Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/12**

Paper 1 Multiple Choice **February/March 2020**

1 hour 15 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- Any rough working should be done on this question paper.

This document has **20** pages. Blank pages are indicated.

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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 unit	$1\,\text{u} = 1.66 \times 10^{-27}\,\text{kg}$
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.	$v = v_0 \cos \omega t$ $v = \pm\omega\sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
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	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{ntq}$
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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[Turn over

1 The table shows some measurable quantities.

Which row gives the correct order of magnitude of the measurable quantity in the stated unit?

	measurable quantity	order of magnitude	unit
A	mass of a coin	10^{-4}	kg
B	thickness of a sheet of paper	10^{-2}	m
C	weight of an apple	10^{0}	N
D	temperature of a person's body	10^{1}	K

2 A byte (b) comprises 8 bits.

How many bits are there in 1 terabyte (1Tb)?

A 1×10^{9} **B** 8×10^{9} **C** 1×10^{12} **D** 8×10^{12}

3 Which pair of quantities contains both a scalar **and** a vector?

A acceleration and momentum

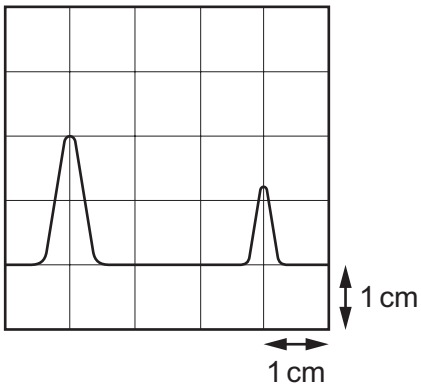
B charge and resistance

C kinetic energy and mass

D temperature and velocity

4 A transmitter emits a pulse of electromagnetic waves towards a reflector. The pulse is reflected and returns to the transmitter.

A detector is located at the transmitter. The emitted pulse and the reflected pulse are displayed on a cathode-ray oscilloscope (CRO) as shown.



The pulse takes 6.3 μs to travel from the transmitter to the reflector.

What is the time-base setting of the CRO?

A $2.1\,\mu s\,cm^{-1}$ **B** $3.2\,\mu s\,cm^{-1}$ **C** $4.2\,\mu s\,cm^{-1}$ **D** $6.3\,\mu s\,cm^{-1}$

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5 A micrometer is used to measure the diameters of two cylinders.

diameter of first cylinder = (12.78 ± 0.02) mm

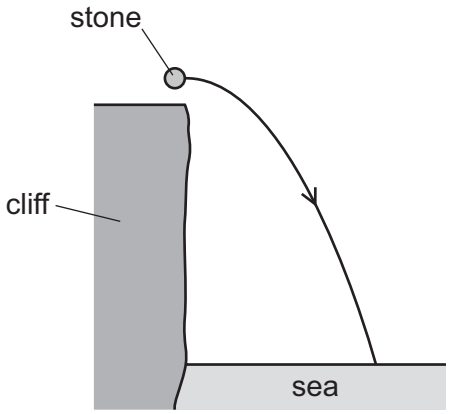
diameter of second cylinder = (16.24 ± 0.03) mm

The difference in the diameters is calculated.

What is the uncertainty in this difference?

A 0.01 mm **B** 0.02 mm **C** 0.03 mm **D** 0.05 mm

6 A stone is thrown horizontally from the top of a cliff and falls into the sea below. Air resistance is negligible. The path of the stone is shown.



In which direction does the resultant force on the stone act during its fall?

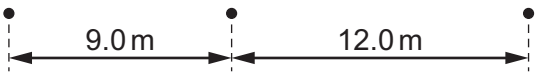
A horizontally to the right

B parallel to its velocity

C perpendicular to its velocity

D vertically downwards

7 A car moves with uniform acceleration along a straight road. Oil leaks from the car at the rate of one drop every two seconds. The diagram shows the distances between three successive oil drops on the road.



What is the acceleration of the car?

A $0.75\,m\,s^{-2}$ **B** $1.5\,m\,s^{-2}$ **C** $3.0\,m\,s^{-2}$ **D** $6.0\,m\,s^{-2}$

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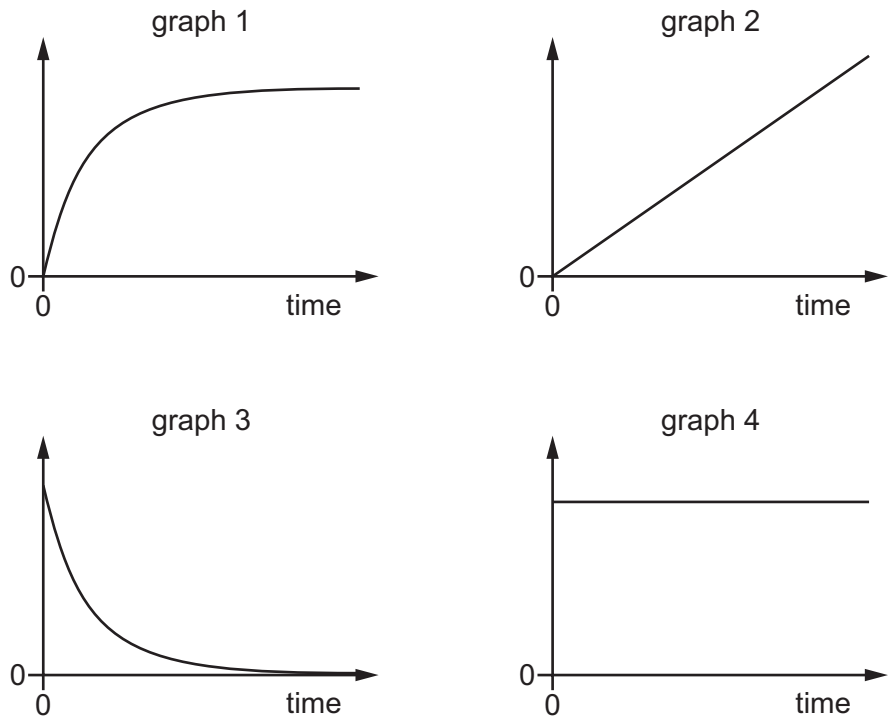
8 A person of mass 60 kg stands on accurate bathroom scales, placed on the floor of an elevator (lift) which operates in a tall building.

At a certain instant the bathroom scales read 58 kg.

Which row could give the person's direction of movement and type of motion?

	direction	motion
A	downwards	constant speed
B	downwards	slowing down
C	upwards	constant speed
D	upwards	slowing down

9 The diagram shows graphs of various quantities plotted against time for an object dropped from a stationary balloon high in the atmosphere.



Which statement could be correct?

A Graph 1 is acceleration against time and graph 3 is resultant force against time.

B Graph 1 is acceleration against time and graph 4 is resultant force against time.

C Graph 3 is acceleration against time and graph 1 is velocity against time.

D Graph 3 is acceleration against time and graph 2 is velocity against time.

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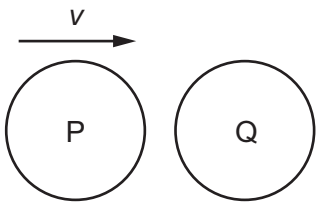
10 The diagram shows a particle P, travelling at speed v, about to collide with a stationary particle Q of the same mass. The collision is perfectly elastic.



Which statement describes the motion of P and of Q immediately after the collision?

A P and Q both travel in the same direction with speed $\frac{1}{2}v$.

B P comes to rest and Q acquires speed v.

C P rebounds with speed $\frac{1}{2}v$ and Q acquires speed $\frac{1}{2}v$.

D P rebounds with speed v and Q remains stationary.

11 A particle is in a uniform field. The particle experiences a force in the opposite direction to the field.

In which type of field is the particle, and on which property of the particle is the field acting?

	type of field	property of particle on which the field acts
A	electric	charge
B	electric	current
C	gravitational	mass
D	gravitational	weight

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12 A uniform rod of weight 20 N and length 2.0 m is acted upon by two vertical forces, as shown.



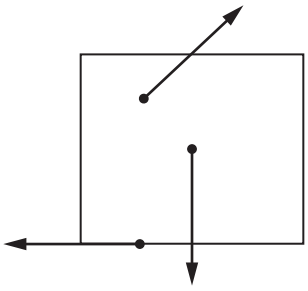
What are the resultant force acting on the rod and the resultant moment about the centre of gravity of the rod?

	resultant force / N	resultant moment / N m
A	0	10
B	0	20
C	20	10
D	20	20

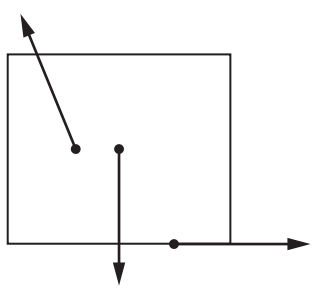
13 Three coplanar forces act on a block.

Which diagram shows the directions of the forces such that the block could be in equilibrium?

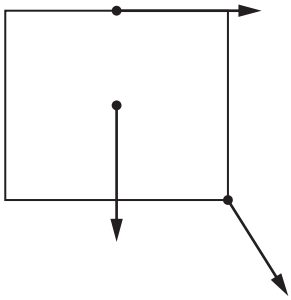
A



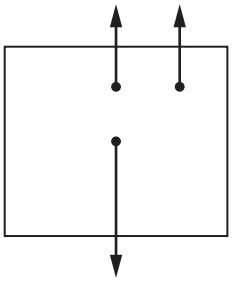
B



C



D



14 A cylinder contains a volume of $0.012\,m^3$ of gas at a pressure of $1.0 \times 10^5\,Pa$.

400 J of work is done **on** this gas, with its pressure remaining constant throughout.

What is the final volume of the gas?

A $0.0040\,m^3$ **B** $0.0080\,m^3$ **C** $0.016\,m^3$ **D** $0.020\,m^3$

15 A ball is thrown vertically upwards from the surface of the Earth.

Which statement describes the energy of the ball as it rises through the air?

A The kinetic energy of the ball decreases as the gravitational potential energy decreases.

B The kinetic energy of the ball decreases as the gravitational potential energy increases.

C The kinetic energy of the ball increases as the gravitational potential energy decreases.

D The total energy of the ball increases.

16 A sledge of mass 50 kg sits on a snowy surface. It is pulled horizontally for 10 m against a frictional force of 200 N, then it is pulled horizontally across ice for 10 m. There is no friction between the ice and the sledge. It is lifted up vertically by 1 m and finally carried back at a constant speed to where it started.

During which stage of its journey is most work done on the sledge?

A being carried back 20 m at constant speed

B being lifted up 1 m

C being pulled 10 m across ice

D being pulled 10 m across snow

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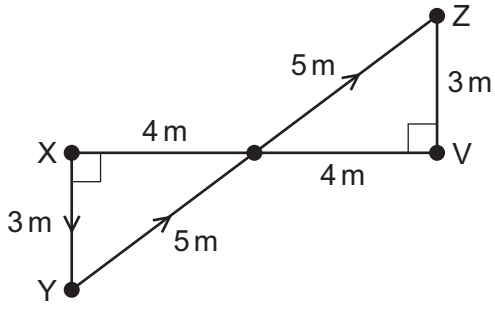
17 An object is moved in a vertical plane from X to Y, and then from Y to Z, as shown in the diagram.



The distances between various points are indicated on the diagram.

Lines XY and VZ are vertical.

The object weighs 20 N.

How much gravitational potential energy does the object gain by moving from X to Z?

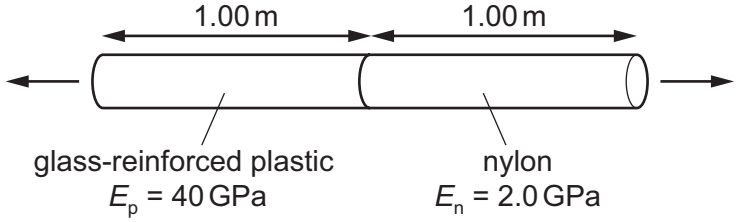
A 60 J **B** 120 J **C** 140 J **D** 260 J

18 A car travels at a constant speed of 25 m s^{-1} up a slope. The wheels driven by the engine exert a forward force of 3000 N. The total force due to air resistance and friction is 2100 N. The weight of the car has a component down the slope of 900 N.

What is the rate at which thermal energy is dissipated?

A zero **B** 2.3×10^4 W **C** 5.3×10^4 W **D** 7.5×10^4 W

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



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

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

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

A 2.9×10^6 Pa

B 5.7×10^6 Pa

C 2.9×10^9 Pa

D 5.7×10^9 Pa

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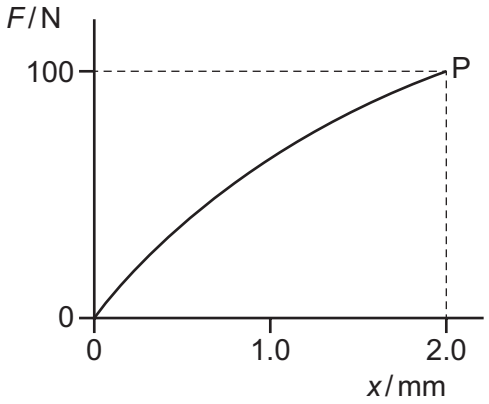
20 The graph shows the non-linear force–extension curve for a wire made from a new composite material.



What is the best estimate of the work done in stretching the wire to point P?

A 0.09 J **B** 0.10 J **C** 0.11 J **D** 0.20 J

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

What is the phase difference between two points 2.0 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 0.80 of a cycle.

22 Which row describes a longitudinal wave and a medium through which it can travel?

	direction of oscillation of the medium compared with the direction of propagation of wave energy	medium
A	parallel	air
B	parallel	vacuum
C	perpendicular	air
D	perpendicular	vacuum

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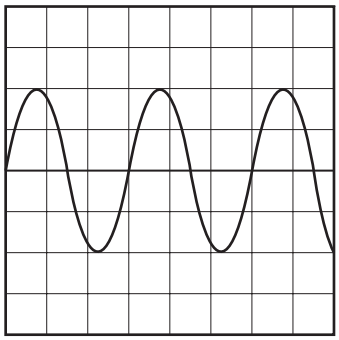
23 A sound wave is displayed on the screen of a cathode-ray oscilloscope, as shown.



The time-base setting is 0.50 ms per division.

What is the frequency of the sound wave?

A 500 Hz **B** 670 Hz **C** 1000 Hz **D** 1300 Hz

24 An observer is situated at the top of a tall tower. An aeroplane emitting sound at a frequency of 1000 Hz approaches the observer at a speed of 165 m s^{-1}.

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

What is the frequency of the sound received by the observer?

A 330 Hz **B** 667 Hz **C** 1000 Hz **D** 2000 Hz

25 What is the order of magnitude of the wavelengths of microwaves and X-rays?

	wavelength of microwaves / m	wavelength of X-rays / m
A	10^{-6}	10^{3}
B	10^{-2}	10^{3}
C	10^{-6}	10^{-10}
D	10^{-2}	10^{-10}

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26 A musical instrument is made using a long tube with a mouthpiece at one end. The other end is open and flared, as shown.



A musician maintains stationary sound waves with a node at the mouthpiece and an antinode at the other end. The lowest frequency of sound that the instrument can produce is 92 Hz.

Which different frequencies of sound can be produced by the instrument?

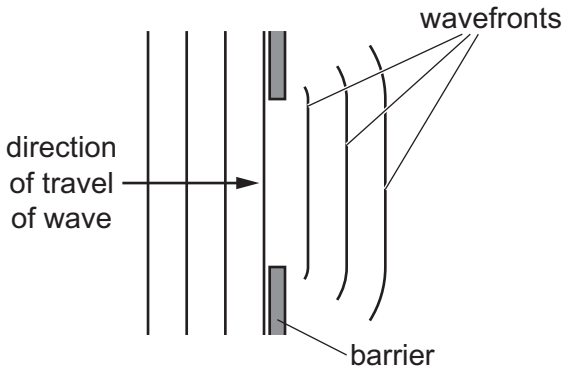
A 92 Hz, 138 Hz, 184 Hz, 230 Hz

B 92 Hz, 184 Hz, 276 Hz, 368 Hz

C 92 Hz, 276 Hz, 460 Hz, 644 Hz

D 92 Hz, 276 Hz, 828 Hz, 1288 Hz

27 A water wave passes through a gap between two barriers. The wavefronts spread out as shown.



What is the name of this phenomenon?

A coherence

B diffraction

C interference

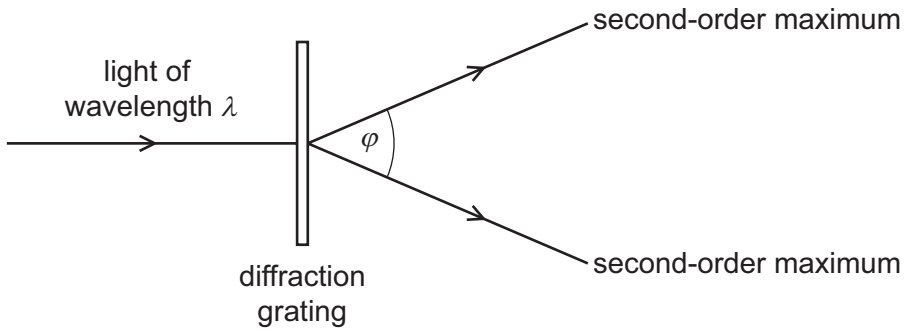
D superposition

28 The table shows four possible combinations of values for the laser wavelength, slit separation and slit-screen distance in a two-slit interference experiment to show the interference of visible light on a white screen.

Which combination will result in visible fringes being observed?

	laser wavelength / nm	slit separation / mm	slit-screen distance / m
A	200	0.10	5.0
B	200	100	1.0
C	600	0.10	5.0
D	600	100	1.0

29 Light of wavelength λ is incident normally on a diffraction grating, as shown.



The angle between the two second-order maxima is φ.

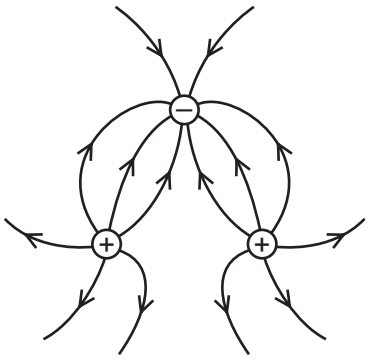
Which expression gives the spacing of the lines on the diffraction grating?

A $\dfrac{\lambda}{\sin\varphi}$ **B** $\dfrac{\lambda}{\sin(\varphi/2)}$ **C** $\dfrac{2\lambda}{\sin\varphi}$ **D** $\dfrac{2\lambda}{\sin(\varphi/2)}$

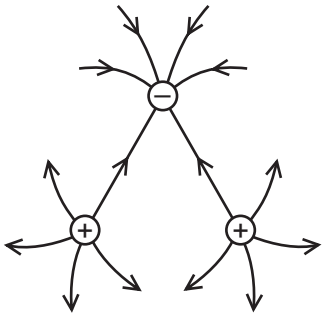
30 Two positive charges and one negative charge, all of equal magnitude, are set at the corners of an equilateral triangle.

Which diagram represents the electric field surrounding the charges?

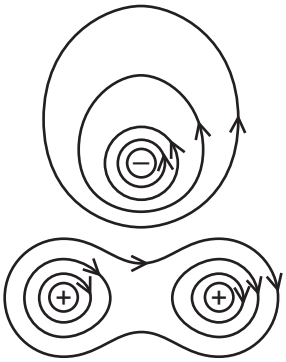
A



B



C



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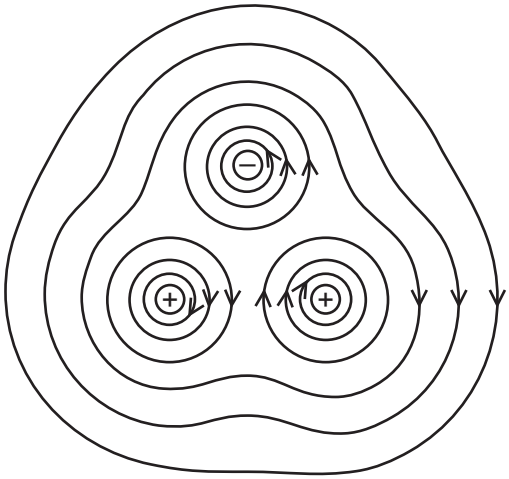
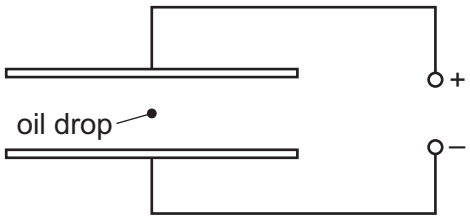


31 A negatively charged oil drop is held stationary, equidistant between two plates connected to a high voltage supply, as shown.



Which change would **not** increase the upward electrical force on the drop?

A decreasing the distance between the plates whilst keeping the drop equidistant from them

B increasing the amount of negative charge on the drop

C increasing the supply voltage

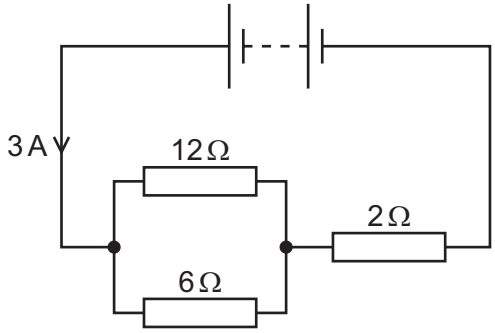
D moving the drop closer to the positive plate

32 Electrons move in a vacuum from one metal plate to another metal plate. As a result of this, there is an electric current of 48 μA between the two plates.

How many electrons are emitted by the first plate in a time of 5.0 minutes?

A 1.4×10^{4} **B** 1.5×10^{15} **C** 1.8×10^{16} **D** 9.0×10^{16}

33 A battery is connected to three resistors of resistances 12 Ω, 6 Ω and 2 Ω, as shown.



The current from the battery is 3 A.

What is the value of the ratio $\frac{\text{power dissipated in the resistor of resistance } 6\,\Omega}{\text{power dissipated in the resistor of resistance } 2\,\Omega}$?

A $\frac{1}{3}$ **B** $\frac{4}{3}$ **C** $\frac{2}{1}$ **D** $\frac{3}{1}$

34 A manufacturer recommends that the longer the extension cord you use with an electric drill, the bigger the cross-sectional area of the cord should be.

What is a reason for this recommendation?

A Resistance is inversely proportional to both the length and the cross-sectional area.

B Resistance is inversely proportional to the length and directly proportional to the cross-sectional area.

C Resistance is proportional to both the length and the cross-sectional area.

D Resistance is proportional to the length and inversely proportional to the cross-sectional area.

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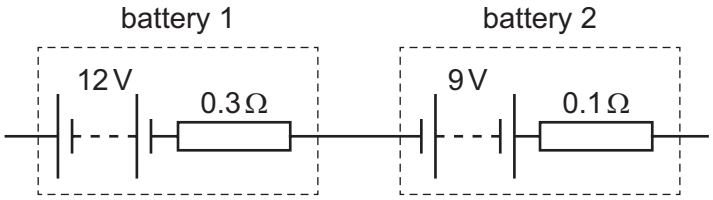
35 Two batteries are connected together, as shown.



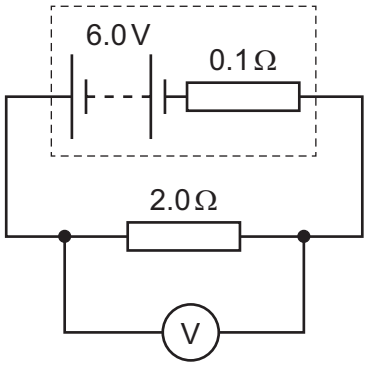
Battery 1 has electromotive force (e.m.f.) 12 V and internal resistance 0.3 Ω.

Battery 2 has e.m.f. 9 V and internal resistance 0.1 Ω.

What are the e.m.f. and the internal resistance of a single battery that has the same effect as the combination?

	e.m.f. / V	internal resistance / Ω
A	3	0.2
B	3	0.4
C	21	0.2
D	21	0.4

36 The diagram shows a circuit.



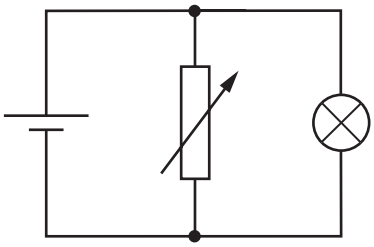
What is the reading on the voltmeter?

A 0.3 V **B** 5.7 V **C** 6.0 V **D** 6.3 V

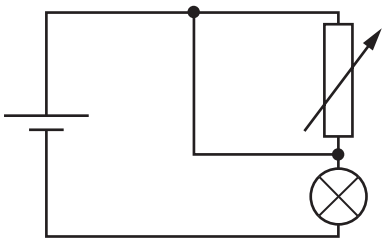
37 In the circuits shown, the cell has negligible internal resistance.

Which diagram shows a potential divider circuit that can vary the potential difference (p.d.) across the lamp?

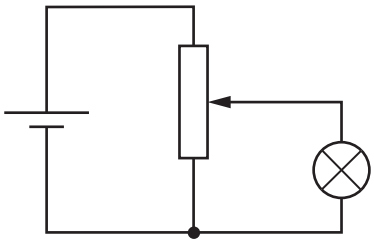
A



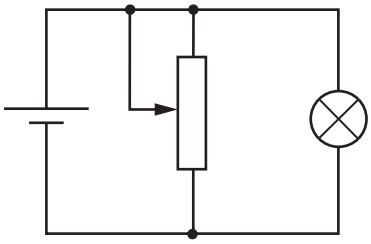
B



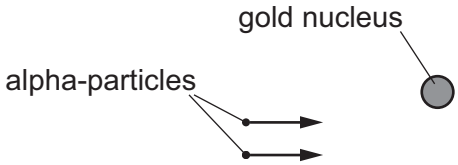
C



D

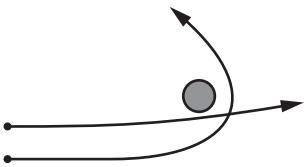


38 Two alpha-particles with the same kinetic energy are moving towards, and are then deflected by, a gold nucleus.

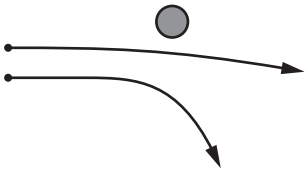


Which diagram could show the paths of the two alpha-particles?

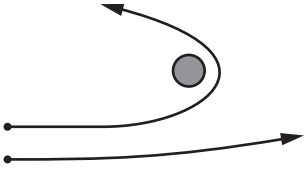
A



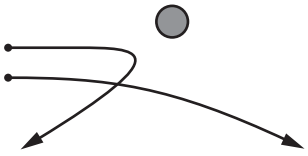
B



C



D



39 The equation represents the decay of a nucleus X to a nucleus Y.

$$^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + p + q$$

What are particles p and q?

	p	q
A	β^- particle	neutron
B	β^- particle	proton
C	β^+ particle	antineutrino
D	β^+ particle	neutrino

40 Which row gives the correct type and quark composition for the named particle?

	particle	type	quark composition
A	neutron	hadron	u u d
B	neutron	lepton	u d d
C	proton	hadron	u u d
D	proton	lepton	u d d

key

u = up quark

d = down quark

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