



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

PHYSICS

9702/11

Paper 1 Multiple Choice

October/November 2012

1 hour

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



READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

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

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

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any working should be done in this booklet.

This document consists of **26** 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 What is the unit of weight in terms of SI base unit(s)?

A kg m s^{-1}

B kg m s^{-2}

C N

D J m^{-1}

2 Vectors P and Q are drawn to scale.



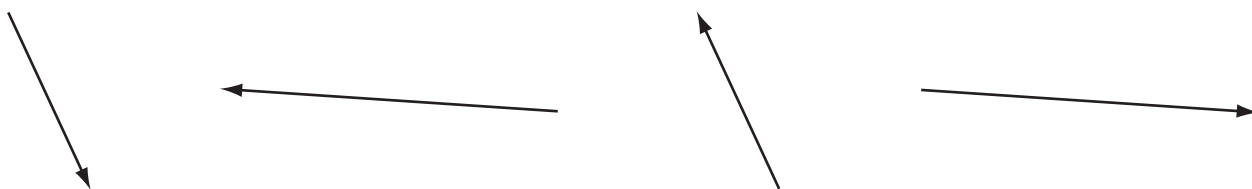
Which diagram represents the vector $(P - Q)$?

A

B

C

D



3 What is the approximate temperature of a red-hot ring on an electric cooker?

A 100°C

B 200°C

C 400°C

D 800°C

Space for working

4 Which list contains only scalar quantities?

- A area, length, displacement
- B kinetic energy, speed, power
- C potential energy, momentum, time
- D velocity, distance, temperature

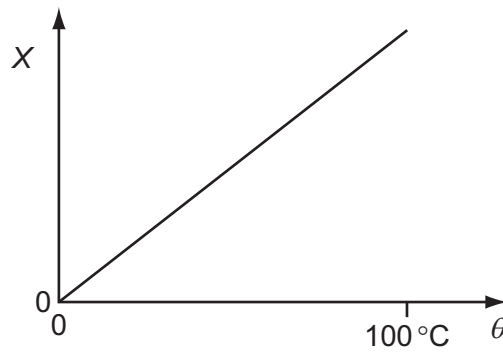
5 The density of the material of a coil of thin wire is to be found.

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

- A metre rule, protractor, spring balance
- B micrometer, metre rule, top-pan balance
- C stopwatch, newton-meter, vernier calipers
- D tape measure, vernier calipers, lever balance

Space for working

- 6 A quantity X varies with temperature θ as shown.



θ is determined from the corresponding values of X by using this graph.
 X is measured with a percentage uncertainty of $\pm 1\%$ of its value at all temperatures.

Which statement about the uncertainty in θ is correct?

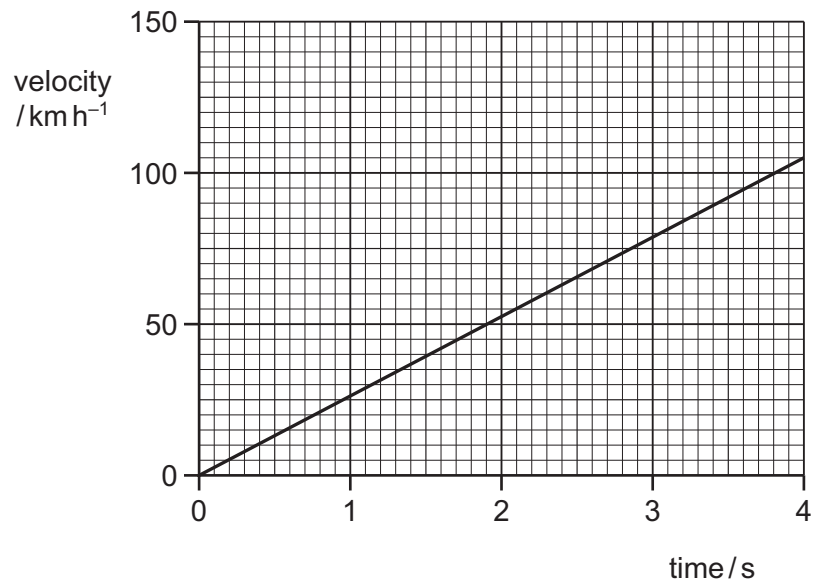
- A The percentage uncertainty in θ is least near 0°C .
 - B The percentage uncertainty in θ is least near 100°C .
 - C The actual uncertainty in θ is least near 0°C .
 - D The actual uncertainty in θ is least near 100°C .
- 7 The measurement of a physical quantity may be subject to random errors and to systematic errors.

Which statement is correct?

- A Random errors can be reduced by taking the average of several measurements.
- B Random errors are always caused by the person taking the measurement.
- C A systematic error cannot be reduced by adjusting the apparatus.
- D A systematic error results in a different reading each time the measurement is taken.

Space for working

- 8 The velocity of an electric car changes as shown.



What is the acceleration of the car?

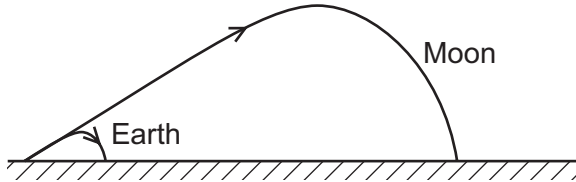
- A** 190 ms^{-2} **B** 53 ms^{-2} **C** 26 ms^{-2} **D** 7.3 ms^{-2}
- 9 A ball is thrown vertically in air.
- Neglecting air resistance, which property of the ball can **never** be zero at any time during the flight?
- A** acceleration
B kinetic energy
C speed
D velocity

Space for working

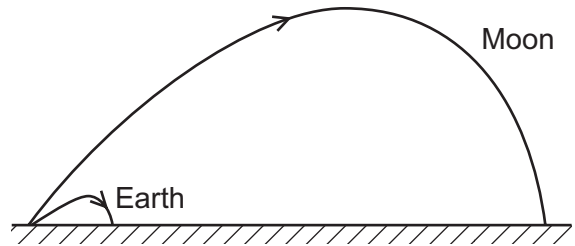
10 A golf ball is hit with the same force and direction on the Earth and on the Moon.

Which diagram best represents the shapes of the paths taken by the golf ball?

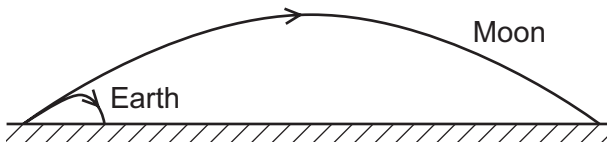
A



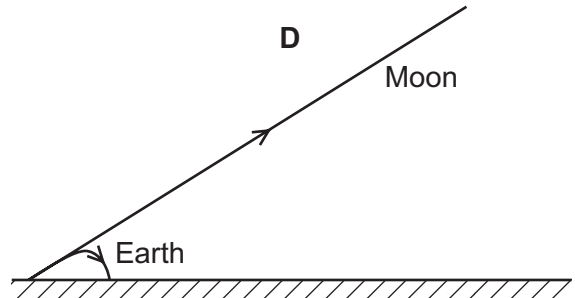
B



C

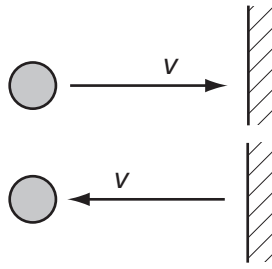


D



Space for working

- 11 An object travelling with velocity v strikes a wall and rebounds as shown.

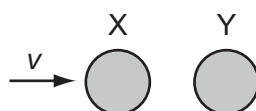


Which property of the object is **not** conserved?

- A kinetic energy
- B mass
- C momentum
- D speed

Space for working

- 12 A particle X has speed v and collides with a stationary identical particle Y. The collision is perfectly elastic.

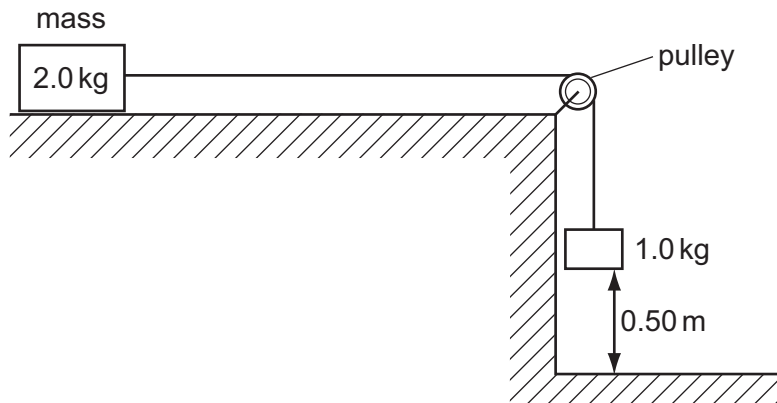


What are the speed and direction of motion of each of the two particles after the collision?

	X	Y
A	stationary	v to the right
B	$\frac{v}{2}$ to the right	$\frac{v}{2}$ to the right
C	$\frac{v}{2}$ to the left	$\frac{v}{2}$ to the right
D	v to the left	stationary

Space for working

- 13 A mass of 2.0 kg rests on a frictionless surface. It is attached to a 1.0 kg mass by a light, thin string which passes over a frictionless pulley. The 1.0 kg mass is released and it accelerates downwards.

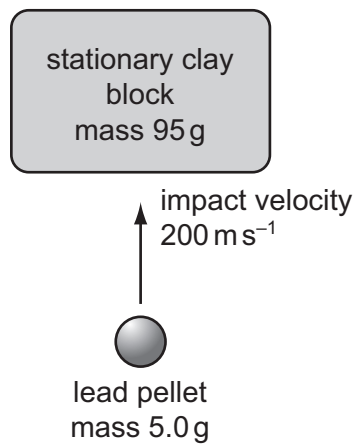


What is the speed of the 2.0 kg mass as the 1.0 kg mass hits the floor, having fallen a distance of 0.50 m?

- A** 1.8 ms^{-1} **B** 2.2 ms^{-1} **C** 3.1 ms^{-1} **D** 9.8 ms^{-1}

Space for working

- 14 A lead pellet is shot vertically upwards into a clay block that is stationary at the moment of impact but is able to rise freely after impact.



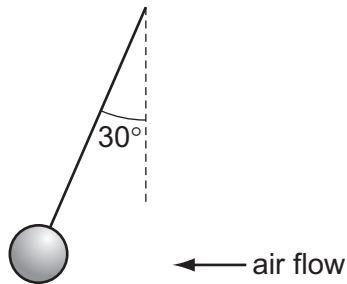
The pellet hits the block with an initial velocity of 200 m s^{-1} . It embeds itself in the block and does not emerge.

How high above its initial position will the block rise?
(Mass of pellet = 5.0 g; mass of clay block = 95 g.)

- A** 5.1 m **B** 5.6 m **C** 10 m **D** 2000 m

Space for working

- 15 The diagram shows an experiment to measure the force exerted on a ball by a horizontal air flow.



The ball is suspended by a light string and weighs 0.15 N .

The deflection of the string from vertical is 30° .

What is the force on the ball from the air flow?

- A** 0.075 N **B** 0.087 N **C** 0.26 N **D** 0.30 N
- 16 A student balances a 30 cm ruler on a fulcrum set at the 15 cm mark. She then places a 50 g mass on the 23 cm mark and a 20 g mass on the 11 cm mark, as shown.



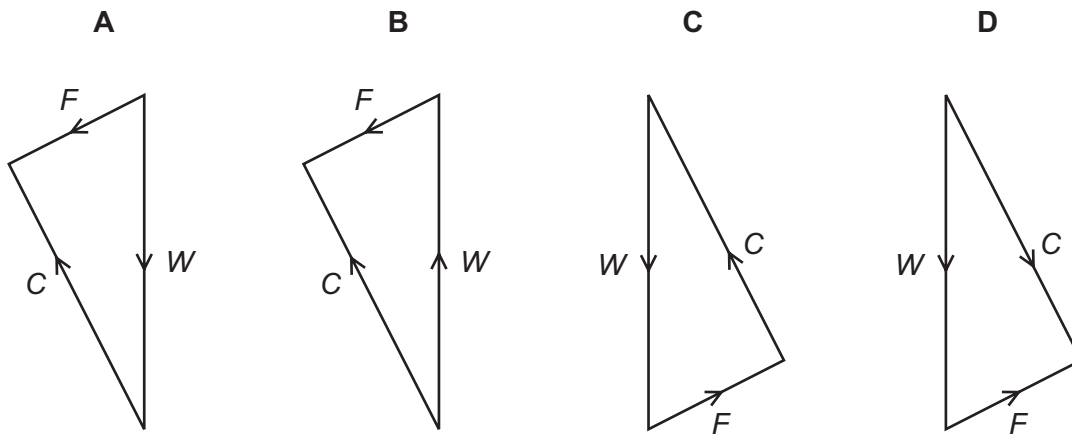
Which mass should she place on the 7 cm mark to restore the balance?

- A** 30 g **B** 40 g **C** 47 g **D** 133 g

Space for working

- 17 A sledge slides down a slope at a constant velocity. The three forces that act on the sledge are the normal contact force C , the weight W and a constant frictional force F .

Which diagram represents these forces acting on the sledge?



- 18 The kinetic energy of a particle is increased by a factor of 4.

By what factor does its speed increase?

- A 2 B 4 C 8 D 16

- 19 A piston in a gas supply pump has an area of 600 cm^2 and it moves a distance of 40 cm during one stroke. The pump moves the gas against a fixed pressure of 5000 Pa.

How much work is done by the piston during one stroke?

- A $1.2 \times 10^2 \text{ J}$ B $1.2 \times 10^4 \text{ J}$ C $1.2 \times 10^6 \text{ J}$ D $1.2 \times 10^8 \text{ J}$

Space for working

- 20** A railway engine accelerates a train of total mass 800 tonnes (1 tonne = 1000 kg) from rest to a speed of 50 ms^{-1} .

How much work must be done on the train to reach this speed?

- A** $1.0 \times 10^6 \text{ J}$ **B** $2.0 \times 10^6 \text{ J}$ **C** $1.0 \times 10^9 \text{ J}$ **D** $2.0 \times 10^9 \text{ J}$

- 21** Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of 500 kg s^{-1} . The reservoir is 300 m above the level of the turbine.

The electrical output from the generator driven by the turbine is 200 A at a potential difference of 6000 V.

What is the efficiency of the system?

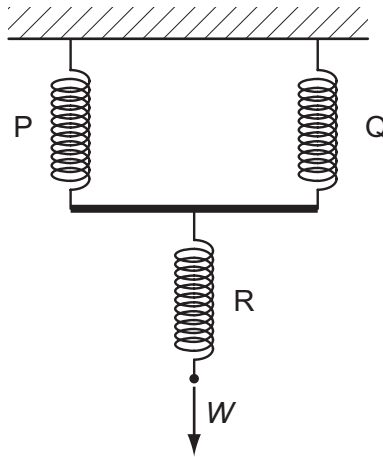
- A** 8.0 % **B** 8.2 % **C** 80 % **D** 82 %

- 22** Which row correctly describes the spacing, ordering and motion of the molecules in water and in ice when both are at a temperature of 0°C ?

	spacing	ordering	motion
A	molecules in ice are closer together than molecules in water	a regular pattern of molecules in both ice and water	molecules in both ice and water have the same average speed
B	molecules in ice are closer together than molecules in water	a regular pattern of molecules in ice but not in water	molecules in ice travel more slowly than those in water
C	molecules in ice are further apart than molecules in water	a regular pattern of molecules in both ice and water	molecules in ice travel more slowly than those in water
D	molecules in ice are further apart than molecules in water	a regular pattern of molecules in ice but not in water	molecules in both ice and water have the same average speed

Space for working

23 Three springs are arranged vertically as shown.



Springs P and Q are identical and have spring constant k . Spring R has spring constant $3k$.

What is the increase in the overall length of the arrangement when a force W is applied as shown?

A $\frac{5W}{6k}$

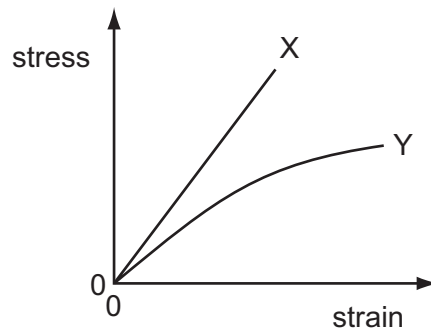
B $\frac{4W}{3k}$

C $\frac{7}{2}kW$

D $4kW$

Space for working

- 24 The diagram shows the stress-strain graph for two wires X and Y of different materials up to their breaking points. Both wires have the same initial dimensions.



Which statement is **not** correct?

- A Material X extends elastically.
 - B Material X extends more than material Y when loaded with the same force.
 - C Material X has a larger ultimate tensile stress.
 - D Material X is brittle.
- 25 A steel wire and a brass wire are joined end to end and are hung vertically with the steel wire attached to a point on the ceiling. The steel wire is twice as long as the brass wire and has half the diameter.

A large mass is hung from the end of the brass wire so that both wires are stretched elastically.

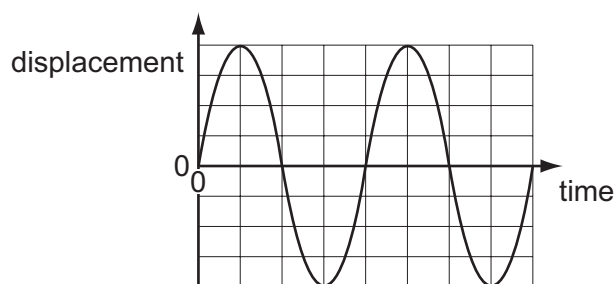
The Young modulus for steel is 2.0×10^{11} Pa and for brass is 1.0×10^{11} Pa.

What is the ratio of the extension of the steel to the extension of the brass?

- A 2
- B 4
- C 8
- D 16

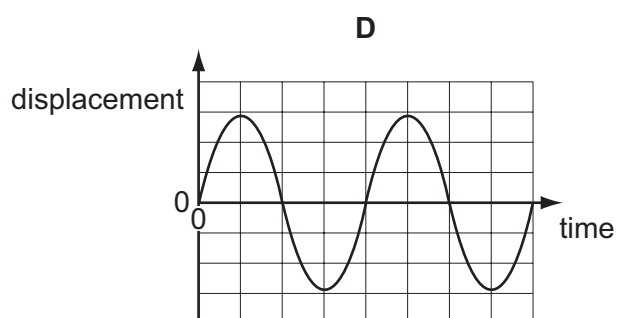
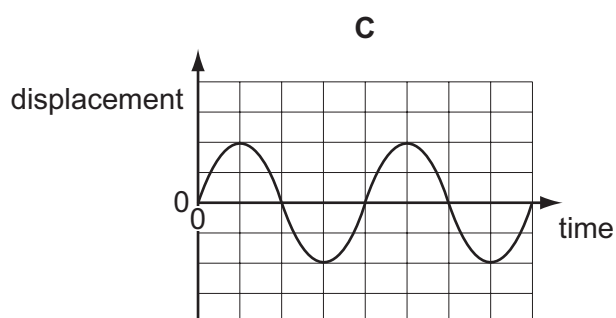
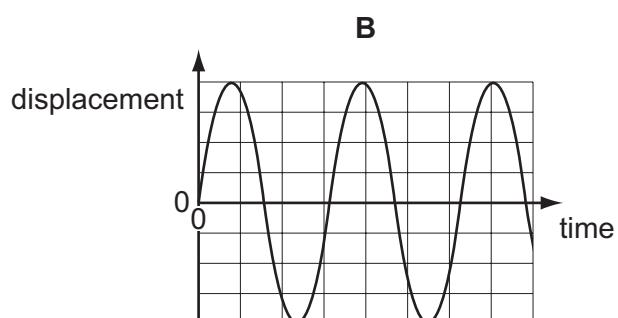
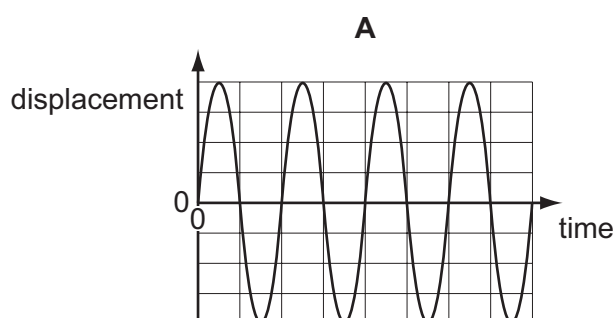
Space for working

26 The diagram shows a graph of displacement against time for a sound wave.



The intensity of the sound is halved.

Which graph shows the displacement of this sound wave?



Space for working

27 What do **not** travel at the speed of light in a vacuum?

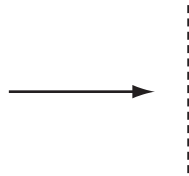
- A electrons
- B microwaves
- C radio waves
- D X-rays

28 A musical organ produces notes by blowing air into a set of pipes that are open at one end and closed at the other.

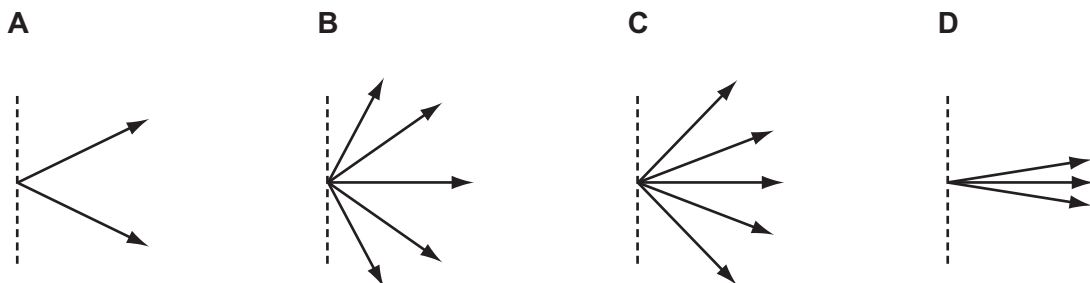
What is the lowest frequency of sound produced by a pipe of length 10 m?
(The speed of sound in the pipe is 320 m s^{-1} .)

- A 4 Hz
- B 8 Hz
- C 16 Hz
- D 32 Hz

29 Monochromatic light is directed at a diffraction grating as shown.



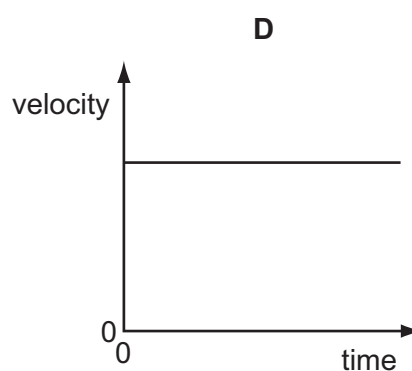
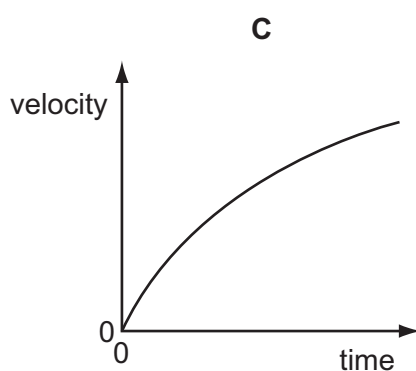
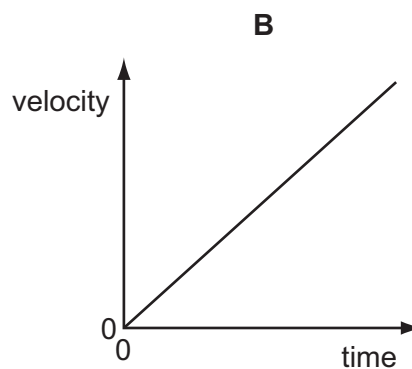
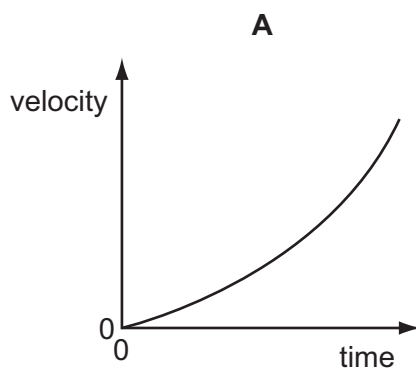
Which diagram shows all the possible directions of the light, after passing through the grating, that give maximum intensity?



Space for working

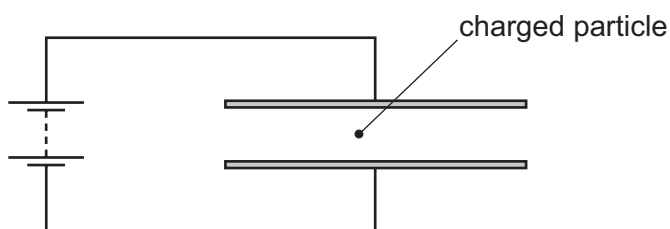
30 An electron is initially at rest in a uniform electric field.

Which graph shows the variation with time of the velocity of the electron?



Space for working

- 31 A charged particle is in the electric field between two horizontal metal plates connected to a source of constant potential difference, as shown.



There is a force F on the particle due to the electric field.

The separation of the plates is doubled.

What will be the new force on the particle?

- A $\frac{F}{4}$ B $\frac{F}{2}$ C F D $2F$
- 32 The potential difference between point X and point Y in a circuit is 20V. The time taken for charge carriers to move from X to Y is 15 s. In this time, the energy of the charge carriers changes by 12J.

What is the current between X and Y?

- A 0.040 A B 0.11 A C 9.0 A D 25 A

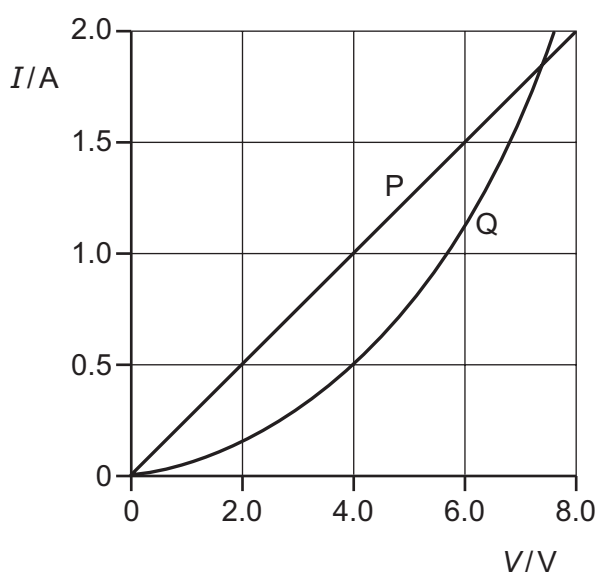
Space for working

- 33** A cylindrical wire of length 10 m and diameter 2.0 mm has a resistance of $0.050\ \Omega$.

From which material is the wire made?

	material	resistivity/ $\Omega\text{ m}$
A	bronze	1.6×10^{-7}
B	nichrome	1.6×10^{-6}
C	silver	1.6×10^{-8}
D	zinc	6.3×10^{-8}

- 34** The I - V characteristics of two electrical components P and Q are shown below.

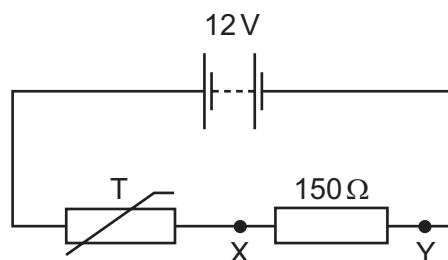


Which statement is correct?

- A** P is a resistor and Q is a filament lamp.
- B** The resistance of Q increases as the current in it increases.
- C** For a current of 1.9 A, the resistance of Q is approximately half that of P.
- D** For a current of 0.5 A, the power dissipated in Q is double that in P.

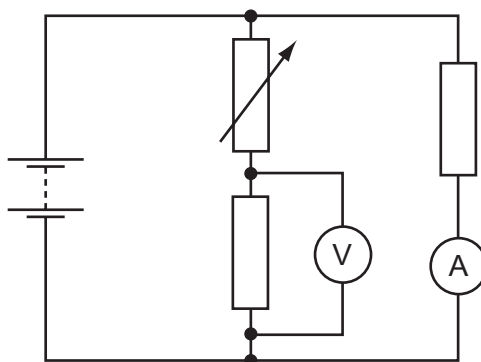
Space for working

- 35** In a fire alarm system, a thermistor T has a resistance of 2000Ω at room temperature. Its resistance decreases as the temperature increases. The alarm is triggered when the potential difference between X and Y reaches 4.5 V .



What is the resistance of the thermistor when the alarm is triggered?

- A** 90Ω **B** 150Ω **C** 250Ω **D** 1300Ω
- 36** A network of electrical components is connected across a battery of negligible internal resistance, as shown.



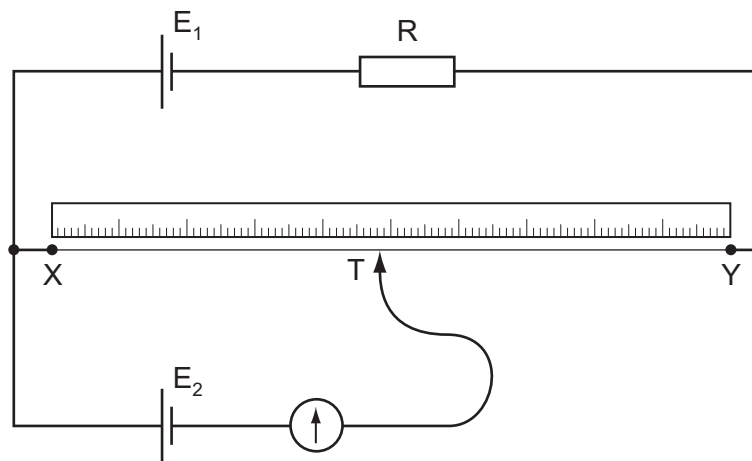
The resistance of the variable resistor is increased.

What is the effect on the readings of the ammeter and voltmeter?

	ammeter	voltmeter
A	decreases	increases
B	increases	decreases
C	unchanged	decreases
D	unchanged	increases

Space for working

37 The diagram shows a potentiometer circuit.



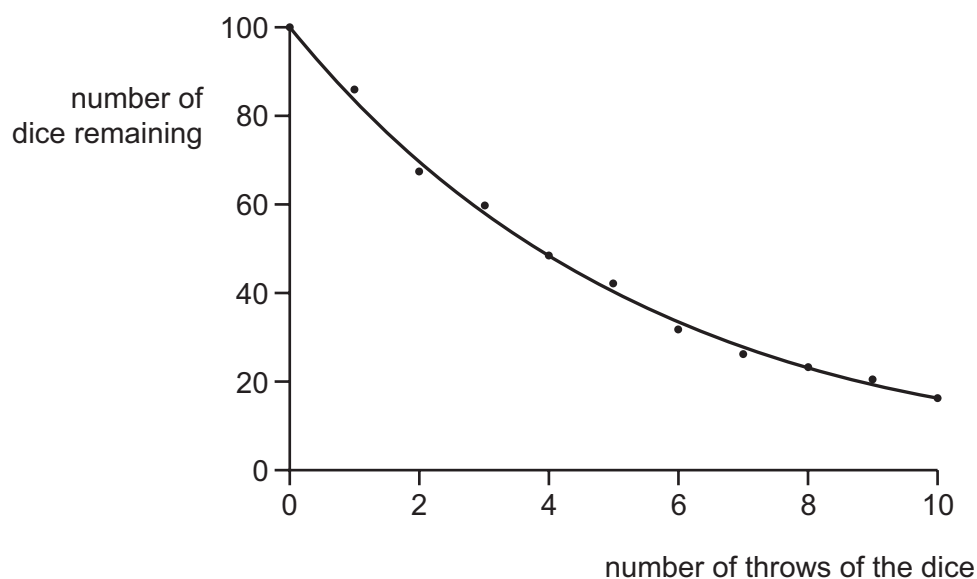
The contact T is placed on the wire and moved along the wire until the galvanometer reading is zero. The length XT is then noted.

In order to calculate the potential difference per unit length of the wire XY, which value must also be known?

- A the e.m.f. of the cell E_1
- B the e.m.f. of the cell E_2
- C the resistance of resistor R
- D the resistance of the wire XY

Space for working

- 38 A class of students used dice to simulate radioactive decay. After each throw, those dice showing a '6' were removed. The graph shows the results.



What could the scatter of points about the best-fit curve represent for actual radioactive decay?

- A background count not being taken into account
- B more than one type of radiation being present
- C the random nature of radioactive decay
- D the spontaneous nature of radioactive decay

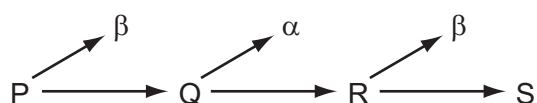
Space for working

39 Which statement about alpha, beta and gamma radiation is correct?

- A Alpha radiation has the greatest ionising power.
- B Beta radiation has the greatest ionising power.
- C Gamma radiation has the greatest ionising power.
- D Alpha, beta and gamma radiation have nearly equal ionising powers.

40 In a radioactive decay series, three successive decays each result in a particle being emitted.

The first decay results in the emission of a β -particle. The second decay results in the emission of an α -particle. The third decay results in the emission of another β -particle.



Nuclides P and S are compared.

Which statement is correct?

- A P and S are identical in all respects.
- B P and S are isotopes of the same element.
- C S is a different element of lower atomic number.
- D S is a different element of reduced mass.

Space for working

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

PHYSICS

9702/12

Paper 1 Multiple Choice

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1 hour

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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,

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

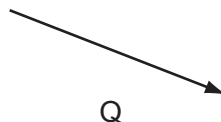
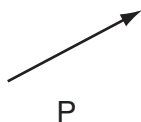
decay constant,

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

1 Which quantity has the same base units as momentum?

- A density $\times$ energy
- B density $\times$ volume $\times$ velocity
- C pressure $\times$ area
- D weight $\div$ area

2 Vectors P and Q are drawn to scale.



Which diagram represents the vector $(P + Q)$?

A



B



C



D



Space for working

- 3 What is the approximate kinetic energy of an Olympic athlete when running at maximum speed during a 100 m race?

A 400 J B 4000 J C 40 000 J D 400 000 J

- 4 Physical quantities can be classed as vectors or as scalars.

Which pair of quantities are both vectors?

- A kinetic energy and elastic force
- B momentum and time
- C velocity and electric field strength
- D weight and temperature

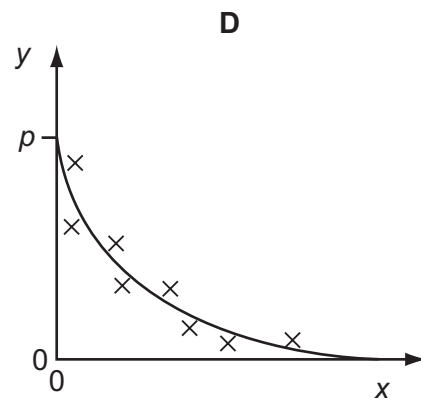
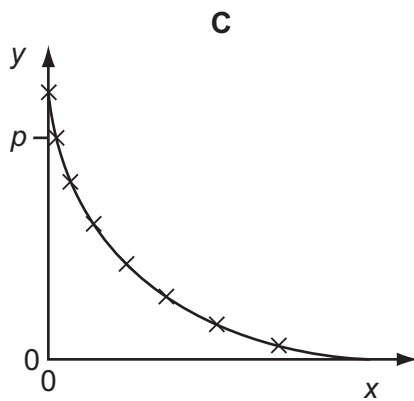
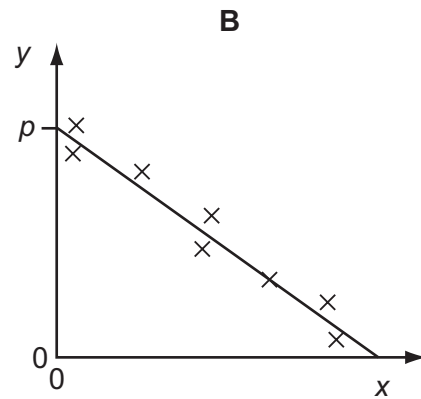
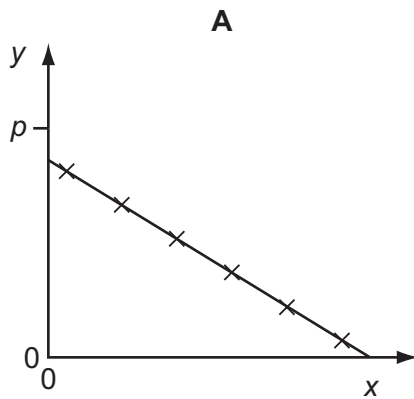
- 5 A student is given a reel of wire of diameter less than 0.2 mm and is asked to find the density of the metal.

Which pair of instruments would be most suitable for finding the **volume** of the wire?

- A balance and micrometer
- B metre rule and micrometer
- C metre rule and vernier calipers
- D micrometer and vernier calipers

Space for working

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



Space for working

- 7 The speed of a car is calculated from measurements of the distance travelled and the time taken.

The distance is measured as 200 m, with an uncertainty of ± 2 m.

The time is measured as 10.0 s, with an uncertainty of ± 0.2 s.

What is the percentage uncertainty in the calculated speed?

- A** $\pm 0.5\%$ **B** $\pm 1\%$ **C** $\pm 2\%$ **D** $\pm 3\%$

- 8 A science museum designs an experiment to show the fall of a feather in a vertical glass vacuum tube.

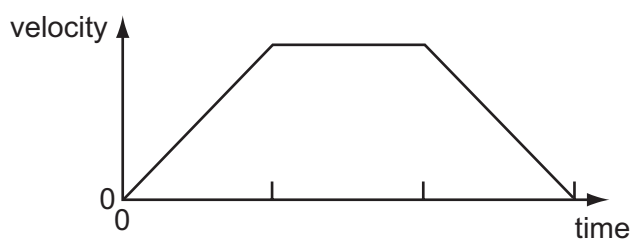
The time of fall from rest is to be close to 0.5 s.

What length of tube is required?

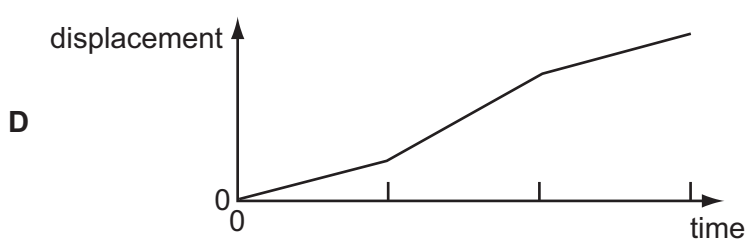
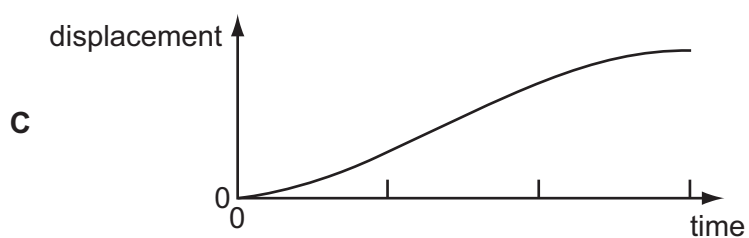
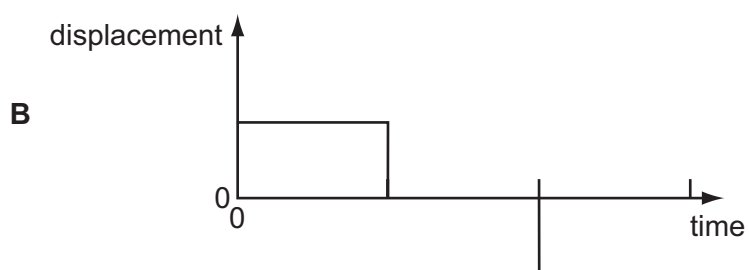
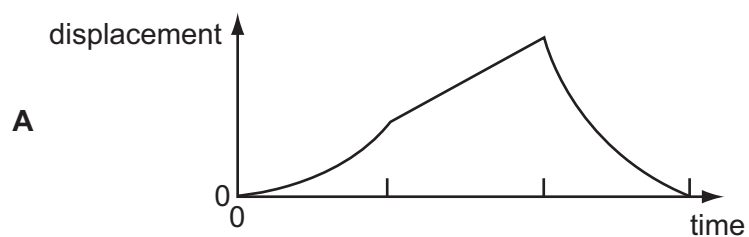
- A** 1.3 m **B** 2.5 m **C** 5.0 m **D** 10.0 m

Space for working

- 9 The graph of velocity against time for an object moving in a straight line is shown.

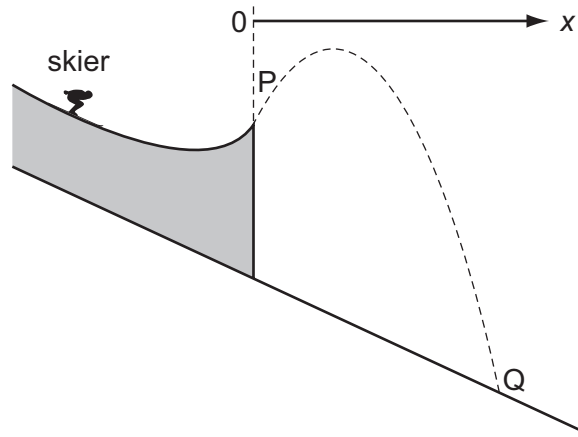


What is the corresponding graph of displacement against time?

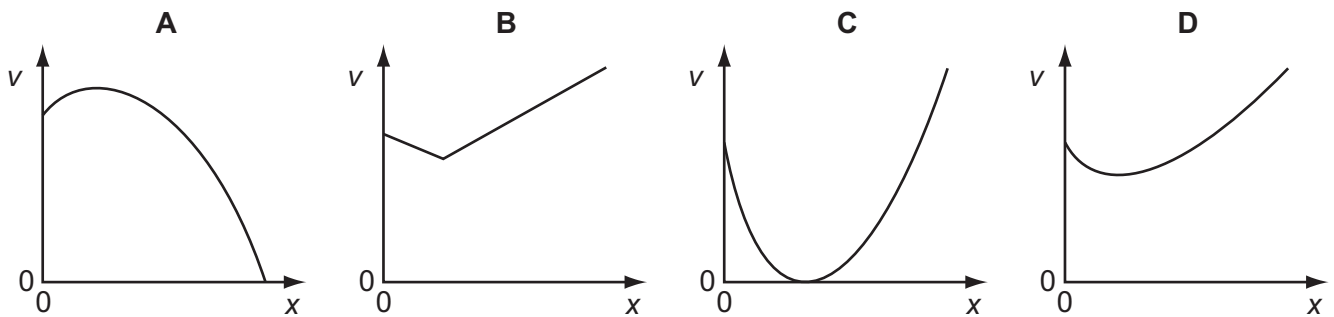


Space for working

10 The dotted line shows the path of a competitor in a ski-jumping competition.

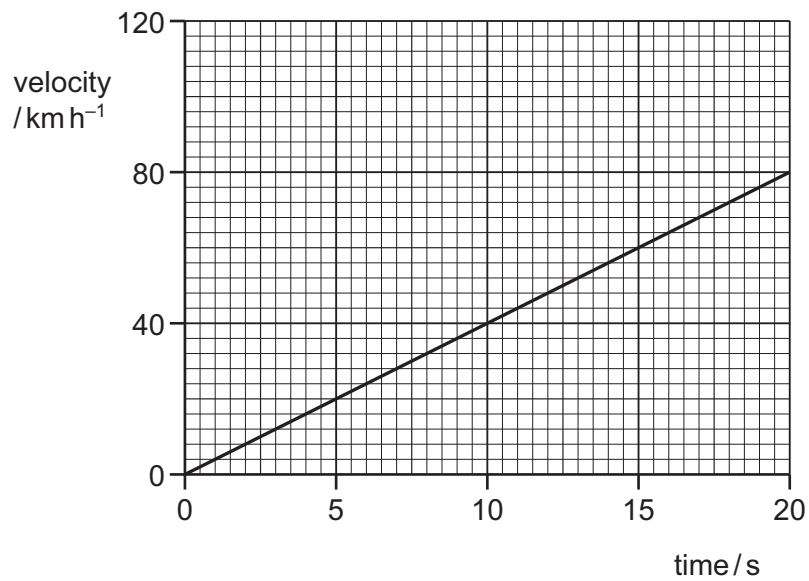


Ignoring air resistance, which graph best represents the variation of his speed v with the horizontal distance x covered from the start of his jump at P before landing at Q?



Space for working

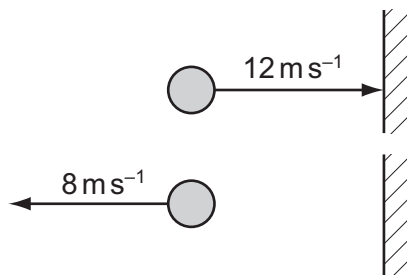
11 The velocity of a car changes as shown.



What is the acceleration of the car?

- A** 1.1 ms^{-2} **B** 4.0 ms^{-2} **C** 224 ms^{-2} **D** 800 ms^{-2}

12 A ball of mass 0.5 kg is thrown against a wall at a speed of 12 ms^{-1} . It bounces back with a speed of 8 ms^{-1} . The collision lasts for 0.10 s .

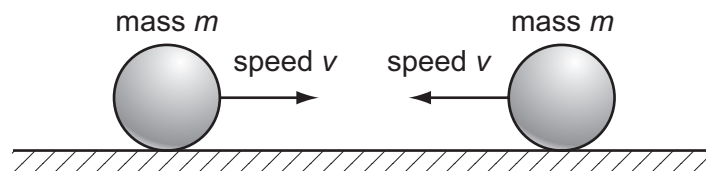


What is the average force on the ball due to the collision?

- A** 0.2 N **B** 1 N **C** 20 N **D** 100 N

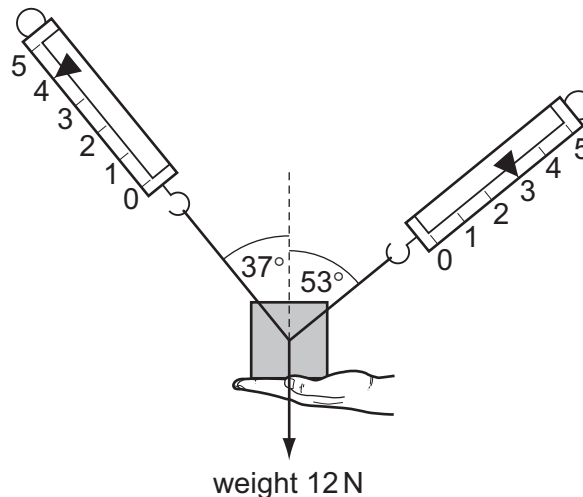
Space for working

- 13 Two identical, perfectly elastic spheres have the same mass m . They travel towards each other with the same speed v along a horizontal frictionless surface.



Which statement about the sum of the kinetic energies of the spheres is correct?

- A The sum of their kinetic energies before impact is zero.
 - B The sum of their kinetic energies before impact is $\frac{1}{2}mv^2$.
 - C The sum of their kinetic energies after impact is zero.
 - D The sum of their kinetic energies after impact is mv^2 .
- 14 A 1.2 kg mass is supported by a person's hand and two newton-meters as shown.



When the person's hand is removed, what is the initial vertical acceleration of the mass?

- A 0.6 ms^{-2}
- B 2 ms^{-2}
- C 4 ms^{-2}
- D 6 ms^{-2}

Space for working

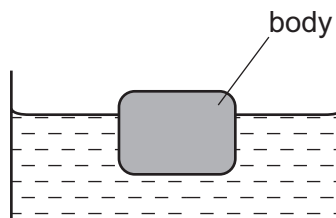
15 A lorry of mass 20 000 kg has a constant resultant force F acting on it.

It accelerates from 6.0 m s^{-1} to 30.0 m s^{-1} in a time of 300 s.

What is the change in momentum of the lorry and the value of F ?

	change in momentum / N s	force F / N
A	48 000	160
B	480 000	1600
C	600 000	2000
D	600 000	20 000

16 A stationary body floats in water.



Which statement about the forces acting on the body is correct?

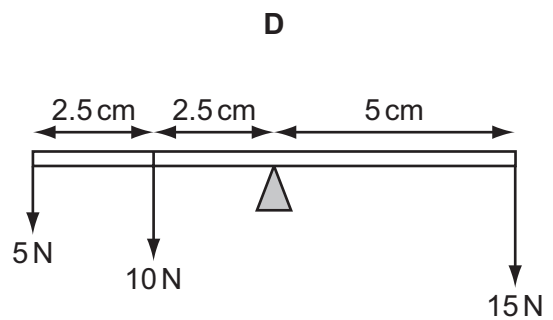
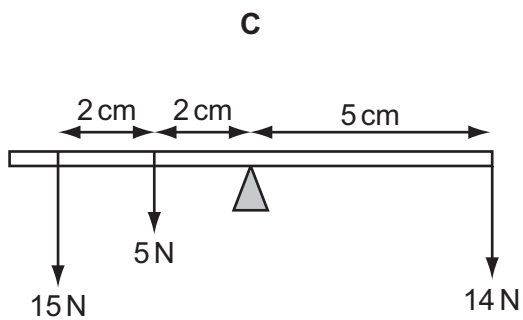
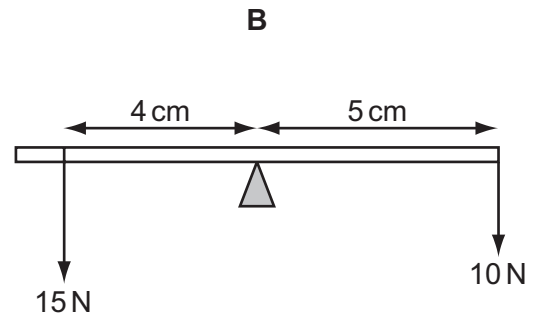
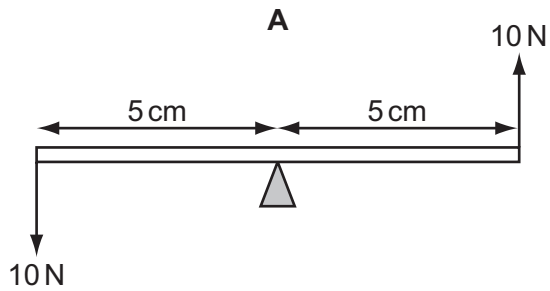
- A** The gravitational force is equal to the viscous force.
- B** The gravitational force is greater than the upthrust.
- C** The upthrust is zero.
- D** The viscous force is zero.

Space for working

17 A rigid uniform beam is pivoted horizontally at its midpoint.

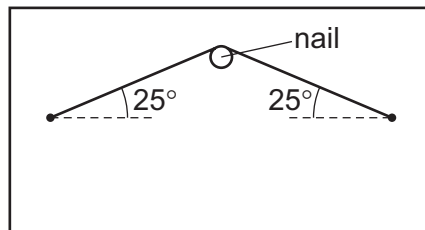
Different vertical forces are applied to different positions on the beam.

In which diagram is the beam in equilibrium?



Space for working

- 18 A picture on a wall is supported by a wire looped over a nail.



The mass of the picture is 4.2 kg.

What is the tension in the supporting wire?

- A** 5.0 N **B** 23 N **C** 49 N **D** 97 N
- 19 A piston in a gas supply pump has an area of 500 cm^2 and it moves a distance of 30 cm during one stroke.
- The pump moves the gas against a fixed pressure of 4000 Pa.
- How much work is done by the piston during one stroke?
- A** 60 J **B** $6.0 \times 10^3 \text{ J}$ **C** $6.0 \times 10^5 \text{ J}$ **D** $6.0 \times 10^7 \text{ J}$
- 20 A railway engine accelerates a train of total mass 1200 tonnes (1 tonne = 1000 kg) from rest to a speed of 75 m s^{-1} .

How much useful work must be done on the train to reach this speed?

- A** $1.7 \times 10^6 \text{ J}$ **B** $3.4 \times 10^6 \text{ J}$ **C** $1.7 \times 10^9 \text{ J}$ **D** $3.4 \times 10^9 \text{ J}$

Space for working

- 21 A crane is being used to lift containers off a ship. One container has a mass of 14 000 kg and is being lifted vertically with a speed of 3.2 ms^{-1} .

The electric motor being used to supply the power to lift the container is using a current of 240 A at a potential difference of 2200 V.

What is the efficiency of the system?

- A 8.1 % B 8.5 % C 48 % D 83 %

- 22 Trains supply coal to a power station. The table below gives quantities describing the operation of the power station.

	symbol	unit
power station output	P	W
number of trains per day	N	
mass of coal on a train	M	kg
energy from 1 kg of coal	J	J
number of seconds in one day	S	

Which expression gives the efficiency of the power station?

- A $\frac{PS}{NMJ}$ B $\frac{PSN}{MJ}$ C $\frac{NMJ}{PS}$ D $\frac{NM}{PSJ}$

Space for working

- 23 Which row correctly describes the spacing and motion of the molecules in water and in ice when both are at a temperature of 0 °C?

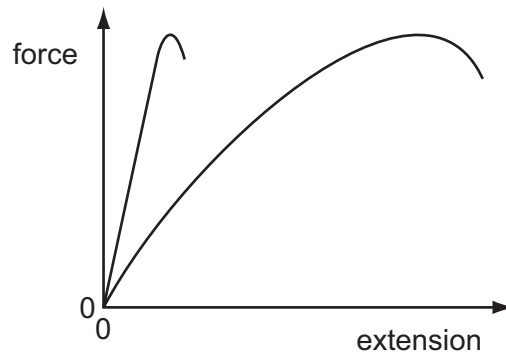
	spacing	motion
A	molecules in ice are further apart than molecules in water	molecules in both ice and water have the same average speed
B	molecules in ice are further apart than molecules in water	molecules in ice travel more slowly than those in water
C	molecules in ice are closer than molecules in water	molecules in ice travel more slowly than those in water
D	molecules in ice are closer than molecules in water	molecules in both ice and water have the same average speed

- 24 Which row gives the correct description for the arrangement of atoms in the four types of material?

	atoms have no long-range order	atoms form giant chain-like molecules	atoms have an ordered arrangement in regions, but these ordered regions are at angles to one another	atoms are arranged in an ordered way throughout
A	crystalline	amorphous	polymeric	polycrystalline
B	polycrystalline	crystalline	amorphous	polymeric
C	polymeric	polycrystalline	crystalline	amorphous
D	amorphous	polymeric	polycrystalline	crystalline

Space for working

- 25 What leads to the conclusion that the movement of molecules is random?
- A evaporation of water at room temperature
 - B conduction of electricity in water
 - C convection currents in air
 - D motion of dust particles in air
- 26 The diagram shows the force-extension graphs for two materials, of the same dimensions, loaded to fracture.



What describes the behaviour of the materials?

- A Both materials are brittle.
- B Both materials obey Hooke's law.
- C Both materials are plastic.
- D Both materials have the same ultimate tensile stress.

Space for working

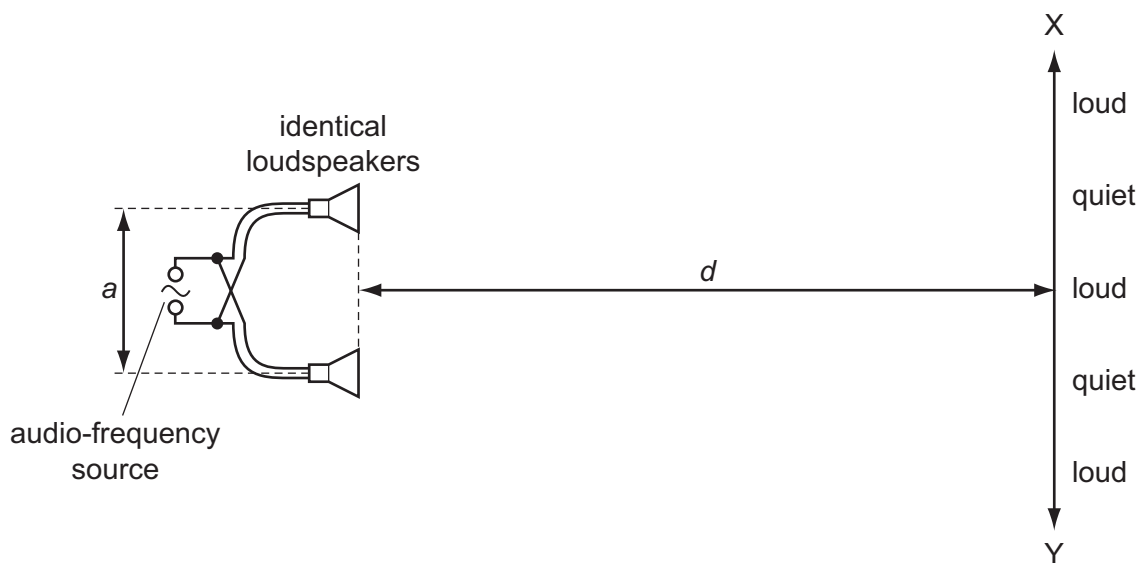
- 27 Two wires, X and Y, are made from different metals and have different dimensions. The Young modulus of wire X is twice that of wire Y. The diameter of wire X is half that of wire Y.

Both wires are extended with equal strain and obey Hooke's law.

What is the ratio $\frac{\text{tension in wire X}}{\text{tension in wire Y}}$?

- A $\frac{1}{8}$ B $\frac{1}{2}$ C 1 D 8

- 28 The diagram shows two identical loudspeakers driven in phase by a common audio-frequency source.



When a student moves along line XY, she notices that there are variations in the loudness of the sound. The regions in which the sound is heard are alternately loud and quiet as indicated on the diagram.

How may the distance between loud regions be reduced?

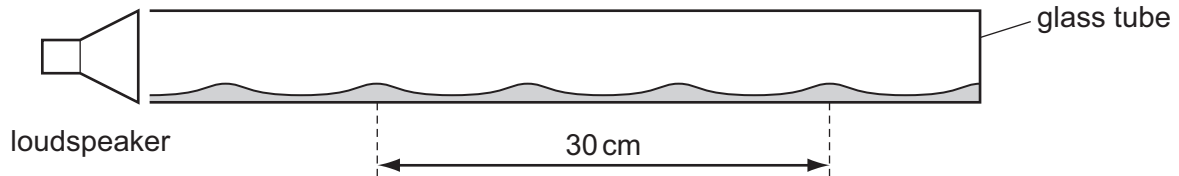
- A decreasing the distance a between the speakers
 B increasing distance d
 C increasing the frequency of the audio-frequency source
 D increasing the power output from the audio-frequency source

Space for working

- 29** A horizontal glass tube, closed at one end, has a layer of dust laid inside it on its lower side. Sound is emitted from a loudspeaker that is placed near the open end of the tube.

The frequency of the sound is varied and, at one frequency, a stationary wave is formed inside the tube so that the dust forms small heaps.

The distance between four heaps of dust is 30 cm.

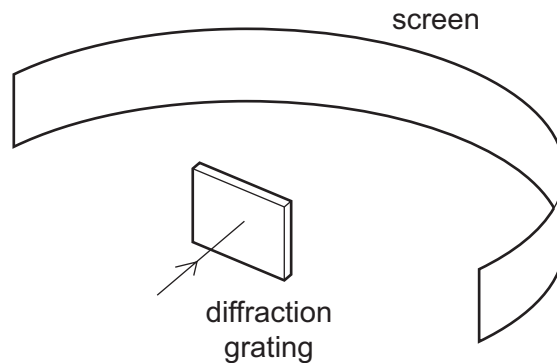


The speed of sound in the tube is 330 m s^{-1} .

What is the frequency of the sound emitted by the loudspeaker?

- A** 1650 Hz **B** 2200 Hz **C** 3300 Hz **D** 6600 Hz

- 30** Monochromatic light of wavelength 690 nm passes through a diffraction grating with 300 lines per mm, producing a series of maxima on a screen.

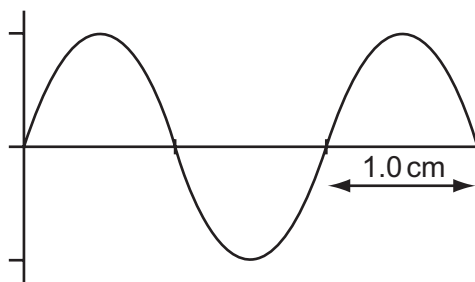


What is the greatest number of maxima that can be observed?

- A** 4 **B** 5 **C** 8 **D** 9

Space for working

- 31 The diagram shows a cathode-ray oscilloscope display of an electromagnetic wave.



The time base setting is $0.20 \mu\text{s cm}^{-1}$.

Which statement is correct?

- A The frequency of the wave is 2.5 MHz and it lies in the radio wave region of the electromagnetic spectrum.
 - B The frequency of the wave is 2.5 MHz and it lies in the microwave region of the electromagnetic spectrum.
 - C The frequency of the wave is 5.0 MHz and it lies in the radio wave region of the electromagnetic spectrum.
 - D The frequency of the wave is 5.0 MHz and it lies in the microwave region of the electromagnetic spectrum.
- 32 A charged particle moves in a uniform electric field between two parallel metal plates.

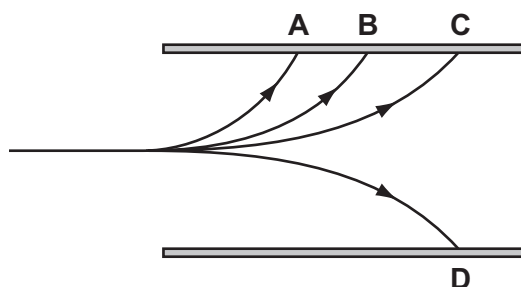
To calculate the force acting on the particle due to the electric field, which quantity is **not** required?

- A particle charge
- B particle speed
- C plate separation
- D potential difference between the plates

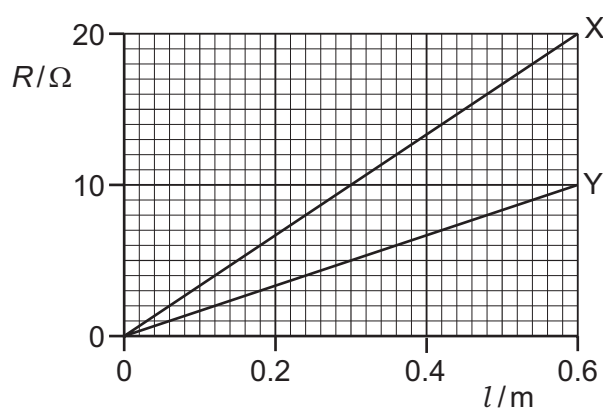
Space for working

- 33 A single proton travelling with a constant horizontal velocity enters a uniform electric field between two parallel charged plates. In the diagram, **B** shows the path taken by the proton.

Which path is taken by a helium nucleus that enters the electric field at the same point and with the same velocity as the proton?



- 34 The graph shows the variation with length l of resistance R for two wires X and Y made from the same material.



What does the graph show?

- A** cross-sectional area of X = $2 \times$ cross-sectional area of Y
- B** resistivity of X = $2 \times$ resistivity of Y
- C** when equal lengths of X and Y are connected in series to a battery, power in X = $2 \times$ power in Y
- D** when equal lengths of X and Y are connected in parallel to a battery, current in X = $2 \times$ current in Y

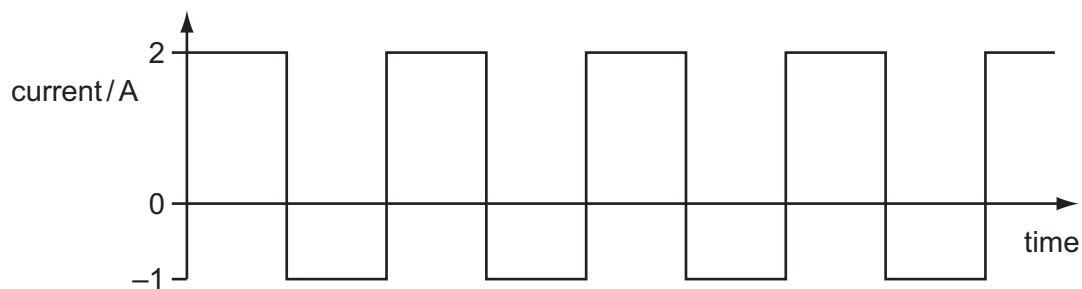
Space for working

- 35** A cell of internal resistance $2.0\ \Omega$ and electromotive force (e.m.f.) $1.5\ \text{V}$ is connected to a resistor of resistance $3.0\ \Omega$.

What is the potential difference across the $3.0\ \Omega$ resistor?

- A** $1.5\ \text{V}$ **B** $1.2\ \text{V}$ **C** $0.9\ \text{V}$ **D** $0.6\ \text{V}$

- 36** A $100\ \Omega$ resistor conducts a current with changing direction and magnitude, as shown.

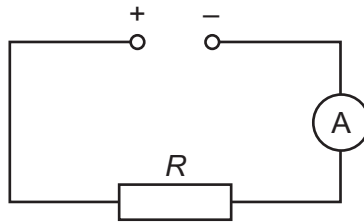


What is the mean power dissipated in the resistor?

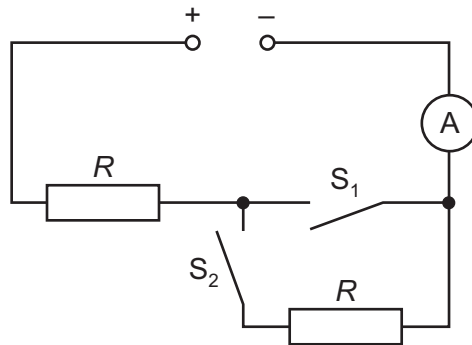
- A** $100\ \text{W}$ **B** $150\ \text{W}$ **C** $250\ \text{W}$ **D** $400\ \text{W}$

Space for working

37 The ammeter reading in the circuit below is I .



Another circuit containing the same voltage supply, two switches, an ammeter and two resistors each of resistance R , is shown.

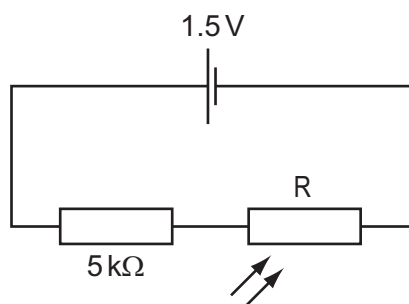


Which row is **not** correct?

	S_1	S_2	ammeter reading
A	closed	closed	I
B	closed	open	I
C	open	closed	I
D	open	open	0

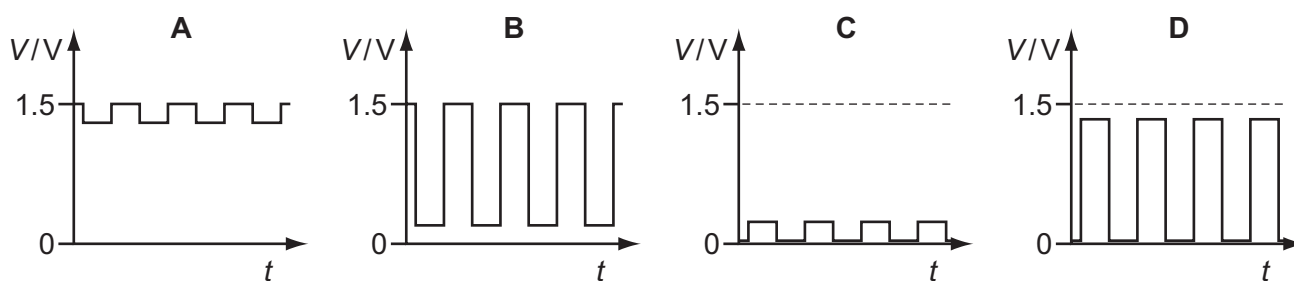
Space for working

- 38 A light-dependent resistor R has resistance of about $1\text{ M}\Omega$ in the dark and about $1\text{ k}\Omega$ when illuminated. It is connected in series with a $5\text{ k}\Omega$ resistor to a 1.5 V cell of negligible internal resistance.



The light-dependent resistor is illuminated (in an otherwise dark room) by a flashing light.

Which graph best shows the variation with time t of potential difference V across R ?



Space for working

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

Which statement about this material is correct?

- A The number of atoms in the material diminishes at a rate of 100 s^{-1} .
 - B The number of neutrons in the material diminishes at a rate of 100 s^{-1} .
 - C The number of nucleons in the material diminishes at a rate of 400 s^{-1} .
 - D The number of protons in the material diminishes at a rate of 100 s^{-1} .
- 40 A different nucleus can be formed by bombarding a stable nucleus with an energetic α -particle.

${}^{23}_{11}\text{Na}$ is bombarded with an energetic α -particle.

What could be the products of this nuclear reaction?

- A ${}^{25}_{10}\text{Ne}$ + neutron
- B ${}^{25}_{11}\text{Na}$ + proton
- C ${}^{26}_{12}\text{Mg}$ + β
- D ${}^{27}_{13}\text{Al}$ + γ

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

October/November 2012

1 hour

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

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

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

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

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any working should be done in this booklet.

This document consists of **27** 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

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

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$$p = \rho gh$$

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,

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

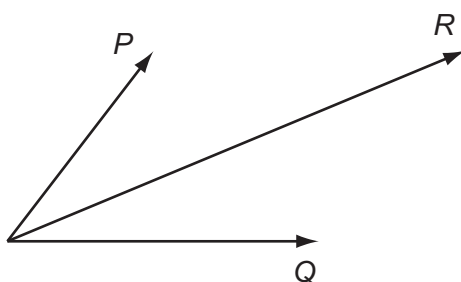
decay constant,

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

- 1 The units of all physical quantities can be expressed in terms of SI base units.

Which pair contains quantities with the same base units?

- A force and momentum
 - B pressure and Young modulus
 - C power and kinetic energy
 - D mass and weight
- 2 Two physical quantities P and Q are added. The sum of P and Q is R , as shown.



Which quantity could be represented by P and by Q ?

- A kinetic energy
- B power
- C speed
- D velocity

Space for working

- 3 A 1.5 V cell supplies 0.20 A to a lamp for seven hours before the lamp goes out.

What is a sensible estimate for the initial chemical energy content of the cell?

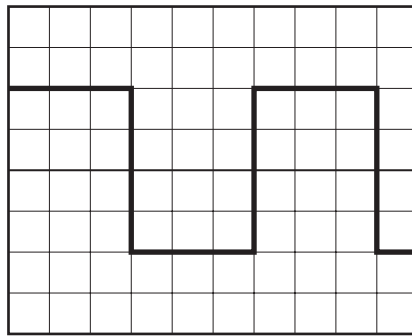
- A $1 \times 10^2 \text{ J}$ B $1 \times 10^4 \text{ J}$ C $1 \times 10^6 \text{ J}$ D $1 \times 10^8 \text{ J}$

- 4 Three of these quantities have the same unit.

Which quantity has a different unit?

- A $\frac{\text{energy}}{\text{distance}}$
 B force
 C power $\times$ time
 D rate of change of momentum

- 5 A cathode-ray oscilloscope displays a square wave, as shown in the diagram.



The time-base setting is 0.20 ms per division.

What is the frequency of the square wave?

- A 8.3 Hz B 830 Hz C 1300 Hz D 1700 Hz

Space for working

- 6 What will reduce the systematic errors when taking a measurement?
- A adjusting the needle on a voltmeter so that it reads zero when there is no potential difference across it
 - B measuring the diameter of a wire at different points and taking the average
 - C reducing the parallax effects by using a marker and a mirror when measuring the amplitude of oscillation of a pendulum
 - D timing 20 oscillations, rather than a single oscillation, when finding the period of a pendulum
- 7 In an experiment to determine the acceleration of free fall g , the time t taken for a ball to fall through distance s was measured. The uncertainty in the measurement of s is estimated to be 2%. The uncertainty in the measurement of t is estimated to be 3%.

The value of g is determined using the equation

$$g = \frac{2s}{t^2}.$$

What is the uncertainty in the calculated value of g ?

- A 1% B 5% C 8% D 11%

Space for working

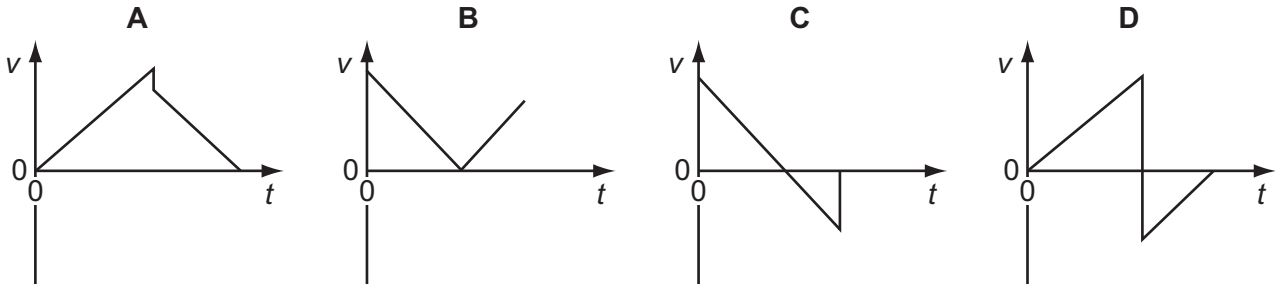
- 8 A bicycle brakes so that it undergoes uniform deceleration from a speed of 8 m s^{-1} to 6 m s^{-1} over a distance of 7 m.

If the deceleration of the bicycle remains constant, what further distance will it travel before coming to rest?

- A** 7 m **B** 9 m **C** 16 m **D** 21 m

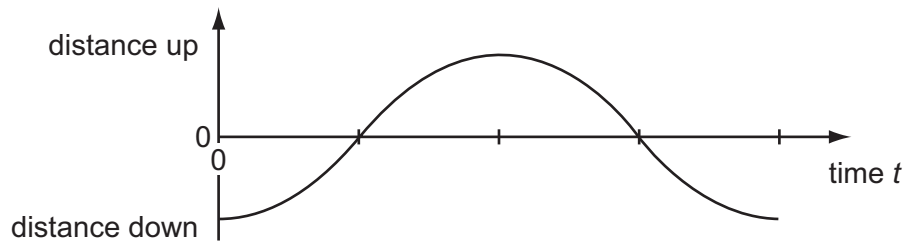
- 9 A ball is released from rest above a horizontal surface. It bounces once and is caught.

Which graph represents the variation with time t of the velocity v of the ball?

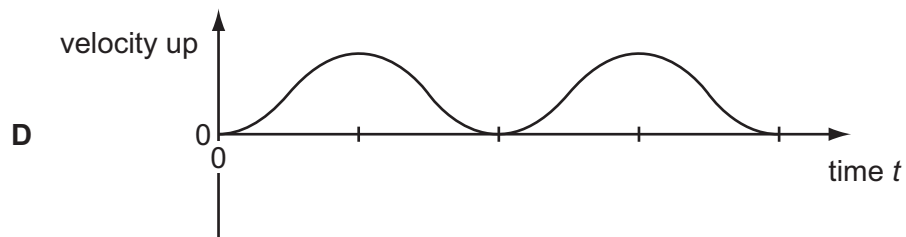
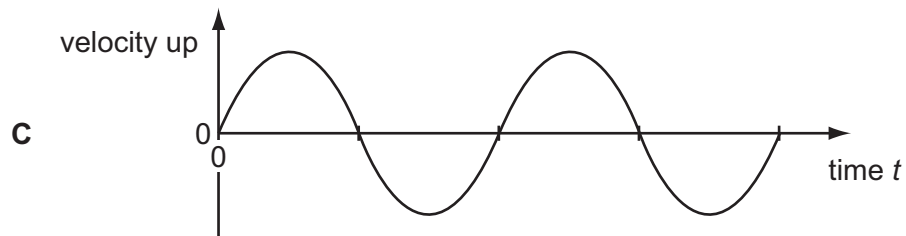
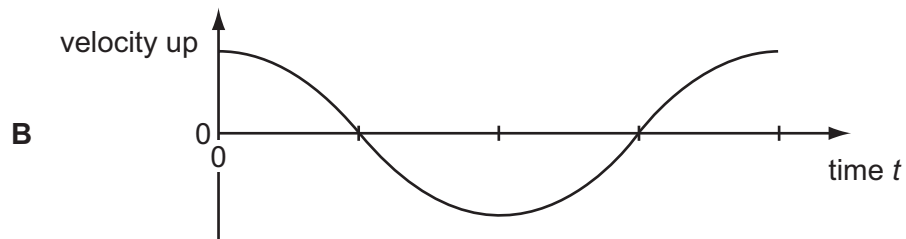
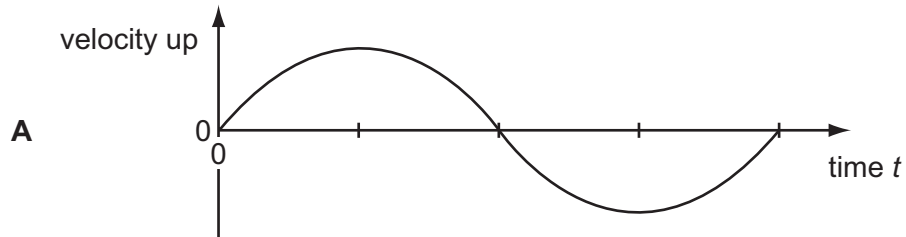


Space for working

- 10 A mass on the end of a spring bounces up and down as shown, after being released at time $t = 0$.



Which graph shows how the velocity varies with time?

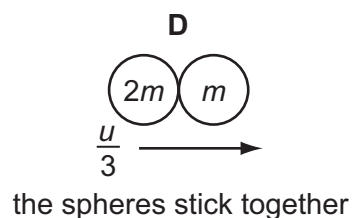
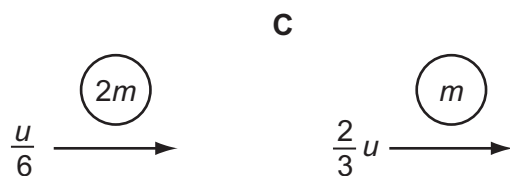
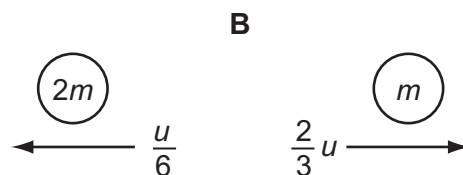
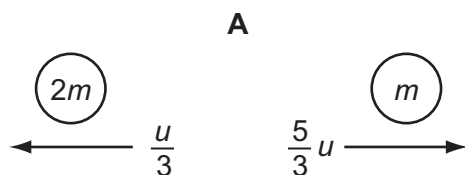


Space for working

- 11 The diagram shows two spherical masses approaching each other head-on at an equal speed u . One is of mass m and the other of mass $2m$.



Which diagram, showing the situation after the collision, is **not** consistent with the principle of conservation of momentum?



Space for working

- 12** A molecule of mass m travelling at speed v hits a wall in a direction perpendicular to the wall. The collision is elastic.

What are the changes in the kinetic energy and in the momentum of the molecule caused by the collision?

	change in momentum	change in kinetic energy
A	0	0
B	0	mv^2
C	$2mv$	0
D	mv^2	0

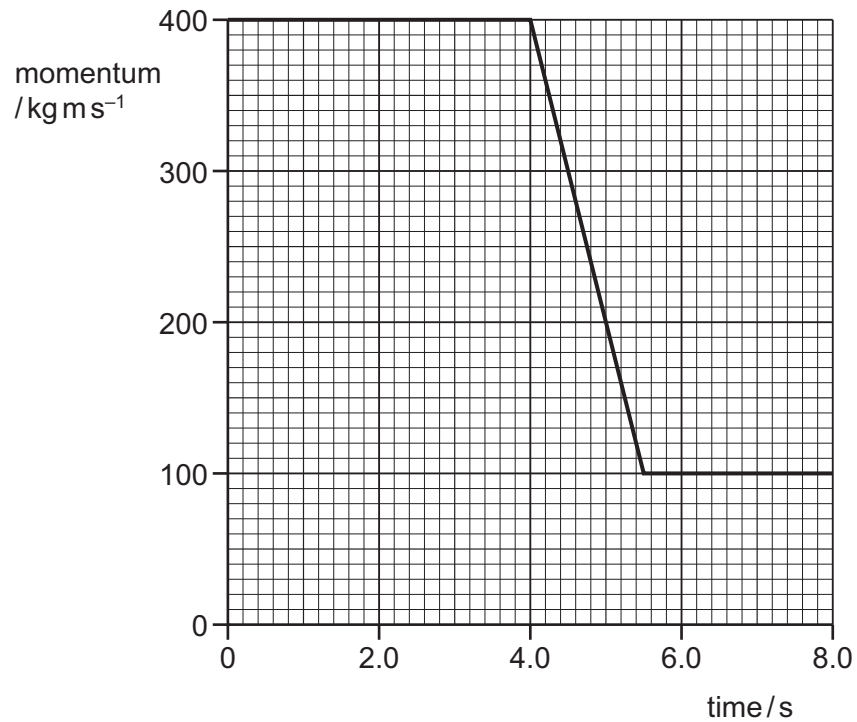
- 13** The IKAROS satellite has mass 320 kg and moves through space using a solar sail of area 20 m^2 . The average solar wind pressure is $1.0 \times 10^{-5}\text{ N m}^{-2}$.

What is the acceleration of the satellite caused by the solar wind?

- A** $3.1 \times 10^{-8}\text{ m s}^{-2}$
B $6.3 \times 10^{-7}\text{ m s}^{-2}$
C $3.2 \times 10^{-3}\text{ m s}^{-2}$
D $6.4 \times 10^{-2}\text{ m s}^{-2}$

Space for working

14 The graph shows the momentum of a cyclist over a period of 8.0 s.



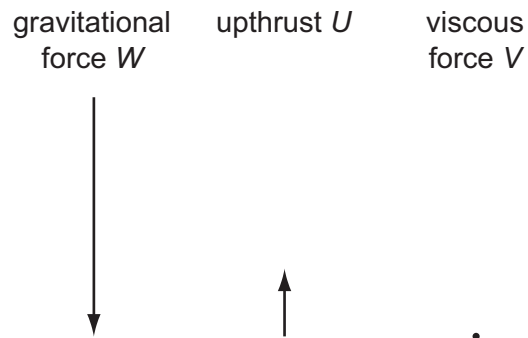
At time 4.0 s, she applies the brakes.

What is the resultant force on the cyclist during the period when the brakes are applied?

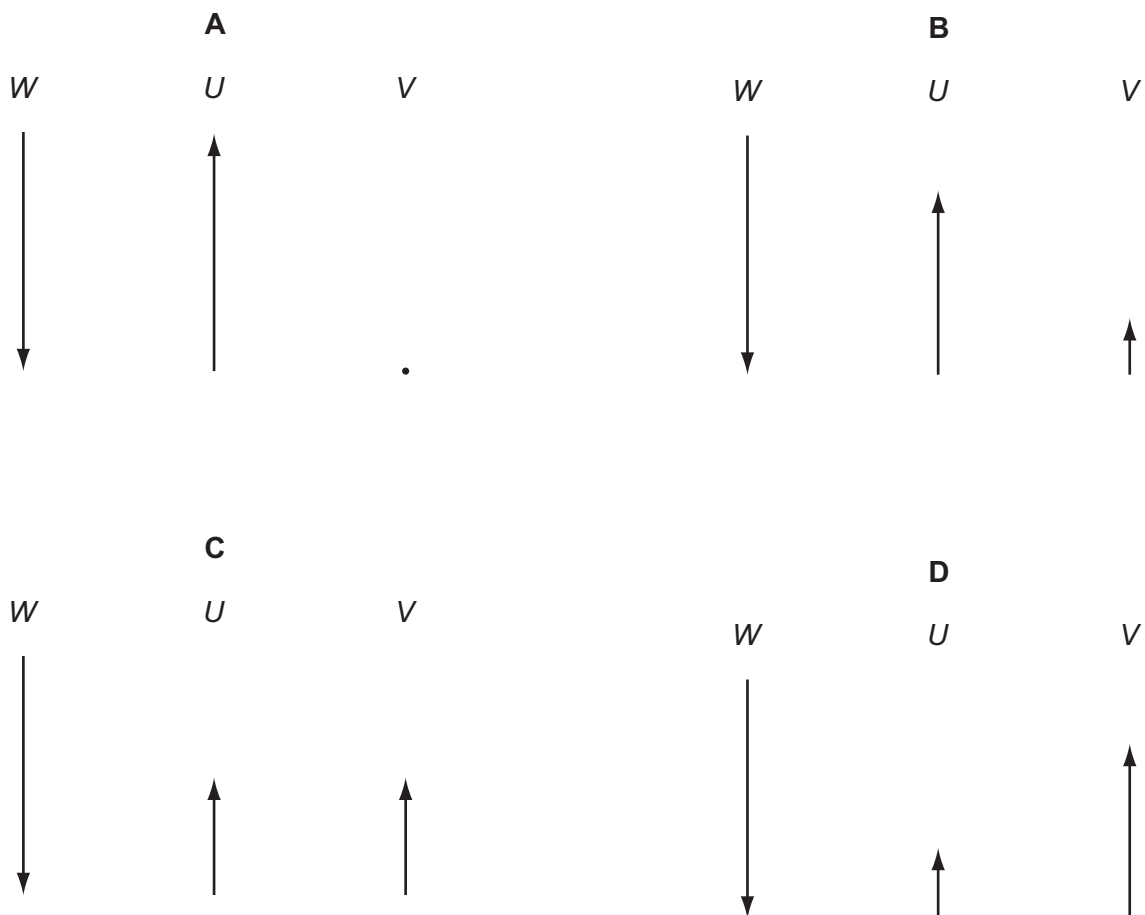
- A** 55 N **B** 200 N **C** 270 N **D** 450 N

Space for working

- 15 A hailstone, initially stationary at the base of a cloud, falls vertically towards the Earth. The diagram shows the magnitudes and directions of the forces acting on the hailstone as it starts to drop.



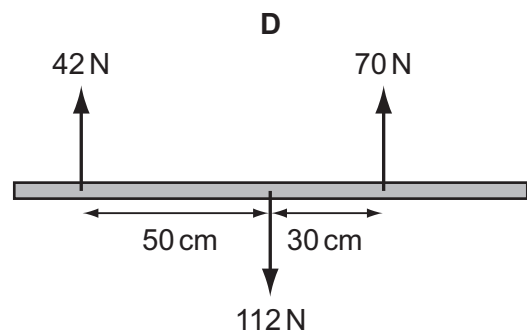
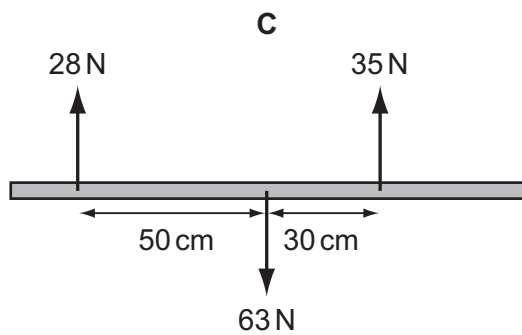
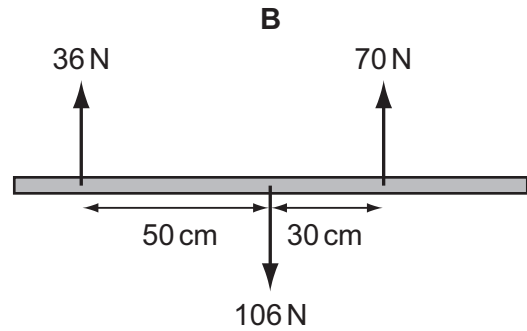
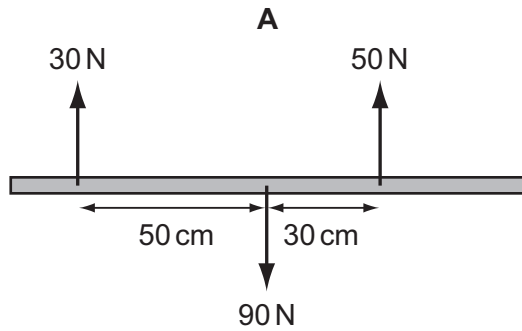
Which diagram shows the magnitudes and directions of these forces when the hailstone attains a terminal (constant) speed in the air (of uniform density)?



Space for working

16 Four beams of the same length each have three forces acting on them.

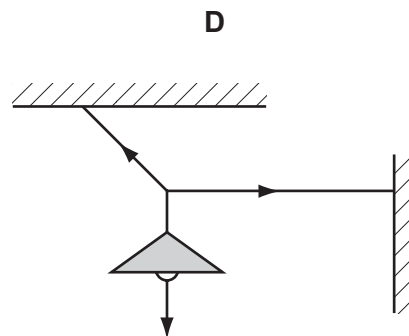
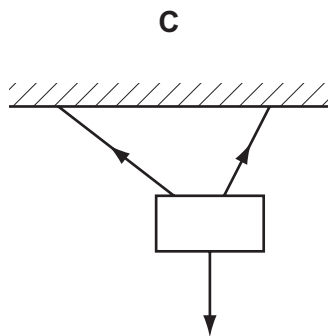
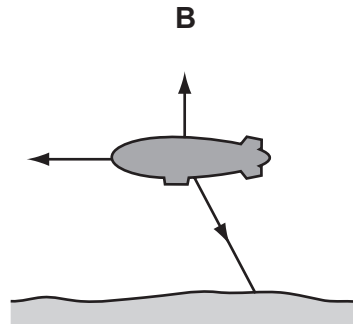
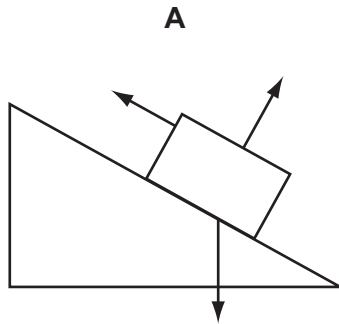
Which beam has both zero resultant force and zero resultant torque acting?



Space for working

17 The diagrams show the forces acting on different bodies.

Which body **cannot** be in equilibrium?



18 A car travelling with speed 28 m s^{-1} leaves a motorway on an exit road. The end of the exit road is 22 m higher than the motorway.

If only the force of gravity is considered, what will be the speed of the car at the end of the exit road?

- A** 7.3 m s^{-1} **B** 19 m s^{-1} **C** 21 m s^{-1} **D** 24 m s^{-1}

Space for working

- 19** A piston in a gas supply pump has an area of 400 cm^2 and it moves a distance of 25 cm during one stroke.

The pump moves the gas against a fixed pressure of 3000 Pa.

How much work is done by the piston during one stroke?

- A** 30 J **B** $3.0 \times 10^3 \text{ J}$ **C** $3.0 \times 10^5 \text{ J}$ **D** $3.0 \times 10^7 \text{ J}$

- 20** A transformer has the following input and output.

	potential difference / V	current / A
input	11 000	28
output	240	1200

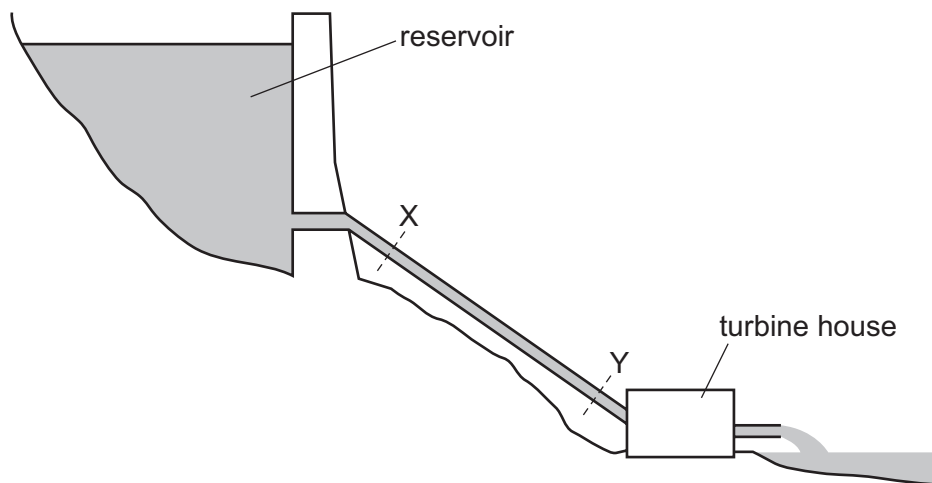
What is the efficiency of the transformer?

- A** 0.94 % **B** 1.0 % **C** 11 % **D** 94 %

Space for working

21 The diagram shows a hydroelectric power station.

The reservoir is linked to the turbines by a pipe of uniform cross-sectional area. Water flows from the reservoir, through the pipe and through the turbines at a constant rate.



Which statement about the change of energy of the water as it moves from X to Y is correct?

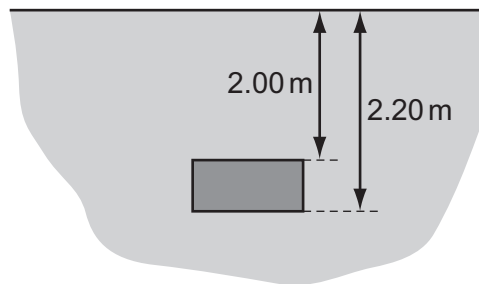
- A It gains both gravitational potential energy and kinetic energy.
- B It loses gravitational potential energy and gains elastic potential energy.
- C It loses gravitational potential energy and gains kinetic energy.
- D It loses both elastic potential energy and gravitational potential energy.

Space for working

- 22 Which row correctly describes the ordering and motion of the molecules in water and in ice when both are at a temperature of 0°C ?

	ordering	motion
A	a regular pattern of molecules in ice but not in water	molecules in both ice and water have the same average speed
B	a regular pattern of molecules in ice but not in water	molecules in ice travel more slowly than those in water
C	a regular pattern of molecules in both ice and water	molecules in ice travel more slowly than those in water
D	a regular pattern of molecules in both ice and water	molecules in both ice and water have the same average speed

- 23 The diagram shows a rectangular block of mass 8.2 kg immersed in sea water of density $1.10 \times 10^3 \text{ kg m}^{-3}$.

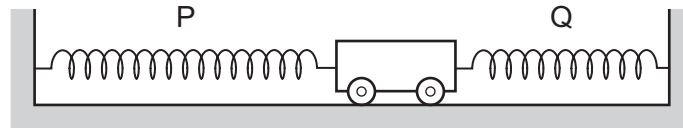


What is the difference in pressure between the top and bottom surfaces of the block?

- A** $2.2 \times 10^2 \text{ Pa}$
- B** $2.2 \times 10^3 \text{ Pa}$
- C** $1.8 \times 10^4 \text{ Pa}$
- D** $2.3 \times 10^4 \text{ Pa}$

Space for working

- 24 A trolley is held at rest between two steel springs.



Each spring has an unstretched length of 0.10 m.

Spring P has spring constant 60 N m^{-1} .
Spring Q has spring constant 120 N m^{-1} .

Spring P has an extension of 0.40 m.

What is the extension of spring Q?

- A** 0.10 m **B** 0.20 m **C** 0.30 m **D** 0.80 m
- 25 A lift is supported by two steel cables, each of length 10 m and diameter 0.5 cm.

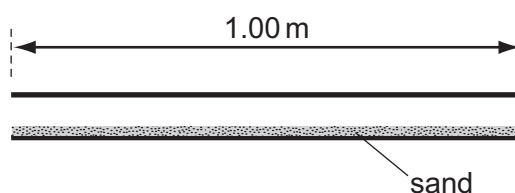
The lift drops 1 mm when a man of mass 80 kg steps into the lift.

What is the best estimate of the value of the Young modulus of the steel?

- A** $2 \times 10^{10} \text{ N m}^{-2}$
B $4 \times 10^{10} \text{ N m}^{-2}$
C $2 \times 10^{11} \text{ N m}^{-2}$
D $4 \times 10^{11} \text{ N m}^{-2}$

Space for working

- 26 The diagram shows an air-filled pipe open at both ends. The length of the pipe is 1.00 m and the lower surface of the inside of the pipe is covered with a layer of fine sand.



When a source of sound of a single frequency is put near one end of the pipe, the air in the pipe is found to resonate and a pattern in the sand shows that a standing wave containing three nodes is formed within the pipe.

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

What is the frequency of the sound?

- A** 330 Hz **B** 495 Hz **C** 990 Hz **D** 1320 Hz

- 27 A stationary sound wave is formed in a measuring cylinder by blowing across the top, as shown.



Which statement is correct?

- A** The fundamental frequency of the stationary wave decreases when some water is added to the cylinder.
B The stationary wave in the cylinder is caused by the superposition of two waves moving in opposite directions.
C The stationary wave in the cylinder is polarised.
D The stationary wave will have an antinode at the bottom of the cylinder.

Space for working

- 28** Diffraction can be observed when a wave passes an obstruction. The diffraction effect is greatest when the wavelength and the obstruction are similar in size.

For waves travelling through air, what is the combination of wave and obstruction that could best demonstrate diffraction?

- A** microwaves passing a steel post
 - B** radio waves passing a copper wire
 - C** sound waves passing a human hair
 - D** visible light waves passing a gate post
- 29** A health inspector is measuring the intensity of a sound. Near a loudspeaker, his meter records an intensity I . This corresponds to an amplitude A of the sound wave. At another position, the meter gives an intensity reading of $2I$.

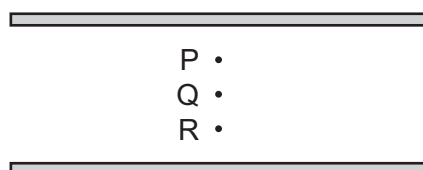
What is the corresponding amplitude of the sound wave?

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

Space for working

- 30 The diagram shows two parallel plates.

The plates are charged so that there is an electric field between them. P, Q and R are points which are $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ of the distance from the top plate to the bottom plate.



What is the electric field strength at point P?

- A the same as that at point Q
 - B twice that at point R
 - C half that at point R
 - D one third that at point Q
- 31 A positive charge of $2.6 \times 10^{-8} \text{ C}$ is in an electric field of constant field strength $300\,000 \text{ V m}^{-1}$.

How much work must be done on the charge in order to move it a distance of 4.0 mm in the opposite direction to the direction of the field?

- A $3.1 \times 10^{-5} \text{ J}$
- B $2.0 \times 10^{-3} \text{ J}$
- C $3.1 \times 10^{-2} \text{ J}$
- D 2.0 J

Space for working

32 Which values of current and resistance will produce a rate of energy transfer of 16 J s^{-1} ?

	current / A	resistance / Ω
A	1	4
B	2	8
C	4	1
D	16	1

33 A copper wire is stretched so that its diameter is reduced from 1.0 mm to a uniform 0.5 mm.

The resistance of the unstretched copper wire is 0.2Ω .

What will be the resistance of the stretched wire?

- A** 0.4Ω **B** 0.8Ω **C** 1.6Ω **D** 3.2Ω

34 Four statements about potential difference or electromotive force are listed.

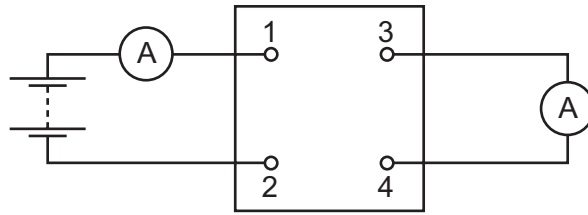
- 1 It involves changing electrical energy into other forms.
- 2 It involves changing other energy forms into electrical energy.
- 3 It is the energy per unit charge to move charge right round a circuit.
- 4 It is the work done per unit charge by the charge moving from one point to another.

Which statements apply to potential difference and which apply to electromotive force?

	potential difference	electromotive force
A	1 and 3	2 and 4
B	1 and 4	2 and 3
C	2 and 3	1 and 4
D	2 and 4	1 and 3

Space for working

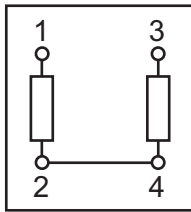
35 The diagram shows a four-terminal box connected to a battery and two ammeters.



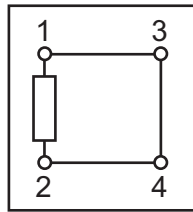
The currents in the two meters are identical.

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

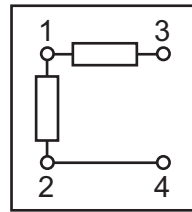
A



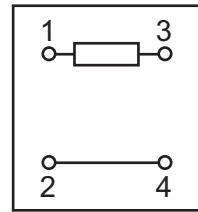
B



C

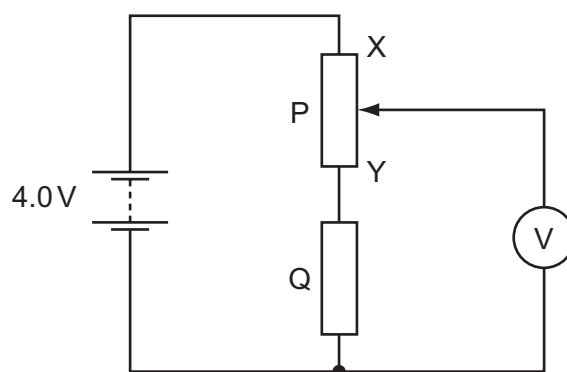


D



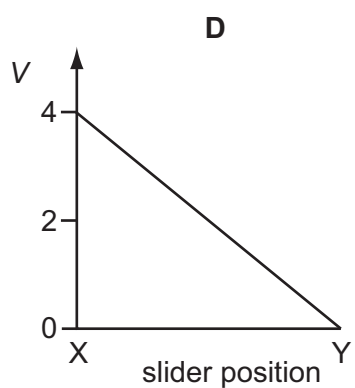
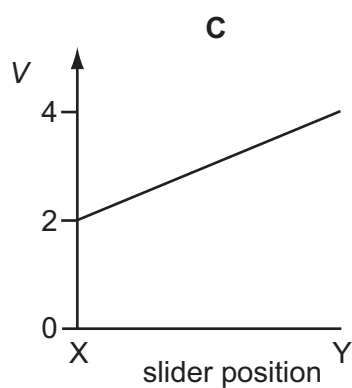
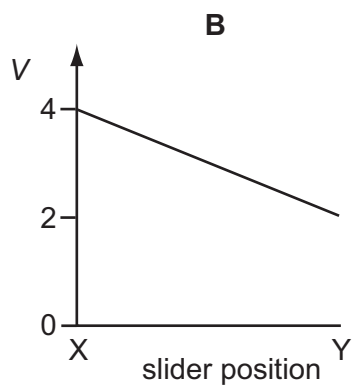
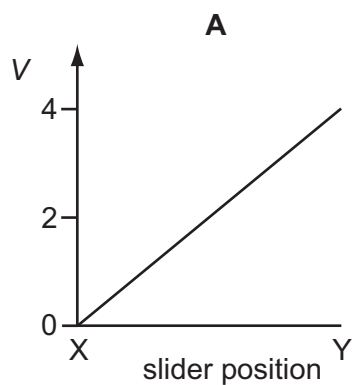
Space for working

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



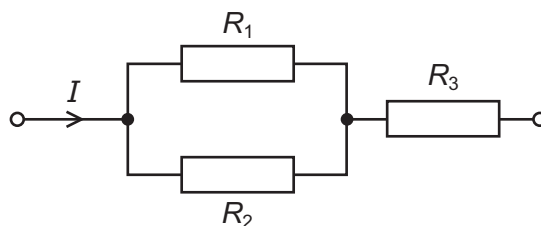
The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph is obtained?



Space for working

37 The diagram shows a resistor network. The potential difference across the network is V .



Is the equation shown below correct for the network?

$$V = I(1/R_1 + 1/R_2 + R_3)$$

- A** Yes, it correctly combines two series resistors with one parallel resistor, and correctly uses Ohm's Law.
- B** Yes, it correctly combines two parallel resistors with one series resistor, and correctly uses Ohm's Law.
- C** No, because it should read $V = I \div (1/R_1 + 1/R_2 + R_3)$.
- D** No, because the terms $1/R_2$ and R_3 have different units and cannot be added.

Space for working

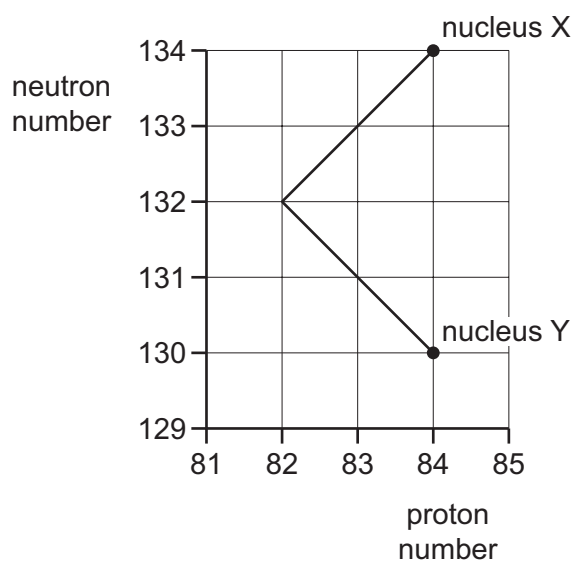
- 38** A nuclear isotope emits radiation which is detected by a Geiger-Müller tube held at a distance of about 10 cm from the radioactive source. The radiation is stopped completely by a 2 mm thick sheet of lead.

What can be deduced from this information about the emission from the isotope?

- A** It could be alpha and beta radiation, but not gamma radiation.
 - B** It could be alpha and gamma radiation, but not beta radiation.
 - C** It could be beta and gamma radiation, but not alpha radiation.
 - D** It could be alpha, beta and gamma radiation.
- 39** What remains constant during β -emission from a number of identical nuclei in a substance?
- A** energy of the β -particles
 - B** neutron number of the nuclei
 - C** nucleon number of the nuclei
 - D** proton number of the nuclei

Space for working

- 40 The graph of neutron number against proton number represents a sequence of radioactive decays.



Nucleus X is at the start of the sequence and, after the decays have occurred, nucleus Y is formed.

What is emitted during the sequence of decays?

- A one α -particle followed by one β -particle
- B one α -particle followed by two β -particles
- C two α -particles followed by two β -particles
- D two β -particles followed by one α -particle

Space for working

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