

PHYSICS

9702/11

Paper 1 Multiple Choice

May/June 2019

1 hour 15 minutes

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

* 7 1 0 8 1 6 7 4 0 0 *



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 **19** printed pages and **1** blank page.



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 Which unit can be expressed in base units as $\text{kg m}^2 \text{s}^{-2}$?

- A joule
- B newton
- C pascal
- D watt

2 The luminosity L of a star is given by

$$L = 4\pi r^2 \sigma T^4$$

where

r is the radius of the star,

T is the temperature of the star and

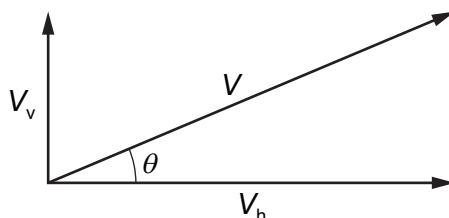
σ is a constant with units $\text{W m}^{-2} \text{K}^{-4}$.

What are the SI base units of L ?

- A $\text{kg m}^2 \text{s}^{-1}$ B $\text{kg m}^2 \text{s}^{-2}$ C $\text{kg m}^2 \text{s}^{-3}$ D $\text{kg m}^2 \text{s}^{-4}$

3 A particle has velocity V at an angle θ to the horizontal.

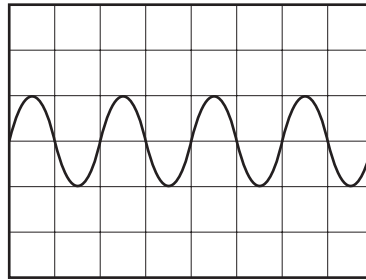
The components of the particle's velocity are V_v upwards in the vertical direction and V_h to the right in the horizontal direction, as shown.



What are expressions for the magnitude of V and for the angle θ ?

	magnitude of V	θ
A	$\sqrt{(V_v^2 + V_h^2)}$	$\tan^{-1} \left(\frac{V_h}{V_v} \right)$
B	$\sqrt{(V_v^2 + V_h^2)}$	$\tan^{-1} \left(\frac{V_v}{V_h} \right)$
C	$\sqrt{(V_v^2 - V_h^2)}$	$\tan^{-1} \left(\frac{V_h}{V_v} \right)$
D	$\sqrt{(V_v^2 - V_h^2)}$	$\tan^{-1} \left(\frac{V_v}{V_h} \right)$

- 4 A whale produces sound waves of frequency 5 Hz. The waves are detected by a microphone and displayed on an oscilloscope.



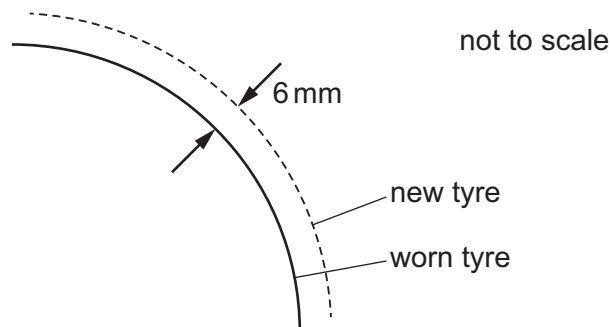
What is the time-base setting on the oscilloscope?

- A** 0.1 ms div^{-1} **B** 1 ms div^{-1} **C** 10 ms div^{-1} **D** 100 ms div^{-1}
- 5 The speed shown on a car's speedometer is proportional to the rate of rotation of the tyres.

The variation of the diameter of a tyre as it wears introduces an error in the speed shown on the speedometer.

A car has new tyres of diameter 600 mm. The speedometer is accurately calibrated for this diameter.

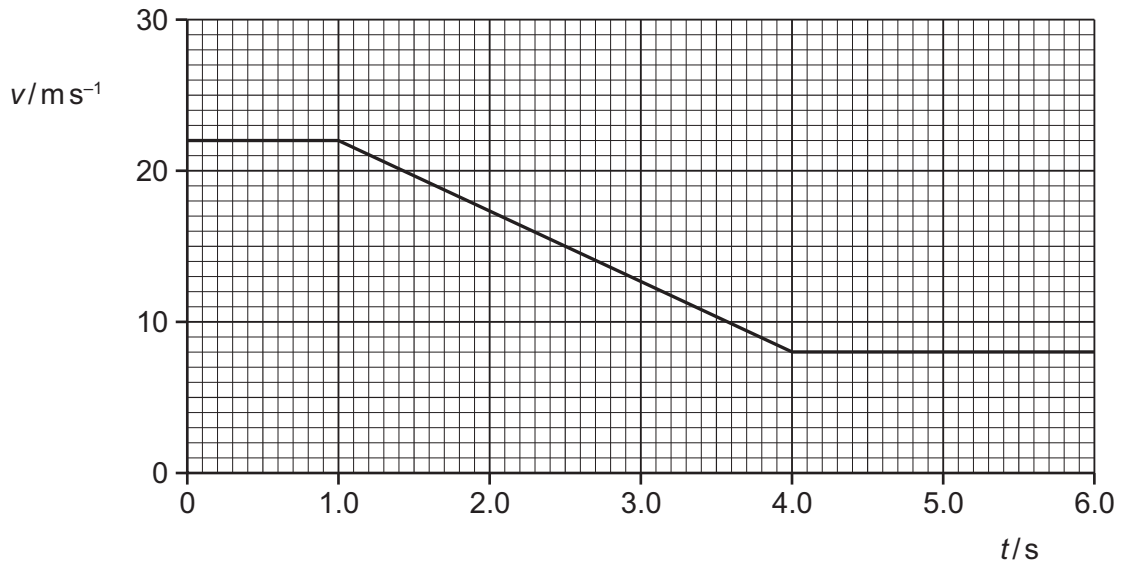
The tyres wear as shown, with 6 mm of material being removed from the outer surface.



What is the error in the speed shown on the speedometer after this wear has taken place?

- A** The speed shown is too high by 1%.
B The speed shown is too high by 2%.
C The speed shown is too low by 1%.
D The speed shown is too low by 2%.

- 6 A car travels along a straight horizontal road. The graph shows the variation of the velocity v of the car with time t for 6.0 s of its journey.

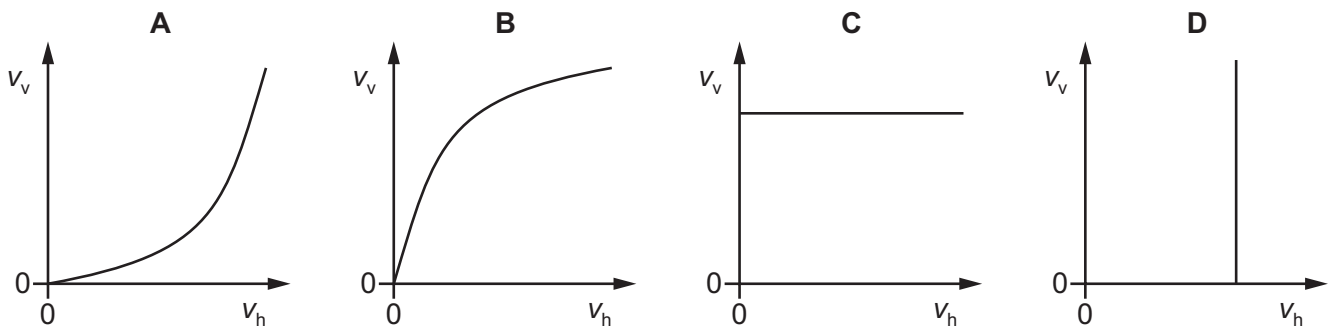


The brakes of the car are applied from $t = 1.0$ s to $t = 4.0$ s.

How far does the car travel while the brakes are applied?

- A** 21 m **B** 45 m **C** 67 m **D** 83 m
- 7 A stone is thrown horizontally from the top of a cliff and falls into the sea some time later. Air resistance is negligible.

Which graph shows how the vertical component v_v of velocity of this stone varies with its horizontal component v_h of velocity as it moves through the air?



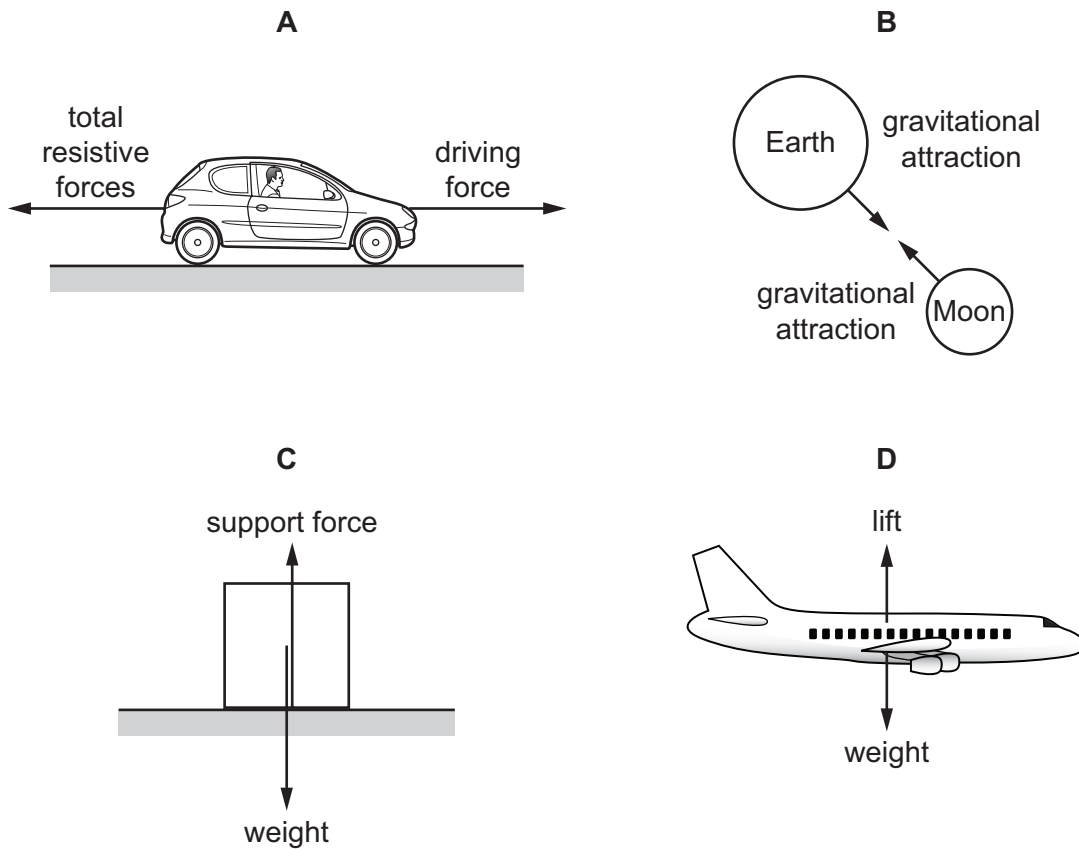
- 8 A positive charge of 2.6×10^{-8} C is in a uniform electric field of field strength $300\,000$ V m $^{-1}$.

How much work must be done on the charge in order to move it a distance of 4.0 mm in the opposite direction to the direction of the field?

- A** 3.1×10^{-5} J
B 2.0×10^{-3} J
C 3.1×10^{-2} J
D 2.0 J

- 9 Each diagram illustrates a pair of forces of equal magnitude.

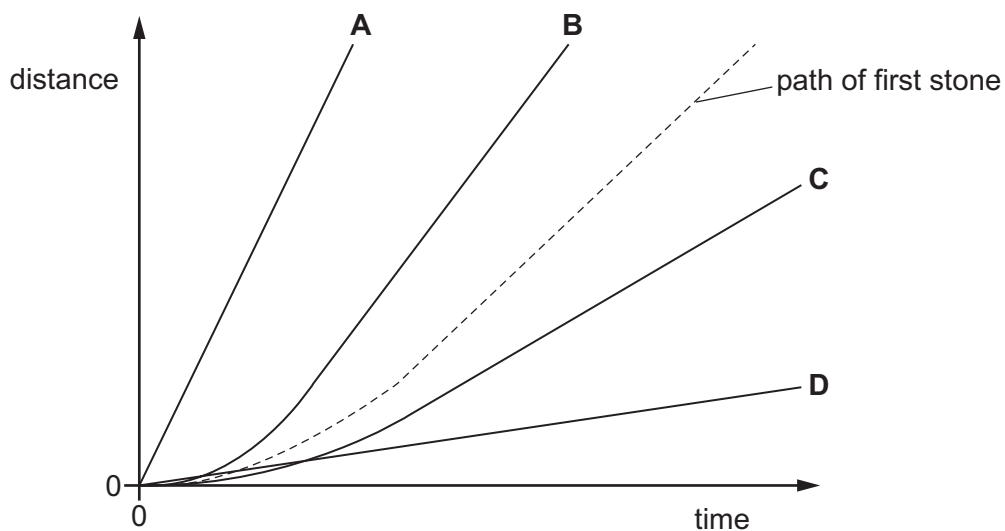
Which diagram gives an example of a pair of forces that is described by Newton's third law of motion?



- 10 A stone is dropped from a tall building. Air resistance is significant. The variation of distance fallen with time is shown by the dashed line.

A second stone with the same dimensions but a smaller mass is dropped from the same building.

Which line represents the motion of the second stone?

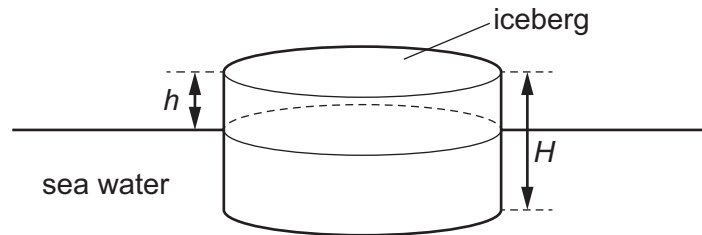


- 11 A helium atom of mass m collides normally with a wall. The atom arrives at the wall with speed v and then rebounds along its original path. Assume that the collision is perfectly elastic.

What is the change in the momentum of the atom during its collision?

- A zero B $0.5mv$ C mv D $2mv$

- 12 A cylindrical iceberg of height H floats in sea water. The top of the iceberg is at height h above the surface of the water.

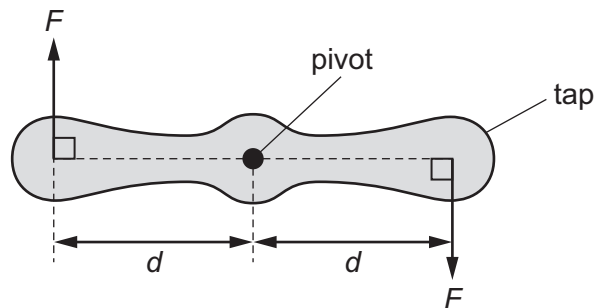


The density of ice is ρ_i and the density of sea water is ρ_w .

What is the height h of the iceberg above the sea water?

- A $\left(1 - \frac{\rho_i}{\rho_w}\right)H$ B $\left(\frac{\rho_i}{\rho_w} - 1\right)H$ C $\frac{\rho_w}{\rho_i}H$ D $\frac{\rho_i}{\rho_w}H$

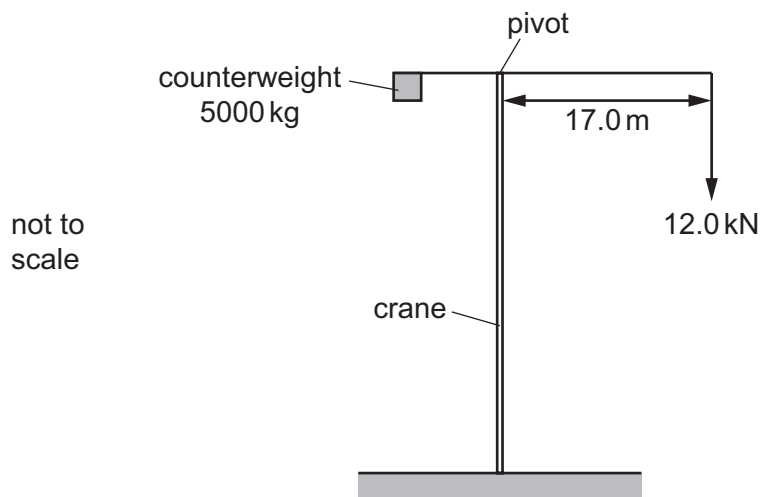
- 13 A couple is applied to a tap as shown.



What is the torque of the couple?

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

- 14 A crane uses a counterweight to stop it from toppling over when lifting a load, as shown.



The counterweight has a mass of 5000 kg. The crane is required to lift a load of 12.0 kN and the horizontal distance from the pivot to the load is 17.0 m.

How far from the pivot should the centre of gravity of the counterweight be positioned in order to keep the crane in equilibrium?

- A 0.0408 m B 0.240 m C 4.16 m D 40.8 m

- 15 Three parallel forces act on an object. As a result of these forces, the object is in equilibrium.

What **must** be correct for these forces?

- A They all act along the same line.
 B They all have the same magnitude.
 C They do **not** all act along the same line.
 D They do **not** all have the same magnitude.

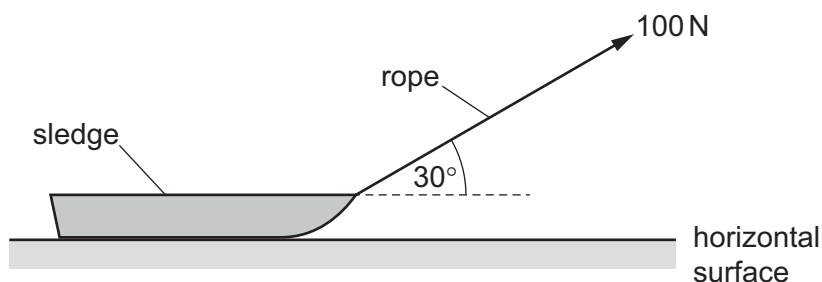
- 16 An empty glass beaker has a mass of 103 g. When filled with water, it has a total mass of 361 g. When filled with cooking oil, it has a total mass of 351 g.

The density of water is 1.00 g cm^{-3} .

What is the density of the cooking oil?

- A 0.961 g cm^{-3} B 0.972 g cm^{-3} C 1.03 g cm^{-3} D 1.04 g cm^{-3}

- 17 A rope is attached to a sledge and a boy uses the rope to pull the sledge along a horizontal surface with a constant velocity. The tension in the rope is 100 N and the rope is held at 30° to the horizontal.



How much work does the boy do on the sledge when he pulls it a distance of 5.0 m along the surface?

- A 250 J B 290 J C 430 J D 500 J
- 18 The kinetic energy E_k of an object of mass m moving at speed v is given by the equation shown.

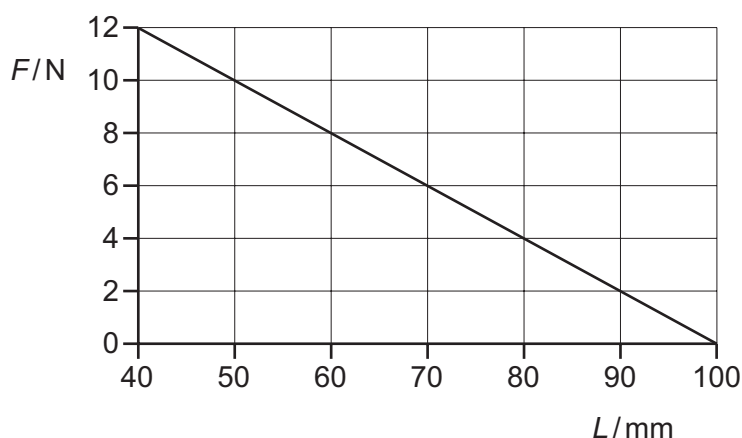
$$E_k = \frac{1}{2}mv^2$$

Which equation is **not** used in the derivation of this equation?

- A $F = ma$ B $s = vt$ C $v^2 = u^2 + 2as$ D $W = Fs$
- 19 A grasshopper of mass 0.12 g jumps vertically. It uses its back legs over a time of 0.020 s to jump, leaving the ground with a velocity of 3.0 m s^{-1} .

What is the average power developed by the legs of the grasshopper?

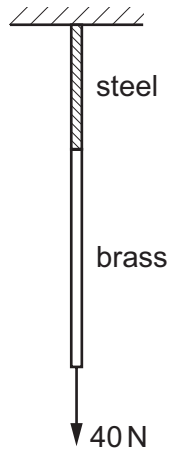
- A $9.0 \times 10^{-3} \text{ W}$ B $1.8 \times 10^{-2} \text{ W}$ C $2.7 \times 10^{-2} \text{ W}$ D 37 W
- 20 A spring of original length 100 mm is compressed by a force. The graph shows the variation of the compressing force F with the length L of the spring.



What is the energy stored in the spring when the length is 70 mm?

- A 0.090 J B 0.21 J C 0.27 J D 0.63 J

- 21 A 0.80 m length of steel wire and a 1.4 m length of brass wire are joined together. The combined wires are suspended from a fixed support and a force of 40 N is applied, as shown.



The Young modulus of steel is 2.0×10^{11} Pa.

The Young modulus of brass is 1.0×10^{11} Pa.

Each wire has a cross-sectional area of $2.4 \times 10^{-6} \text{ m}^2$.

The wires obey Hooke's law.

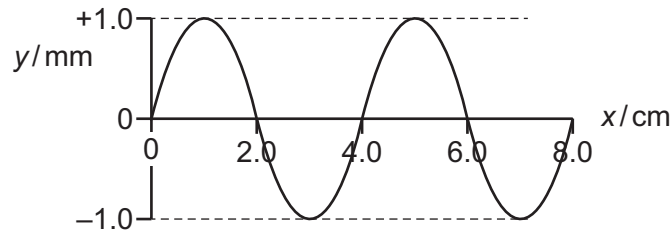
What is the total extension? Ignore the weights of the wires.

- A** $1.7 \times 10^{-4} \text{ m}$ **B** $3.0 \times 10^{-4} \text{ m}$ **C** $3.9 \times 10^{-4} \text{ m}$ **D** $9.0 \times 10^{-4} \text{ m}$

22 A transverse wave in a medium has the waveform shown, where

y = vertical displacement and x = horizontal distance.

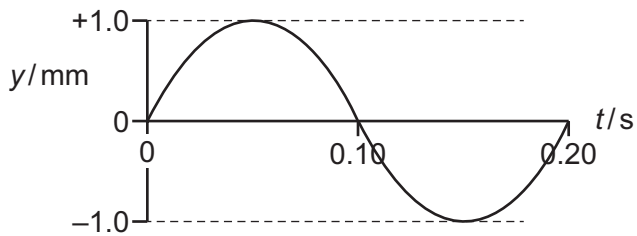
The speed of the wave is 20.0 cm s^{-1} .



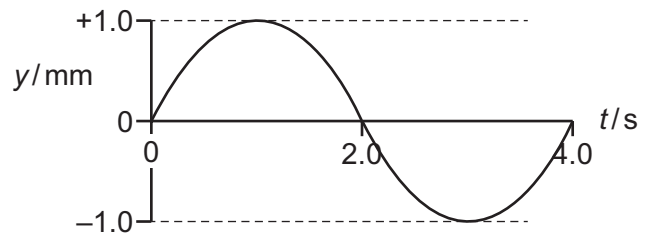
A particle of the medium oscillates vertically.

Which graph of vertical displacement y against time t best represents the motion of this particle?

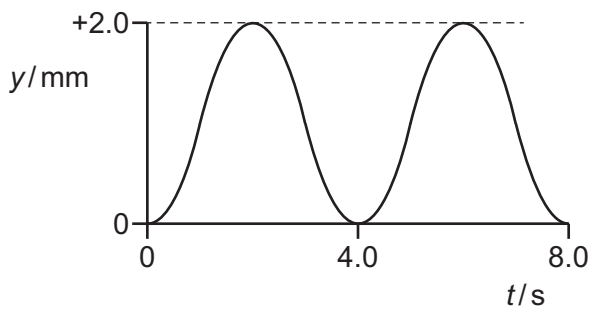
A



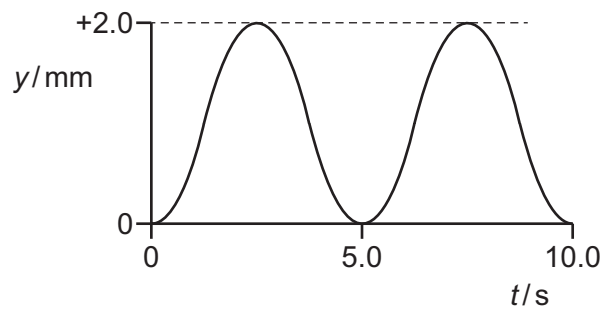
B



C

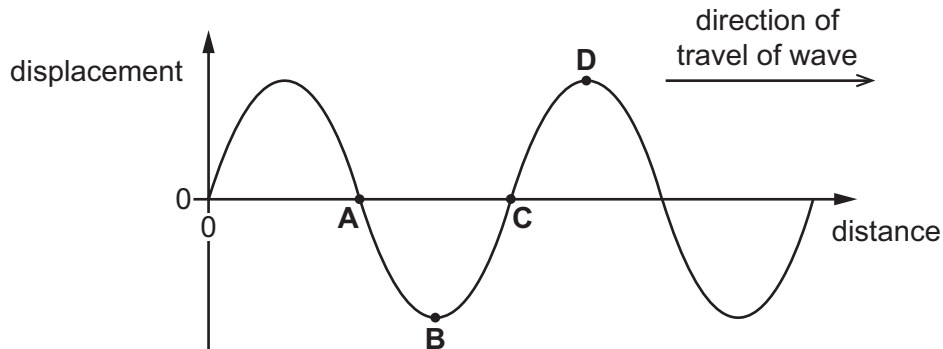


D



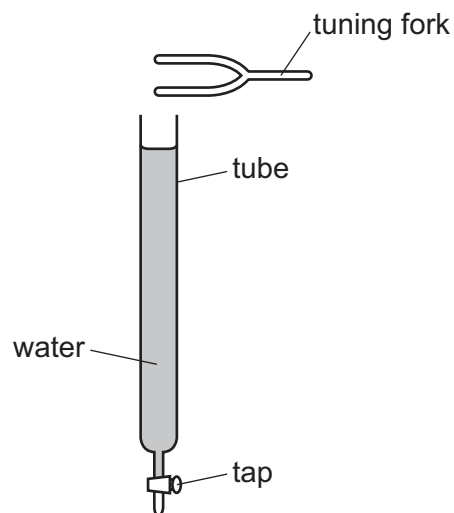
- 23** The graph shows the variation of the displacement of particles with distance along a transverse wave at an instant in time. The wave is moving to the right.

Which position along the wave corresponds to a point where particles in the wave are travelling the fastest upwards?



- 24** A long tube, filled with water, has a tap fitted at its base, as shown.

A tuning fork is sounded above the tube and the water is allowed to run gradually out of the tube.

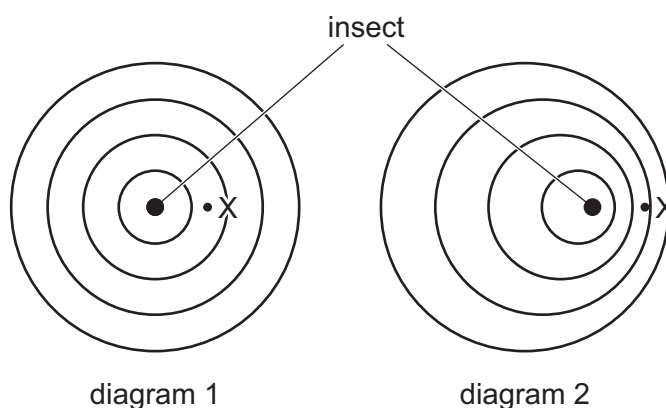


A louder sound is heard at intervals as the water runs out of the tube. The change in water level between louder sounds is 32 cm.

What is the wavelength of the sound in the tube?

- A** 16 cm **B** 32 cm **C** 64 cm **D** 128 cm

- 25** A stationary insect on the surface of water creates circular waves with its legs, as shown in diagram 1. The insect begins to travel to the right as shown in diagram 2.



Which row describes the change to the waves at X caused by the movement of the insect?

	frequency	wave speed
A	decreases	increases
B	decreases	stays the same
C	increases	increases
D	increases	stays the same

- 26** A toy motorboat moving with constant velocity v vibrates up and down on the surface of a pond. This causes the boat to act as a source of circular water waves of frequency 2.0 Hz . The speed of the waves is 1.5 m s^{-1} .

A man, standing at the edge of the pond, observes that the waves from the boat approach him with a frequency of 3.0 Hz .

The formula for Doppler effect calculations with sound waves may also be used for water waves.

What is a possible value of v ?

	speed / m s^{-1}	direction
A	0.50	directly away from the man
B	0.50	directly towards the man
C	0.75	directly away from the man
D	0.75	directly towards the man

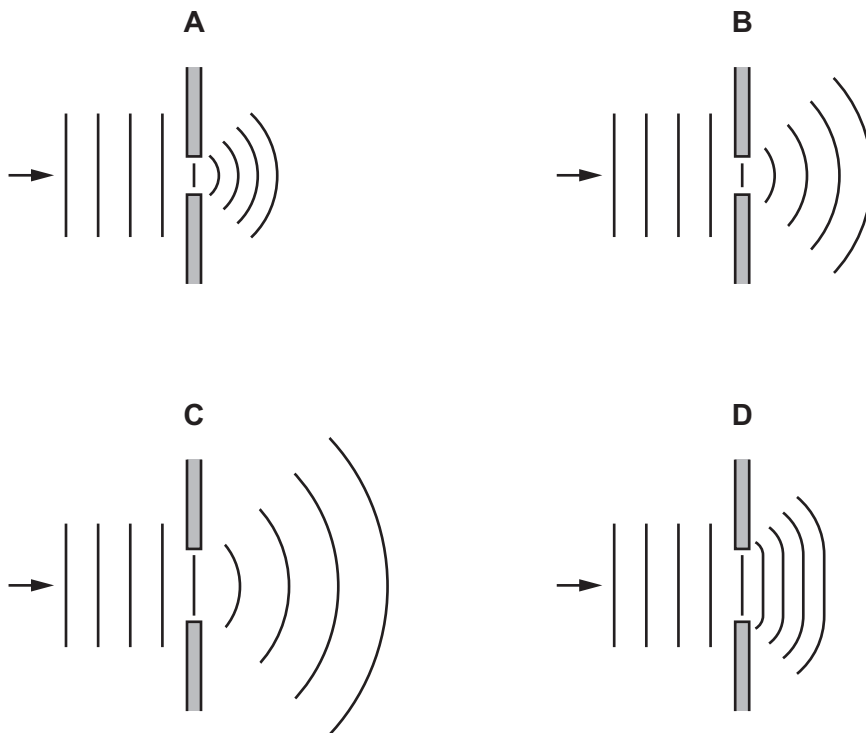
- 27** Two progressive waves of frequency 300 Hz superpose to produce a stationary wave in which adjacent nodes are 1.5 m apart.

What is the speed of the progressive waves?

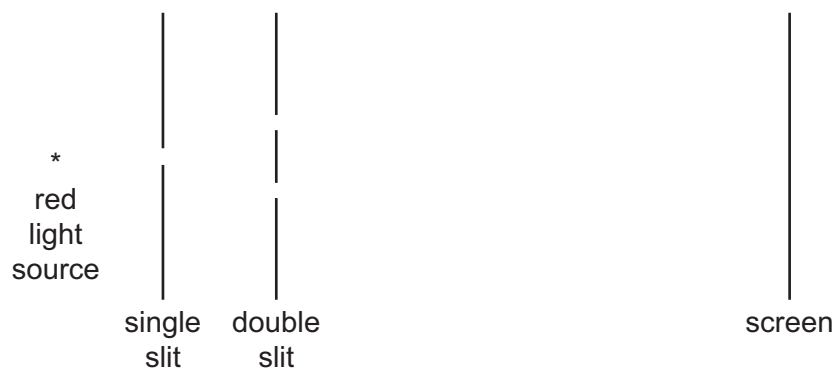
- A** 100 m s^{-1} **B** 200 m s^{-1} **C** 450 m s^{-1} **D** 900 m s^{-1}

- 28 The diagrams show the diffraction of water waves in a ripple tank as they pass through a gap between two barriers.

Which diagram is correct?



- 29 A double-slit interference experiment is set up as shown.



not to scale

Fringes are formed on the screen. The distance between successive bright fringes is found to be 4 mm.

Two changes are then made to the experimental arrangement. The double slit is replaced by another double slit which has half the spacing. The screen is moved so that its distance from the double slit is twice as great.

What is now the distance between successive bright fringes?

- A** 1 mm **B** 4 mm **C** 8 mm **D** 16 mm

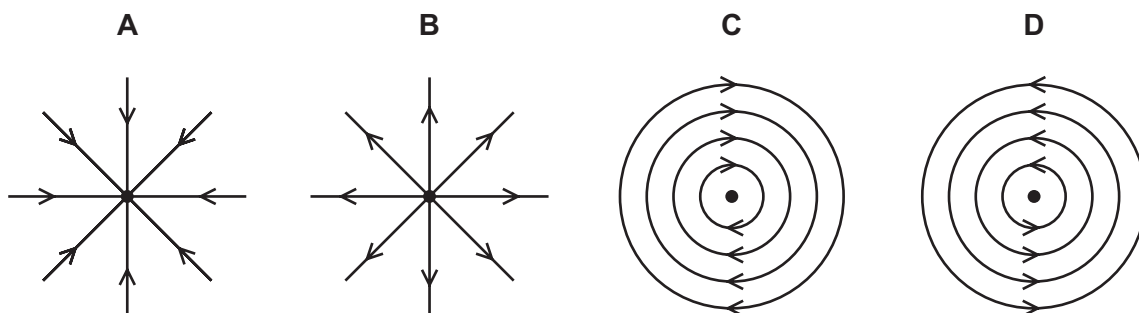
- 30 The interference patterns from a diffraction grating and a double slit are compared.

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

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

What is the fringe separation on the screen?

- A 2.5×10^{-7} m
 B 1.0×10^{-5} m
 C 1.0×10^{-3} m
 D 1.0×10^{-1} m
- 31 Which diagram shows the pattern of the electric field lines due to a negative point charge?

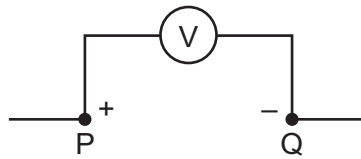


- 32 In an electrolyte, the electric current is carried by charged particles (ions) in solution.

What is **not** a possible value for the charge on an ion in solution?

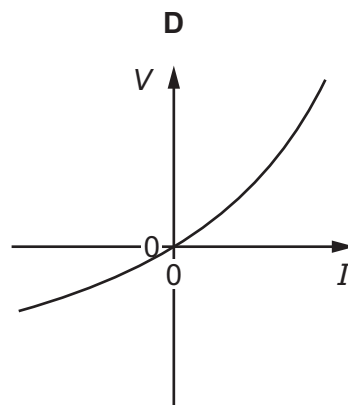
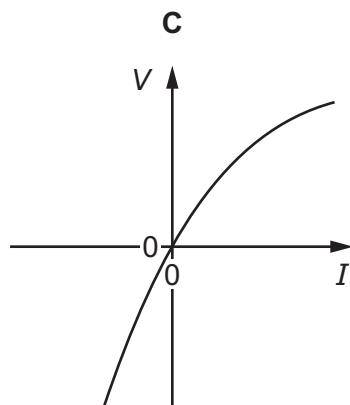
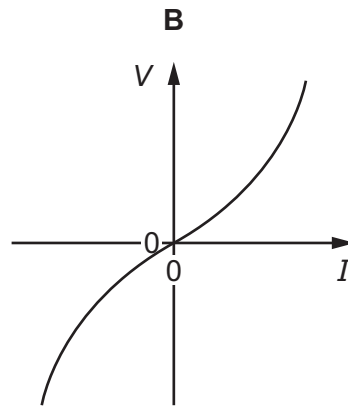
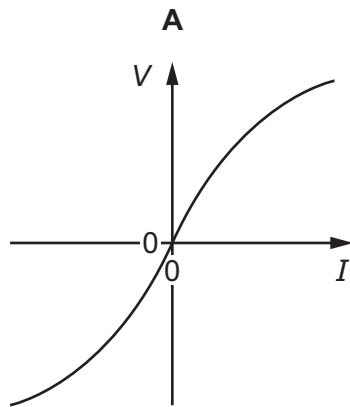
- A -4.8×10^{-19} C
 B $+1.6 \times 10^{-19}$ C
 C $+3.2 \times 10^{-19}$ C
 D $+4.0 \times 10^{-19}$ C

- 33 A voltmeter connected between two points P and Q in an electrical circuit shows a reading of 1 V.



Which statement is correct?

- A The energy needed to move +1 C of charge from P to Q is 1 J.
 - B The energy needed to move +1 C of charge from Q to P is 1 J.
 - C The energy needed to move one electron from P to Q is 1 J.
 - D The energy needed to move one electron from Q to P is 1 J.
- 34 Which graph best represents the variation with current I of potential difference V for a filament lamp?



- 35** When a battery is connected to a resistor, the battery gradually becomes warm. This causes the internal resistance of the battery to increase whilst its electromotive force (e.m.f.) stays unchanged.

As the internal resistance of the battery increases, how do the terminal potential difference and the output power change, if at all?

	terminal potential difference	output power
A	decreases	decreases
B	decreases	unchanged
C	unchanged	decreases
D	unchanged	unchanged

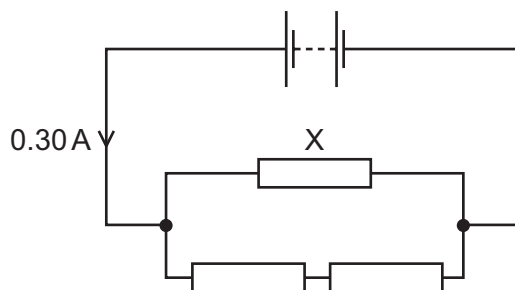
- 36** A cell is connected to a resistor of resistance $3.00\ \Omega$. The current in the resistor is $1.00\ \text{A}$.

A second identical resistor is added in parallel. The current becomes $1.93\ \text{A}$.

What are the e.m.f. E and internal resistance r of the cell?

	E/V	r/Ω
A	0.113	3.11
B	3.04	0.0358
C	3.11	0.113
D	9.34	6.34

- 37** A battery with negligible internal resistance is connected to three resistors, as shown.



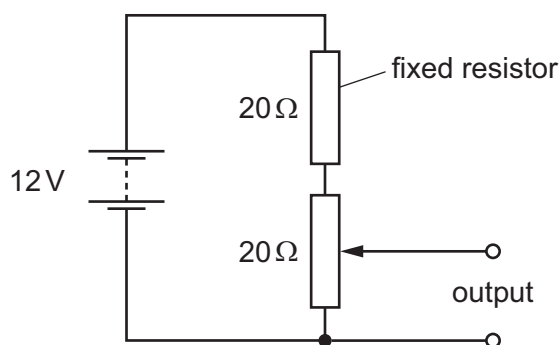
All three resistors have the same resistance.

The current in the battery is $0.30\ \text{A}$.

What is the current in resistor X?

- A** $0.10\ \text{A}$ **B** $0.15\ \text{A}$ **C** $0.20\ \text{A}$ **D** $0.30\ \text{A}$

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



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

What is the range of output voltages?

- A** 0–6V **B** 0–12V **C** 6–12V **D** 12–20V
- 39 Which statement about the alpha-particle scattering experiment provides evidence for the existence of the nucleus?
- A** A tiny proportion of the alpha-particles are deflected through large angles.
B Slower alpha-particles are deflected through larger angles.
C The kinetic energies of the deflected alpha-particles are unchanged.
D The number of alpha-particles deflected depends on the thickness of the foil.
- 40 Some particles are a combination of three quarks.

Which combination of quarks would **not** result in a particle with a charge of either $+1.6 \times 10^{-19}\text{C}$ or zero?

- A** up, down, down
B up, strange, strange
C up, up, down
D up, up, up

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PHYSICS

9702/12

Paper 1 Multiple Choice

May/June 2019

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Sheet
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This document consists of **20** printed pages and **4** blank 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 equivalent to 2000 microvolts?

- A $2\mu\text{JC}^{-1}$ B 2 mV C 2 pV D 2000 mV

2 What is the number of SI base units required to express electric field strength and power?

	electric field strength	power
A	3	3
B	3	2
C	4	2
D	4	3

3 The Planck constant h has SI units J s.

Which equation could be used to calculate the Planck constant?

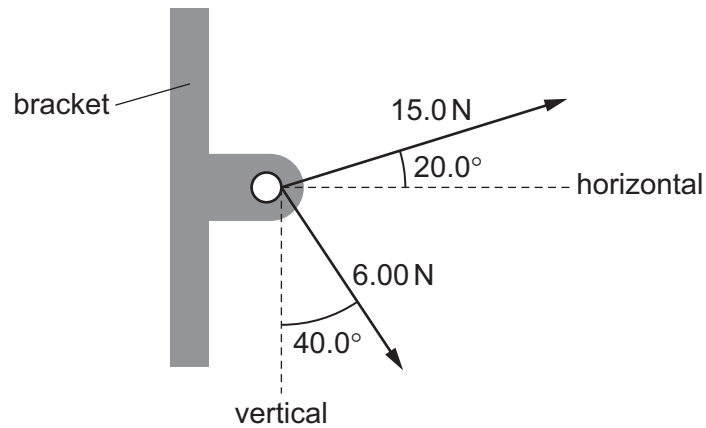
A $h = \frac{DE}{v}$ where D is distance, E is energy and v is velocity

B $h = \frac{v}{D}$ where v is velocity and D is distance

C $h = \frac{1}{4\pi E}$ where E is electric field strength

D $h = \frac{Fr^2}{m}$ where F is force, r is radius and m is mass

- 4 Two cables are attached to a bracket and exert forces as shown.



What are the magnitudes of the horizontal and vertical components of the resultant of the two forces?

	horizontal component / N	vertical component / N
A	9.73	0.534
B	9.73	10.2
C	18.0	0.534
D	18.0	10.2

- 5 A student wishes to determine the density ρ of lead. She measures the mass and diameter of a small sphere of lead:

$$\text{mass} = (0.506 \pm 0.005) \text{ g}$$

$$\text{diameter} = (2.20 \pm 0.02) \text{ mm}.$$

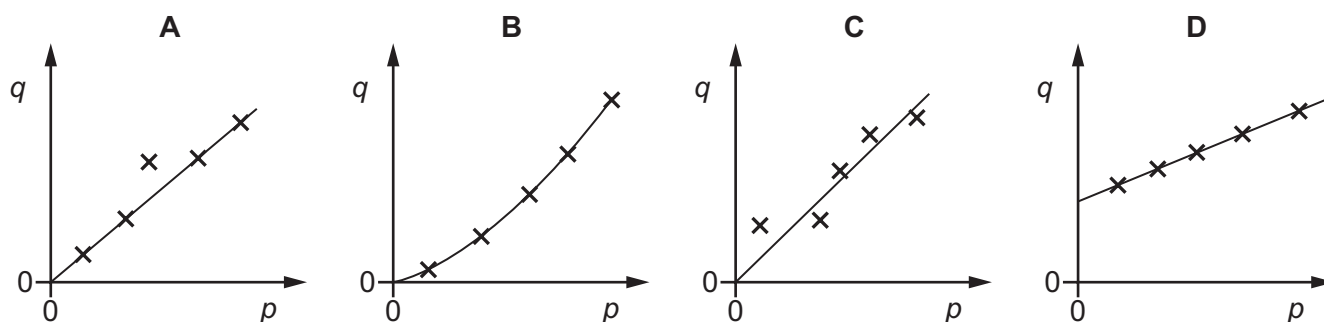
What is the best estimate of the percentage uncertainty in her calculated value of ρ ?

- A** 1.7% **B** 1.9% **C** 2.8% **D** 3.7%

- 6 Two quantities p and q are directly proportional to each other.

Experimental results are taken and plotted in a graph of q against p .

Which graph shows there were random errors in the measurements of p and q ?



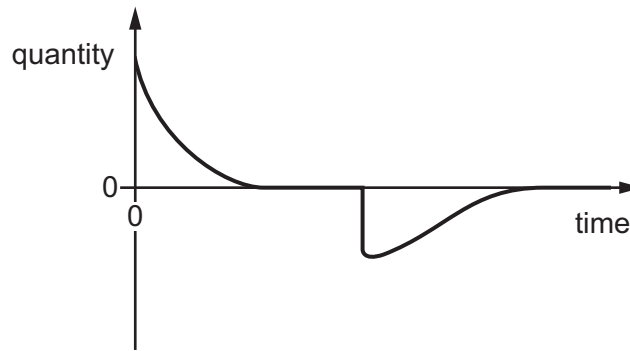
- 7 A man of mass 75.2 kg uses a set of weighing scales to measure his mass three times. He obtains the following readings.

	mass / kg
reading 1	80.2
reading 2	80.1
reading 3	80.2

Which statement best describes the precision and accuracy of the weighing scales?

- A** not precise to ± 0.1 kg and accurate to ± 0.1 kg
- B** not precise to ± 0.1 kg and not accurate to ± 0.1 kg
- C** precise to ± 0.1 kg and accurate to ± 0.1 kg
- D** precise to ± 0.1 kg and not accurate to ± 0.1 kg

- 8 The graph shows how a physical quantity varies with time.



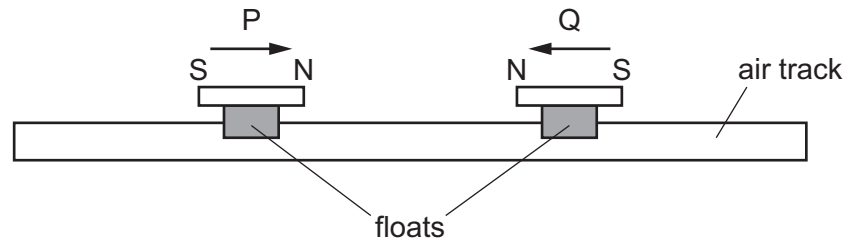
Which event could best be represented by the graph?

- A** the acceleration of a firework rising to a maximum height and falling to the ground
 - B** the acceleration of a skydiver leaving an aircraft, falling, opening a parachute and falling to the ground
 - C** the speed of a javelin as it leaves an athlete's hand, falls and sinks into the ground
 - D** the speed of a high jump athlete leaving the ground, jumping over a bar and descending to the ground
- 9 What describes the mass of an object?
- A** the force the object experiences due to gravity
 - B** the momentum of the object before a collision
 - C** the resistance of the object to changes in motion
 - D** the weight of the object as measured by a balance
- 10 A car has mass m . A person needs to push the car with force F in order to give the car acceleration a . The person needs to push the car with force $2F$ in order to give the car acceleration $3a$.

Which expression gives the constant resistive force opposing the motion of the car?

- A** ma
- B** $2ma$
- C** $3ma$
- D** $4ma$

- 11 Two bar magnets P and Q are mounted on floats which can slide without friction along an air track.



The two magnets slide towards each other along the air track and interact, without making contact.

The relative speed of approach of the magnets is equal to their relative speed of separation.

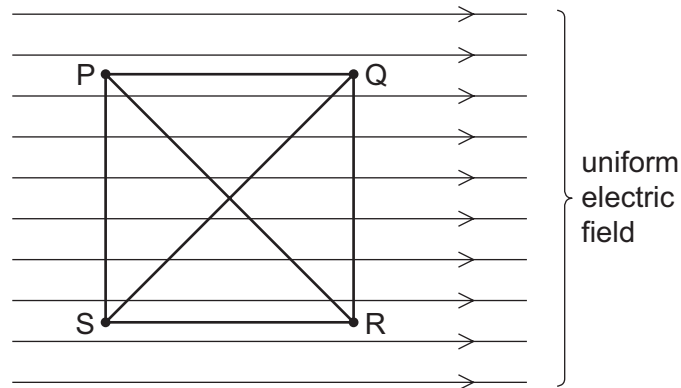
Which statement about P and Q must be correct?

- A During the interaction between P and Q some of the total kinetic energy is lost.
 - B During the interaction between P and Q some of the total momentum is lost.
 - C The momentum of Q after the interaction is equal to the momentum of P before the interaction.
 - D The values of (kinetic energy of P + kinetic energy of Q) before and after the interaction are equal.
- 12 A submarine descends vertically at constant velocity. The three forces acting on the submarine are viscous drag, upthrust and weight.

Which relationship between their magnitudes is correct?

- A weight < drag
- B weight = drag
- C weight < upthrust
- D weight > upthrust

- 13 A small positive charge can move inside a uniform electric field.

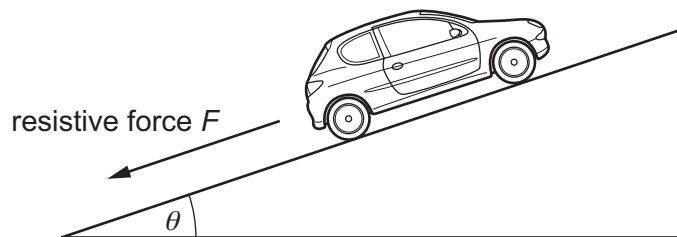


The charge moves along different straight paths between points P, Q, R and S.

Which row gives two paths that result in the same total work done on the charge?

	path 1	path 2
A	P to R	Q to S
B	P to R	P to S
C	S to Q	S to R
D	S to Q	R to P

- 14 A car of mass m travels at constant speed up a slope at an angle θ to the horizontal, as shown in the diagram. Air resistance and friction provide a resistive force F . The acceleration of free fall is g .



What is the force needed to propel the car at this constant speed?

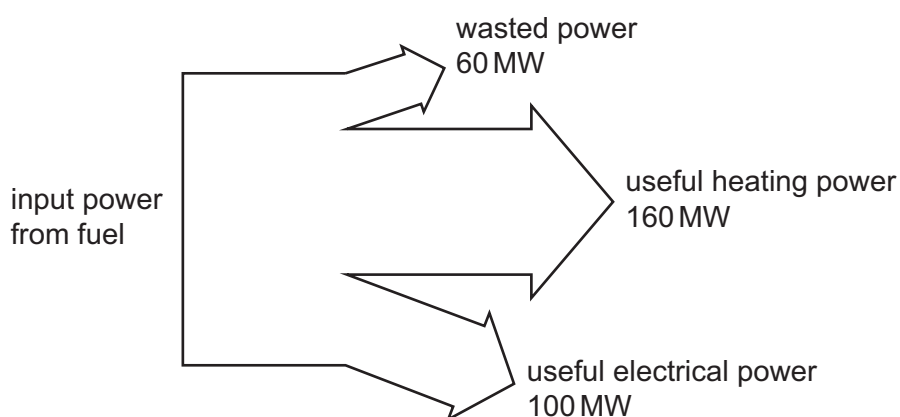
- A** $mg \cos \theta$
- B** $mg \sin \theta$
- C** $mg \cos \theta + F$
- D** $mg \sin \theta + F$

- 15 A volume of 1.5 m^3 of water is mixed with 0.50 m^3 of alcohol. The density of water is 1000 kg m^{-3} and the density of alcohol is 800 kg m^{-3} .

The volume of the mixture is 2.0 m^3 .

What is the density of the mixture?

- A 850 kg m^{-3} B 900 kg m^{-3} C 940 kg m^{-3} D 950 kg m^{-3}
- 16 A parachutist is falling at constant (terminal) velocity.
- Which statement is **not** correct?
- A Gravitational potential energy is converted into kinetic energy of the air.
B Gravitational potential energy is converted into kinetic energy of the parachutist.
C Gravitational potential energy is converted into thermal energy of the air.
D Gravitational potential energy is converted into thermal energy of the parachutist.
- 17 A combined heat and power (CHP) station generates electrical power and useful heat. The diagram shows the input and output powers for a CHP station.



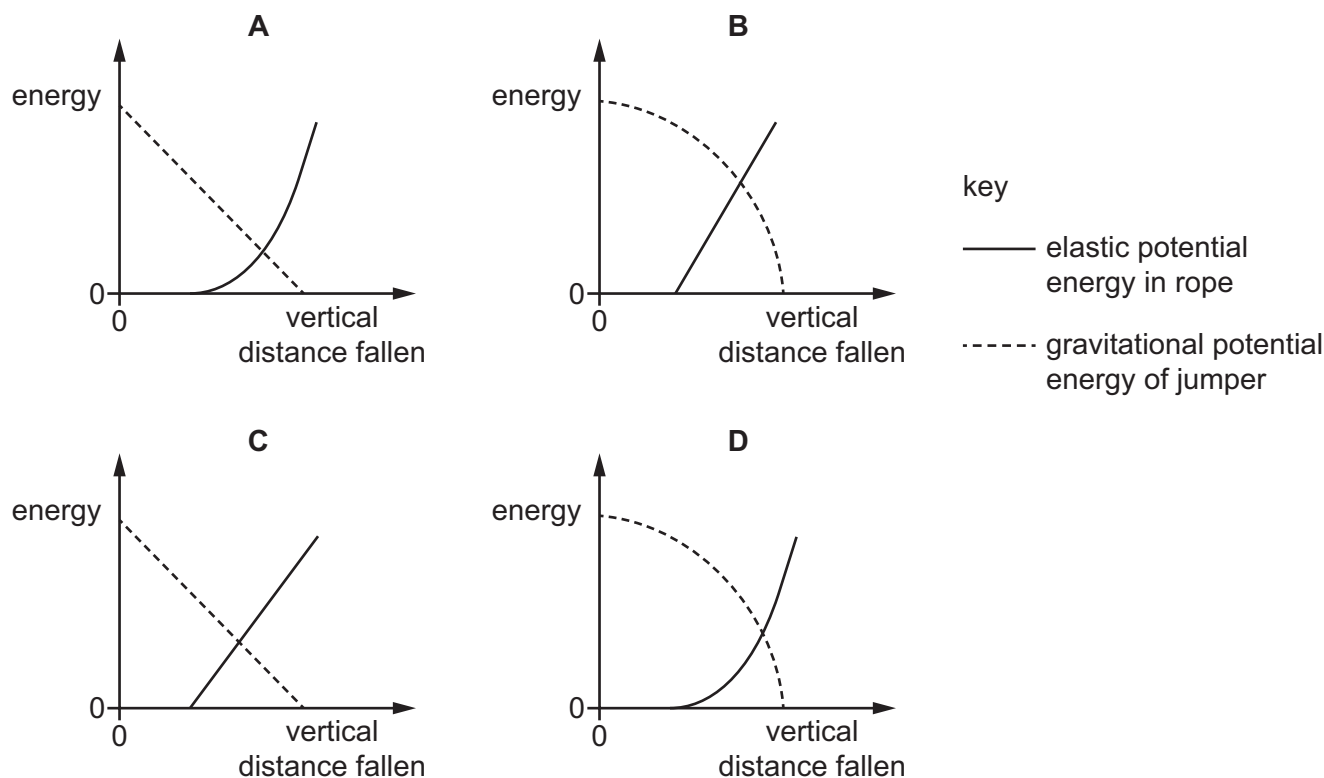
What is the efficiency of the CHP station for producing useful power?

- A 31% B 38% C 50% D 81%

- 18** A bungee jumper jumps off a high bridge, when attached to it by a long elastic rope which obeys Hooke's law.

The gravitational potential energy of the jumper is measured relative to the lowest point reached by the jumper.

Which graph shows the variation of the gravitational potential energy of the jumper, and the elastic potential energy in the rope, with the vertical distance fallen from the top of the bridge?



- 19** A train on a mountain railway is carrying 200 people of average mass 70 kg up a slope at an angle of 30° to the horizontal and at a speed of 6.0 m s^{-1} . The train itself has a mass of 80 000 kg. The percentage of the power from the engine which is used to raise the passengers and the train is 40%.

What is the power of the engine?

- A** 1.1 MW **B** 2.8 MW **C** 6.9 MW **D** 14 MW

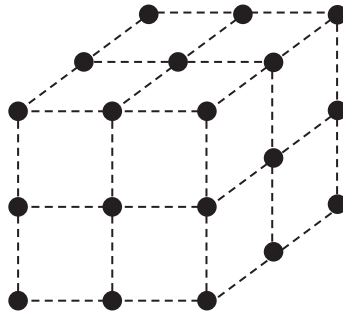
- 20** A wire X is stretched by a force and gains elastic potential energy E .

The same force is applied to wire Y of the same material, with the same initial length but twice the diameter of wire X. Both wires obey Hooke's law.

What is the gain in elastic potential energy of wire Y?

- A** $0.25E$ **B** $0.5E$ **C** $2E$ **D** $4E$

21 The diagram shows the arrangement of atoms in a particular crystal.



Each atom is at the corner of a cube.

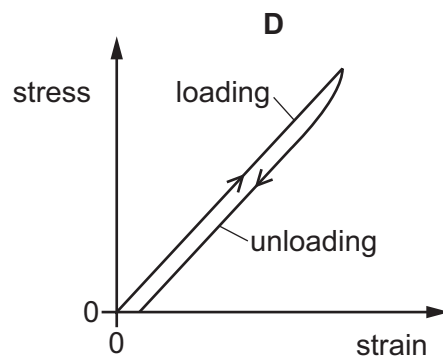
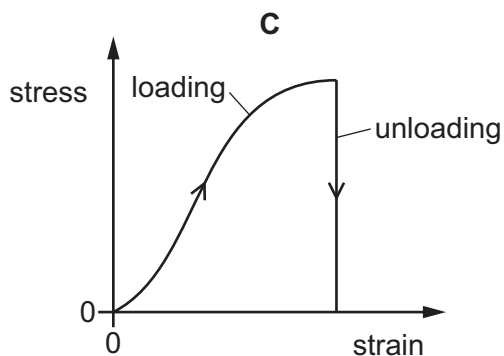
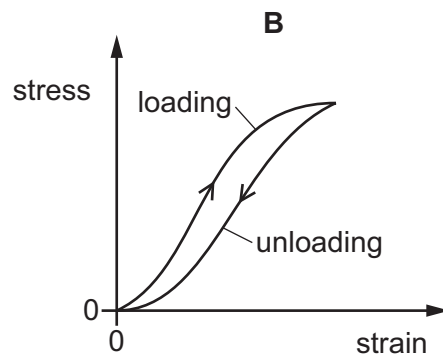
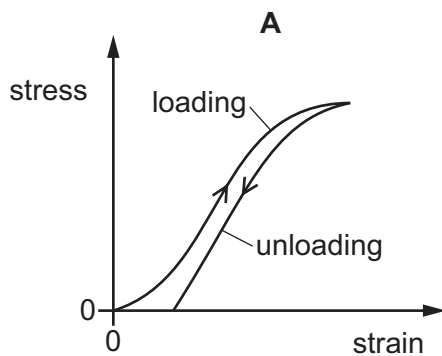
The mass of each atom is 3.5×10^{-25} kg. The density of the crystal is $9.2 \times 10^3 \text{ kg m}^{-3}$.

What is the shortest distance between the centres of two adjacent atoms?

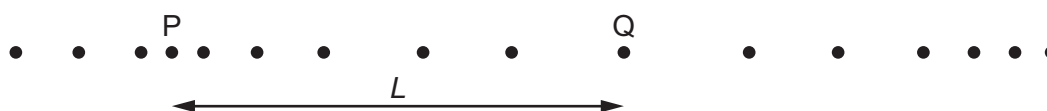
- A $3.8 \times 10^{-29} \text{ m}$
- B $6.2 \times 10^{-15} \text{ m}$
- C $3.4 \times 10^{-10} \text{ m}$
- D $3.0 \times 10^{-9} \text{ m}$

22 The stress-strain graphs for loading and unloading four different materials are shown.

Which material exhibits purely elastic behaviour?



- 23 The diagram illustrates the position of particles in a progressive sound wave at one instant in time.



The speed of the wave is v . P and Q are two points in the wave a distance L apart.

What is an expression for the frequency of the wave?

A $\frac{v}{2L}$

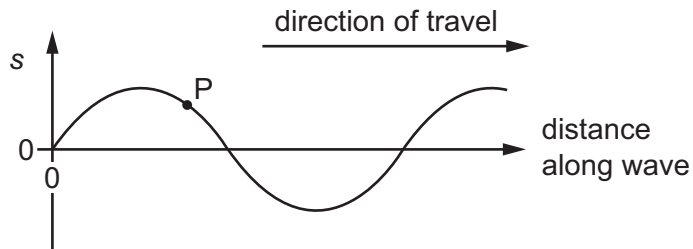
B $\frac{v}{L}$

C $\frac{2v}{L}$

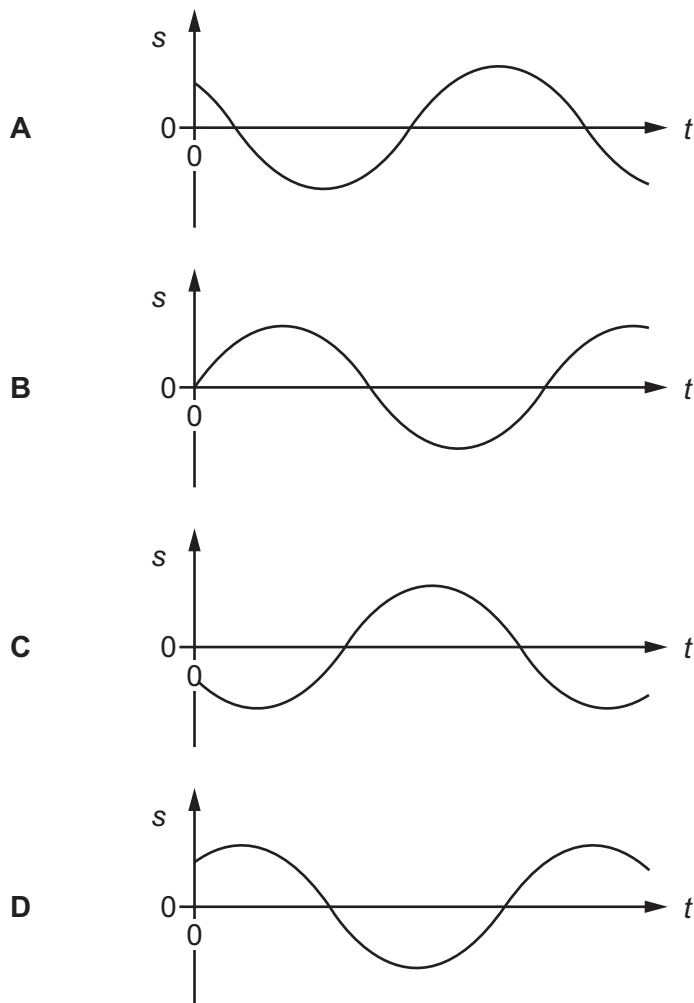
D $\frac{L}{v}$

- 24** A wave moves along the surface of water.

The diagram shows the variation of displacement s with distance along the wave at time $t = 0$.



Which graph best shows the variation with time t of the displacement s of the point P on the wave?



- 25** In an experiment to determine the wavelength of sound in air, a stationary wave is set up in an air column.

The distance between a node and an adjacent antinode is L .

What is the wavelength of the sound?

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

- 26** In one of the first experiments to demonstrate the Doppler effect, a train was filled with trumpeters all playing a note of frequency 440 Hz. The difference in observed frequency of the note as the train directly approached a stationary observer was 22 Hz. The speed of sound was 340 m s^{-1} .

At which speed was the train moving?

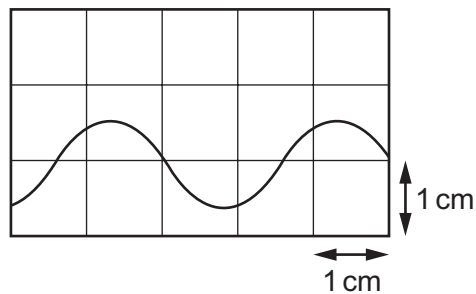
- A** 15.4 m s^{-1} **B** 16.2 m s^{-1} **C** 17.0 m s^{-1} **D** 17.9 m s^{-1}

- 27** The electromagnetic spectrum consists of waves with different wavelengths.

Which row correctly identifies regions of the electromagnetic spectrum?

	10^{-10} m	10^{-8} m	10^{-5} m	10^{-2} m
A	microwaves	X-rays	ultraviolet	infrared
B	infrared	microwaves	X-rays	ultraviolet
C	microwaves	infrared	ultraviolet	X-rays
D	X-rays	ultraviolet	infrared	microwaves

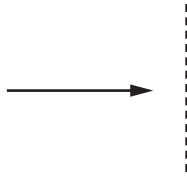
- 28** A cathode-ray oscilloscope (CRO) is used to display the trace from a sound wave. The time-base is set at $5 \mu\text{s mm}^{-1}$.



What is the frequency of the sound wave?

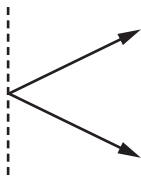
- A** 6.7 Hz **B** 67 Hz **C** 6.7 kHz **D** 67 kHz

29 Monochromatic light is directed at a diffraction grating, as shown.

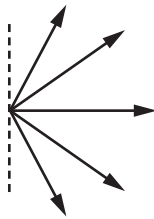


Which diagram could show all the possible directions of the light, after passing through the grating, that give maximum intensity?

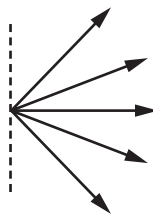
A



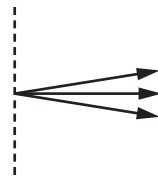
B



C



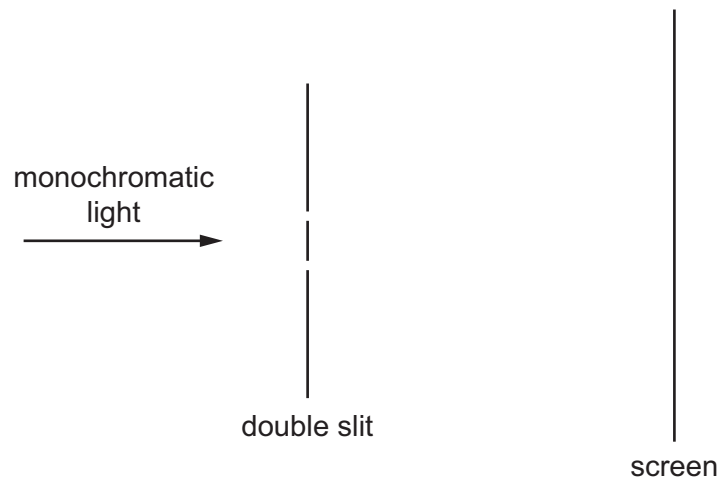
D



30 Why can an observable interference pattern **never** be obtained between two monochromatic beams of light from different lamps?

- A** The frequency of the light from the two lamps can never be the same.
- B** The light from the two lamps can never be coherent.
- C** The temperature of the filaments of the two lamps used can never be the same.
- D** The wavelength of the light from the two lamps must always be different.

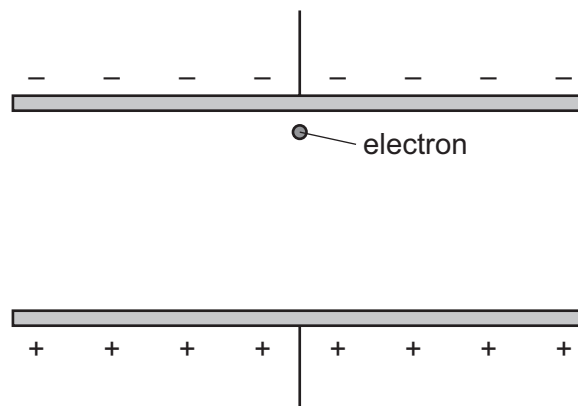
- 31 A student sets up apparatus to observe the double-slit interference of monochromatic light, as shown.



Interference fringes are formed on the screen.

Which change would increase the distance between adjacent fringes?

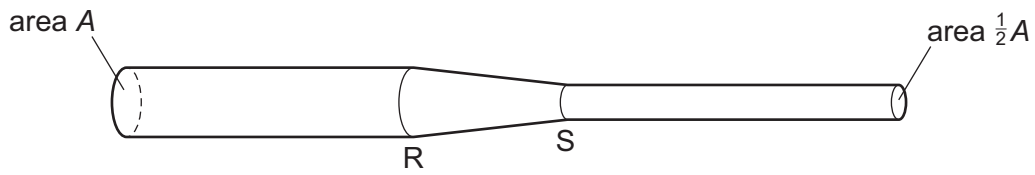
- A Decrease the distance between the two slits.
 - B Decrease the width of each slit.
 - C Move the screen closer to the double slit.
 - D Use light of a higher frequency.
- 32 An electron is situated in a vacuum between two charged plates, as shown.



Which statement describes the motion of the electron due to the uniform electric field?

- A It moves downwards with a constant acceleration.
- B It moves downwards with zero acceleration.
- C It moves upwards with a constant acceleration.
- D It moves upwards with a decreasing acceleration.

- 33 A length of wire is connected into a circuit.



The area of the cross-section of the wire changes from A at R to $\frac{1}{2}A$ at S .

There is a constant current in the wire. Charge Q passes R in time t .

What is the charge passing point S in the same time t ?

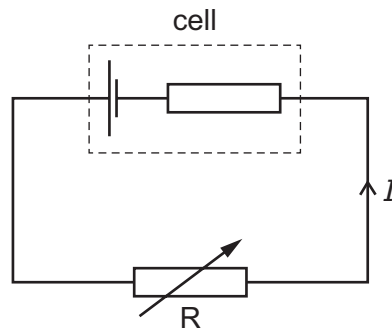
- A $\frac{1}{2}Q$ B Q C $Q\sqrt{2}$ D $2Q$

- 34 Four wires are made of the same metal. The cross-sectional areas, lengths and thermodynamic temperatures of the wires are shown.

Which wire has the largest resistance?

	cross-sectional area	length	temperature
A	A	$2L$	$2T$
B	A	L	T
C	$2A$	$2L$	$2T$
D	$2A$	L	T

- 35 A cell with internal resistance is connected to a variable resistor R as shown.



The resistance of R is gradually decreased.

How do the current I and the terminal potential difference across the cell change?

	current I	terminal potential difference across cell
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

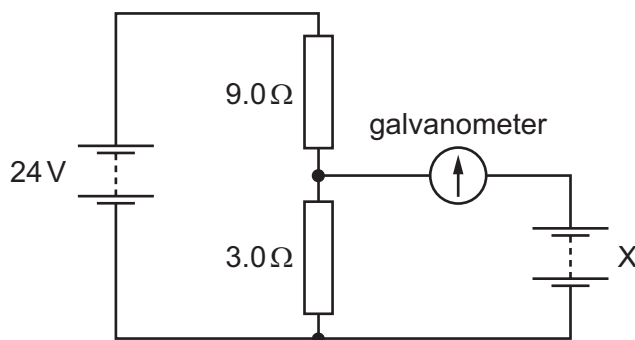
- 36 Kirchhoff's first law states that the sum of the currents entering a junction in a circuit is equal to the sum of the currents leaving it.

The law is based on the conservation of a physical quantity.

What is this physical quantity?

- A** charge
- B** energy
- C** mass
- D** momentum

- 37 A circuit contains two batteries, each of negligible internal resistance, and two resistors as shown.



The galvanometer has a current reading of zero.

What is the electromotive force (e.m.f.) of battery X?

- A** 6.0V **B** 8.0V **C** 16.0V **D** 18.0V
- 38 A nucleus of francium-221 ($^{221}_{87}\text{Fr}$) decays into a nucleus of bismuth-209 ($^{209}_{83}\text{Bi}$) in several steps.
- Which particles could be emitted?
- A** 2 α -particles and 4 β^- particles
B 2 α -particles and 4 β^+ particles
C 3 α -particles and 2 β^- particles
D 3 α -particles and 2 β^+ particles
- 39 Which equation describes the changes to the quark composition of a nucleus and the lepton emission during the process of β^+ decay?
- A** down $\rightarrow$ up + positron + electron neutrino
B down $\rightarrow$ up + positron + electron antineutrino
C up $\rightarrow$ down + positron + electron neutrino
D up $\rightarrow$ down + positron + electron antineutrino
- 40 There are protons, neutrons and electrons in the simple model of an atom.

To which class (group), hadron or lepton, do these particles belong?

	hadron	lepton
A	electron	proton and neutron
B	neutron	proton and electron
C	proton and electron	neutron
D	proton and neutron	electron

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PHYSICS

9702/13

Paper 1 Multiple Choice

May/June 2019

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 **17** printed pages and **3** blank pages.

Data

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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 Which is an SI base unit?

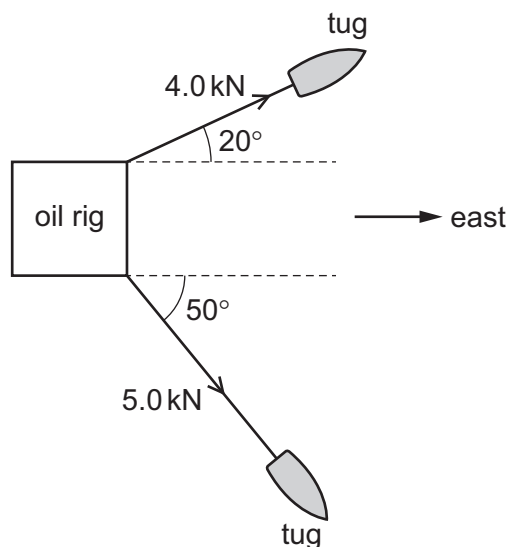
- A current
- B gram
- C kelvin
- D volt

2 Osmium, a naturally occurring element, has a density of $23\,000\text{ kg m}^{-3}$.

What is also a value of the density of osmium?

- A $2.3 \times 10^4\text{ }\mu\text{g cm}^{-3}$
- B $2.3 \times 10^4\text{ g cm}^{-3}$
- C 2.3 kg cm^{-3}
- D $2.3 \times 10^{-2}\text{ kg cm}^{-3}$

3 Two tugs are towing an oil rig as shown.



The tensions in the towing cables are 4.0 kN and 5.0 kN.

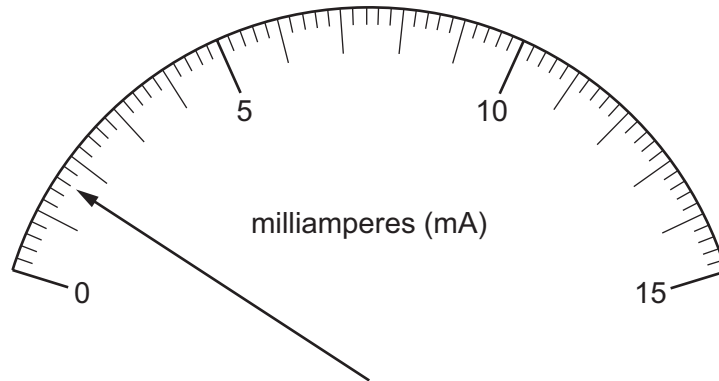
What is the total force acting on the rig due to the cables, in the direction to the east?

- A 3.1 kN
- B 5.2 kN
- C 7.0 kN
- D 7.3 kN

4 What is the approximate kinetic energy of an Olympic athlete when running at maximum speed during a 100 m race?

- A 400 J
- B 4000 J
- C 40 000 J
- D 400 000 J

- 5 The diagram shows the reading on an analogue ammeter.



Which digital ammeter reading is the same as the reading on the analogue ammeter?

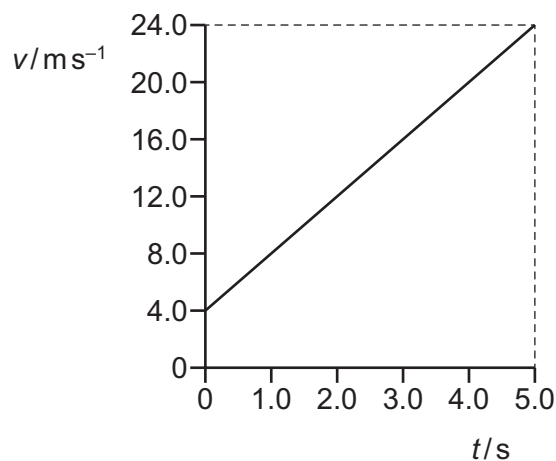
	display units	display reading
A	μA	1600
B	μA	160
C	mA	16.0
D	A	1.60

- 6 A micrometer screw gauge is used to measure the diameter of a small uniform steel sphere. The micrometer reading is $5.00 \text{ mm} \pm 0.01 \text{ mm}$.

What will be the percentage uncertainty in a calculation of the volume of the sphere, using these values?

- A** 0.2% **B** 0.4% **C** 0.6% **D** 1.2%

- 7 The graph shows the variation of velocity v with time t for an object.



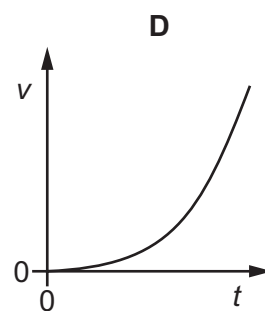
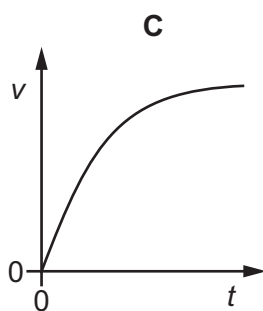
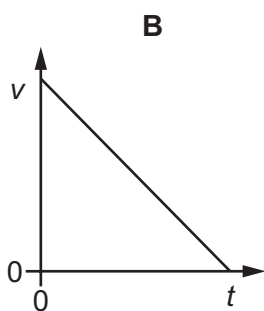
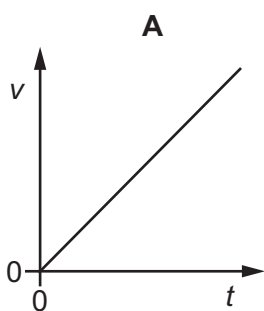
The object passes a fixed point at time $t = 0$.

What is the displacement of the object from the fixed point at time $t = 5.0$ s and what is the acceleration of the object?

	displacement /m	acceleration /ms ⁻²
A	60	4.0
B	70	4.0
C	60	4.8
D	70	4.8

- 8 A skydiver jumps from an aeroplane and falls vertically through the air.

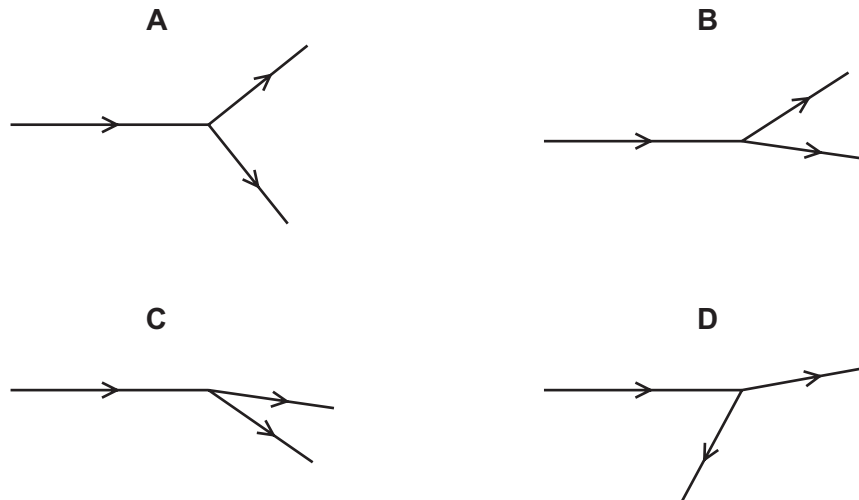
Which graph shows the variation with time t of the skydiver's vertical velocity v ?



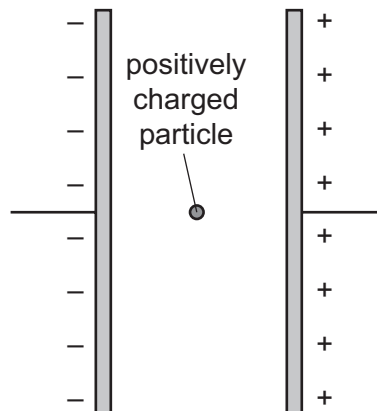
- 9 A nucleus collides with a stationary nucleus in a vacuum. The diagrams show the paths of the nuclei before and after the collision.

No other particles are involved in the collision.

Which diagram is **not** possible?



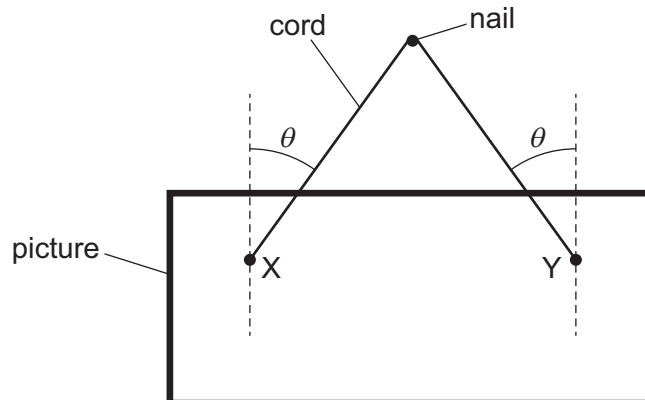
- 10 A uniform electric field is created by two parallel vertical plates. A positively charged particle is in the vacuum between the plates, as shown.



Which statement is correct?

- A The electric field makes the particle move towards the negative plate with a constant speed.
- B The electric field makes the particle move towards the negative plate with a constant acceleration.
- C The electric field produces a uniform rate of decrease in the particle's acceleration.
- D The electric field produces a uniform rate of increase in the particle's acceleration.

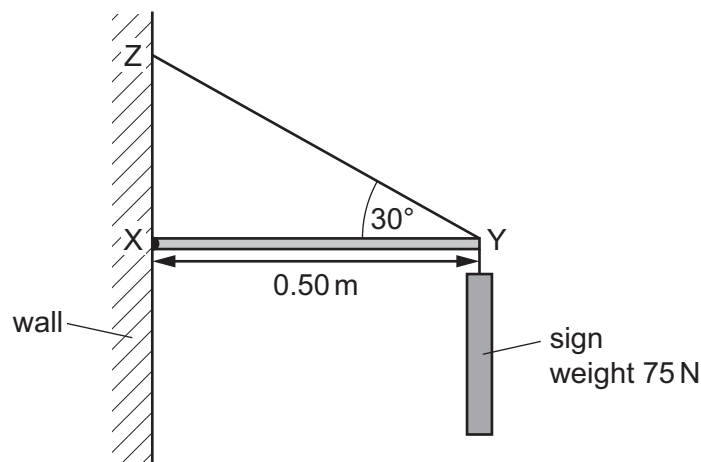
- 11 A picture is suspended from a nail by a single cord connected to two points X and Y on the picture. There is negligible friction between the cord and the nail so that the tension in both sides of the cord is the same. The picture hangs symmetrically, as shown.



The tension in the cord is T . The angle between the cord and the vertical is θ on both sides.

Which statement is correct?

- A Increasing the length of the cord, with points X and Y in the same place on the picture, would reduce the tension in the cord.
 - B Moving points X and Y further apart on the picture while keeping the length of the cord constant would reduce the tension in the cord.
 - C Moving points X and Y to the top edge of the picture while keeping their distance apart constant and the length of the cord constant would reduce the tension in the cord.
 - D The weight of the picture is equal to $T \cos \theta$.
- 12 A shop sign weighing 75 N hangs from a frame attached to a vertical wall.

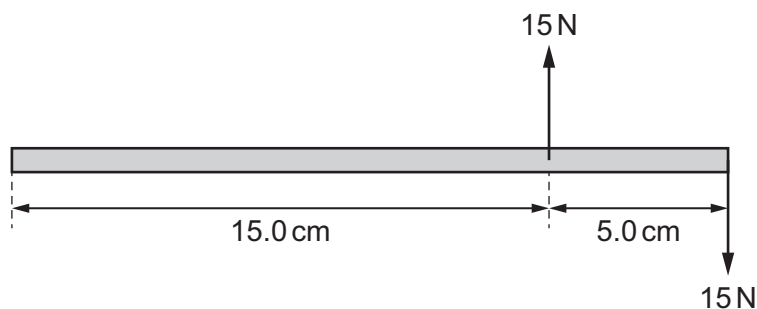


The frame consists of a horizontal rod XY and a rod YZ that is at an angle of 30° to the horizontal. Rod XY is attached to the wall by a hinge at X and has length 0.50 m. Assume that the weights of the rods are negligible.

What is the horizontal force exerted by the wall on rod XY?

- A 0 N
- B 43 N
- C 130 N
- D 150 N

13 What is the torque of the couple shown?



- A** 0.75 N m **B** 1.50 N m **C** 3.00 N m **D** 5.25 N m

14 Water has a density of 1.0 g cm^{-3} .

Glycerine has a density of 1.3 g cm^{-3} .

A student measures out a volume of 40 cm^3 of glycerine into a container.

The student adds water to the container to make a mixture of water and glycerine. Assume that the total volume of water and glycerine does not change when the two liquids are mixed.

Which volume of water needs to be added to make a mixture of density 1.1 g cm^{-3} ?

- A** 4.0 cm^3 **B** 8.0 cm^3 **C** 34 cm^3 **D** 80 cm^3

15 Which statement about the principle of conservation of energy is correct?

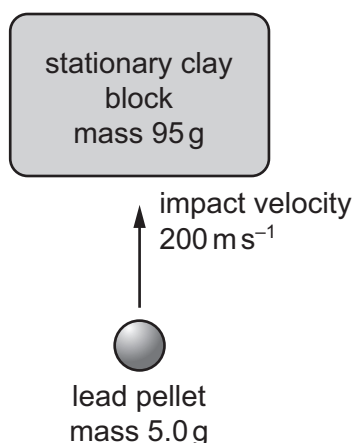
- A** Energy conversion helps to conserve energy sources.
B Energy is conserved only in systems with an efficiency of 100%.
C The supply of energy is limited so energy should be conserved.
D The total amount of energy in a closed system is constant.

16 A student can run or walk up the stairs to her classroom.

Which statement describes the power required and the gravitational potential energy gained while running up the stairs compared to walking up them?

- A** Running provides more gravitational potential energy and uses more power.
B Running provides more gravitational potential energy and uses the same power.
C Running provides the same gravitational potential energy and uses more power.
D Running provides the same gravitational potential energy and uses the same power.

- 17 A lead pellet is shot vertically upwards into a clay block that is stationary at the moment of impact but is able to rise freely after impact.



The mass of the pellet is 5.0 g and the mass of the clay block is 95 g.

The pellet hits the block with an initial vertical velocity of 200 m s⁻¹. It embeds itself in the block and does not emerge.

How high above its initial position will the block rise?

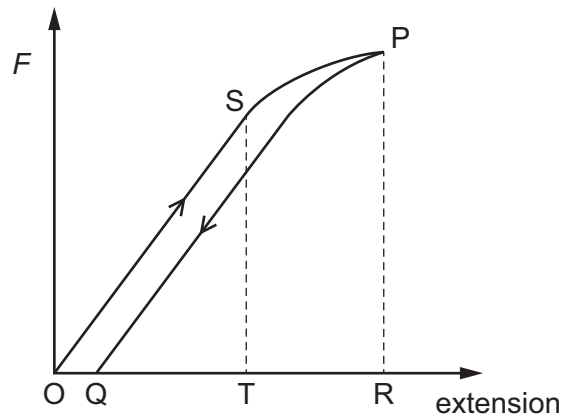
- A** 5.1 m **B** 5.6 m **C** 10 m **D** 100 m
- 18 On the surface of a planet, 30 J of work is done against gravity to raise a mass of 1.0 kg through a height of 10 m.
- How much work must be done to raise a mass of 4.0 kg through a height of 5.0 m on this planet?
- A** 15 J **B** 60 J **C** 120 J **D** 200 J
- 19 Four solid steel rods, each of length 2.0 m and cross-sectional area 250 mm², equally support an object weighing 10 kN. The weight of the object causes the rods to contract by 0.10 mm. The rods obey Hooke's law.

What is the Young modulus of steel?

- A** $2.0 \times 10^8 \text{ N m}^{-2}$
B $2.0 \times 10^{11} \text{ N m}^{-2}$
C $8.0 \times 10^8 \text{ N m}^{-2}$
D $8.0 \times 10^{11} \text{ N m}^{-2}$

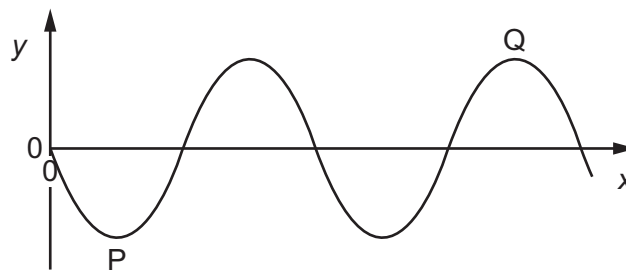
- 20** A wire is attached at one end to a fixed point. A tensile force F is applied to the other end of the wire, causing it to extend. This is shown on the graph by the line OSP.

The force F is then gradually reduced to zero and the wire contracts. This is shown on the graph by the line PQ.



Which area on the graph represents the work done by the wire as it contracts?

- A** OSTO **B** OSPRO **C** QPRQ **D** OSPQO
- 21** The graph shows the variation of displacement y with distance x along a progressive wave at one instant in time.



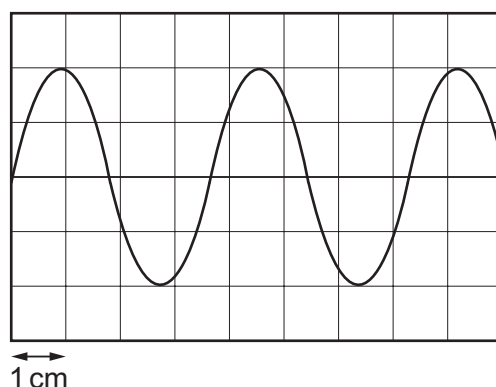
What is the phase difference between points P and Q on the wave?

- A** 90° **B** 270° **C** 540° **D** 630°
- 22** Wave-power generators take advantage of the energy that is transferred by the motion of waves across the surface of the oceans. The energy of a wave depends on its amplitude.

What is the correct definition of amplitude?

- A** the average amount of energy possessed by a wave
B the difference in displacement between a peak and a trough
C the maximum displacement of a point on the wave from equilibrium
D the number of oscillations of a wave that occur per second

- 23** A sound wave of frequency 270 Hz is recorded by a cathode-ray oscilloscope (CRO). The waveform on the CRO is shown.



What is the time-base setting on the CRO?

- A** 0.1 ms cm^{-1} **B** 1 ms cm^{-1} **C** 10 ms cm^{-1} **D** 100 ms cm^{-1}
- 24** A motor boat vibrates in the water so that it produces water waves of frequency 0.20 Hz . The speed of these waves in the water is 20 ms^{-1} . The motor boat moves with a speed of 5.0 ms^{-1} directly towards a stationary sailing boat.

The Doppler effect equation for sound waves also applies to water waves.

What is the frequency with which the waves hit the stationary sailing boat?

- A** 0.15 Hz **B** 0.16 Hz **C** 0.25 Hz **D** 0.27 Hz
- 25** Infrared laser light is used for the transmission of data along optic fibres.

What is a typical wavelength of infrared radiation?

- A** $5 \times 10^{-5}\text{ m}$ **B** $5 \times 10^{-7}\text{ m}$ **C** $2 \times 10^{-9}\text{ m}$ **D** $2 \times 10^{-11}\text{ m}$
- 26** An elastic string is attached to an oscillator at one end and clamped at the other end so that the string is horizontal and in tension.

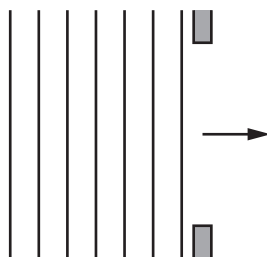
The oscillator is made to oscillate vertically. The frequency of oscillation is gradually increased from zero until a stationary wave is set up in the string. The frequency is then increased further to frequency f , when a second stationary wave is set up in the string.

The frequency is then increased further.

At which frequency does a third stationary wave occur?

- A** $1.2f$ **B** $1.5f$ **C** $2.0f$ **D** $3.0f$

- 27 In an experiment, water waves in a ripple tank are incident on a gap, as shown.



Some diffraction of the water waves is observed.

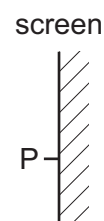
Which change to the experiment would provide a better demonstration of diffraction?

- A Increase the amplitude of the waves.
 - B Increase the frequency of the waves.
 - C Increase the wavelength of the waves.
 - D Increase the width of the gap.
- 28 Light of wavelength λ is emitted from two point sources R and S and falls onto a distant screen.

R •

S •

(not to scale)



At point P on the screen, the light intensity is zero.

What could explain the zero intensity at P?

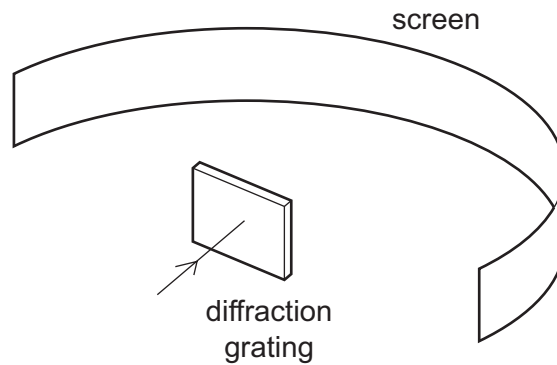
- A Light from the two sources is emitted 180° out of phase and the path difference to P is $\frac{1}{2}\lambda$.
 - B Light from the two sources is emitted in phase and the path difference to P is λ .
 - C Light from the two sources is emitted 90° out of phase and the path difference to P is λ .
 - D Light from the two sources is emitted in phase and the path difference to P is $\frac{1}{2}\lambda$.
- 29 Apparatus is arranged to show double-slit interference using monochromatic light. The slit separation is 0.10 mm. The distance from the double slit to the screen where the interference pattern is observed is 2.4 m and the fringe width is 12 mm.

The distance to the screen is now changed to 1.8 m and the slit separation is doubled.

What is the new fringe width?

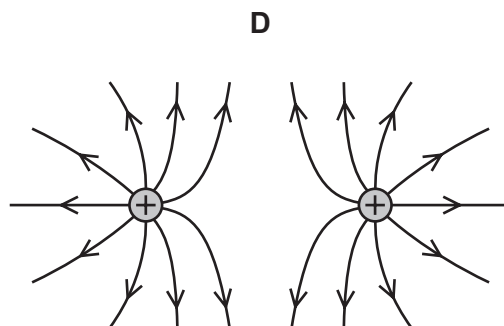
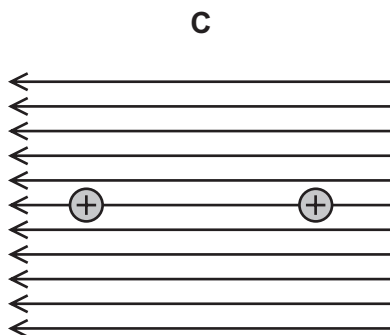
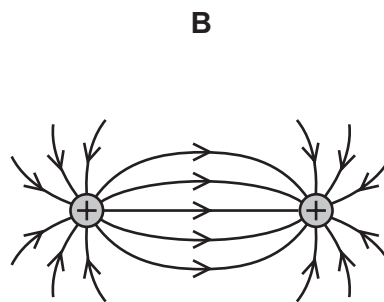
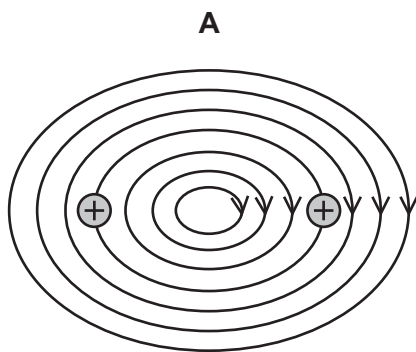
- A 1.5 mm
- B 4.5 mm
- C 6.0 mm
- D 9.0 mm

- 30 Monochromatic light of wavelength 690 nm passes through a diffraction grating with 300 lines per mm, producing a series of maxima (bright spots) on a screen.



What is the greatest number of maxima that can be observed?

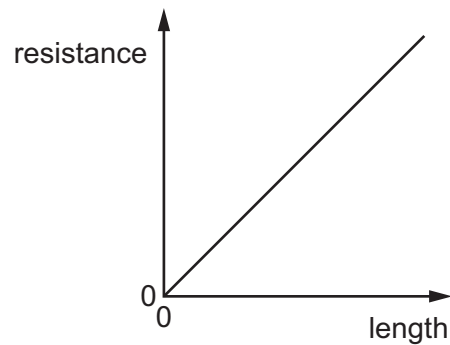
- A 4 B 5 C 8 D 9
- 31 Which diagram represents the electric field line pattern due to a combination of two positive charges?



- 32 Which two units are used to define the volt?

- A ampere and ohm
 B coulomb and joule
 C coulomb and ohm
 D coulomb and second

- 33 The graph shows the variation with length of the resistance of a uniform metal wire.



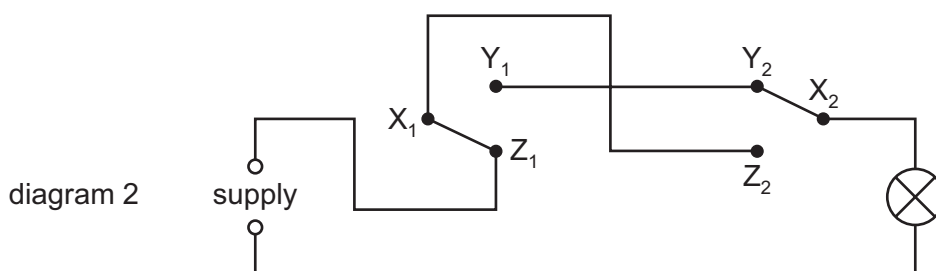
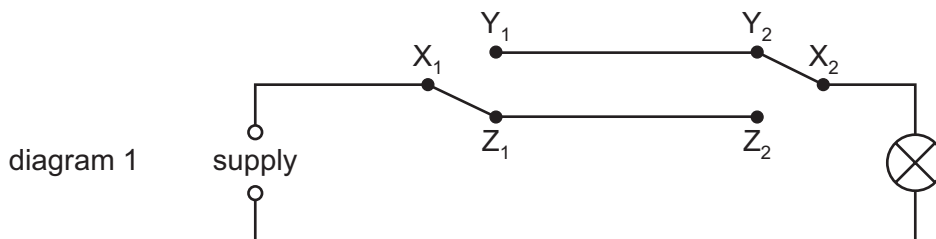
The gradient of the graph is G .
The wire has cross-sectional area A .

Which expression could be used to calculate the resistivity of the metal of the wire?

- A** $G \times A$ **B** $\frac{G}{A}$ **C** $\frac{A}{G}$ **D** $G \times A^2$

- 34 Diagram 1 shows a lamp connected to a supply through two switches.

During repairs, an electrician mistakenly reverses the connections X_1 and Z_1 , so that Z_1 is connected to the supply and X_1 to the other switch at Z_2 , as shown in diagram 2.



Which switch positions will now light the lamp?

A	X_1 to Y_1	X_2 to Y_2
B	X_1 to Y_1	X_2 to Z_2
C	X_1 to Z_1	X_2 to Y_2
D	X_1 to Z_1	X_2 to Z_2

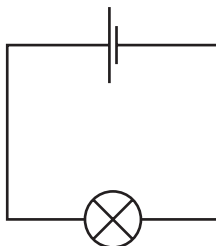
- 35** A wire supplying a shower heater with a current of 35 A has a resistance of 25 m Ω .

What is the power dissipated in the wire?

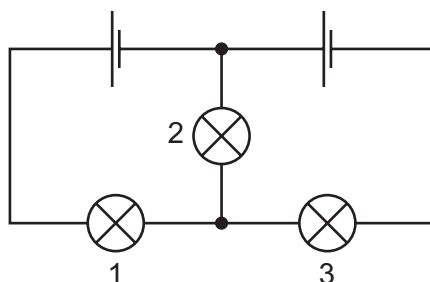
- A** 31 W **B** 49 W **C** 31 kW **D** 49 kW

- 36** A student has a set of identical cells and identical lamps. The cells have negligible internal resistance.

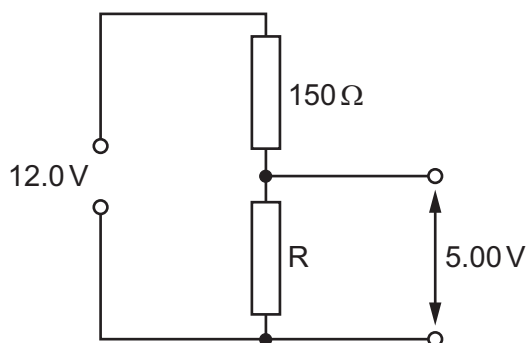
A lamp connected to a cell lights with normal brightness.



What happens when the student connects the lamps and the cells as shown?



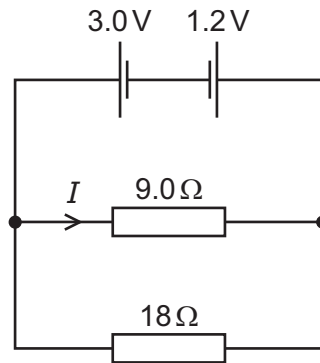
- A** All three lamps light with normal brightness.
B Only lamp 2 lights with normal brightness.
C Only lamps 1 and 3 light with normal brightness.
D None of the lamps light with normal brightness.
- 37** A potential divider circuit is shown.



What is the resistance of resistor R in the potential divider circuit?

- A** 62.5 Ω **B** 107 Ω **C** 210 Ω **D** 360 Ω

- 38 Two cells of electromotive force (e.m.f.) 3.0 V and 1.2 V and negligible internal resistance are connected to resistors of resistance $9.0\ \Omega$ and $18\ \Omega$ as shown.



What is the current I in the $9.0\ \Omega$ resistor?

- A** 0.10 A **B** 0.20 A **C** 0.30 A **D** 0.47 A
- 39 What is a correct estimate of the order of magnitude of the diameter of a typical atomic nucleus?
- A** 10^{-14} m **B** 10^{-18} m **C** 10^{-22} m **D** 10^{-26} m
- 40 Which statement describes β^- decay in terms of a simple quark model?
- A** A down quark changes to an up quark, and an electron and an electron antineutrino are emitted.
- B** A down quark changes to an up quark, and a positron and an electron neutrino are emitted.
- C** An up quark changes to a down quark, and an electron and an electron antineutrino are emitted.
- D** An up quark changes to a down quark, and a positron and an electron neutrino are emitted.

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