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

**PHYSICS** **9702/01**

Paper 1 Multiple Choice

May/June 2005

**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 rough working should be done in this booklet.

**Data**

| | |
|---|---|
| speed of light in free space, | $c = 3.00 \times 10^{8}\,\mathrm{m\,s^{-1}}$ |
| permeability of free space, | $\mu_0 = 4\pi \times 10^{-7}\,\mathrm{H\,m^{-1}}$ |
| permittivity of free space, | $\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{F\,m^{-1}}$ |
| elementary charge, | $e = 1.60 \times 10^{-19}\,\mathrm{C}$ |
| the Planck constant, | $h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$ |
| unified atomic mass constant, | $u = 1.66 \times 10^{-27}\,\mathrm{kg}$ |
| rest mass of electron, | $m_\mathrm{e} = 9.11 \times 10^{-31}\,\mathrm{kg}$ |
| rest mass of proton, | $m_\mathrm{p} = 1.67 \times 10^{-27}\,\mathrm{kg}$ |
| molar gas constant, | $R = 8.31\,\mathrm{J\,K^{-1}\,mol^{-1}}$ |
| the Avogadro constant, | $N_\mathrm{A} = 6.02 \times 10^{23}\,\mathrm{mol^{-1}}$ |
| the Boltzmann constant, | $k = 1.38 \times 10^{-23}\,\mathrm{J\,K^{-1}}$ |
| gravitational constant, | $G = 6.67 \times 10^{-11}\,\mathrm{N\,m^{2}\,kg^{-2}}$ |
| acceleration of free fall, | $g = 9.81\,\mathrm{m\,s^{-2}}$ |

**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, $\phi = -\frac{Gm}{r}$

simple harmonic motion, $a = -\omega^2 x$

velocity of particle in s.h.m., $v = v_0 \cos \omega t$

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

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

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

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, $W = \frac{1}{2}QV$

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

hydrostatic pressure, $p = \rho g h$

pressure of an ideal gas, $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$

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

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

critical density of matter in the Universe, $\rho_0 = \frac{3H_0^2}{8\pi G}$

equation of continuity, $Av = \text{constant}$

Bernoulli equation (simplified), $p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$

Stokes' law, $F = Ar\eta v$

Reynolds' number, $R_e = \frac{\rho v r}{\eta}$

drag force in turbulent flow, $F = Br^2 \rho v^2$

**1** Decimal sub-multiples and multiples of units are indicated using a prefix to the unit. For example, the prefix milli (m) represents $10^{-3}$.

Which of the following gives the sub-multiples or multiples represented by pico (p) and giga (G)?

| | pico (p) | giga (G) |
|---|---|---|
| **A** | $10^{-9}$ | $10^{9}$ |
| **B** | $10^{-9}$ | $10^{12}$ |
| **C** | $10^{-12}$ | $10^{9}$ |
| **D** | $10^{-12}$ | $10^{12}$ |

**2** A metal sphere of radius $r$ is dropped into a tank of water. As it sinks at speed $v$, it experiences a drag force $F$ given by $F = krv$, where $k$ is a constant.

What are the SI base units of $k$?

**A** $\text{kg m}^2\text{ s}^{-1}$ **B** $\text{kg m}^{-2}\text{ s}^{-2}$ **C** $\text{kg m}^{-1}\text{ s}^{-1}$ **D** $\text{kg m s}^{-2}$

**3** An Olympic athlete of mass 80 kg competes in a 100 m race.

What is the best estimate of his mean kinetic energy during the race?

**A** $4 \times 10^2$ J **B** $4 \times 10^3$ J **C** $4 \times 10^4$ J **D** $4 \times 10^5$ J

**4** In an experiment, a radio-controlled car takes $2.50 \pm 0.05$ s to travel $40.0 \pm 0.1$ m.

What is the car's average speed and the uncertainty in this value?

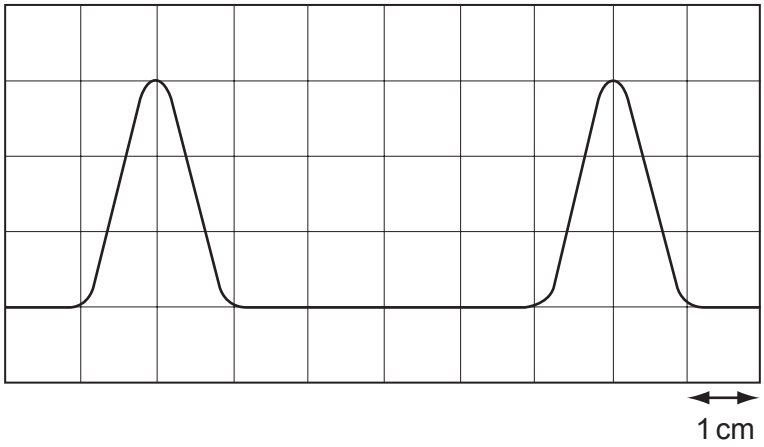
**A** $16 \pm 1\text{ m s}^{-1}$

**B** $16.0 \pm 0.2\text{ m s}^{-1}$

**C** $16.0 \pm 0.4\text{ m s}^{-1}$

**D** $16.00 \pm 0.36\text{ m s}^{-1}$

**5** The diagram shows two pulses on the screen of a cathode ray oscilloscope. A grid of 1 cm squares covers the screen. The time base setting is $1\,\mu s\,cm^{-1}$.




How long does each pulse last?

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

**6** Which feature of a graph allows acceleration to be determined?

**A** the area under a displacement-time graph

**B** the area under a velocity-time graph

**C** the slope of a displacement-time graph

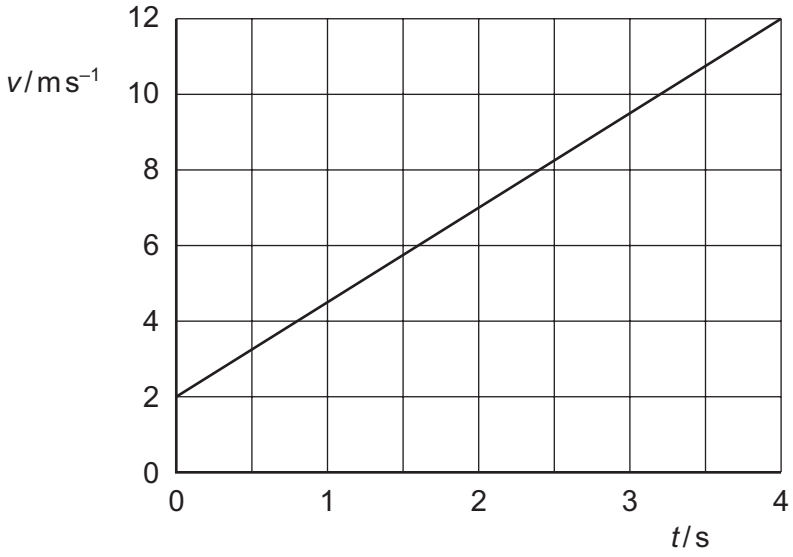
**D** the slope of a velocity-time graph

**7** A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and falls back to his hands.

Which of the following gives the acceleration of the ball at various stages in its motion? Take vertically upwards as positive. Neglect air resistance.

| | rising | at maximum height | falling |
|---|---|---|---|
| **A** | $-9.81\,m\,s^{-2}$ | 0 | $+9.81\,m\,s^{-2}$ |
| **B** | $-9.81\,m\,s^{-2}$ | $-9.81\,m\,s^{-2}$ | $-9.81\,m\,s^{-2}$ |
| **C** | $+9.81\,m\,s^{-2}$ | $+9.81\,m\,s^{-2}$ | $+9.81\,m\,s^{-2}$ |
| **D** | $+9.81\,m\,s^{-2}$ | 0 | $-9.81\,m\,s^{-2}$ |

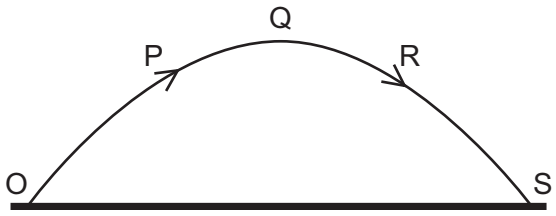
**8** The diagram shows a velocity-time graph for a car.




What is the distance travelled between time $t = 0$ and $t = 4\,s$?

**A** 2.5 m **B** 3.0 m **C** 20 m **D** 28 m

**9** A projectile is launched at point O and follows the path OPQRS, as shown. Air resistance may be neglected.




Which statement is true for the projectile when it is at the highest point Q of its path?

**A** The horizontal component of the projectile's acceleration is zero.

**B** The horizontal component of the projectile's velocity is zero.

**C** The kinetic energy of the projectile is zero.

**D** The momentum of the projectile is zero.

**10** Which is **not** one of Newton's laws of motion?

**A** The total momentum of a system of interacting bodies remains constant, providing no external force acts.

**B** The rate of change of momentum of a body is directly proportional to the external force acting on the body and takes place in the direction of the force.

**C** If body A exerts a force on body B, then body B exerts an equal and oppositely-directed force on body A.

**D** A body continues in a state of rest or of uniform motion in a straight line unless acted upon by some external force.

**11** Two equal masses travel towards each other on a frictionless air track at speeds of $60\,cm\,s^{-1}$ and $40\,cm\,s^{-1}$. They stick together on impact.


What is the speed of the masses after impact?

**A** $10\,cm\,s^{-1}$ **B** $20\,cm\,s^{-1}$ **C** $40\,cm\,s^{-1}$ **D** $50\,cm\,s^{-1}$

**12** What is the centre of gravity of an object?

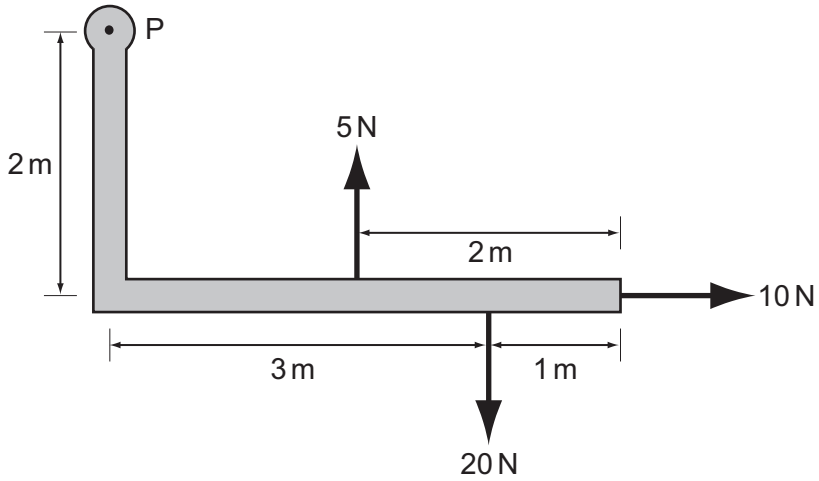
**A** the geometrical centre of the object

**B** the point about which the total torque is zero

**C** the point at which the weight of the object may be considered to act

**D** the point through which gravity acts

**13** An L-shaped rigid lever arm is pivoted at point P.

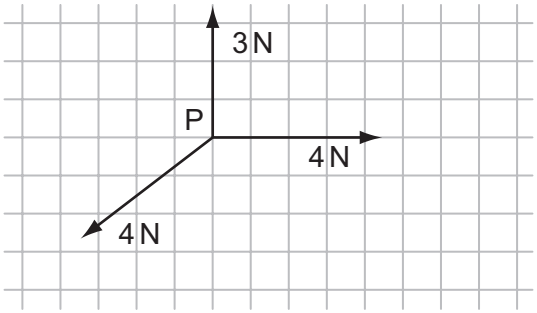



Three forces act on the lever arm, as shown in the diagram.

What is the magnitude of the resultant moment of these forces about point P?

**A** 30 N m **B** 35 N m **C** 50 N m **D** 90 N m

**14** The vector diagram shows three coplanar forces acting on an object at P.




The magnitude of the resultant of these three forces is 1 N.

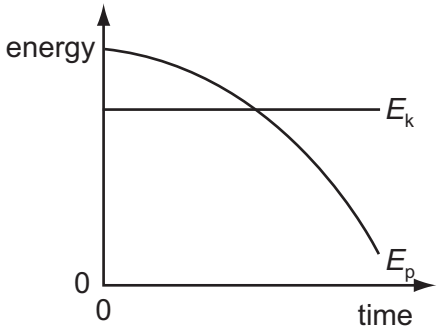
What is the direction of this resultant?

**A** ↓ **B** ↘ **C** ↙ **D** ↗

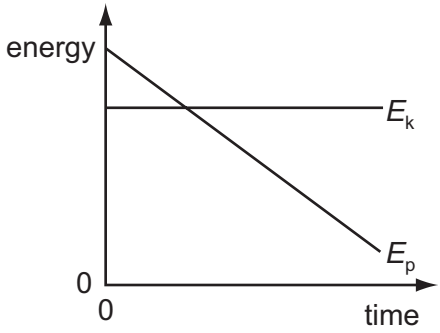
**15** A steel ball is falling at constant speed in oil.

Which graph shows the variation with time of the gravitational potential energy $E_p$ and the kinetic energy $E_k$ of the ball?

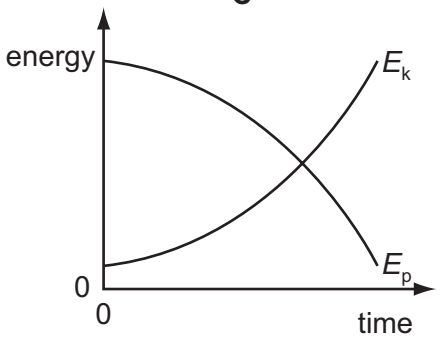
**A**



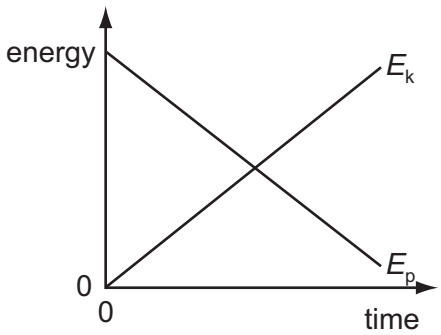

**B**



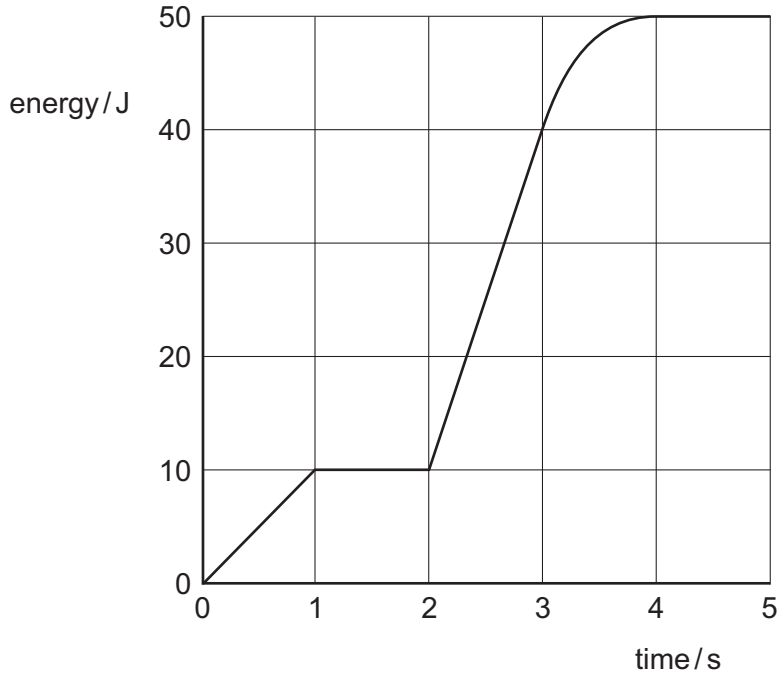

**C**




**D**



**16** An electrical generator is started at time zero. The total electrical energy generated during the first 5 seconds is shown in the graph.




What is the maximum electrical power generated at any instant during these first 5 seconds?

**A** 10 W **B** 13 W **C** 30 W **D** 50 W

**17** A concrete cube of side 0.50 m and uniform density 2.0 x $10^3$ kg $m^{-3}$ is lifted 3.0 m vertically by a crane.

What is the change in potential energy of the cube?

**A** 0.75 kJ **B** 7.4 kJ **C** 29 kJ **D** 470 kJ

**18** The hydrostatic pressure $p$ at a depth $h$ in a liquid of density $\rho$ is given by the formula $p = h\rho g$.

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

**A** density = mass ÷ volume

**B** potential energy = $mgh$

**C** atmospheric pressure decreases with height

**D** density increases with depth

**19** Pollen grains are suspended in a liquid and are illuminated strongly. When observed under a microscope they are seen to be in continuous random motion.

What is the reason for this?

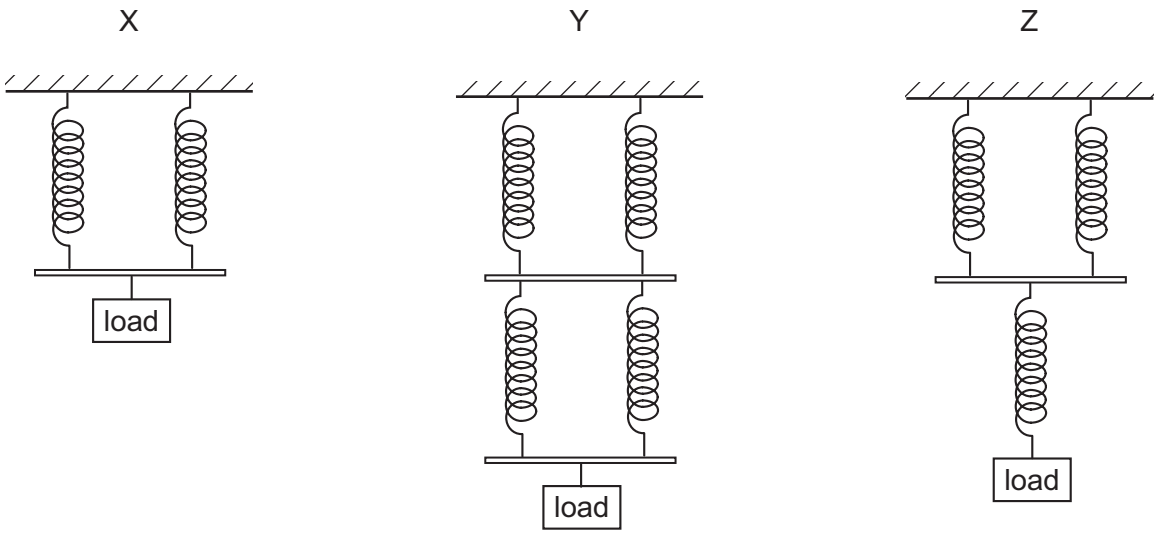
**A** convection currents in the liquid

**B** evaporation of the liquid

**C** molecules of the liquid colliding with the pollen grains

**D** pollen grains colliding with each other

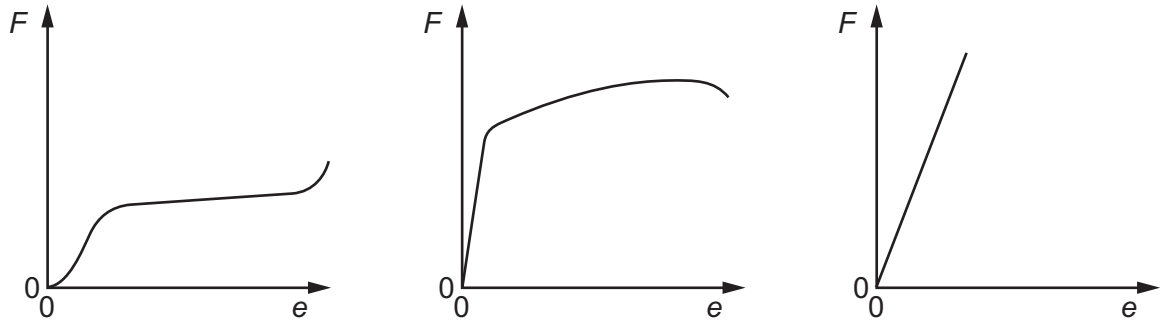
**20** A number of similar springs, each having the same spring constant, are joined in three arrangements X, Y and Z. The same load is applied to each.




What is the order of increasing extension for these arrangements?

| | smallest ⟶ | | largest |
|---|---|---|---|
| **A** | X | Y | Z |
| **B** | Z | X | Y |
| **C** | Z | Y | X |
| **D** | Y | X | Z |

**21** Cylindrical samples of steel, glass and rubber are each subjected to a gradually increasing tensile force *F*. The extensions *e* are measured and graphs are plotted as shown below.




Which row correctly relates the graphs to the materials?

| | steel | glass | rubber |
|---|---|---|---|
| **A** | X | Y | Z |
| **B** | X | Z | Y |
| **C** | Y | X | Z |
| **D** | Y | Z | X |

**22** Two steel wires P and Q have lengths $l$ and $2l$ respectively, and cross-sectional areas $A$ and $\frac{A}{2}$ respectively. Both wires obey Hooke's law.

What is the ratio $\frac{\text{tension in P}}{\text{tension in Q}}$ when both wires are stretched to the same extension?

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

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

**A** electrons

**B** microwaves

**C** radio waves

**D** X-rays

**24** The number of wavelengths of visible light in one metre is of the order of

**A** $10^4$. **B** $10^6$. **C** $10^8$. **D** $10^{10}$.

**25** 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 sound wave amplitude?

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

**26** A sound wave is set up in a long tube, closed at one end. The length of the tube is adjusted until the sound from the tube is loudest.

What is the nature of the sound wave in the tube?

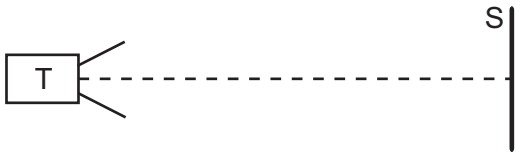
**A** longitudinal and progressive

**B** longitudinal and stationary

**C** transverse and progressive

**D** transverse and stationary

**27** T is a microwave transmitter placed at a fixed distance from a flat reflecting surface S.




A small microwave receiver is moved steadily from T towards S and receives signals of alternate maxima and minima of intensity.

The distance between successive maxima is 15 mm.

What is the frequency of the microwaves?

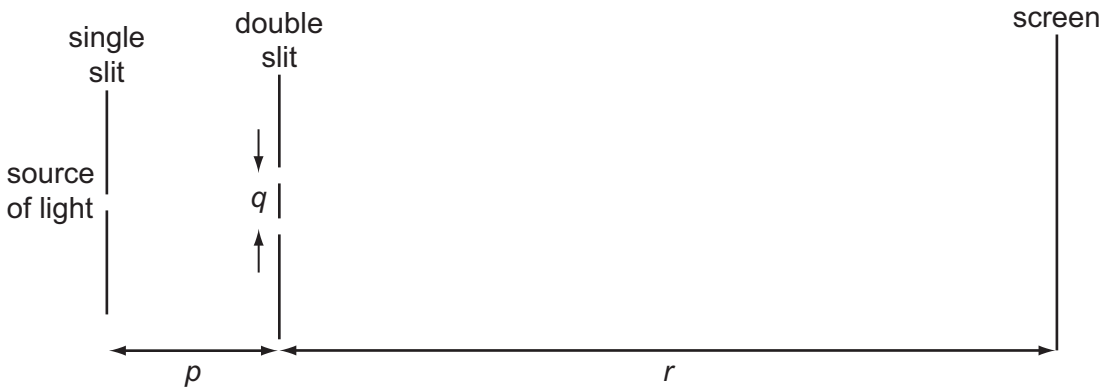
**A** $1.0 \times 10^7$ Hz

**B** $2.0 \times 10^7$ Hz

**C** $1.0 \times 10^{10}$ Hz

**D** $2.0 \times 10^{10}$ Hz

**28** A teacher sets up the apparatus shown to demonstrate a two-slit interference pattern on the screen.




Which change to the apparatus will increase the fringe spacing?

**A** decreasing the distance *p*

**B** decreasing the distance *q*

**C** decreasing the distance *r*

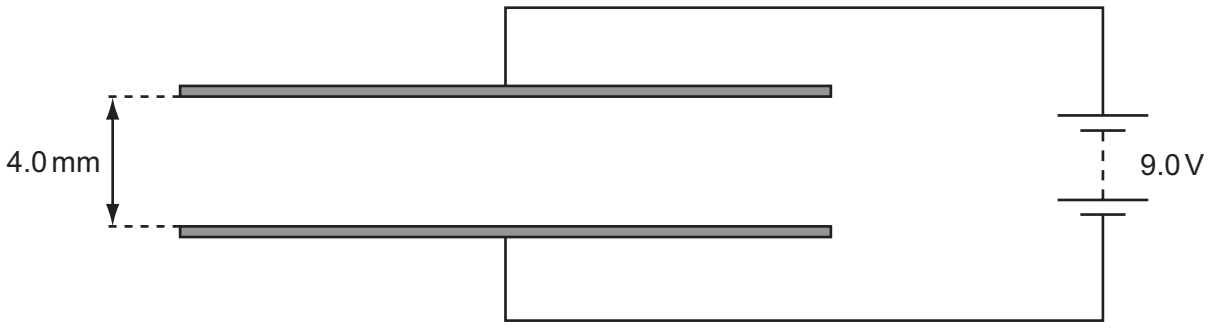
**D** decreasing the wavelength of the light

**29** A parallel beam of white light is incident normally on a diffraction grating. It is noted that the second-order and third-order spectra partially overlap.

Which wavelength in the third-order spectrum appears at the same angle as the wavelength of 600 nm in the second-order spectrum?

**A** 300 nm **B** 400 nm **C** 600 nm **D** 900 nm

**30** The diagram shows a pair of metal plates 4.0 mm apart connected to a 9.0 V battery.




What is the electric field between the plates?

**A** $4.4 \times 10^{-4}\,\mathrm{N\,C^{-1}}$

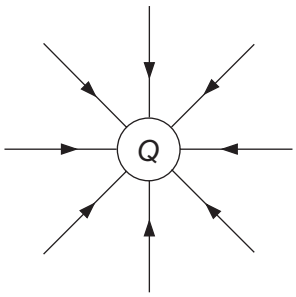
**B** $3.6 \times 10^{-2}\,\mathrm{N\,C^{-1}}$

**C** $36\,\mathrm{N\,C^{-1}}$

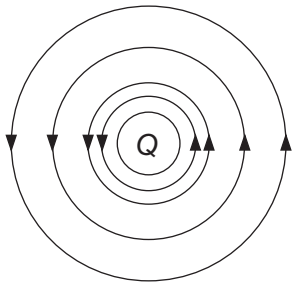
**D** $2.3 \times 10^{3}\,\mathrm{N\,C^{-1}}$

**31** Which diagram represents the electric field in the vicinity of a positive electric charge of magnitude $Q$?

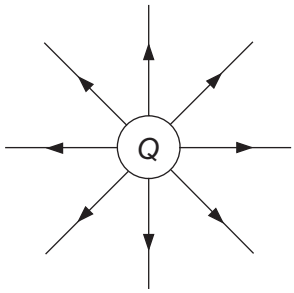
**A**



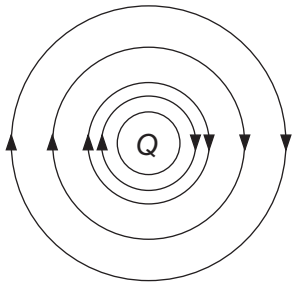

**B**




**C**




**D**




**32** A copper wire of cross-sectional area 2.0 mm$^2$ carries a current of 10 A.

How many electrons pass through a given cross-section of the wire in one second?

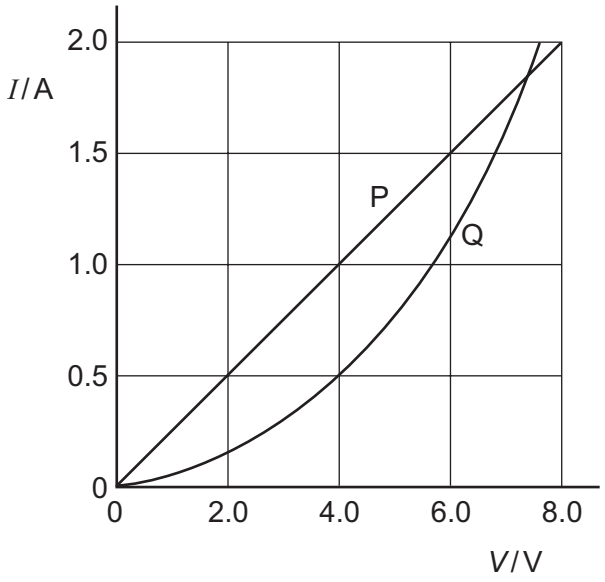
**A** $1.0 \times 10^1$ **B** $5.0 \times 10^6$ **C** $6.3 \times 10^{19}$ **D** $3.1 \times 10^{25}$

**33** A cylindrical piece of a soft, electrically-conducting material has resistance $R$. It is rolled out so that its length is doubled but its volume stays constant.

What is its new resistance?

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

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




Which statement is correct?

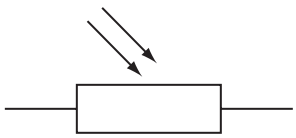
**A** P is a resistor and Q is a filament lamp.

**B** The resistance of Q increases as the current in it increases.

**C** At 1.9 A the resistance of Q is approximately half that of P.

**D** At 0.5 A the power dissipated in Q is double that in P.

**35** Which electrical component is represented by the following symbol?



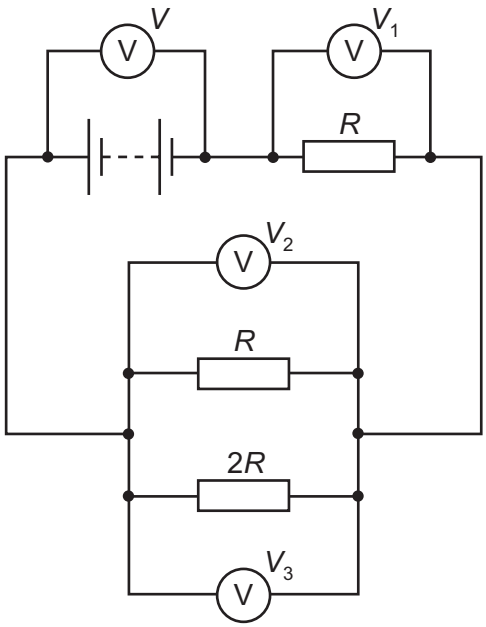
**A** a diode

**B** a light-dependent resistor

**C** a resistor

**D** a thermistor

**36** The diagram shows a circuit with four voltmeter readings $V$, $V_1$, $V_2$ and $V_3$.




Which equation relating the voltmeter readings must be true?

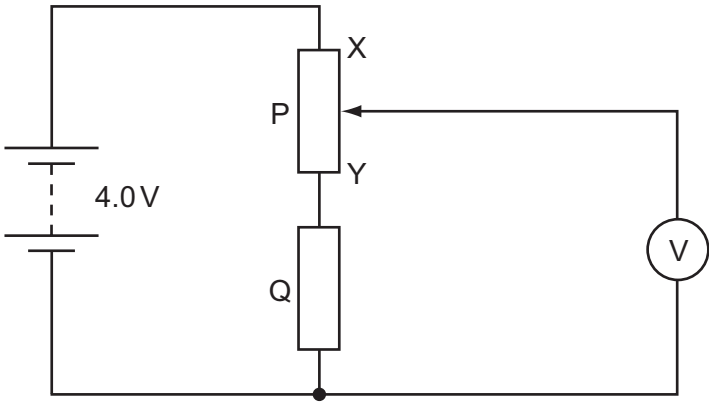
**A** $V = V_1 + V_2 + V_3$

**B** $V + V_1 = V_2 + V_3$

**C** $V_3 = 2(V_2)$

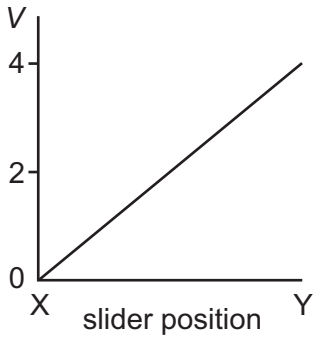
**D** $V - V_1 = V_3$

**37** In the circuit below, P is a potentiometer of total resistance 10 Ω and Q is a fixed resistor of resistance 10 Ω. The battery has an e.m.f. of 4.0 V 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.

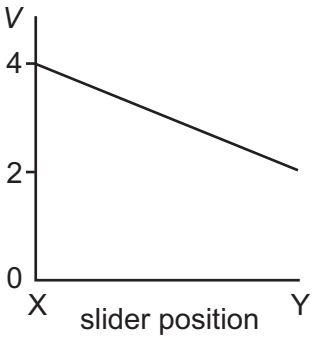



Which graph is obtained?

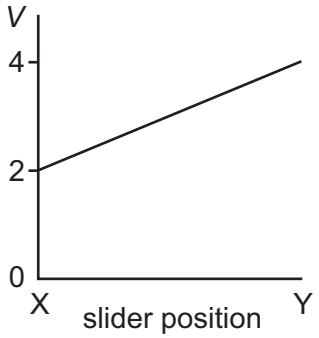
**A**



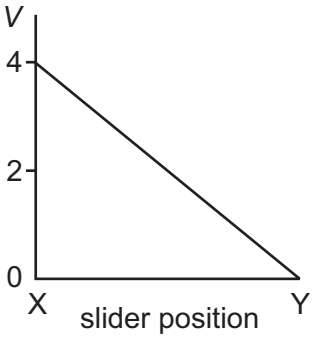

**B**




**C**




**D**




**38** Which two nuclei contain the same number of neutrons?

**A** $^{12}_{6}C$ and $^{14}_{6}C$

**B** $^{16}_{7}N$ and $^{15}_{8}O$

**C** $^{23}_{11}Na$ and $^{24}_{12}Mg$

**D** $^{32}_{14}Si$ and $^{32}_{15}P$

**39** A student conducts an experiment using an $\alpha$-particle source.

When considering safety precautions, what can be assumed to be the maximum range of $\alpha$-particles in air?

**A** between 0 and 5 mm

**B** between 5 mm and 200 mm

**C** between 200 mm and 500 mm

**D** between 500 mm and 1000 mm

**40** The following represents a sequence of radioactive decays involving two $\alpha$-particles and one $\beta$-particle.

$$^{217}_{85}\text{At} \xrightarrow{\alpha} \text{V} \xrightarrow{\alpha} \text{W} \xrightarrow{\beta} \text{X}$$

What is the nuclide X?

**A** $^{213}_{85}\text{At}$ **B** $^{215}_{77}\text{Ir}$ **C** $^{209}_{82}\text{Pb}$ **D** $^{217}_{81}\text{Tl}$

**BLANK PAGE**