Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/12**

Paper 1 Multiple Choice **October/November 2019**

1 hour 15 minutes

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

0358068952

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 **18** printed pages and **2** 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	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
	$\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$
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 unit	$1\,\text{u} = 1.66 \times 10^{-27}\,\text{kg}$
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.	$v = v_0 \cos \omega t$ $v = \pm\omega\sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
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	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_0 \sin \omega t$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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[Turn over

1 A cyclist has a speed of $5\,m\,s^{-1}$ and a small car has a speed of $12\,m\,s^{-1}$.

Which statement does **not** give a reasonable estimate?

A The kinetic energy of the cyclist is $1 \times 10^3\,J$.

B The kinetic energy of the car is $7 \times 10^4\,J$.

C The momentum of the cyclist is $4 \times 10^2\,kg\,m\,s^{-1}$.

D The momentum of the car is $2 \times 10^5\,kg\,m\,s^{-1}$.

2 Which expression gives an SI base quantity?

A charge per unit time

B force per unit area

C mass per unit volume

D work done per unit distance

3 Which list contains only scalar quantities?

A area, length, displacement

B kinetic energy, speed, power

C potential energy, momentum, time

D velocity, distance, temperature

4 A micrometer is used to measure the 28.50 mm width of a plastic ruler. The micrometer reads to the nearest 0.01 mm.

What is the correct way to record this reading?

A $0.02850 \pm 0.01\,m$

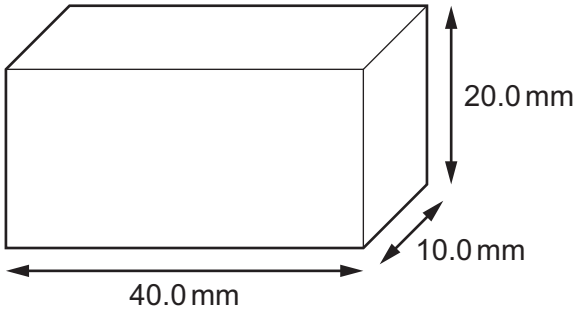
B $0.0285 \pm 0.001\,m$

C $(2.850 \pm 0.001) \times 10^{-2}\,m$

D $(2.850 \pm 0.001) \times 10^{-3}\,m$

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5 The sides of a wooden block are measured with calipers. The lengths of the sides are measured as 20.0 mm, 40.0 mm and 10.0 mm.



The calipers can measure with an absolute uncertainty of ±0.1 mm.

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

A 0.3% **B** 1.8% **C** 3.8% **D** 30%

6 A ball is thrown vertically upwards from ground level and reaches a maximum height of 12.7 m before falling back to ground level.

Assume air resistance is negligible.

What is the total time for which the ball is in the air?

A 1.61 s **B** 3.22 s **C** 3.88 s **D** 5.18 s

7 A snooker ball has a mass of 200 g. It hits the cushion of a snooker table and rebounds along its original path.

The ball arrives at the cushion with a speed of 14.0 m s^{-1} and then leaves it with a speed of 7.0 m s^{-1}. The ball and the cushion are in contact for a time of 0.60 s.

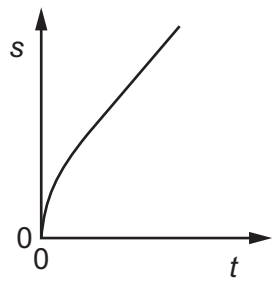
What is the average force exerted on the ball by the cushion?

A 1.4 N **B** 2.3 N **C** 4.2 N **D** 7.0 N

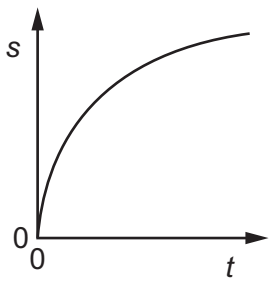
8 A tennis ball is released from rest at time t = 0 and falls through air for a long time.

Which graph of its displacement s against time t best represents the motion of the ball?

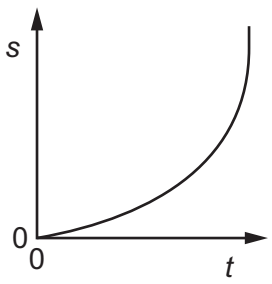
A



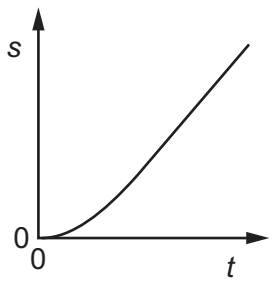
B



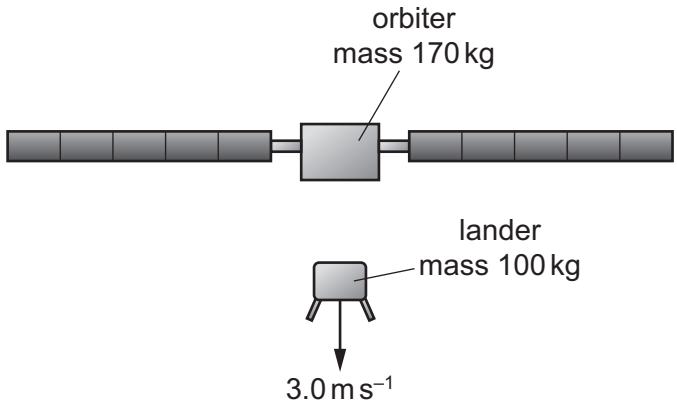
C



D



9 The space probe Rosetta was designed to investigate a comet. The probe consisted of an orbiter and a lander. The orbiter had a mass of 170 kg and the lander had a mass of 100 kg. When the two parts separated, the lander was pushed towards the surface of the comet so that its change in velocity towards the comet was $3.0\,m\,s^{-1}$.



Assume that the orbiter and lander were an isolated system.

The orbiter moved away from the comet during the separation.

What was the change in the speed of the orbiter?

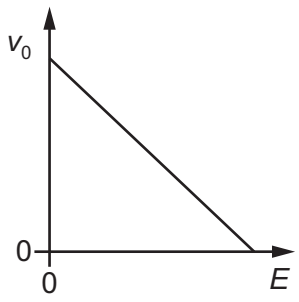
A $1.8\,m\,s^{-1}$ **B** $2.3\,m\,s^{-1}$ **C** $3.0\,m\,s^{-1}$ **D** $5.1\,m\,s^{-1}$

10 A positively charged oil droplet falls in air in a uniform electric field that is vertically upwards. The droplet has a constant terminal speed v_0 and the electric field strength is E.

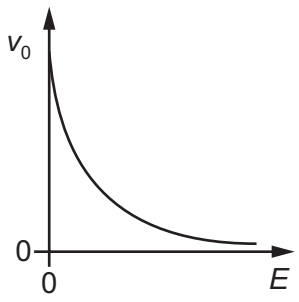
The magnitude of the force due to air resistance acting on the droplet is proportional to the speed of the droplet.

Which graph shows the variation with E of v_0?

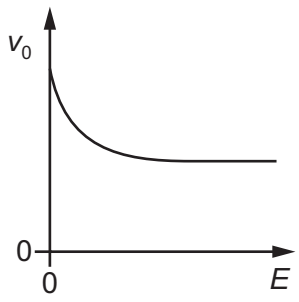
A



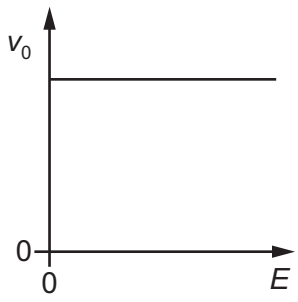
B



C

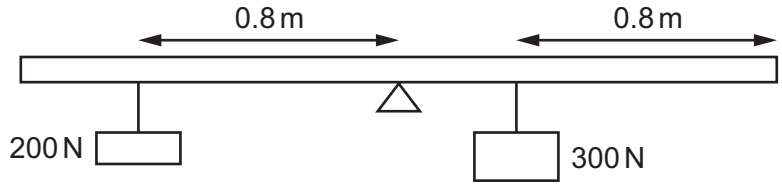


D



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11 A rigid uniform bar of length 2.4 m is pivoted horizontally at its midpoint.



Weights are hung from two points on the bar as shown in the diagram. To maintain equilibrium, a couple is applied to the bar.

What is the torque and direction of this couple?

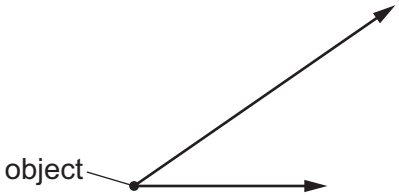
A 40 N m clockwise

B 40 N m anticlockwise

C 80 N m clockwise

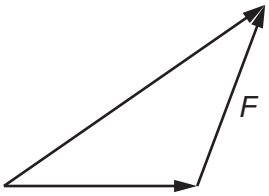
D 80 N m anticlockwise

12 Two coplanar forces act on an object as shown.

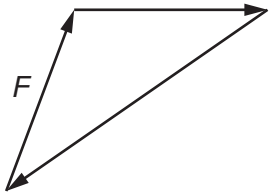


Which diagram shows the resultant *F* of these two forces?

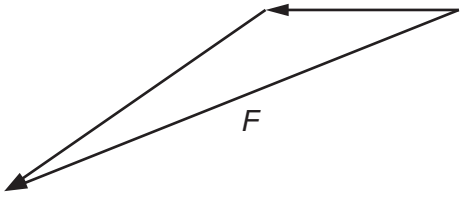
A



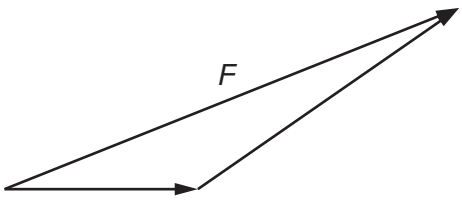
B



C

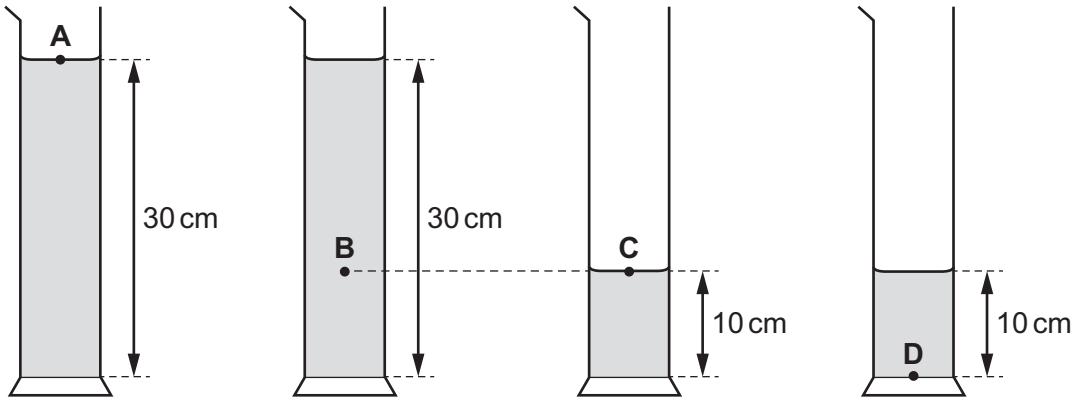


D

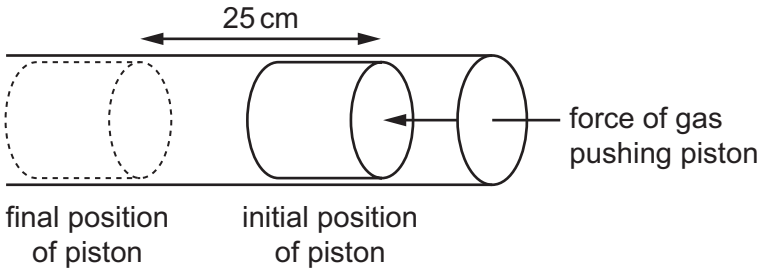


13 Four measuring cylinders are filled with the same liquid to the heights shown.

At which position is the pressure the greatest?



14 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 4.6×10^5 Pa.



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

A 9.2×10^2 J **B** 9.2×10^4 J **C** 9.2×10^6 J **D** 9.2×10^8 J

15 A power station using coal as fuel has an average power output of 3000 MW. Coal is supplied by 20 trains each day. The efficiency of the station in converting the thermal energy released from the coal to electrical energy is 26%.

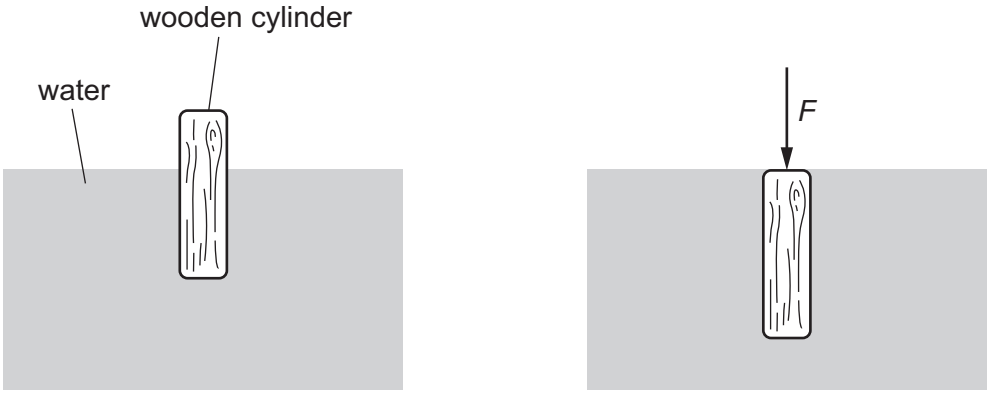
A mass of 1.0 kg of coal will release 33 MJ of thermal energy when burnt.

Which mass of coal does each train bring?

A 2.5×10^4 kg **B** 6.3×10^4 kg **C** 1.5×10^6 kg **D** 3.0×10^7 kg

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16 A wooden cylinder floats partially submerged in a bath of water. A force *F* is applied to the cylinder until it is just fully submerged.



Which statement is **not** correct?

A Some of the water gains gravitational potential energy.

B The cylinder loses gravitational potential energy.

C Work is done by force *F* on the cylinder.

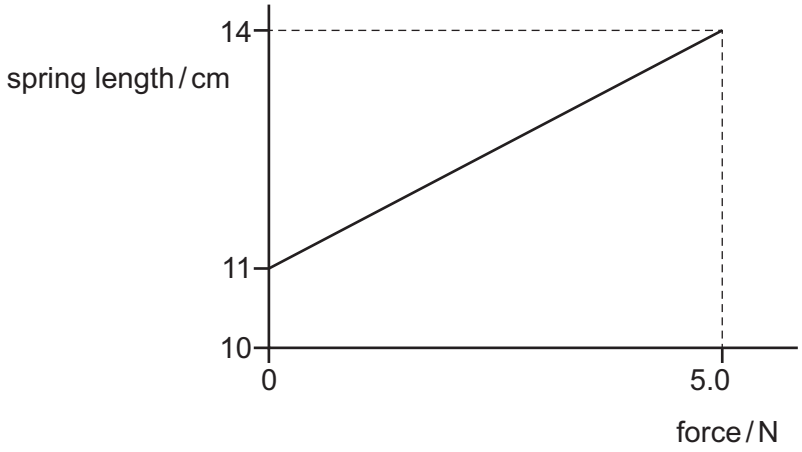
D Work is done by the upthrust on the cylinder.

17 The motor of a crane lifts a load of mass 600 kg. The load rises vertically at a constant speed of 12 m per minute.

What is the useful power output of the motor?

A 0.12 kW **B** 1.2 kW **C** 7.2 kW **D** 71 kW

18 The graph shows the effect of applying a force of up to 5.0 N to a spring.

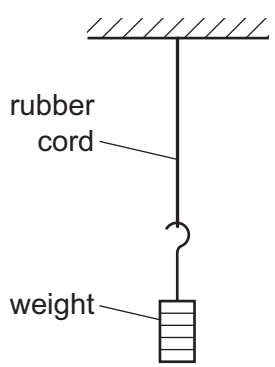


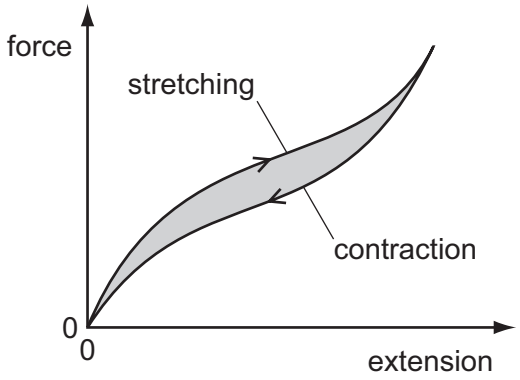
The spring obeys Hooke's law for forces up to 7.0 N.

What is the total extension of the spring produced by a 7.0 N force?

A 4.2 cm **B** 5.6 cm **C** 15 cm **D** 20 cm

19 A rubber cord hangs from a rigid support. A weight attached to its lower end is gradually increased from zero, and then gradually reduced to zero.





The force–extension curve for contraction is below the force–extension curve for stretching.

What does the shaded area between the curves represent?

A the elastic potential energy stored in the rubber cord

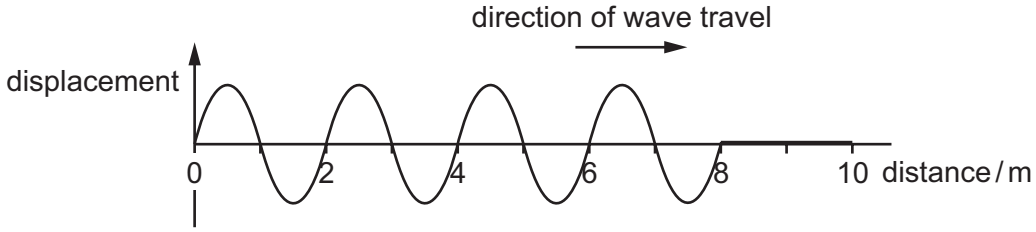
B the thermal energy dissipated in the rubber cord

C the work done on the rubber cord during stretching

D the work done by the rubber cord during contraction

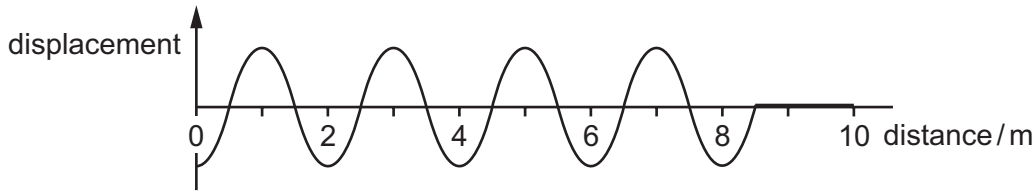
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20 A transverse wave is travelling along a rope. The frequency of the wave is 2.0 Hz. The graph shows the variation with distance of the displacement of the wave at time $t = 0$.

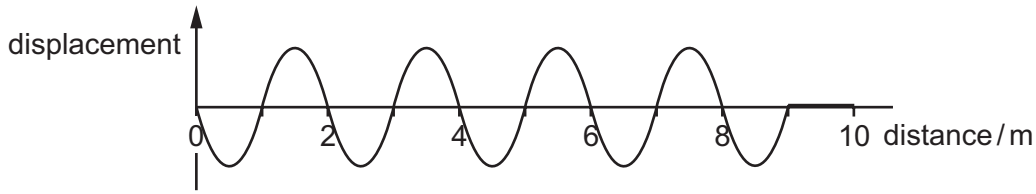


Which diagram shows the position of the wave at time $t = 0.5$ s?

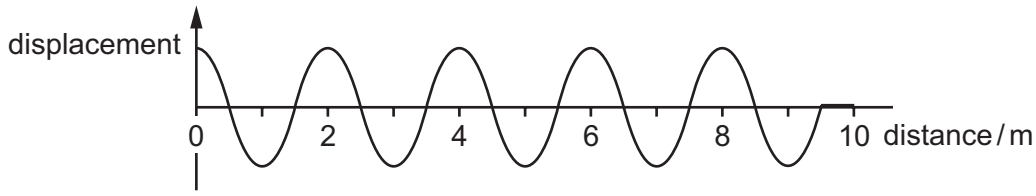
A



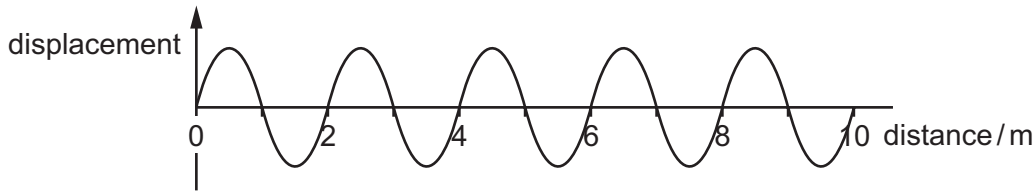
B



C

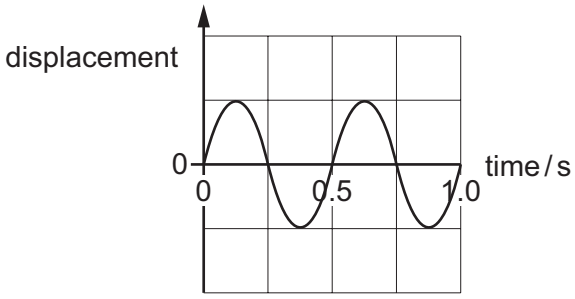


D

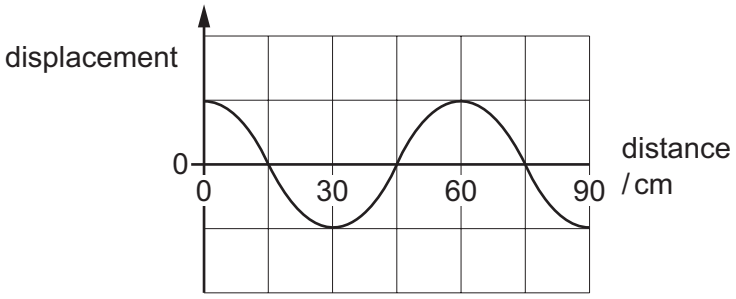


21 The two graphs represent the same wave.

Graph 1 shows the variation with time of the displacement at a particular distance. Graph 2 shows the variation with distance of the displacement at one instant.



graph 1

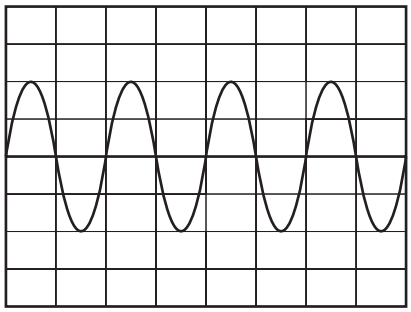


graph 2

What is the speed of the wave?

A 22.5 cm s^{-1} **B** 30.0 cm s^{-1} **C** 90.0 cm s^{-1} **D** 120 cm s^{-1}

22 A microphone is connected to a cathode-ray oscilloscope (CRO). When a tuning fork is struck and then held next to the microphone, the following waveform is shown on the display of the CRO.



The time-base setting on the CRO is 2.00 ms per division.

What is the best estimate of the frequency of the sound produced by the tuning fork?

A 63 Hz **B** 170 Hz **C** 250 Hz **D** 500 Hz

23 A loudspeaker emitting a constant frequency of 2000 Hz is swung in a horizontal circle with a speed of 15.0 m s^{-1}.

A stationary observer is level with the loudspeaker and situated a long distance from the loudspeaker. The observer hears a sound of varying frequency. The maximum frequency heard is 2097 Hz.

What is the speed of the sound in the air?

A 294 m s^{-1} **B** 309 m s^{-1} **C** 324 m s^{-1} **D** 330 m s^{-1}

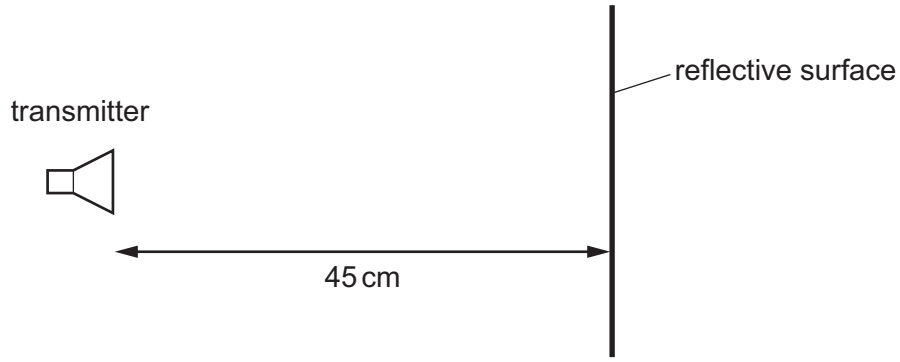
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24 Two electromagnetic waves have wavelengths of 5.0×10^{-7} m and 5.0×10^{-2} m.

Which row identifies the regions of the electromagnetic spectrum to which the waves belong?

	wavelength 5.0×10^{-7} m	wavelength 5.0×10^{-2} m
A	ultraviolet	infrared
B	visible	microwave
C	ultraviolet	microwave
D	visible	infrared

25 A transmitter of electromagnetic waves is placed 45 cm from a reflective surface.



The emitted waves have a frequency of 1.00 GHz. A stationary wave is produced with a node at the transmitter and a node at the surface.

How many antinodes are in the space between the transmitter and the surface?

A 1 **B** 2 **C** 3 **D** 4

26 Which statement about a light wave and a sound wave is correct?

A Both can travel through free space.

B Both have a frequency inversely proportional to their wavelength.

C Both have an intensity proportional to their amplitude.

D Both have oscillations perpendicular to the direction of energy transfer.

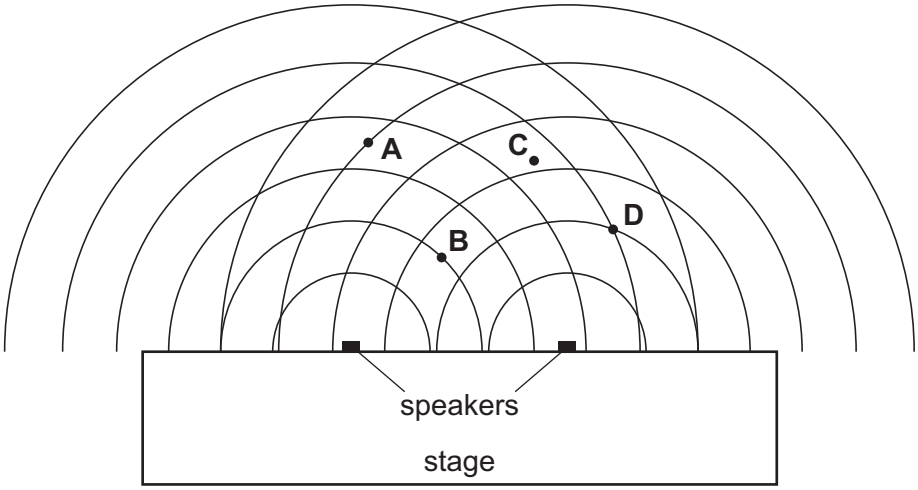
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27 An outdoor concert has two large speakers beside the stage for broadcasting music.

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?



28 An electromagnetic wave is incident normally on a diffraction grating.

A second-order maximum is produced at an angle of 30° to a normal to the grating.

The grating has 5000 lines per cm.

What is the wavelength of the wave?

A 2.5×10^{-7} m **B** 5.0×10^{-7} m **C** 1.0×10^{-6} m **D** 5.0×10^{-5} m

29 P is a point near to charge X as shown.



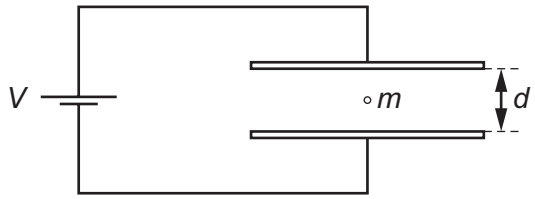
When a negatively charged test charge is placed at point P, it is found to experience a force of repulsion from X that is radially away from X.

Which arrow correctly shows the direction of the electric field at point P due to the charge X?

A **B** **C** **D**



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 When the current in a wire is 5.0 A, the average drift speed of the conduction electrons in the wire is $7.4 \times 10^{-4}\,\text{m s}^{-1}$.

Which row gives a possible cross-sectional area and number of conduction electrons per unit volume for this wire?

	cross-sectional area / m^2	number of conduction electrons per unit volume / m^{-3}
A	7.2×10^{-7}	1.2×10^{28}
B	7.2×10^{-7}	5.9×10^{28}
C	2.3×10^{-6}	7.3×10^{26}
D	2.3×10^{-6}	3.7×10^{27}

32 A fixed resistor of resistance 12 Ω is connected to a battery. There is a current of 0.20 A in the resistor. The current is now doubled.

What is the new power dissipated in the resistor?

A 0.48 W **B** 0.96 W **C** 1.9 W **D** 4.8 W

33 There is a current in a resistor for an unknown time.

Which two quantities can be used to calculate the energy dissipated by the resistor?

A the current in the resistor and the potential difference across the resistor

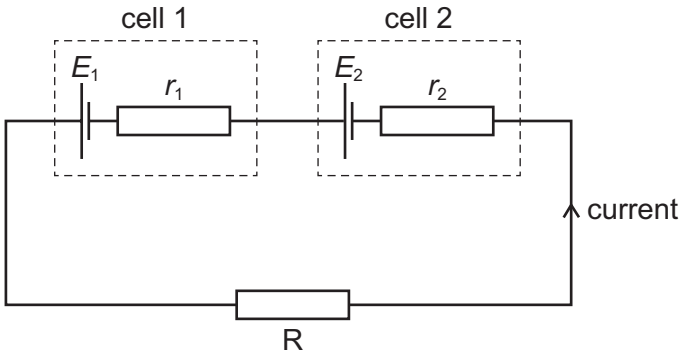
B the resistance of the resistor and the current in the resistor

C the total charge passing through the resistor and the potential difference across the resistor

D the total charge passing through the resistor and the resistance of the resistor

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34 Two cells with electromotive forces E_1 and E_2 and internal resistances r_1 and r_2 are connected to a resistor R as shown.

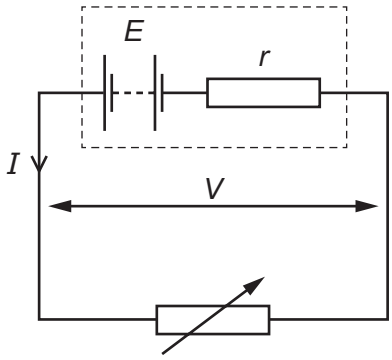


The terminal potential difference across cell 1 is zero.

Which expression gives the resistance of resistor R?

A $\frac{E_2r_1 - E_1r_2}{E_1}$ **B** $\frac{E_2r_1 - E_1r_2}{E_2}$ **C** $\frac{E_1r_2 - E_2r_1}{E_1}$ **D** $\frac{E_1r_2 - E_2r_1}{E_2}$

35 A battery has an electromotive force (e.m.f.) E and internal resistance r. The battery delivers a current I to a variable resistor and the potential difference (p.d.) across its terminals is V.



The variable resistor is adjusted so that I increases.

Why does V decrease?

A The e.m.f. E decreases.

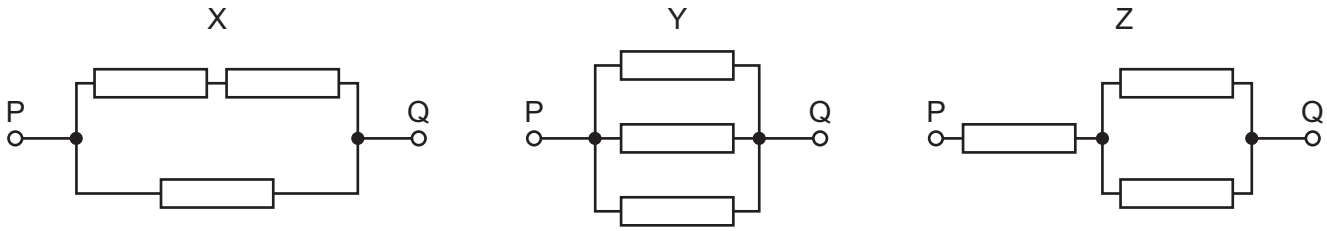
B The internal resistance r increases.

C The p.d. across r increases.

D The resistance of the variable resistor increases.

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36 Three identical resistors are connected between terminals P and Q in different networks X, Y and Z as shown.



What is the order of increasing combined resistance between P and Q (lowest first)?

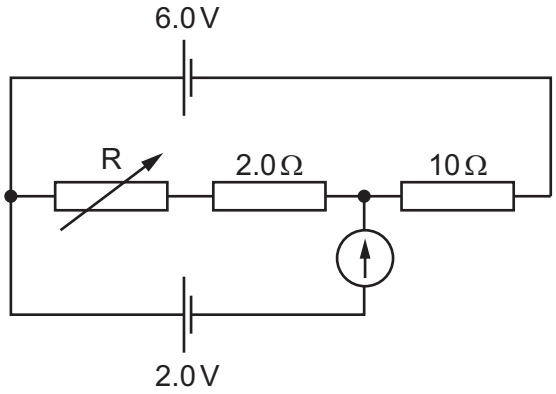
A $X \rightarrow Y \rightarrow Z$

B $X \rightarrow Z \rightarrow Y$

C $Y \rightarrow X \rightarrow Z$

D $Y \rightarrow Z \rightarrow X$

37 The diagram shows a variable resistor R and two fixed resistors connected in series in a circuit to act as a potential divider.



The cell of electromotive force (e.m.f.) 6.0 V has negligible internal resistance. A cell of e.m.f. 2.0 V and a galvanometer are connected into the potential divider. The resistance of R is varied until the galvanometer reads zero.

What is the resistance of resistor R?

A 3.0 Ω **B** 5.0 Ω **C** 8.0 Ω **D** 18 Ω

38 The table gives some data relating to four neutral (uncharged) atoms W, X, Y and Z.

	W	X	Y	Z
nucleon (mass) number	16	17	17	18
total number of particles (protons, neutrons and electrons) in the atom	24	26	25	28

Two of the atoms are isotopes of the same element.

What is the proton number of this element?

A 7 **B** 8 **C** 9 **D** 10

39 What is **not** a fundamental particle?

A electron

B neutrino

C neutron

D positron

40 An unstable nucleus decays and emits a β^- particle.

Which changes, if any, occur to the quark composition of the nucleus?

	quark changes	
	up quarks	down quarks
A	+1	0
B	+1	–1
C	–1	+1
D	0	+1

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