

PHYSICS

9702/11

Paper 1 Multiple Choice

May/June 2015

1 hour

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

* 9 7 0 4 7 7 0 5 2 2 *



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

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 constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

work done on/by a gas,

$$W = p\Delta V$$

gravitational potential,

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

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.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{(x_0^2 - x^2)}$$

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,

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

resistors in series,

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

resistors in parallel,

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

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 Which pair contains one vector and one scalar quantity?

- A displacement acceleration
- B force kinetic energy
- C momentum velocity
- D power speed

3 When a constant braking force is applied to a vehicle moving at speed v , the distance d moved by the vehicle in coming to rest is given by the expression

$$d = kv^2$$

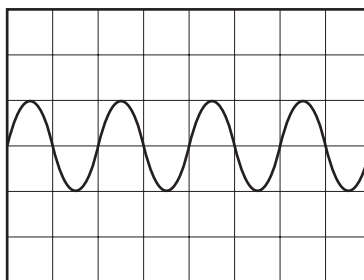
where k is a constant.

When d is measured in metres and v is measured in metres per second, the constant has a value of k_1 .

What is the value of the constant when the distance is measured in metres, and the speed is measured in kilometres per hour?

- A $0.0772 k_1$
- B $0.278 k_1$
- C $3.60 k_1$
- D $13.0 k_1$

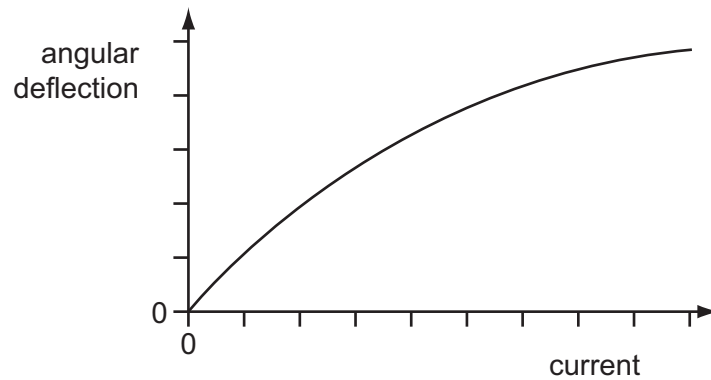
4 A whale produces sound waves of frequency 5 Hz. The waves are detected by a microphone and displayed on an oscilloscope.



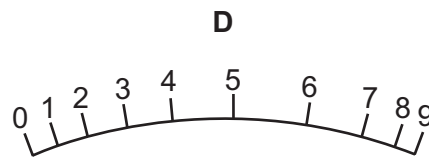
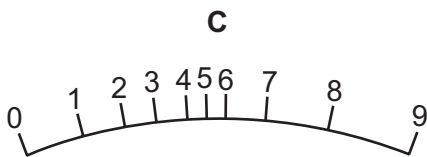
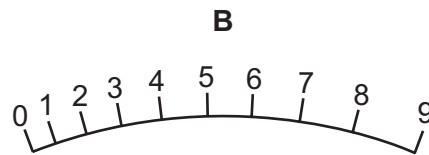
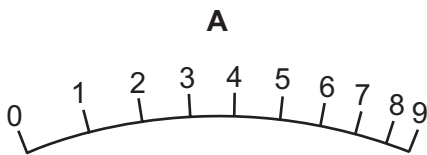
What is the time-base setting on the oscilloscope?

- A 0.1 ms div^{-1}
- B 1 ms div^{-1}
- C 10 ms div^{-1}
- D 100 ms div^{-1}

- 5 The angular deflection of the needle of an ammeter varies with the current in the ammeter as shown in the graph.



Which diagram could represent the appearance of the scale on this meter?



- 6 The strain energy W of a spring is determined from its spring constant k and extension x . The spring obeys Hooke's law and the value of W is calculated using the equation shown.

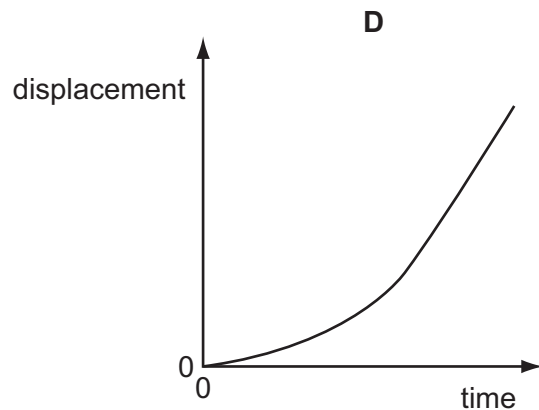
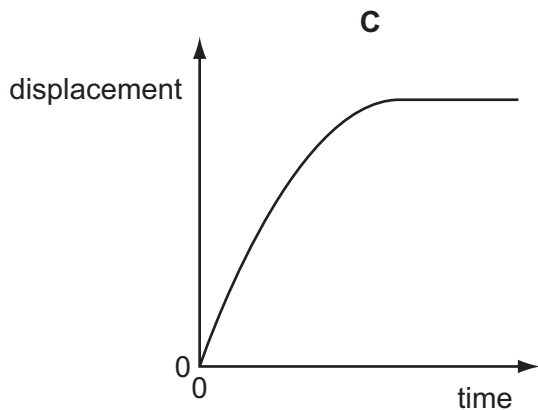
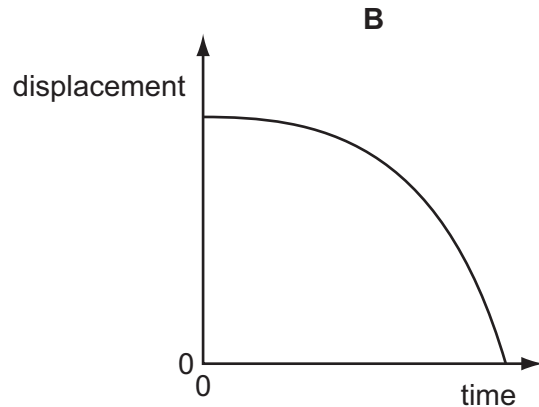
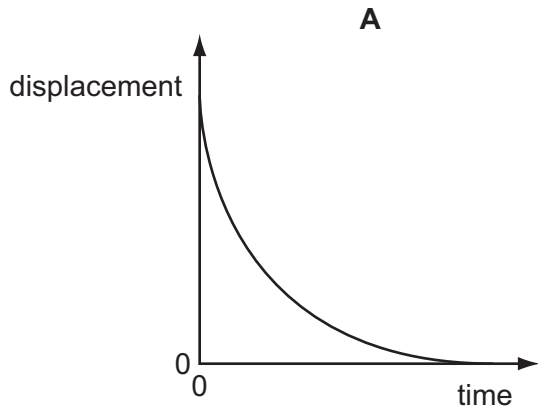
$$W = \frac{1}{2} kx^2$$

The spring constant is $100 \pm 2 \text{ N m}^{-1}$ and the extension is $0.050 \pm 0.002 \text{ m}$.

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

- A** 6% **B** 10% **C** 16% **D** 32%

- 7 A sphere is released and falls. Its initial acceleration reduces until it eventually begins to travel at constant terminal velocity. Which displacement-time graph best represents the motion of the sphere?



- 8 An insect jumps with an initial vertical velocity of 1.0 ms^{-1} , reaching a maximum height of $3.5 \times 10^{-2} \text{ m}$. Assume the deceleration is uniform.

What is the magnitude of the deceleration?

- A** 3.6 ms^{-2} **B** 9.8 ms^{-2} **C** 14 ms^{-2} **D** 29 ms^{-2}

- 9 A body having uniform acceleration a increases its velocity from u to v in time t .

Which expression would **not** give a correct value for the body's displacement during time t ?

- A** $ut + \frac{1}{2}at^2$
B $vt - \frac{1}{2}at^2$
C $\frac{(v+u)(v-u)}{2a}$
D $\frac{(v-u)t}{2}$

- 10 What is a reasonable estimate of the average gravitational force acting on a fully grown woman standing on the Earth?

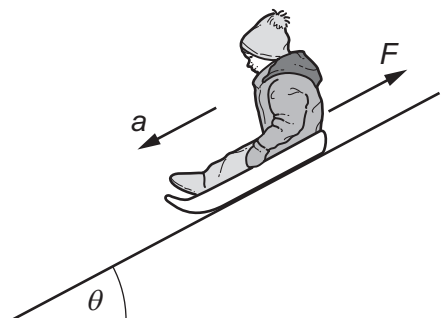
A 60 N B 250 N C 350 N D 650 N

- 11 A molecule of mass m travelling at speed v hits a wall in a direction perpendicular to the wall. The collision is elastic.

What are the changes in the momentum and in the kinetic energy of the molecule caused by the collision?

	change in momentum	change in kinetic energy
A	0	0
B	0	mv^2
C	$2mv$	0
D	mv^2	0

- 12 A child on a sledge slides down a hill with acceleration a . The hill makes an angle θ with the horizontal.

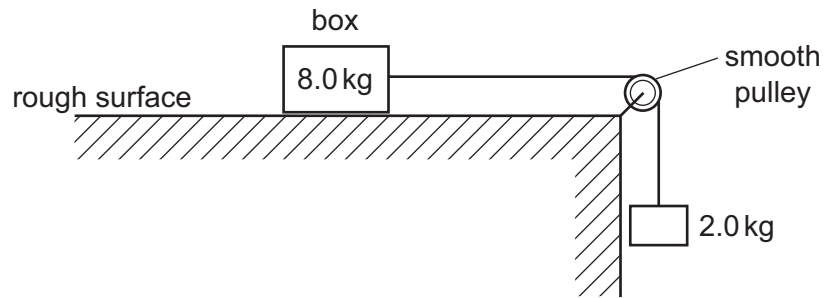


The total mass of the child and the sledge is m . The acceleration of free fall is g .

What is the friction force F ?

- A $m(g \cos \theta - a)$
 B $m(g \cos \theta + a)$
 C $m(g \sin \theta - a)$
 D $m(g \sin \theta + a)$

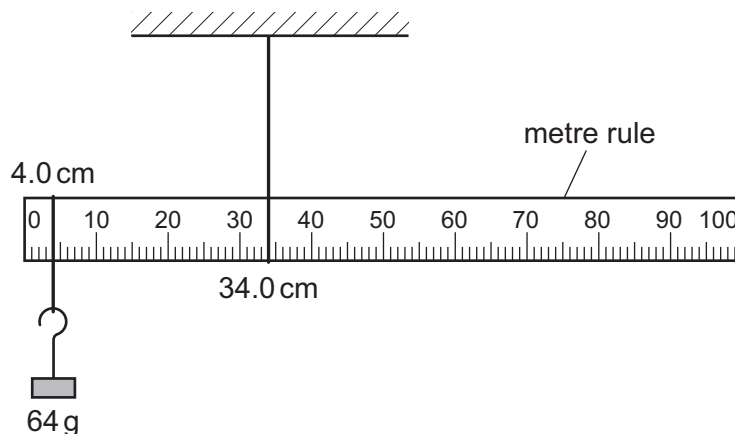
- 13 A box of mass 8.0 kg rests on a horizontal rough surface. A string attached to the box passes over a smooth pulley and supports a 2.0 kg mass at its other end.



When the box is released, a frictional force of 6.0 N acts on it.

What is the acceleration of the box?

- A 1.4 ms^{-2} B 1.7 ms^{-2} C 2.0 ms^{-2} D 2.6 ms^{-2}
- 14 What is the **definition** of the force on a body?
- A the mass of the body multiplied by its acceleration
 B the power input to the body divided by its velocity
 C the rate of change of momentum of the body
 D the work done on the body divided by its displacement
- 15 A uniform metre rule is pivoted at the 34.0 cm mark, as shown.



The rule balances when a 64 g mass is hung from the 4.0 cm mark.

What is the mass of the metre rule?

- A 38 g B 44 g C 120 g D 136 g

- 16 A team of nine dogs can pull a sledge with a combined force of 800 N at a speed of 1.5 m s^{-1} for 360 minutes.

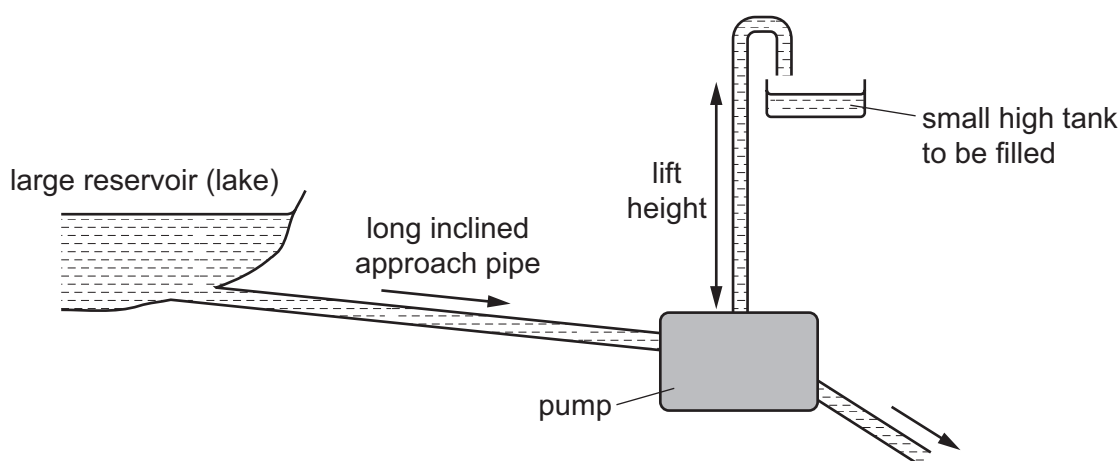
What is the average work done by each dog during this time?

- A $4.8 \times 10^4 \text{ J}$ B $4.3 \times 10^5 \text{ J}$ C $2.9 \times 10^6 \text{ J}$ D $2.6 \times 10^7 \text{ J}$

- 17 Which statement is correct?

- A A ball lands on the ground and bounces. The kinetic energy changes sign, because the ball changes direction.
 B A car drives up a slope at a steady speed. The power generated by the engine equals the potential energy gained per unit time.
 C An electric heater can be 100% efficient.
 D It is impossible for momentum to be conserved in a collision.

- 18 The diagram shows a pump called a hydraulic ram.



In one such pump the long approach pipe holds 500 kg of water. A valve shuts when the speed of this water reaches 2.0 m s^{-1} and the kinetic energy of this water is used to lift a small quantity of water by a height of 15 m.

The efficiency of the pump is 10%.

Which mass of water could be lifted 15 m?

- A 0.15 kg B 0.68 kg C 1.5 kg D 6.8 kg

- 19 A conveyor belt is driven at velocity v by a motor. Sand drops vertically on to the belt at a rate of $m \text{ kg s}^{-1}$.

What is the additional power needed to keep the conveyor belt moving at a steady speed when the sand starts to fall on it?

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

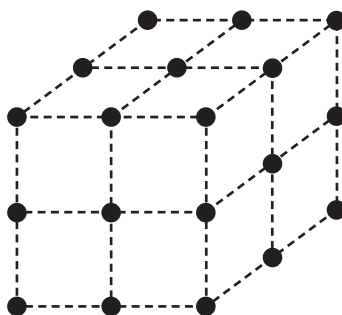
20 Descriptions of three different types of material are listed.

- 1 a polycrystalline material made up of large numbers of small crystals
- 2 an amorphous material with little or no ordered arrangement of molecules
- 3 a polymeric material consisting of long chains of molecules

Which row correctly matches the descriptions to nylon, copper and glass?

	1	2	3
A	copper	glass	nylon
B	copper	nylon	glass
C	glass	nylon	copper
D	nylon	copper	glass

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



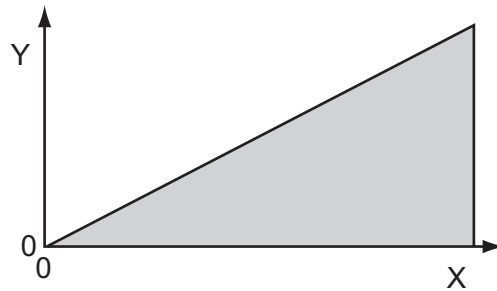
Each atom is at the corner of a cube.

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

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

- A** 3.8×10^{-29} m
- B** 6.2×10^{-15} m
- C** 3.4×10^{-10} m
- D** 3.0×10^{-9} m

- 22 The graph shown was plotted in an experiment on a metal wire.

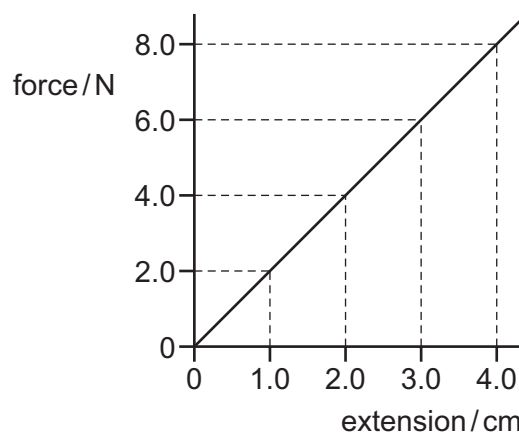


The shaded area represents the total strain energy stored in stretching the wire.

How should the axes be labelled?

	Y	X
A	force	extension
B	mass	extension
C	strain	energy
D	stress	strain

- 23 The variation with applied force of the extension of a spring is shown in the graph.

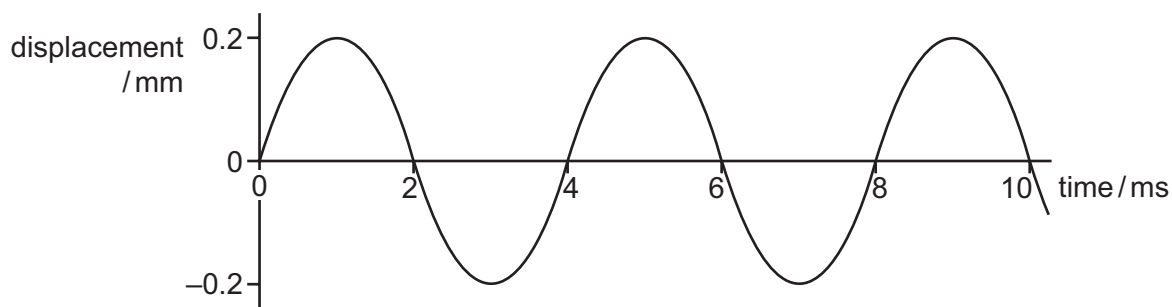


When there is no force applied to the spring, it has a length of 1.0 cm.

What is the **increase** in the strain energy stored in the spring when its **length** is increased from 2.0 cm to 3.0 cm?

- A** 0.020 J **B** 0.030 J **C** 0.040 J **D** 0.050 J

- 24** A sound wave moves with a speed of 320 m s^{-1} through air. The variation with time of the displacement of an air particle due to this wave is shown in the graph.



Which statement about the sound wave is correct?

- A** The frequency of the wave is 500 Hz.
- B** The graph shows that sound is a transverse wave.
- C** The intensity of the wave will be doubled if its amplitude is increased to 0.4 mm.
- D** The wavelength of the sound wave is 1.28 m.

- 25** A wave of frequency 15 Hz travels at 24 m s^{-1} through a medium.

What is the phase difference between two points 2 m apart?

- A** There is no phase difference.
- B** They are out of phase by a quarter of a cycle.
- C** They are out of phase by half a cycle.
- D** They are out of phase by 0.8 of a cycle.

- 26** A wave of amplitude a has an intensity of 3.0 W m^{-2} .

What is the intensity of a wave of the same frequency that has an amplitude $2a$?

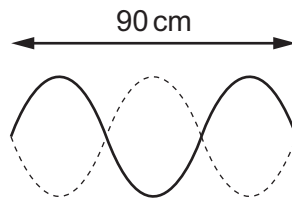
- A** 4.2 W m^{-2} **B** 6.0 W m^{-2} **C** 9.0 W m^{-2} **D** 12 W m^{-2}

- 27** An electromagnetic wave has a wavelength that is numerically of the same order of magnitude as the diameter of a nucleus.

In which region of the electromagnetic spectrum does the wave occur?

- A** gamma ray
- B** X-ray
- C** visible light
- D** infra-red

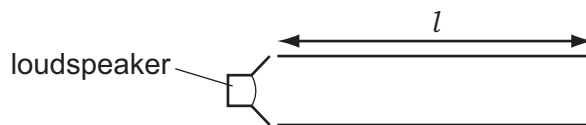
- 28 The diagram shows a stationary wave on a string at two instants of maximum vertical displacement.



The frequency of the wave is 12 Hz.

What is the speed of the wave?

- A 3.6 ms^{-1} B 7.2 ms^{-1} C 360 ms^{-1} D 720 ms^{-1}
- 29 A loudspeaker emitting sound of frequency f is placed at the open end of a pipe of length l which is closed at the other end. A standing wave is set up in the pipe.



A series of pipes are then set up with either one or two loudspeakers of frequency f . The pairs of loudspeakers vibrate in phase with each other.

Which pipe contains a standing wave?

- A
- B
- C
- D

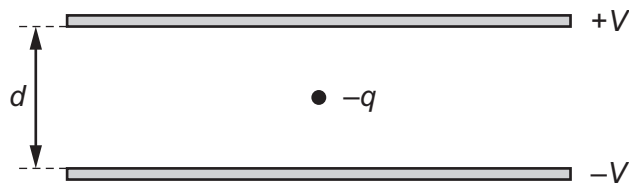
- 30 In a double-slit experiment the distance between the fringes, on a screen, was too small to measure.

What would increase the distance between the fringes?

- A increasing the distance between the light source and the slits
 - B increasing the distance between the slits and the screen
 - C increasing the distance between the slits
 - D increasing the frequency of the light source
- 31 Two parallel metal plates, a distance of 2 mm apart, have a potential difference of 1000 V across them.

What is the electric field strength between the plates?

- A 500 V m^{-1}
 - B $50\,000 \text{ V m}^{-1}$
 - C $50\,000 \text{ N C}^{-1}$
 - D $500\,000 \text{ N C}^{-1}$
- 32 An oil droplet has charge $-q$ and is situated between two horizontal metal plates as shown in the diagram.

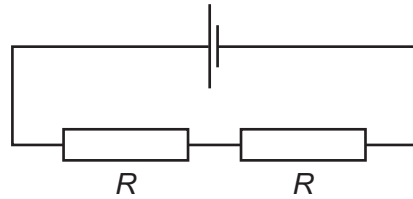
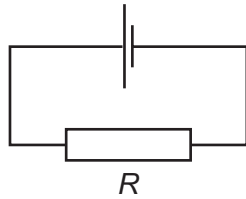


The separation of the plates is d . The droplet is observed to be stationary when the upper plate is at potential $+V$ and the lower plate is at potential $-V$.

For this to occur, what is the weight of the droplet?

- A $\frac{Vq}{d}$
- B $\frac{2Vq}{d}$
- C $\frac{Vd}{q}$
- D $\frac{2Vd}{q}$

- 33 The diagrams show two different circuits.



The cells in each circuit have the same electromotive force and zero internal resistance. The three resistors each have the same resistance R .

In the circuit on the left, the power dissipated in the resistor is P .

What is the total power dissipated in the circuit on the right?

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

- 34 Which equation that links some of the following terms is correct?

potential difference (p.d.)	V
current	I
resistance	R
charge	Q
energy	E
power	P
time	t

- A $P = \frac{Q^2 R}{t}$
 B $ER^2 = V^2 t$
 C $\frac{VI}{P} = t$
 D $PQ = EI$

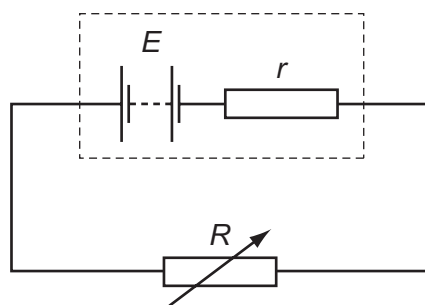
- 35 The charge that an electric battery can deliver is specified in ampere-hours.

For example, a battery of capacity 40 ampere-hours could supply, when fully charged, 0.2A for 200 hours.

What is the maximum energy that a fully charged 12 V, 40 ampere-hour battery could supply?

- A 1.7 kJ B 29 kJ C 1.7 MJ D 29 MJ

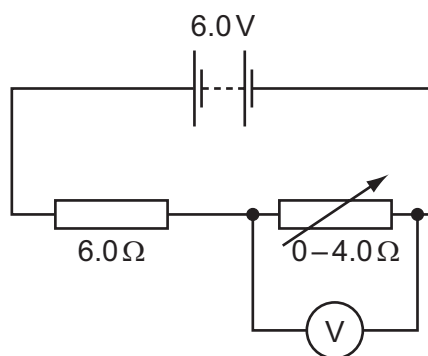
- 36 A battery with e.m.f. E and internal resistance r is connected in series with a variable external resistor.



The value of the external resistance R is slowly increased from zero.

Which statement is correct? (Ignore any temperature effects.)

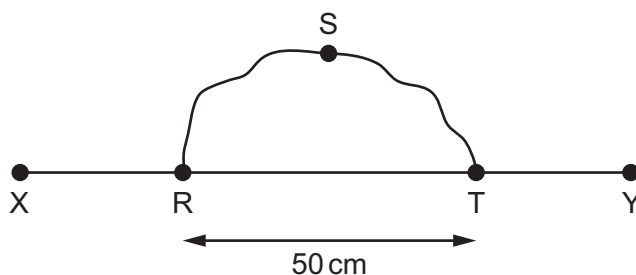
- A The potential difference across the external resistance decreases.
 - B The potential difference across the internal resistance increases.
 - C The power dissipated in r increases and then decreases.
 - D The power dissipated in R increases and then decreases.
- 37 A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected in series with a resistor of resistance $6.0\ \Omega$ and a variable resistor of resistance from zero to $4.0\ \Omega$. A voltmeter is connected across the variable resistor. The resistance of the variable resistor is changed.



What is the range of the voltmeter reading?

- A $0\text{ V} - 2.4\text{ V}$
- B $0\text{ V} - 3.6\text{ V}$
- C $2.4\text{ V} - 6.0\text{ V}$
- D $3.6\text{ V} - 6.0\text{ V}$

38 A wire RST is connected to another wire XY as shown.



Each wire is 100 cm long with a resistance per unit length of $10\ \Omega\ \text{m}^{-1}$.

What is the total resistance between X and Y?

- A** $3.3\ \Omega$ **B** $5.0\ \Omega$ **C** $8.3\ \Omega$ **D** $13.3\ \Omega$

39 When α -particles are directed at gold leaf

- 1 almost all α -particles pass through without deflection,
- 2 a few α -particles are deviated through large angles.

What are the reasons for these effects?

	1	2
A	most α -particles have enough energy to pass right through the gold leaf	gold is very dense so a few low energy α -particles bounce back from the gold surface
B	most α -particles miss all gold atoms	a few α -particles bounce off gold atoms
C	the gold nucleus is very small so most α -particles miss all nuclei	occasionally the path of an α -particle is close to a nucleus
D	the positive charge in an atom is not concentrated enough to deflect an α -particle	occasionally an α -particle experiences many small deflections in the same direction

40 The nuclide $^{222}_{86}\text{Rn}$ decays in a sequence of stages to form the nuclide $^{206}_{82}\text{Pb}$.

Four of the nuclides formed in the sequence are α -particle emitters. The others are β -particle emitters.

How many nuclides formed in the decay sequence are β -particle emitters?

- A** 2 **B** 4 **C** 8 **D** 12

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$$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$$

simple harmonic motion,

$$a = -\omega^2 x$$

velocity of particle in s.h.m.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{(x_0^2 - x^2)}$$

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,

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

resistors in series,

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

resistors in parallel,

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

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 definition is correct and uses only quantities rather than units?
- A Density is mass per cubic metre.
 - B Potential difference is energy per unit current.
 - C Pressure is force per unit area.
 - D Speed is distance travelled per second.
- 2 The average kinetic energy E of a gas molecule is given by the equation

$$E = \frac{3}{2} kT$$

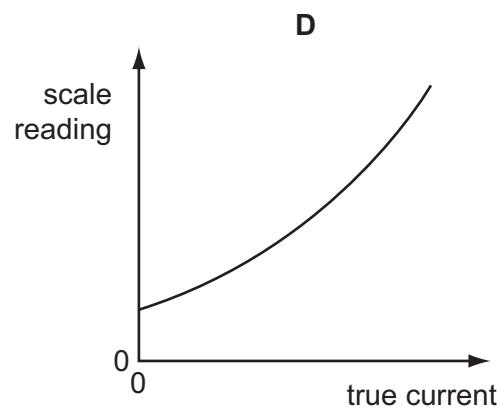
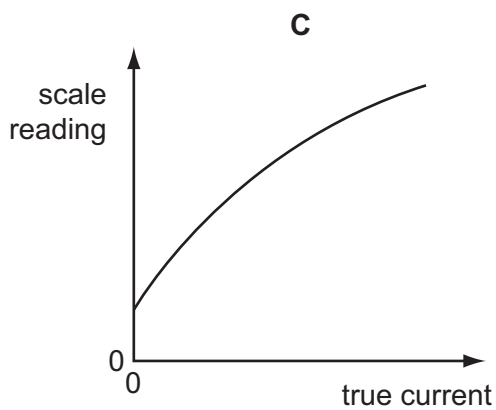
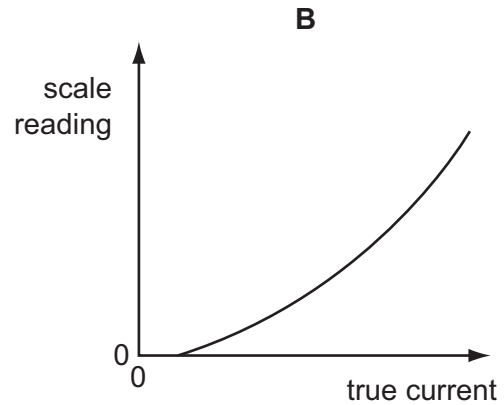
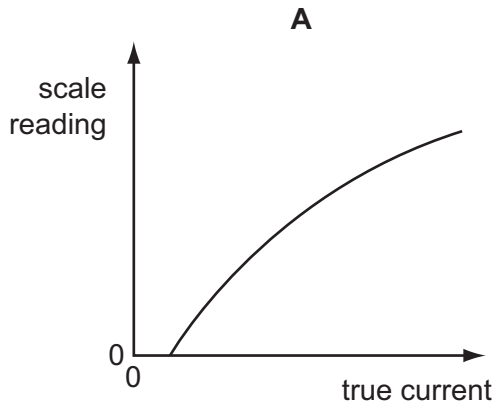
where T is the absolute (kelvin) temperature.

What are the SI base units of k ?

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

- 3 An analogue ammeter has a pointer which moves over a scale. Following prolonged use, the pointer does not return fully to zero when the current is turned off and the meter has become less sensitive at higher currents than it is at lower currents.

Which diagram best represents the calibration graph needed to obtain an accurate current reading?



- 4 The arrow represents the vector R .



Which diagram does **not** represent R as two perpendicular components?

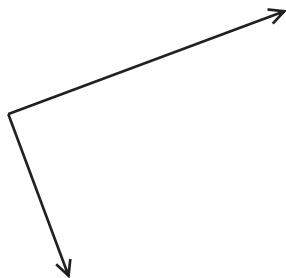
A



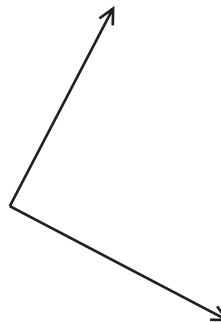
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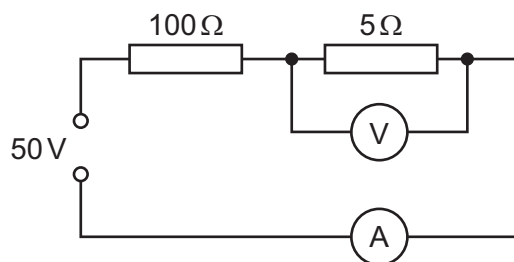
C



D



- 5 A power supply of electromotive force (e.m.f.) 50 V and negligible internal resistance is connected in series with resistors of resistance $100\ \Omega$ and $5\ \Omega$, as shown.



A voltmeter measures the potential difference (p.d.) across the $5\ \Omega$ resistor and an ammeter measures the current in the circuit.

What are suitable ranges for the ammeter and for the voltmeter?

	ammeter range / A	voltmeter range / V
A	0–0.1	0–1
B	0–0.1	0–3
C	0–1.0	0–1
D	0–1.0	0–3

- 6 A single sheet of aluminium foil is folded twice to produce a stack of four sheets. The total thickness of the stack of sheets is measured to be (0.80 ± 0.02) mm. This measurement is made using a digital caliper with a zero error of (-0.20 ± 0.02) mm.

What is the percentage uncertainty in the calculated thickness of a single sheet?

- A 1.0% B 2.0% C 4.0% D 6.7%

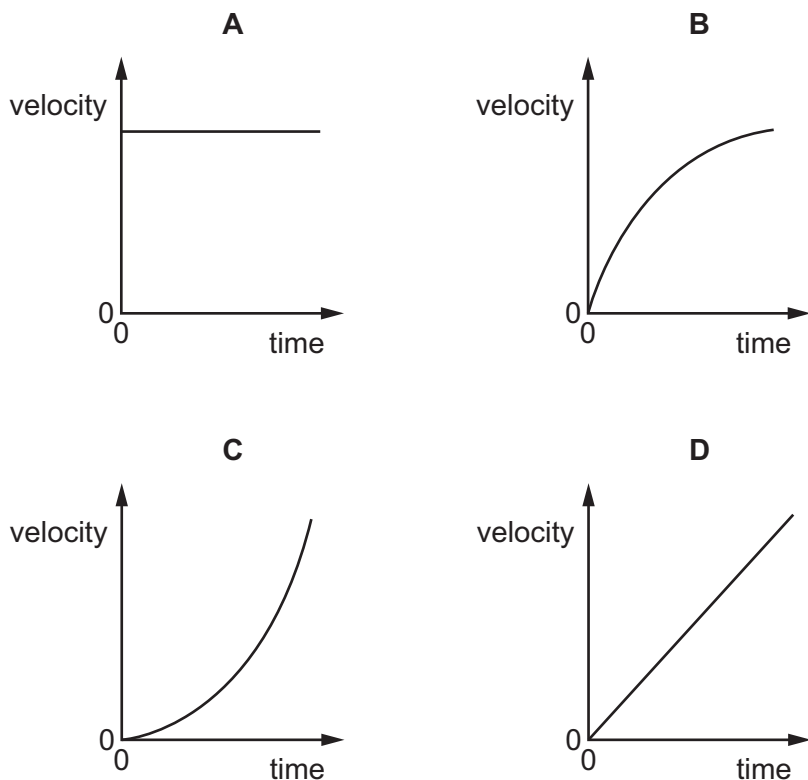
- 7 In an experiment to determine the acceleration of free fall g , a ball bearing is held by an electromagnet. When the current to the electromagnet is switched off, a clock starts and the ball bearing falls. After falling a distance h , the ball bearing strikes a switch to stop the clock which measures the time t of the fall.

If systematic errors cause t and h to be measured incorrectly, which error **must** cause g to appear greater than 9.81 ms^{-2} ?

- A h measured as being **smaller** than it actually is and t is measured correctly
 B h measured as being **smaller** than it actually is and t measured as being **larger** than it actually is
 C h measured as being **larger** than it actually is and t measured as being **larger** than it actually is
 D h is measured correctly and t measured as being **smaller** than it actually is

- 8 A stone is thrown horizontally from the top of a cliff. Air resistance is negligible.

Which graph shows the variation with time of the vertical component of the stone's velocity?



- 9 A sprinter runs a 100 m race in a straight line. He accelerates from the starting block at a constant acceleration of 2.5 m s^{-2} to reach his maximum speed of 10 m s^{-1} . He maintains this speed until he crosses the finish line.

Which time does it take the sprinter to run the race?

- A** 4 s **B** 10 s **C** 12 s **D** 20 s

- 10 A firework rocket is fired vertically upwards. The fuel burns and produces a constant upwards force on the rocket. After 5 seconds there is no fuel left. Air resistance is negligible.

What is the acceleration before and after 5 seconds?

	before 5 seconds	after 5 seconds
A	constant	constant
B	constant	zero
C	increasing	constant
D	increasing	zero

- 11 Trolley X, moving along a horizontal frictionless track, collides with a stationary trolley Y. The two trolleys become attached and move off together.

Which statement about this interaction is correct?

- A** Some of the kinetic energy of trolley X is changed to momentum in the collision.
B Some of the momentum of trolley X is changed to kinetic energy in the collision.
C Trolley X loses some of its momentum as heat in the collision.
D Trolley X shares its momentum with trolley Y but some of its kinetic energy is lost.

- 12 An astronaut throws a stone with a horizontal velocity near to the Moon's surface.

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

	horizontal force	vertical force
A	constant	constant
B	constant	decreasing
C	zero	constant
D	zero	decreasing

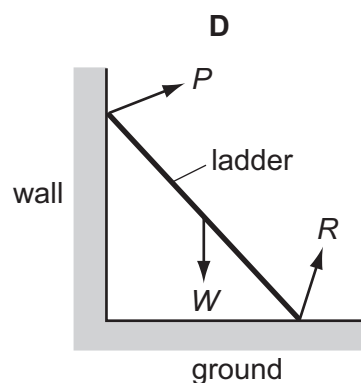
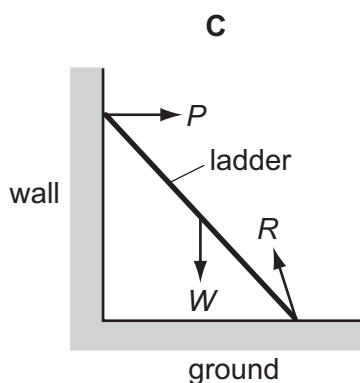
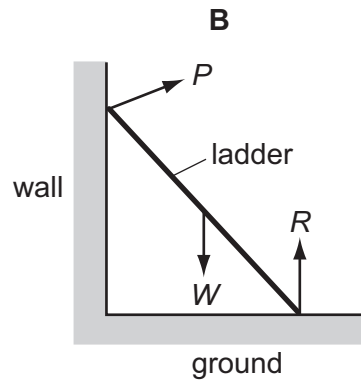
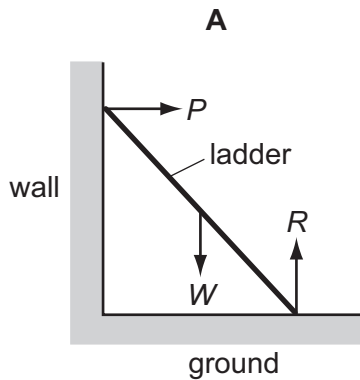
- 13 Newton's third law of motion is often summarised as 'Every action (force) has an equal and opposite reaction.'

A book rests on a table.

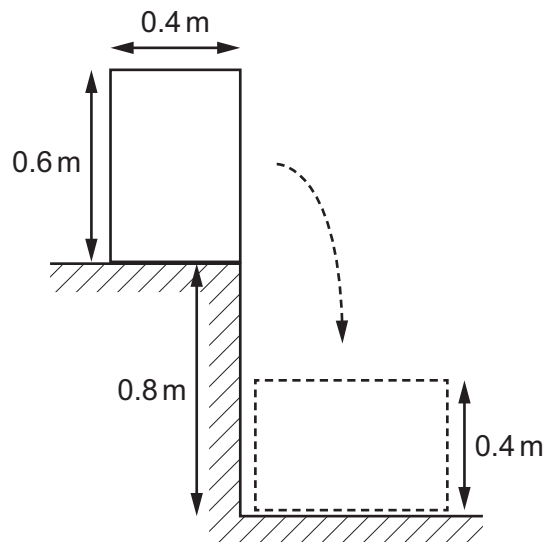
If the weight of the book is the 'action' force, what is the 'reaction' force?

- A the pull of the book on the Earth
 - B the pull of the Earth on the book
 - C the push of the book on the table
 - D the push of the table on the book
- 14 A ladder is positioned on icy (frictionless) ground and is leant against a rough wall. At the instant of release it begins to slide.

Which diagram correctly shows the directions of the forces P , W and R acting on the ladder as it slides?



- 15** A uniform solid block has weight 500 N, width 0.4 m and height 0.6 m. The block rests on the edge of a step of depth 0.8 m, as shown.

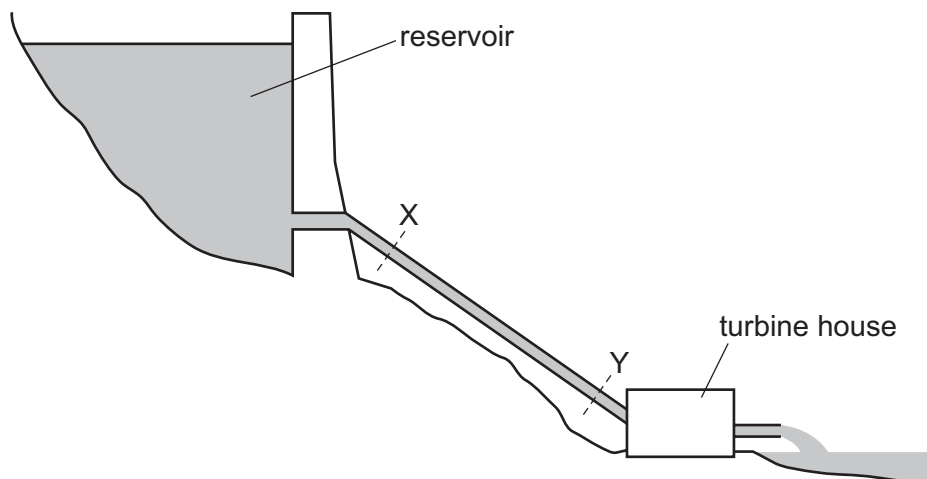


The block is knocked over the edge of the step and rotates through 90° before coming to rest with the 0.6 m edge horizontal.

What is the change in gravitational potential energy of the block?

- A** 300 J **B** 400 J **C** 450 J **D** 550 J
- 16** The diagram shows a hydroelectric power station.

The reservoir is linked to the turbines by a pipe of uniform cross-sectional area.



Water flows from X to Y at constant speed. Which statement about the change of energy of the water as it moves from X to Y is correct?

- A** It gains both gravitational potential energy and kinetic energy.
B It loses both elastic potential energy and kinetic energy.
C It loses both elastic potential energy and gravitational potential energy.
D It loses gravitational potential energy and gains elastic potential energy.

- 17 A fisherman lifts a fish of mass 250 g from rest through a vertical height of 1.8 m. The fish gains a speed of 1.1 m s^{-1} .

What is the energy gained by the fish?

- A 0.15 J B 4.3 J C 4.4 J D 4.6 J

- 18 Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of 500 kg s^{-1} . The reservoir is 300 m above the level of the turbine.

The electrical output from the generator driven by the turbine is 200 A at a potential difference of 6000 V.

What is the efficiency of the system?

- A 8.0% B 8.2% C 80% D 82%

- 19 Which row correctly describes the ordering and motion of the molecules in liquid water and in ice when both are at a temperature of 0°C ?

	ordering	motion
A	a regular pattern of molecules in ice but not in water	molecules in both ice and water have the same average speed
B	a regular pattern of molecules in ice but not in water	molecules in ice travel more slowly than those in water
C	a regular pattern of molecules in both ice and water	molecules in ice travel more slowly than those in water
D	a regular pattern of molecules in both ice and water	molecules in both ice and water have the same average speed

- 20 The maximum pressure that granite rock can withstand is $2.0 \times 10^8 \text{ N m}^{-2}$. Above this pressure, the rock begins to flow like a liquid. The density of granite is $2.7 \times 10^3 \text{ kg m}^{-3}$.

What would be the height of a pure granite mountain whose base is just beginning to flow?

- A $3.8 \times 10^3 \text{ m}$ B $7.6 \times 10^3 \text{ m}$ C $3.7 \times 10^4 \text{ m}$ D $7.4 \times 10^4 \text{ m}$

21 To determine the Young modulus of a wire, several measurements are taken.

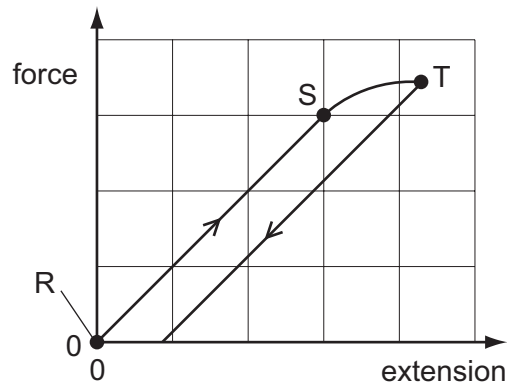
In which row can the measurement **not** be taken **directly** with the stated apparatus?

	measurement	apparatus
A	area of cross-section of wire	micrometer screw gauge
B	extension of wire	vernier scale
C	mass of load applied to wire	electronic balance
D	original length of wire	metre rule

22 A long, thin metal wire is suspended from a fixed support and hangs vertically. Masses are suspended from its lower end.

The load on the lower end is increased from zero and then decreased again back to zero.

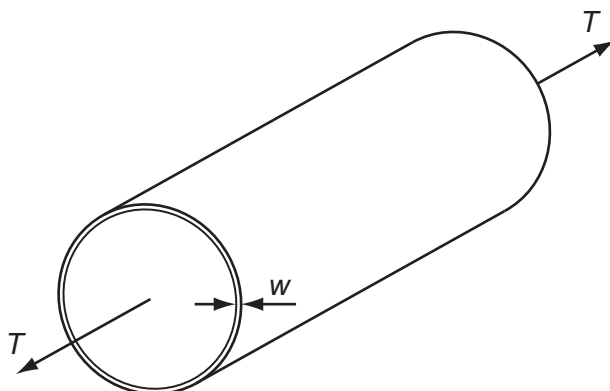
The diagram shows the force-extension graph produced.



Where on the graph would the elastic limit be found?

- A** anywhere between point R and point S
- B** just beyond point S
- C** exactly at point S
- D** exactly at point T

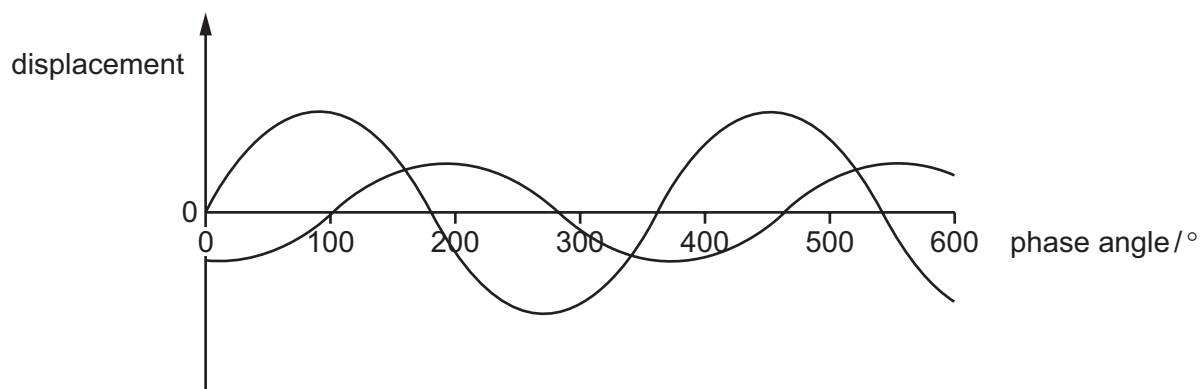
- 23 The diagram represents a steel tube with wall thickness w which is small in comparison with the diameter of the tube.



The tube is under tension, caused by a force T , parallel to the axis of the tube. To reduce the stress in the material of the tube, it is proposed to thicken the wall.

The tube diameter and the tension being constant, which wall thickness gives half the stress?

- A $\frac{w}{2}$ B $\sqrt{2}w$ C $2w$ D $4w$
- 24 Two light waves of the same frequency are represented by the diagram.



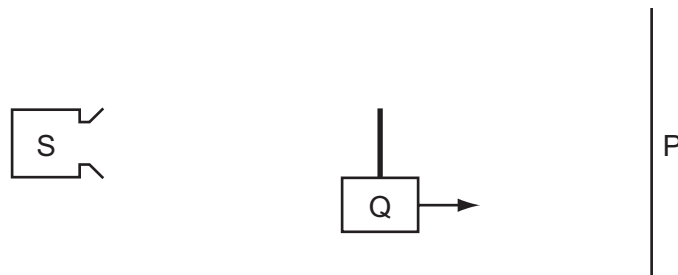
What could be the phase difference between the two waves?

- A 150° B 220° C 260° D 330°
- 25 A sound wave has a speed of 330 m s^{-1} and a frequency of 50 Hz .

What is a possible distance between two points on the wave that have a phase difference of 60° ?

- A 0.03 m B 1.1 m C 2.2 m D 6.6 m

- 26 What is **not** an **essential** condition for an observable interference pattern to occur between the waves from two sources?
- A The frequencies of the two sources must be equal.
 - B The sources must be coherent.
 - C The sources must emit waves of equal amplitude.
 - D The waves from the two sources must overlap.
- 27 Source S emits microwaves with a constant amplitude. The microwaves hit a metal screen P and are reflected. A stationary wave is formed between S and P. The wavelength of the microwaves is much smaller than the distance between S and P.

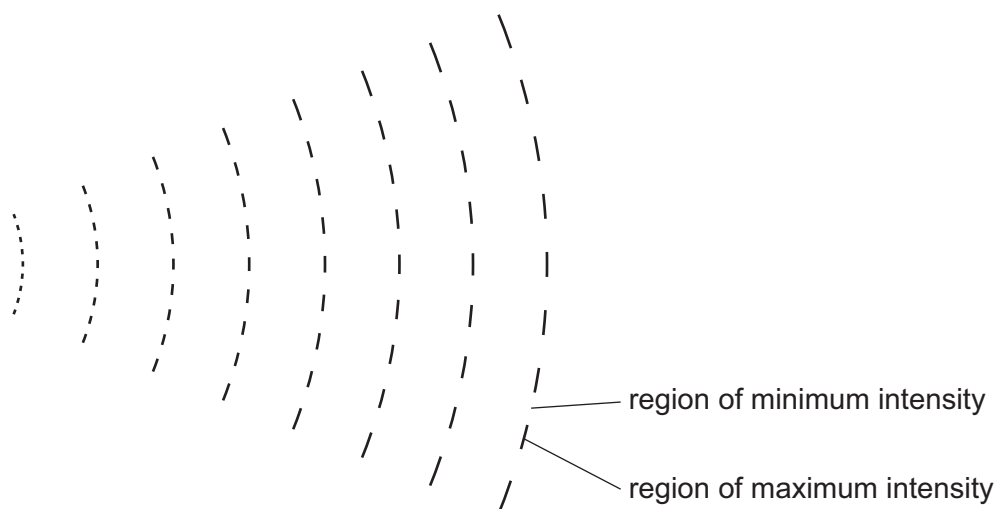


A detector Q is moved at a slow, constant speed from S to P.

What happens to the amplitude of the signal detected by Q?

- A decreases steadily
- B increases and decreases regularly
- C increases steadily
- D remains constant

- 28 A pattern of waves was observed without being able to view the source of the waves. The pattern is represented in the diagram.

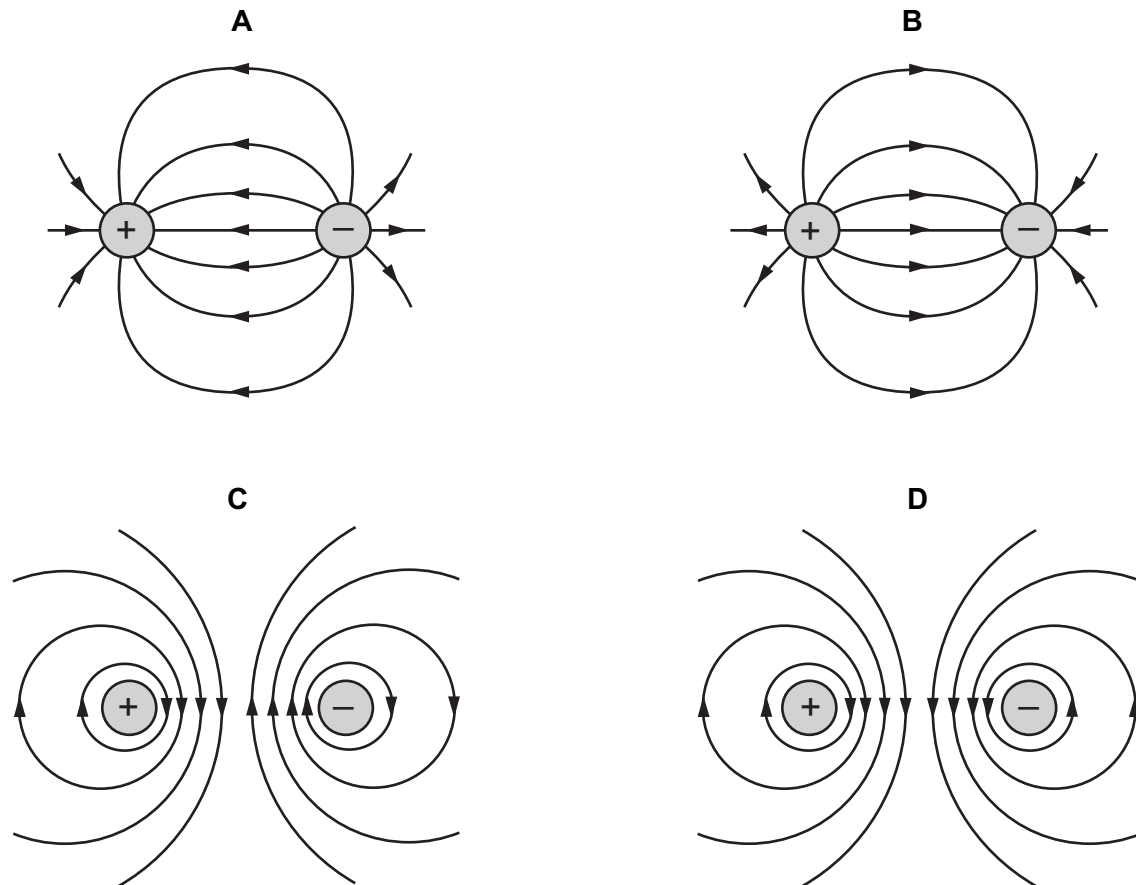


What can cause this pattern?

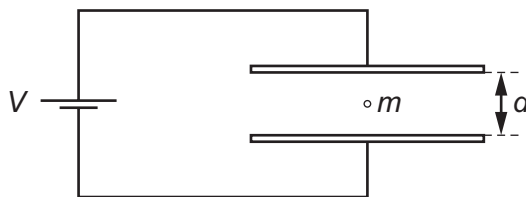
- A coherence only
- B diffraction and interference
- C diffraction only
- D interference only

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

Which diagram best represents the associated electric field?



- 30 A charged oil drop of mass m , with n excess electrons, is held stationary in the uniform electric field between two horizontal plates separated by a distance d .



The voltage between the plates is V , the elementary charge is e and the acceleration of free fall is g .

What is the value of n ?

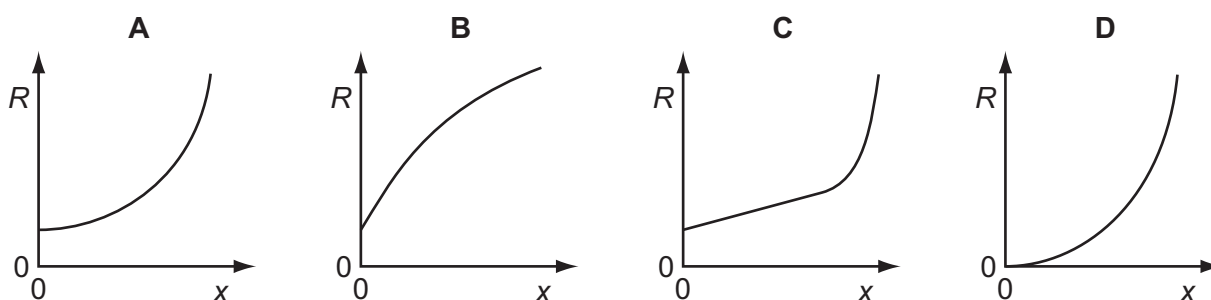
- A $\frac{eV}{mgd}$ B $\frac{mgd}{eV}$ C $\frac{meV}{gd}$ D $\frac{gd}{meV}$

31 Which unit is **not** used in either the definition of the coulomb or the definition of the volt?

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

32 When a thin metal wire is stretched, it becomes longer and thinner. This causes a change in the resistance of the wire. The volume of the wire remains constant.

Which graph could represent the variation with extension x of the resistance R of the wire?



33 Which statement is **not** valid?

- A Current is the speed of the charged particles that carry it.
- B Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms per unit charge.
- C The potential difference (p.d.) between two points is the work done per unit charge when moving charge from one point to the other.
- D The resistance between two points is the p.d. between the two points per unit current.

34 A cell of e.m.f. E delivers a charge Q to an external circuit.

Which statement is correct?

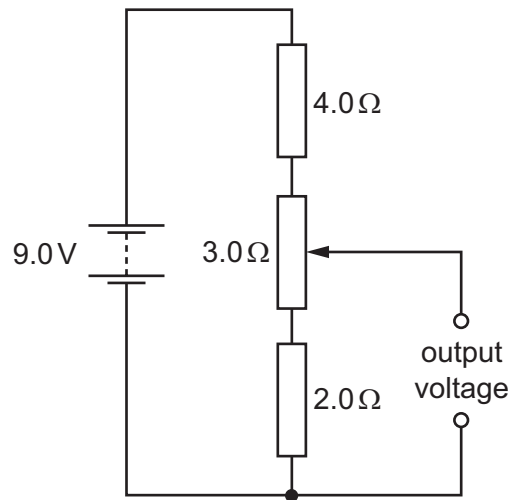
- A The energy dissipation in the external circuit is EQ .
- B The energy dissipation within the cell is EQ .
- C The external resistance is EQ .
- D The total energy dissipation in the cell and the external circuit is EQ .

35 Each of Kirchhoff's two laws presumes that some quantity is conserved.

Which row states Kirchhoff's **first** law and names the quantity that is conserved?

	statement	quantity
A	the algebraic sum of currents into a junction is zero	charge
B	the algebraic sum of currents into a junction is zero	energy
C	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	charge
D	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	energy

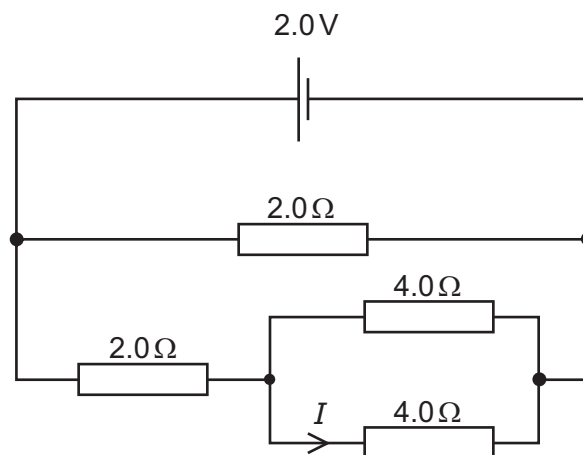
- 36** A potential divider circuit consists of fixed resistors of resistance 2.0Ω and 4.0Ω connected in series with a 3.0Ω resistor fitted with a sliding contact. These are connected across a battery of e.m.f. 9.0V and zero internal resistance, as shown.



What are the maximum and the minimum output voltages of this potential divider circuit?

	maximum voltage / V	minimum voltage / V
A	4.0	2.0
B	5.0	2.0
C	9.0	0
D	9.0	2.0

- 37** A cell of e.m.f. 2.0V and negligible internal resistance is connected to a network of resistors as shown.



What is the current I ?

- A** 0.25A **B** 0.33A **C** 0.50A **D** 1.5A

- 38 An experiment in which α -particles were deflected by a gold foil produced new insights into the structure of the atom.

Which conclusion can be drawn from the results of the experiment?

- A Atomic nuclei occupy a very small fraction of the volume of an atom.
- B Electrons orbit the atomic nucleus.
- C Some atoms of the same element contain different numbers of neutrons.
- D The atomic nucleus contains protons and neutrons.

- 39 A radioactive substance contains a number of identical nuclei that emit β -particles.

Which property of these nuclei remains unaltered by the emission?

- A charge
- B neutron number
- C nucleon number
- D proton number

- 40 A uranium-238 nucleus, ${}_{92}^{238}\text{U}$, undergoes nuclear decays to form uranium-234, ${}_{92}^{234}\text{U}$.

Which series of decays could give this result?

- A emission of four β -particles
- B emission of four γ -rays
- C emission of one α -particle and two β -particles
- D emission of two α -particles and eight β -particles

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PHYSICS

Paper 1 Multiple Choice

9702/13

May/June 2015

1 hour

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

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, 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 constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

work done on/by a gas,

$$W = p\Delta V$$

gravitational potential,

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

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.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{(x_0^2 - x^2)}$$

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,

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

resistors in series,

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

resistors in parallel,

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

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 statement includes a correct unit?

- A energy = 7.8 N s
- B force = 3.8 N s
- C momentum = 6.2 N s
- D torque = 4.7 N s

2 What is the joule (J) in SI base units?

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

3 The speed of an aeroplane in still air is 200 km h^{-1} . The wind blows from the west at a speed of 85.0 km h^{-1} .

In which direction must the pilot steer the aeroplane in order to fly due north?

- A 23.0° east of north
- B 23.0° west of north
- C 25.2° east of north
- D 25.2° west of north

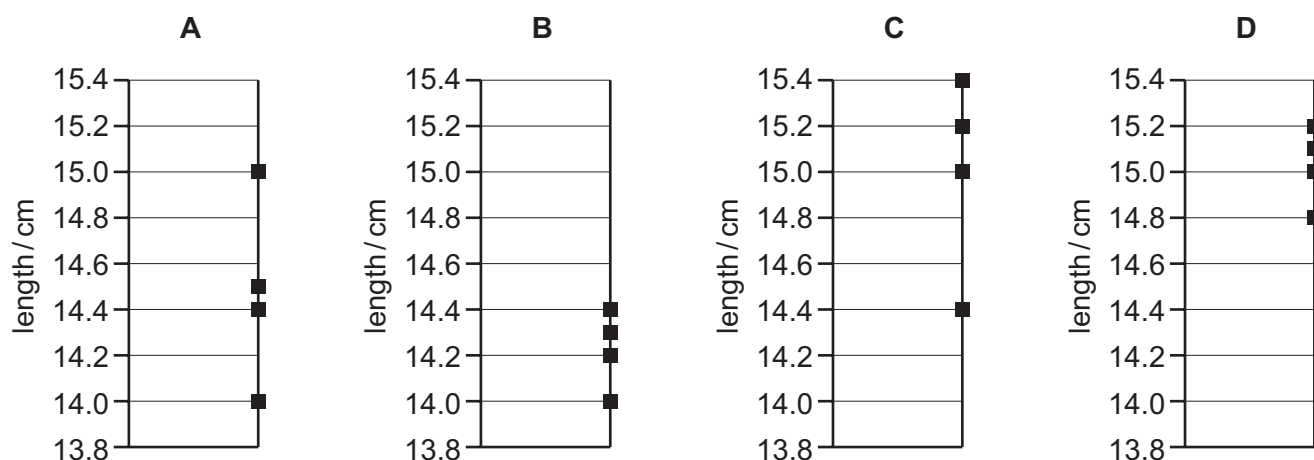
4 A student is given a reel of wire of diameter less than 0.2 mm and is asked to find the density of the metal.

Which pair of instruments would be most suitable for finding the **volume** of the wire?

- A balance and micrometer
- B metre rule and micrometer
- C metre rule and vernier calipers
- D micrometer and vernier calipers

- 5 Four different students use a ruler to measure the length of a 15.0 cm pencil. Their measurements are recorded on four different charts.

Which chart shows measurements that are precise but **not** accurate?

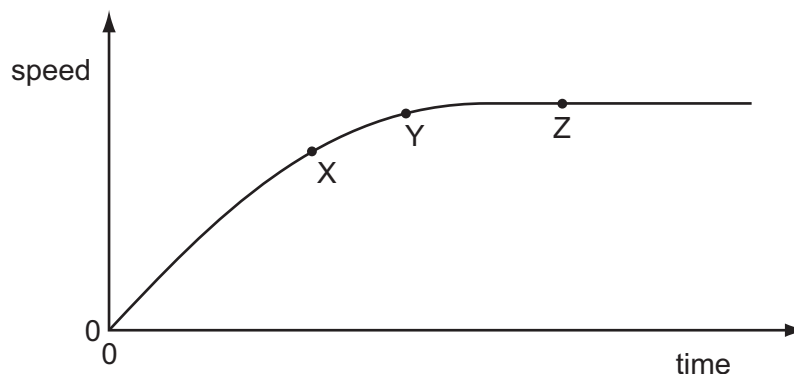


- 6 In a simple electrical circuit, the current in a resistor is measured as (2.50 ± 0.05) mA. The resistor is marked as having a value of $4.7 \Omega \pm 2\%$.

If these values were used to calculate the power dissipated in the resistor, what would be the percentage uncertainty in the value obtained?

- A 2% B 4% C 6% D 8%

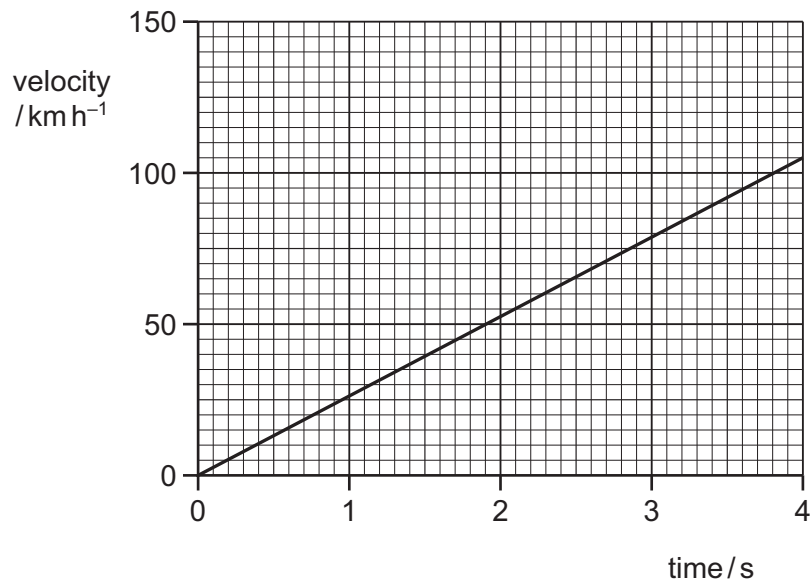
- 7 A raindrop falls vertically from rest in air. The variation with time of the speed of the raindrop is shown in the graph.



Which statement about the raindrop is correct?

- A At point X, the raindrop has an acceleration of 9.81 m s^{-2} .
- B At point Z, the force on the raindrop due to air resistance has reached its maximum value and so the acceleration of the raindrop has also reached its maximum value.
- C At point Z, the force due to air resistance is equal and opposite to the weight of the raindrop and so the speed of the raindrop is zero.
- D The resultant force on the raindrop at point Y is less than the resultant force on the raindrop at point X.

- 8 The velocity of an electric car changes as shown.



What is the acceleration of the car?

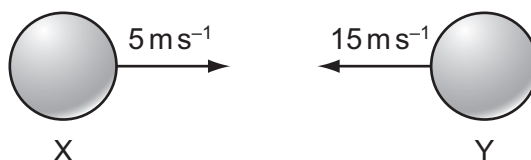
- A** 210 ms^{-2} **B** 58 ms^{-2} **C** 26 ms^{-2} **D** 7.3 ms^{-2}
- 9 A body falling in a uniform gravitational field encounters air resistance. The air resistance increases until terminal velocity is reached.
- Which factor does **not** affect its terminal velocity?
- A** the density of the air
B the height from which the body falls
C the mass of the body
D the shape of the body
- 10 Which of the following is a statement of the principle of conservation of momentum?
- A** Momentum is the product of mass and velocity.
B In an elastic collision, momentum is constant.
C The momentum of an isolated system is constant.
D The force acting on a body is proportional to its rate of change of momentum.

- 11 A moving object strikes a stationary object. The collision is inelastic. The objects move off together.

Which row shows the possible values of total momentum and total kinetic energy for the system before and after the collision?

	total momentum before collision / kg m s^{-1}	total momentum after collision / kg m s^{-1}	total kinetic energy before collision / J	total kinetic energy after collision / J
A	6	2	90	30
B	6	6	30	90
C	6	6	90	30
D	6	6	90	90

- 12 Two balls X and Y are moving towards each other with speeds of 5 m s^{-1} and 15 m s^{-1} respectively.

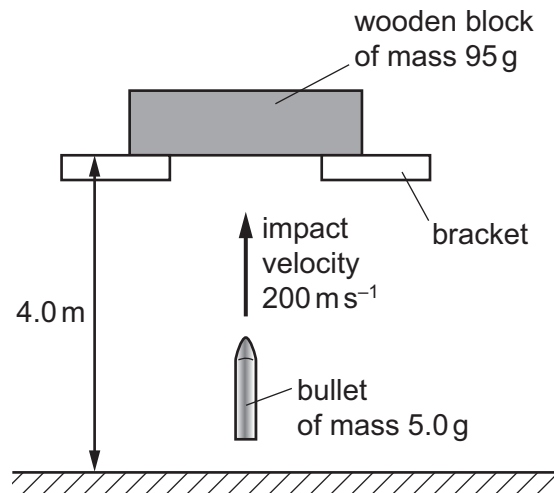


They make a perfectly elastic head-on collision and ball Y moves to the right with a speed of 7 m s^{-1} .

What is the speed and direction of ball X after the collision?

- A** 3 m s^{-1} to the left
- B** 13 m s^{-1} to the left
- C** 3 m s^{-1} to the right
- D** 13 m s^{-1} to the right

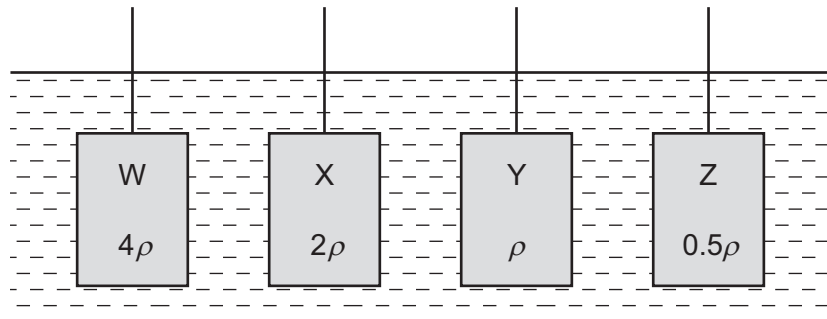
- 13 A wooden block is freely supported on brackets at a height of 4.0 m above the ground, as shown.



A bullet of mass 5.0 g is shot vertically upwards into the wooden block of mass 95 g. It embeds itself in the block. The impact causes the block to rise above its supporting brackets.

The bullet hits the block with a velocity of 200 m s^{-1} . How far above the ground will the block be at the maximum height of its path?

- A 5.1 m B 5.6 m C 9.1 m D 9.6 m
- 14 Four cuboids with identical length, breadth and height 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 .

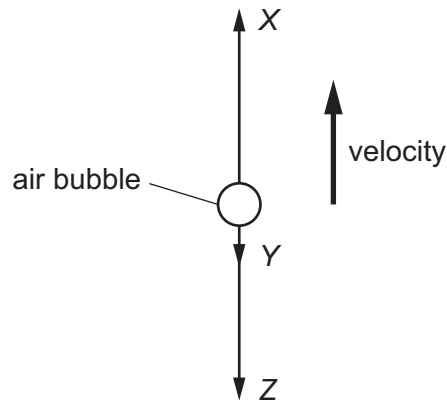
Cuboid Y is made of material of density ρ .

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.

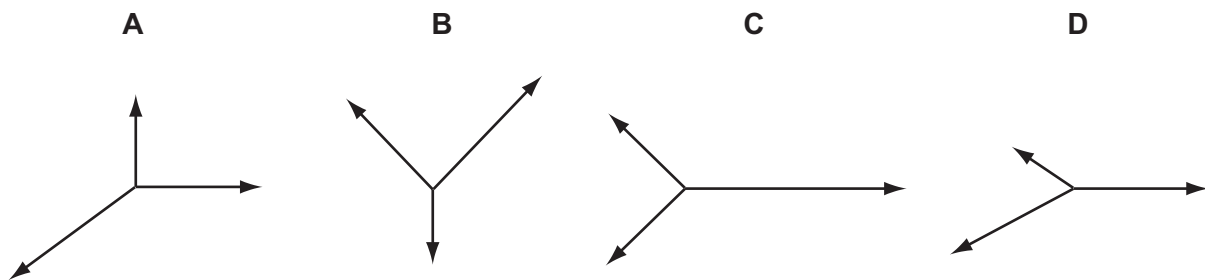
- 15** An air bubble in a tank of water is rising with constant velocity. The forces acting on the bubble are X , Y and Z as shown.



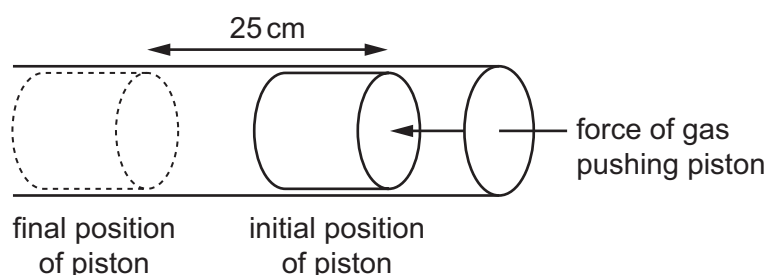
What describes the three forces?

- A** Z is the viscous drag on the bubble, Y is the weight of the bubble, X is the upthrust on the bubble and $X = Y + Z$.
- B** Z is the viscous drag on the bubble, Y is the weight of the bubble, X is the upthrust on the bubble and $X > Y + Z$.
- C** Z is the weight of the bubble, Y is the viscous drag on the bubble, X is the upthrust on the bubble and $X = Y + Z$.
- D** Z is the weight of the bubble, Y is the viscous drag on the bubble, X is the upthrust on the bubble and $X > Y + Z$.
- 16** The diagrams represent systems of coplanar forces acting at a point. The lengths of the force vectors represent the magnitudes of the forces.

Which system of forces is in equilibrium?



- 17 The gas in an engine does work on a piston of cross-sectional area 80 cm^2 . The pressure on the piston has a constant value of $4.6 \times 10^5\text{ Pa}$.



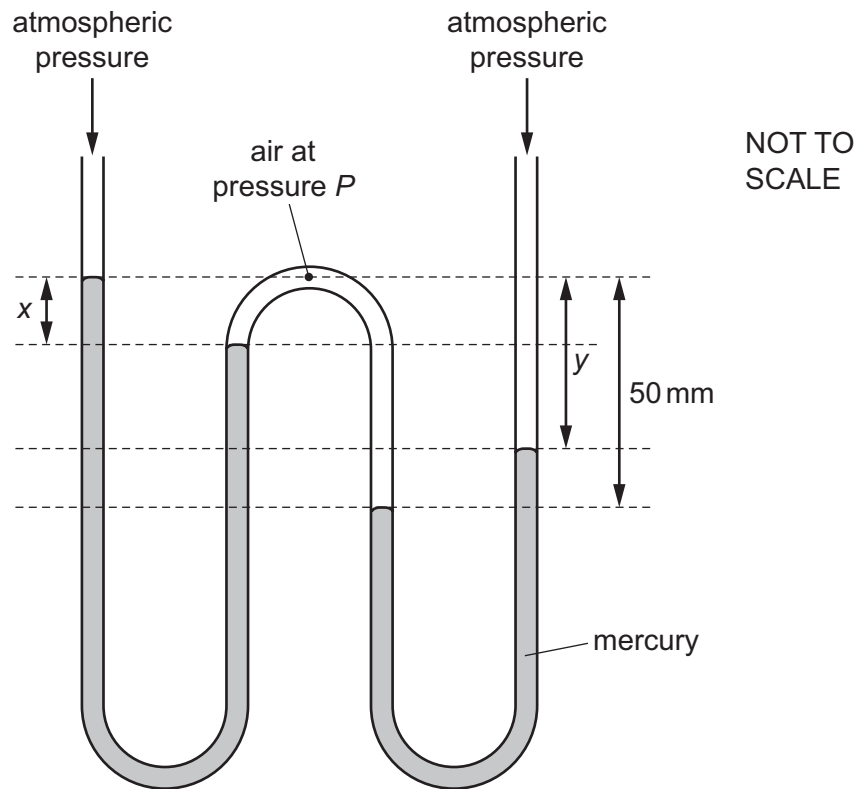
How much work is done by the gas on the piston when it moves through a distance of 25 cm?

- A $9.2 \times 10^2\text{ J}$ B $9.2 \times 10^4\text{ J}$ C $9.2 \times 10^6\text{ J}$ D $9.2 \times 10^8\text{ J}$
- 18 A loaded aeroplane has a total mass of $1.2 \times 10^5\text{ kg}$ while climbing after take-off. It climbs at an angle of 23° to the horizontal with a speed of 50 ms^{-1} . What is the rate at which it is gaining potential energy at this time?
- A $2.3 \times 10^6\text{ J s}^{-1}$
 B $2.5 \times 10^6\text{ J s}^{-1}$
 C $2.3 \times 10^7\text{ J s}^{-1}$
 D $2.5 \times 10^7\text{ J s}^{-1}$
- 19 When a horizontal force F is applied to a frictionless trolley over a distance s , the kinetic energy of the trolley changes from 4.0 J to 8.0 J .
- If a force of $2F$ is applied to the trolley over a distance of $2s$, what will the original kinetic energy of 4.0 J become?
- A 16 J B 20 J C 32 J D 64 J
- 20 When ice melts, it contracts.

Which row is correct for ice turning into water?

	distance between molecules	density
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 21 A W-shaped tube contains two amounts of mercury, each open to the atmosphere. Air at pressure P is trapped in between them. The diagram shows two vertical distances x and y .



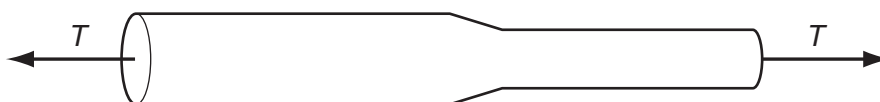
Atmospheric pressure is equal to the pressure that would be exerted by a column of mercury of height 760 mm. The pressure P is expressed in this way.

Which values of x , y and P are possible?

	x/mm	y/mm	$P/\text{mm of mercury}$
A	20	20	780
B	20	30	780
C	30	20	810
D	30	30	790

- 22 A steel bar of circular cross-section is under tension T , as shown.

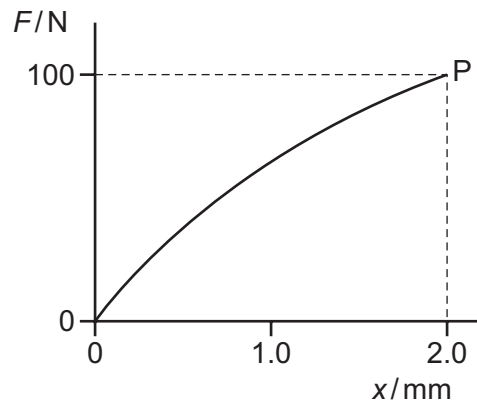
The diameter of the wide portion is double the diameter of the narrow portion.



What is the value of $\frac{\text{stress in the wide portion}}{\text{stress in the narrow portion}}$?

- A** 0.25 **B** 0.50 **C** 2.0 **D** 4.0

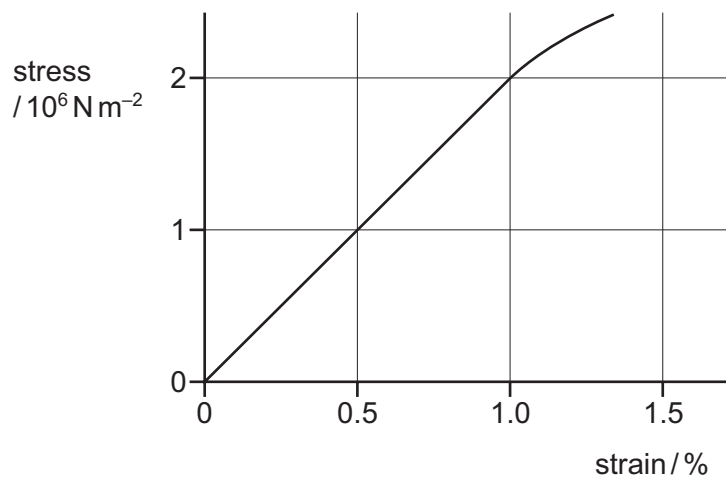
- 23 The graph shows the non-linear force-extension curve for a wire made from a new composite material.



What could be the value of the strain energy stored in the wire when it is stretched elastically to point P?

- A** 0.09 J **B** 0.10 J **C** 0.11 J **D** 0.20 J

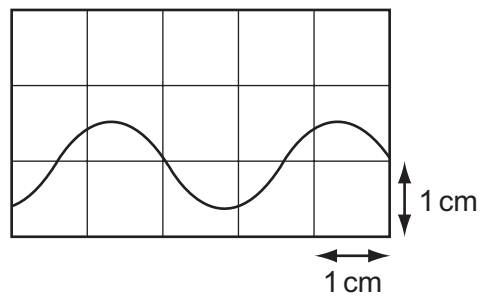
- 24 The diagram shows the stress-strain graph for bone.



What is the Young modulus of bone?

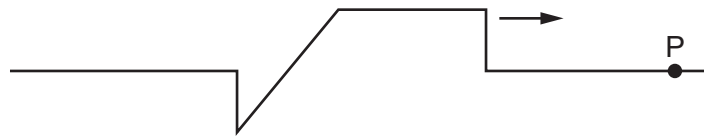
- A** $1 \times 10^6 \text{ N m}^{-2}$
B $2 \times 10^6 \text{ N m}^{-2}$
C $1 \times 10^8 \text{ N m}^{-2}$
D $2 \times 10^8 \text{ N m}^{-2}$

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

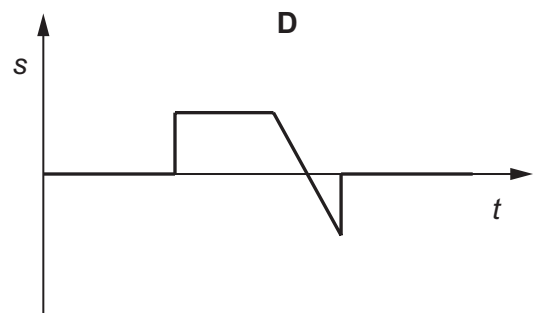
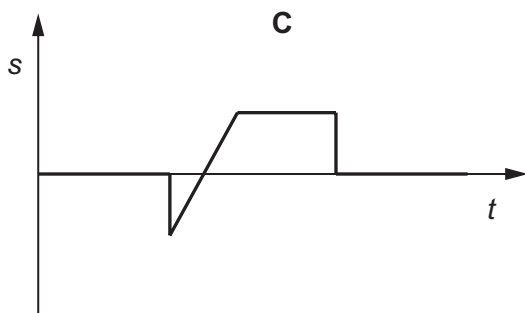
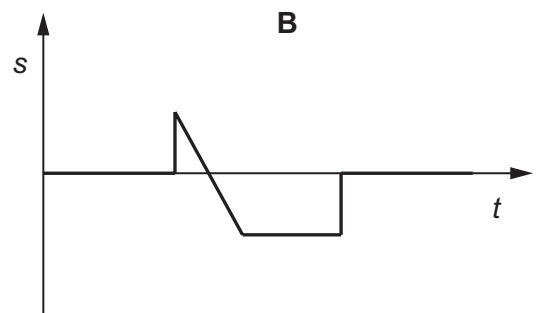
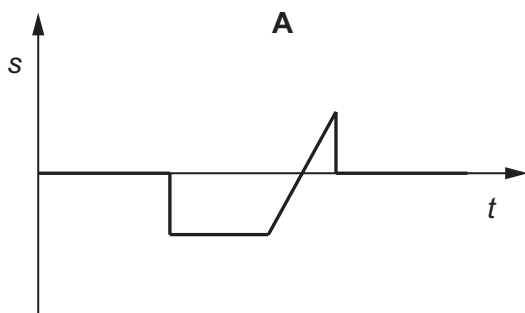


What is the frequency of the sound wave?

- A 6.7 Hz B 67 Hz C 6.7 kHz D 67 kHz
- 26 A wave pulse moves along a stretched rope in the direction shown.



Which diagram correctly shows the variation with time t of the displacement s of the particle P in the rope?



27 The table contains statements about stationary and progressive waves.

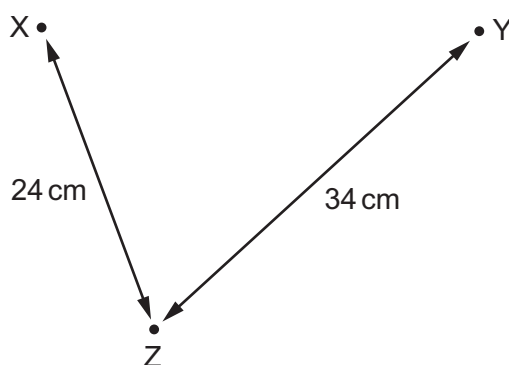
Which row is correct?

	stationary wave	progressive wave
A	all particles vibrate with the same amplitude	all particles vibrate with the same amplitude
B	energy is transferred along the wave	energy is transferred along the wave
C	particles in adjacent loops vibrate in antiphase	particles vibrate in phase with their immediate neighbours
D	particles one wavelength apart vibrate in phase	particles one wavelength apart vibrate in phase

28 Which electromagnetic wave would cause the most significant diffraction effect for an atomic lattice of spacing around 10^{-10} m?

- A** infra-red
- B** microwave
- C** ultraviolet
- D** X-ray

29 Wave generators at points X and Y produce water waves of the same wavelength. At point Z, the waves from X have the same amplitude as the waves from Y. Distances XZ and YZ are as shown.

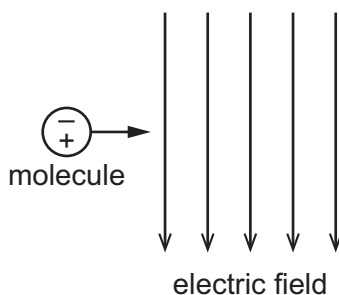


When the wave generators operate in phase, the amplitude of oscillation at Z is zero.

What could be the wavelength of the waves?

- A** 2 cm
- B** 3 cm
- C** 4 cm
- D** 6 cm

- 30 A molecule behaves as an electric dipole consisting of two equal point charges, of opposite sign, separated by a fixed distance. The molecule moves with constant horizontal velocity as it enters a vertical uniform electric field, as shown.

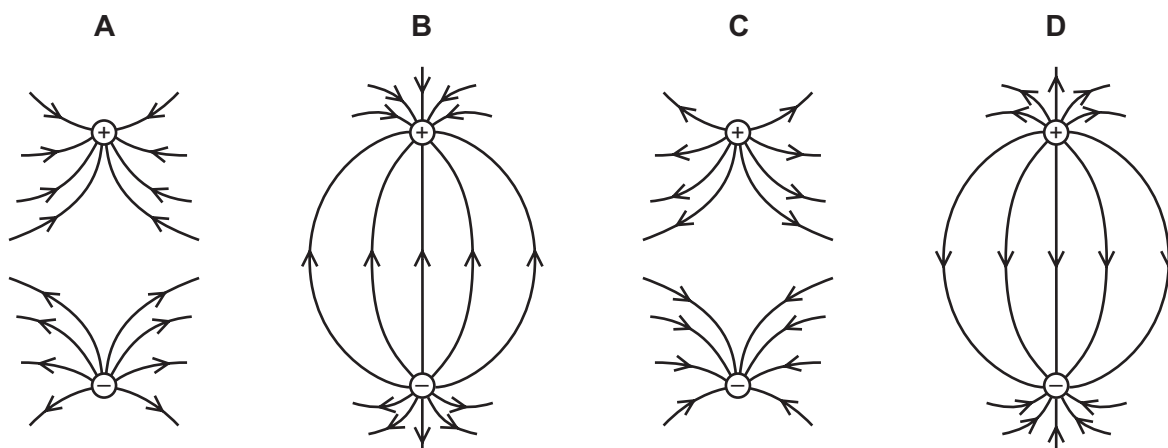


The positive and negative charges of the molecule enter the field at the same time.

Which row describes the velocity of the molecule in the field?

	horizontal component of velocity	vertical component of velocity
A	constant	increases
B	constant	zero
C	increases	increases
D	increases	zero

- 31 Which diagram best represents the electric field between two point charges of equal magnitude and opposite sign?

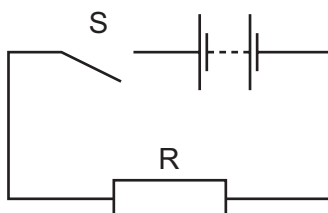


- 32 A pedal bicycle is fitted with an electric motor. The rider switches on the motor for a time of 3.0 minutes. A constant current of 3.5 A in the electric motor is provided from a battery with a terminal voltage of 24 V.

What is the energy supplied by the battery?

- A** 84 J **B** 250 J **C** 630 J **D** 15 000 J

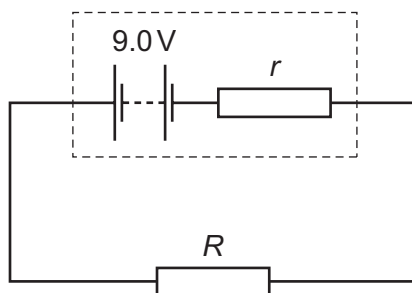
33 The diagram shows a simple circuit.



Which statement is correct?

- A** When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.
- B** When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance of R.
- C** When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.
- D** When switch S is closed, the potential difference across the battery falls because work is done against the resistance of R.

34 A simple circuit is formed by connecting a resistor of resistance R between the terminals of a battery of electromotive force (e.m.f.) 9.0 V and constant internal resistance r .



A charge of 6.0 C flows through the resistor in a time of 2.0 minutes causing it to dissipate 48 J of thermal energy.

What is the internal resistance r of the battery?

- A** $0.17\ \Omega$ **B** $0.33\ \Omega$ **C** $20\ \Omega$ **D** $160\ \Omega$

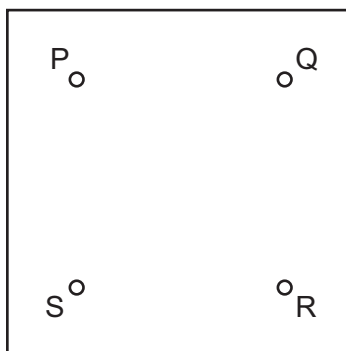
35 A source of e.m.f. 9.0 mV has an internal resistance of $6.0\ \Omega$.

It is connected across a galvanometer of resistance $30\ \Omega$.

What is the current in the galvanometer?

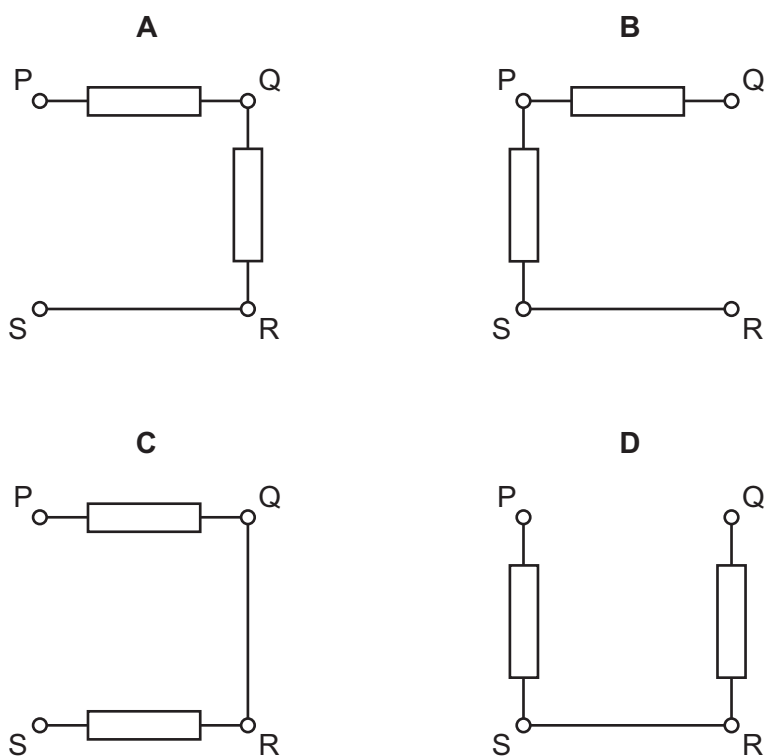
- A** $250\ \mu\text{A}$ **B** $300\ \mu\text{A}$ **C** 1.5 mA **D** 2.5 mA

- 36 A box with four terminals P, Q, R and S contains two identical resistors.

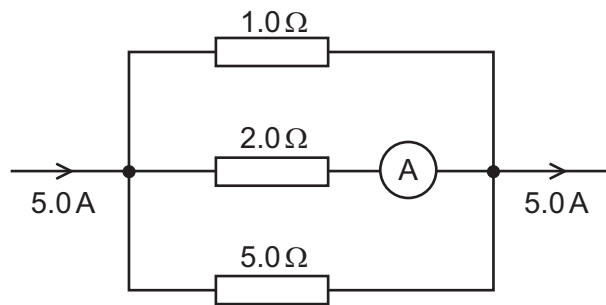


When a battery of electromotive force (e.m.f.) E and negligible internal resistance is connected across PS, a high-resistance voltmeter connected across QR reads $\frac{E}{2}$.

Which diagram shows the correct arrangement of the two resistors inside the box?



- 37 The diagram shows part of a current-carrying circuit. The ammeter has negligible resistance.



What is the reading on the ammeter?

- A** $0.7\ \text{A}$ **B** $1.3\ \text{A}$ **C** $1.5\ \text{A}$ **D** $1.7\ \text{A}$

- 38 Nucleus P decays in two stages to produce nucleus Q.

Which decay sequence will result in the highest number of neutrons in nucleus Q?

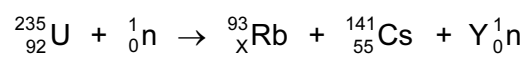
- A** an α -particle followed by a β -particle
B an α -particle followed by a γ -ray
C a β -particle followed by another β -particle
D a β -particle followed by a γ -ray

- 39 A neutral atom has a nucleus given by the symbol $^{133}_{55}\text{Cs}$.

How many protons, neutrons and electrons are in this atom?

	protons	neutrons	electrons
A	55	78	55
B	55	133	55
C	78	55	78
D	133	55	133

40 The nuclear equation for a fission reaction is shown below.



What are the values of X and Y?

	X	Y
A	37	0
B	37	1
C	37	2
D	38	2

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