Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/13**

Paper 1 Multiple Choice **October/November 2015**

1 hour

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

9986071575

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 **21** printed pages and **3** blank pages.

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Data

speed of light in free space, $c = 3.00 \times 10^{8}\,\text{m s}^{-1}$

permeability of free space, $\mu_0 = 4\pi \times 10^{-7}\,\text{H m}^{-1}$

permittivity of free space, $\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$

$\left(\dfrac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$

elementary charge, $e = 1.60 \times 10^{-19}\,\text{C}$

the Planck constant, $h = 6.63 \times 10^{-34}\,\text{J s}$

unified atomic mass constant, $u = 1.66 \times 10^{-27}\,\text{kg}$

rest mass of electron, $m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$

rest mass of proton, $m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$

molar gas constant, $R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$

the Avogadro constant, $N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$

the Boltzmann constant, $k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$

gravitational constant, $G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$

acceleration of free fall, $g = 9.81\,\text{m s}^{-2}$

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Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

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

work done on/by a gas, $W = p\Delta V$

gravitational potential, $\phi = -\frac{Gm}{r}$

hydrostatic pressure, $p = \rho gh$

pressure of an ideal gas, $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$

simple harmonic motion, $a = -\omega^2 x$

velocity of particle in s.h.m., $v = v_0 \cos \omega t$

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

electric potential, $V = \frac{Q}{4\pi\varepsilon_0 r}$

capacitors in series, $1/C = 1/C_1 + 1/C_2 + \ldots$

capacitors in parallel, $C = C_1 + C_2 + \ldots$

energy of charged capacitor, $W = \frac{1}{2}QV$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

alternating current/voltage, $x = x_0 \sin \omega t$

radioactive decay, $x = x_0 \exp(-\lambda t)$

decay constant, $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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1 What is the unit of the Young modulus when expressed in SI base units?

A $\mathrm{kg\,m^{-1}\,s^{-2}}$

B $\mathrm{kg\,m^{3}\,s^{-2}}$

C $\mathrm{kg\,m^{-2}}$

D $\mathrm{kg\,m^{-1}\,s^{-1}}$

2 The Reynolds number R is a constant used in the study of liquids flowing through pipes. R is a pure number with no unit.

$$R = \frac{\rho v D}{\mu}$$

where ρ is the density of the liquid, v is the speed of the liquid and D is the diameter of the pipe through which the liquid flows.

What are the SI base units of μ?

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

3 When a force F moves its point of application through a displacement s in the direction of the force, the work W done by the force is given by

$$W = Fs.$$

How many vector quantities and scalar quantities does this equation contain?

A one scalar quantity and two vector quantities

B one vector quantity and two scalar quantities

C three scalar quantities

D three vector quantities

4 Measurements are subject to systematic error and random error.

Which measurements have high accuracy and low precision?

A high random error and high systematic error

B high random error and low systematic error

C low random error and high systematic error

D low random error and low systematic error

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5 The density of the material of a coil of thin wire is to be found.

Which set of instruments could be used to do this most accurately?

A metre rule, protractor, spring balance

B micrometer, metre rule, top-pan balance

C stopwatch, newton-meter, vernier calipers

D tape measure, vernier calipers, lever balance

6 A cylindrical tube rolling down a slope of inclination θ moves a distance L in time T. The equation relating these quantities is

$$L\left(3+\frac{a^2}{P}\right) = QT^2 \sin\theta$$

where a is the internal radius of the tube and P and Q are constants.

Which row gives the correct units for P and for Q?

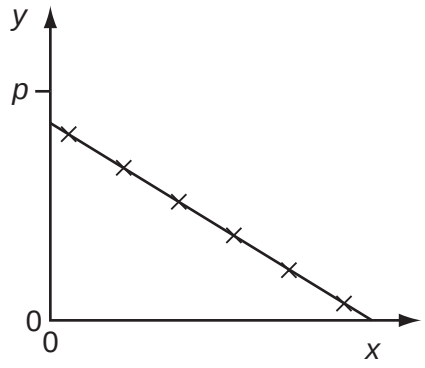
	P	Q
A	m^2	$m^2 s^{-2}$
B	m^2	$m s^{-2}$
C	m^2	$m^3 s^{-2}$
D	m^3	$m s^{-2}$

7 Variables x and y are related by the equation $y = p - qx$ where p and q are constants.

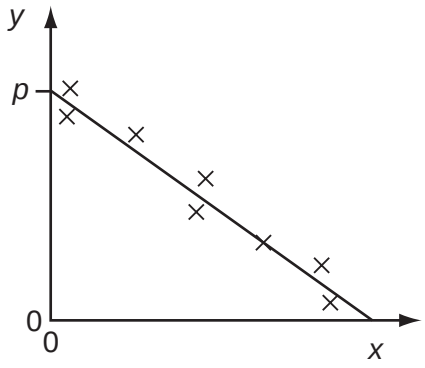
Values of x and y are measured experimentally. The results contain a systematic error.

Which graph best represents these results?

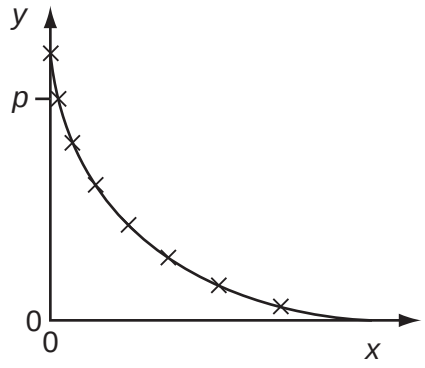
A



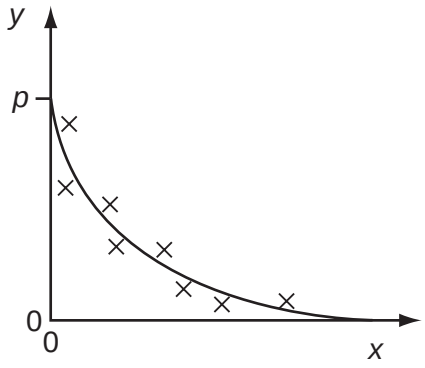
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C

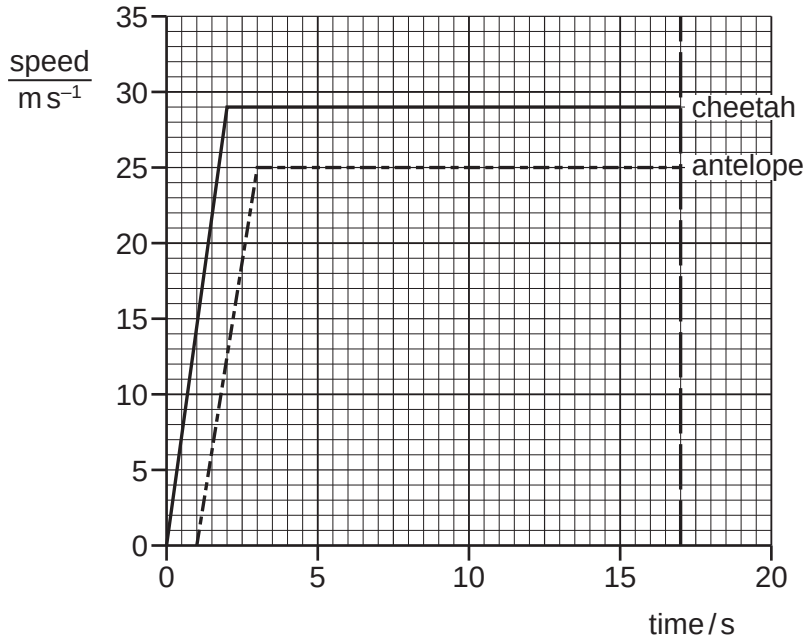


D



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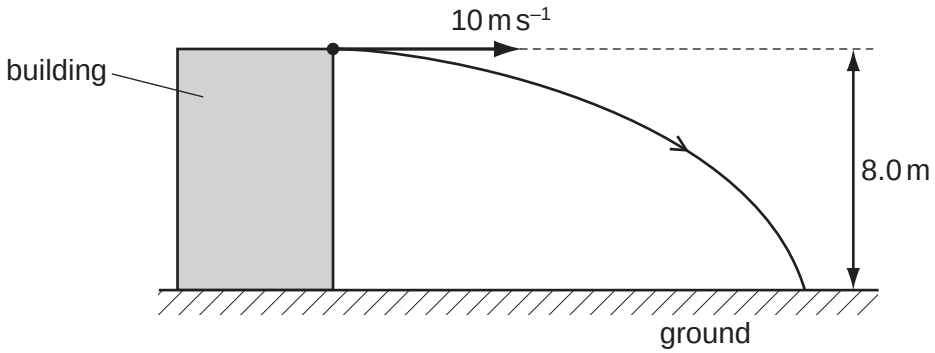
8 A cheetah and an antelope are 100 m apart. The cheetah spots the antelope and runs towards it. The antelope reacts to the cheetah after one second and runs directly away from the cheetah. Both animals take 2 seconds to reach their top speeds. The graph shows how the speeds of the two animals vary with time.



How far apart are the animals, 17 seconds after the cheetah began running?

A 4 m **B** 11 m **C** 54 m **D** 89 m

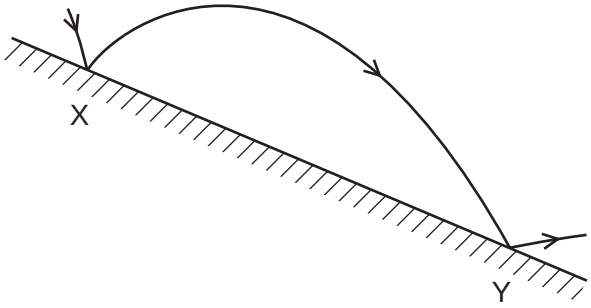
9 A boy throws a stone with a horizontal velocity of 10 m s^{-1} from the top of a building. The height of the building is 8.0 m. The stone travels along a curved path until it hits the ground, as shown in the diagram.



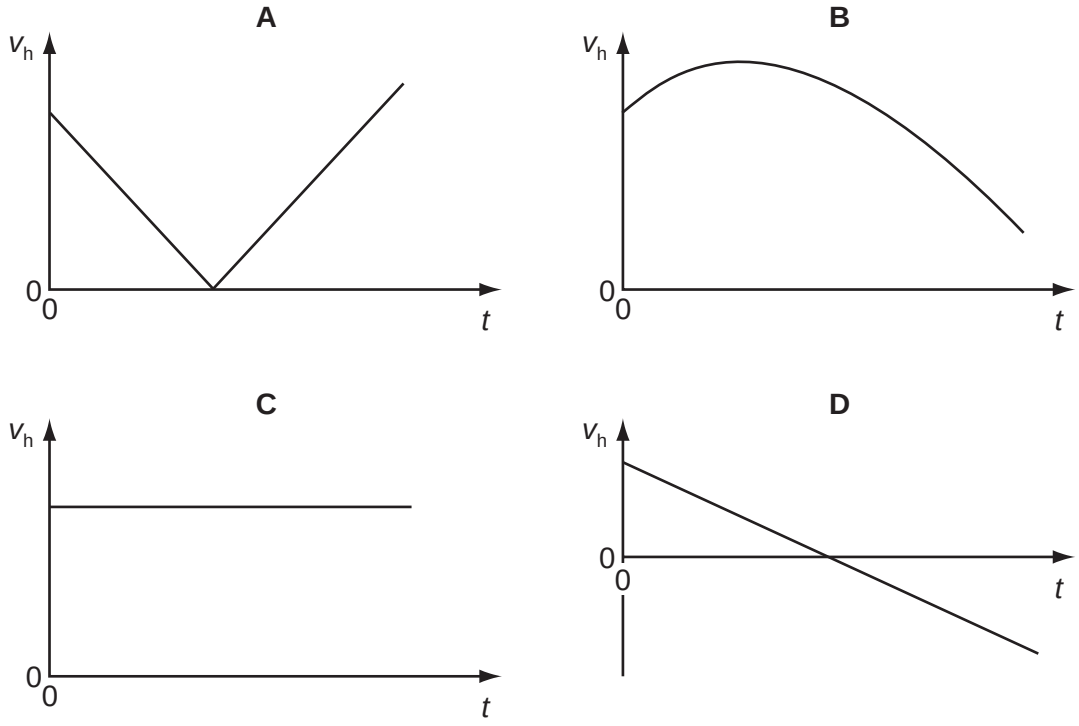
How long does it take the stone to reach the ground? (Air resistance can be neglected.)

A 0.61 s **B** 0.80 s **C** 1.3 s **D** 1.6 s

10 A football is released above a plane, sloping surface and bounces several times. The diagram shows its path between its bounces at X and at Y. Assume that there is no air resistance.



Which graph correctly shows the variation with time t of the horizontal component of its velocity v_h between X and Y?



11 A rocket of mass 30 000 kg sits on a launch pad on the Earth's surface. The rocket motors provide an upward force of 330 kN on the rocket.

What is the initial acceleration of the rocket?

A $0.12\,m\,s^{-2}$

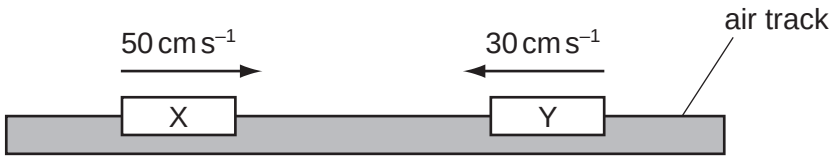
B $1.1\,m\,s^{-2}$

C $1.2\,m\,s^{-2}$

D $11\,m\,s^{-2}$

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12 Two equal masses X and Y are moving towards each other on a frictionless air track as shown. The masses make an elastic collision.



Which row gives possible velocities for the two masses after the collision?

	velocity of X	velocity of Y
A	zero	20 cm s^{-1} to the right
B	10 cm s^{-1} to the right	10 cm s^{-1} to the right
C	20 cm s^{-1} to the left	zero
D	30 cm s^{-1} to the left	50 cm s^{-1} to the right

13 Which statement is correct with reference to perfectly elastic collisions between two bodies?

A Neither total momentum nor total kinetic energy need be conserved but total energy must be conserved.

B Total momentum and total energy are conserved but total kinetic energy may be changed into some other form of energy.

C Total kinetic energy and total energy are both conserved but total momentum is conserved only if the two bodies have equal masses.

D Total momentum, total kinetic energy and total energy are all conserved.

14 Which statement best describes a couple?

A a pair of forces of equal magnitude acting in opposite directions which produce rotational motion but not translational motion

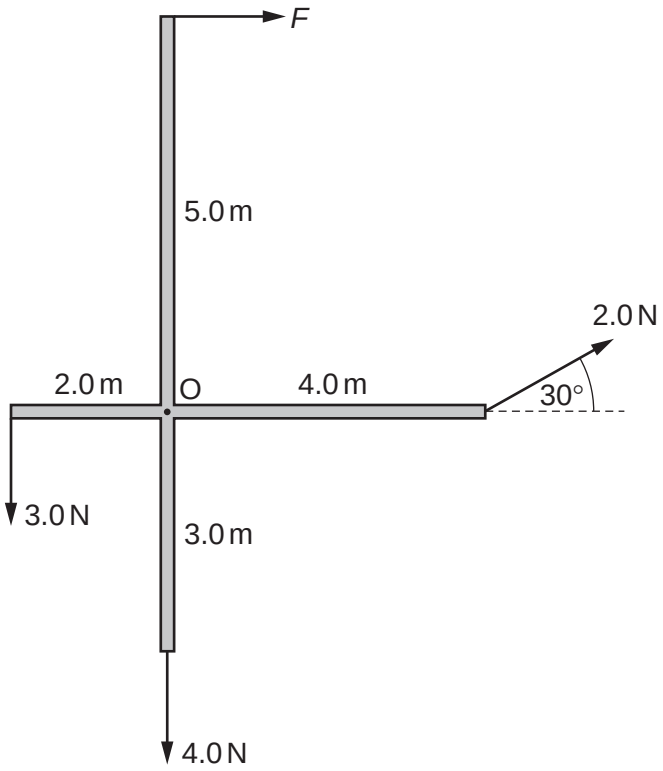
B a pair of forces of equal magnitude acting in opposite directions which produce translational motion but not rotational motion

C a pair of forces of equal magnitude acting in the same direction which produce rotational motion but not translational motion

D a pair of forces of equal magnitude acting in the same direction which produce translational motion but not rotational motion

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15 A cross-shaped structure, freely pivoted at O, has arms of lengths 5.0 m, 4.0 m, 3.0 m and 2.0 m. It is acted on by forces of 2.0 N, 3.0 N, 4.0 N and an unknown force *F*. The structure is in rotational equilibrium.

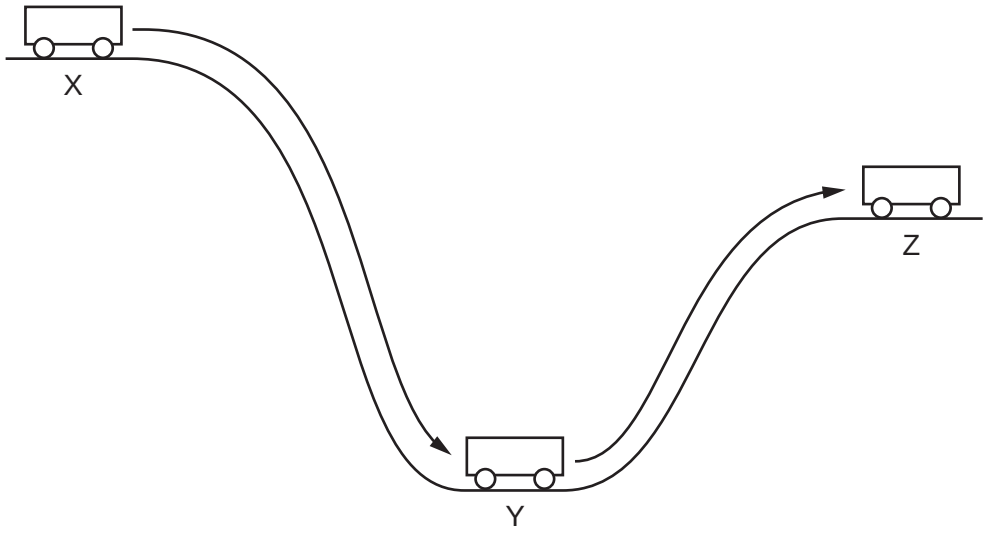


What is the magnitude of force *F*?

A 0.40 N **B** 2.0 N **C** 2.6 N **D** 4.4 N

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16 A trolley starts from rest at X. It rolls down to Y and eventually comes to rest at Z.



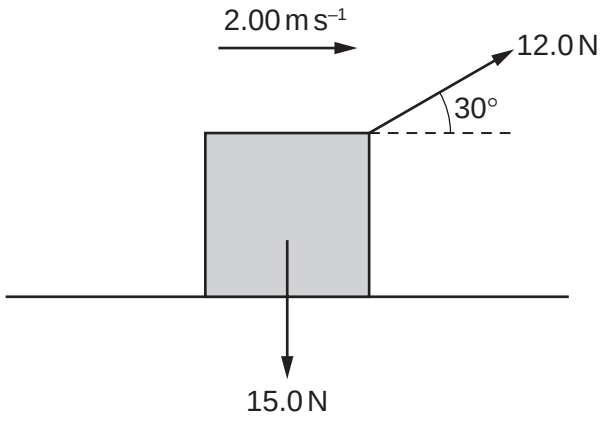
Which row is a possible summary of the energy changes during this process?

	X to Y	Y to Z
A	p.e. → k.e.	k.e. → p.e.
B	p.e. → k.e.	k.e. → p.e. + heat
C	p.e. → k.e. + heat	k.e. → p.e.
D	p.e. → k.e. + heat	k.e. → p.e. + heat

key
p.e. = potential energy
k.e. = kinetic energy

17 An object of weight 15.0 N is pulled along a horizontal surface at a constant velocity of 2.00 m s^{-1}.

The force pulling the object is 12.0 N at 30° to the horizontal, as shown.



What is the power used to move the object?

A 12.0 W **B** 20.8 W **C** 24.0 W **D** 30.0 W

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18 Brownian motion can be demonstrated by illuminating smoke particles inside a closed, transparent container. When the particles are viewed using a microscope, bright specks of light are observed to move with constant, random motion.

What **cannot** be inferred from this observation?

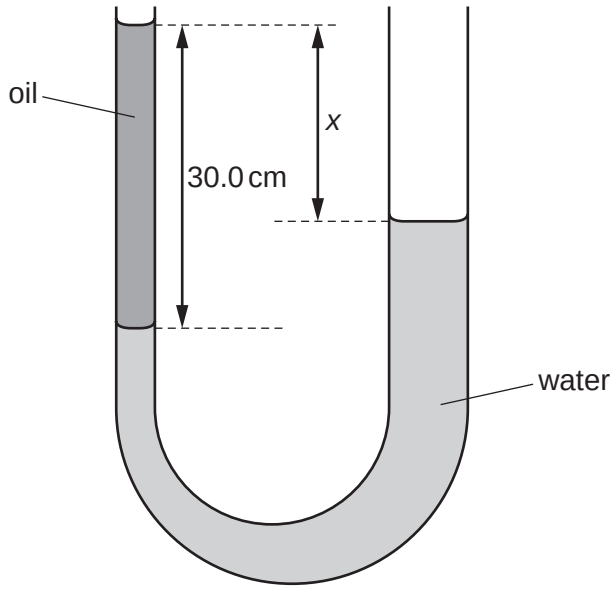
A Air molecules are in constant motion.

B Air molecules are in random motion.

C Air pressure is due to air molecules colliding with the container.

D The mass of an air molecule is much less than the mass of a smoke particle.

19 A U-tube has one arm of area of cross-section A and the other of cross-section $4A$. The tube contains water of density $1000\,\text{kg}\,\text{m}^{-3}$ and oil of density $850\,\text{kg}\,\text{m}^{-3}$, as shown.



The column of oil on top of the water in the left-hand arm is of length 30.0 cm.

What is the difference in height x between the levels in the two arms of the tube?

A 4.5 cm **B** 6.2 cm **C** 23.8 cm **D** 25.5 cm

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20 The Young modulus of a metal may be determined from the ratio $\frac{\text{stress}}{\text{strain}}$ when the metal is stretched elastically. This can be done by making measurements when loads are added to a wire.

Which measurements are needed to calculate the stress and strain of the wire in such an experiment?

	stress		strain	
A	wire diameter	initial and final positions of load	wire's original length	mass added
B	wire diameter	mass added	wire's original length	initial and final positions of load
C	wire's original length	initial and final positions of load	wire diameter	mass added
D	wire's original length	mass added	wire diameter	initial and final positions of load

21 A copper wire of length 3.6 m and diameter 1.22 mm is stretched elastically by a force of 37 N. The Young modulus of copper is 1.17×10^{11} Pa.

Which extension is caused by this force?

A 0.24 mm **B** 0.76 mm **C** 0.97 mm **D** 3.1 mm

22 When all the other features of a wave are constant, which relationship is correct?

A Amplitude is directly proportional to velocity.

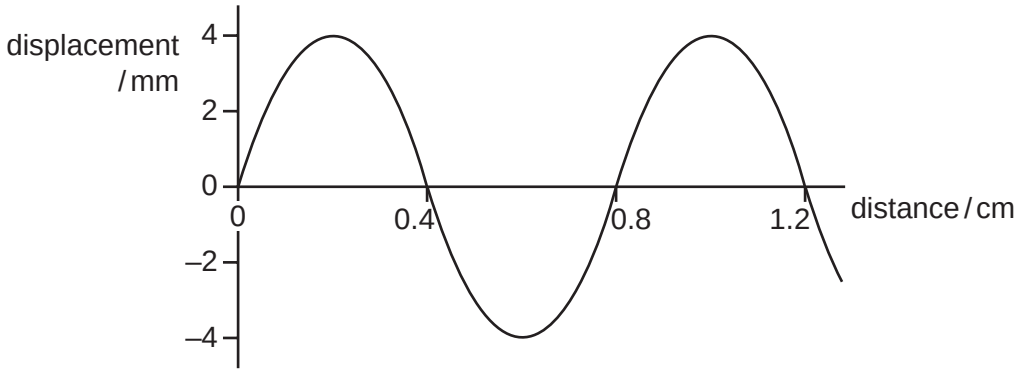
B Intensity is directly proportional to amplitude.

C Velocity is directly proportional to wavelength.

D Wavelength is directly proportional to frequency.

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23 A vibrating rod makes a water wave in a ripple tank. The graph shows the displacement of the wave at one instant as it travels away from the rod. The wave speed is $2.0\,\text{cm}\,\text{s}^{-1}$.



What is the frequency of the wave?

A 0.8 Hz **B** 1.6 Hz **C** 2.5 Hz **D** 5.0 Hz

24 Polarisation is a phenomenon associated with a certain type of wave.

Which condition **must** be fulfilled if a wave is to be polarised?

A It must be a light wave.

B It must be a longitudinal wave.

C It must be a radio wave.

D It must be a transverse wave.

25 Monochromatic light passes through two narrow slits and produces an interference pattern on a screen some distance away. The interference fringes are very close together.

Which change would **increase** the distance between the fringes?

A Increase the brightness of the light source.

B Increase the distance between the slits and the screen.

C Increase the distance between the two slits.

D Increase the frequency of the light used.

26 The following statements describe the diffraction of waves passing through a narrow slit.

Which statement is **not** correct?

A Both transverse and longitudinal waves can be diffracted.

B Diffraction can only be seen with light when the light is monochromatic.

C Red light diffracts through a greater angle than blue light.

D The angle of diffraction increases when the width of the slit decreases.

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27 Monochromatic light is directed onto a pair of slits. Interference fringes that are 2.0 mm apart are observed on a distant screen.

The frequency of the light used is then doubled and the slit separation is halved.

How far apart are the new interference fringes?

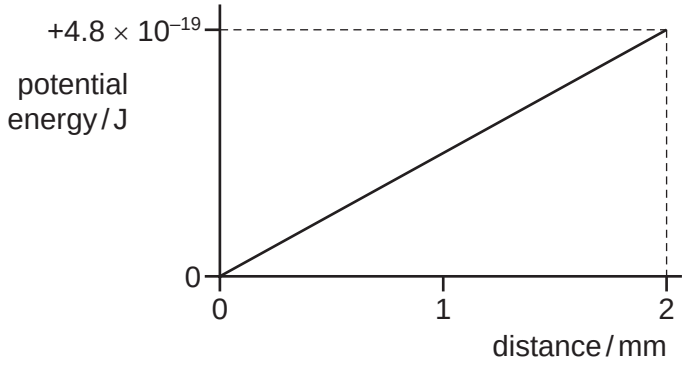
A 0.50 mm **B** 2.0 mm **C** 4.0 mm **D** 8.0 mm

28 A diffraction grating has N lines per unit length and is placed at 90° to monochromatic light of wavelength λ.

What is the expression for θ, the angle to the normal to the grating at which the third order diffraction peak is observed?

A $\sin\theta = \frac{1}{3N\lambda}$ **B** $\sin\theta = \frac{N\lambda}{3}$ **C** $\sin\theta = 3N\lambda$ **D** $\sin\theta = \frac{3\lambda}{N}$

29 Two parallel plates R and S are 2 mm apart in a vacuum. An electron with charge -1.6×10^{-19} C moves along a straight line in the electric field between the plates. The graph shows how the potential energy of the electron varies with its distance from plate R.



Which deduction is **not** correct?

A The electric field between R and S is uniform.

B The electric field strength is 3000 N C^{-1}.

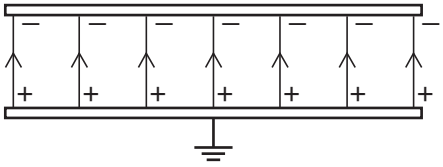
C The force on the electron is constant.

D The magnitude of the potential difference between R and S is 3 V.

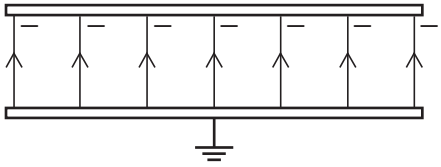
30 Two parallel, conducting plates with air between them are placed close to one another. The top plate is given a negative charge and the bottom one is earthed.

Which diagram best represents the distribution of charges and the field between the plates?

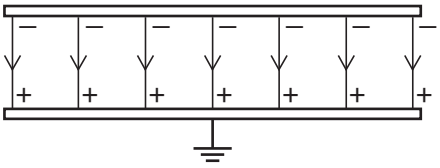
A



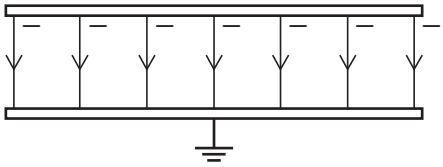
B



C



D

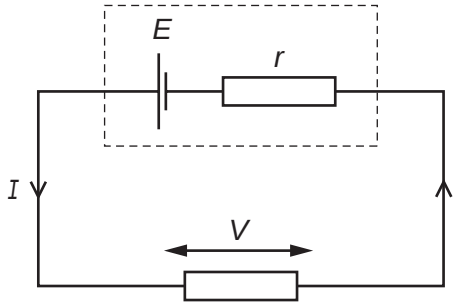


31 In terms of energy transfer W and charge q, what are the definitions of potential difference (p.d.) and electromotive force (e.m.f.)?

	p.d.	e.m.f.
A	$\frac{W}{q}$	$\frac{W}{q}$
B	$\frac{W}{q}$	Wq
C	Wq	$\frac{W}{q}$
D	Wq	Wq

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32 A cell of electromotive force E and internal resistance r is connected to an external resistor, as shown.



The current in the circuit is I and the potential difference (p.d.) across the external resistor is V.

In the equation $(E - V) = Ir$, what does the term $(E - V)$ represent?

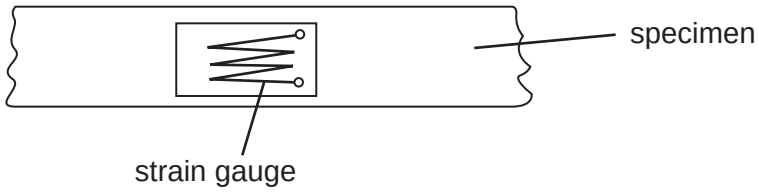
A electrical energy per unit charge lost in the cell

B electrical energy per unit charge lost in the complete circuit

C electrical energy per unit charge lost in the connecting wire

D electrical energy per unit charge lost in the external resistor

33 Tensile strain may be measured by the change in electrical resistance of a device called a strain gauge. A strain gauge consists of folded fine metal wire mounted on a flexible insulating backing sheet. The strain gauge is firmly attached to the specimen.



When the strain in the specimen is increased, what happens to the resistance of the wire?

A It decreases, because the length decreases and the cross-sectional area increases.

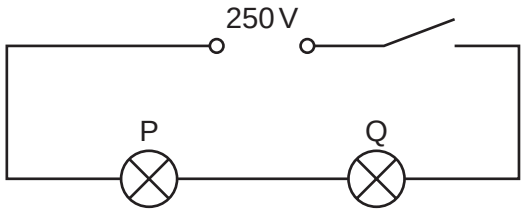
B It decreases, because the length increases and the cross-sectional area decreases.

C It increases, because the length decreases and the cross-sectional area increases.

D It increases, because the length increases and the cross-sectional area decreases.

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34 In the circuit shown, lamp P is rated 250 V, 50 W and lamp Q is rated 250 V, 200 W. The two lamps are connected in series to a 250 V power supply.



Assume that the resistance of each lamp remains constant.

Which statement most accurately describes what happens when the switch is closed?

A Lamp P emits four times as much power as lamp Q.

B Lamp P emits twice as much power as lamp Q.

C Lamp Q emits four times as much power as lamp P.

D Lamp Q emits twice as much power as lamp P.

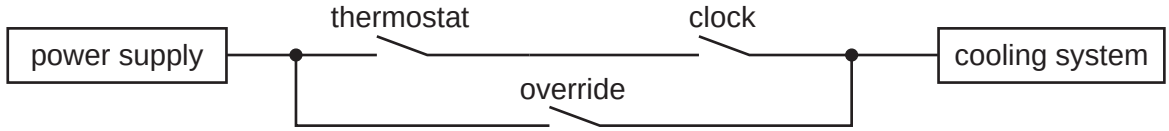
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35 The cooling system in many houses is controlled by three electrical switches. These are:

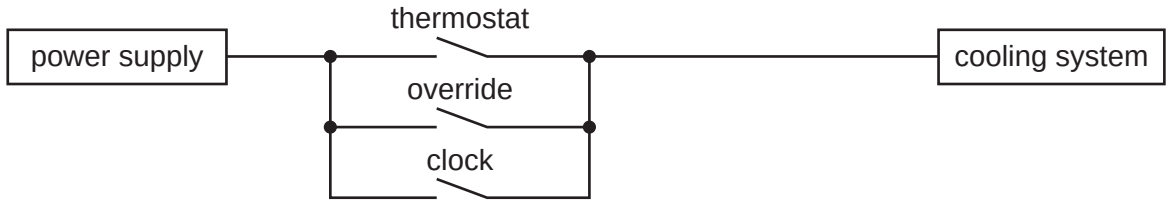
- a thermostat switch that closes when the temperature rises to a given value,
- a clock switch that closes at times when cooling may be required,
- an override switch that closes to turn on the system when exceptional temperature rises occur.

Which diagram shows the switches correctly connected between the power supply and the cooling system?

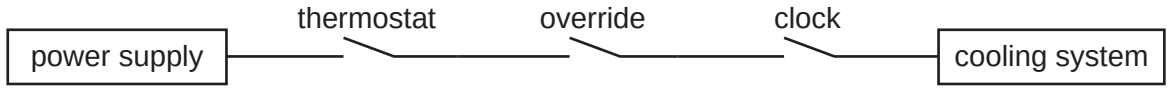
A



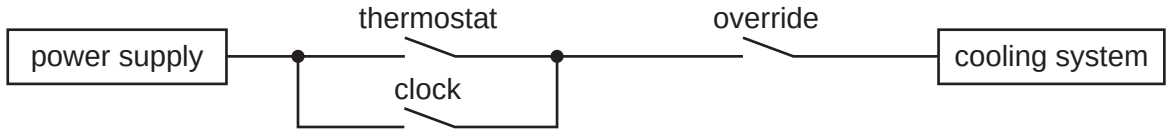
B



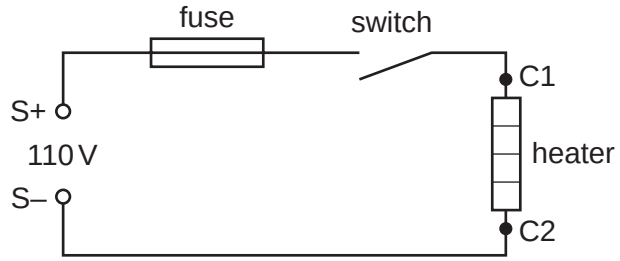
C



D



36 A 110 V supply of negligible internal resistance is connected to a heater through a fuse and a switch.



Terminals S+ and S– are the positive and negative terminals of the supply. Points C1 and C2 at either side of the heater are accessible for fault-finding.

A voltmeter is connected between S– and C1.

With the circuit working correctly, the voltmeter reading is noted with the switch closed.

A fault occurs and the voltmeter is again connected between S– and C1 with the switch closed.

Which fault would result in the same two voltmeter readings?

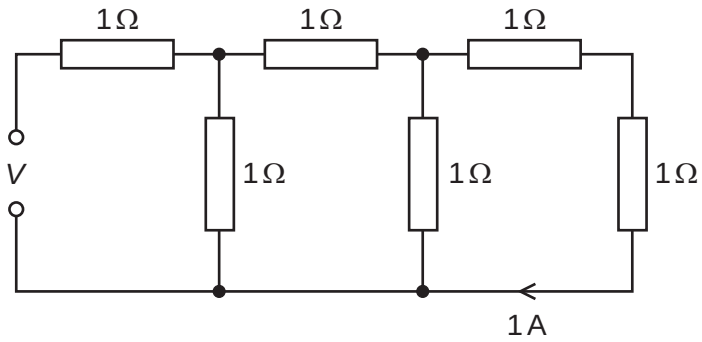
A a break in the wire of the heater

B a broken switch that cannot close correctly

C a melted fuse

D a short circuit in the heater

37 A network of resistors, each of resistance 1 Ω, is connected as shown.



The current passing through the end resistor is 1 A.

What is the potential difference (p.d.) *V* across the input terminals?

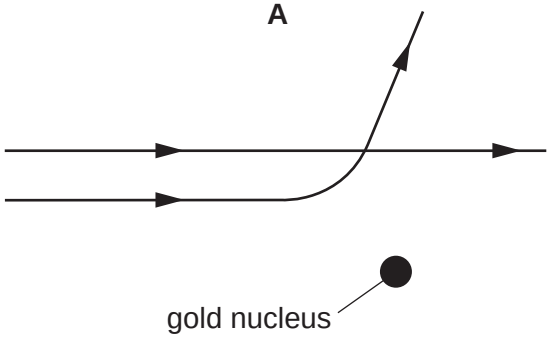
A 2 V **B** 5 V **C** 8 V **D** 13 V

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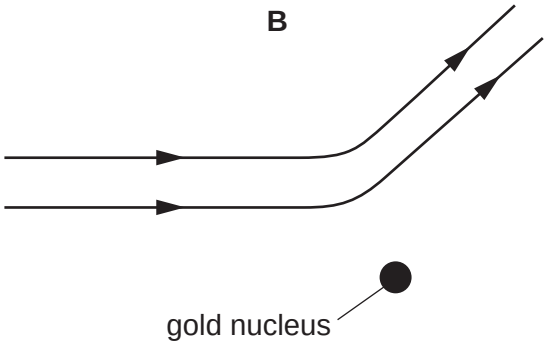
38 Two α-particles with equal energies are fired towards the nucleus of a gold atom.

Which diagram best represents their paths?

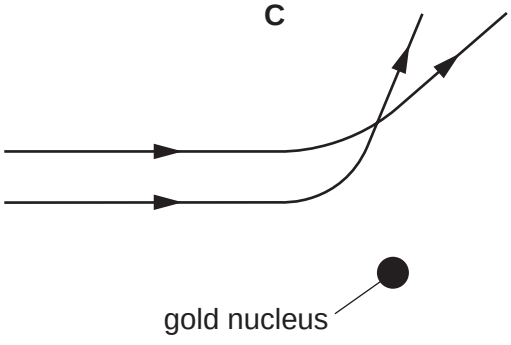
A



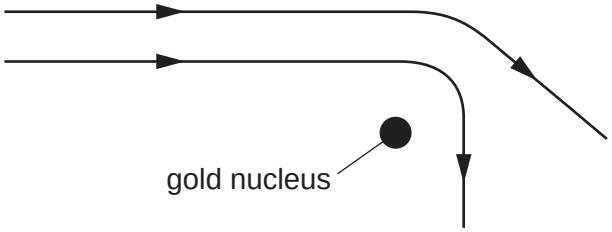
B



C



D



39 When a nucleus emits an α-particle, how do the proton number and the nucleon number of the original nucleus change?

	proton number	nucleon number
A	–4	–2
B	–2	–2
C	–2	–4
D	+1	no change

40 A simple theory of α-particle scattering by a thin metal foil uses the four assumptions given below.

Which assumption is exact and is **not** an approximation?

A Each α-particle interacts with just one nucleus.

B The α-particles lose no kinetic energy when they are deflected.

C The metal nuclei do not recoil.

D Total momentum is conserved.

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