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

PHYSICS **9702/01**

Paper 1 Multiple Choice

October/November 2006

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,	$c = 3.00 \times 10^{8}\,\text{m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\,\text{H m}^{-1}$
permittivity of free space,	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
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,	$g = 9.81\,\text{m s}^{-2}$

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 Which product-pair of metric prefixes has the greatest magnitude?

A pico × mega

B nano × kilo

C micro × giga

D milli × tera

2 In the expressions below

a is acceleration,
F is force,
m is mass,
t is time,
v is velocity.

Which expression represents energy?

A Ft **B** Fvt **C** $\frac{2mv}{t}$ **D** $\frac{at^2}{2}$

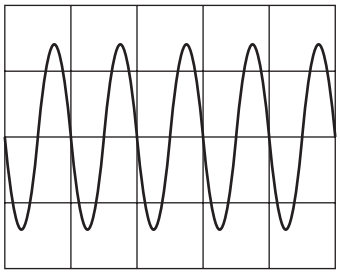
3 Which row of the table shows a physical quantity and its correct unit?

	physical quantity	unit
A	electric field strength	$\mathrm{kg\,m\,s^{-2}\,C^{-1}}$
B	specific heat capacity	$\mathrm{kg^{-1}\,m^{2}\,s^{-2}\,K^{-1}}$
C	tensile strain	$\mathrm{kg\,m^{-1}\,s^{-2}}$
D	the Young modulus	$\mathrm{kg\,m^{-1}\,s^{-3}}$

4 The Y-input terminals of a cathode-ray oscilloscope (c.r.o.) are connected to a supply of peak value 5.0 V and of frequency 50 Hz. The time-base is set at 10 ms per division and the Y-gain at 5.0 V per division.

Which trace is obtained?

A



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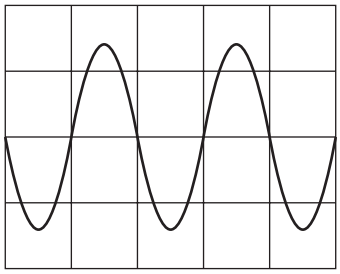

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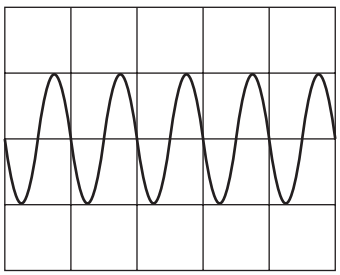

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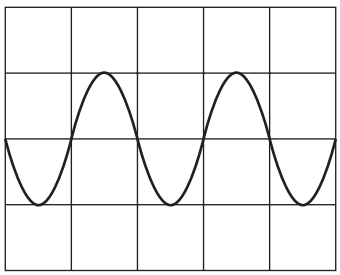


5 The measurement of a physical quantity may be subject to random errors and to systematic errors.

Which statement is correct?

A Random errors can be reduced by taking the average of several measurements.

B Random errors are always caused by the person taking the measurement.

C A systematic error cannot be reduced.

D A systematic error results in a different reading each time the measurement is taken.

6 An experiment is done to measure the resistance of a wire.

The current in the wire is $1.0 \pm 0.2\,\text{A}$ and the potential difference across the wire is $8.0 \pm 0.4\,\text{V}$.

What is the resistance of the wire and its uncertainty?

A $(8.0 \pm 0.2)\,\Omega$

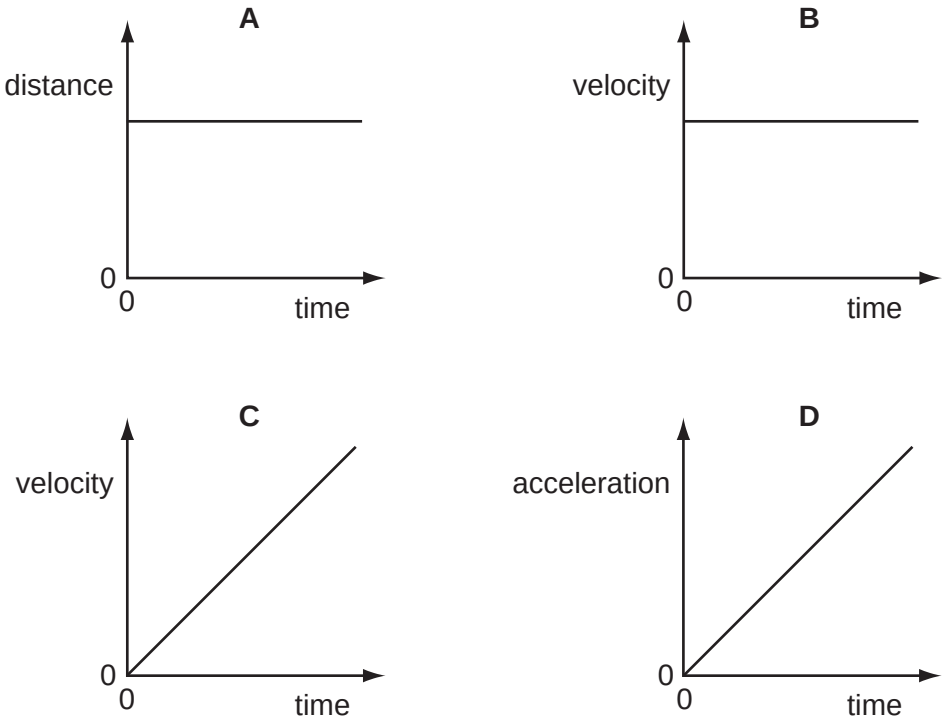
B $(8.0 \pm 0.6)\,\Omega$

C $(8 \pm 1)\,\Omega$

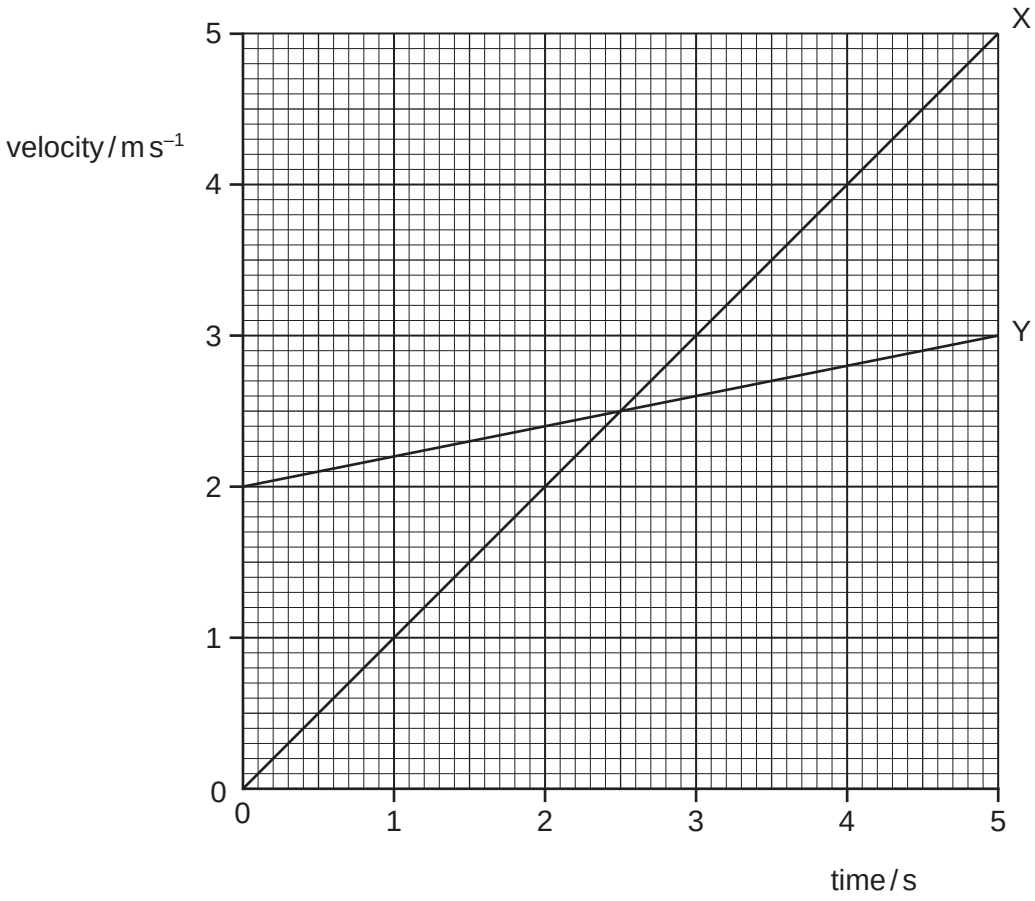
D $(8 \pm 2)\,\Omega$

7 A particle is moving in a straight line with uniform acceleration.

Which graph represents the motion of the particle?



8 The graph shows velocity-time plots for two vehicles X and Y. The accelerations and distances travelled by the two vehicles can be estimated from these plots.



Which statement is correct?

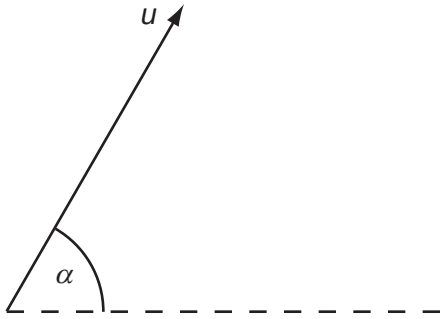
A The accelerations of X and Y are the same at 2.5 s.

B The initial acceleration of Y is greater than that of X.

C The distance travelled by X is greater than that travelled by Y in the 5 s period.

D The distances travelled by X and Y in the 5 s period are the same.

9 A projectile is fired at an angle α to the horizontal at a speed u, as shown.



What are the vertical and horizontal components of its velocity after a time t?
Assume that air resistance is negligible. The acceleration of free fall is g.

	vertical component	horizontal component
A	$u \sin \alpha$	$u \cos \alpha$
B	$u \sin \alpha - gt$	$u \cos \alpha - gt$
C	$u \sin \alpha - gt$	$u \cos \alpha$
D	$u \cos \alpha$	$u \sin \alpha - gt$

10 A force F is applied to a freely moving object. At one instant of time, the object has velocity v and acceleration a.

Which quantities **must** be in the same direction?

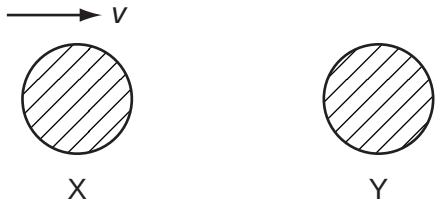
A a and v only

B a and F only

C v and F only

D v, F and a

11 The diagram shows two identical spheres X and Y.

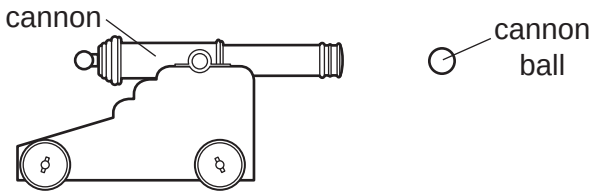


Initially X moves with speed v directly towards Y. Y is stationary. The spheres collide elastically.

What happens?

	X	Y
A	moves with speed $\frac{1}{2}v$ to the right	moves with speed $\frac{1}{2}v$ to the right
B	moves with speed v to the left	remains stationary
C	moves with speed $\frac{1}{2}v$ to the left	moves with speed $\frac{1}{2}v$ to the right
D	stops	moves with speed v to the right

12 The diagram shows a cannon ball fired from a cannon.



The mass of the cannon is 1000 kg and the mass of the cannon ball is 10 kg.

The recoil velocity of the cannon is $5\,m\,s^{-1}$ horizontally.

What is the horizontal velocity of the cannon ball?

A $200\,m\,s^{-1}$ **B** $500\,m\,s^{-1}$ **C** $2000\,m\,s^{-1}$ **D** $5000\,m\,s^{-1}$

13 Which force is caused by a pressure difference?

A friction

B upthrust

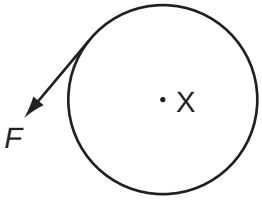
C viscous force

D weight

14 A rigid circular disc of radius *r* has its centre at X. A number of forces of equal magnitude *F* act at the edge of the disc. All the forces are in the plane of the disc.

Which arrangement of forces provides a moment of magnitude 2*Fr* about X?

A



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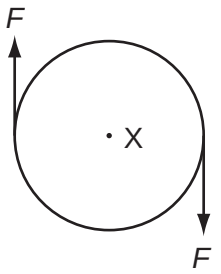

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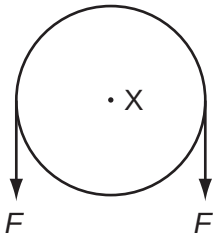

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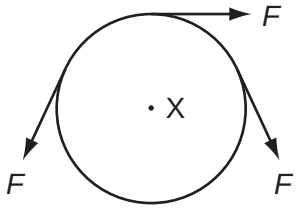
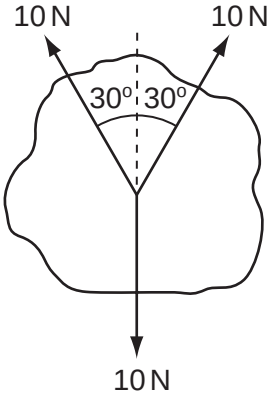


15 Three coplanar forces, each of magnitude 10 N, act through the same point of a body in the directions shown.



What is the magnitude of the resultant force?

A 0 N **B** 1.3 N **C** 7.3 N **D** 10 N

16 To get to his office from the entrance of the building, a man has to walk up six flights of stairs. The height of each flight is 2.5 m and the man has a mass of 80 kg.

What is the approximate gain in the man's gravitational potential energy during the climb?

A 1200 J **B** 2000 J **C** 4800 J **D** 12 000 J

17 In many old-style filament lamps, as much as 93 J of energy is emitted as thermal energy for every 7 J of energy emitted as light.

What is the efficiency of the lamp, as the percentage of electrical energy converted to light energy?

A 7 % **B** 8 % **C** 92 % **D** 93 %

18 An electric railway locomotive has a maximum mechanical output power of 4.0 MW. Electrical power is delivered at 25 kV from overhead wires. The overall efficiency of the locomotive in converting electrical power to mechanical power is 80 %.

What is the current from the overhead wires when the locomotive is operating at its maximum power?

A 130 A **B** 160 A **C** 200 A **D** 250 A

19 Which statement defines the density of a substance?

A the force per unit area acting on the substance

B the increase in length per unit length of the substance

C the mass per unit volume of the substance

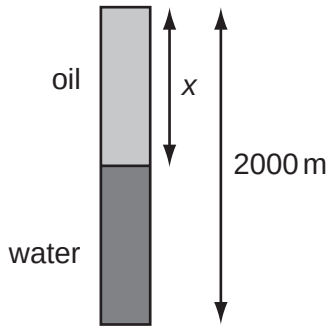
D the work done per unit time by the substance

20 The table summarises some properties of evaporation.

Which row of the table is correct?

	involves a change in state from liquid to vapour	occurs at a fixed temperature	involves a reduction in the average kinetic energy of the remaining atoms
A	true	true	true
B	true	false	true
C	true	false	false
D	false	true	false

21 A bore hole of depth 2000 m contains both oil and water as shown. The pressure at the bottom is 17.5 MPa. The density of the oil is 830 kg m^{-3} and the density of the water is 1000 kg m^{-3}.



What is the depth *x* of the oil?

A 907 m **B** 1000 m **C** 1090 m **D** 1270 m

22 What is represented by the gradient of a graph of force (vertical axis) against extension (horizontal axis)?

A elastic limit

B spring constant

C stress

D the Young modulus

23 What is the unit of the Young modulus?

A N m^{-1} **B** N m **C** N m^{-2} **D** N m^{2}

24 A wave motion is described by the oscillation of particles.

What is the name given to the number of complete oscillations of a particle in one second?

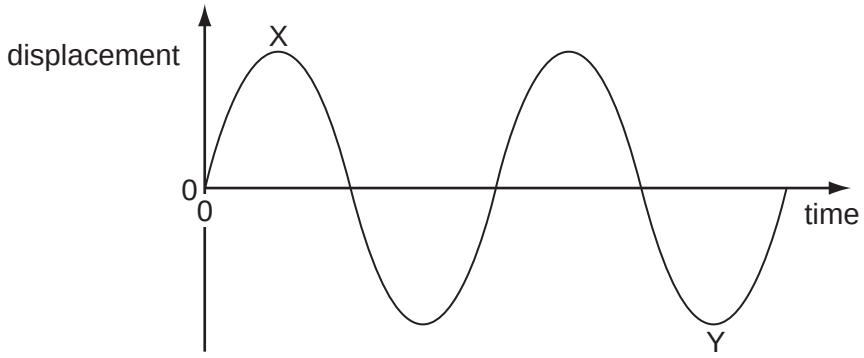
A amplitude

B frequency

C wavelength

D wave speed

25 A displacement-time graph for a transverse wave is shown in the diagram.



The phase difference between X and Y can be expressed as $n\pi$.

What is the value of n?

A 1.5 **B** 2.5 **C** 3.0 **D** 6.0

26 Continuous water waves are diffracted through a gap in a barrier in a ripple tank.

Which change will cause the diffraction of the waves to increase?

A increasing the frequency of the waves

B increasing the width of the gap

C reducing the wavelength of the waves

D reducing the width of the gap

27 The interference patterns from a diffraction grating and a double slit are compared.

Using the diffraction grating, yellow light of the first order is seen at 30° to the normal to the grating.

The same light produces interference fringes on a screen 1.0 m from the double slit. The slit separation is 500 times greater than the line spacing of the grating.

What is the fringe separation on the screen?

A 2.5×10^{-7} m

B 1.0×10^{-5} m

C 1.0×10^{-3} m

D 1.0×10^{-1} m

28 What may be used to produce stationary waves?

A blowing air over the top of an empty bottle

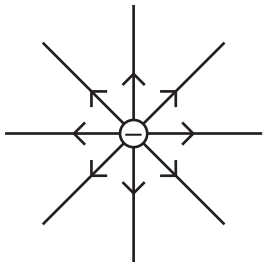
B making a loud sound near a mountain

C passing monochromatic light through a double slit

D passing water waves through a narrow slit

29 Which diagram shows the electric field pattern of an isolated negative point charge?

A



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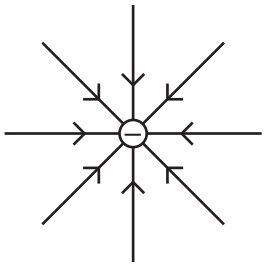

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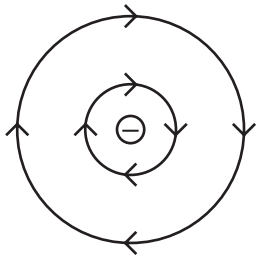

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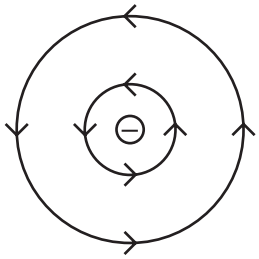
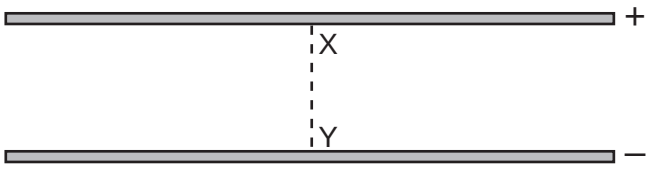
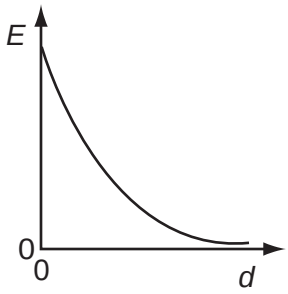


30 An electric field exists in the space between two charged metal plates.



Which graph shows the variation of electric field strength E with distance d from X along the line XY?

A



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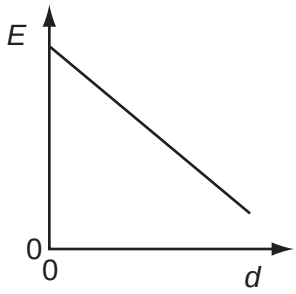

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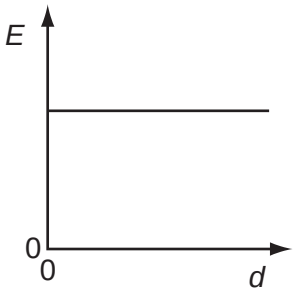

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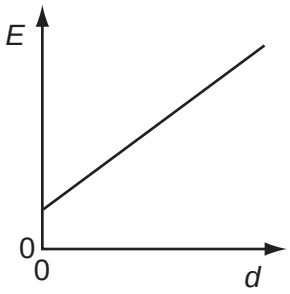
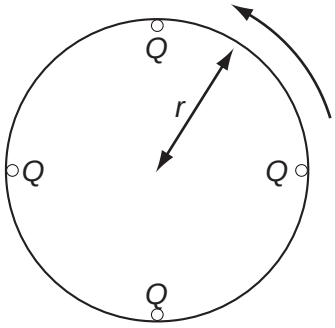


31 Four point charges, each of charge Q, are placed on the edge of an insulating disc of radius r.

The frequency of rotation of the disc is f.

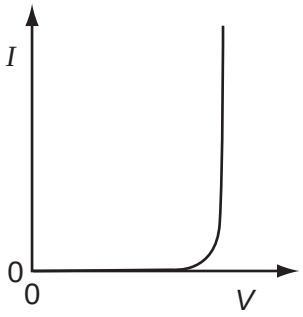


What is the equivalent electric current at the edge of the disc?

A $4Qf$ **B** $\frac{4Q}{f}$ **C** $8\pi rQf$ **D** $\frac{2Qf}{\pi r}$

32 Which graph shows the $I - V$ characteristic of a filament lamp?

A



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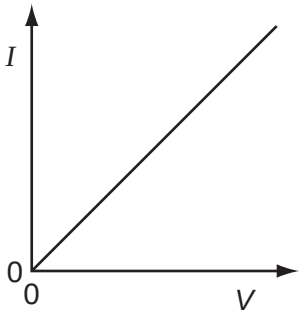
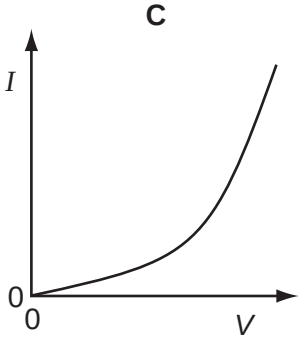
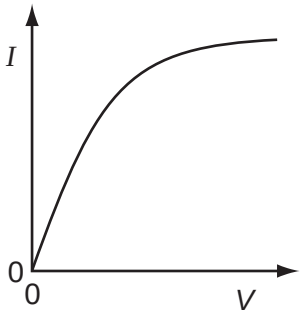


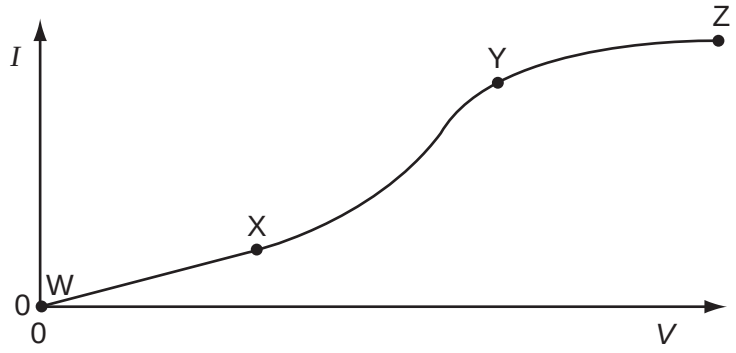
C



D



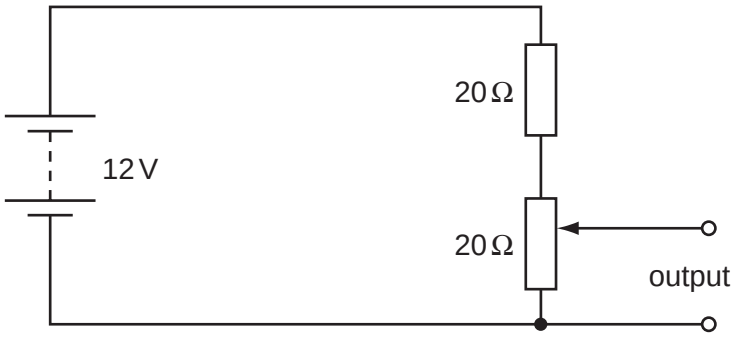
33 An electrical component has a potential difference V across it and a current I through it. A graph of I against V is drawn and is marked in three sections WX, XY and YZ.



In which ways does the resistance of the component vary within each of the three sections?

	WX	XY	YZ
A	constant	decreases	increases
B	constant	increases	increases
C	increases	decreases	constant
D	increases	increases	decreases

34 The diagram shows a potentiometer and a fixed resistor connected across a 12 V battery of negligible internal resistance.



The fixed resistor and the potentiometer each have resistance 20 Ω. The circuit is designed to provide a variable output voltage.

What is the range of output voltages?

A 0 – 6 V **B** 0 – 12 V **C** 6 – 12 V **D** 12 – 20 V

35 The resistance of a device is designed to change with temperature.

What is the device?

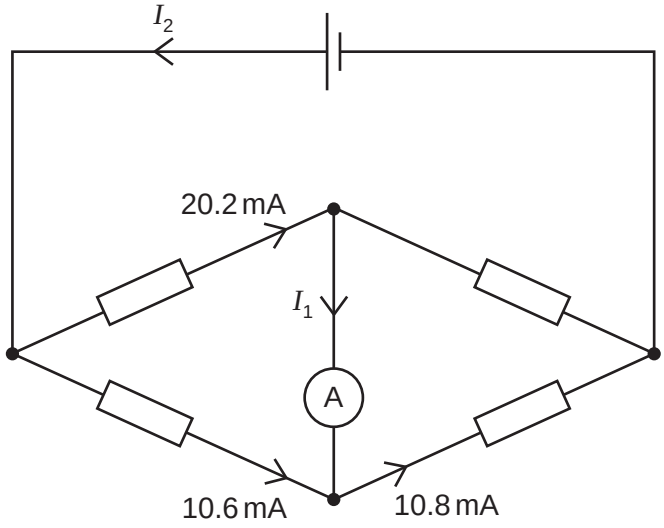
A a light-dependent resistor

B a potential divider

C a semiconductor diode

D a thermistor

36 The diagram represents a circuit.



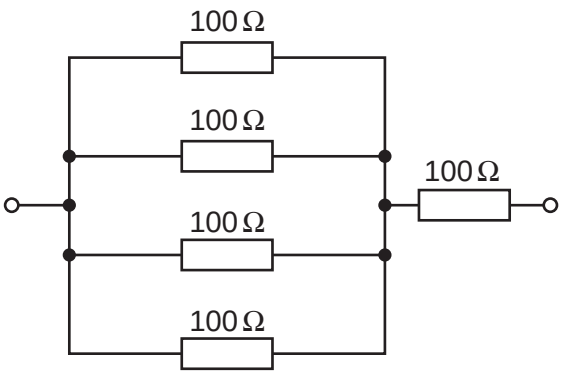
Some currents have been shown on the diagram.

What are the currents I_1 and I_2?

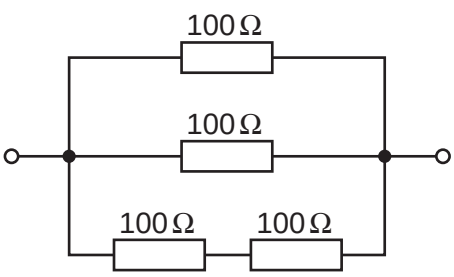
	I_1	I_2
A	0.2 mA	10.8 mA
B	0.2 mA	30.8 mA
C	–0.2 mA	20.0 mA
D	–0.2 mA	30.8 mA

37 Which circuit has a resistance of 40 Ω between the terminals?

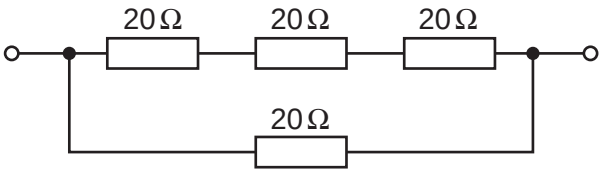
A



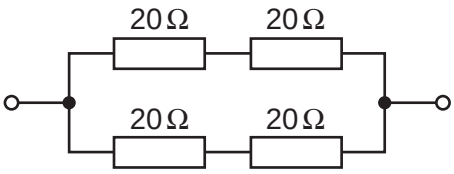
B



C



D



38 Which statement concerning α-particles is correct?

A An α-particle has charge +4*e*.

B An α-particle is a helium atom.

C When α-particles travel through air, they cause ionisation.

D When α-particles travel through a sheet of gold foil, they make the gold radioactive.

39 Where are electrons, neutrons and protons found in an atom?

	electrons	neutrons	protons
A	in the nucleus	in the nucleus	orbiting the nucleus
B	in the nucleus	orbiting the nucleus	in the nucleus
C	orbiting the nucleus	in the nucleus	orbiting the nucleus
D	orbiting the nucleus	in the nucleus	in the nucleus

40 Radon $^{222}_{86}Rn$ decays by $\alpha-$ and $\beta-$emission to bismuth $^{214}_{83}Bi$.

For the decay of each nucleus of radon, how many $\alpha-$ and $\beta-$particles are emitted?

	$\alpha-$particles	$\beta-$particles
A	1	1
B	2	1
C	1	2
D	2	2

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