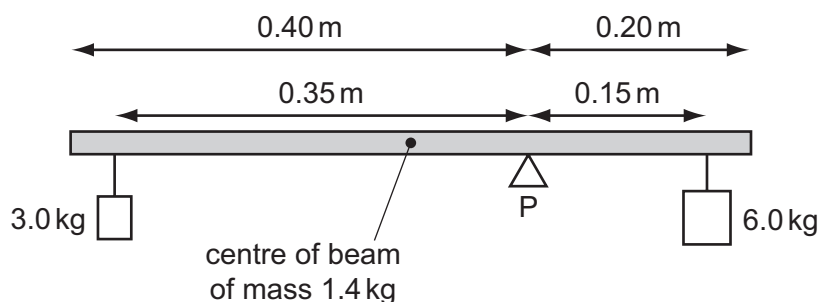
- 13** All external forces on a body cancel out.

Which statement **must** be correct?

- A** The body does not move.
- B** The momentum of the body remains unchanged.
- C** The speed of the body remains unchanged.
- D** The total energy (kinetic and potential) of the body remains unchanged.

Space for working

- 14** A uniform beam of mass 1.4 kg is pivoted at P as shown. The beam has a length of 0.60 m and P is 0.20 m from one end. Loads of 3.0 kg and 6.0 kg are suspended 0.35 m and 0.15 m from the pivot as shown.



What torque must be applied to the beam in order to maintain it in equilibrium?

- A** 0.010 Nm **B** 0.10 Nm **C** 0.29 Nm **D** 2.8 Nm
- 15** A ball is thrown vertically upwards.
- Neglecting air resistance, which statement is correct?
- A** The kinetic energy of the ball is greatest at the greatest height attained.
- B** By the principle of conservation of energy, the total energy of the ball is constant throughout its motion.
- C** By the principle of conservation of momentum, the momentum of the ball is constant throughout its motion.
- D** The potential energy of the ball increases uniformly with time during its ascent.
- 16** A bow of mass 400 g shoots an arrow of mass 120 g vertically upwards. The potential energy stored in the bow just before release is 80 J. The system has an efficiency of 28%.

What is the height reached by the arrow when air resistance is neglected?

- A** 4 m **B** 19 m **C** 187 m **D** 243 m

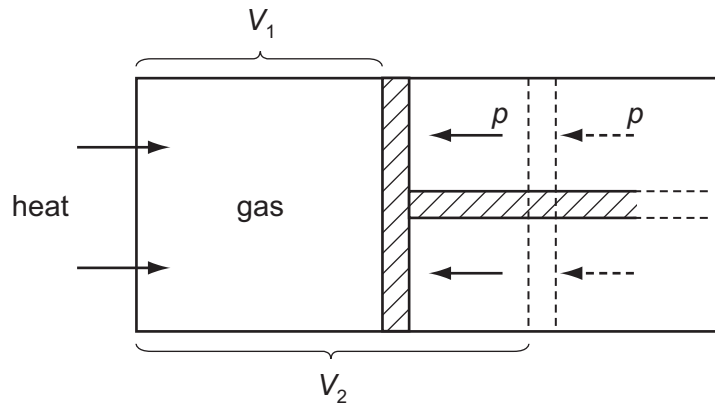
Space for working

- 17 A train on a mountain railway is carrying 200 people of average mass 70 kg up a slope at an angle of 30° to the horizontal and at a speed of 6.0 ms^{-1} . The train itself has a mass of 80 000 kg. The percentage of the power from the engine which is used to raise the passengers and the train is 40 %.

What is the power of the engine?

- A 1.1 MW B 2.8 MW C 6.9 MW D 14 MW

- 18 A gas is enclosed inside a cylinder which is fitted with a frictionless piston.



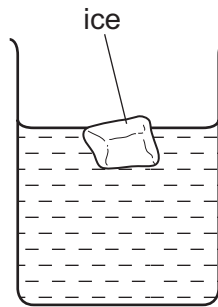
Initially, the gas has a volume V_1 and is in equilibrium with an external pressure p . The gas is then heated slowly so that it expands, pushing the piston back until the volume of the gas has increased to V_2 .

How much work is done by the gas during this expansion?

- A $p(V_2 - V_1)$ B $\frac{1}{2}p(V_2 - V_1)$ C $p(V_2 + V_1)$ D $\frac{1}{2}p(V_2 + V_1)$

Space for working

- 19 The diagram shows an ice cube floating in water.



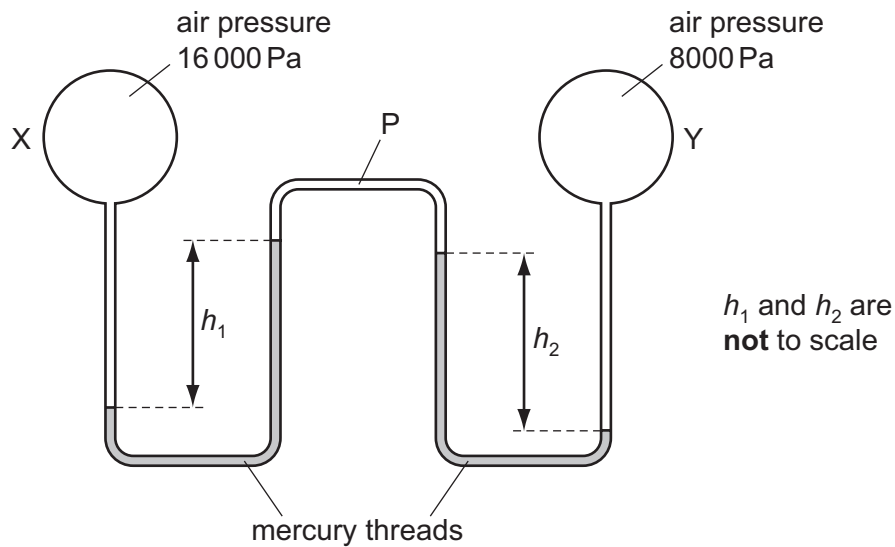
Both the ice cube and the water are at 0°C .

Which statement correctly compares the molecular properties of the ice and those of the water?

- A** The mean inter-molecular potential energies are the same for both the ice molecules and the water molecules.
- B** The mean inter-molecular separations are the same for both the ice and the water.
- C** The mean kinetic energies are the same for both the ice molecules and the water molecules.
- D** The mean total energies are the same for both the ice molecules and the water molecules.

Space for working

- 20 Two bulbs X and Y containing air at different pressures are connected by a tube P which contains two mercury threads.



The density of mercury is $13\,600\text{ kg m}^{-3}$.

Which pair of values of h_1 and h_2 is possible?

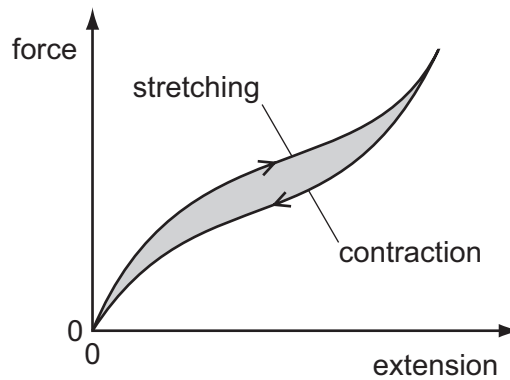
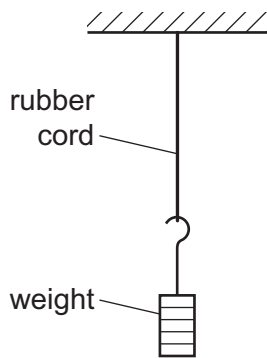
	h_1/cm	h_2/cm
A	4.0	2.0
B	6.0	6.0
C	12.0	18.0
D	18.0	12.0

- 21 What is the unit of the Young modulus?

A Nm^{-1} **B** Nm **C** Nm^{-2} **D** Nm^2

Space for working

- 22 A rubber cord hangs from a rigid support. A weight attached to its lower end is gradually increased from zero, and then gradually reduced to zero.



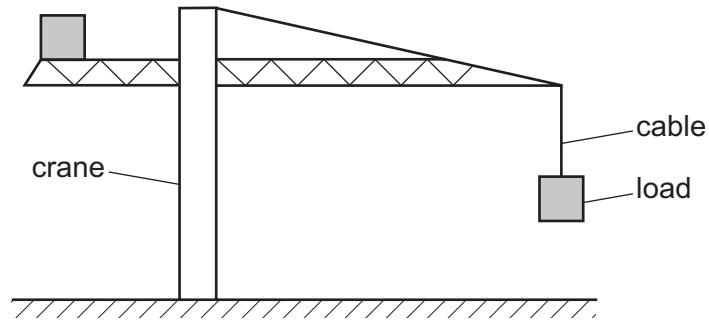
The force-extension curve for contraction is below the force-extension curve for stretching.

What does the shaded area between the curves represent?

- A the amount of elastic energy stored in the rubber
- B the amount of thermal energy dissipated in the rubber
- C the work done on the rubber cord during stretching
- D the work done by the rubber cord during contraction

Space for working

- 23 The diagram shows a large crane on a construction site lifting a cube-shaped load.



A model is made of the crane, its load and the cable supporting the load.

The material used for each part of the model is the same as that in the full-size crane, cable and load. The model is one tenth full-size in all linear dimensions.

What is the ratio $\frac{\text{stress in the cable on the full-size crane}}{\text{stress in the cable on the model crane}}$?

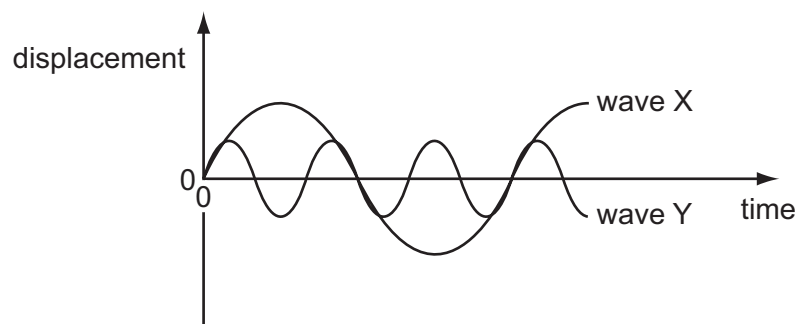
- A 10^0 B 10^1 C 10^2 D 10^3
- 24 The order of magnitude of the frequency of the shortest wavelength of visible light waves can be expressed as 10^x Hz.

What is the value of x ?

- A 12 B 13 C 14 D 15

Space for working

25 The diagram shows two waves X and Y.



Wave X has amplitude 8 cm and frequency 100 Hz.

What are the amplitude and the frequency of wave Y?

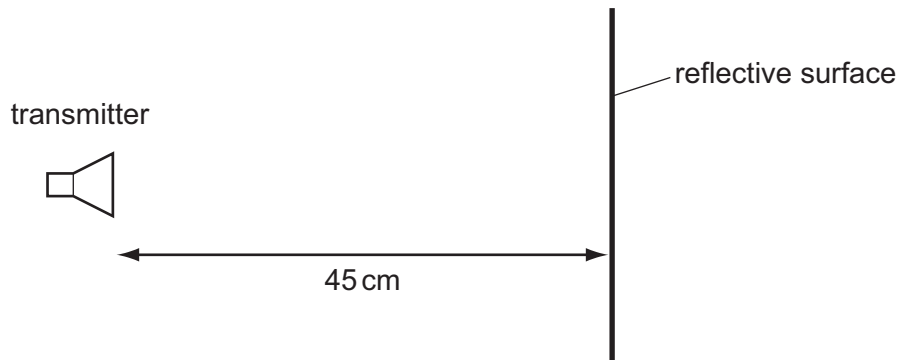
	amplitude / cm	frequency / Hz
A	2	33
B	2	300
C	4	33
D	4	300

26 What is correct for all transverse waves?

- A** They are all electromagnetic.
- B** They can all be polarised.
- C** They can all travel through a vacuum.
- D** They all involve the oscillation of atoms.

Space for working

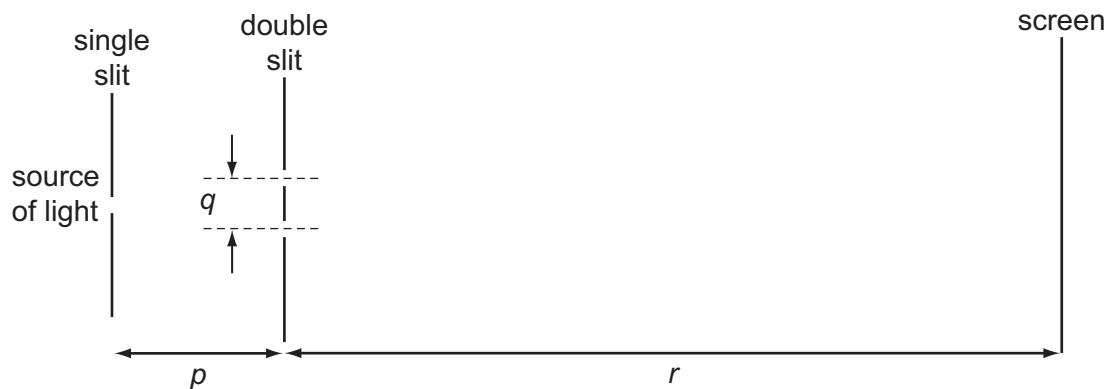
- 27 A transmitter of electromagnetic waves is placed 45 cm from a reflective surface.



The emitted waves have a frequency of 1.00 GHz. A stationary wave is produced with a node at the transmitter and a node at the surface.

How many antinodes are in the space between the transmitter and the surface?

- A** 1 **B** 2 **C** 3 **D** 4
- 28 A teacher sets up the apparatus shown to demonstrate a two-slit interference pattern on the screen.



Which change to the apparatus will increase the fringe spacing?

- A** decreasing the distance p
B decreasing the distance q
C decreasing the distance r
D decreasing the wavelength of the light

Space for working

- 29 Monochromatic light of wavelength $5.30 \times 10^{-7} \text{ m}$ is incident normally on a diffraction grating. The first order maximum is observed at an angle of 15.4° to the direction of the incident light.

What is the angle between the first and second order diffraction maxima?

- A 7.6° B 15.4° C 16.7° D 32.0°

- 30 Two conducting layers of a liquid crystal display of a calculator are $8 \mu\text{m}$ apart. A 1.5 V cell is connected across the conducting layers when the calculator is switched on.

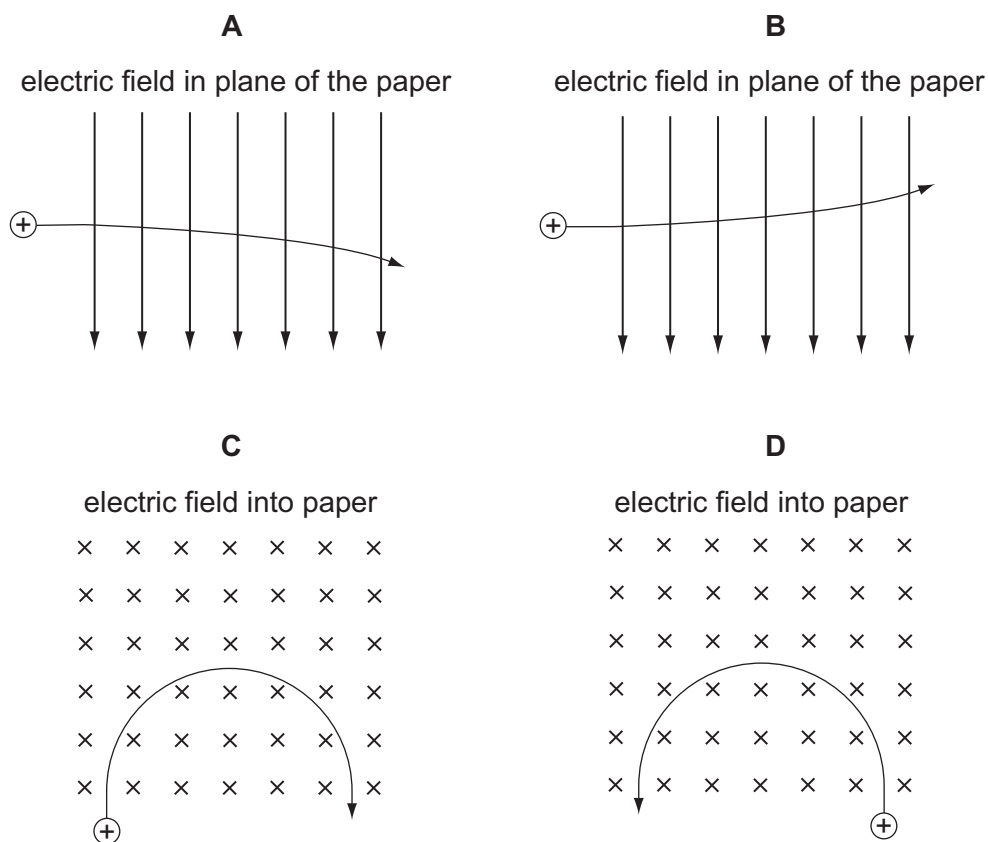
What is the electric field strength between the layers?

- A $1.2 \times 10^{-5} \text{ V m}^{-1}$
B 0.19 V m^{-1}
C 12 V m^{-1}
D $1.9 \times 10^5 \text{ V m}^{-1}$

Space for working

- 31 A positively-charged particle is projected into a uniform electric field.

Which diagram represents the path of the particle in the electric field?



- 32 A power cable has length 2000 m. The cable is made of twelve parallel strands of copper wire, each with diameter 0.51 mm.

What is the resistance of the cable? (resistivity of copper = $1.7 \times 10^{-8} \Omega \text{ m}$)

- A** 0.014 Ω **B** 3.5 Ω **C** 14 Ω **D** 166 Ω

- 33 A low-voltage supply with an e.m.f. of 20 V and an internal resistance of 1.5 Ω is used to supply power to a heater of resistance 6.5 Ω in a fish tank.

What is the power supplied to the water in the fish tank?

- A** 41 W **B** 50 W **C** 53 W **D** 62 W

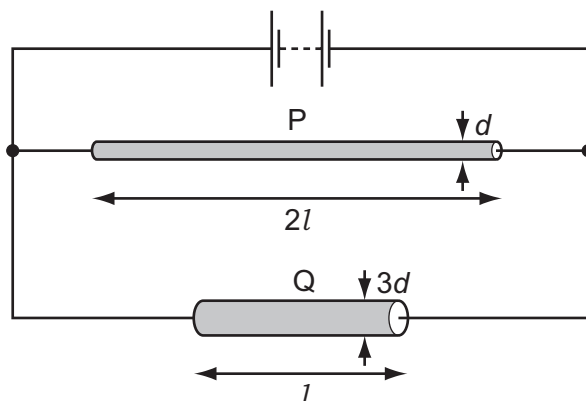
Space for working

- 34 A filament lamp has a resistance of $180\ \Omega$ when the current in it is $500\ \text{mA}$.

What is the power transformed in the lamp?

- A** $45\ \text{W}$ **B** $50\ \text{W}$ **C** $90\ \text{W}$ **D** $1400\ \text{W}$

- 35 Two wires P and Q made of the same material are connected to the same electrical supply. P has twice the length of Q and one-third of the diameter of Q, as shown in the diagram.

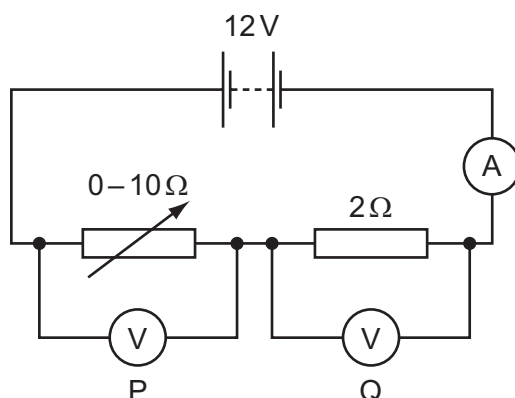


What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

- A** $\frac{2}{3}$ **B** $\frac{2}{9}$ **C** $\frac{1}{6}$ **D** $\frac{1}{18}$

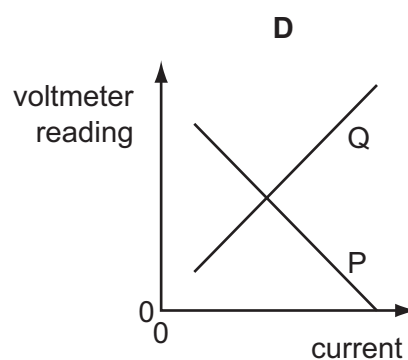
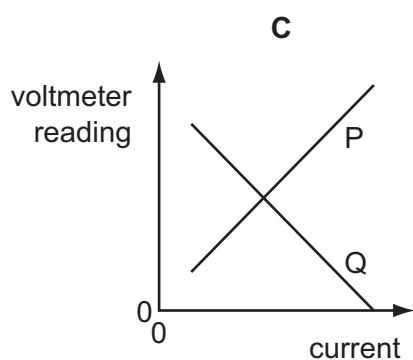
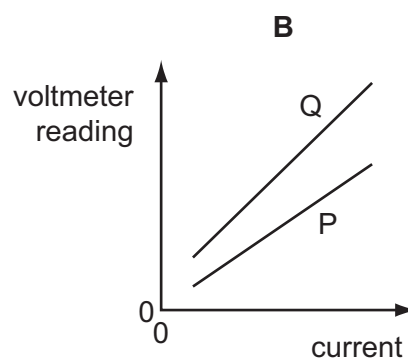
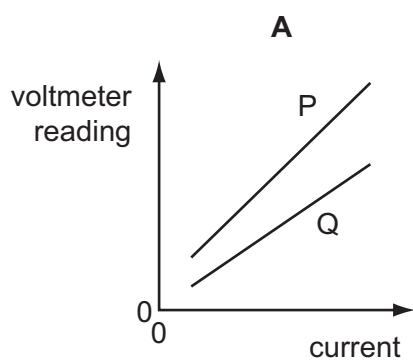
Space for working

- 36 A 12 V battery is in series with an ammeter, a 2Ω fixed resistor and a $0-10\Omega$ variable resistor. High-resistance voltmeters P and Q are connected across the variable resistor and the fixed resistor respectively, as shown.



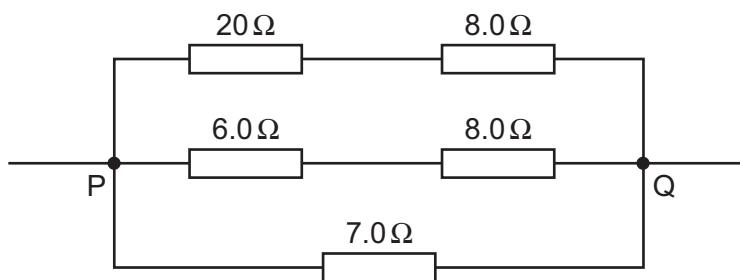
The resistance of the variable resistor is changed from its maximum value to zero.

Which graph shows the variation with current of the voltmeter readings?



Space for working

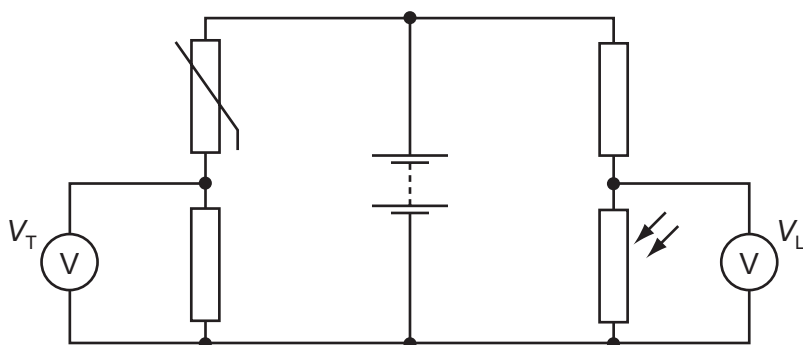
37 Five resistors are connected as shown.



What is the total resistance between P and Q?

- A** $0.25\ \Omega$ **B** $0.61\ \Omega$ **C** $4.0\ \Omega$ **D** $16\ \Omega$

38 In the circuit below, the reading V_T on the voltmeter changes from high to low as the temperature of the thermistor changes. The reading V_L on the voltmeter changes from high to low as the level of light on the light-dependent resistor (LDR) changes.



The readings V_T and V_L are both high.

What are the conditions of temperature and light level?

	temperature	light level
A	low	low
B	low	high
C	high	low
D	high	high

Space for working

39 What is the approximate mass of an alpha particle?

- A 10^{-28} kg
- B 10^{-26} kg
- C 10^{-24} kg
- D 10^{-22} kg

40 An actinium nucleus has a nucleon number of 227 and a proton number of 89. It decays to form a radium nucleus, emitting a beta particle and an alpha particle in the process.

What are the nucleon number and the proton number of this radium nucleus?

	nucleon number	proton number
A	223	87
B	223	88
C	224	87
D	225	86

Space for working

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

PHYSICS

9702/13

Paper 1 Multiple Choice

May/June 2013

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.

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 **26** printed pages and **2** blank pages.



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

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alternating current/voltage,

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

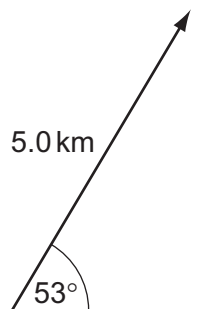
radioactive decay,

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

decay constant,

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

- 1 The diagram shows a displacement vector.

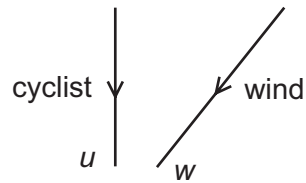


What is the vertical component of this displacement vector?

- A** 3.0 km **B** 4.0 km **C** 5.0 km **D** 6.6 km
- 2 What is the unit of power, expressed in SI base units?
- A** $\text{kg m}^2 \text{s}^{-3}$ **B** kg m s^{-3} **C** kg m s^{-2} **D** $\text{kg m}^2 \text{s}^{-1}$
- 3 Which statement is **incorrect** by a factor of 100 or more?
- A** Atmospheric pressure is about $1 \times 10^5 \text{ Pa}$.
- B** Light takes $5 \times 10^2 \text{ s}$ to reach us from the Sun.
- C** The frequency of ultra-violet light is $3 \times 10^{12} \text{ Hz}$.
- D** The life-span of a man is about $2 \times 10^9 \text{ s}$.

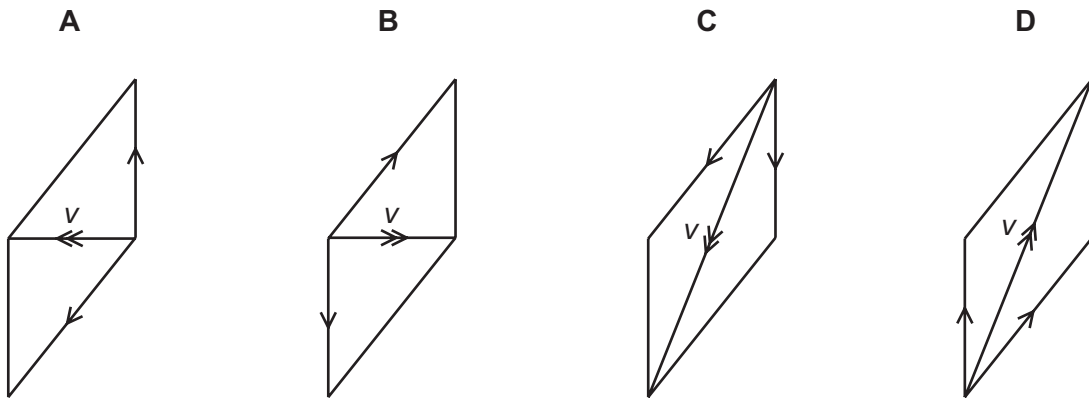
Space for working

- 4 A cyclist is travelling due south with velocity u . The wind is blowing from the north-east with velocity w .



The wind has a velocity v relative to the cyclist, where $v = w - u$.

Which vector diagram shows the magnitude and direction of velocity v ?



- 5 A student takes measurements of the current in a resistor of constant resistance and the potential difference (p.d.) across it. The readings are then used to plot a graph of current against p.d.

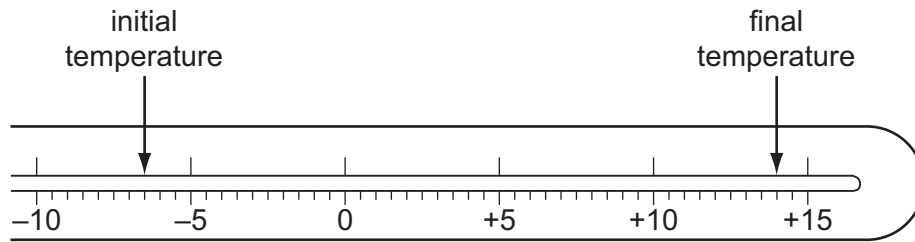
There is a systematic error in the current readings.

How could this be identified from the graph?

- A At least one anomalous data point can be identified.
- B The data points are scattered about the straight line of best fit.
- C The graph is a curve, not a straight line.
- D The straight line graph does not pass through the origin.

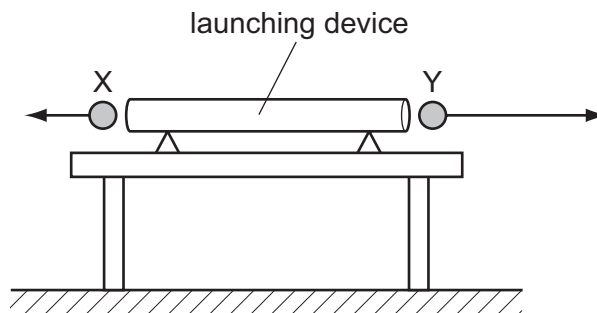
Space for working

- 6 The diagram shows the stem of a Celsius thermometer, marked to show initial and final temperature values.



What is the temperature change expressed to an appropriate number of significant figures?

- A** 14°C **B** 20.5°C **C** 21°C **D** 22.0°C
- 7 A double-ended launching device fires two identical steel balls X and Y at exactly the same time. The diagram shows the initial velocities of the balls. They are both launched horizontally, but Y has greater speed.



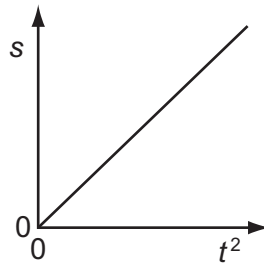
Which statement explains what an observer would see?

- A** Both X and Y reach the ground simultaneously, because air resistance will cause both to have the same final speed.
- B** Both X and Y reach the ground simultaneously, because gravitational acceleration is the same for both.
- C** X reaches the ground before Y, because X lands nearer to the launcher.
- D** Y reaches the ground before X, because Y has greater initial speed.

Space for working

- 8 At time $t = 0$, a body moves from rest with constant acceleration in a straight line. At time t , the body is distance s from its rest position.

A graph is drawn of s against t^2 , as shown.

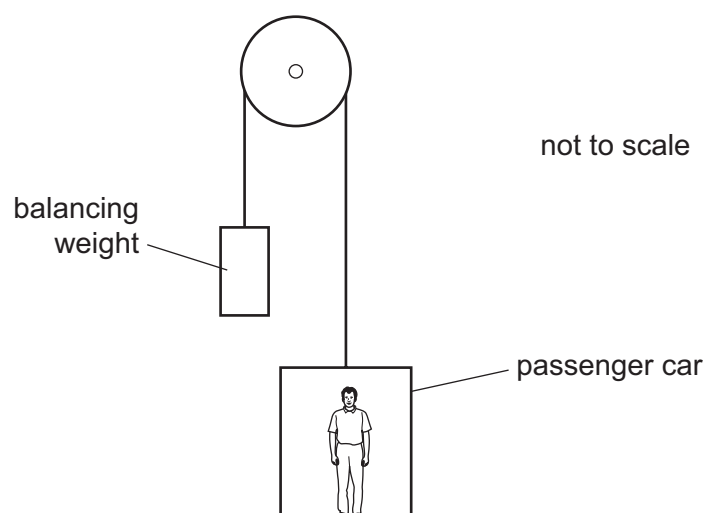


Which statement describes the acceleration of the body?

- A It is equal to half the value of the gradient of the graph.
- B It is equal to the value of the gradient of the graph.
- C It is equal to twice the value of the gradient of the graph.
- D It is equal to the reciprocal of the gradient of the graph.

Space for working

- 9 A lift (elevator) consists of a passenger car supported by a cable which runs over a light, frictionless pulley to a balancing weight. The balancing weight falls as the passenger car rises.



Some masses are shown in the table.

	mass / kg
passenger car	520
balancing weight	640
passenger	80

What is the magnitude of the acceleration of the car when carrying just one passenger and when the pulley is free to rotate?

- A** 0.032 ms^{-2} **B** 0.32 ms^{-2} **C** 0.61 ms^{-2} **D** 0.65 ms^{-2}

Space for working

- 10 A stationary nucleus has nucleon number A .

The nucleus decays by emitting a proton with speed v to form a new nucleus with speed u . The new nucleus and the proton move away from one another in opposite directions.

Which equation gives v in terms of A and u ?

- A $v = (\frac{A}{4} - 1)u$
 B $v = (A - 1)u$
 C $v = Au$
 D $v = (A + 1)u$
- 11 Two spheres travel along the same line with velocities u_1 and u_2 . They collide and after collision their velocities are v_1 and v_2 .

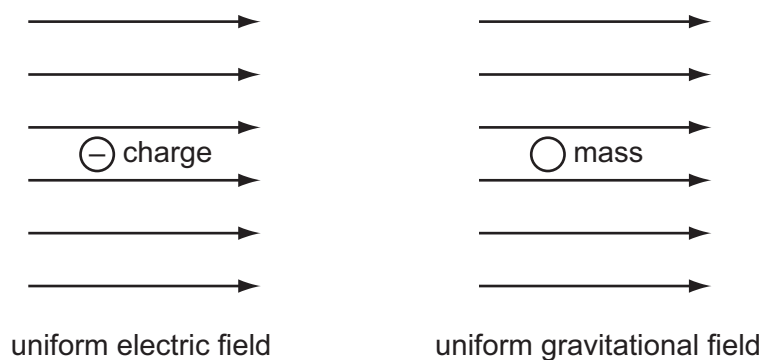


Which collision is **not** elastic?

	u_1/ms^{-1}	u_2/ms^{-1}	v_1/ms^{-1}	v_2/ms^{-1}
A	2	-5	-5	-2
B	3	-3	0	6
C	3	-2	1	6
D	5	2	3	6

Space for working

- 12 The diagrams show a negative electric charge situated in a uniform electric field and a mass situated in a uniform gravitational field.

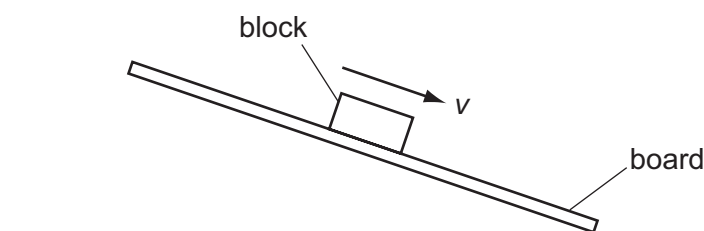


Which row shows the directions of the forces acting on the charge and on the mass?

	charge	mass
A		
B		
C		
D		

Space for working

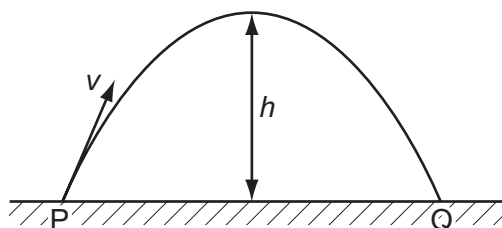
- 13 A wooden block rests on a rough board. The end of the board is then raised until the block slides down the plane of the board at constant velocity v .



Which row describes the forces acting on the block when sliding with constant velocity?

	frictional force on block	resultant force on block
A	down the plane	down the plane
B	down the plane	zero
C	up the plane	down the plane
D	up the plane	zero

- 14 A ball of mass m is thrown up to height h in air with an initial velocity v , as shown.



Air resistance is considered negligible. The acceleration of free fall is g .

What is the **total** work done by the gravitational force on the ball during its flight from P to Q?

- A** zero **B** $\frac{1}{2}mv^2$ **C** mgh **D** $2mgh$

- 15 A spring of unextended length 40 mm is suspended from a fixed point. A load of 16 N is applied to the free end of the spring. This causes the spring to extend so that its final length is five times its original length. The spring obeys Hooke's Law.

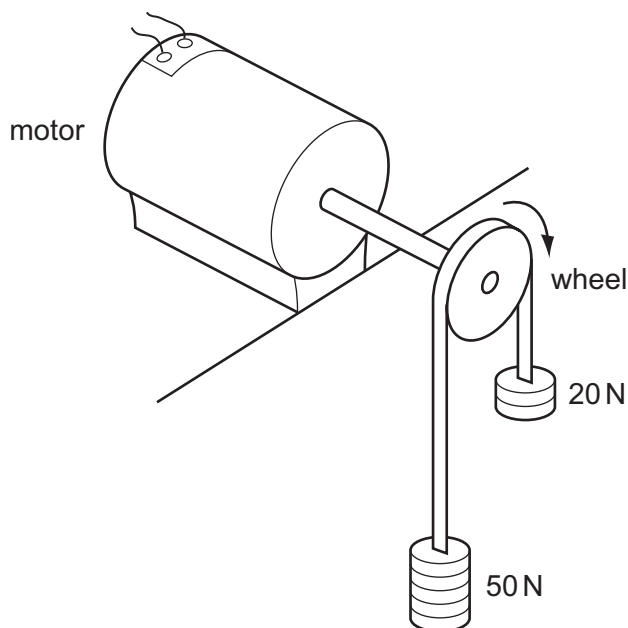
What is the energy stored in the spring due to this extension?

- A** 1.3 J **B** 1.6 J **C** 2.6 J **D** 3.2 J

Space for working

- 16 The diagram shows an arrangement used to find the output power of an electric motor.

The wheel attached to the motor's axle has a circumference of 0.5 m and the belt which passes over it is stationary when the weights have the values shown.



If the wheel is making 20 revolutions per second, what is the output power of the motor?

- A** 300 W **B** 500 W **C** 600 W **D** 700 W

- 17 Ice at a temperature of 0°C is a rare example of a solid that floats on its liquid form, in this case water, when they are both at the same temperature.

What is the explanation for this?

- A** The average speed of the molecules in the ice is greater than the average speed of the molecules in the water.
- B** The average speed of the molecules in the water is greater than the average speed of the molecules in the ice.
- C** The mean separation of the molecules in the ice is greater than the mean separation of the molecules in the water.
- D** The mean separation of the molecules in the water is greater than the mean separation of the molecules in the ice.

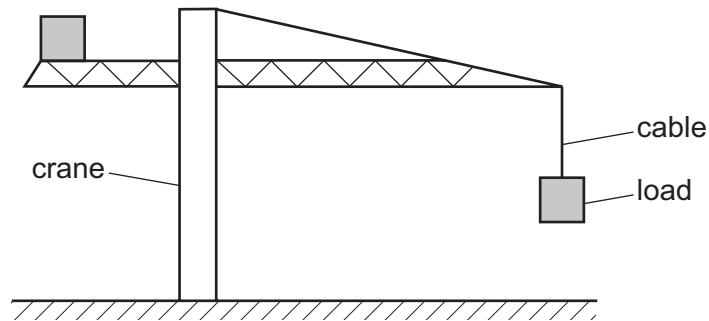
Space for working

- 18 The formula for hydrostatic pressure is $p = \rho gh$.

Which equation, or principle of physics, is used in the derivation of this formula?

- A density = $\frac{\text{mass}}{\text{volume}}$
- B potential energy = mgh
- C atmospheric pressure decreases with height
- D density increases with depth

- 19 The diagram shows a large crane on a construction site lifting a cube-shaped load.



A model is made of the crane, its load and the cable supporting the load.

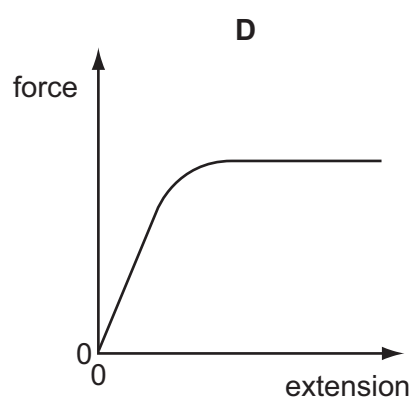
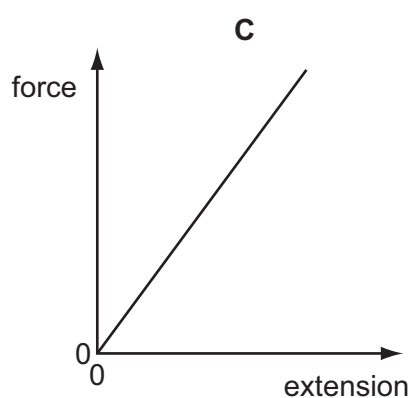
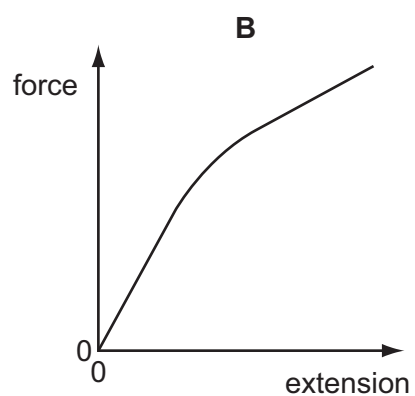
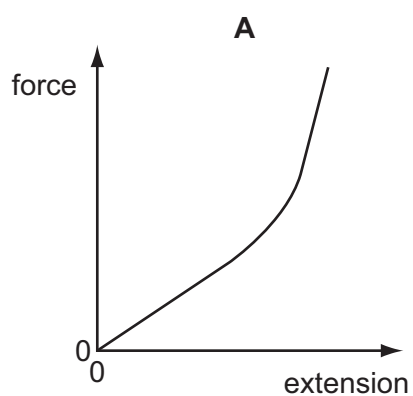
The material used for each part of the model is the same as that in the full-size crane, cable and load. The model is one tenth full-size in all linear dimensions.

What is the ratio $\frac{\text{extension of the cable on the full-size crane}}{\text{extension of the cable on the model crane}}$?

- A 10^0
- B 10^1
- C 10^2
- D 10^3

Space for working

- 20 Which graph represents the force-extension relationship of a rubber band that is stretched almost to its breaking point?



Space for working

- 21** A spring is stretched over a range within which elastic deformation occurs. Its spring constant is 3.0 N cm^{-1} .

Which row, for the stated applied force, gives the correct extension and strain energy?

	force / N	extension / cm	strain energy / mJ
A	3.0	1.0	1.5
B	6.0	2.0	120
C	12.0	3.0	180
D	24.0	8.0	960

- 22** Which statement about different types of electromagnetic wave is correct?

- A** The frequency of infra-red waves is less than the frequency of blue light.
- B** The frequency of radio waves is greater than the frequency of gamma rays.
- C** The wavelength of red light is less than the wavelength of ultraviolet waves.
- D** The wavelength of X-rays is greater than the wavelength of microwaves.

- 23** Orange light has a wavelength of 600 nm.

What is the frequency of this light?

- A** 180 GHz **B** 180 Hz **C** 500 THz **D** 500 kHz

Space for working

- 24** Electromagnetic waves of wavelength λ and frequency f travel at speed c in a vacuum.

What describes the wavelength and speed of electromagnetic waves of frequency $f/2$?

	wavelength	speed in a vacuum
A	$\lambda/2$	$c/2$
B	$\lambda/2$	c
C	2λ	c
D	2λ	$2c$

- 25** When the liquid crystal display of a calculator is observed through a polarising film, the display changes as the film is rotated.

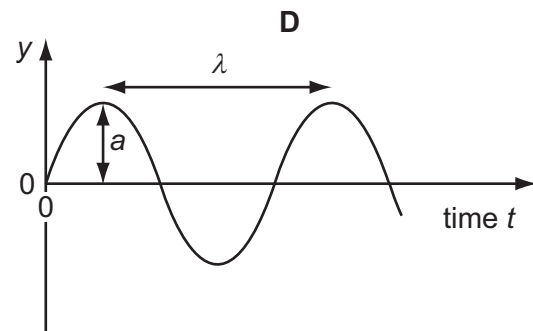
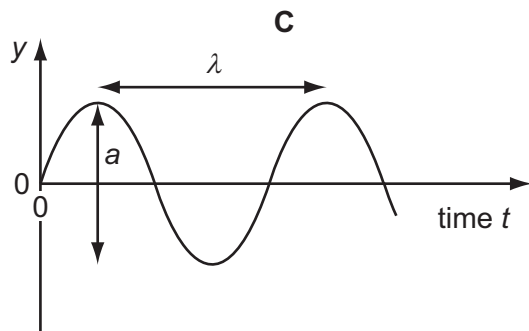
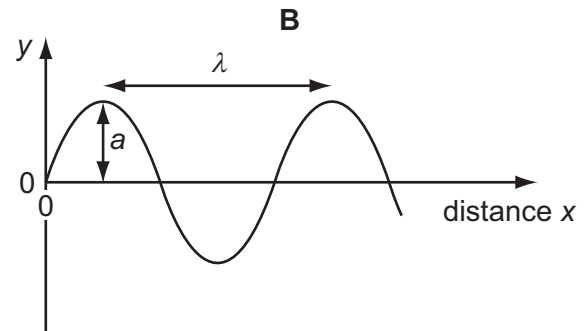
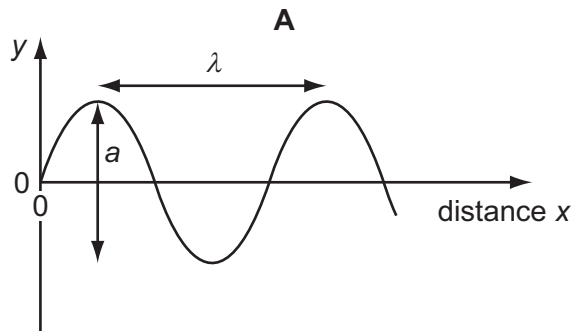
Which property describes the radiation from the calculator display?

- A** unpolarised
- B** a longitudinal wave
- C** a transverse wave
- D** a wave with a 3 cm wavelength

Space for working

- 26 A sound wave has displacement y at distance x from its source at time t .

Which graph correctly shows the amplitude a and the wavelength λ of the wave?



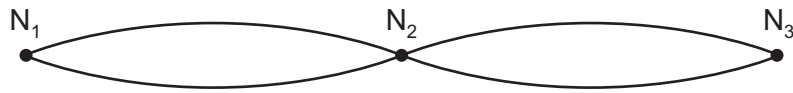
- 27 A parallel beam of red light of wavelength 700 nm is incident normally on a diffraction grating that has 400 lines per millimetre.

What is the total number of transmitted maxima?

- A** 3 **B** 4 **C** 6 **D** 7

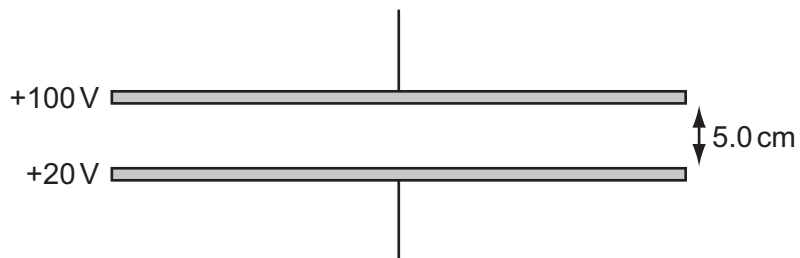
Space for working

- 28 The diagram shows a standing wave on a string. The standing wave has three nodes N_1 , N_2 and N_3 .



Which statement is correct?

- A All points on the string vibrate in phase.
 - B All points on the string vibrate with the same amplitude.
 - C Points equidistant from N_2 vibrate with the same frequency and in phase.
 - D Points equidistant from N_2 vibrate with the same frequency and the same amplitude.
- 29 Two metal plates are held horizontal and parallel, 5.0 cm apart. The plates are at potentials of +100 V and +20 V.

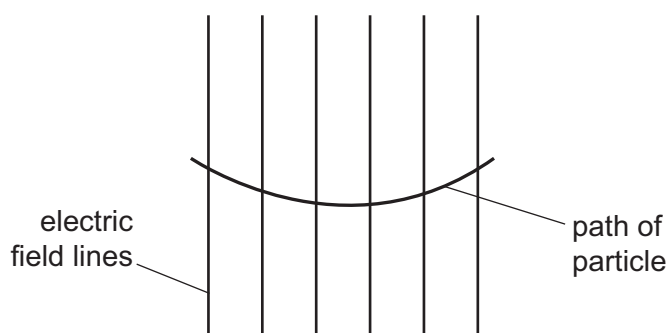


What is the force experienced by an electron in the electric field between the plates?

- A $2.6 \times 10^{-18} \text{ N}$
- B $3.8 \times 10^{-18} \text{ N}$
- C $2.6 \times 10^{-16} \text{ N}$
- D $3.8 \times 10^{-16} \text{ N}$

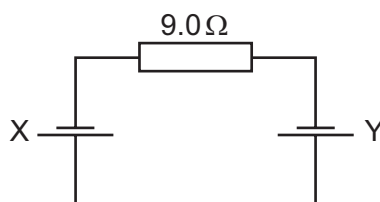
Space for working

- 30 The diagram shows the path of a charged particle through a uniform electric field, having vertical field lines.



What could give a path of this shape?

- A a positive charge travelling left to right in a field directed downwards
 - B a positive charge travelling right to left in a field directed downwards
 - C a negative charge travelling right to left in a field directed upwards
 - D a negative charge travelling left to right in a field directed downwards
- 31 Two cells X and Y are connected in series with a resistor of resistance 9.0Ω , as shown.



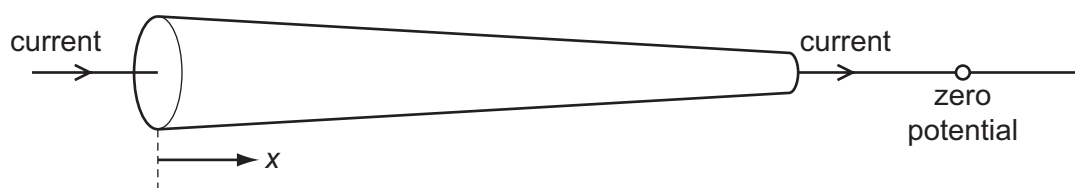
Cell X has an electromotive force (e.m.f.) of 1.0V and an internal resistance of 1.0Ω . Cell Y has an e.m.f. of 2.0V and an internal resistance of 2.0Ω .

What is the current in the circuit?

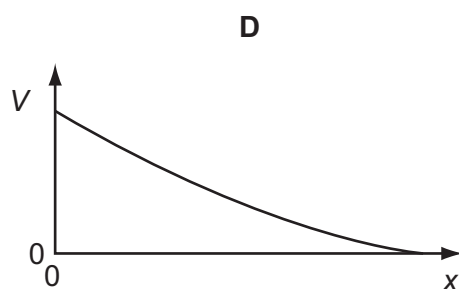
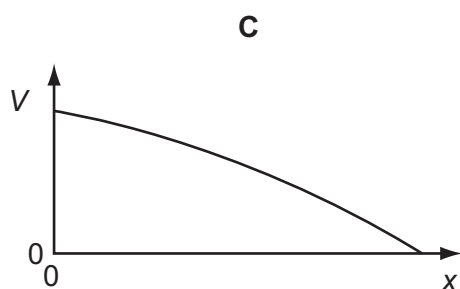
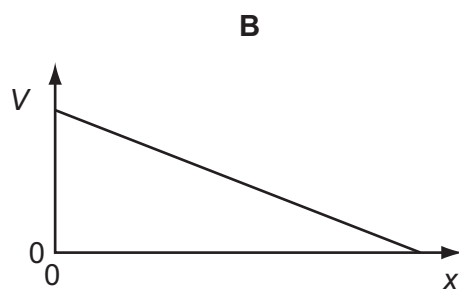
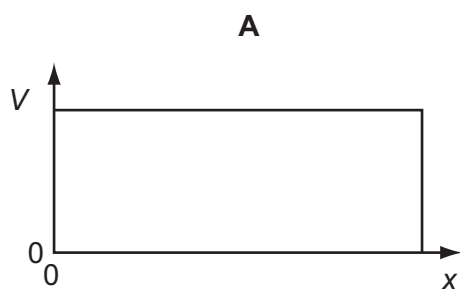
- A 0.25A
- B 0.17A
- C 0.10A
- D 0.083A

Space for working

- 32 The circular cross-sectional area of a metal wire varies along its length. There is a current in the wire. The narrow end of the wire is at a reference potential of zero.

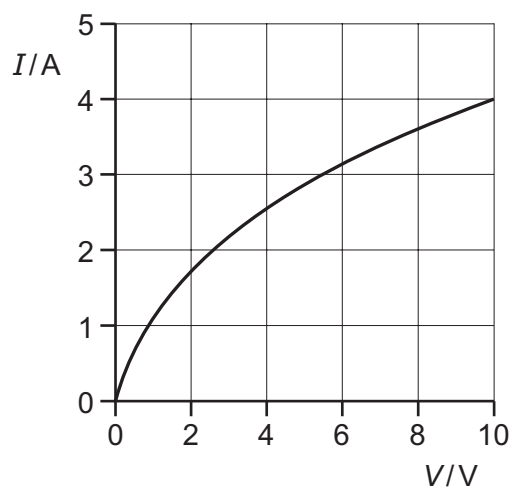


Which graph best represents the variation with distance x along the wire of the potential difference V relative to the reference zero?



Space for working

- 33 The graph shows how current I varies with voltage V for a filament lamp.



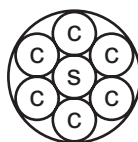
Since the graph is not a straight line, the resistance of the lamp varies with V .

Which row gives the correct resistance at the stated value of V ?

	V/V	R/Ω
A	2.0	1.5
B	4.0	3.2
C	6.0	1.9
D	8.0	0.9

Space for working

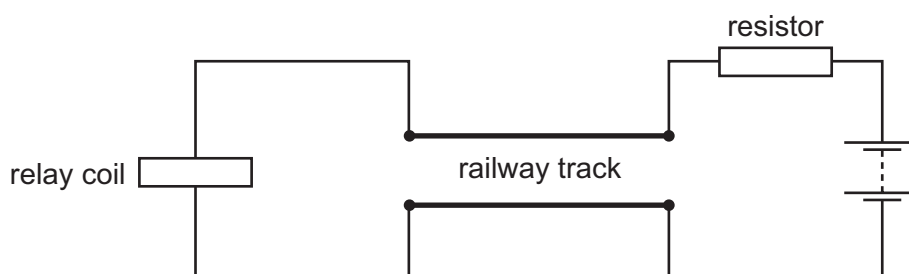
- 34 An electric power cable consists of six copper wires c surrounding a steel core s.



A length of 1.0 km of one of the copper wires has a resistance of $10\ \Omega$ and 1.0 km of the steel core has a resistance of $100\ \Omega$.

What is the approximate resistance of a 1.0 km length of the power cable?

- A** $0.61\ \Omega$ **B** $1.6\ \Omega$ **C** $160\ \Omega$ **D** $610\ \Omega$
- 35 The diagram shows a length of track from a model railway connected to a battery, a resistor and a relay coil.



With no train present, there is a current in the relay coil which operates a switch to turn on a light.

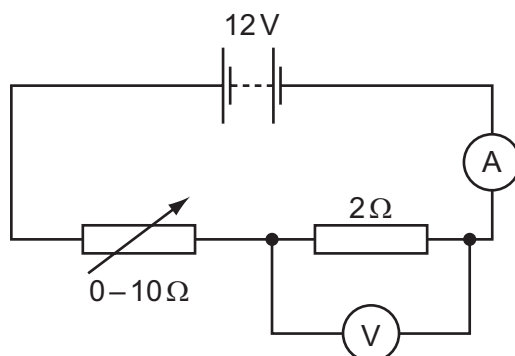
When a train occupies the section of track, most of the current flows through the wheels and axles of the train in preference to the relay coil. The switch in the relay turns off the light.

Why is a resistor placed between the battery and the track?

- A** to limit the heating of the wheels of the train
B to limit the energy lost in the relay coil when a train is present
C to prevent a short circuit of the battery when a train is present
D to protect the relay when a train is present

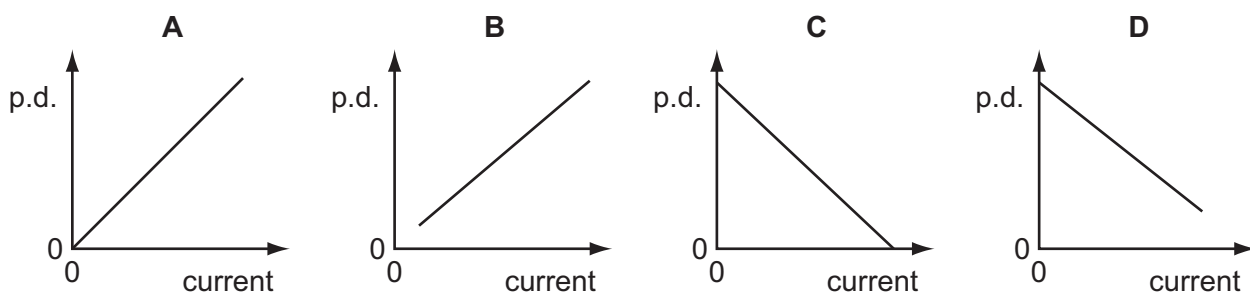
Space for working

- 36 A 12 V battery is in series with an ammeter, a $2\ \Omega$ fixed resistor and a $0-10\ \Omega$ variable resistor. A high-resistance voltmeter is connected across the fixed resistor.



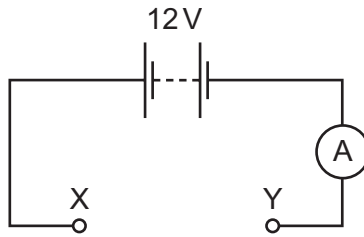
The resistance of the variable resistor is changed from zero to its maximum value.

Which graph shows how the potential difference (p.d.) measured by the voltmeter varies with the current measured by the ammeter?



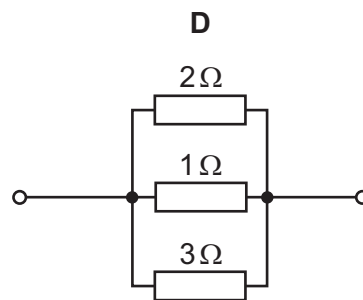
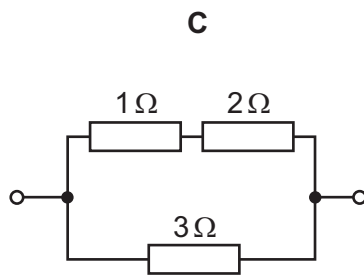
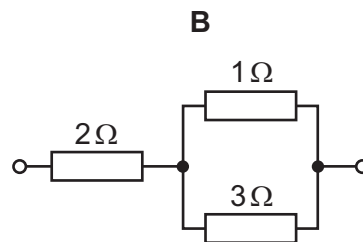
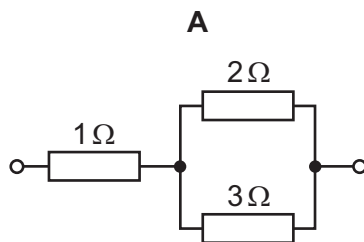
Space for working

37 In the circuit shown, the battery and ammeter each have negligible resistance.



The following combinations of resistors are placed in turn between the terminals X and Y of the circuit.

Which combination would give an ammeter reading of 8 A?



Space for working

- 38** Scientists investigating the count rate from a radioactive source observed that the count rate fluctuates.

What do these fluctuations imply about the nature of radioactive decay?

- A** It involves atomic nuclei.
- B** It is predictable.
- C** It is random.
- D** It is spontaneous.

- 39** The decay of a nucleus of neptunium is accompanied by the emission of a β -particle and γ -radiation.

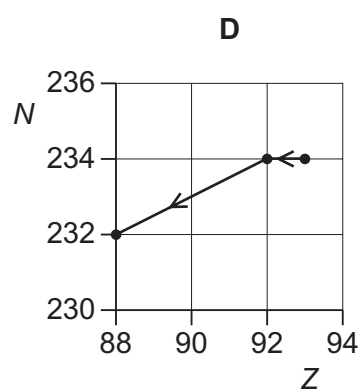
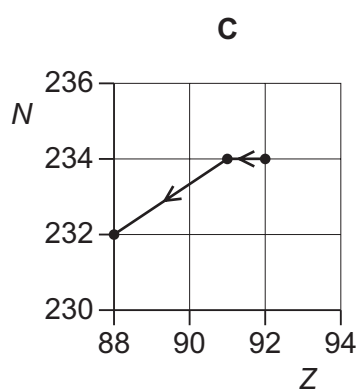
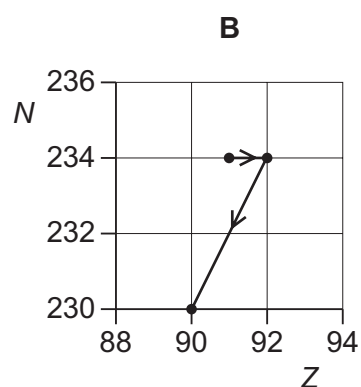
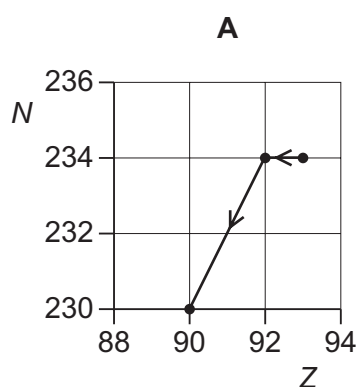
What effect (if any) does this decay have on the proton number and on the nucleon number of the nucleus?

	proton number	nucleon number
A	increases	decreases
B	decreases	increases
C	unchanged	decreases
D	increases	unchanged

Space for working

40 A radioactive nucleus is formed by β -decay. This nucleus then decays by α -emission.

Which graph of nucleon number N plotted against proton number Z shows the β -decay followed by the α -emission?



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