Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/11**

Paper 1 Multiple Choice **May/June 2015**

1 hour

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

* 9 7 0 4 7 0 5 2 2 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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

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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, $\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$

$\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$

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, $m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$

rest mass of proton, $m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$

molar gas constant, $R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$

the Avogadro constant, $N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$

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, $g = 9.81\,\text{m s}^{-2}$

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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, $V = \frac{Q}{4\pi\varepsilon_0 r}$

capacitors in series, $1/C = 1/C_1 + 1/C_2 + \ldots$

capacitors in parallel, $C = C_1 + C_2 + \ldots$

energy of charged capacitor, $W = \frac{1}{2}QV$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

alternating current/voltage, $x = x_0 \sin \omega t$

radioactive decay, $x = x_0 \exp(-\lambda t)$

decay constant, $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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1 Which is an SI base unit?

A current

B gram

C kelvin

D volt

2 Which pair contains one vector and one scalar quantity?

A	displacement	acceleration
B	force	kinetic energy
C	momentum	velocity
D	power	speed

3 When a constant braking force is applied to a vehicle moving at speed v, the distance d moved by the vehicle in coming to rest is given by the expression

$$d = kv^2$$

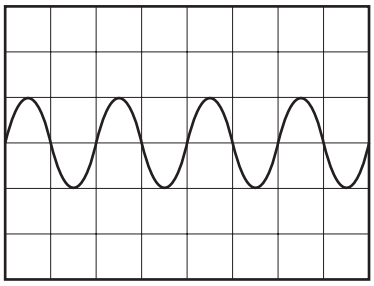
where k is a constant.

When d is measured in metres and v is measured in metres per second, the constant has a value of k_1.

What is the value of the constant when the distance is measured in metres, and the speed is measured in kilometres per hour?

A $0.0772\,k_1$ **B** $0.278\,k_1$ **C** $3.60\,k_1$ **D** $13.0\,k_1$

4 A whale produces sound waves of frequency 5 Hz. The waves are detected by a microphone and displayed on an oscilloscope.



What is the time-base setting on the oscilloscope?

A $0.1\,\text{ms div}^{-1}$ **B** $1\,\text{ms div}^{-1}$ **C** $10\,\text{ms div}^{-1}$ **D** $100\,\text{ms div}^{-1}$

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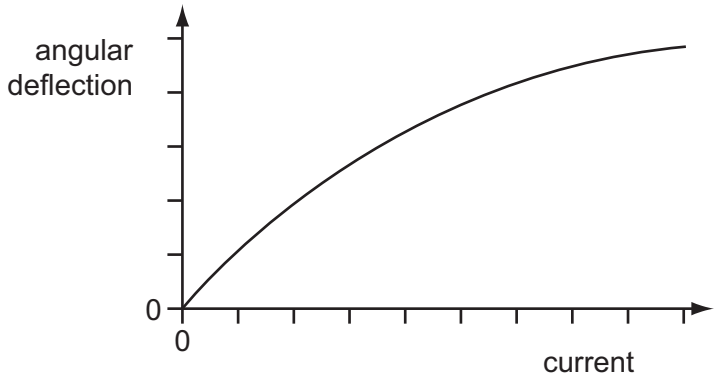
5 The angular deflection of the needle of an ammeter varies with the current in the ammeter as shown in the graph.



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

A



B



C



D



6 The strain energy W of a spring is determined from its spring constant k and extension x. The spring obeys Hooke's law and the value of W is calculated using the equation shown.

$$W = \tfrac{1}{2} kx^2$$

The spring constant is $100 \pm 2\,\text{N m}^{-1}$ and the extension is $0.050 \pm 0.002\,\text{m}$.

What is the percentage uncertainty in the calculated value of W?

A 6% **B** 10% **C** 16% **D** 32%

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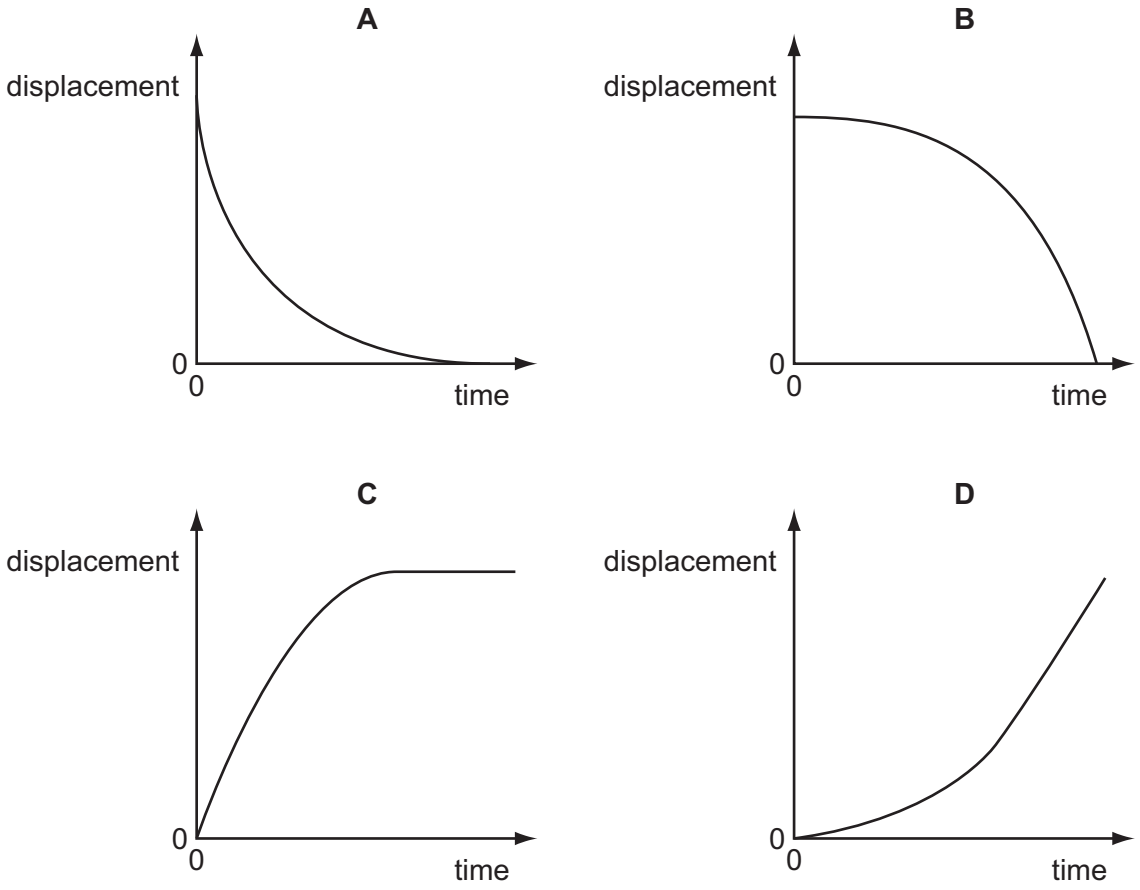
7 A sphere is released and falls. Its initial acceleration reduces until it eventually begins to travel at constant terminal velocity. Which displacement-time graph best represents the motion of the sphere?



8 An insect jumps with an initial vertical velocity of $1.0\,\text{m s}^{-1}$, reaching a maximum height of $3.5 \times 10^{-2}\,\text{m}$. Assume the deceleration is uniform.

What is the magnitude of the deceleration?

A $3.6\,\text{m s}^{-2}$ **B** $9.8\,\text{m s}^{-2}$ **C** $14\,\text{m s}^{-2}$ **D** $29\,\text{m s}^{-2}$

9 A body having uniform acceleration a increases its velocity from u to v in time t.

Which expression would **not** give a correct value for the body's displacement during time t?

A $ut + \frac{1}{2}at^2$

B $vt - \frac{1}{2}at^2$

C $\dfrac{(v+u)(v-u)}{2a}$

D $\dfrac{(v-u)t}{2}$

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10 What is a reasonable estimate of the average gravitational force acting on a fully grown woman standing on the Earth?

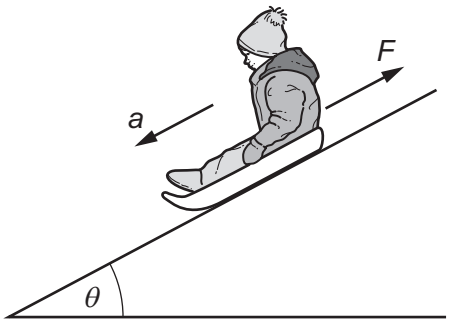
A 60 N **B** 250 N **C** 350 N **D** 650 N

11 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 momentum and in the kinetic energy 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

12 A child on a sledge slides down a hill with acceleration a. The hill makes an angle θ with the horizontal.



The total mass of the child and the sledge is m. The acceleration of free fall is g.

What is the friction force F?

A $m(g\cos\theta - a)$

B $m(g\cos\theta + a)$

C $m(g\sin\theta - a)$

D $m(g\sin\theta + a)$

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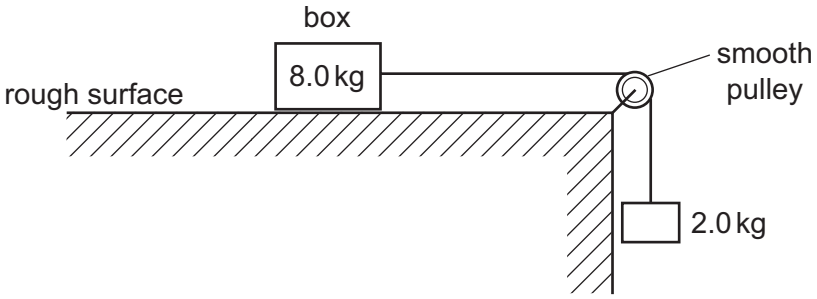
13 A box of mass 8.0 kg rests on a horizontal rough surface. A string attached to the box passes over a smooth pulley and supports a 2.0 kg mass at its other end.



When the box is released, a frictional force of 6.0 N acts on it.

What is the acceleration of the box?

A $1.4\,m\,s^{-2}$ **B** $1.7\,m\,s^{-2}$ **C** $2.0\,m\,s^{-2}$ **D** $2.6\,m\,s^{-2}$

14 What is the **definition** of the force on a body?

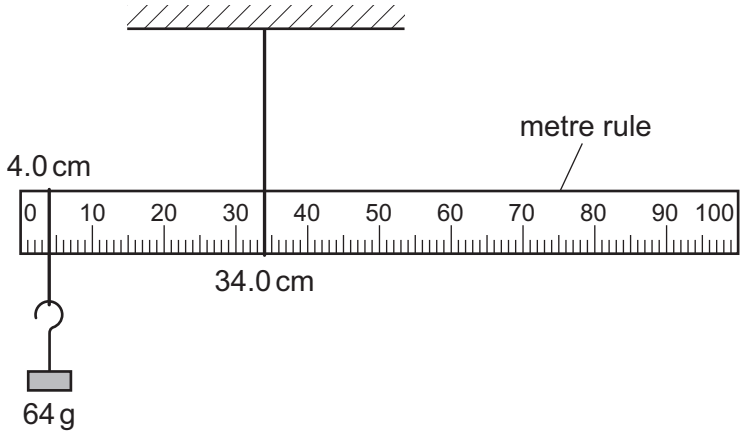
A the mass of the body multiplied by its acceleration

B the power input to the body divided by its velocity

C the rate of change of momentum of the body

D the work done on the body divided by its displacement

15 A uniform metre rule is pivoted at the 34.0 cm mark, as shown.



The rule balances when a 64 g mass is hung from the 4.0 cm mark.

What is the mass of the metre rule?

A 38 g **B** 44 g **C** 120 g **D** 136 g

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16 A team of nine dogs can pull a sledge with a combined force of 800 N at a speed of $1.5\,m\,s^{-1}$ for 360 minutes.

What is the average work done by each dog during this time?

A 4.8×10^4 J **B** 4.3×10^5 J **C** 2.9×10^6 J **D** 2.6×10^7 J

17 Which statement is correct?

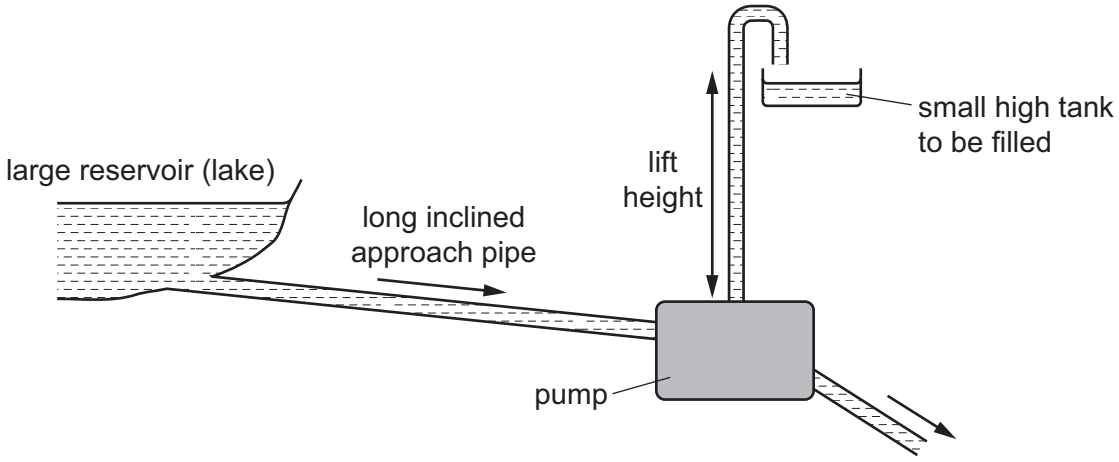
A A ball lands on the ground and bounces. The kinetic energy changes sign, because the ball changes direction.

B A car drives up a slope at a steady speed. The power generated by the engine equals the potential energy gained per unit time.

C An electric heater can be 100% efficient.

D It is impossible for momentum to be conserved in a collision.

18 The diagram shows a pump called a hydraulic ram.



In one such pump the long approach pipe holds 500 kg of water. A valve shuts when the speed of this water reaches $2.0\,m\,s^{-1}$ and the kinetic energy of this water is used to lift a small quantity of water by a height of 15 m.

The efficiency of the pump is 10%.

Which mass of water could be lifted 15 m?

A 0.15 kg **B** 0.68 kg **C** 1.5 kg **D** 6.8 kg

19 A conveyor belt is driven at velocity v by a motor. Sand drops vertically on to the belt at a rate of $m\,kg\,s^{-1}$.

What is the additional power needed to keep the conveyor belt moving at a steady speed when the sand starts to fall on it?

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

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20 Descriptions of three different types of material are listed.

1 a polycrystalline material made up of large numbers of small crystals

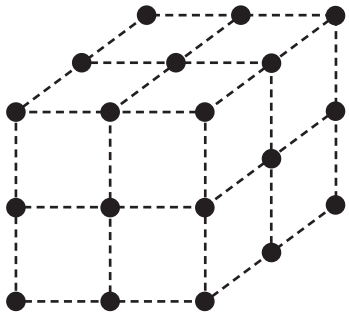
2 an amorphous material with little or no ordered arrangement of molecules

3 a polymeric material consisting of long chains of molecules

Which row correctly matches the descriptions to nylon, copper and glass?

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

21 The diagram shows the arrangement of atoms in a particular crystal.



Each atom is at the corner of a cube.

The mass of each atom is 3.5×10^{-25} kg. The density of the crystal is 9.2×10^{3} kg m^{-3}.

What is the shortest distance between the centres of two adjacent atoms?

A 3.8×10^{-29} m

B 6.2×10^{-15} m

C 3.4×10^{-10} m

D 3.0×10^{-9} m

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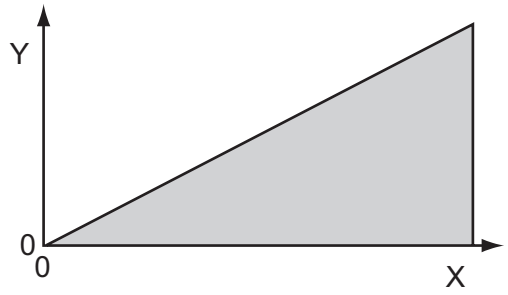
22 The graph shown was plotted in an experiment on a metal wire.

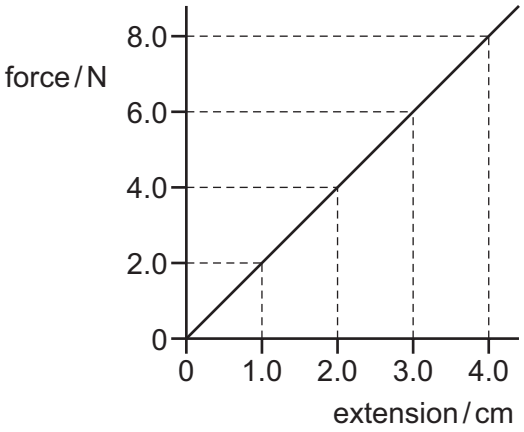


The shaded area represents the total strain energy stored in stretching the wire.

How should the axes be labelled?

	Y	X
A	force	extension
B	mass	extension
C	strain	energy
D	stress	strain

23 The variation with applied force of the extension of a spring is shown in the graph.



When there is no force applied to the spring, it has a length of 1.0 cm.

What is the **increase** in the strain energy stored in the spring when its **length** is increased from 2.0 cm to 3.0 cm?

A 0.020 J **B** 0.030 J **C** 0.040 J **D** 0.050 J

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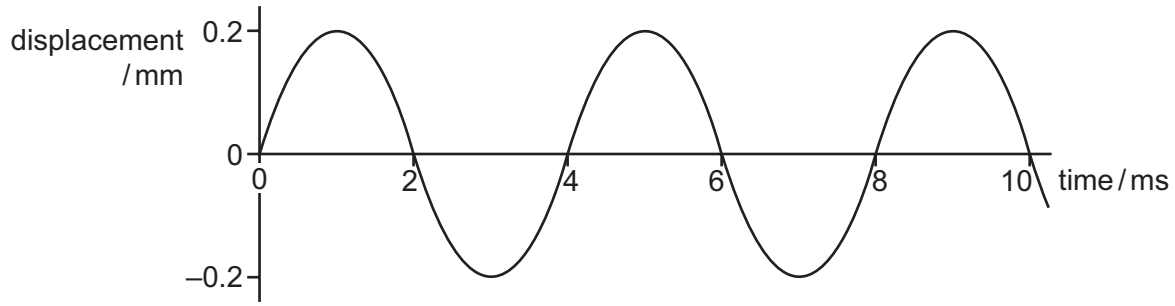
24 A sound wave moves with a speed of $320\,m\,s^{-1}$ through air. The variation with time of the displacement of an air particle due to this wave is shown in the graph.



Which statement about the sound wave is correct?

A The frequency of the wave is 500 Hz.

B The graph shows that sound is a transverse wave.

C The intensity of the wave will be doubled if its amplitude is increased to 0.4 mm.

D The wavelength of the sound wave is 1.28 m.

25 A wave of frequency 15 Hz travels at $24\,m\,s^{-1}$ through a medium.

What is the phase difference between two points 2 m apart?

A There is no phase difference.

B They are out of phase by a quarter of a cycle.

C They are out of phase by half a cycle.

D They are out of phase by 0.8 of a cycle.

26 A wave of amplitude *a* has an intensity of $3.0\,W\,m^{-2}$.

What is the intensity of a wave of the same frequency that has an amplitude 2*a*?

A $4.2\,W\,m^{-2}$ **B** $6.0\,W\,m^{-2}$ **C** $9.0\,W\,m^{-2}$ **D** $12\,W\,m^{-2}$

27 An electromagnetic wave has a wavelength that is numerically of the same order of magnitude as the diameter of a nucleus.

In which region of the electromagnetic spectrum does the wave occur?

A gamma ray

B X-ray

C visible light

D infra-red

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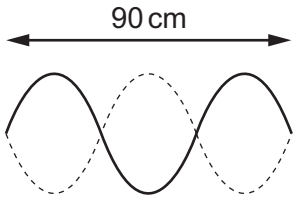
28 The diagram shows a stationary wave on a string at two instants of maximum vertical displacement.

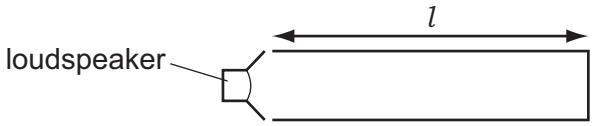


The frequency of the wave is 12 Hz.

What is the speed of the wave?

A $3.6\,m\,s^{-1}$ **B** $7.2\,m\,s^{-1}$ **C** $360\,m\,s^{-1}$ **D** $720\,m\,s^{-1}$

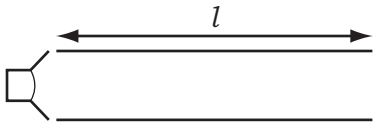
29 A loudspeaker emitting sound of frequency *f* is placed at the open end of a pipe of length l which is closed at the other end. A standing wave is set up in the pipe.



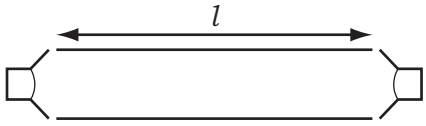
A series of pipes are then set up with either one or two loudspeakers of frequency *f*. The pairs of loudspeakers vibrate in phase with each other.

Which pipe contains a standing wave?

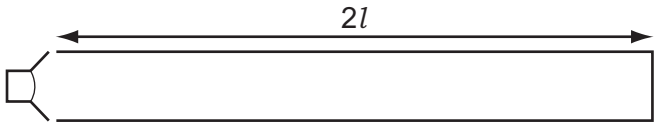
A



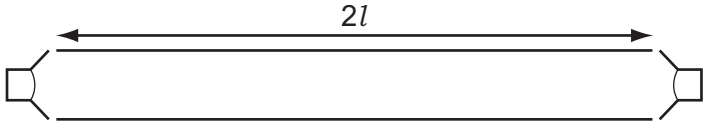
B



C



D



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30 In a double-slit experiment the distance between the fringes, on a screen, was too small to measure.

What would increase the distance between the fringes?

A increasing the distance between the light source and the slits

B increasing the distance between the slits and the screen

C increasing the distance between the slits

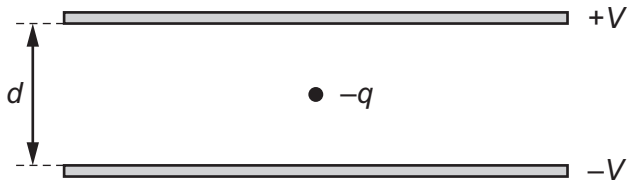
D increasing the frequency of the light source

31 Two parallel metal plates, a distance of 2 mm apart, have a potential difference of 1000 V across them.

What is the electric field strength between the plates?

A $500\,\text{V m}^{-1}$ **B** $50\,000\,\text{V m}^{-1}$ **C** $50\,000\,\text{N C}^{-1}$ **D** $500\,000\,\text{N C}^{-1}$

32 An oil droplet has charge $-q$ and is situated between two horizontal metal plates as shown in the diagram.



The separation of the plates is d. The droplet is observed to be stationary when the upper plate is at potential $+V$ and the lower plate is at potential $-V$.

For this to occur, what is the weight of the droplet?

A $\frac{Vq}{d}$ **B** $\frac{2Vq}{d}$ **C** $\frac{Vd}{q}$ **D** $\frac{2Vd}{q}$

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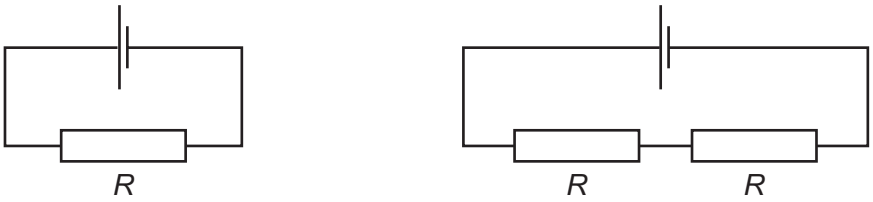
33 The diagrams show two different circuits.



The cells in each circuit have the same electromotive force and zero internal resistance. The three resistors each have the same resistance R.

In the circuit on the left, the power dissipated in the resistor is P.

What is the total power dissipated in the circuit on the right?

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

34 Which equation that links some of the following terms is correct?

potential difference (p.d.)	V
current	I
resistance	R
charge	Q
energy	E
power	P
time	t

A $P = \frac{Q^2R}{t}$

B $ER^2 = V^2t$

C $\frac{VI}{P} = t$

D $PQ = EI$

35 The charge that an electric battery can deliver is specified in ampere-hours.

For example, a battery of capacity 40 ampere-hours could supply, when fully charged, 0.2 A for 200 hours.

What is the maximum energy that a fully charged 12 V, 40 ampere-hour battery could supply?

A 1.7 kJ **B** 29 kJ **C** 1.7 MJ **D** 29 MJ

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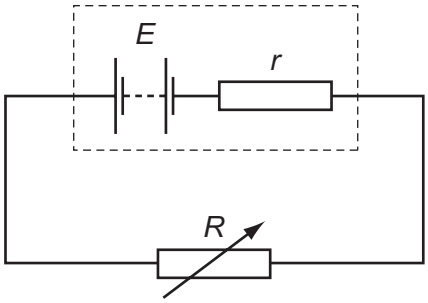
36 A battery with e.m.f. E and internal resistance r is connected in series with a variable external resistor.



The value of the external resistance R is slowly increased from zero.

Which statement is correct? (Ignore any temperature effects.)

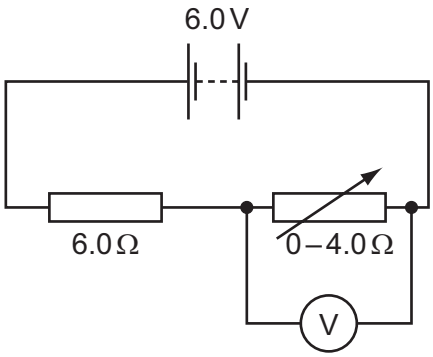
A The potential difference across the external resistance decreases.

B The potential difference across the internal resistance increases.

C The power dissipated in r increases and then decreases.

D The power dissipated in R increases and then decreases.

37 A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected in series with a resistor of resistance 6.0 Ω and a variable resistor of resistance from zero to 4.0 Ω. A voltmeter is connected across the variable resistor. The resistance of the variable resistor is changed.



What is the range of the voltmeter reading?

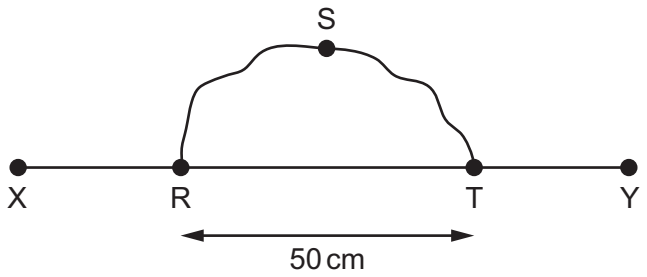
A 0 V – 2.4 V

B 0 V – 3.6 V

C 2.4 V – 6.0 V

D 3.6 V – 6.0 V

38 A wire RST is connected to another wire XY as shown.



Each wire is 100 cm long with a resistance per unit length of $10\,\Omega\,m^{-1}$.

What is the total resistance between X and Y?

A $3.3\,\Omega$ **B** $5.0\,\Omega$ **C** $8.3\,\Omega$ **D** $13.3\,\Omega$

39 When α-particles are directed at gold leaf

1 almost all α-particles pass through without deflection,

2 a few α-particles are deviated through large angles.

What are the reasons for these effects?

	1	2
A	most α-particles have enough energy to pass right through the gold leaf	gold is very dense so a few low energy α-particles bounce back from the gold surface
B	most α-particles miss all gold atoms	a few α-particles bounce off gold atoms
C	the gold nucleus is very small so most α-particles miss all nuclei	occasionally the path of an α-particle is close to a nucleus
D	the positive charge in an atom is not concentrated enough to deflect an α-particle	occasionally an α-particle experiences many small deflections in the same direction

40 The nuclide $^{222}_{86}Rn$ decays in a sequence of stages to form the nuclide $^{206}_{82}Pb$.

Four of the nuclides formed in the sequence are α-particle emitters. The others are β-particle emitters.

How many nuclides formed in the decay sequence are β-particle emitters?

A 2 **B** 4 **C** 8 **D** 12

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