

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)

* 5 3 9 9 2 6 9 0 0 5 *



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.



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	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ ($\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1}$)
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 unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
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

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

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

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

capacitors in series

$$1/C = 1/C_1 + 1/C_2 + \dots$$

capacitors in parallel

$$C = C_1 + C_2 + \dots$$

energy of charged capacitor

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

electric current

$$I = Anvq$$

resistors in series

$$R = R_1 + R_2 + \dots$$

resistors in parallel

$$1/R = 1/R_1 + 1/R_2 + \dots$$

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

$$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$$

1 What is a unit for stress?

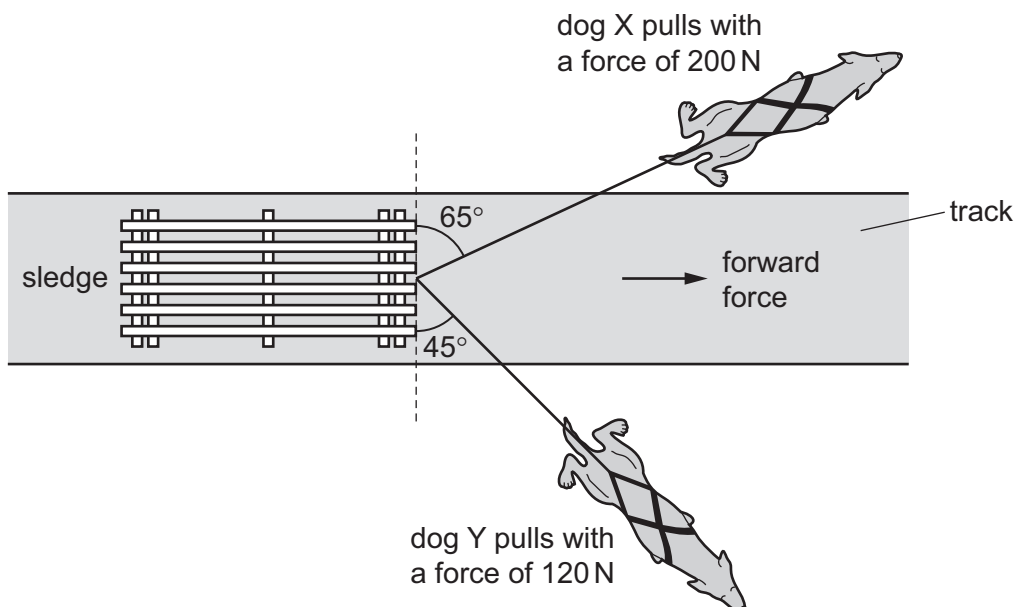
- A** $\text{kg m}^{-1} \text{s}^{-2}$ **B** $\text{kg m}^{-2} \text{s}^{-2}$ **C** N m^{-1} **D** N m

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.

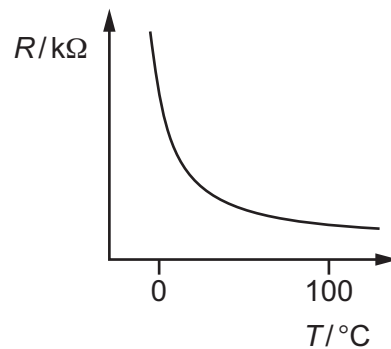
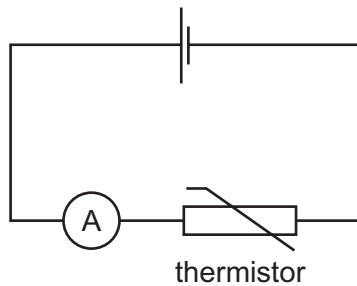


Dog X pulls with a force of 200 N at an angle of 65° to the front edge of the sledge. Dog Y pulls with a force of 120 N at an angle of 45° to the front edge of the sledge.

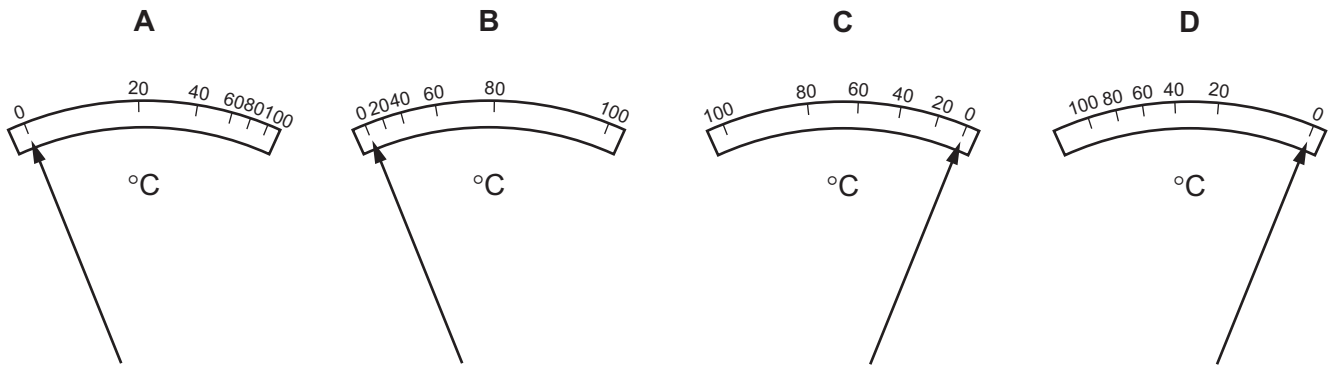
What is the resultant forward force on the sledge exerted by the two dogs?

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

- 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?



- 5 The sides of a cube are measured with calipers.

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

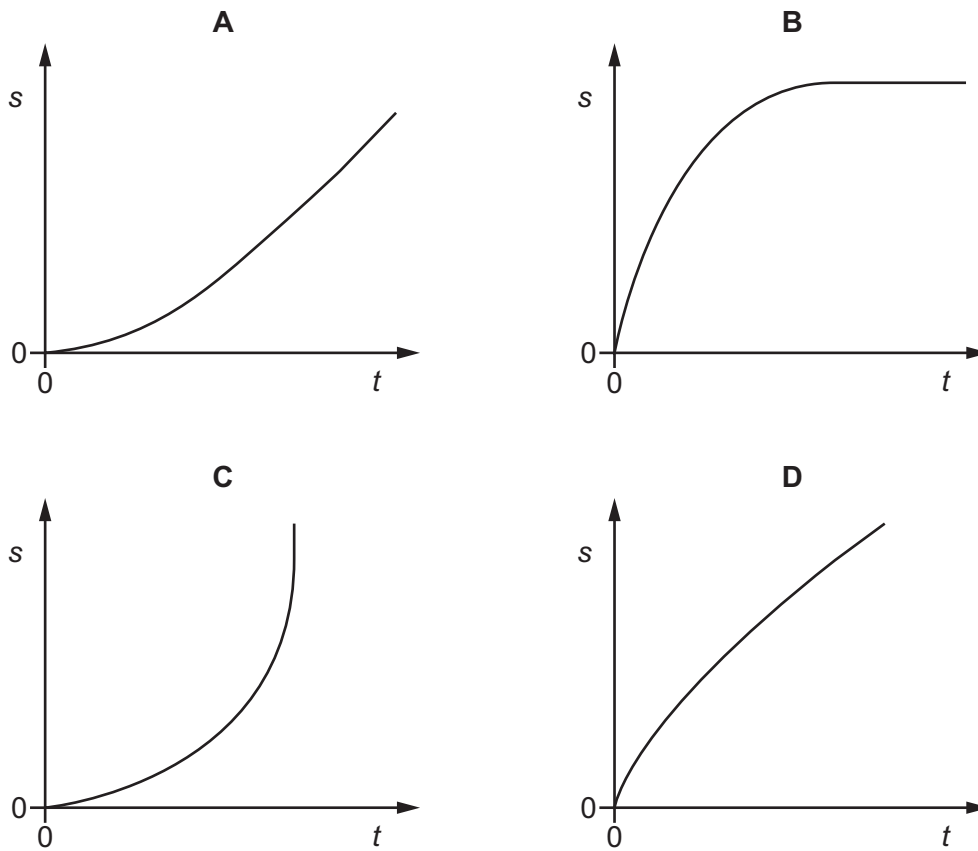
The measurements are used to calculate the volume of the cube.

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

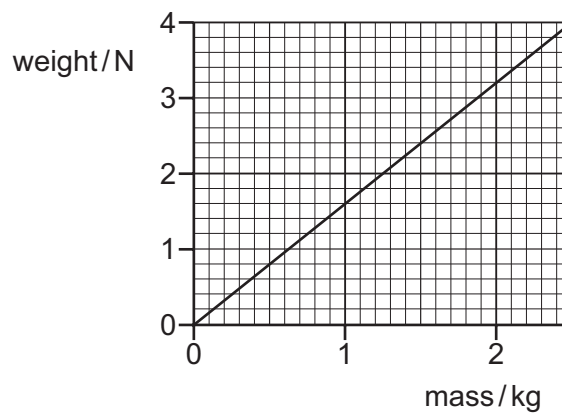
- A 0.01% B 0.3% C 1% D 3%

- 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?

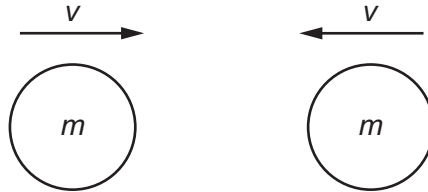
- A** 0.63 ms^{-2} **B** 1.6 ms^{-2} **C** 3.2 ms^{-2} **D** 9.8 ms^{-2}

- 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 $\frac{p_1 - p_2}{2m}$

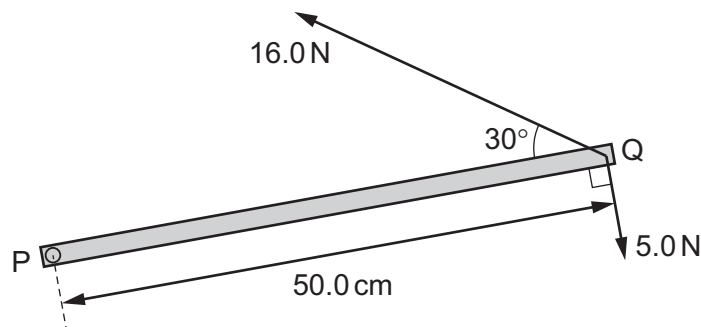
- 9 Two similar spheres, each of mass m and travelling with speed v , are moving towards each other.



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.



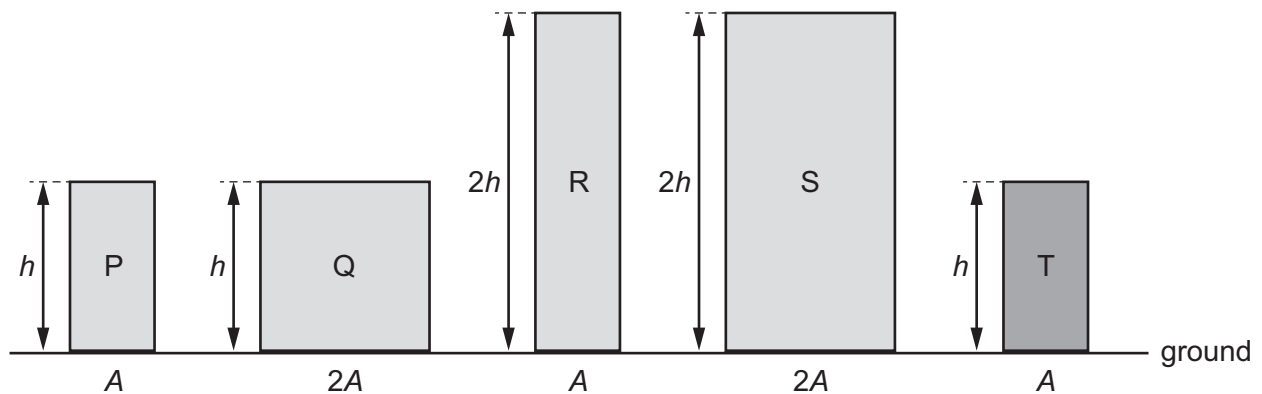
Two forces of 16.0 N and 5.0 N are in the horizontal plane and act on end Q as shown in the diagram.

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

- A 1.5 Nm B 4.4 Nm C 6.5 Nm D 9.4 Nm

- 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.

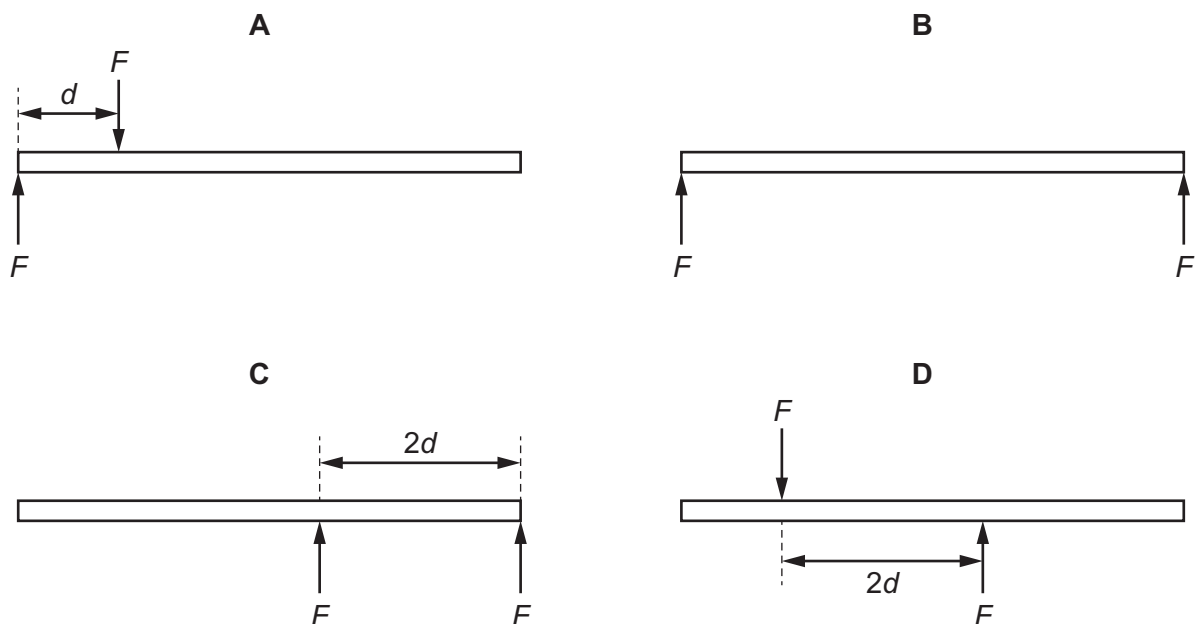


Which two blocks exert the same pressure on the ground?

- 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?



- 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 $3.3 \times 10^6 \text{ kg}$ 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.

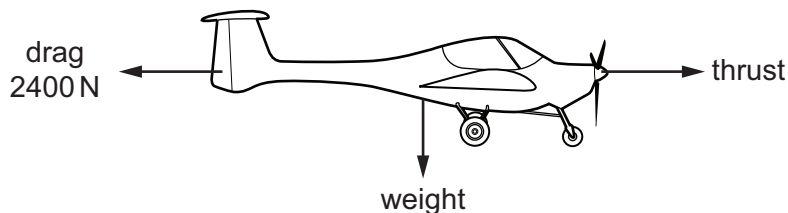
What is the speed of the train?

- A** 0.43 ms^{-1} **B** 4.2 ms^{-1} **C** 39 ms^{-1} **D** 380 ms^{-1}
- 15** A cannon-ball of mass 3.50 kg is fired at a speed of 22.0 ms^{-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 ms^{-1} in horizontal flight. The diagram shows some of the forces acting on the aircraft.

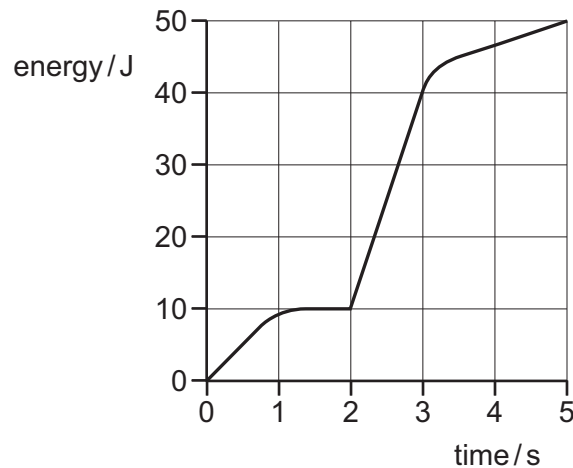


The mass of the aircraft is 2000 kg .

What is the power produced by the thrust force?

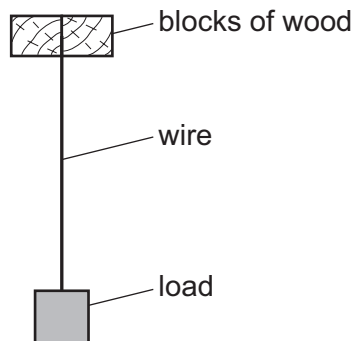
- A** $1.8 \times 10^5 \text{ W}$ **B** $2.2 \times 10^5 \text{ W}$ **C** $1.8 \times 10^6 \text{ W}$ **D** $2.0 \times 10^6 \text{ W}$

- 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 $2D$ and length $3L$. Both wires obey Hooke's law.

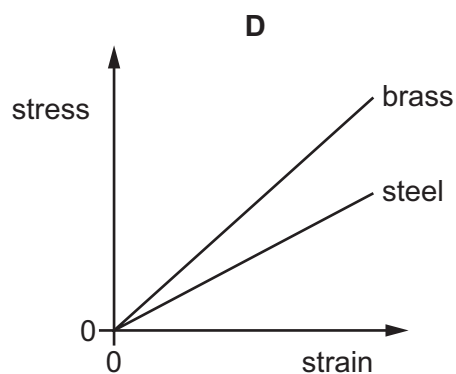
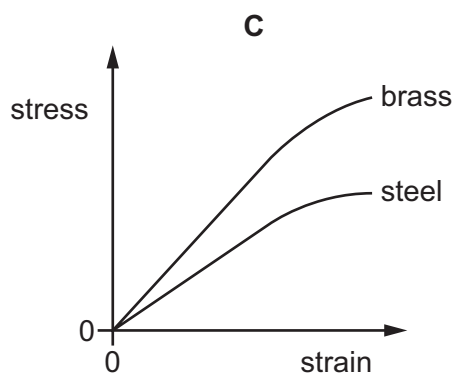
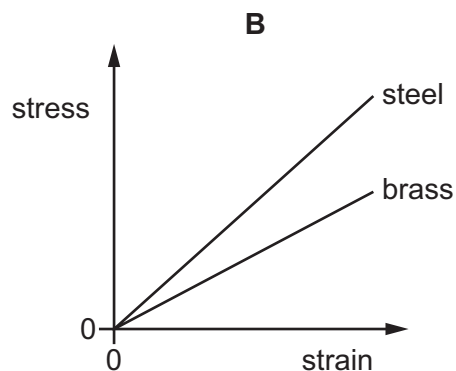
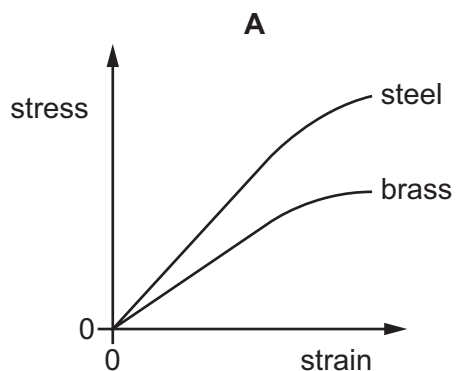
What is the extension of the second wire when the same load is applied?

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

- 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.

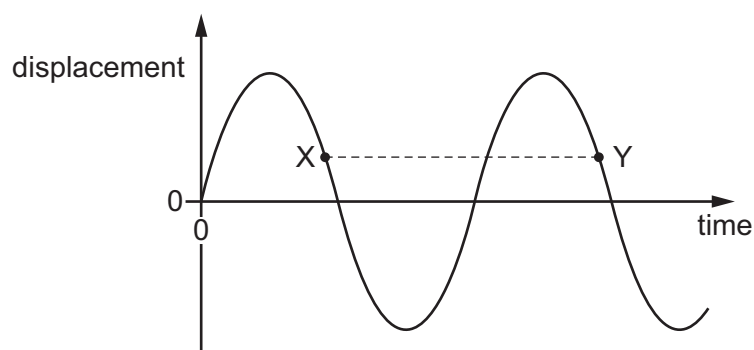
The Young modulus for brass is less than the Young modulus for steel.

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



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

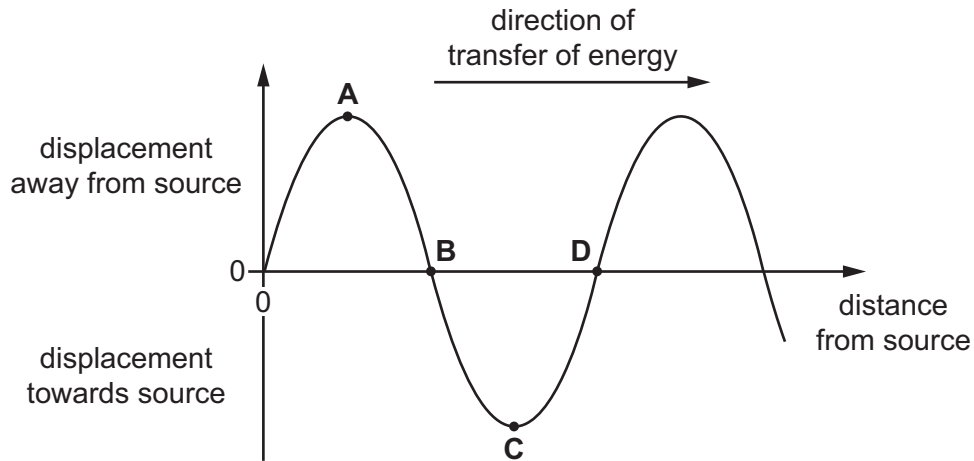
21 Which region of the electromagnetic spectrum includes waves with a frequency of 10^7 MHz?

- A** infra-red waves
- B** radio waves
- C** ultraviolet waves
- D** X-rays

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

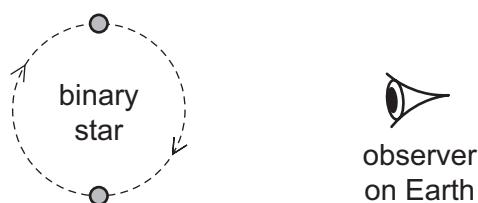
The wave can be represented on a graph showing the variation of the displacement of the particles with distance from the source.

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

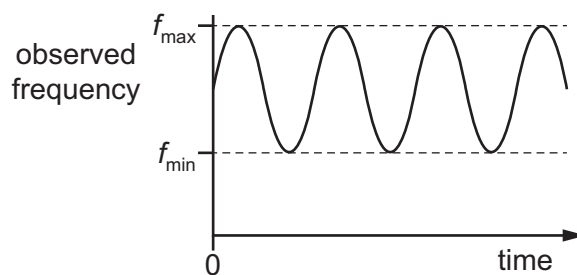


- 23** What can be deduced from a table of wavelengths of the waves in the electromagnetic spectrum?
- A** Green light has a shorter wavelength than X-rays.
 - B** Red light has a shorter wavelength than green light.
 - C** The wavelength range for radio waves is less than that for infra-red waves.
 - D** The wavelength range for X-rays is less than that for radio waves.

- 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.

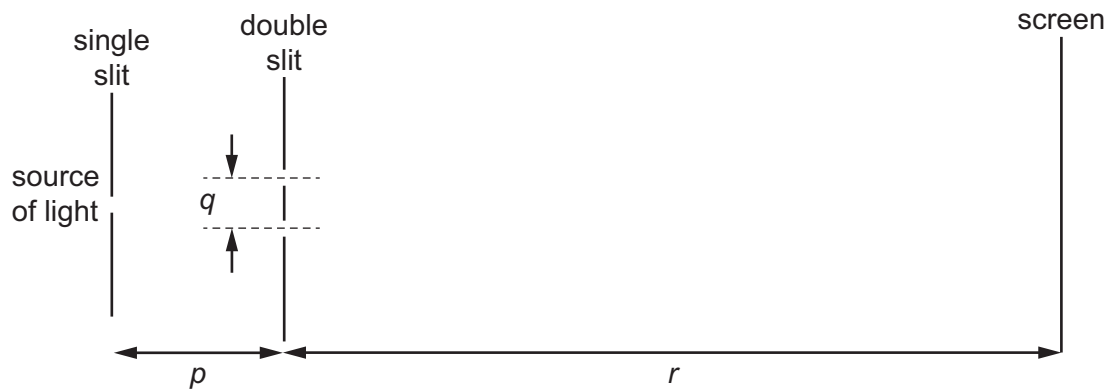


The rate of rotation of the binary star increases.

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

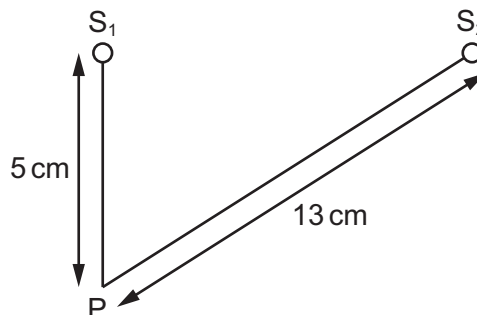
	$f_{\max}$	$f_{\min}$
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 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° .

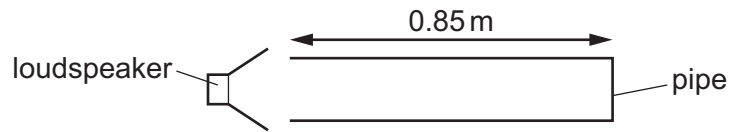


The sources each generate a wave of wavelength 2.0 cm. Each source produces a wave that has amplitude x_0 when it reaches point P.

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.

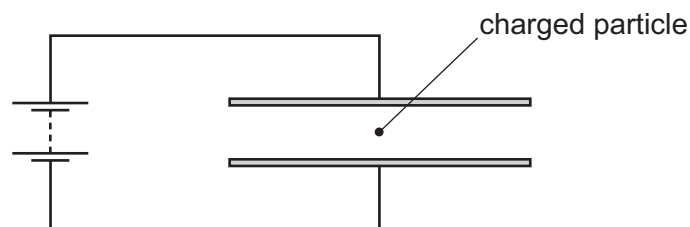
The speed of sound in air is 340 m s^{-1} .

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 $+2.0 \text{ mC}$ and is in a vertical uniform electric field. An electric force of $1.0 \times 10^{-2} \text{ N}$ 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?

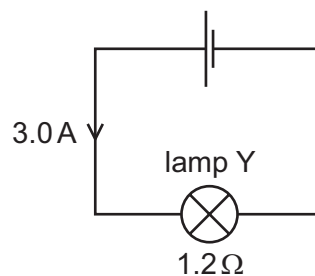
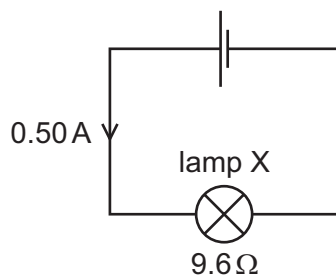
- A** $\frac{F}{4}$ **B** $\frac{F}{2}$ **C** F **D** $2F$

- 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 $9.6\ \Omega$. The current in lamp Y is 3.0 A and its resistance is $1.2\ \Omega$.



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.

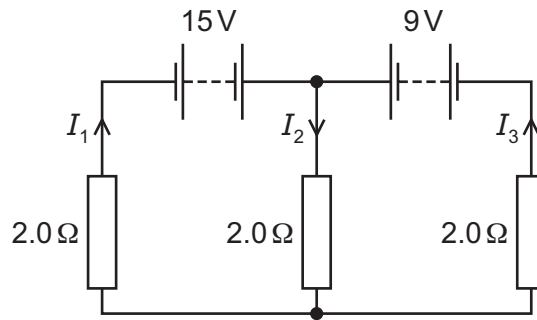
What is its new resistance?

- 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.

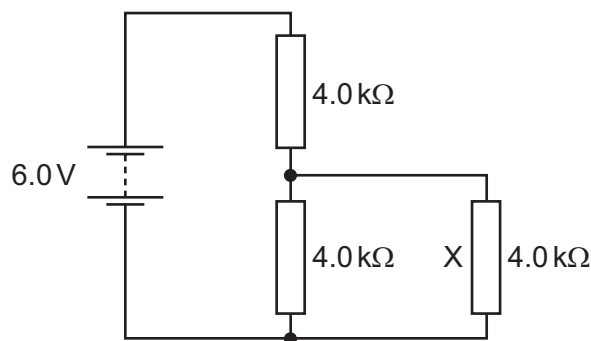
- 34 In the circuit shown, the batteries have negligible internal resistance.



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.

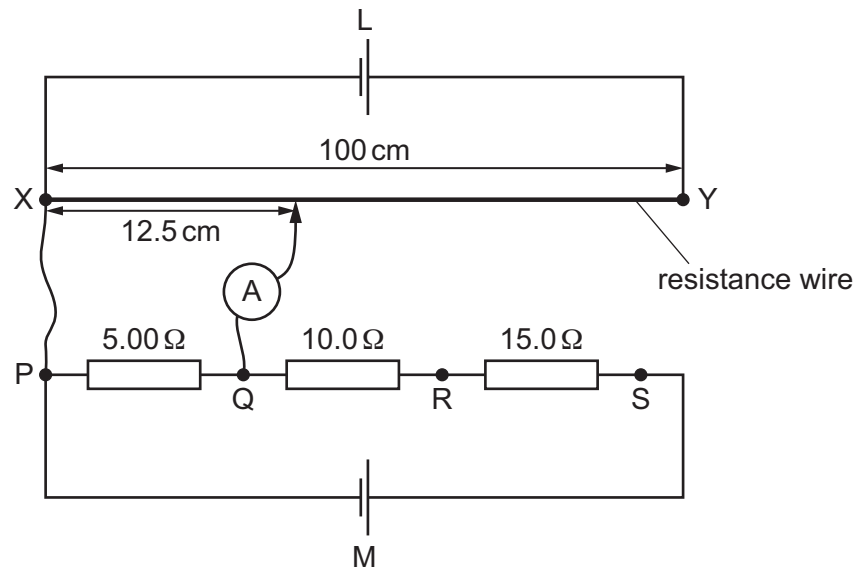


Each resistor has a resistance of $4.0\text{ k}\Omega$.

What is the current in resistor X?

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

- 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 $5.00\ \Omega$, $10.0\ \Omega$ and $15.0\ \Omega$.



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.

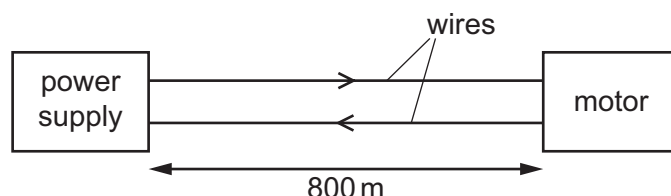
The p.d. across the other resistors is then balanced against other lengths of the resistance wire.

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 $0.0050\ \Omega$ 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, ${}^3_1\text{H}$?
- 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

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

PHYSICS

9702/12

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)

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.

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	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ ($\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1}$)
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 unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
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	$\phi = -\frac{Gm}{r}$
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	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel	$C = C_1 + C_2 + \dots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
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	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

- 1 A sheet of gold leaf has a thickness of $0.125\text{ }\mu\text{m}$. A gold atom has a radius of 174 pm .

Approximately how many layers of atoms are there in the sheet?

- A 4 B 7 C 400 D 700

- 2 The drag coefficient C_d is a number with no units. It is used to compare the drag on different cars at different speeds. C_d is given by the equation

$$C_d = \frac{2F}{v^n \rho A}$$

where F is the drag force on the car, ρ is the density of the air, A is the cross-sectional area of the car and v is the speed of the car.

What is the value of n ?

- A 1 B 2 C 3 D 4

- 3 A student measures the current through a resistor and the potential difference (p.d.) across it. There is a 4% uncertainty in the current reading and a 1% uncertainty in the p.d. reading. The student calculates the resistance of the resistor.

What is the percentage uncertainty in the calculated resistance?

- A 0.25% B 3% C 4% D 5%

- 4 A student applies a potential difference V of $(4.0 \pm 0.1)\text{ V}$ across a resistor of resistance R of $(10.0 \pm 0.3)\Omega$ for a time t of $(50 \pm 1)\text{ s}$.

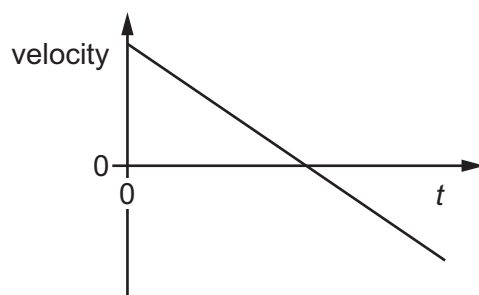
The student calculates the energy E dissipated using the equation below.

$$E = \frac{V^2 t}{R} = \frac{4.0^2 \times 50}{10.0} = 80\text{ J}$$

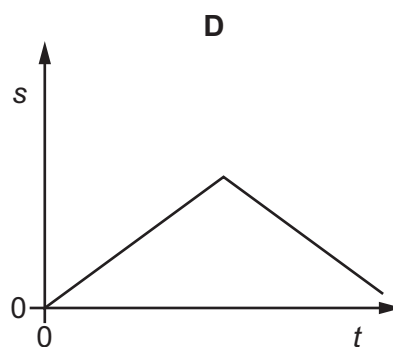
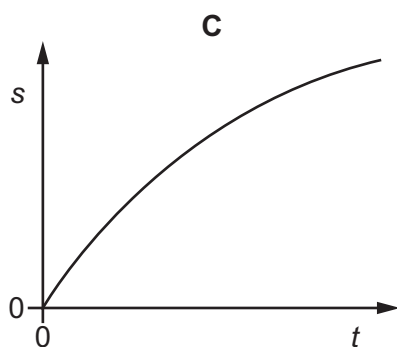
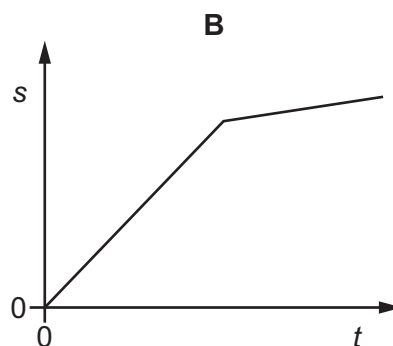
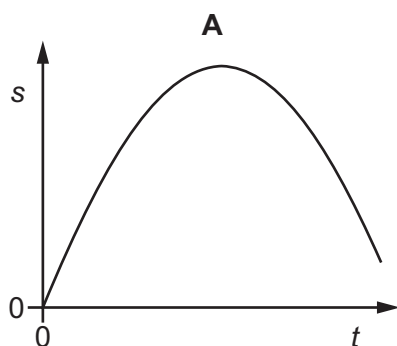
What is the absolute uncertainty in the calculated energy value?

- A 1.5 J B 3 J C 6 J D 8 J

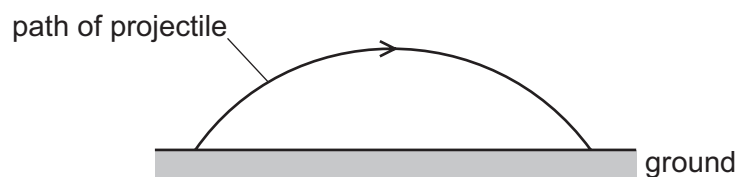
- 5 The velocity of an object changes with time t as shown.



Which graph best shows the variation with time t of the displacement s of the object?

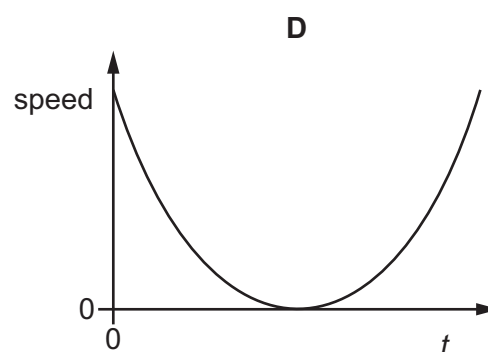
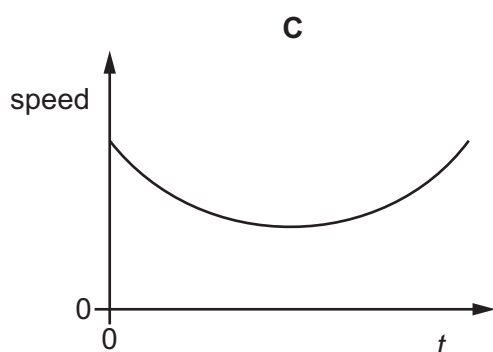
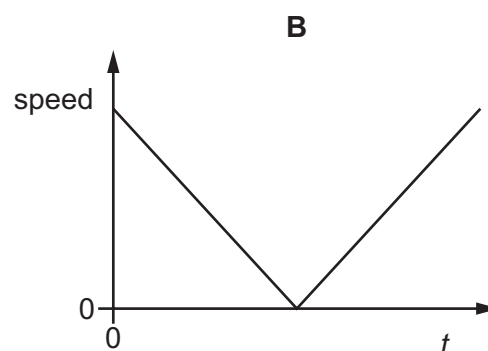
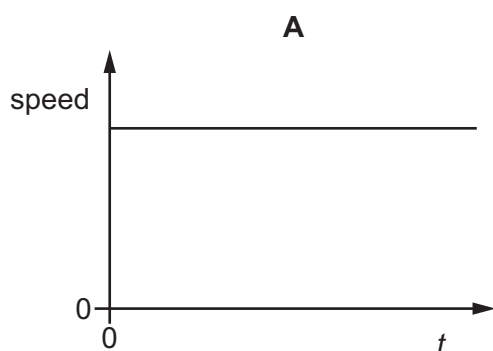


- 6 A projectile is launched at an angle to the horizontal at time $t = 0$. It travels over horizontal ground, as shown.

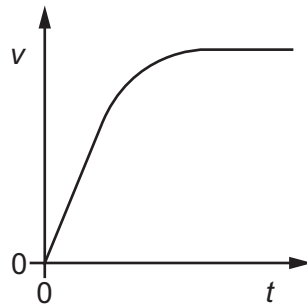


Assume that air resistance is negligible.

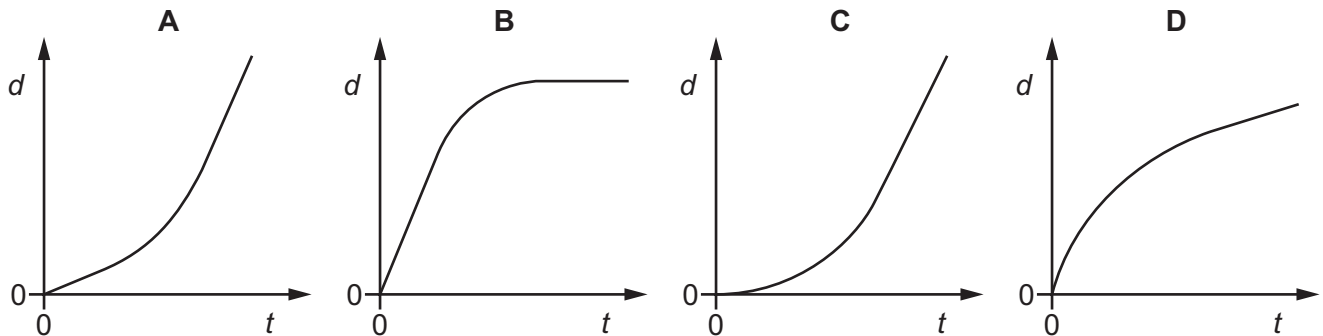
Which graph best shows the variation with t of the speed of the projectile from when it is launched to when it lands on the ground?



- A sky-diver falls vertically from a helicopter and reaches constant (terminal) velocity. The graph shows the variation with time t of the speed v of the sky-diver.



Which graph shows the variation with time t of the distance d fallen by the sky-diver?



- 8 A tennis ball of mass 55 g is travelling horizontally with a speed of 30 ms^{-1} . The ball makes contact with a wall before rebounding in the horizontal direction with a speed of 20 ms^{-1} . The ball is in contact with the wall for a time of $5.0 \times 10^{-3} \text{ s}$.

What is the average force exerted on the wall by the ball?

- A** 110 N **B** 220 N **C** 330 N **D** 550 N

- 9** An elastic collision occurs between two bodies X and Y. The mass of body X is m and the mass of body Y is $4m$. Body X travels at speed v before the collision and speed $\frac{3v}{5}$ in the opposite direction after the collision. Body Y is stationary before the collision.



What is the kinetic energy of body Y after the collision?

- A** $\frac{8}{10}mv^2$ **B** $\frac{34}{50}mv^2$ **C** $\frac{16}{50}mv^2$ **D** $\frac{1}{5}mv^2$

- 10 The density of water is 1.0 g cm^{-3} and the density of glycerine is 1.3 g cm^{-3} .

Water is added to a measuring cylinder containing 40 cm^3 of glycerine so that the density of the mixture is 1.1 g cm^{-3} . Assume that the mixing process does not change the total volume of the liquid.

What is the volume of water added?

- A** 40 cm^3 **B** 44 cm^3 **C** 52 cm^3 **D** 80 cm^3

- 11 An astronaut throws a stone horizontally near to the surface of the Moon, where there is no atmosphere.

Which row describes the horizontal and vertical forces acting on the stone after release?

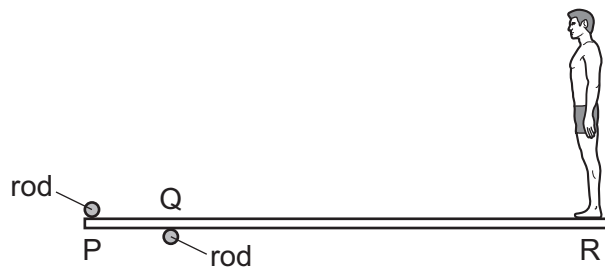
	horizontal force	vertical force
A	non-zero and constant	constant
B	non-zero and constant	decreasing
C	zero	constant
D	zero	decreasing

- 12 A cylindrical block of wood has cross-sectional area A and weight W . It is totally immersed in water with its axis vertical. The block experiences pressures p_t and p_b at its top and bottom surfaces respectively.

Which expression is equal to the upthrust on the block?

- A** $(p_b - p_t)$
B $(p_b - p_t)A$
C $(p_b - p_t)A - W$
D $(p_b - p_t)A + W$

- 13** A uniform diving-board is held by two fixed rods at points P and Q. A person stands at end R of the diving-board, as shown.

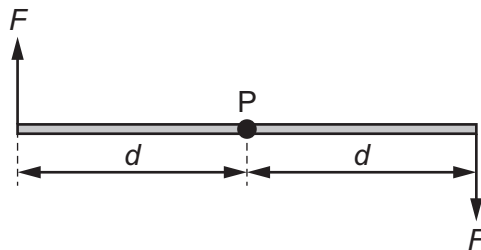


The forces exerted by the rods on the board are vertical. The board remains in equilibrium as the person slowly moves towards point Q from end R.

Which row describes the changes to the forces exerted by the rods on the board?

	force at P	force at Q
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 14** Two forces, each of magnitude F , act in opposite directions on a rod.

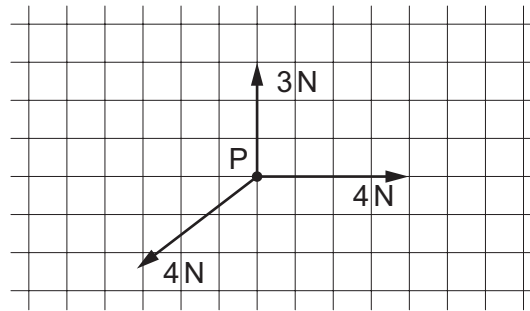


Each force acts on the rod at a distance d from the pivot P.

What is the torque of this couple about P?

- A** 0 **B** $F \times d$ **C** $2F \times d$ **D** $2F \times 2d$

- 15 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 force?

- A B C D

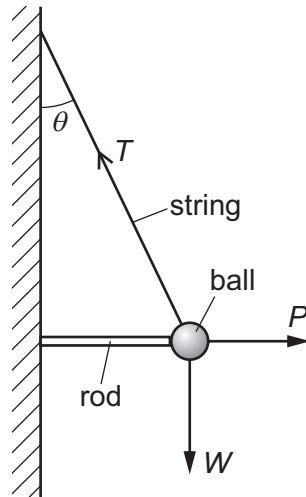
- 16 In 'normal driving conditions', an electric car has a range of 150 km. This uses all of the 200 MJ of energy stored in its batteries.

With the batteries initially fully charged, the car is driven 100 km in 'normal driving conditions'. The batteries are then recharged from a household electrical supply delivering a constant current of 13.0 A at a potential difference of 230 V.

What is the minimum time required to recharge the batteries?

- A 0.95 hours
B 12.4 hours
C 18.6 hours
D 27.9 hours

- 17 The diagram shows a ball of weight W hanging in equilibrium from a string.



The string is at an angle θ to the vertical. The tension in the string is T . The ball is held away from the wall by a horizontal force P from a metal rod.

What is the relationship between the magnitudes of T , P and W ?

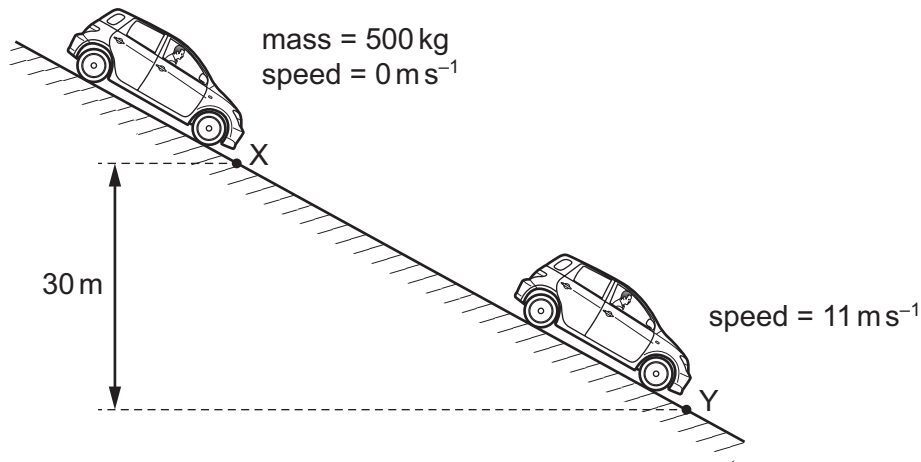
- A $P = T \cos \theta$ and $W = T \sin \theta$
 - B $T = P + W$
 - C $T^2 = P^2 + W^2$
 - D $W = P \tan \theta$ and $W = T \cos \theta$
- 18 A steel sphere is dropped vertically onto a horizontal metal plate. The sphere hits the plate with speed u , leaves it at speed v , and rebounds vertically to half of its original height. Ignore air resistance.

Which expression gives the value of $\frac{v}{u}$?

- A $\frac{1}{2^2}$
- B $\frac{1}{2}$
- C $\frac{1}{\sqrt{2}}$
- D $1 - \frac{1}{\sqrt{2}}$

- 19 A car of mass 500 kg is at rest at point X on a slope, as shown.

The car's brakes are released and the car rolls down the slope with its engine switched off. At point Y the car has moved through a vertical height of 30 m and has a speed of 11 m s^{-1} .



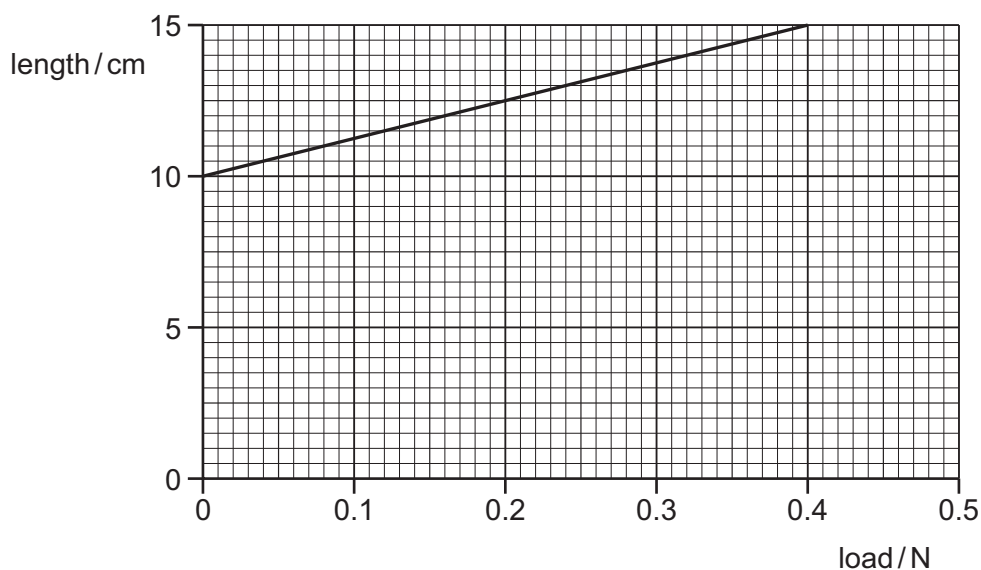
What is the energy dissipated by frictional forces when the car moves from X to Y?

- A $3.0 \times 10^4 \text{ J}$ B $1.2 \times 10^5 \text{ J}$ C $1.5 \times 10^5 \text{ J}$ D $1.8 \times 10^5 \text{ J}$
- 20 An elastic material with Young modulus E is subjected to a tensile stress S . Hooke's law is obeyed.

What is the expression for the elastic energy stored per unit volume of the material?

- A $\frac{E}{2S^2}$ B $\frac{2E}{S^2}$ C $\frac{S^2}{E}$ D $\frac{S^2}{2E}$

- 21 The graph shows the length of a spring as it is stretched by an increasing load.



What is the spring constant of the spring?

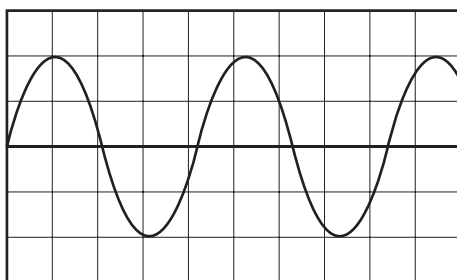
- A 0.080 N m^{-1} B 0.13 N m^{-1} C 2.7 N m^{-1} D 8.0 N m^{-1}

- 22 Two lasers emit light in a vacuum. One laser emits red light and the other emits green light.

Which property of the two laser beams **must** be different?

- A amplitude
- B frequency
- C intensity
- D speed

- 23 The diagram shows the screen of a cathode-ray oscilloscope (c.r.o.) displaying a wave.

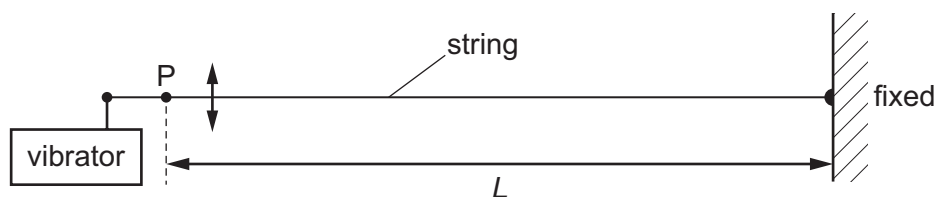


The time-base of the c.r.o. is set at 10 ms/division.

What is the frequency of the wave?

- A 0.24 Hz
- B 4.2 Hz
- C 12 Hz
- D 24 Hz

- 24 A string is fixed at one end and the other end is attached to a vibrator. The frequency of the vibrator is slowly increased from zero. A series of stationary waves is formed. Assume that for a stationary wave there is a node at point P.



What are the first five wavelengths of the stationary waves that could be formed?

- A $2\frac{L}{1}, 2\frac{L}{2}, 2\frac{L}{3}, 2\frac{L}{4}, 2\frac{L}{5}$
- B $2\frac{L}{2}, 2\frac{L}{3}, 2\frac{L}{4}, 2\frac{L}{5}, 2\frac{L}{6}$
- C $4\frac{L}{1}, 4\frac{L}{2}, 4\frac{L}{3}, 4\frac{L}{4}, 4\frac{L}{5}$
- D $4\frac{L}{1}, 4\frac{L}{3}, 4\frac{L}{5}, 4\frac{L}{7}, 4\frac{L}{9}$

- 25 Which region of the electromagnetic spectrum has waves of wavelength 1000 times smaller than the wavelength of visible light?
- A infra-red
B microwaves
C ultraviolet
D X-rays
- 26 The diagram shows apparatus for the measurement of the frequency of a sound wave.



Sound of the unknown frequency is reflected back from a metal plate. A microphone placed at a distance D from the metal plate detects the sound intensity. A minimum intensity is detected with $D = 12.0\text{ cm}$. The plate is moved further away from the microphone until the next minimum is detected with $D = 15.0\text{ cm}$.

The speed of sound in air is 336 m s^{-1} .

What is the frequency of the sound?

- A 56 Hz B 112 Hz C 5600 Hz D 11 200 Hz
- 27 An astronomer observes the light from a star that is moving away from the Earth.
- For the observed light, what has been increased due to the star's motion?
- A amplitude
B frequency
C speed
D wavelength

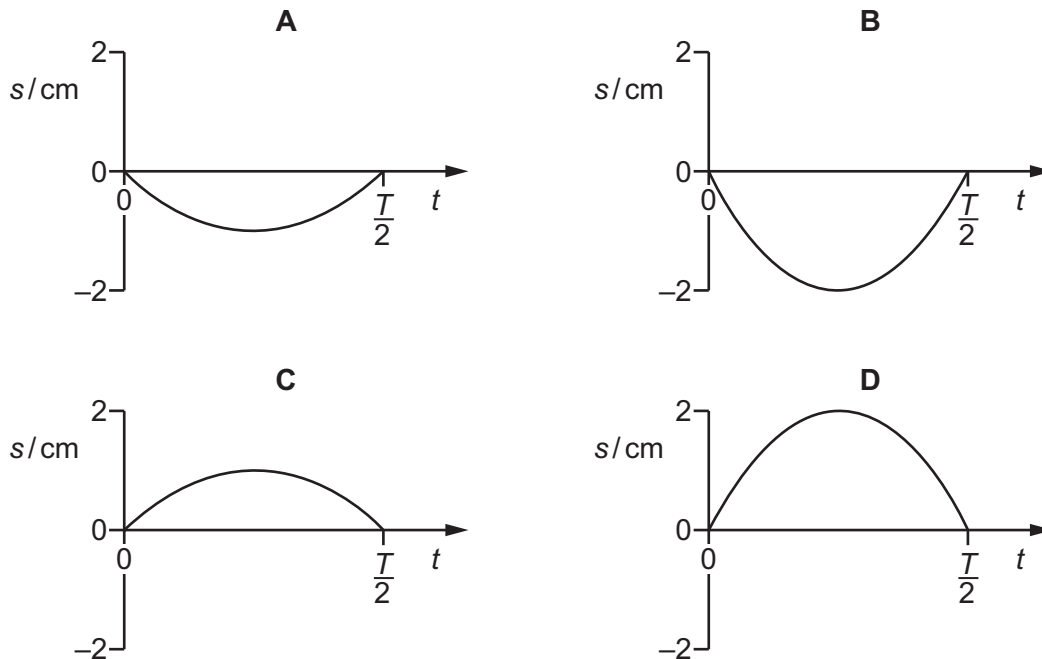
- 28 The diagram shows a stationary wave, at time $t = 0$, that has been set up on a string fixed between points P and S.



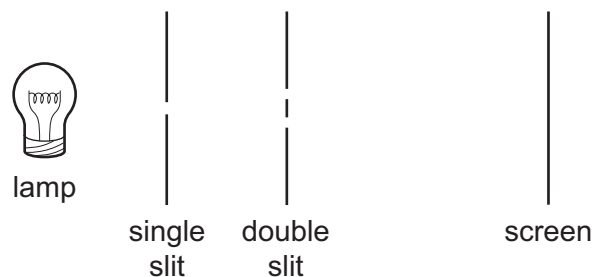
The nodes of the stationary wave occur on the string at P, Q, R and S. Point X is moving down at time $t = 0$. The points on the string vibrate with time period T and maximum amplitude 2 cm.

The displacement s is positive in the upward direction.

Which graph best shows the variation with t of the displacement s of point Y on the string?



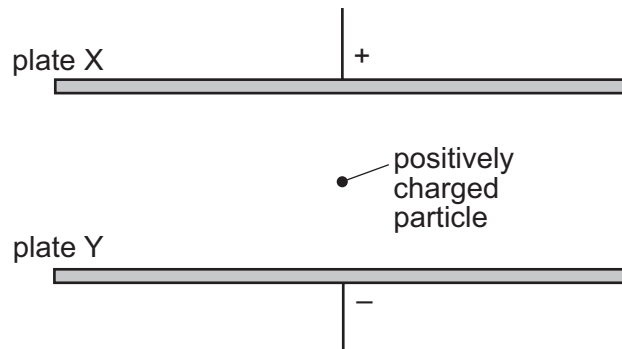
- 29 A two-source interference experiment uses the apparatus shown.



What is the main purpose of the single slit?

- A to make a narrow beam of light
- B to make the same amplitude of light incident on each slit
- C to provide coherent light
- D to provide monochromatic light

- 30 Two large parallel metal plates X and Y are situated in a vacuum as shown.

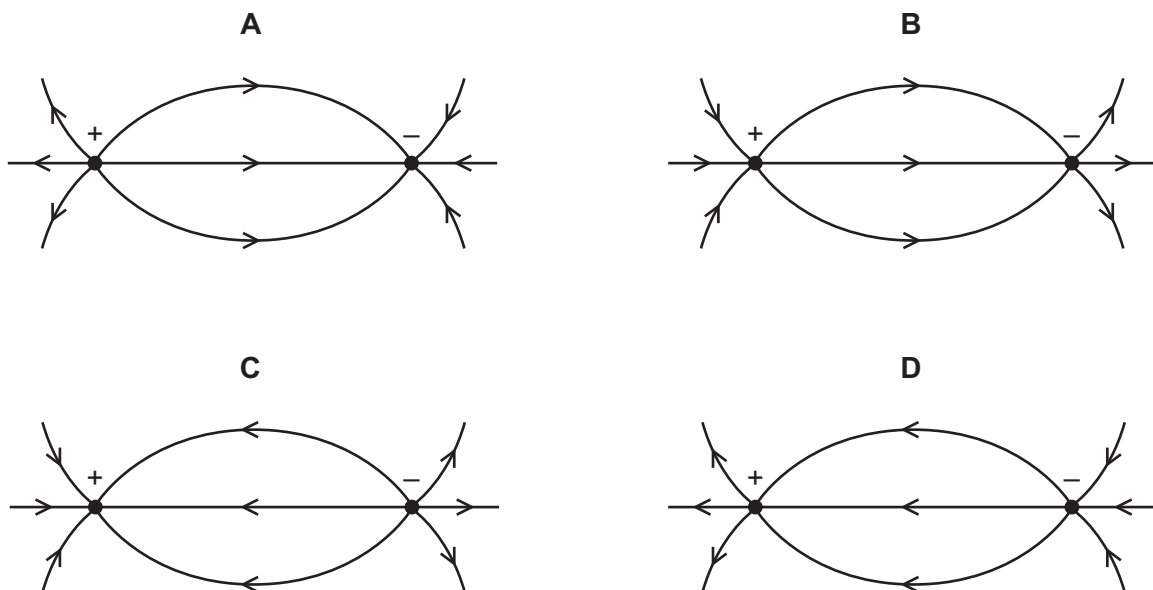


Plates X and Y carry equal and opposite charges.

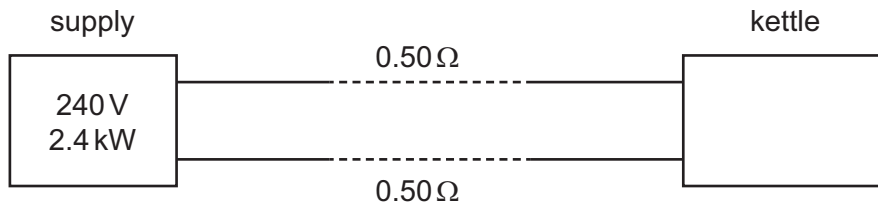
What happens to the force on a positively charged particle as it moves from plate X to plate Y?

- A** It decreases because the positively charged particle is moving away from the positively charged plate.
- B** It decreases because the positively charged particle is moving in the direction of the electric field between the plates.
- C** It increases because the positively charged particle is moving closer to a negatively charged plate.
- D** It remains constant because the positively charged particle is in the uniform electric field between the plates.
- 31 Four diagrams representing the electric field between two oppositely-charged point charges are shown.

Which diagram correctly shows the electric field lines?



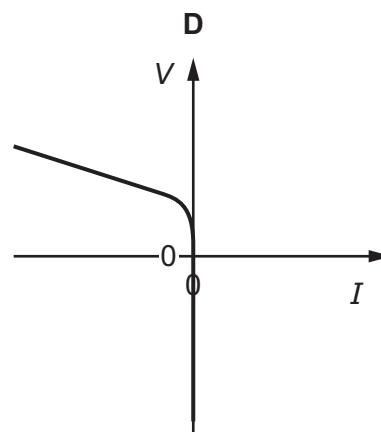
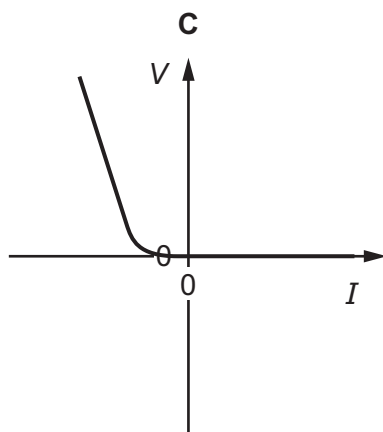
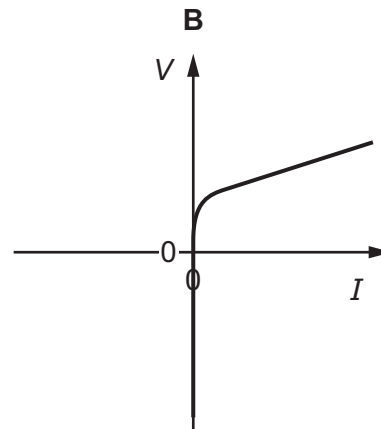
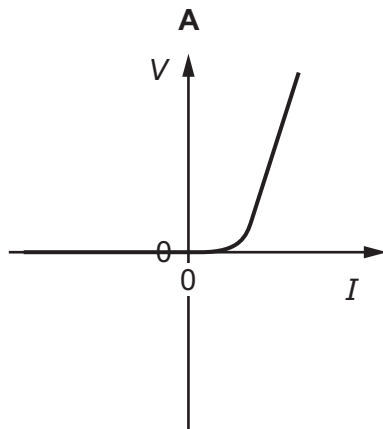
- 32 The power output of an electrical supply is 2.4 kW at a potential difference (p.d.) of 240 V. The two wires between the supply and a kettle each have a resistance of $0.50\ \Omega$, as shown.



What is the power supplied to the kettle and what is the p.d. across the kettle?

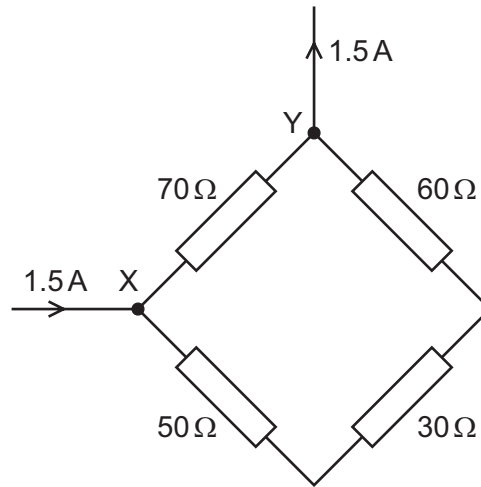
	power/kW	p.d./V
A	2.3	230
B	2.3	235
C	2.4	230
D	2.4	235

- 33 Which graph shows the variation of voltage V with current I for a semiconductor diode?



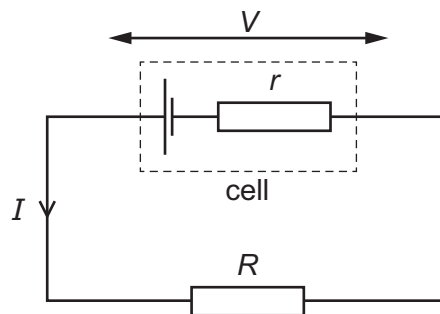
- 34 Four different resistors are arranged as shown.

A current of 1.5 A enters the network at junction X and leaves through junction Y.



What is the current in the resistor of resistance $30\ \Omega$?

- A** 0.21 A **B** 0.50 A **C** 0.75 A **D** 1.0 A
- 35 A cell of constant electromotive force drives a current I through an external resistor of resistance R . The terminal potential difference (p.d.) across the cell is V .

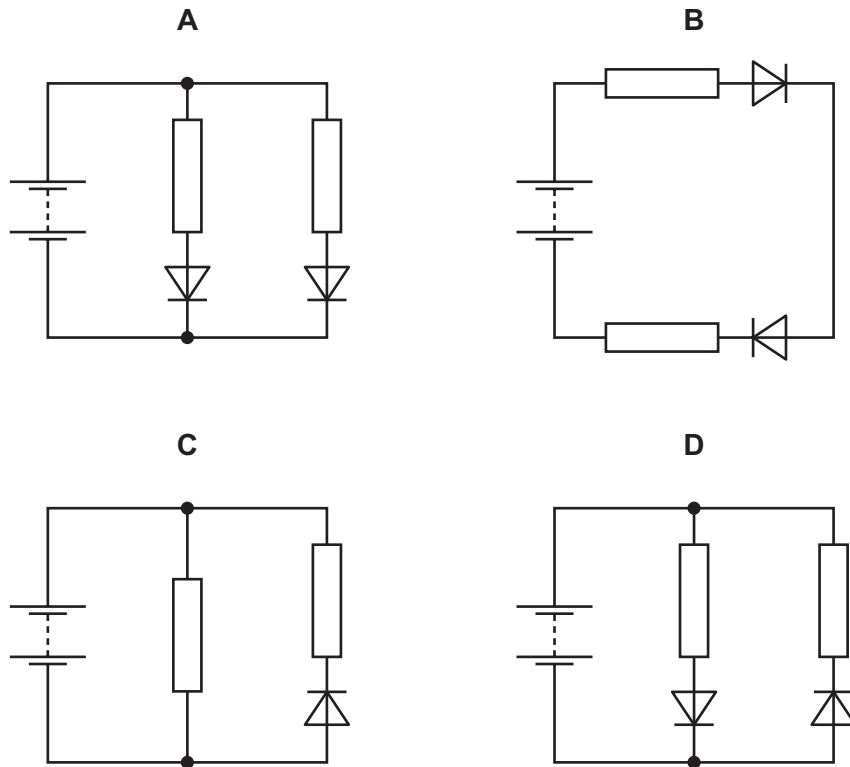


When the internal resistance r of the cell increases, what is the effect on V and on I ?

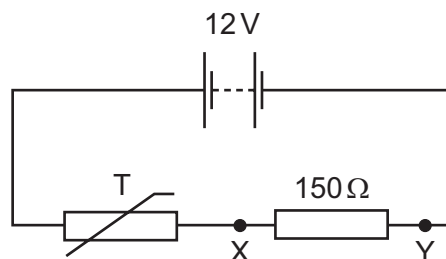
	V	I
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 36** In the circuits shown, the batteries are identical and all have negligible internal resistance. All of the resistors have the same resistance. The diodes have zero resistance when conducting and infinite resistance when not conducting.

In which circuit is the current in the battery greatest?



- 37** A thermistor is an electrical component with a resistance that varies with temperature. A thermistor T is used in a fire alarm system. The alarm is triggered when the potential difference between X and Y is 4.5 V .



What is the resistance of T when the alarm is triggered?

- A** $90\ \Omega$ **B** $150\ \Omega$ **C** $250\ \Omega$ **D** $400\ \Omega$

- 38 In the α -particle scattering experiment, a beam of α -particles is aimed at a thin gold foil. Most of the α -particles go straight through or are deflected by a small angle. A very small proportion are deflected through more than 90° , effectively rebounding towards the source of the α -particles.

Which conclusion about the structure of atoms **cannot** be drawn from this experiment alone?

- A Most of the atom is empty space.
- B Most of the mass of an atom is concentrated in the nucleus.
- C The nucleus contains both protons and neutrons.
- D The nucleus is charged.

- 39 Radon-211, $^{211}_{86}\text{Rn}$, francium-210, $^{210}_{87}\text{Fr}$, and radium-212, $^{212}_{88}\text{Ra}$, are three nuclides.

How many neutrons does each nuclide have in its nucleus?

	radon-211	francium-210	radium-212
A	86	87	88
B	125	123	124
C	211	210	212
D	297	297	300

- 40 A neutron is composed of one up (u) quark and two down (d) quarks. When the neutron decays to a proton, there is β -emission.

What is the change in the quark structure of the neutron due to the β -emission?

(The symbol for a neutrino is ν_e and for an antineutrino is $\bar{\nu}_e$.)

- A $d \rightarrow u + \beta^- + \nu_e$
- B $d \rightarrow u + \beta^- + \bar{\nu}_e$
- C $u \rightarrow d + \beta^+ + \nu_e$
- D $u \rightarrow d + \beta^+ + \bar{\nu}_e$

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

PHYSICS

9702/13

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)

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.



Data

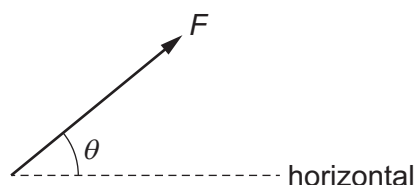
speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ ($\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1}$)
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
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	$\phi = -\frac{Gm}{r}$
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	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel	$C = C_1 + C_2 + \dots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
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	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

- 1 What is the best way of describing a physical quantity?
- A a quantity with a magnitude and a direction but no unit
 - B a quantity with a magnitude and a unit
 - C a quantity with a magnitude but no direction
 - D a quantity with a unit but no magnitude
- 2 Which pair includes a vector quantity and a scalar quantity?
- A displacement and acceleration
 - B force and kinetic energy
 - C power and speed
 - D work and potential energy

- 3 A force F acts at an angle θ to the horizontal.



What are the horizontal and the vertical components of the force?

	horizontal component	vertical component
A	$F \cos \theta$	$F \cos (90^\circ - \theta)$
B	$F \cos \theta$	$F \sin (90^\circ - \theta)$
C	$F \sin \theta$	$F \cos \theta$
D	$F \sin \theta$	$F \cos (90^\circ - \theta)$

- 4 What will reduce the systematic errors when taking a measurement?
- A adjusting the needle on a voltmeter so that it reads zero when there is no potential difference across it
 - B measuring the diameter of a wire at different points and taking the average
 - C reducing the parallax effects by using a marker and a mirror when measuring the amplitude of oscillation of a pendulum
 - D timing 20 oscillations, rather than a single oscillation, when finding the period of a pendulum

- 5 In an experiment to determine the Young modulus E of the material of a wire, the measurements taken are shown.

mass hung on end of wire $m = 2.300 \pm 0.002 \text{ kg}$

original length of wire $l = 2.864 \pm 0.005 \text{ m}$

diameter of wire $d = 0.82 \pm 0.01 \text{ mm}$

extension of wire $e = 7.6 \pm 0.2 \text{ mm}$

The Young modulus is calculated using

$$E = \frac{4mgl}{\pi d^2 e}$$

where g is the acceleration of free fall.

The calculated value of E is $1.61 \times 10^{10} \text{ Nm}^{-2}$.

How should the calculated value of E and its uncertainty be expressed?

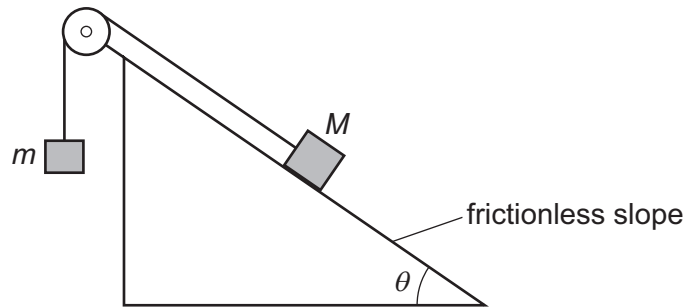
- A** $(1.61 \pm 0.04) \times 10^{10} \text{ Nm}^{-2}$
- B** $(1.61 \pm 0.05) \times 10^{10} \text{ Nm}^{-2}$
- C** $(1.61 \pm 0.07) \times 10^{10} \text{ Nm}^{-2}$
- D** $(1.61 \pm 0.09) \times 10^{10} \text{ Nm}^{-2}$
- 6 A rock on the surface of Mars is projected vertically upwards with an initial speed of 9.4 m s^{-1} . The rock rises to a height of 12 m above the surface.

Assume there is no atmosphere on Mars.

What is the acceleration of free fall near the surface of Mars?

- A** 0.39 m s^{-2} **B** 3.7 m s^{-2} **C** 7.4 m s^{-2} **D** 9.8 m s^{-2}

- 7 Two masses, M and m , are connected by an inextensible string which passes over a frictionless pulley. Mass M rests on a frictionless slope, as shown.



The slope is at an angle θ to the horizontal.

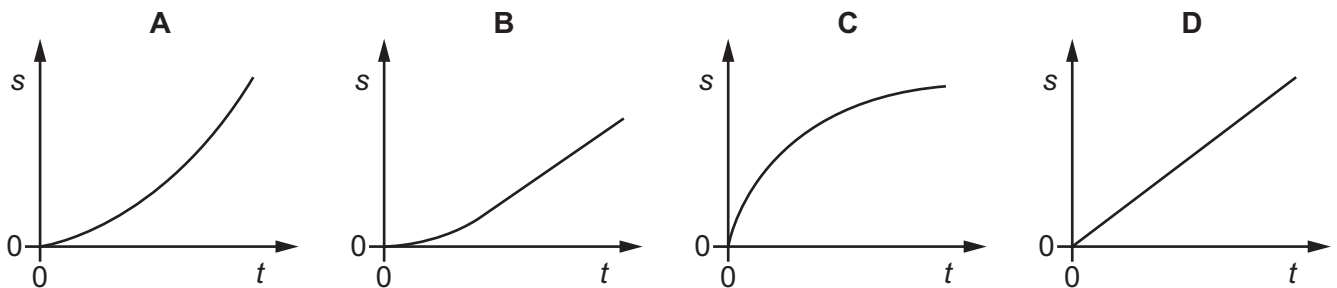
The two masses are initially held stationary and then released. Mass M moves down the slope.

Which expression **must** be correct?

- A $\sin \theta < \frac{m}{M}$ B $\cos \theta < \frac{m}{M}$ C $\sin \theta > \frac{m}{M}$ D $\cos \theta > \frac{m}{M}$

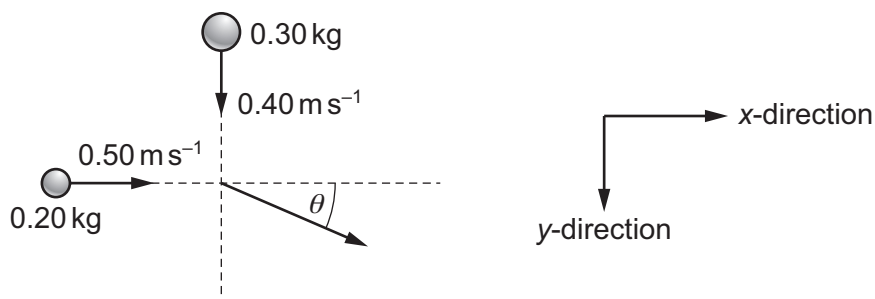
- 8 A sky-diver falls from a stationary balloon at time $t = 0$. As the sky-diver falls, her speed and the air resistance increase until the force of the air resistance is equal to her weight.

Which graph best shows the variation with time t of the displacement s for the motion of the sky-diver?



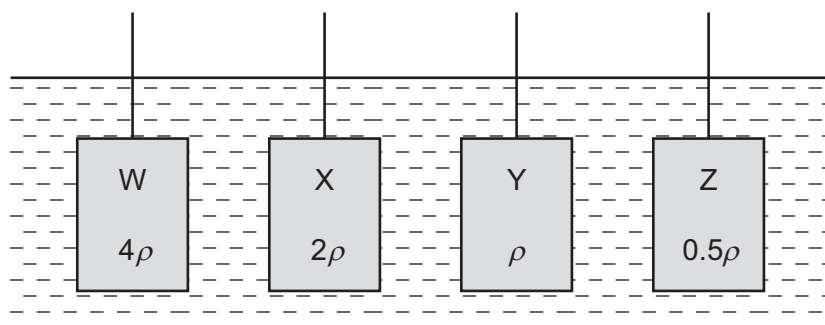
- 9 A ball of mass 0.20 kg , travelling in the x -direction at a speed of 0.50 m s^{-1} , collides with a ball of mass 0.30 kg travelling in the y -direction at a speed of 0.40 m s^{-1} .

The two balls stick together after the collision, travelling at an angle θ to the x -direction.



What is the value of θ ?

- A 39° B 40° C 50° D 51°
- 10 Four cuboids with identical lengths, breadths and heights are immersed in water. The cuboids are held at the same depth and in identical orientations by vertical rods, as shown.



Water has density ρ .

Cuboid W is made of material of density 4ρ .

Cuboid X is made of material of density 2ρ .

Cuboid Y is made of material of density ρ .

Cuboid Z is made of material of density 0.5ρ .

Which statement is correct?

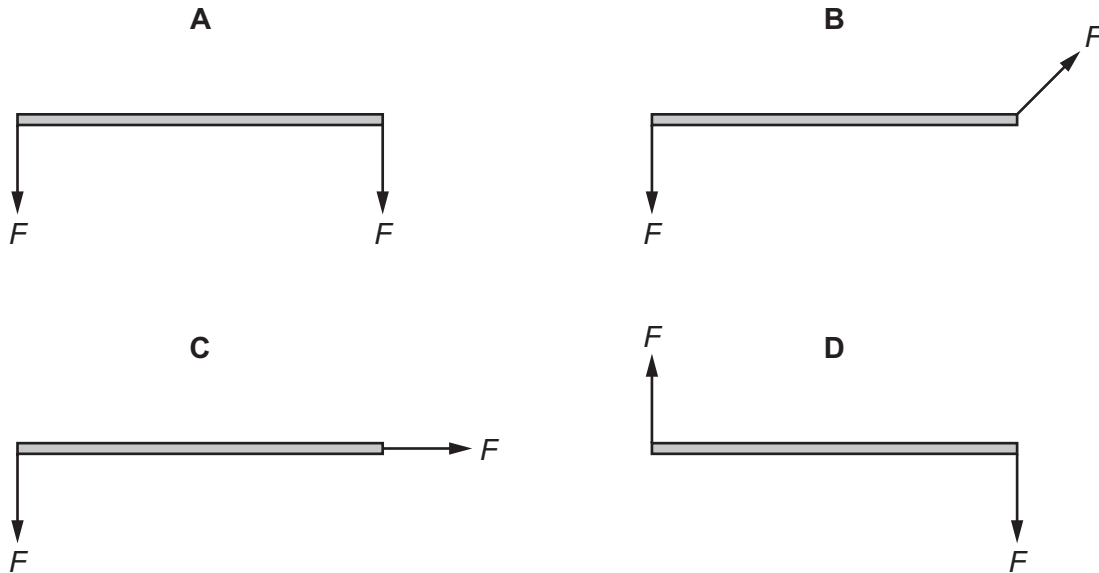
- A The upthrust of the water on each of the cuboids is the same.
- B The upthrust of the water on W is twice the upthrust of the water on X.
- C The upthrust of the water on X is twice the upthrust of the water on W.
- D The upthrust of the water on Y is zero.

- 11 A rectangular block of lead of density $1.13 \times 10^4 \text{ kg m}^{-3}$ has sides of length 12.0 cm, 15.0 cm and 10.0 cm.

What is the maximum pressure the block can exert when resting on a table?

- A** 1.13 kPa **B** 1.70 kPa **C** 11.1 kPa **D** 16.6 kPa

- 12 Which diagram shows a couple formed by two forces, each of magnitude F , acting on a rod?



- 13 Full-fat milk is made up of fat-free milk mixed with fat.

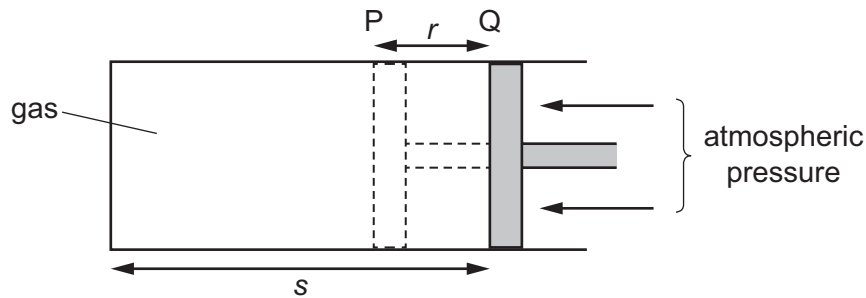
A volume of $1.000 \times 10^{-3} \text{ m}^3$ of full-fat milk has a mass of 1.035 kg. It contains 4.00% fat by volume.

The density of fat-free milk is $1.040 \times 10^3 \text{ kg m}^{-3}$.

What is the density of fat?

- A** $1.25 \times 10^2 \text{ kg m}^{-3}$
B $9.15 \times 10^2 \text{ kg m}^{-3}$
C $9.28 \times 10^2 \text{ kg m}^{-3}$
D $1.16 \times 10^3 \text{ kg m}^{-3}$

- 14 Gas is trapped inside a cylinder by a piston of cross-sectional area A . The piston is **not** frictionless.



The gas is heated and this causes it to expand, pushing back the piston through distance r from position P to position Q. The length of the gas column is then s .

Which expression represents the amount of work done by the gas against the atmosphere during this expansion?

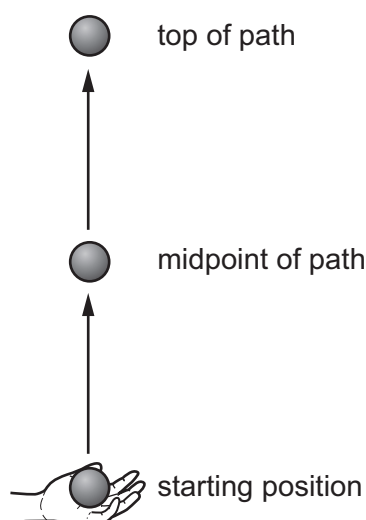
- A (atmospheric pressure) $\times Ar$
 - B (atmospheric pressure) $\times As$
 - C (pressure inside the gas) $\times Ar$
 - D (pressure inside the gas) $\times As$
- 15 Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of 510 kg s^{-1} . The reservoir is 280 m above the level of the turbine.

The electrical output from the generator driven by the turbine is a current of 205 A at a potential difference of 5800 V.

What is the efficiency of the system?

- A 8.3%
- B 12%
- C 83%
- D 85%

- 16 A ball is thrown vertically up into the air. It rises to the top of its path before beginning to fall vertically downwards.



Assume that the gravitational potential energy of the ball is zero at its starting position.

Which statement about the ball is **not** correct?

- A As it rises, its kinetic energy is transferred to gravitational potential energy.
 - B At the midpoint of its path, its gravitational potential energy is equal to its initial kinetic energy.
 - C At the top of its path, its kinetic energy is zero.
 - D At the top of its path, its total energy is less than its initial total energy.
- 17 A force of 1000 N is needed to lift the hook of a crane at a constant velocity. The crane is then used to lift a load of mass 1000 kg at a constant velocity of 0.50 m s^{-1} .

What is the power needed to lift the hook and the load?

- A 4.9 kW B 5.4 kW C 20 kW D 22 kW
- 18 Data for a steel wire on an electric guitar are listed.

$$\text{diameter} = 5.0 \times 10^{-4} \text{ m}$$

$$\text{Young modulus} = 2.0 \times 10^{11} \text{ Pa}$$

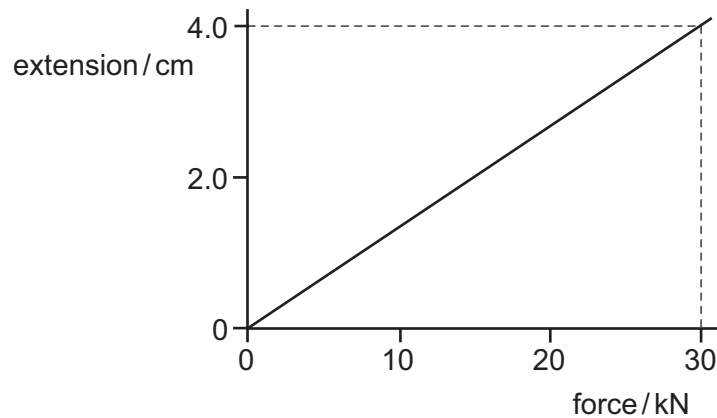
$$\text{tension} = 20 \text{ N}$$

The wire snaps and contracts elastically. Assume the wire obeys Hooke's law.

By what percentage does the length l of a piece of the wire contract?

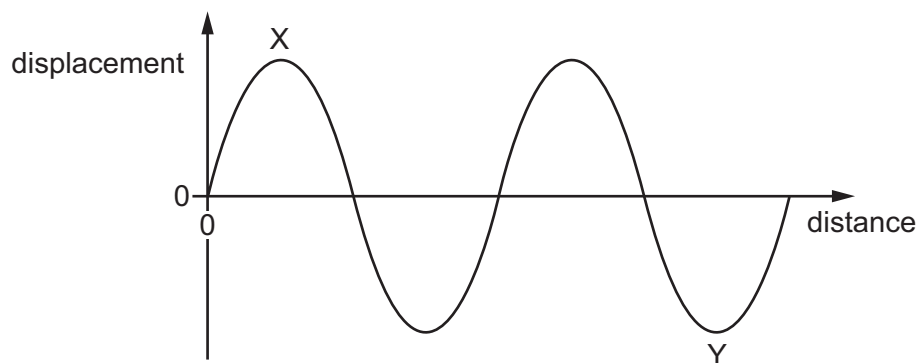
- A $1.3 \times 10^{-4} \%$ B $5.1 \times 10^{-4} \%$ C $1.3 \times 10^{-2} \%$ D $5.1 \times 10^{-2} \%$

- 19 The graph shows how the extension of a spring varies with the force used to stretch it.



What is the strain energy in the spring when the extension is 4.0 cm?

- A** 60 J **B** 120 J **C** 600 J **D** 1200 J
- 20 The displacement-distance graph for a transverse progressive wave is shown.



The phase difference between points X and Y can be expressed as $(180n)^\circ$.

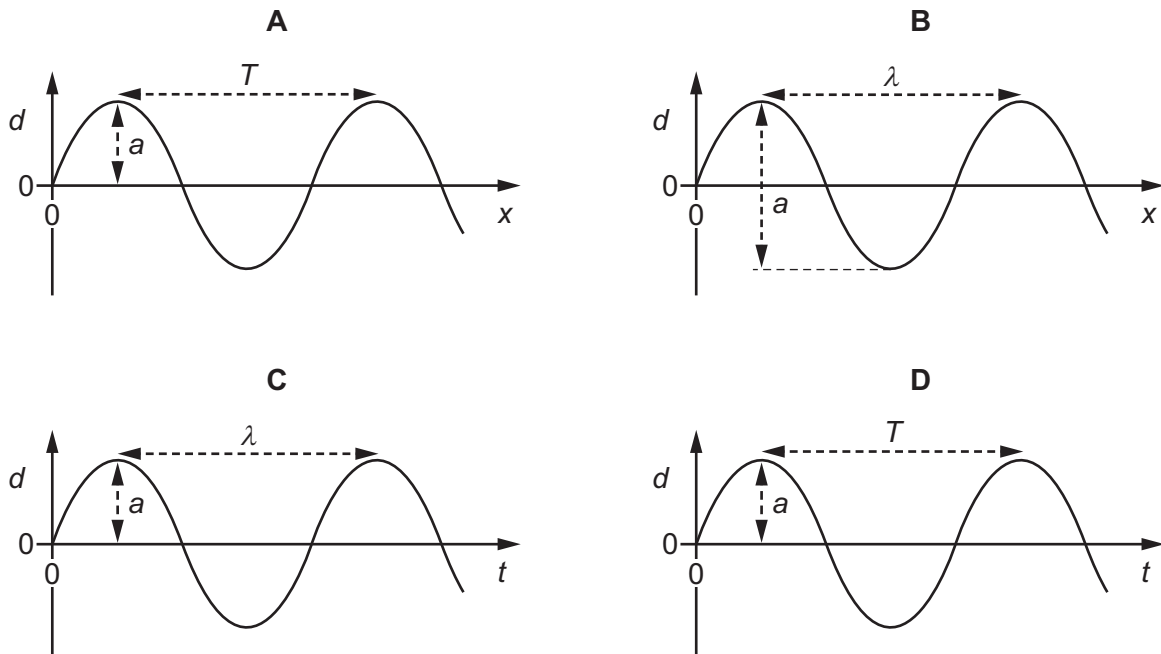
What is the value of n ?

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

- 21** The four graphs represent a progressive wave on a stretched string. Graphs **A** and **B** show how the displacement d varies with distance x along the string at one instant. Graphs **C** and **D** show how the displacement d varies with time t at a particular value of x .

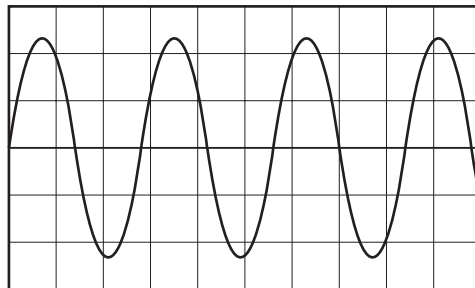
The labels on the graphs are intended to show the wavelength λ , the period T and the amplitude a of the wave, but only one graph is correctly labelled.

Which graph is correctly labelled?



- 22** A cathode-ray oscilloscope (c.r.o.) is used to determine the frequency of a sound wave.

The diagram shows the waveform on the screen.



The time-base setting is 5.0 ms/div .

What is the frequency of the sound wave?

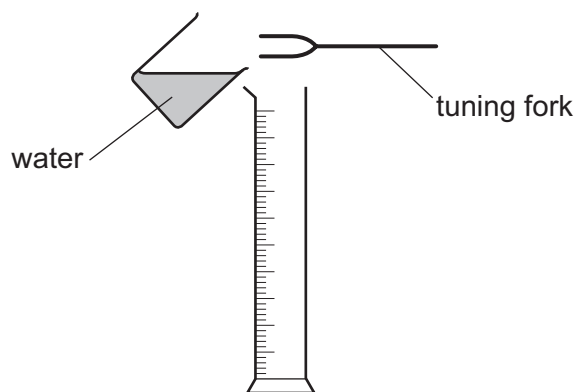
- A** 57 Hz **B** 71 Hz **C** 114 Hz **D** 143 Hz

- 23** A police car travels at a velocity of 30.0 m s^{-1} directly towards a stationary observer. The horn of the car emits sound of frequency 2000 Hz . The speed of sound is 340 m s^{-1} .

What is the frequency of the sound heard by the observer?

- A** 1840 Hz **B** 2000 Hz **C** 2180 Hz **D** 2190 Hz

- 24** A vibrating tuning fork is held over a measuring cylinder, as shown.



Water is then gradually poured into the measuring cylinder. A much louder sound is first heard when the water level is 2.9 cm above the base of the measuring cylinder. A second much louder sound is heard when the water level reaches a height of 67.3 cm above the base.

The speed of sound in air is 330 m s^{-1} .

What is the frequency of the tuning fork?

- A** 128 Hz **B** 256 Hz **C** 512 Hz **D** 1024 Hz

- 25** A water wave in a ripple tank is diffracted as it passes through a gap in a barrier.

Which two factors affect the angle of diffraction of the wave?

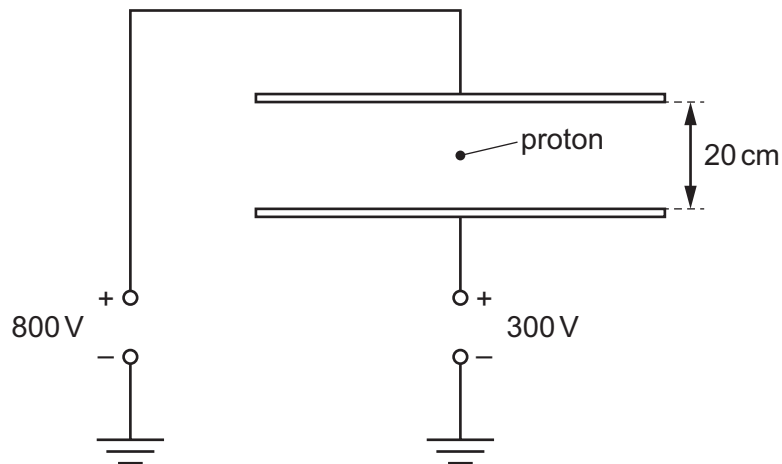
- A** the amplitude and frequency of the incident wave
B the amplitude of the incident wave and the width of the gap
C the wavelength and amplitude of the incident wave
D the wavelength of the incident wave and the width of the gap

- 26** A double-slit interference pattern using red light of wavelength $7.0 \times 10^{-7} \text{ m}$ has a fringe spacing of 3.5 mm .

Which fringe spacing would be observed for the same arrangement of apparatus but using blue light of wavelength $4.5 \times 10^{-7} \text{ m}$?

- A** 2.3 mm **B** 3.5 mm **C** 5.4 mm **D** 9.0 mm

- 27 Two parallel metal plates are situated 20 cm apart in a vacuum. They are connected to two sources of potential difference as shown.



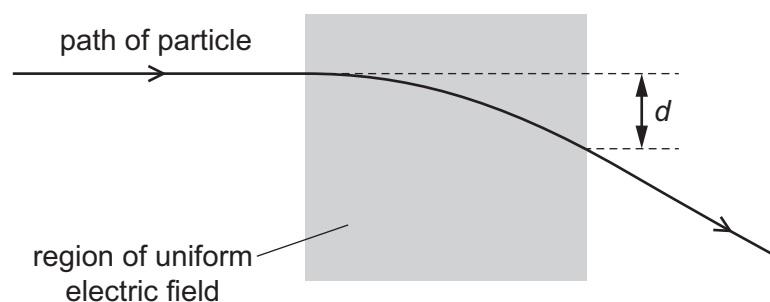
A proton is released in the space between the plates.

What is the magnitude and direction of the acceleration of the proton?

- A** $2.4 \times 10^{11} \text{ m s}^{-2}$ downwards
B $2.4 \times 10^{11} \text{ m s}^{-2}$ upwards
C $5.3 \times 10^{11} \text{ m s}^{-2}$ downwards
D $5.3 \times 10^{11} \text{ m s}^{-2}$ upwards
- 28 A particle having mass m and charge $+q$ enters a uniform electric field with speed v .

Initially, the particle is travelling at right-angles to the electric field.

During its movement through the field, the particle is deflected through distance d , as shown.



A second particle of mass $2m$, charge $+q$ and speed v enters the electric field along the same path.

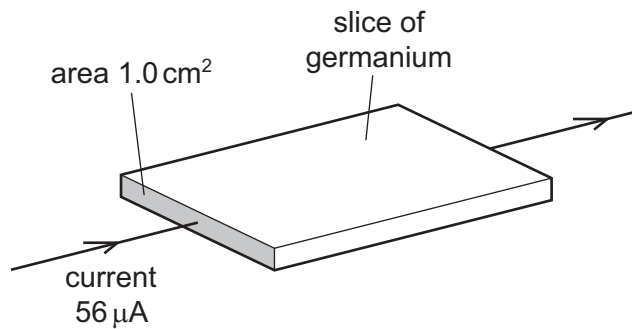
What is the distance through which this particle is deflected in the electric field?

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

29 What is a possible charge on a particle?

- A $6.40 \times 10^{-20} \text{ C}$
- B $4.00 \times 10^{-19} \text{ C}$
- C $1.12 \times 10^{-18} \text{ C}$
- D $9.11 \times 10^{-18} \text{ C}$

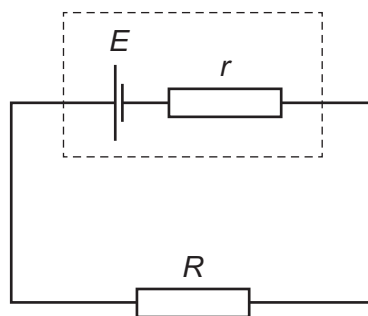
30 A slice of germanium of cross-sectional area 1.0 cm^2 carries a current of $56 \mu\text{A}$. The number density of charge carriers in the germanium is $2.0 \times 10^{13} \text{ cm}^{-3}$. Each charge carrier has a charge equal to the charge on an electron.



What is the average drift velocity of the charge carriers in the germanium?

- A 0.18 ms^{-1}
- B 18 ms^{-1}
- C 180 ms^{-1}
- D 1800 ms^{-1}

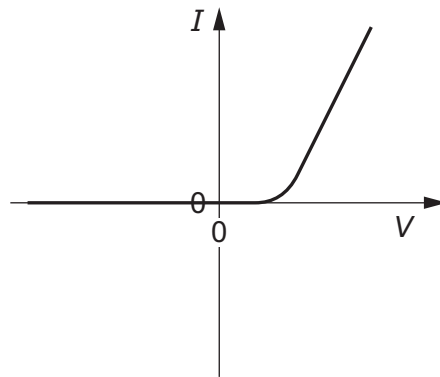
31 A cell of electromotive force (e.m.f.) E and internal resistance r is connected to an external resistor of resistance R , as shown.



What is the power dissipated in the external resistor?

- A $\frac{E^2(R+r)}{R^2}$
- B $\frac{E^2 R}{(R+r)^2}$
- C $\frac{E^2(R+r)}{r^2}$
- D $\frac{E^2 r}{(R+r)^2}$

32 The graph shows the I - V characteristic of an electrical component.



What is the component?

- A a filament lamp
- B a metallic conductor at constant temperature
- C a resistor
- D a semiconductor diode

33 A metal wire of length 1.4 m has a uniform cross-sectional area of $7.8 \times 10^{-7} \text{ m}^2$.

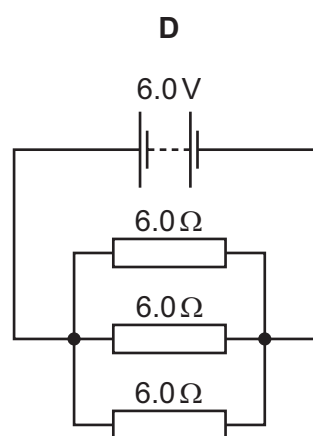
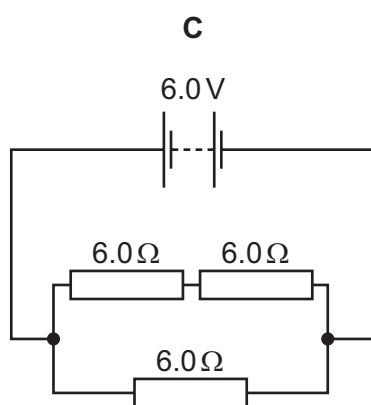
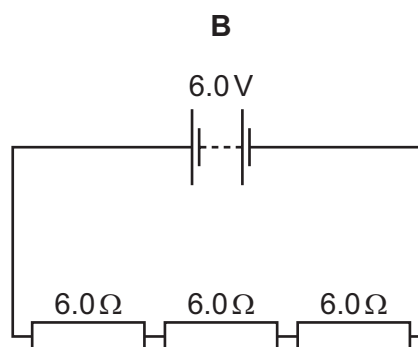
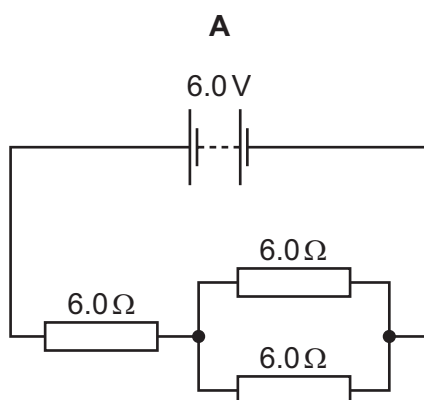
The resistivity of the metal is $1.7 \times 10^{-8} \Omega \text{ m}$.

What is the resistance of the wire?

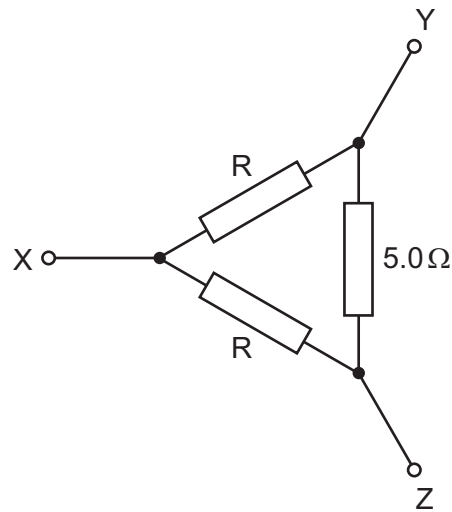
- A 0.016Ω B 0.031Ω C 33Ω D 64Ω

- 34 A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected to three resistors each of resistance $6.0\ \Omega$.

Which circuit will produce a current through the battery of 0.67 A ?



- 35** The diagram shows a network of three resistors. Two of these, marked R , are identical. The other resistor has a resistance of $5.0\ \Omega$.

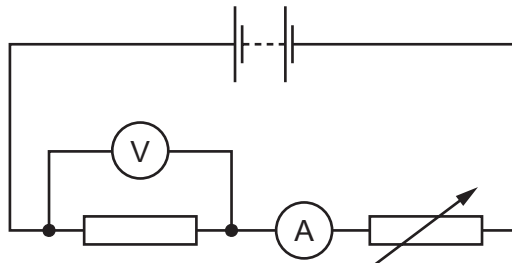


The resistance between Y and Z is found to be $2.5\ \Omega$.

What is the resistance between X and Y?

- A** $0.30\ \Omega$ **B** $0.53\ \Omega$ **C** $1.9\ \Omega$ **D** $3.3\ \Omega$
- 36** The diagram shows a battery, a fixed resistor, an ammeter and a variable resistor connected in series.

A voltmeter is connected across the fixed resistor.

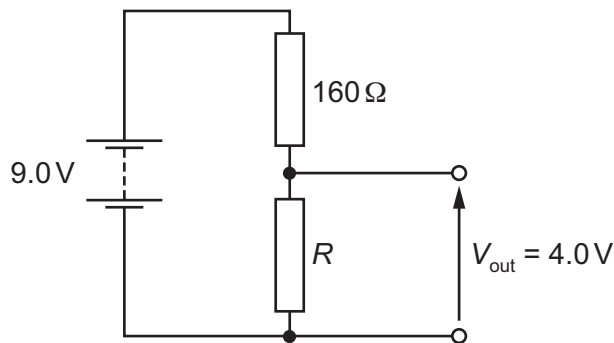


The resistance of the variable resistor is reduced.

Which row describes the changes in the readings of the ammeter and of the voltmeter?

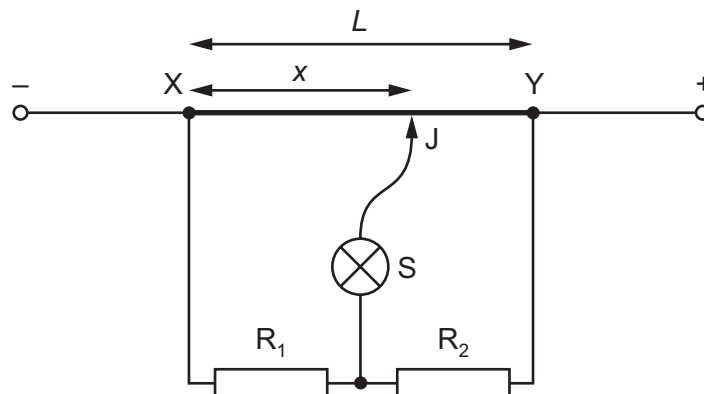
	ammeter	voltmeter
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

- 37 The circuit diagram shows a battery of electromotive force (e.m.f.) 9.0 V and negligible internal resistance. It is connected to two resistors of resistances $160\ \Omega$ and R . The output potential difference V_{out} is 4.0 V .



What is the resistance R ?

- A** $32\ \Omega$ **B** $49\ \Omega$ **C** $71\ \Omega$ **D** $128\ \Omega$
- 38 In the circuit shown, XY is a length L of uniform resistance wire. A potential difference is applied across XY . R_1 and R_2 are unknown resistors. J is a sliding contact that joins the junction of R_1 and R_2 to points on XY through a lamp S .



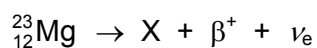
J is moved along XY to a point at which the lamp is off. This point is at a distance x from X .

The potential difference across R_1 is V_1 and the potential difference across R_2 is V_2 .

What is the value of the ratio $\frac{V_1}{V_2}$?

- A** $\frac{L}{x}$ **B** $\frac{x}{L}$ **C** $\frac{L-x}{x}$ **D** $\frac{x}{L-x}$

- 39 A nucleus of magnesium-23 undergoes β^+ decay, as represented by the nuclear equation shown.



What is nucleus X?

- A ${}_{11}^{22}\text{Na}$ B ${}_{13}^{22}\text{Al}$ C ${}_{11}^{23}\text{Na}$ D ${}_{13}^{23}\text{Al}$

- 40 Which list contains only leptons?

- A electron, neutrino, positron
B electron, neutrino, proton
C electron, proton, neutron
D neutrino, neutron, positron

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.