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

PHYSICS **9702/01**

Paper 1 Multiple Choice

May/June 2003

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.

This document consists of **18** printed pages and **2** blank pages.

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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,	$\epsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$
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,	$m_e = 9.11 \times 10^{-31}\ \text{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \text{kg}$
molar gas constant,	$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \text{mol}^{-1}$
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, $V = \frac{Q}{4\pi\epsilon_0 r}$

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), $p_1 + \frac{1}{2}\rho v_1^2 = \rho_2 + \frac{1}{2}\rho v_2^2$

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

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

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

[Turn over

1 Which of the following is a scalar quantity?

A acceleration

B mass

C momentum

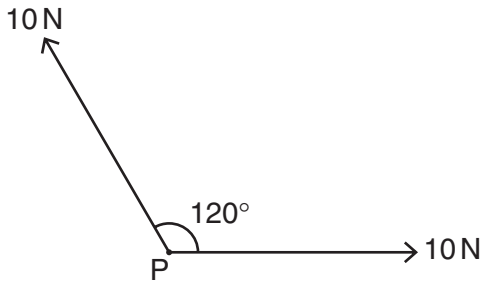
D velocity

2 The unit of work, the joule, may be defined as the work done when the point of application of a force of 1 newton is moved a distance of 1 metre in the direction of the force.

Express the joule in terms of the base units of mass, length and time, the kg, m and s.

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

3 Two forces, each of 10 N, act at a point P as shown in the diagram. The angle between the directions of the forces is 120°.



What is the magnitude of the resultant force?

A 5 N **B** 10 N **C** 17 N **D** 20 N

4 Which experimental technique reduces the systematic error of the quantity being investigated?

A adjusting an ammeter to remove its zero error before measuring a current

B measuring several internodal distances on a standing wave to find the mean internodal distance

C measuring the diameter of a wire repeatedly and calculating the average

D timing a large number of oscillations to find a period

5 A student makes measurements from which she calculates the speed of sound as $327.66\,m\,s^{-1}$. She estimates that her result is accurate to ±3 %.

Which of the following gives her result expressed to the appropriate number of significant figures?

A $327.7\,m\,s^{-1}$ **B** $328\,m\,s^{-1}$ **C** $330\,m\,s^{-1}$ **D** $300\,m\,s^{-1}$

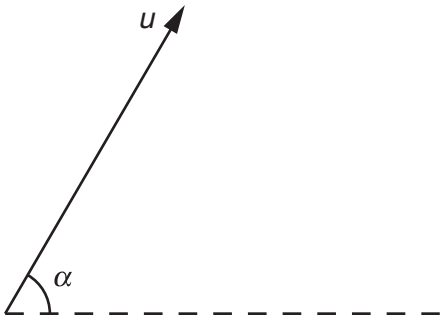
6 A steel rule can be read to the nearest millimetre. It is used to measure the length of a bar whose true length is 895 mm. Repeated measurements give the following readings.

length / mm	892, 891, 892, 891, 891, 892

Are the readings accurate and precise to within 1 mm?

	results are accurate to within 1 mm	results are precise to within 1 mm
A	no	no
B	no	yes
C	yes	no
D	yes	yes

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

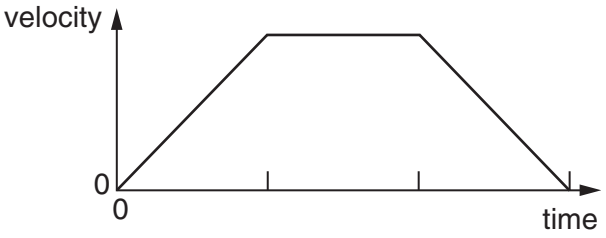


What will be the vertical and horizontal components of its velocity after a time t?
Assume that air resistance is negligible. The acceleration of free fall is g.

	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	$u \cos \alpha$	$u \sin \alpha - gt$

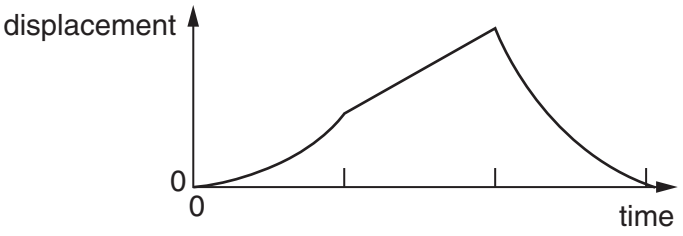
[Turn over

8 The graph of velocity against time for an object moving in a straight line is shown.

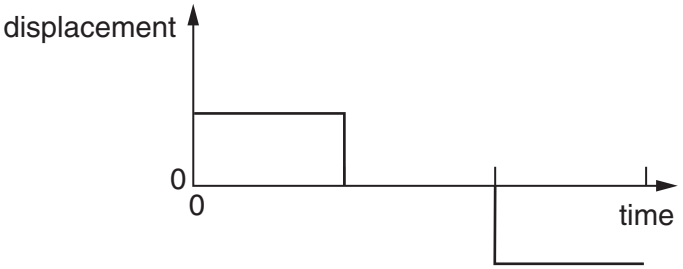


Which of the following is the corresponding graph of displacement against time?

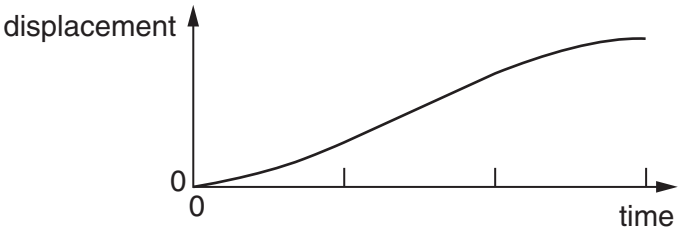
A



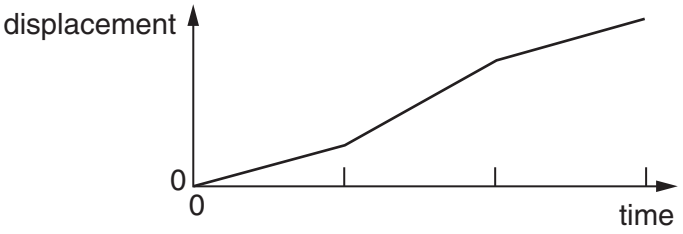
B



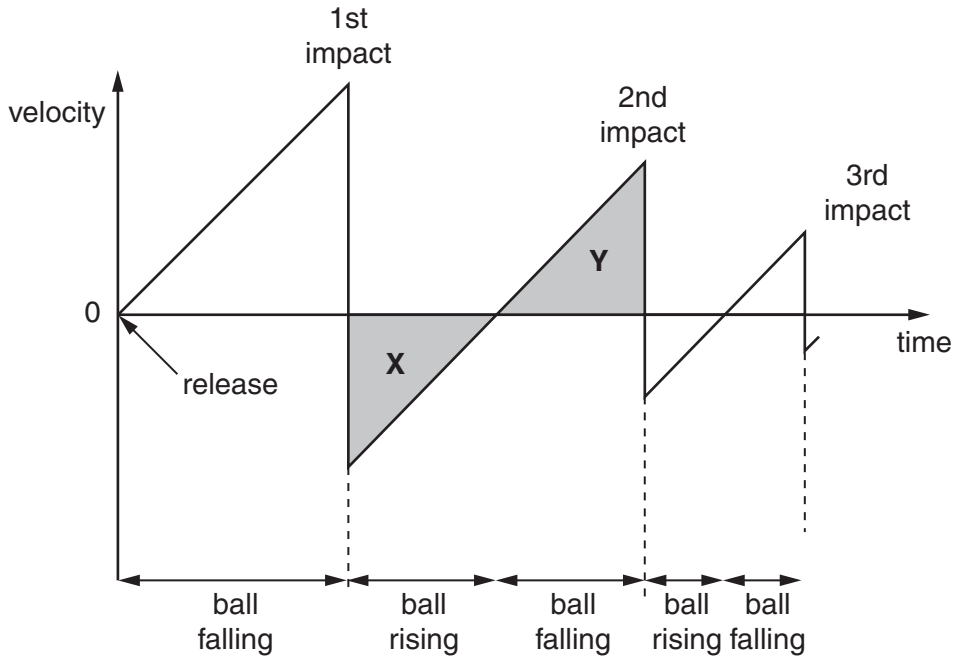
C



D



9 A ball is released from rest above a horizontal surface. The graph shows the variation with time of its velocity.



Areas **X** and **Y** are equal.

This is because

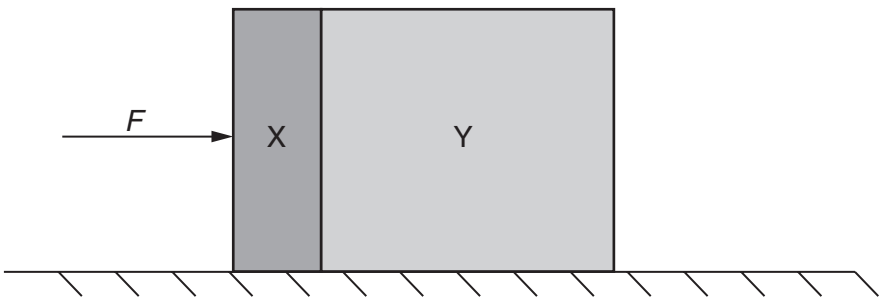
A the ball's acceleration is the same during its upward and downward motion.

B the speed at which the ball leaves the surface after an impact is equal to the speed at which it returns to the surface for the next impact.

C for one impact, the speed at which the ball hits the surface equals the speed at which it leaves the surface.

D the ball rises and falls through the same distance between impacts.

10 Two blocks X and Y, of masses m and $3m$ respectively, are accelerated along a smooth horizontal surface by a force F applied to block X as shown.

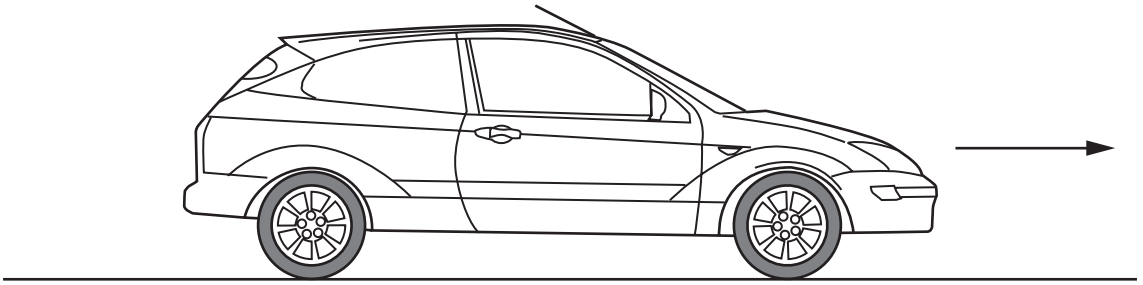


What is the magnitude of the force exerted by block X on block Y during this acceleration?

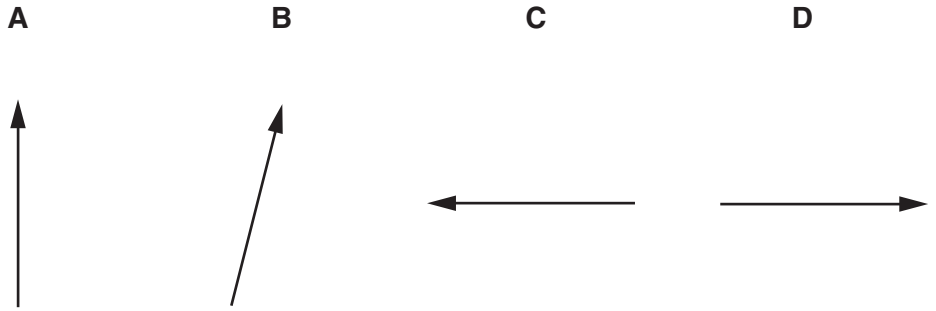
A $\frac{F}{4}$ **B** $\frac{F}{3}$ **C** $\frac{F}{2}$ **D** $\frac{3F}{4}$

[Turn over

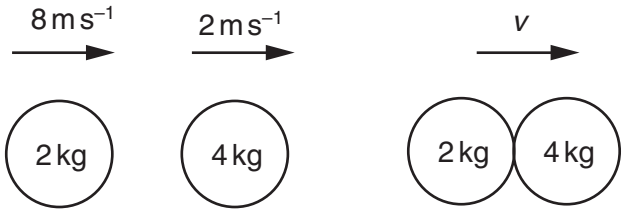
11 A car with front-wheel drive accelerates in the direction shown.



Which diagram best shows the direction of the total force exerted by the road on the front wheels?



12 A ball of mass 2 kg travelling at 8 m s^{-1} strikes a ball of mass 4 kg travelling at 2 m s^{-1}. Both balls are moving along the same straight line as shown.

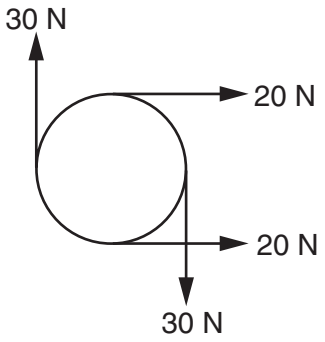


After collision, both balls move at the same velocity *v*.

What is the magnitude of the velocity *v*?

A 4 m s^{-1} **B** 5 m s^{-1} **C** 6 m s^{-1} **D** 8 m s^{-1}

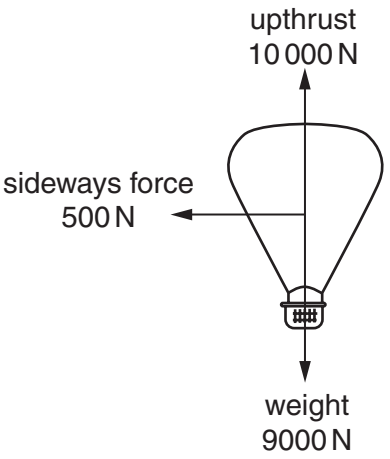
13 The diagram shows four forces applied to a circular object.



Which of the following describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	zero	zero
B	zero	non-zero
C	non-zero	zero
D	non-zero	non-zero

14 A balloon is acted upon by three forces, weight, upthrust and sideways force due to the wind, as shown in the diagram.



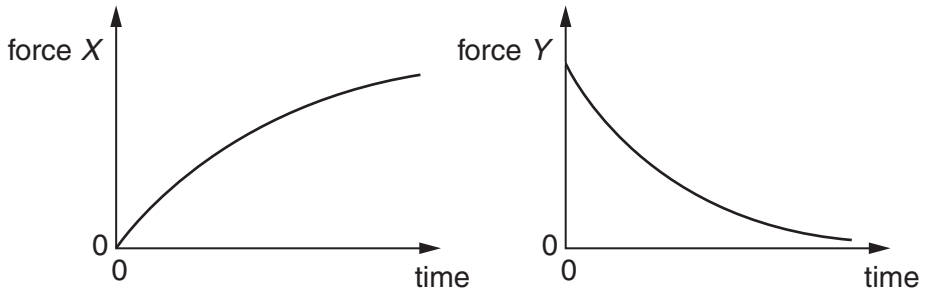
What is the vertical component of the resultant force on the balloon?

A 500 N **B** 1000 N **C** 10 000 N **D** 10 500 N

[Turn over

15 A ball falls from rest through air and eventually reaches a constant velocity.

For this fall, forces *X* and *Y* vary with time as shown.



What are forces *X* and *Y*?

	force *X*	force *Y*
A	air resistance	resultant force
B	air resistance	weight
C	upthrust	resultant force
D	upthrust	weight

16 Which of the following expressions **defines** power?

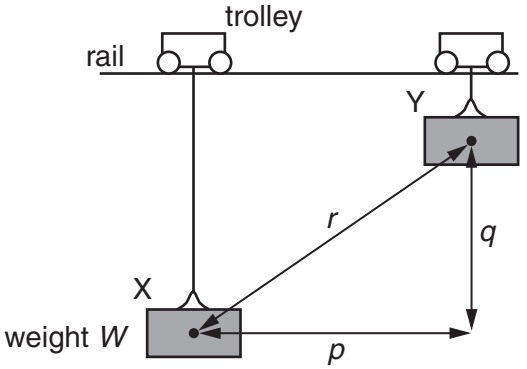
A force x distance moved in the direction of the force

B force x velocity

C work done ÷ time taken

D work done x time taken

17 A weight *W* hangs from a trolley that runs along a rail. The trolley moves horizontally through a distance *p* and simultaneously raises the weight through a height *q*.



As a result, the weight moves through a distance *r* from X to Y. It starts and finishes at rest.

How much work is done on the weight during this process?

A Wp **B** $W(p + q)$ **C** Wq **D** Wr

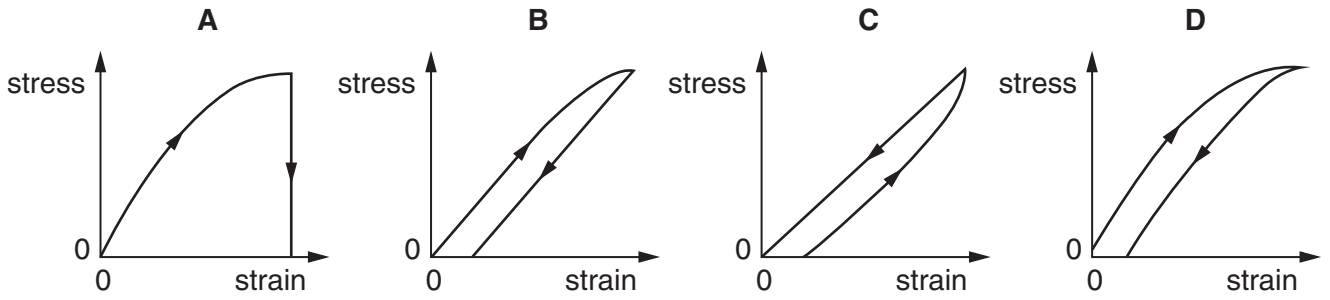
18 A motorist travelling at 10 m s^{-1} can bring his car to rest in a distance of 10 m.

If he had been travelling at 30 m s^{-1}, in what distance could he bring the car to rest using the same braking force?

A 17 m **B** 30 m **C** 52 m **D** 90 m

19 A suspended copper wire is gradually loaded until it is stretched just beyond the elastic limit, and it is then gradually unloaded.

Which graph (with arrows indicating the sequence) best illustrates the variation of the tensile stress with longitudinal strain?



20 A child drinks a liquid of density ρ through a vertical straw.

Atmospheric pressure is p_0 and the child is capable of lowering the pressure at the top of the straw by 10%. The acceleration of free fall is g.

What is the maximum length of straw that would enable the child to drink the liquid?

A $\frac{p_0}{10\rho g}$ **B** $\frac{9p_0}{10\rho g}$ **C** $\frac{p_0}{\rho g}$ **D** $\frac{10p_0}{\rho g}$

21 What is the ultimate tensile stress of a material?

A the stress at which the material becomes ductile

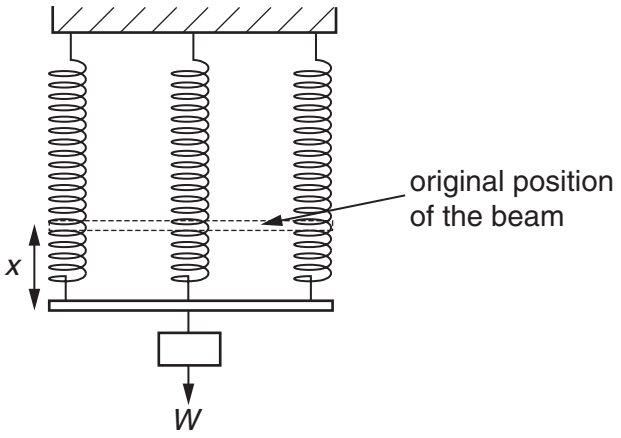
B the stress at which the material breaks

C the stress at which the material deforms plastically

D the stress at which the material reaches its elastic limit

[Turn over

22 A beam, the weight of which may be neglected, is supported by three identical springs. When a weight W is hung from the middle of the beam, the extension of each spring is x.



The middle spring and the weight are removed.

What is the extension when a weight of $2W$ is hung from the middle of the beam?

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

23 Which of the following is true for all transverse waves?

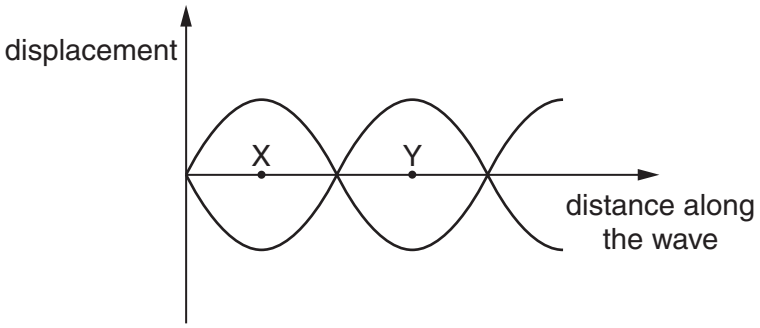
A They are all electromagnetic.

B They can all be polarised.

C They can all travel through a vacuum.

D They all involve the oscillation of atoms.

24 The graph represents a stationary wave at two different times.



What does the distance XY represent?

A half the amplitude

B half the frequency

C half the period

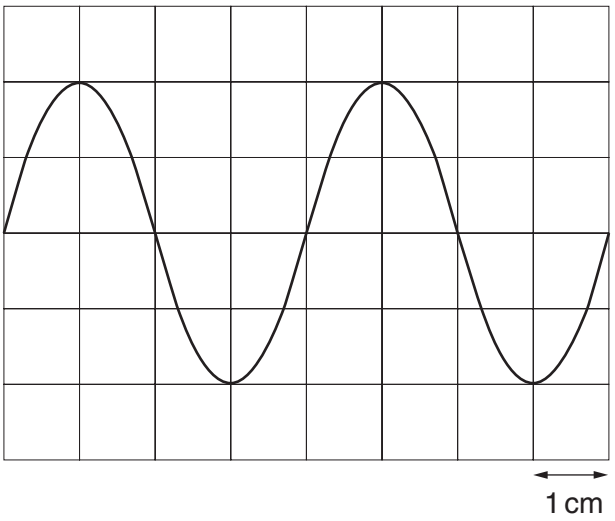
D half the wavelength

25 Electromagnetic waves of wavelength λ and frequency f travel at speed c in a vacuum.

Which of the following describes the wavelength and speed of electromagnetic waves of frequency $f/2$?

	wavelength	speed in a vacuum
A	$\lambda/2$	$c/2$
B	$\lambda/2$	c
C	2λ	c
D	2λ	$2c$

26 A sound wave is displayed on the screen of a cathode-ray oscilloscope. The time base of the c.r.o. is set at 2.5 ms / cm.



What is the frequency of the sound wave?

A 50 Hz **B** 100 Hz **C** 200 Hz **D** 400 Hz

27 When the light from two lamps falls on a screen, no interference pattern can be obtained.

Why is this?

A The lamps are not point sources.

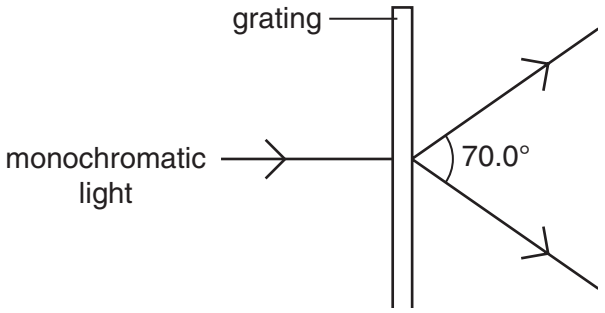
B The lamps emit light of different amplitudes.

C The light from the lamps is not coherent.

D The light from the lamps is white.

[Turn over

28 A diffraction grating is used to measure the wavelength of monochromatic light, as shown in the diagram.



The spacing of the slits in the grating is 1.00×10^{-6} m. The angle between the first order diffraction maxima is 70.0°.

What is the wavelength of the light?

A 287 nm **B** 470 nm **C** 574 nm **D** 940 nm

29 What physical quantity would result from a calculation in which a potential difference is multiplied by an electric charge?

A electric current

B electric energy

C electric field strength

D electric power

30 The current in a component is reduced uniformly from 100 mA to 20 mA over a period of 8.0 s.

What is the charge that flows during this time?

A 160 mC **B** 320 mC **C** 480 mC **D** 640 mC

31 The sum of the electrical currents into a point in a circuit is equal to the sum of the currents out of the point.

Which of the following is correct?

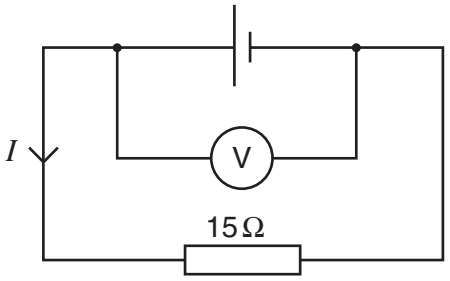
A This is Kirchhoff's first law, which results from the conservation of charge.

B This is Kirchhoff's first law, which results from the conservation of energy.

C This is Kirchhoff's second law, which results from the conservation of charge.

D This is Kirchhoff's second law, which results from the conservation of energy.

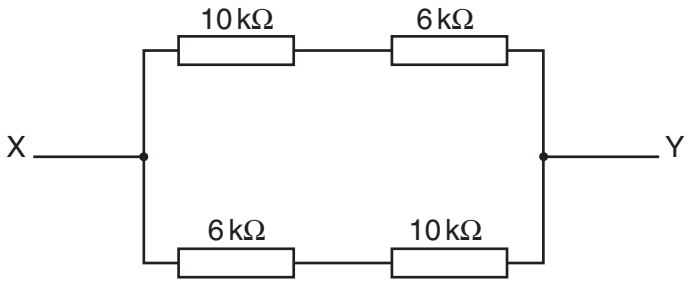
32 The e.m.f. of the cell in the following circuit is 9.0 V. The reading on the high-resistance voltmeter is 7.5 V.



What is the current I?

A 0.1 A **B** 0.5 A **C** 0.6 A **D** 2.0 A

33 The diagram shows an arrangement of four resistors.

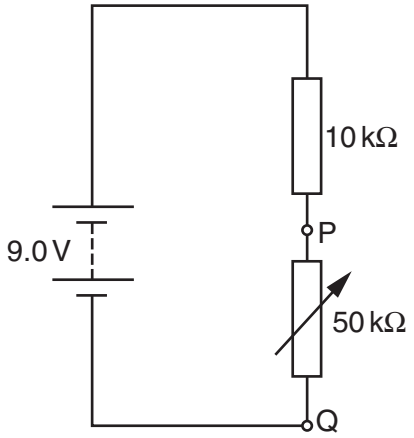


What is the resistance between X and Y?

A 4 kΩ **B** 8 kΩ **C** 16 kΩ **D** 32 kΩ

[Turn over

34 The diagram shows a potential divider connected to a 9.0 V supply of negligible internal resistance.



What range of voltages can be obtained between P and Q?

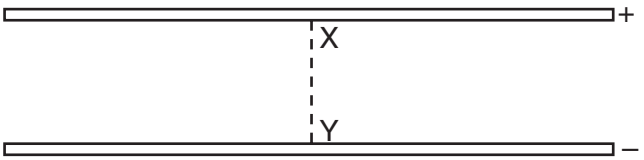
A zero to 1.5 V

B zero to 7.5 V

C 1.5 V to 7.5 V

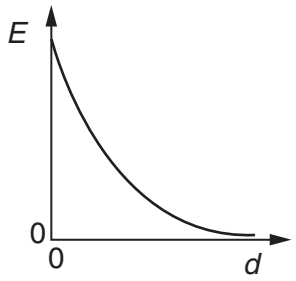
D 1.5 V to 9.0 V

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

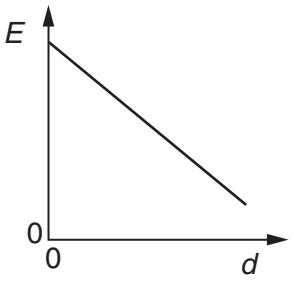


Which of the following graphs shows the variation of electric field strength *E* with distance *d* from X along the line XY?

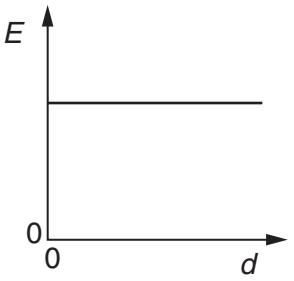
A



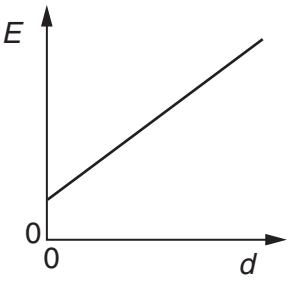
B



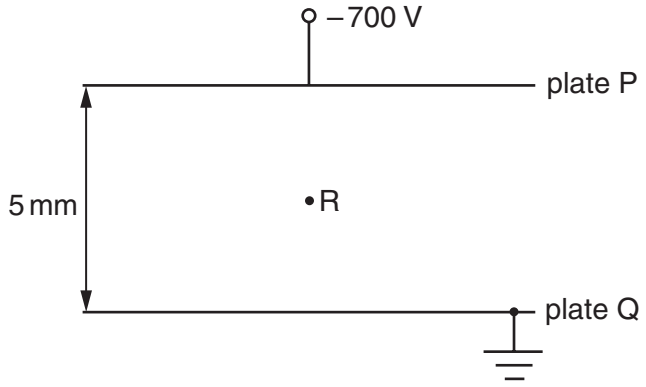
C



D



36 The diagram shows two metal plates P and Q between which there is a potential difference of 700 V. Plate Q is earthed.



What is the magnitude and direction of the electric field at point R?

A $1.4 \times 10^2\,N\,C^{-1}$ from P towards Q

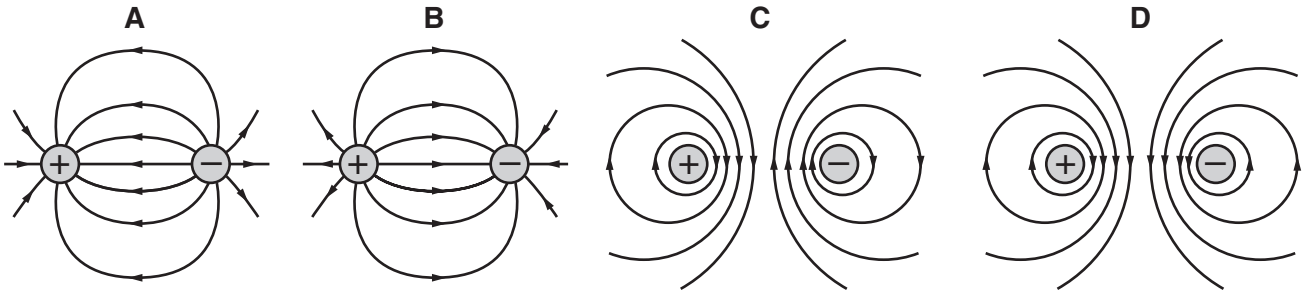
B $1.4 \times 10^2\,N\,C^{-1}$ from Q towards P

C $1.4 \times 10^5\,N\,C^{-1}$ from P towards Q

D $1.4 \times 10^5\,N\,C^{-1}$ from Q towards P

37 A positive charge and a negative charge of equal magnitude are placed a short distance apart.

Which diagram best represents the associated electric field?



38 In what way do the atoms of the isotopes $^{12}_{6}C$, $^{13}_{6}C$ and $^{14}_{6}C$ differ?

A different charge

B different numbers of electrons

C different numbers of neutrons

D different numbers of protons

39 Strontium- 90 ($^{90}_{38}Sr$) is radioactive and emits β-particles.

Which equation could represent this nuclear decay?

A $^{90}_{38}Sr \rightarrow {}^{90}_{39}Sr + {}^{0}_{-1}\beta$

B $^{90}_{38}Sr \rightarrow {}^{90}_{39}Y + {}^{0}_{-1}\beta$

C $^{90}_{38}Sr \rightarrow {}^{90}_{37}Rb + {}^{0}_{1}\beta$

D $^{90}_{38}Sr \rightarrow {}^{90}_{37}Sr + {}^{0}_{1}\beta$

40 Protons and neutrons are thought to consist of smaller particles called quarks.

The 'up' quark has a charge of $\frac{2}{3}e$: a 'down' quark has a charge of $-\frac{1}{3}e$, where e is the elementary charge ($+1.6 \times 10^{-19}$ C).

How many up quarks and down quarks must a proton contain?

	up quarks	down quarks
A	0	3
B	1	1
C	1	2
D	2	1

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