Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/12**

Paper 1 Multiple Choice **May/June 2022**

1 hour 15 minutes

You must answer on the multiple choice answer sheet.

3154375392

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.

This document has **20** pages. Any blank pages are indicated.

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[Turn over

Data

acceleration of free fall	$g = 9.81\,\text{m s}^{-2}$
speed of light in free space	$c = 3.00 \times 10^{8}\,\text{m s}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19}\,\text{C}$
unified atomic mass unit	$1\,\text{u} = 1.66 \times 10^{-27}\,\text{kg}$
rest mass of proton	$m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$
rest mass of electron	$m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$
Avogadro constant	$N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$
molar gas constant	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$ $\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$
Planck constant	$h = 6.63 \times 10^{-34}\,\text{J s}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\,\text{W m}^{-2}\,\text{K}^{-4}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
hydrostatic pressure	$\Delta p = \rho g \Delta h$
upthrust	$F = \rho g V$
Doppler effect for sound waves	$f_\text{o} = \frac{f_\text{s} v}{v \pm v_\text{s}}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

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1 Which estimate is reasonable?

A 1×10^{-3} kg for the mass of a grain of sand

B 1×10^{-2} m^3 for the volume of a tennis ball

C 1×10^{0} J for the work done lifting an apple from waist height to head height

D 1×10^{4} W for the power of a light bulb in a house

2 What is the symbol for the SI base unit of temperature?

A C **B** K **C** °C **D** °K

3 Which statement about systematic errors is **not** correct?

A A systematic error can be caused by using an incorrectly calibrated instrument.

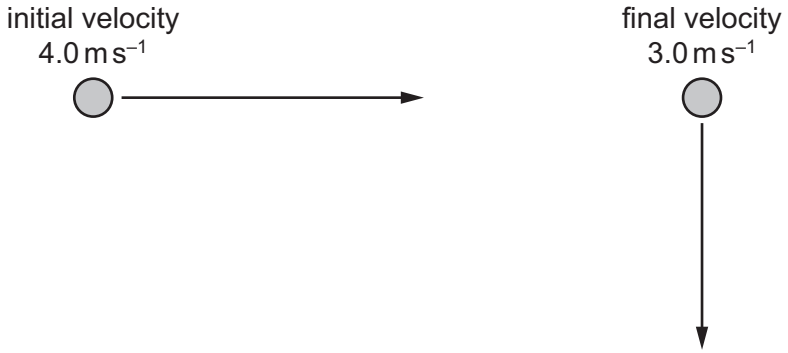
B One particular type of systematic error can affect all the measurements by the same amount.

C The effect of a systematic error can be reduced by repeating and averaging the measurements.

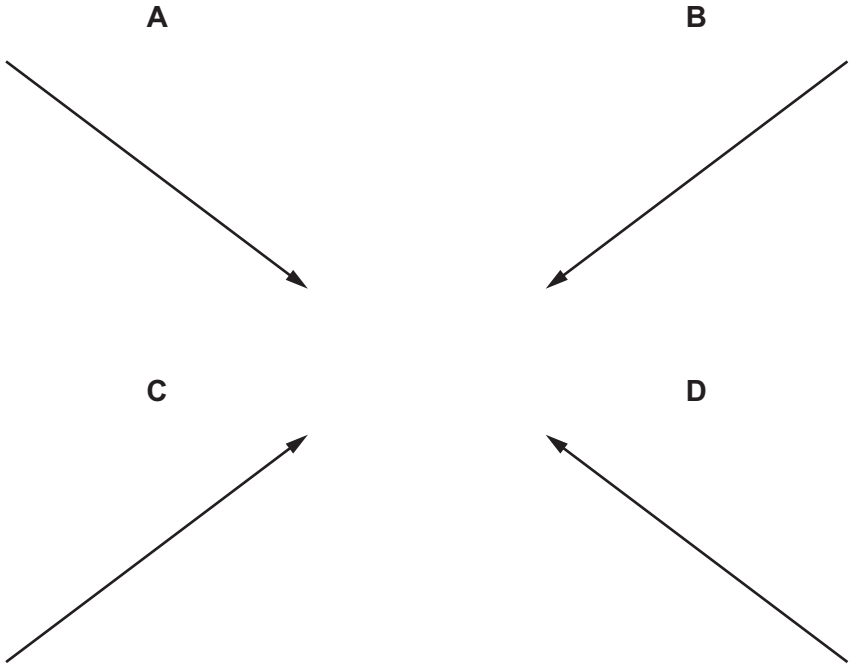
D Zero error is a type of systematic error.

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4 An object is moving with an initial velocity of $4.0\,m\,s^{-1}$ to the right. The velocity of the object changes so that its final velocity is $3.0\,m\,s^{-1}$ downwards, as shown.

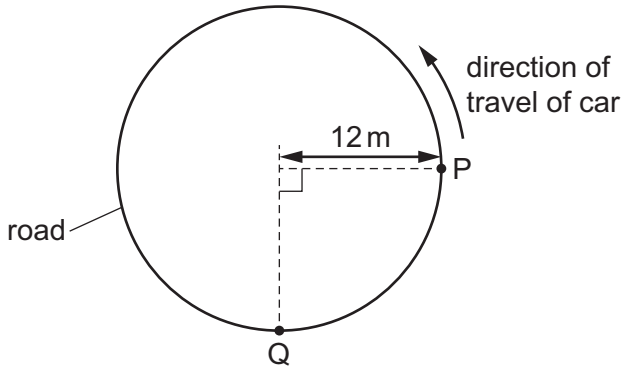


Which arrow represents the change in velocity of the object?



5 A car travels anticlockwise along a horizontal circular road of radius 12 m, as shown.

The car takes a time of 4.0 s to move from position P to position Q.



What is the magnitude of the average velocity of the car for the journey from P to Q?

A $4.2\,m\,s^{-1}$ **B** $4.7\,m\,s^{-1}$ **C** $6.0\,m\,s^{-1}$ **D** $14\,m\,s^{-1}$

6 The water surface in a deep well is 78.0 m below the top of the well. A person at the top of the well drops a heavy stone down the well.

Air resistance is negligible. The speed of sound in the air is $330\,m\,s^{-1}$.

What is the time interval between the person dropping the stone and hearing it hitting the water?

A 3.75 s **B** 3.99 s **C** 4.19 s **D** 4.22 s

7 Which statement is **not** a requirement of a pair of forces that obey Newton's third law of motion?

A The forces act in opposite directions.

B The forces act on different objects.

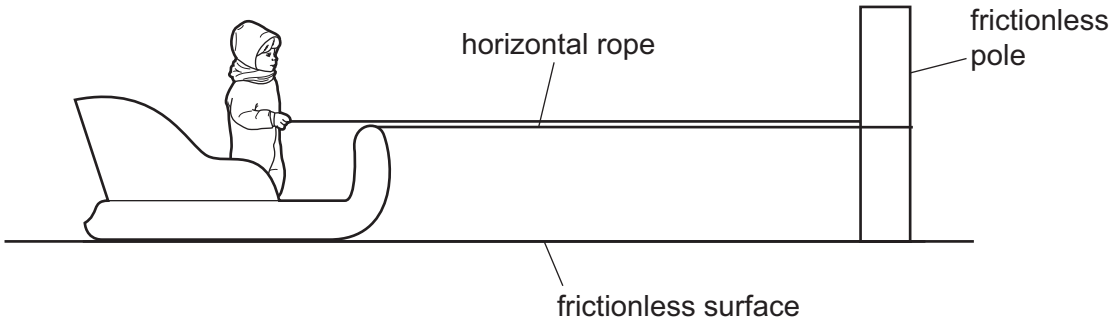
C The forces act on objects in contact.

D The forces are of equal magnitude.

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8 A child of mass 20 kg stands on the rough surface of a sledge of mass 40 kg. The sledge can slide on a horizontal frictionless surface.

One end of a rope is attached to the sledge. The rope passes around a fixed frictionless pole, and the other end of the rope is held by the child, as shown.



The rope is horizontal. The child pulls on the rope with a horizontal force of 12 N. This causes the child and the sledge to move with equal acceleration towards the pole.

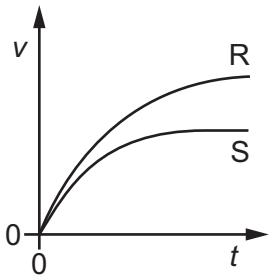
What is the frictional force between the child and the sledge?

A 4.0 N **B** 6.0 N **C** 8.0 N **D** 12 N

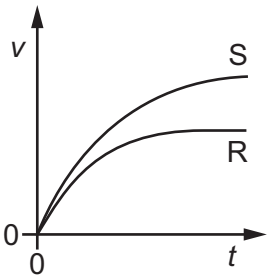
9 A stone S and a foam rubber ball R are identical spheres of equal volume. They are released from rest at time $t = 0$ and fall vertically through the air. Both reach terminal velocity.

Which graph best shows the variation with time t of the speed v of the stone and of the rubber ball?

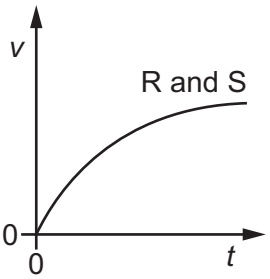
A



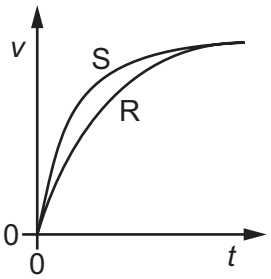
B



C

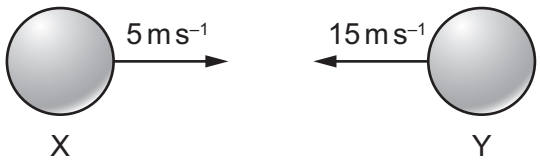


D



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10 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

11 Two forces form a couple.

Which statement describes the two forces?

A They are in the same direction.

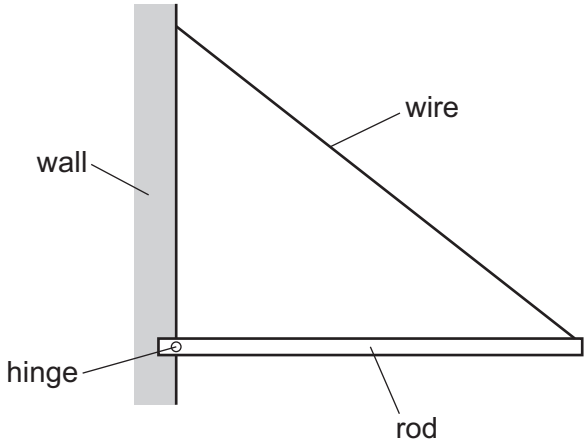
B They are perpendicular to each other.

C They have the same magnitude.

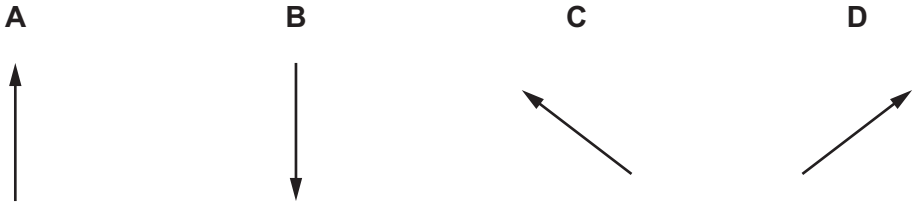
D They pass through the same point.

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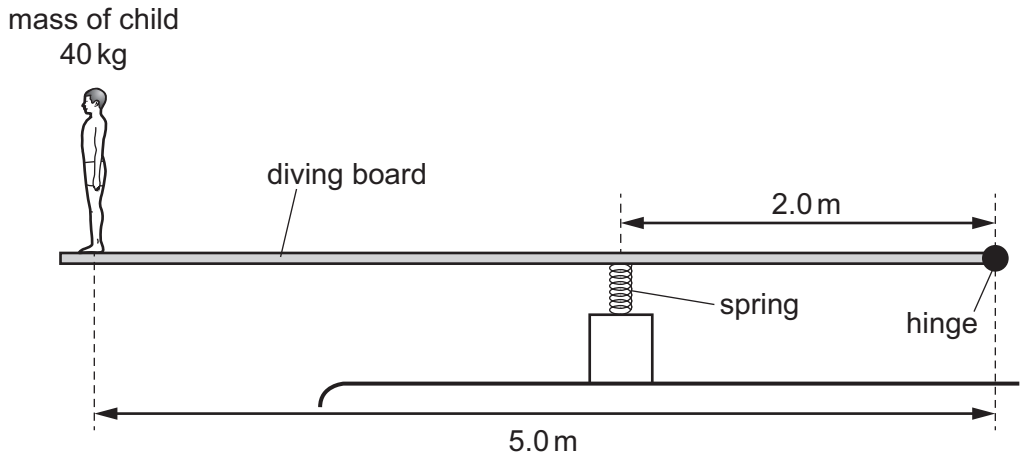
12 A uniform rod is attached by a hinge at one end to a wall. The other end of the rod is supported by a wire so that the rod is horizontal and in equilibrium.



Which arrow shows the direction of the force on the rod from the hinge?



13 A diving board of length 5.0 m is hinged at one end and supported 2.0 m from this end by a spring of spring constant 10 kN m^{-1}. A child of mass 40 kg stands at the far end of the board.



What is the extra compression of the spring caused by the child standing on the end of the board?

A 1.0 cm **B** 1.6 cm **C** 9.8 cm **D** 16 cm

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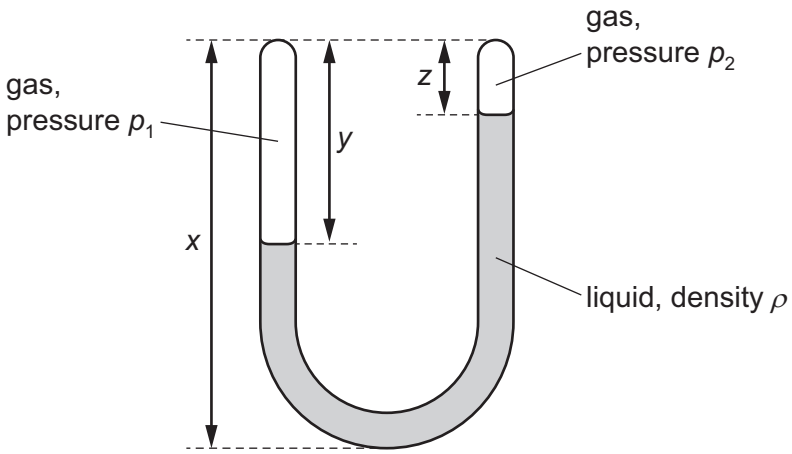
14 A granite rock at the surface of the Earth has density ρ. The rock is transported to the surface of another planet.

The acceleration of free fall on the surface of the other planet is twice that on the surface of the Earth.

What is the density of the rock on the other planet?

A 0.5ρ **B** ρ **C** 2ρ **D** 4ρ

15 A closed U-shaped tube contains a stationary liquid of density ρ. One side of the tube contains a gas at pressure p_1 and the other side contains a gas at pressure p_2, as shown.



The acceleration of free fall is g.

Which equation is correct?

A $p_1 = \rho g y$

B $p_2 = \rho g(x - z)$

C $p_1 - p_2 = \rho g(y - z)$

D $p_1 + p_2 = \rho g x$

16 Which product of two quantities is equal to power?

A force × distance

B force × velocity

C work done × time

D work done × velocity

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17 Researchers have developed a new type of filament lamp with an efficiency of 40%. Old-type filament lamps have an efficiency of 5.0%. The two types of lamp produce the same useful output power.

What is the ratio $\frac{\text{input power to new type of lamp}}{\text{input power to old type of lamp}}$?

A 0.13 **B** 0.63 **C** 1.6 **D** 8.0

18 A student attempts to derive the formula for kinetic energy E_K. She begins by considering an object of mass m which is initially at rest. A constant force F applied to the object causes it to accelerate to final velocity v in displacement s. The kinetic energy gained by the object is equal to the work done on the object by the force F.

Which equation would the student **not** need in order to derive the formula for E_K?

A $F = ma$ **B** $W = Fs$ **C** $E = \frac{1}{2}Fs$ **D** $v^2 = u^2 + 2as$

19 A metal wire obeys Hooke's law and has a Young modulus of 2.0×10^{11} Pa. The wire has an original length of 1.6 m and a diameter of 0.48×10^{-3} m.

What is the spring constant of the wire?

A $7.2 \times 10^3\,\text{N m}^{-1}$

B $2.3 \times 10^4\,\text{N m}^{-1}$

C $2.9 \times 10^4\,\text{N m}^{-1}$

D $9.0 \times 10^4\,\text{N m}^{-1}$

20 A wire is being stretched by a tensile force.

Which statement about the elastic limit **must** be correct?

A The deformation is plastic after the elastic limit has been reached.

B The deformation is plastic until the elastic limit is reached.

C The extension is proportional to the tensile force after the elastic limit has been reached.

D The extension is proportional to the tensile force until the elastic limit is reached.

21 Which statement is correct for **all** types of progressive wave?

A The distance from a peak to the next trough is equal to a wavelength.

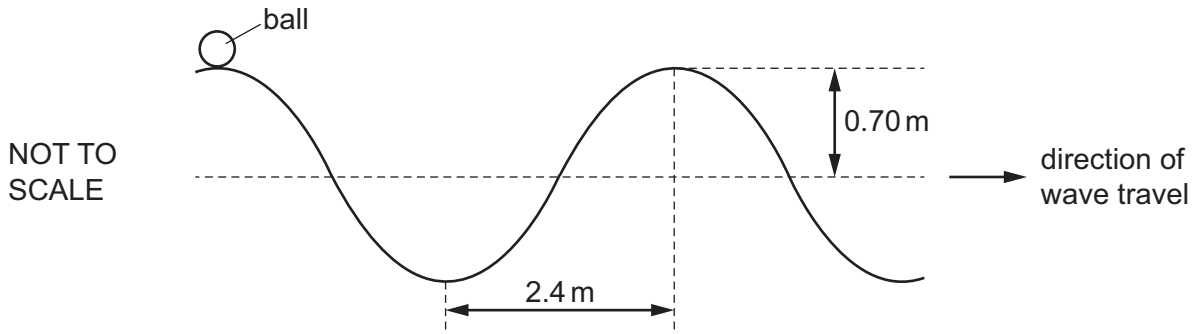
B They can be demonstrated in ripple tanks.

C They consist of vibrating atoms.

D They transfer energy from one position to another.

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22 A transverse water wave is moving along the surface of some water. This causes a ball to move vertically without moving horizontally as it floats upon the surface. At one instant, the ball is at the position shown.



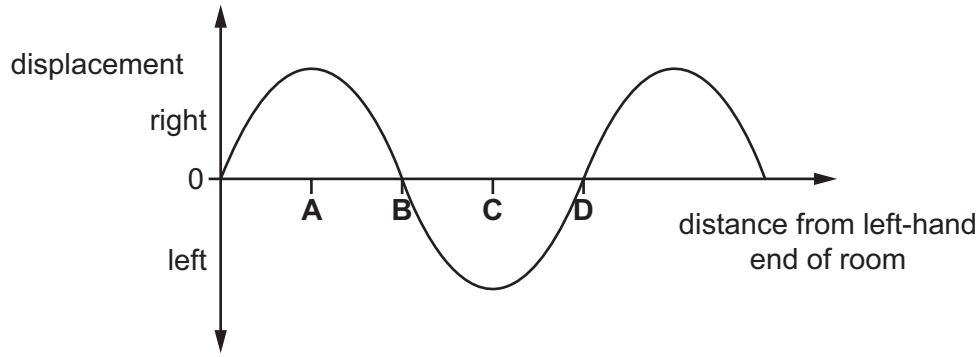
The wave has a frequency of 0.20 Hz and an amplitude of 0.70 m. The distance between a trough and an adjacent peak is 2.4 m.

What is the distance travelled by the ball in a time of 20 s?

A 5.6 m **B** 9.6 m **C** 11.2 m **D** 19.2 m

23 A sound wave travels from left to right across a room. The variation with distance across the room of the displacement of the air molecules at one instant is shown.

At which distance will the air pressure be lowest?



24 A source emits a sound wave of a single frequency. The Doppler effect causes a different frequency of sound to be heard by a stationary observer.

What is a requirement for the Doppler effect to occur?

A a source that is moving as it produces the sound wave

B a source that produces a polarised sound wave

C a source that produces a sound wave of changing amplitude

D a source that produces a sound wave of changing frequency

25 An electromagnetic wave in free space has a frequency of 2.5×10^{14} Hz.

Which region of the electromagnetic spectrum includes this frequency?

A infrared

B microwave

C ultraviolet

D X-ray

26 Two polarising filters are placed next to each other so that their planes are parallel.

The first polarising filter has its transmission axis at an angle of 50° to the vertical.

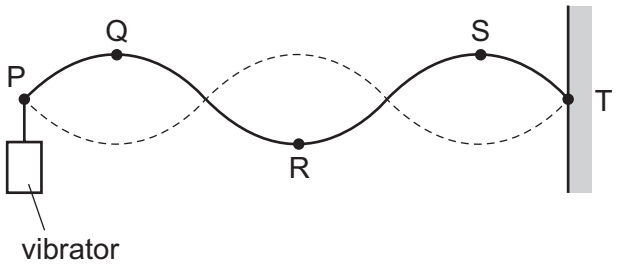
The second polarising filter has its transmission axis at an angle of 20° to the vertical. The angle between the transmission axes of the two polarising filters is 30°.

A beam of vertically polarised light of intensity $8.0\,\text{W m}^{-2}$ is incident normally on the first polarising filter.

What is the intensity of the light that is transmitted from the second polarising filter?

A zero **B** $2.5\,\text{W m}^{-2}$ **C** $2.9\,\text{W m}^{-2}$ **D** $6.0\,\text{W m}^{-2}$

27 A stationary wave on a stretched string is set up between two points P and T.



Which statement about the stationary wave is correct?

A Point R is at a node.

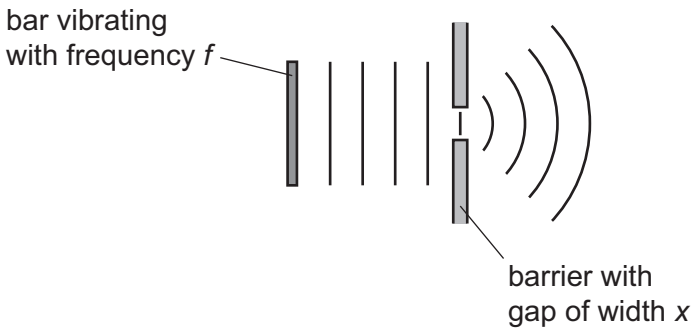
B Points Q and S vibrate in phase.

C The distance between P and T is three wavelengths.

D The wave transfers energy from P to T.

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28 A bar vibrates with frequency f to produce water waves in a ripple tank.



The waves pass through a gap of width x in a barrier so that diffraction occurs.

Which combination of vibration frequency and gap width will produce the smallest angle of diffraction?

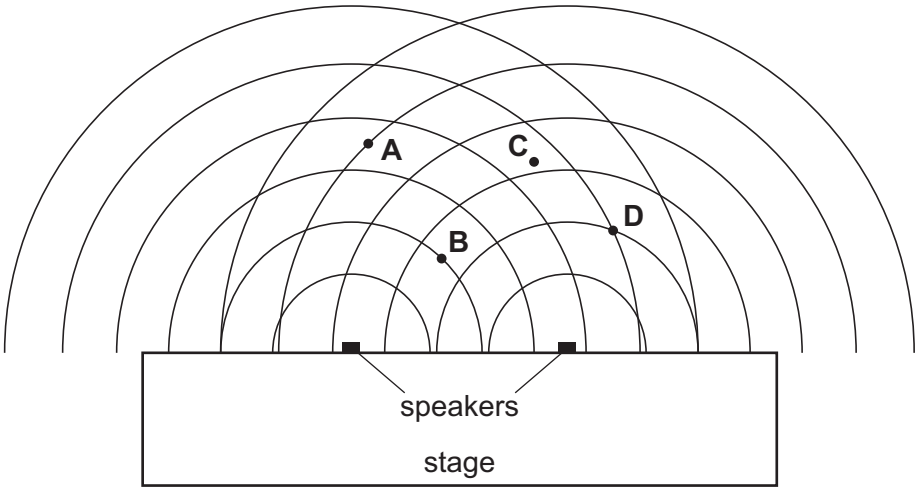
	vibration frequency	gap width
A	$\frac{f}{2}$	$\frac{x}{2}$
B	$\frac{f}{2}$	$2x$
C	$2f$	$\frac{x}{2}$
D	$2f$	$2x$

29 An outdoor concert has two large speakers beside the stage for broadcasting music.

In order to test the speakers, they are made to emit sound of the same wavelength and the same amplitude.

The curved lines in the diagram represent wavefronts.

Where is the loudest sound heard?



30 The equation

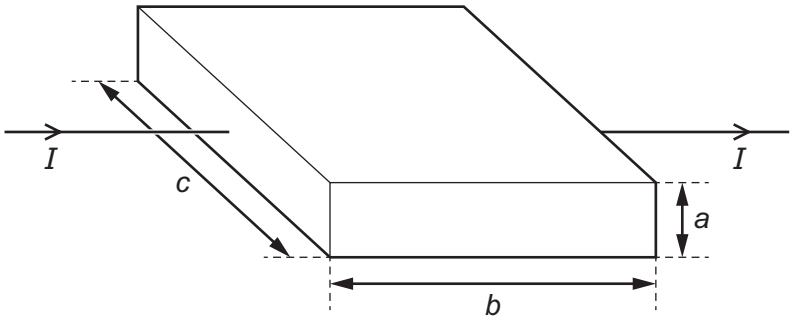
$$\lambda = \frac{d \sin\theta}{n}$$

is used to calculate the wavelength λ of light in an experiment that uses a diffraction grating. The light from the diffraction grating is displayed on a screen.

What do the symbols *n* and *d* represent?

	n	*d*
A	number of slits in the grating	distance between adjacent slits in the grating
B	number of slits in the grating	distance from grating to screen
C	order of intensity maximum	distance between adjacent slits in the grating
D	order of intensity maximum	distance from grating to screen

31 The diagram shows a metal block.



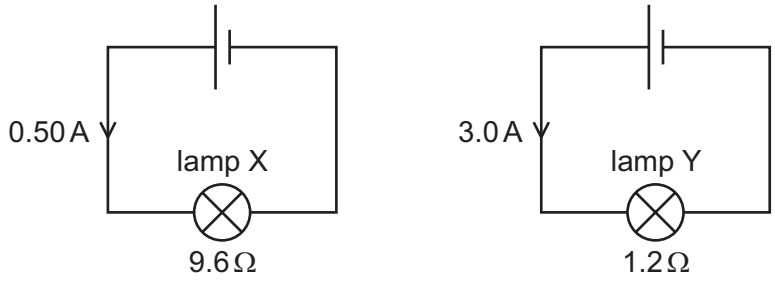
The block has sides of length *a*, *b* and *c* as shown, and its volume is *V*. Each charge carrier has a charge –*q* and the number density of the charge carriers in the metal is *n*. It takes each charge carrier an average time of *t* to pass through the block.

What is an expression for the current *I*?

A $I = nqabc$ **B** $I = \frac{nqV}{t}$ **C** $I = \frac{nqbc}{t}$ **D** $I = nqaV$

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



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

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

33 The intensity of light incident on a light-dependent resistor (LDR) is increased. The temperature of a thermistor is increased. In each case, the current in the component is maintained at a constant value.

What happens to the potential difference across each component?

	LDR	thermistor
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

34 An iron wire has length 8.0 m and diameter 0.50 mm. The wire has resistance R.

A second iron wire has length 2.0 m and diameter 1.0 mm.

What is the resistance of the second wire?

A $\frac{R}{16}$ **B** $\frac{R}{8}$ **C** $\frac{R}{2}$ **D** R

35 A cell with constant electromotive force (e.m.f.) is connected across a fixed resistor. Over time, the internal resistance of the cell increases.

Which change occurs as the internal resistance of the cell increases?

A a decrease in the charge of each charge carrier

B a decrease in the potential difference measured across the cell

C an increase in the energy dissipated per unit time in the fixed resistor

D an increase in the number of charge carriers leaving the cell per unit time

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36 Kirchhoff's first and second laws are consequences of the conservation of different quantities.

What are those quantities?

	Kirchhoff's first law	Kirchhoff's second law
A	charge	energy
B	energy	current
C	current	charge
D	energy	charge

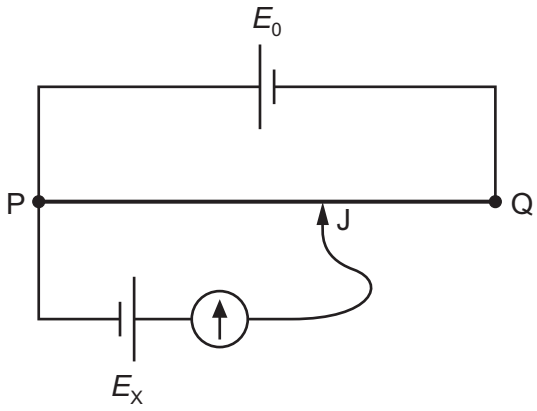
37 A potentiometer circuit is used to determine the electromotive force (e.m.f.) E_X of a cell. The circuit includes a second cell of known e.m.f. E_0 and negligible internal resistance, and a uniform resistance wire PQ of known length.

E_X is less than E_0.

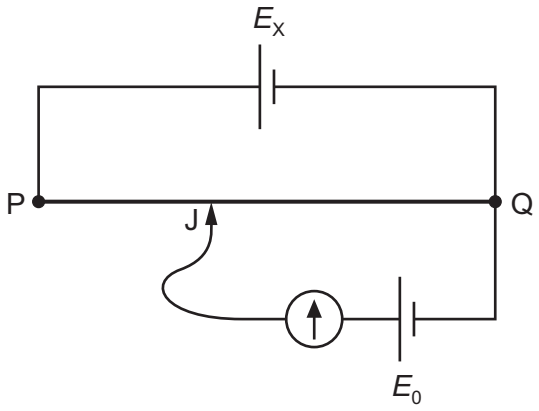
The movable connection J can be positioned anywhere along the length of the resistance wire.

Which circuit is suitable for determining E_X?

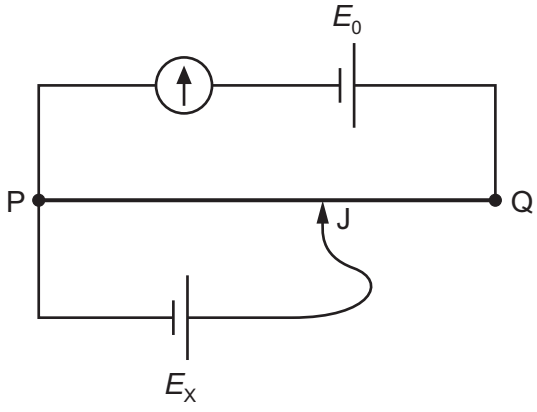
A



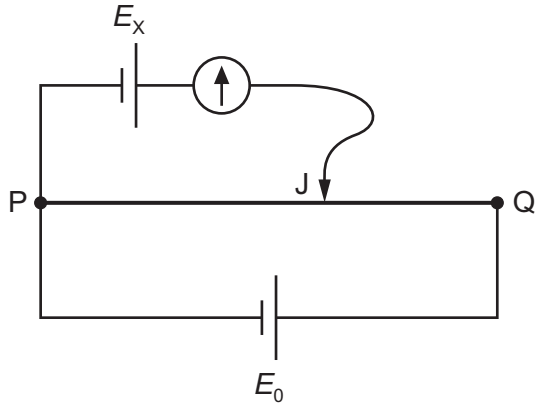
B



C



D



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38 In an experiment on α-particle scattering, α-particles are directed at a thin gold foil. Most of the α-particles pass straight through the foil or are deflected by a small angle. A small number of α-particles are deflected by a large angle.

Which statement **cannot** be deduced from this experiment?

A Atoms are mostly empty space.

B Most of the mass of an atom is concentrated in the nucleus.

C The nucleus of an atom contains protons.

D The nucleus of an atom is small compared to the size of an atom.

39 Four nuclei are represented below.

$$^{28}_{14}\mathrm{E} \qquad ^{25}_{15}\mathrm{G} \qquad ^{25}_{12}\mathrm{M} \qquad ^{24}_{13}\mathrm{Q}$$

Which statement about these nuclei is correct?

A An uncharged atom of element Q has 24 orbital electrons.

B Nuclei G and M are isotopes of the same element.

C When E absorbs a neutron and then emits an α-particle, E transforms into M.

D When M emits a β^- particle, M transforms into Q.

40 A neutron is composed of one up (u) quark and two down (d) quarks. When a neutron decays to a proton, a beta-particle is emitted.

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

(The symbol for a neutrino is ν_e and for an antineutrino is $\overline{\nu_e}$.)

A $\mathrm{d} \rightarrow \mathrm{u} + \beta^- + \nu_e$

B $\mathrm{d} \rightarrow \mathrm{u} + \beta^- + \overline{\nu_e}$

C $\mathrm{u} \rightarrow \mathrm{d} + \beta^+ + \nu_e$

D $\mathrm{u} \rightarrow \mathrm{d} + \beta^+ + \overline{\nu_e}$

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