H2

MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE INTERNATIONAL EDUCATION
General Certificate of Education Advanced Level

**PHYSICS** **9478/01**

Paper 1 Multiple Choice **For examination from 2026**

SPECIMEN PAPER **1 hour**

You must answer on the multiple choice answer sheet.

*0123456789*

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

**INSTRUCTIONS**

- There are **thirty** 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 index number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use an approved calculator.

**INFORMATION**

- The total mark for this paper is 30.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.



Singapore Examinations and Assessment Board

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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 | $\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$ |
| | $(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9\,\text{m F}^{-1})$ |
| elementary charge | $e = 1.60 \times 10^{-19}\,\text{C}$ |
| 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 | $R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$ |
| Avogadro constant | $N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$ |
| 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 | $W = p\Delta V$ |
| pressure | $p = \frac{F}{A}$ |
| gravitational potential | $\phi = -\frac{GM}{r}$ |
| temperature | $T/\text{K} = T/\text{°C} + 273.15$ |
| pressure of an ideal gas | $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$ |
| mean translational kinetic energy of an ideal gas particle | $E = \frac{3}{2}kT$ |

| | |
|---|---|
| displacement of particle in s.h.m. | $x = x_0 \sin \omega t$ |
| velocity of particle in s.h.m. | $v = v_0 \cos \omega t = \pm \omega \sqrt{(x_0^2 - x^2)}$ |
| electric current | $I = nAvq$ |
| resistors in series | $R = R_1 + R_2 + ...$ |
| resistors in parallel | $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ |
| capacitors in series | $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + ...$ |
| capacitors in parallel | $C = C_1 + C_2 + ...$ |
| energy in a capacitor | $U = \frac{1}{2}QV = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}CV^2$ |
| charging a capacitor | $Q = Q_0\left[1 - e^{-\frac{t}{\tau}}\right]$ |
| discharging a capacitor | $Q = Q_0 e^{-\frac{t}{\tau}}$ |
| RC time constant | $\tau = RC$ |
| electric potential | $V = \frac{Q}{4\pi\varepsilon_0 r}$ |
| alternating current / voltage | $x = x_0 \sin \omega t$ |
| magnetic flux density due to a long straight wire | $B = \frac{\mu_0 I}{2\pi d}$ |
| magnetic flux density due to a flat circular coil | $B = \frac{\mu_0 NI}{2r}$ |
| magnetic flux density due to a long solenoid | $B = \mu_0 nI$ |
| energy states for quantum particle in a box | $E_n = \frac{h^2}{8mL^2}n^2$ |
| radioactive decay | $x = x_0 e^{-\lambda t}$ |
| radioactive decay constant | $\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$ |

**1** Which sequence shows the unit prefixes in order of increasing magnitude?

**A** deci, milli, centi

**B** giga, kilo, centi

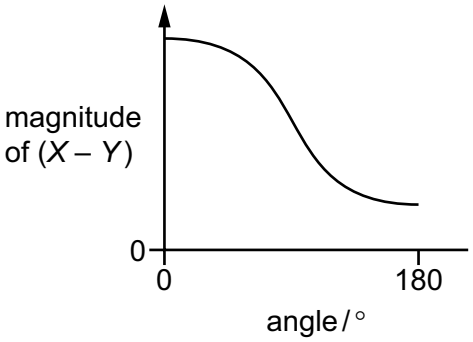
**C** micro, milli, nano

**D** nano, micro, deci

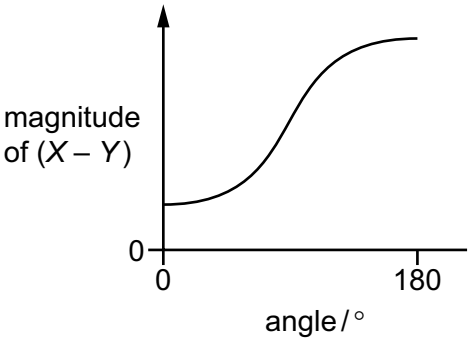
**2** *X* and *Y* are vectors. The magnitude of *X* is less than the magnitude of *Y*. The vectors are initially in opposite directions.

As *Y* is rotated through 180°, how does the magnitude of the vector (*X* – *Y*) vary?

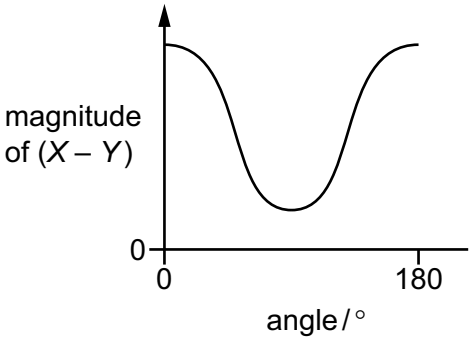
**A**



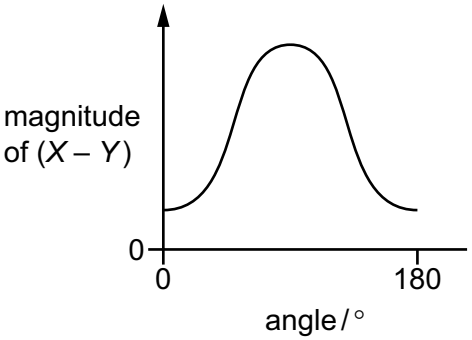

**B**




**C**

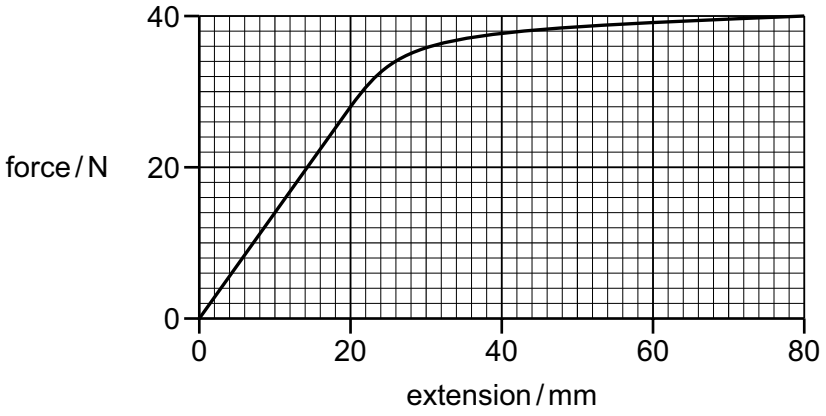



**D**



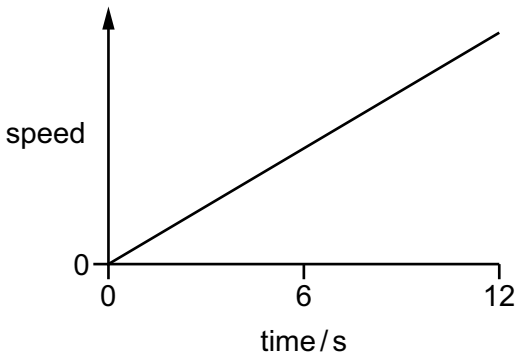
**3** A wire is stretched by an increasing force. A graph of force against extension is shown.




What is the work done in stretching the wire to the first point where it no longer obeys Hooke's Law?

**A** 0.28 J **B** 2.5 J **C** 280 J **D** 2500 J

**4** A car accelerates from rest for 12 s along a straight track. The variation with time of the speed of the car is shown.




What is the ratio $\frac{\text{distance travelled between 6 s and 12 s}}{\text{distance travelled between 0 s and 6 s}}$?

**A** 1 **B** 2 **C** 3 **D** 4

**5** A car of mass 800 kg travels at a constant speed of 20 m $s^{-1}$ along a horizontal road.

The car uses energy from its fuel to do work against a total resistive force of 400 N. The efficiency of this process is 16%.

One kilogram of fuel has an energy value of 48 MJ.

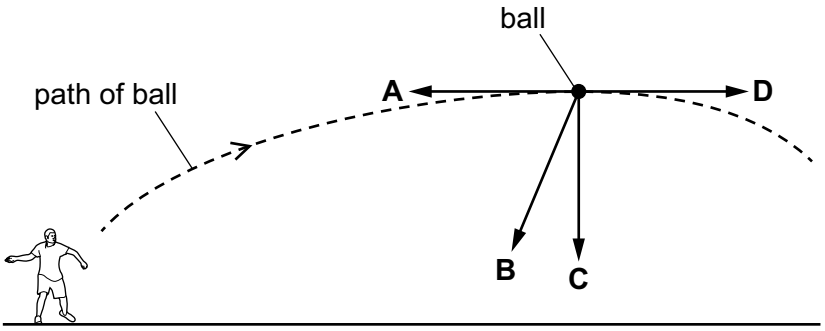
How much fuel does the car use to travel one kilometre?

**A** 52 g **B** 85 g **C** 220 g **D** 260 g

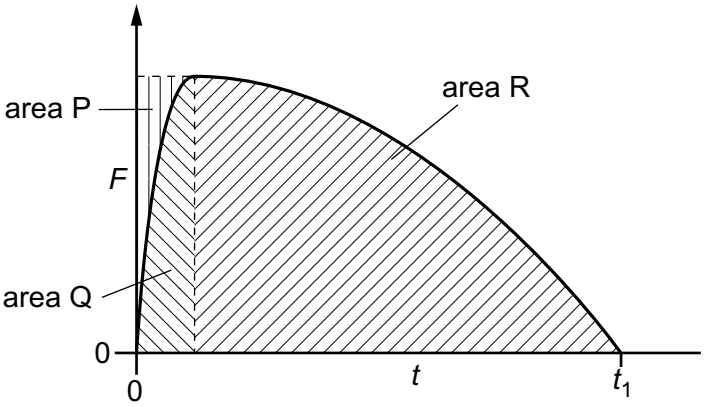
 

**6** The diagram shows a ball which has been thrown and is being acted on by air resistance.

Which labelled arrow shows the direction of the resultant force on the ball when it is at the position shown?




**7** The diagram shows the variation with time $t$ of the force $F$ acting on a tennis ball as it is hit by a tennis racket.



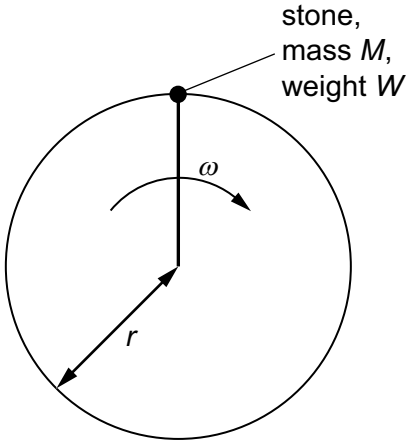

Contact between the racket and the tennis ball starts at time $t = 0$ and finishes at time $t = t_1$.

Which area on the graph represents the impulse given to the tennis ball?

**A** R – Q **B** R **C** R + Q **D** R + Q + P

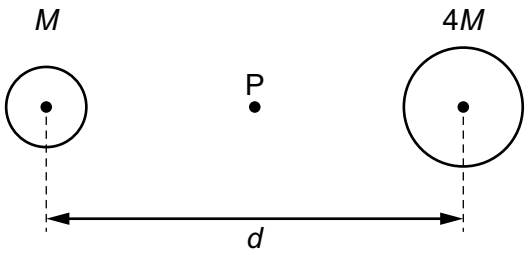
**8** A stone of mass $M$ and weight $W$ is attached to a string and is rotating in a vertical circle of radius $r$. The stone has an angular velocity $\omega$ when it is vertically above the centre of the circle.




What is the tension in the string acting downwards on the stone when the stone is vertically above the centre of the circle?

**A** $Mr\omega^2 - W$ **B** $Mr\omega^2$ **C** $W - Mr\omega^2$ **D** $W + Mr\omega^2$

**9** Two isolated stars, of mass $M$ and $4M$, are separated in space by a distance $d$ between the centres of the stars.




Point P is a point midway between the centres of the two stars.

What is the gravitational potential at P?

**A** $\frac{-4GM^2}{d}$ **B** $\frac{-6GM}{d}$ **C** $\frac{-8GM^2}{d}$ **D** $\frac{-10GM}{d}$

**10** Geostationary satellites are used for communications.

Which statement about geostationary satellites is correct?

**A** Heavier geostationary satellites are in higher orbits.

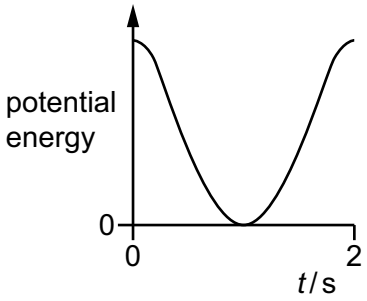
**B** Lighter geostationary satellites have shorter orbital periods.

**C** Their orbits are in the plane of the equator of the Earth.

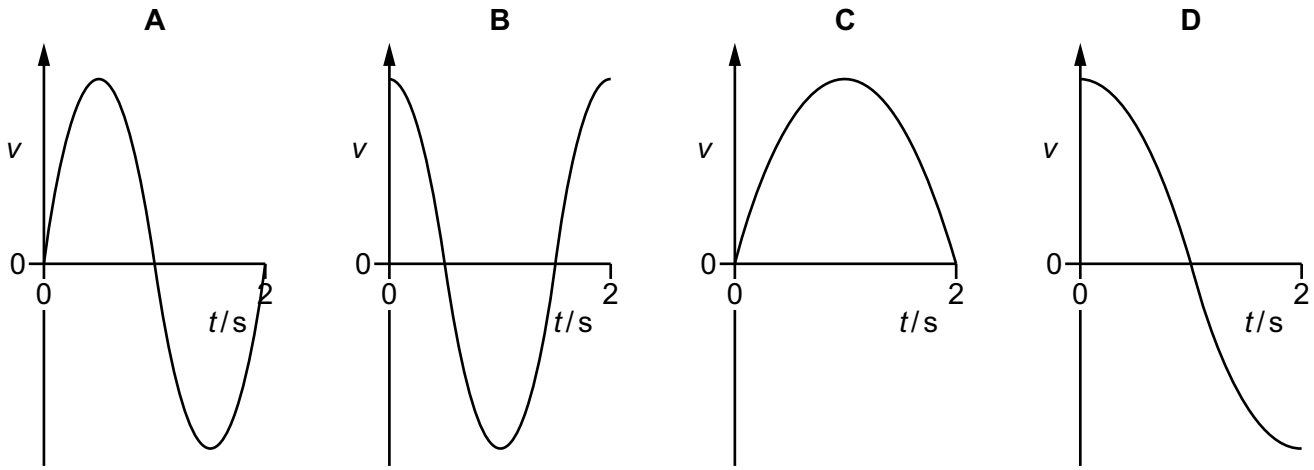
**D** Their speed is the same as the point on the Earth directly below them.

**11** A particle oscillates with simple harmonic motion. The graph shows the variation, with time $t$, of the potential energy of the particle from $t = 0$ to $t = 2\,\text{s}$.




Which graph could represent the variation, with time $t$, of the velocity $v$ of the particle from $t = 0$ to $t = 2\,\text{s}$?




**12** A beam of laser light of frequency $5.0 \times 10^{14}\,\text{Hz}$ is travelling through a vacuum.

What is the phase difference between points on the wave that are $1.5\,\mu\text{m}$ apart?

**A** $0.5\,\text{rad}$ **B** $0.5\pi\,\text{rad}$ **C** $1.0\,\text{rad}$ **D** $1.0\pi\,\text{rad}$

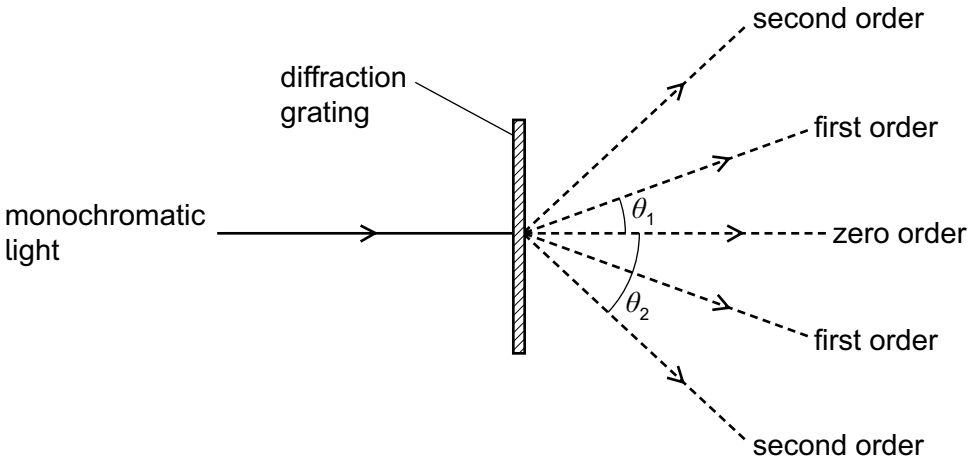
**13** A wave of frequency $f$ and wavelength $\lambda$ has intensity $I$. The wave travels through a boundary into a new medium where the speed and amplitude are both halved.

What are the intensity, frequency and wavelength in the new medium?

| | intensity | frequency | wavelength |
|---|---|---|---|
| **A** | 0.25 $I$ | 0.50 $f$ | $\lambda$ |
| **B** | 0.25 $I$ | $f$ | 0.50 $\lambda$ |
| **C** | 0.50 $I$ | 0.50 $f$ | $\lambda$ |
| **D** | 0.50 $I$ | $f$ | 0.50 $\lambda$ |

**14** Monochromatic light is incident normally on a diffraction grating. First and second order images are observed at angles of diffraction of $\theta_1$ and $\theta_2$ respectively.

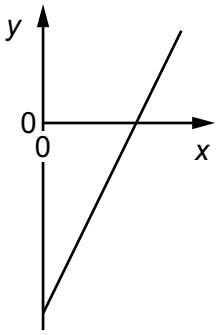
The diagram is not to scale.




What is the relation between the angles of diffraction and between the intensities of light observed in the two orders?

| | angles of diffraction | intensities |
|---|---|---|
| **A** | $2\theta_1 = \theta_2$ | first order brighter |
| **B** | $2\theta_1 = \theta_2$ | same |
| **C** | $2\theta_1 < \theta_2$ | first order brighter |
| **D** | $2\theta_1 < \theta_2$ | same |

**15** The graph shows the relationship between the volume and temperature of a fixed mass of an ideal gas at constant pressure.




What is the quantity and appropriate unit on each axis for this graph?

| | ***y*-axis** | ***x*-axis** |
|---|---|---|
| **A** | volume / $m^3$ | temperature / K |
| **B** | volume / $m^3$ | temperature / °C |
| **C** | temperature / °C | volume / $m^3$ |
| **D** | temperature / K | volume / $m^3$ |

**16** An airgun pellet, of mass $m$ and specific heat capacity $c$, hits a steel plate at speed $v$. During the impact, 50% of the pellet's kinetic energy is transferred to thermal energy in the pellet.

What is the rise in temperature of the pellet?

**A** $\frac{v^2}{2c}$ **B** $\frac{v^2}{4c}$ **C** $\frac{mv^2}{2c}$ **D** $\frac{mv^2}{4c}$

**17** The electric potential due to a point charge at distance $d$ from the point charge is $V$.

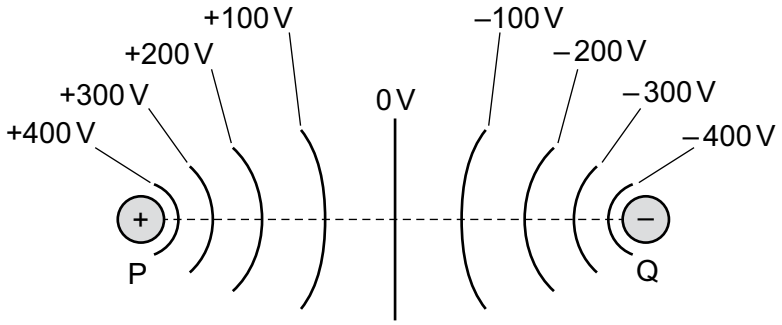
What is the electric potential at distance $\frac{d}{2}$ from the point charge?

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

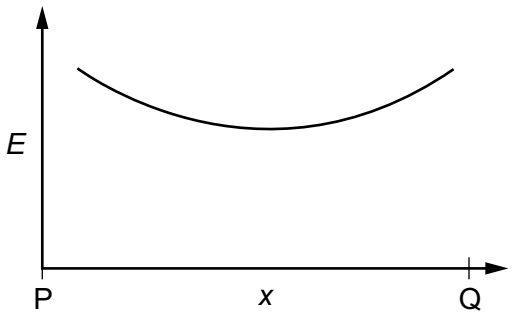
**18** An object with a positive charge is placed at P and a similar object with a negative charge is placed at Q.

The diagram shows a number of solid lines along which the potential has a constant value.

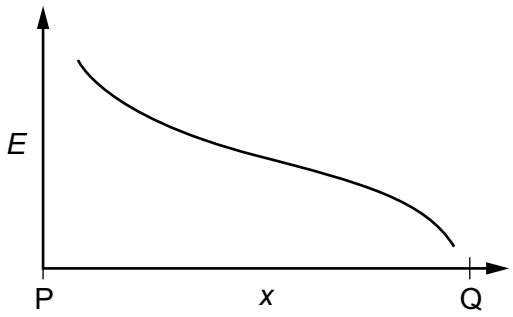



Which graph shows the variation with distance $x$ along the line PQ of the electric field strength $E$?

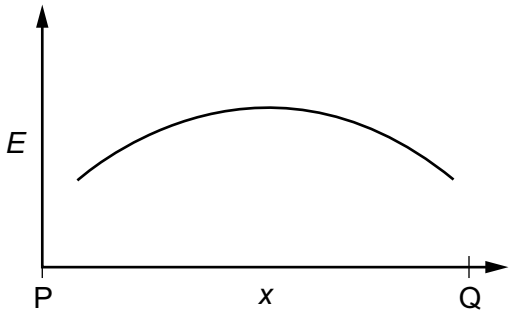
**A**



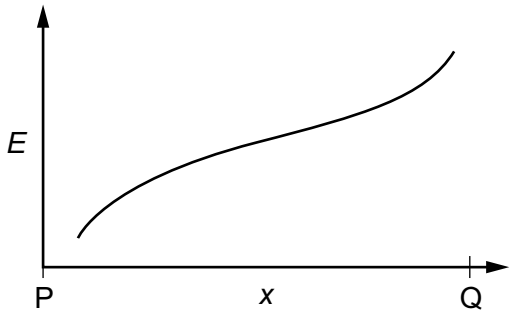

**B**




**C**




**D**



**19** A length of metal wire with a circular cross-section is connected into an electric circuit. There is a constant electric current in the wire.

Part of the wire has a diameter that increases uniformly with distance along the wire.

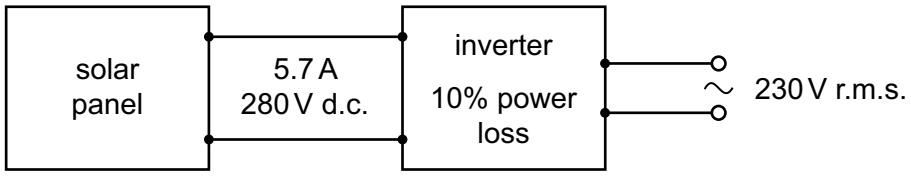

The drift velocity $v$ of the charge carriers in the wire is related by a constant $K$ to the diameter $d$ of the wire.

Which equation for $v$ is correct?

**A** $v = \frac{K}{d^2}$ **B** $v = \frac{K}{d}$ **C** $v = Kd$ **D** $v = Kd^2$

**20** The output from a solar panel is 280 V d.c., 5.7 A.

An inverter changes the d.c. output of the solar panel to alternating current at 230 V r.m.s., as illustrated.



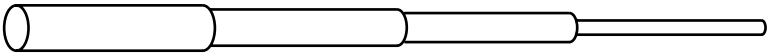

The power loss in the inverter is 10% of the input power.

What is the r.m.s. current from the inverter?

**A** 0.7 A **B** 5.1 A **C** 6.2 A **D** 6.9 A

**21** A composite wire is made by connecting in series four uniform wires made of the same material but having different diameters.

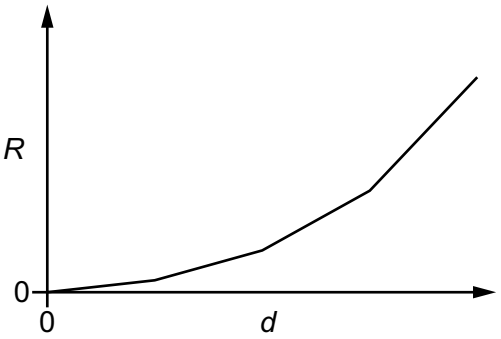


X

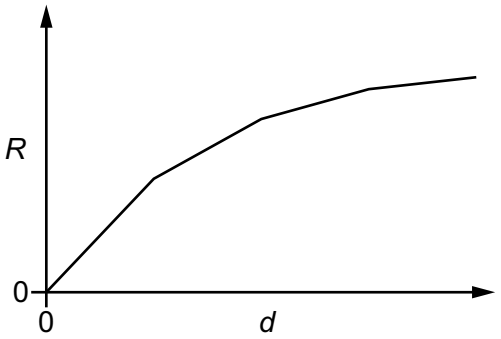
The resistance $R$ of this composite wire is measured between X and other points on the wire at distances $d$ from X.

Which graph best represents the relationship between $R$ and $d$?

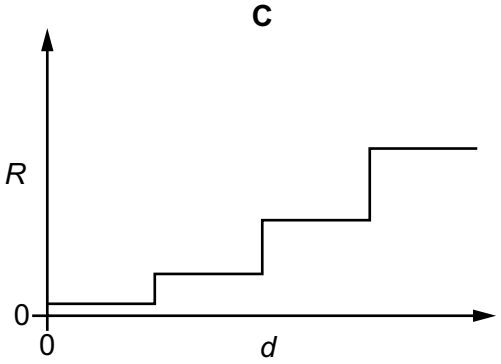
**A**



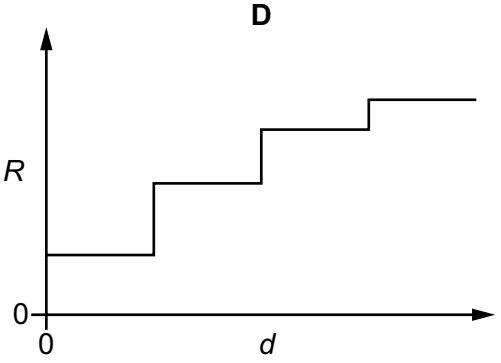

**B**




**C**

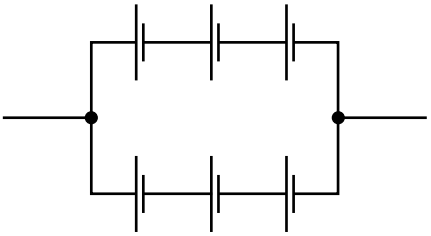



**D**



**22** Six cells are used to make a battery. They are arranged in two parallel branches, each containing three cells in series.

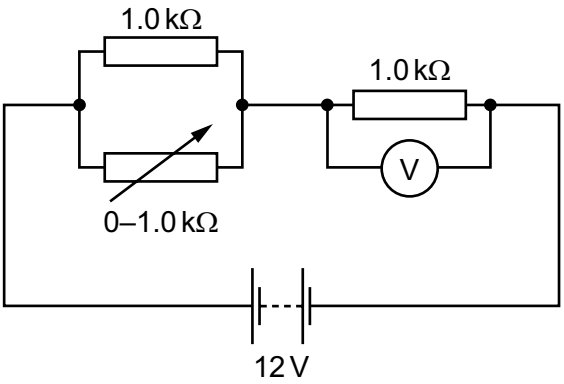
Each cell has an electromotive force (e.m.f.) of 1.5 V and an internal resistance of 0.2 Ω.



What are the e.m.f. and the internal resistance of the battery formed from the six cells?

| | **e.m.f. / V** | **internal resistance / Ω** |
|---|---|---|
| **A** | 4.5 | 0.3 |
| **B** | 4.5 | 0.6 |
| **C** | 9.0 | 0.3 |
| **D** | 9.0 | 0.6 |

**23** The diagram shows a resistor network connected to a 12 V battery of negligible internal resistance. The variable resistor has the range indicated, and the voltmeter has infinite resistance.

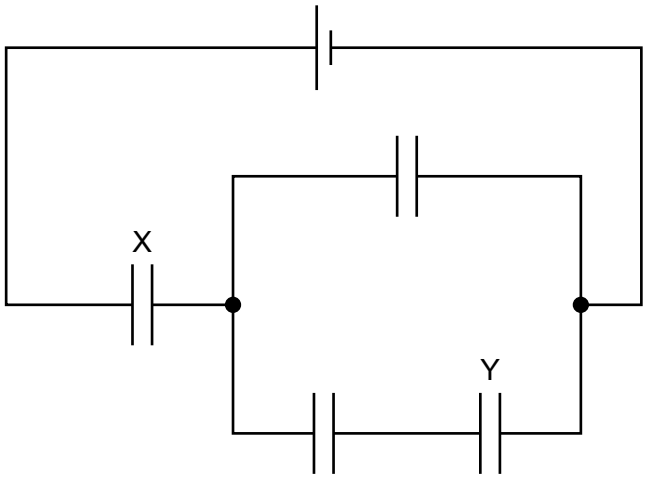



What are the maximum and the minimum possible values of the voltmeter reading as the resistance of the variable resistor is altered?

| | **maximum / V** | **minimum / V** |
|---|---|---|
| **A** | 4 | 0 |
| **B** | 8 | 4 |
| **C** | 8 | 6 |
| **D** | 12 | 8 |

**24** Four identical capacitors are connected to a cell as shown.



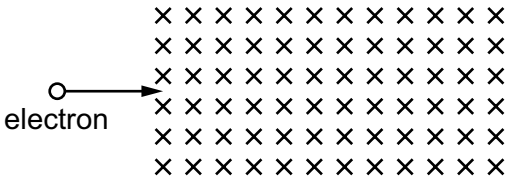

The charge stored on capacitor X is 6 μC.

What is the charge stored on capacitor Y?

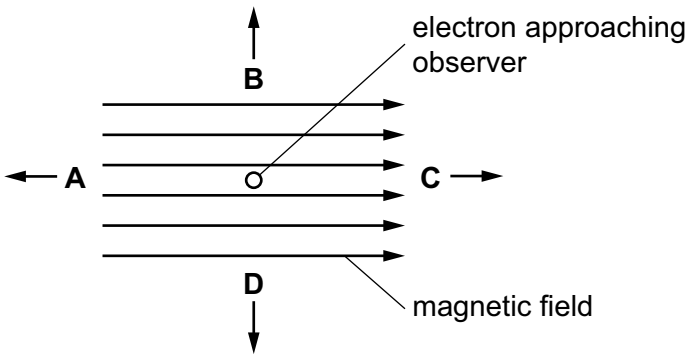
**A** 2 μC **B** 3 μC **C** 4 μC **D** 6 μC

**25** An electron moves into a magnetic field and is deflected by it. The first diagram shows a side view of this and the second diagram shows the view with the electron as it initially comes towards an observer.

In which direction will the electron be deflected?

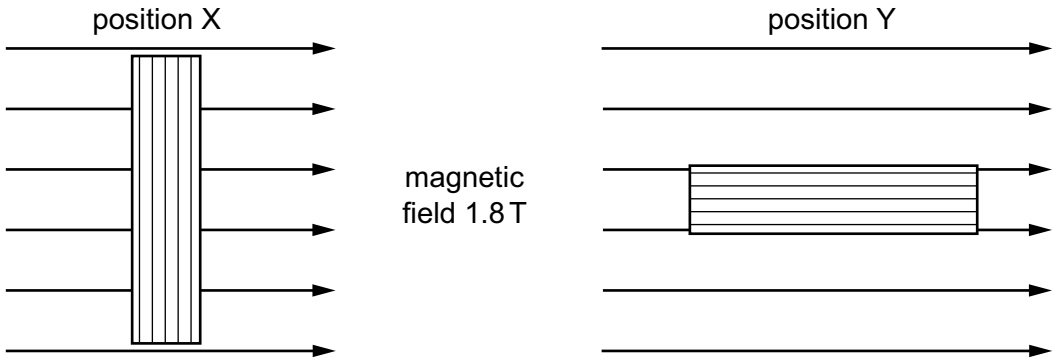



side view; field into paper




view from the front

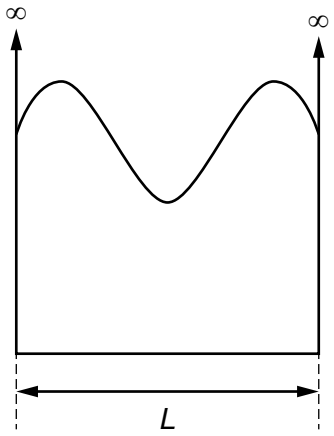
**26** A circular coil of diameter 0.020 m has 3000 turns. It is rotated in a magnetic field of 1.8 T from position X to position Y in 0.060 s.




What is the average electromotive force (e.m.f.) induced in the coil during the rotation?

**A** 28 V **B** 36 V **C** 113 V **D** 1800 V

**27** The diagram shows the wavefunction of a particle of energy $E$ contained in a one-dimensional infinite square well of width $L$.




Which expression gives the mass of the particle?

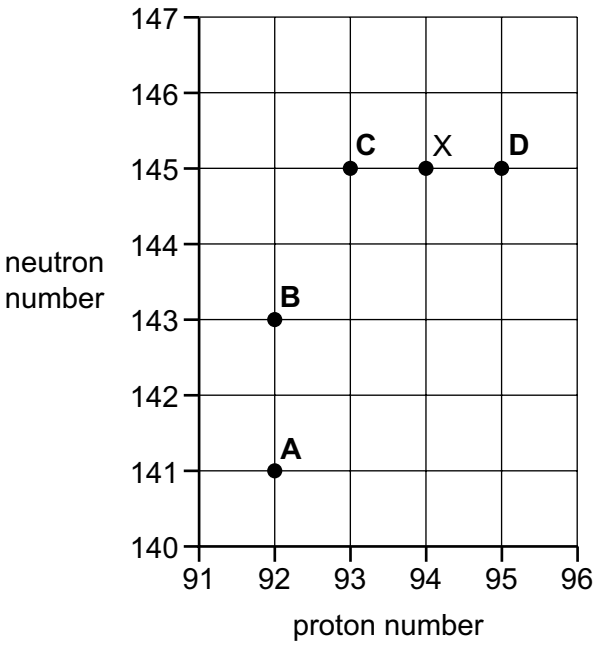
**A** $\frac{h^2}{8L^2E}$ **B** $\frac{3h^2}{8L^2E}$ **C** $\frac{4h^2}{8L^2E}$ **D** $\frac{9h^2}{8L^2E}$

**28** The figure shows part of a chart of nuclides where neutron number is plotted against proton number.

An unstable nuclide X decays spontaneously by emitting an $\alpha$-particle.

Into which nuclide does it decay?




**29** The nucleus of an isotope of bismuth is represented as $^{212}_{83}\text{Bi}$.

The nucleus has mass $M$, a proton has mass $M_p$ and a neutron has mass $M_n$.

What is the mass defect for the bismuth nucleus?

**A** $M - 83M_p - 129M_n$

**B** $M - 212M_p - 83M_n$

**C** $83M_p + 129M_n - M$

**D** $212M_p + 83M_n - M$

**30** The radioactive isotope caesium-137 decays to barium-137 by emitting a β-particle.

The masses of the nuclei and of the β-particle are given in the table.

| nucleus or particle | mass / u |
|---|---|
| caesium-137 | 136.90709 |
| barium-137 | 136.90583 |
| β-particle | $5.49 \times 10^{-4}$ |

How much energy is released during the decay of one nucleus of caesium-137?

**A** $2.4 \times 10^{-14}$ J

**B** $1.1 \times 10^{-13}$ J

**C** $1.9 \times 10^{-13}$ J

**D** $2.7 \times 10^{-13}$ J