Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/11**

Paper 1 Multiple Choice **May/June 2018**

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

5399269005

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, 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.
DO **NOT** WRITE IN ANY BARCODES.

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 working should be done in this booklet.
Electronic calculators may be used.

This document consists of **20** printed 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	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
	$\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$
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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1 What is a unit for stress?

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

2 Physical quantities can be classed as vectors or as scalars.

Which pair of quantities consists of two vectors?

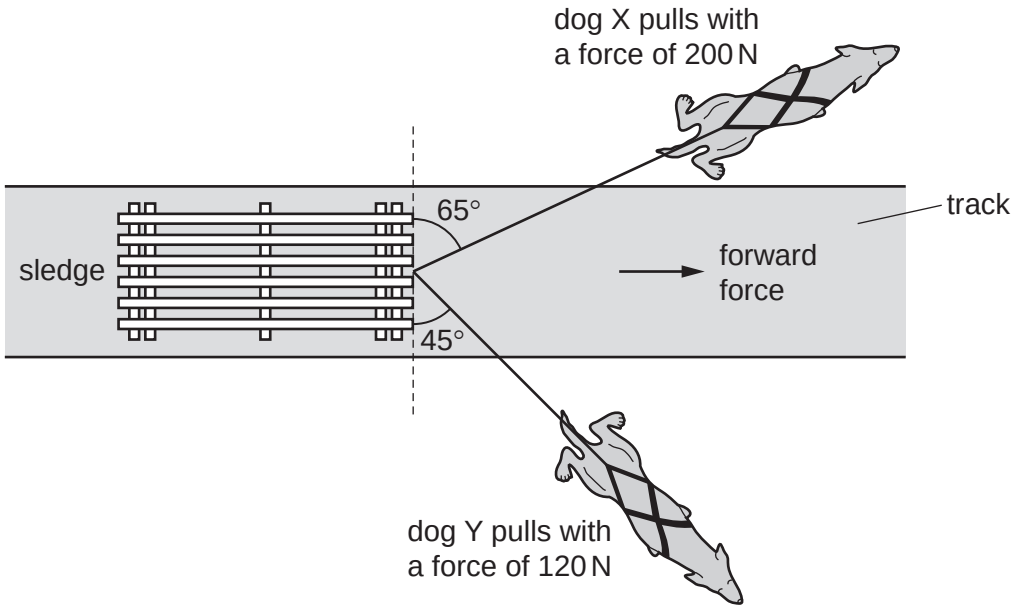
A kinetic energy and force

B momentum and time

C velocity and electric field strength

D weight and temperature

3 Two dogs pull a sledge along an icy track, as shown.



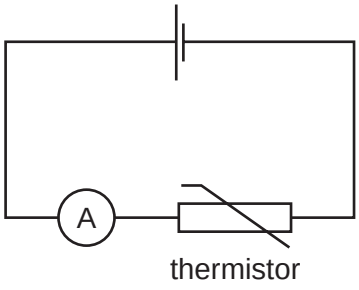
Dog X pulls with a force of 200 N at an angle of 65° to the front edge of the sledge. Dog Y pulls with a force of 120 N at an angle of 45° to the front edge of the sledge.

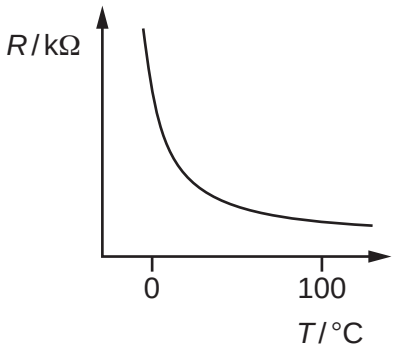
What is the resultant forward force on the sledge exerted by the two dogs?

A 80 N **B** 170 N **C** 270 N **D** 320 N

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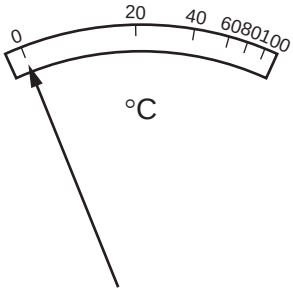
4 In the circuit shown, an analogue ammeter is to be recalibrated as a thermometer. The ammeter is connected in series with a thermistor. The thermistor is a component with a resistance that varies with temperature. The graph shows how the resistance R of the thermistor changes with temperature T.



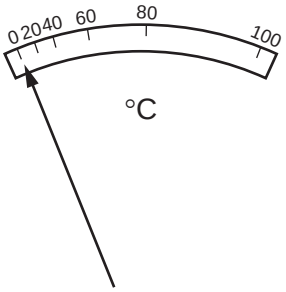


Which diagram could represent the temperature scale on the ammeter?

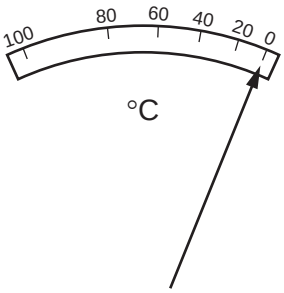
A



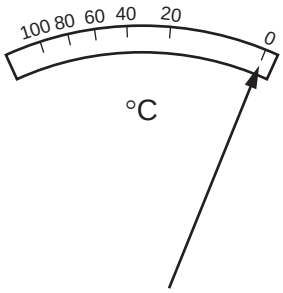
B



C



D



5 The sides of a cube are measured with calipers.

The measured length of each side is (30.0 ± 0.1) mm.

The measurements are used to calculate the volume of the cube.

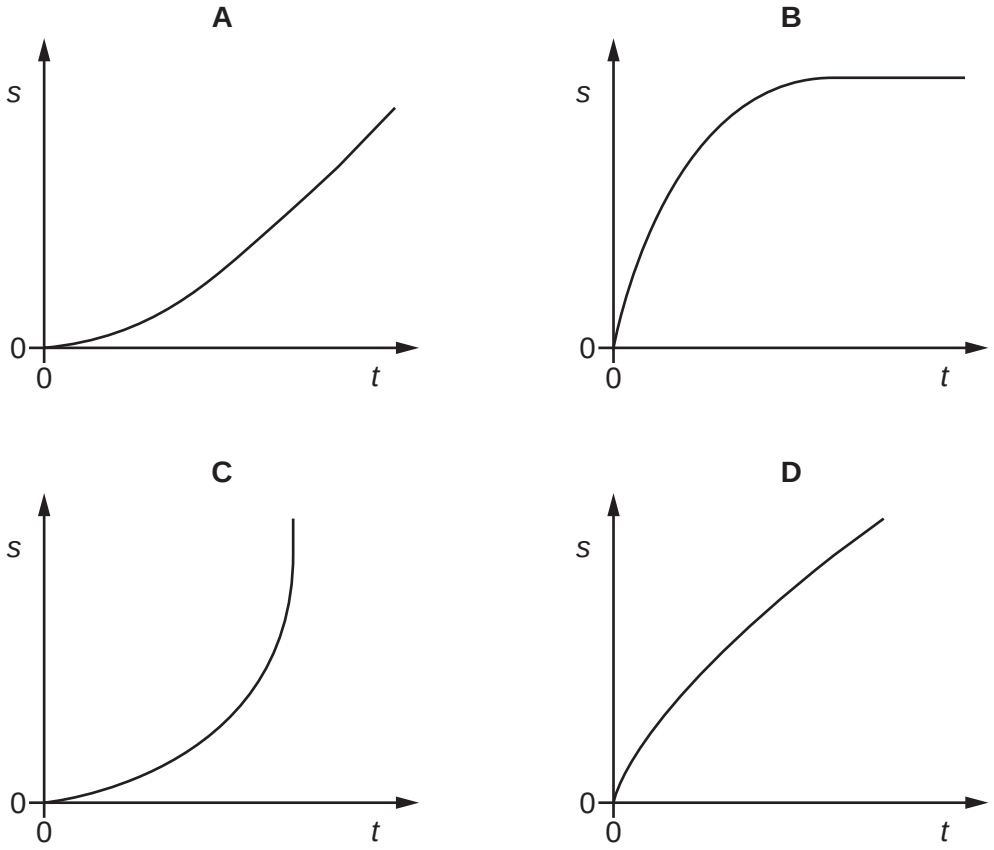
What is the percentage uncertainty in the calculated value of the volume?

A 0.01% **B** 0.3% **C** 1% **D** 3%

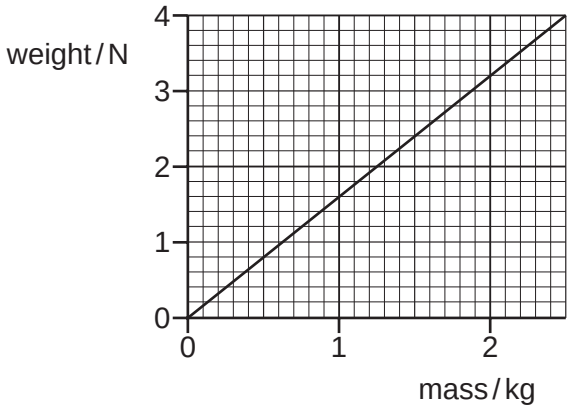
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6 A tennis ball falls freely, in air, from the top of a tall building.

Which graph best represents the variation with time *t* of the distance *s* fallen?



7 The graph shows the variation with mass of the weight of objects on a particular planet.



What is the value of the acceleration of free fall on the planet?

A $0.63\,m\,s^{-2}$ **B** $1.6\,m\,s^{-2}$ **C** $3.2\,m\,s^{-2}$ **D** $9.8\,m\,s^{-2}$

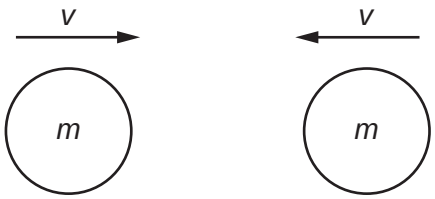
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8 The momentum of a car of mass m increases from p_1 to p_2.

What is the increase in the kinetic energy of the car?

A $\frac{(p_2^2 - p_1^2)}{2m}$ **B** $\frac{(p_2 - p_1)^2}{2m}$ **C** $\frac{p_2 - p_1}{2m}$ **D** $\frac{p_1 - p_2}{2m}$

9 Two similar spheres, each of mass m and travelling with speed v, are moving towards each other.



The spheres have a head-on elastic collision.

Which statement is correct?

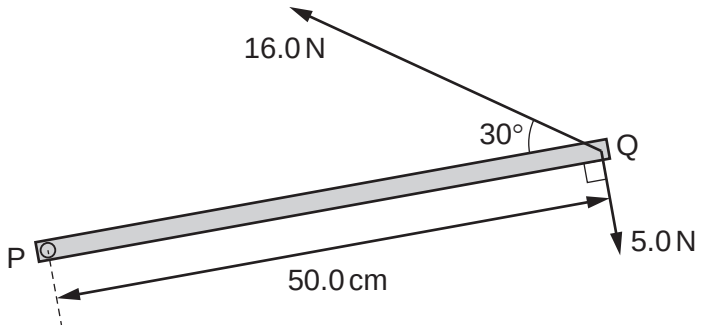
A The spheres stick together on impact.

B The total kinetic energy after impact is mv^2.

C The total kinetic energy before impact is zero.

D The total momentum before impact is $2mv$.

10 A horizontal metal bar PQ of length 50.0 cm is hinged at end P. The diagram shows the metal bar viewed from above.



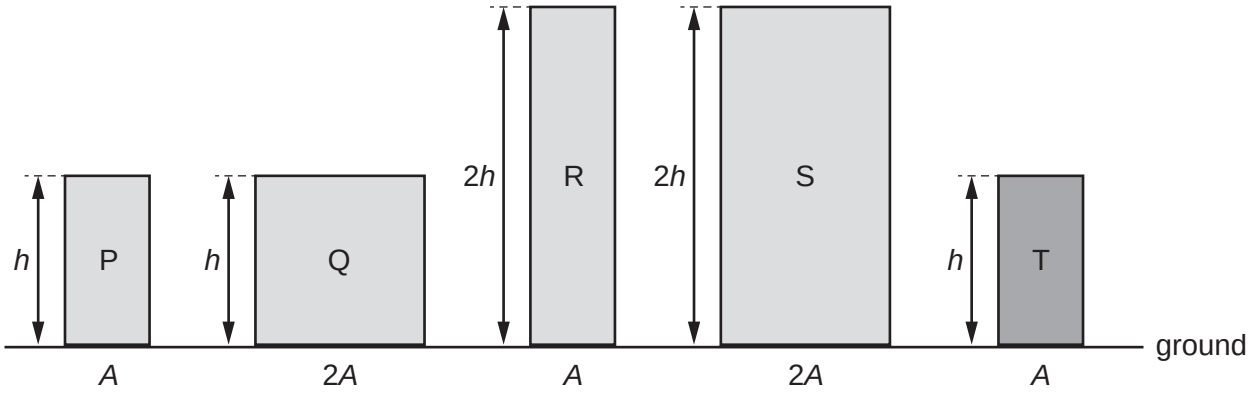
Two forces of 16.0 N and 5.0 N are in the horizontal plane and act on end Q as shown in the diagram.

What is the total moment about P due to the two forces?

A 1.5 N m **B** 4.4 N m **C** 6.5 N m **D** 9.4 N m

11 Blocks P, Q, R and S are made from material of the same density. Block T is made from a material of twice the density of the material of the other blocks.

The cross-sectional area and height of each of the blocks are shown.



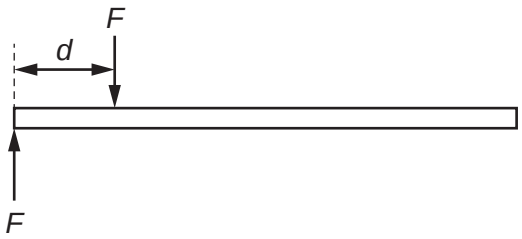
Which two blocks exert the same pressure on the ground?

A P and T **B** Q and R **C** Q and S **D** S and T

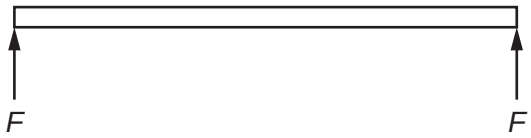
12 Two parallel forces, each of magnitude F, act on a rod of length $5d$.

Which diagram shows the positions of the two forces that will produce the largest torque on the rod?

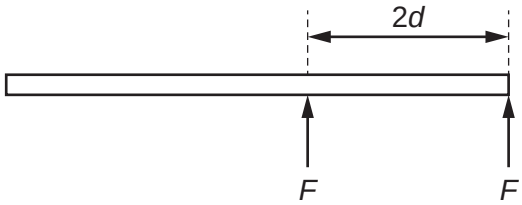
A



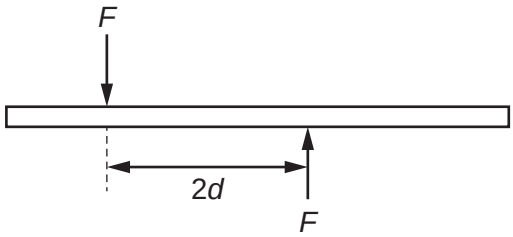
B



C



D



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13 Liquids X and Y are stored in large open tanks. Liquid X has a density of 800 kg m^{-3} and liquid Y has a density of 1200 kg m^{-3}.

At which depths are the pressures equal?

	depth in liquid X / m	depth in liquid Y / m
A	8	20
B	10	15
C	15	10
D	20	8

14 A train of mass 3.3×10^6 kg is moving at a constant speed up a slope inclined at an angle of 0.64° to the horizontal. The engine of the train is producing a useful output power of 14 MW.

Assume that there are no frictional forces opposing the motion of the train.

What is the speed of the train?

A 0.43 m s^{-1} **B** 4.2 m s^{-1} **C** 39 m s^{-1} **D** 380 m s^{-1}

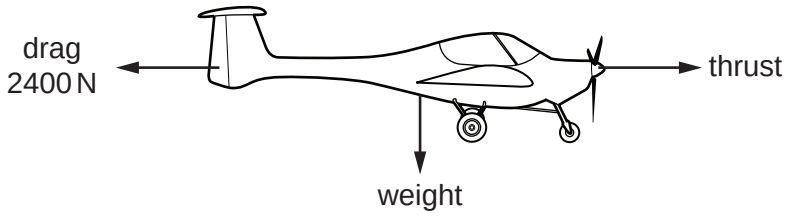
15 A cannon-ball of mass 3.50 kg is fired at a speed of 22.0 m s^{-1} from a gun on a ship at a height of 6.00 m above sea level.

The total energy of the cannon-ball is the sum of the gravitational potential energy relative to the surface of the sea and the kinetic energy.

What is the total energy of the cannon-ball as it leaves the gun?

A 206 J **B** 641 J **C** 847 J **D** 1050 J

16 An aircraft travels at a constant velocity of 90 m s^{-1} in horizontal flight. The diagram shows some of the forces acting on the aircraft.

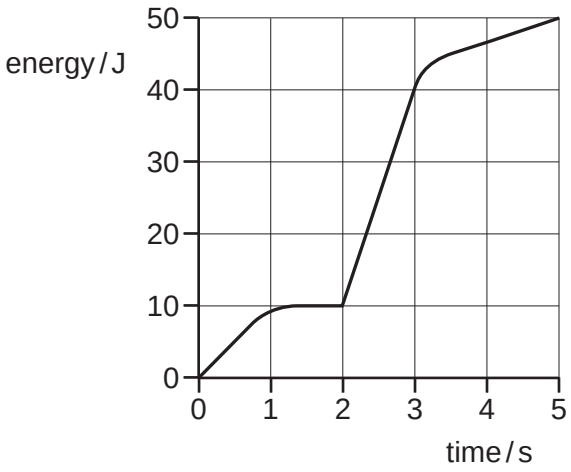


The mass of the aircraft is 2000 kg.

What is the power produced by the thrust force?

A 1.8×10^5 W **B** 2.2×10^5 W **C** 1.8×10^6 W **D** 2.0×10^6 W

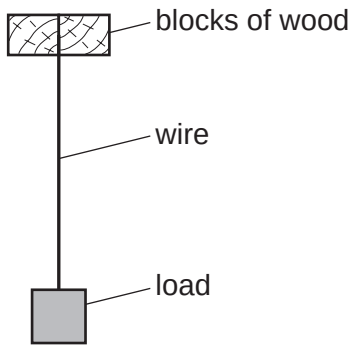
17 An electrical generator is started at time zero. The total electrical energy generated during the first 5 seconds is shown in the graph.



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

18 The diagram shows a wire of diameter *D* and length *L* that is firmly clamped at one end between two blocks of wood. A load is applied to the wire which extends its length by *x*.



A second wire is made of the same material, but of diameter 2*D* and length 3*L*. Both wires obey Hooke's law.

What is the extension of the second wire when the same load is applied?

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

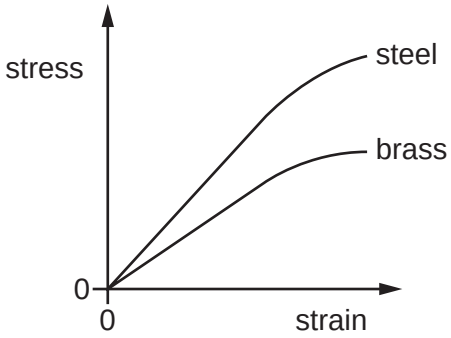
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19 Two wires, one made of brass and the other of steel, are stretched in an experiment. Both wires obey Hooke's law during this experiment.

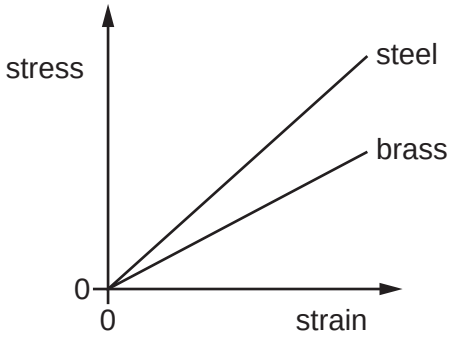
The Young modulus for brass is less than the Young modulus for steel.

Which graph shows how the stress varies with strain for both wires in this experiment?

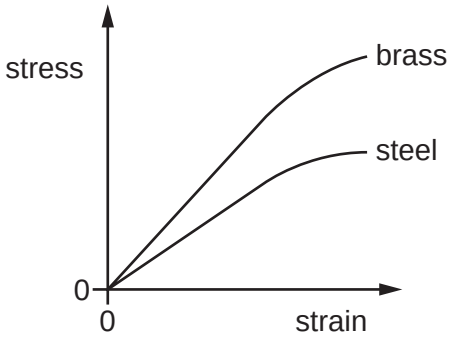
A



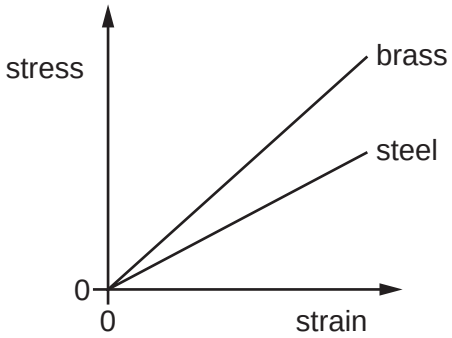
B



C

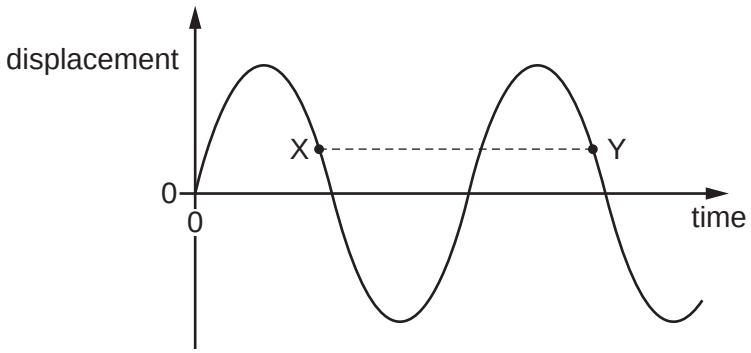


D



20 A transverse progressive wave is set up on a string.

The graph shows the variation with time of displacement for a point on this string.



The separation XY on the graph represents the ……1…… of the wave.

X and Y have equal ……2…… .

Which words correctly complete gaps 1 and 2?

	1	2
A	time period	amplitudes
B	time period	displacements
C	wavelength	amplitudes
D	wavelength	displacements

21 Which region of the electromagnetic spectrum includes waves with a frequency of 10^7 MHz?

A infra-red waves

B radio waves

C ultraviolet waves

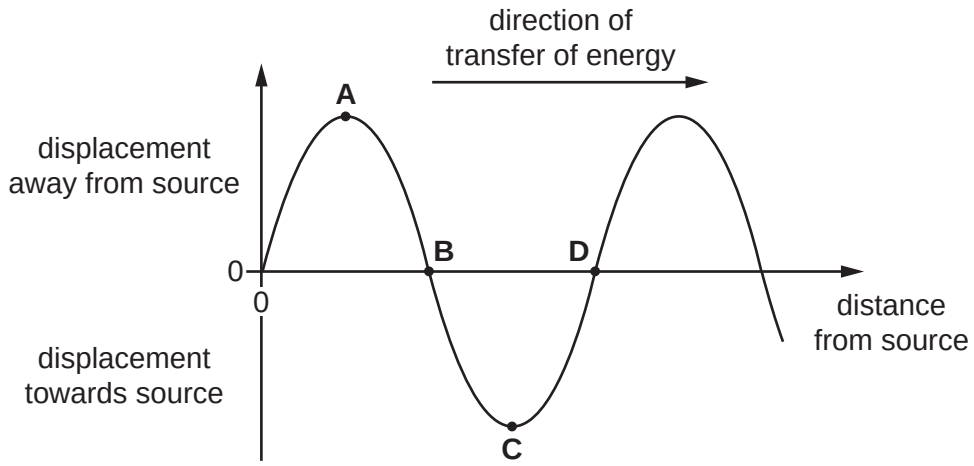
D X-rays

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22 A longitudinal wave has vibrations parallel to the direction of transfer of energy by the wave.

The wave can be represented on a graph showing the variation of the displacement of the particles with distance from the source.

Which point on the graph is the centre of a compression?



23 What can be deduced from a table of wavelengths of the waves in the electromagnetic spectrum?

A Green light has a shorter wavelength than X-rays.

B Red light has a shorter wavelength than green light.

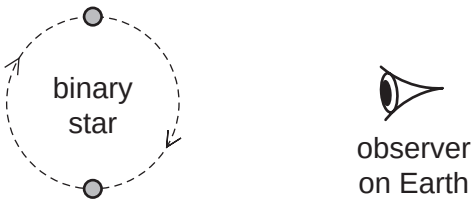
C The wavelength range for radio waves is less than that for infra-red waves.

D The wavelength range for X-rays is less than that for radio waves.

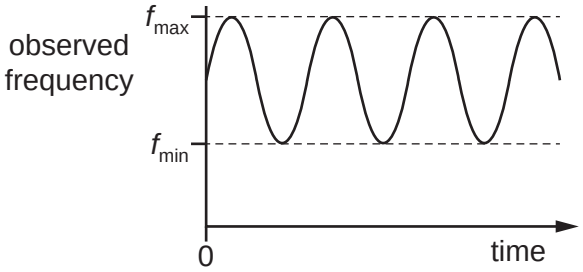
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[Turn over

24 A binary star consists of two stars rotating around a common centre. Light from one of the stars is observed on the Earth.



The observed frequency of the light varies between a minimum frequency f_{min} and a maximum frequency f_{max}, as shown.



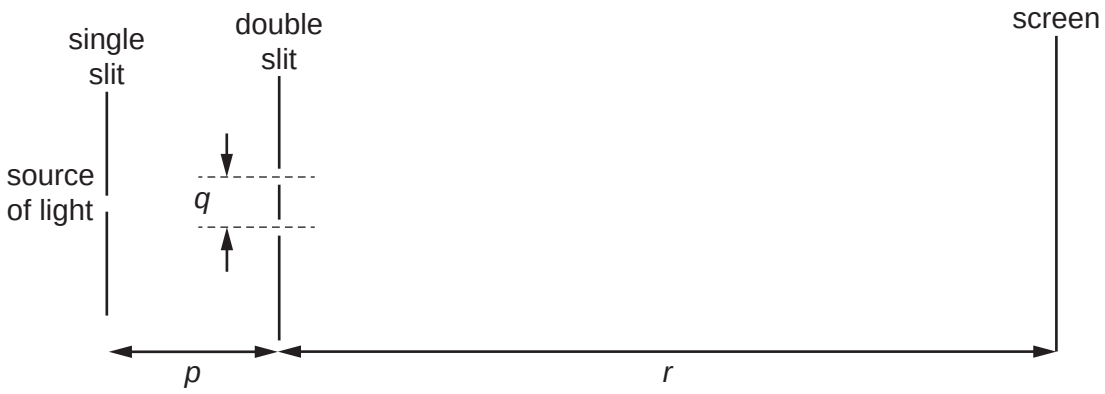
The rate of rotation of the binary star increases.

What is the change to f_{max} and the change to f_{min}?

	f_{max}	f_{min}
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

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25 A teacher sets up the apparatus shown to demonstrate a double-slit interference pattern on the screen.



Which change to the apparatus will increase the fringe spacing?

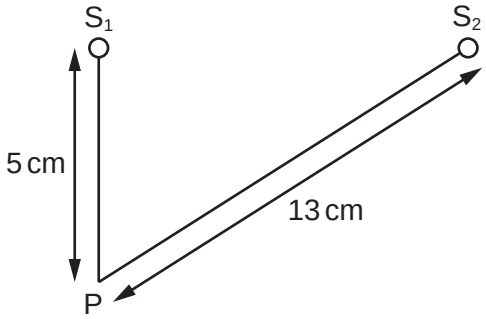
A decreasing the distance *p*

B decreasing the distance *q*

C decreasing the distance *r*

D decreasing the wavelength of the light

26 The diagram shows two sources of waves S_1 and S_2. The sources oscillate with a phase difference of 180°.

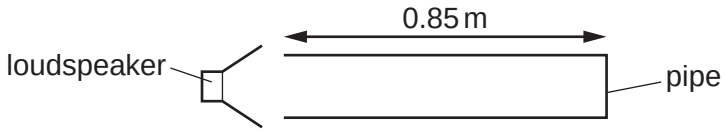


The sources each generate a wave of wavelength 2.0 cm. Each source produces a wave that has amplitude x_0 when it reaches point P.

What is the amplitude of the oscillation at P?

A 0 **B** $\frac{x_0}{2}$ **C** x_0 **D** $2x_0$

27 A pipe, closed at one end, has a loudspeaker at the open end. A stationary sound wave is formed in the air within the pipe with an antinode at the open end of the pipe.



The length of the pipe is 0.85 m.

The speed of sound in air is 340 m s^{-1}.

Which frequency of sound from the loudspeaker would **not** produce a stationary wave?

A 100 Hz **B** 200 Hz **C** 300 Hz **D** 500 Hz

28 A particle has a charge of +2.0 mC and is in a vertical uniform electric field. An electric force of 1.0×10^{-2} N acts upwards on the particle.

What is the electric field strength?

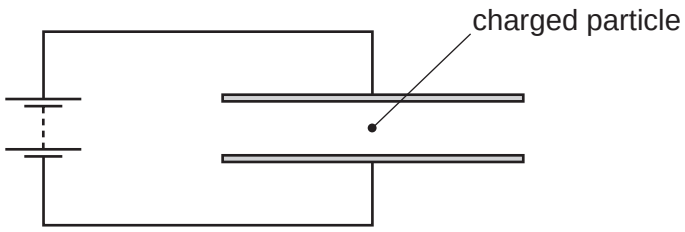
A 0.20 V m^{-1} downwards

B 0.20 V m^{-1} upwards

C 5.0 V m^{-1} downwards

D 5.0 V m^{-1} upwards

29 A charged particle is in the electric field between two horizontal metal plates connected to a battery, as shown. There is a force *F* on the particle due to the electric field.



The separation of the plates is doubled.

What is the new force on the particle?

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

30 The current I in a metal wire is given by the expression shown.

$$I = Anvq$$

What does the symbol n represent?

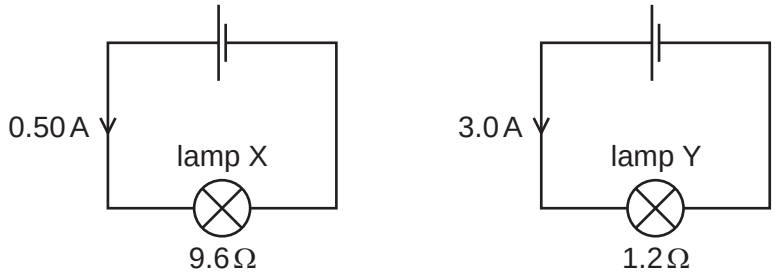
A the number of atoms per unit volume of the metal

B the number of free electrons per atom in the metal

C the number of free electrons per unit volume of the metal

D the total number of electrons per unit volume of the metal

31 The circuit diagrams show two lamps X and Y each connected to a cell. The current in lamp X is 0.50 A and its resistance is 9.6 Ω. The current in lamp Y is 3.0 A and its resistance is 1.2 Ω.



What is the ratio $\frac{\text{power in lamp X}}{\text{power in lamp Y}}$?

A 0.22 **B** 0.75 **C** 1.3 **D** 4.5

32 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** $4R$

33 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 statement is correct?

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

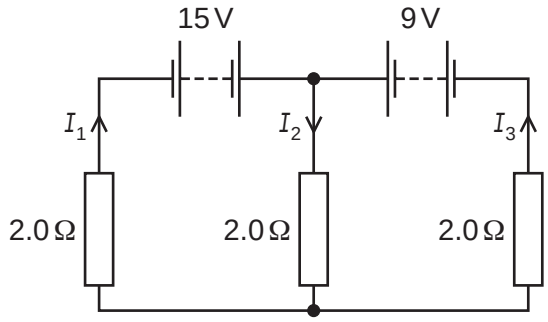
B This is Kirchhoff's first law, which results from the conservation of energy.

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.

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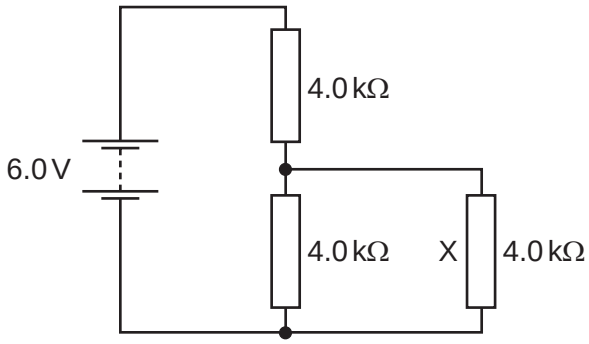
34 In the circuit shown, the batteries have negligible internal resistance.



What are the values of the currents I_1, I_2 and I_3?

	I_1 / A	I_2 / A	I_3 / A
A	–5.5	1.0	6.5
B	0.5	4.0	3.5
C	3.5	4.0	0.5
D	6.5	1.0	–5.5

35 A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected to three resistors as shown.



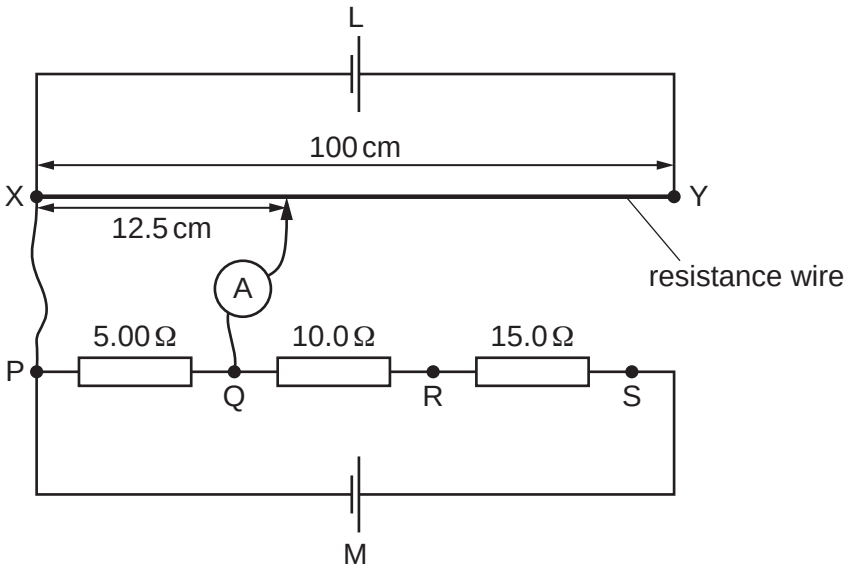
Each resistor has a resistance of 4.0 kΩ.

What is the current in resistor X?

A 0.25 mA **B** 0.50 mA **C** 0.75 mA **D** 1.0 mA

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36 A uniform resistance wire XY of length 100 cm is connected in series with a cell L. Another cell M is connected in series with resistors of resistances 5.00 Ω, 10.0 Ω and 15.0 Ω.



The potential difference (p.d.) between P and Q is balanced against 12.5 cm of the resistance wire, so that the ammeter reads zero.

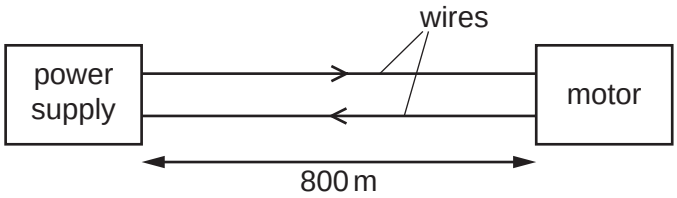
The p.d. across the other resistors is then balanced against other lengths of the resistance wire.

Which balanced lengths of resistance wire correspond to the connection points given in the table?

connection points	balanced length / cm			
	A	**B**	**C**	**D**
Q and R	12.5	25.0	25.0	25.0
Q and S	62.5	62.5	75.0	62.5
P and R	37.5	37.5	37.5	12.5

37 A motor is required to operate at a distance of 800 m from its power supply. The motor requires a potential difference (p.d.) of 16.0 V and a current of 0.60 A to operate.

Two wires are used to supply power to the motor as shown.



The resistance of each of these wires is 0.0050 Ω per metre.

What is the minimum output p.d. of the power supply?

A 11.2 V **B** 16.0 V **C** 18.4 V **D** 20.8 V

38 Which elementary particle is a lepton?

A proton

B neutron

C electron

D quark

39 How many down quarks are in a nucleus of hydrogen-3, $^{3}_{1}\mathrm{H}$?

A 2 **B** 3 **C** 4 **D** 5

40 What is the correct equation for β^{+} decay?

A neutron $\rightarrow$ proton + electron + electron antineutrino

B neutron $\rightarrow$ proton + electron + electron neutrino

C proton $\rightarrow$ neutron + positron + electron antineutrino

D proton $\rightarrow$ neutron + positron + electron neutrino

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