Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/11**

Paper 1 Multiple Choice **October/November 2022**

1 hour 15 minutes

You must answer on the multiple choice answer sheet.

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.

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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 What is needed to accurately represent all physical quantities?

A a base unit and a number

B a unit and a number expressed in standard form (scientific notation)

C a unit and a numerical magnitude

D an SI unit and a numerical magnitude

2 A voltmeter connected across a resistor in a circuit reads 3.6 V.

What could be the current in the resistor and the resistance of the resistor?

	current	resistance
A	150 mA	0.24 kΩ
B	15 mA	2.4 kΩ
C	1.5 mA	0.24 MΩ
D	15 μA	240 kΩ

3 In an experiment to determine the acceleration of free fall *g*, the time *t* taken for a ball to fall through distance *s* is measured. The percentage uncertainty in the measurement of *s* is 2%. The percentage uncertainty in the measurement of *t* is 3%.

The value of *g* is determined using the equation shown.

$$g = \frac{2s}{t^2}$$

What is the percentage uncertainty in the calculated value of *g*?

A 1% **B** 5% **C** 8% **D** 11%

4 Which quantity is a vector?

A momentum

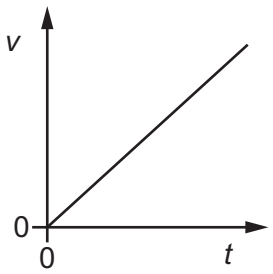
B speed

C temperature

D Young modulus

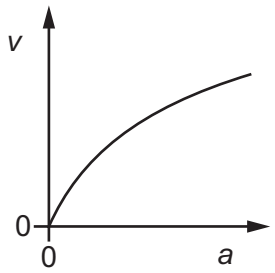
5 A particle accelerates from rest.

The graph shows the variation of the velocity v of the particle with time t.



Which graph shows the variation of the velocity v with the acceleration a of the particle?

A



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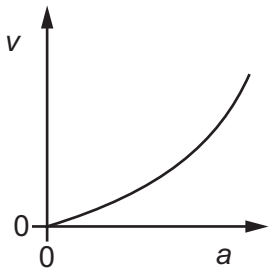

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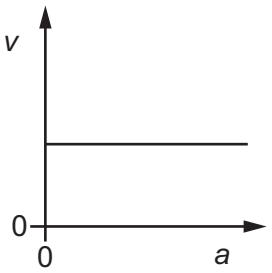
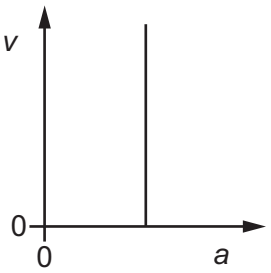
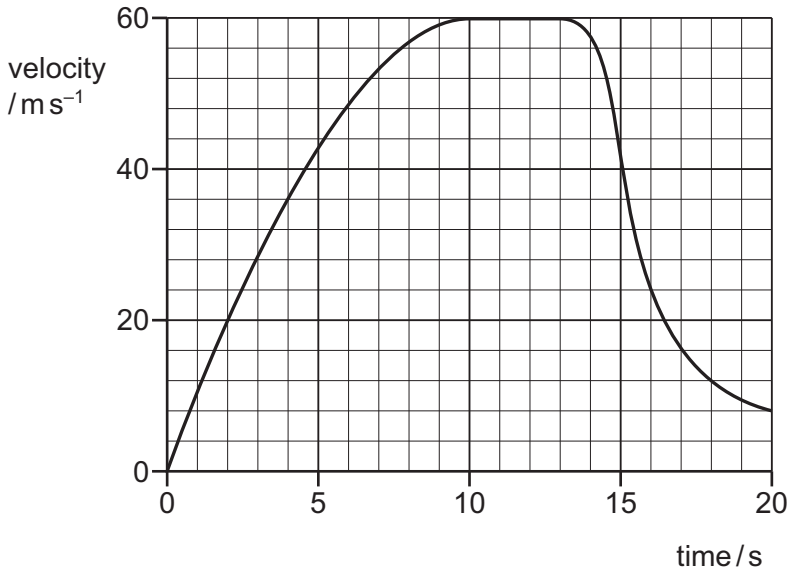


D



6 The graph shows the vertical velocity of a parachutist during the first 20 s of her jump.



Approximately how far does she fall **before** opening the parachute?

A 390 m **B** 570 m **C** 710 m **D** 770 m

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7 What is the definition of linear momentum?

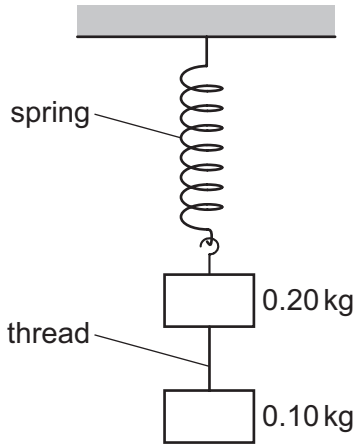
A force per unit time

B product of force and time

C product of velocity and mass

D velocity per unit mass

8 A mass of 0.20 kg is suspended from the lower end of a light spring. A second mass of 0.10 kg is suspended from the first mass by a thread. The arrangement is allowed to come into static equilibrium and then the thread is cut.



Immediately after the thread is cut, what is the upward acceleration of the 0.20 kg mass?

A $4.9\,m\,s^{-2}$ **B** $6.5\,m\,s^{-2}$ **C** $9.8\,m\,s^{-2}$ **D** $15\,m\,s^{-2}$

9 A snowflake and a raindrop are in still air. They both fall from rest at the same time and from the same height, far above the ground.

The snowflake and raindrop contain the same mass of water. Assume that there is no evaporation or melting. Also assume that, for a given speed, the drag force acting on the snowflake is greater than the drag force acting on the raindrop.

Which statement about the snowflake and raindrop is correct?

A The raindrop takes more time than the snowflake to reach terminal velocity.

B The raindrop takes more time than the snowflake to reach the ground.

C They reach the same terminal velocity.

D They take the same amount of time to reach the ground.

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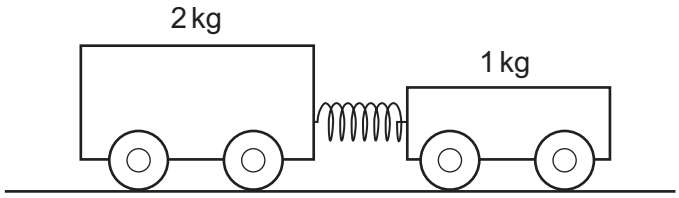
10 Two trolleys are held together on a horizontal surface with a compressed spring between them.



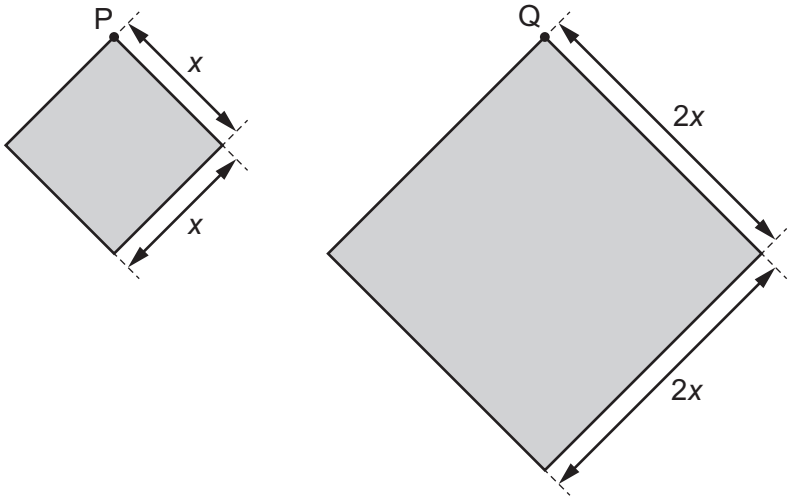
When they are released, the trolleys lose contact with the spring. The trolley of mass 2 kg moves to the left at a final speed of $2\,m\,s^{-1}$.

How much elastic potential energy was stored in the spring?

A 4 J **B** 6 J **C** 8 J **D** 12 J

11 A square board, of side length x, hangs freely from a nail P, as shown.

The board has uniform thickness and is made from material of uniform density.



A second square board, of side length $2x$, is made of the same material and has the same thickness as the original board. This second board is then hung from a nail Q. Nails P and Q are at the same height.

What is the vertical distance between the positions of the centres of gravity of the two boards?

A 0 **B** $\frac{x}{\sqrt{2}}$ **C** x **D** $x\sqrt{2}$

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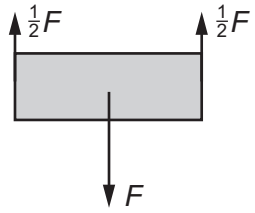
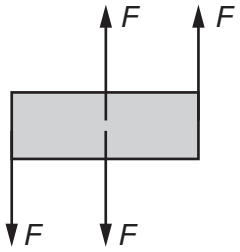
12 Forces are applied to a rigid object. The forces all act in the same plane.

In which diagram is the object in equilibrium?

A



B



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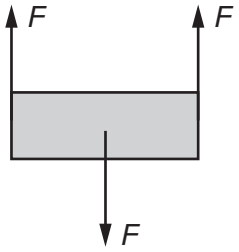
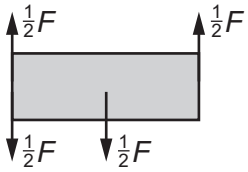
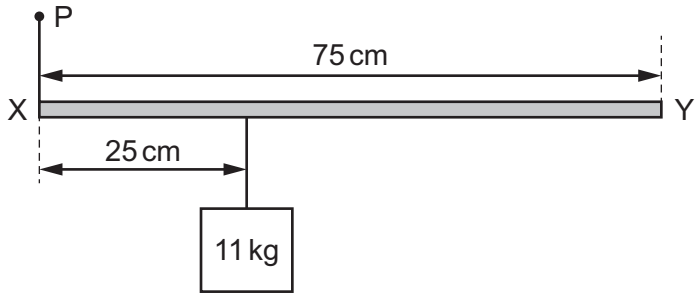


D



13 A rigid rod XY has negligible mass and length 75 cm. The rod is suspended from a fixed point P by a string attached to end X. An object of mass 11 kg is suspended by a string that is attached to the rod at a distance of 25 cm from end X, as shown.



Which vertically upward force acting on end Y of the rod would hold the rod horizontally in equilibrium?

A 3.7 N **B** 33 N **C** 36 N **D** 320 N

14 The density of water is 1.0 g cm^{-3} and the density of glycerine is 1.3 g cm^{-3}.

Water is added to a measuring cylinder containing 40 cm^3 of glycerine so that the density of the mixture is 1.1 g cm^{-3}. Assume that the mixing process does not change the total volume of the liquid.

What is the volume of water added?

A 40 cm^3 **B** 44 cm^3 **C** 52 cm^3 **D** 80 cm^3

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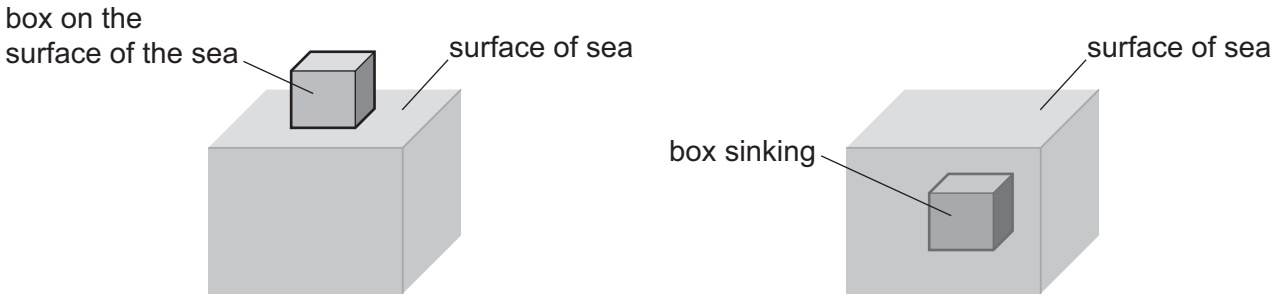
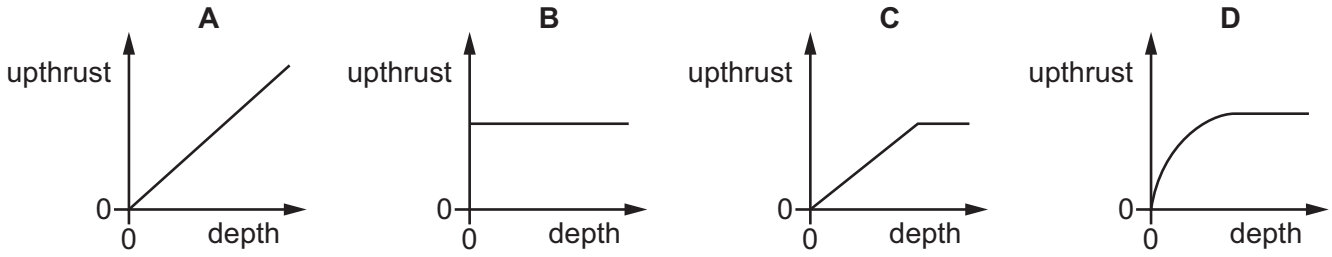
15 A box, in the shape of a cube, falls from a ship into the sea. The box lands with its lower face level with the surface of the sea.



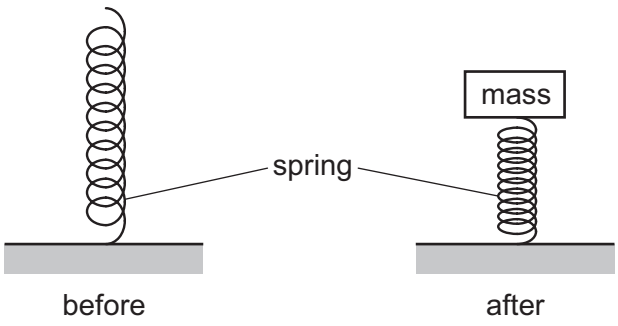
The box begins to sink, becomes totally submerged and then sinks deeper into the sea.

As the box sinks, its lower face is always parallel to the surface of the sea.

Which graph best represents the variation of the upthrust acting on the box with the depth of its lower face below the surface of the sea?



16 A spring is compressed by a mass, as shown.



Which statement describes the changes to the energy of the spring when it is compressed by the mass?

A The spring gains both gravitational potential energy and elastic potential energy.

B The spring gains gravitational potential energy and loses elastic potential energy.

C The spring loses both gravitational potential energy and elastic potential energy.

D The spring loses gravitational potential energy and gains elastic potential energy.

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17 A man of mass 75 kg runs up a staircase consisting of 30 steps. Each step is 20 cm high.

The man takes a time of 7.0 s to run from the bottom of the staircase to the top.

What is the average rate of increase of gravitational potential energy of the man?

A 64 W **B** 450 W **C** 630 W **D** 4400 W

18 An alpha-particle has 2.2×10^{-13} J of kinetic energy.

What is the speed of the alpha-particle?

A $4.1 \times 10^{6}\,m\,s^{-1}$

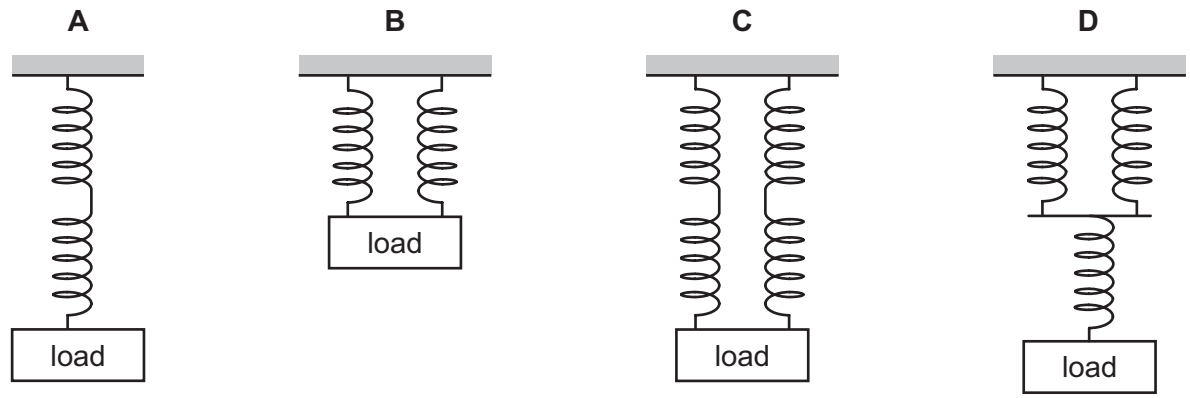
B $5.8 \times 10^{6}\,m\,s^{-1}$

C $8.1 \times 10^{6}\,m\,s^{-1}$

D $1.2 \times 10^{7}\,m\,s^{-1}$

19 Identical springs are joined in four arrangements.

Which arrangement has the same spring constant as a single spring?



20 An unstretched spring has a length of 2.0 cm.

The spring is then stretched within its limit of proportionality by a tensile force of 1.5 N so that the elastic potential energy stored in the spring is 0.045 J.

What is the stretched length of the spring?

A 3.0 cm **B** 5.0 cm **C** 6.0 cm **D** 8.0 cm

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21 A signal generator, amplifier and loudspeaker are used to produce different sound waves in the air of a room. The relationships between the properties of these waves are investigated.

Which relationship is **not** correct?

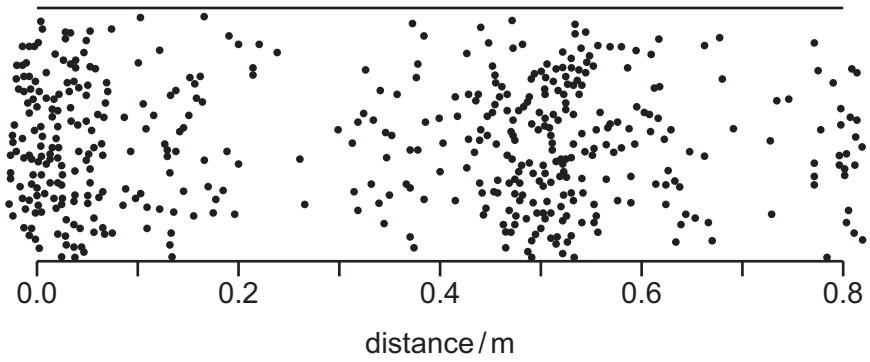
A Amplitude is proportional to wavelength.

B Frequency is inversely proportional to wavelength.

C Intensity is proportional to amplitude squared at a given frequency.

D Period is equal to the reciprocal of frequency.

22 When a guitar string is plucked, it causes a longitudinal sound wave in the air, as shown.



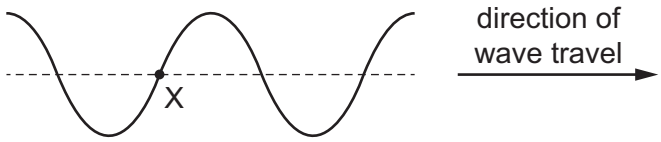
The speed of sound in the air is $340\,m\,s^{-1}$.

What is the approximate frequency of the sound wave shown?

A 430 Hz **B** 680 Hz **C** 1100 Hz **D** 1400 Hz

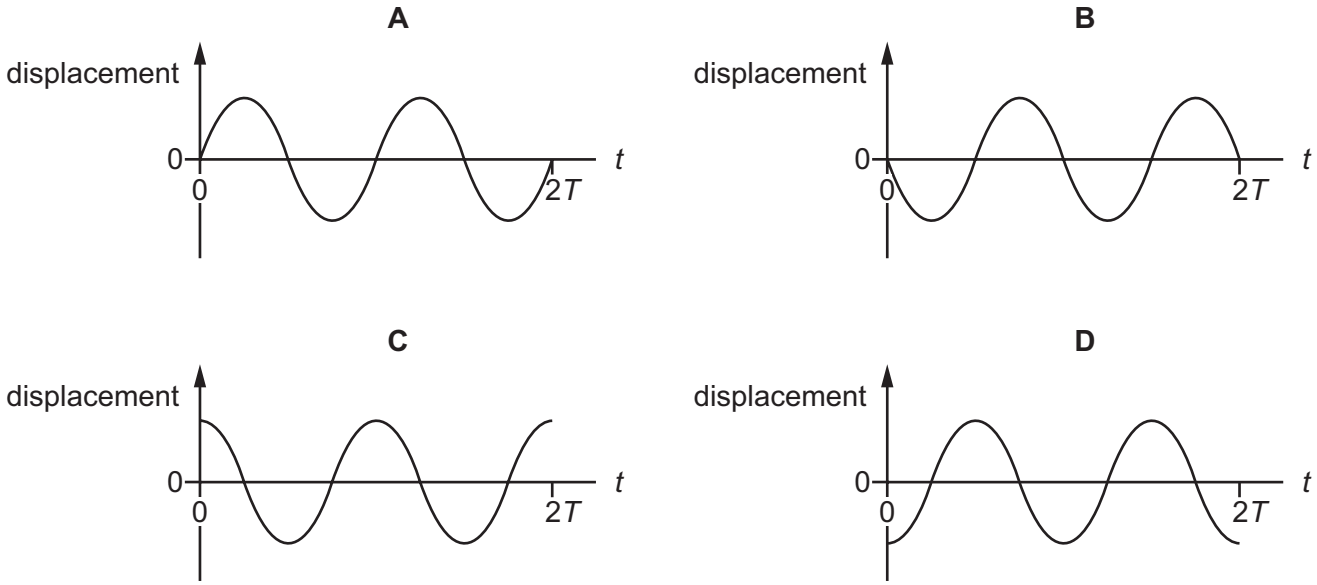
23 A transverse wave travels along a rope. The diagram shows the rope at time $t = 0$.

The wave is travelling from left to right. The period of the wave is T.



One particle of the rope is labelled X.

Which graph shows the variation with time of the displacement of particle X between $t = 0$ and $t = 2T$?



24 A jet aircraft travels at a speed of $0.80v$, where v is the speed of sound. The aircraft directly approaches a stationary observer. The frequency of sound emitted by the aircraft is 100 Hz.

Which frequency does the observer hear?

A 56 Hz **B** 180 Hz **C** 400 Hz **D** 500 Hz

25 A telescope detects and analyses some electromagnetic radiation of wavelength 2 cm.

Which type of telescope is it?

A microwave telescope

B optical telescope

C radio telescope

D X-ray telescope

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26 Two waves of the same type overlap.

When does the principle of superposition apply?

A always

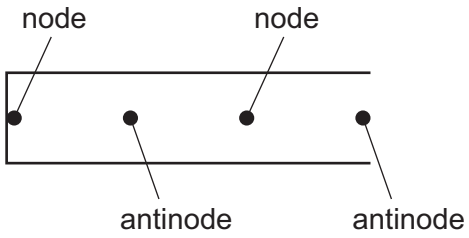
B only when the waves have the same amplitude

C only when the waves have the same frequency

D only when the waves travel in opposite directions

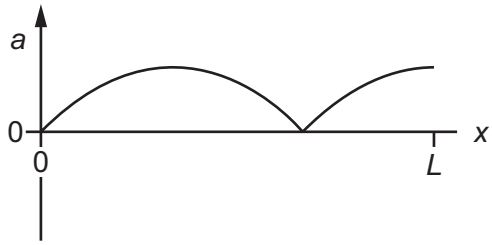
27 A stationary sound wave is formed in a tube of length *L* that is closed at one end.

The diagram shows the positions of the nodes and antinodes of the stationary wave.

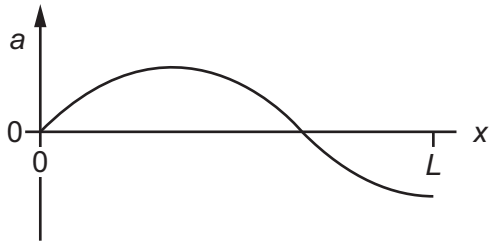


Which graph shows the variation of the amplitude *a* of the wave with distance *x* measured from the closed end of the tube?

A



B



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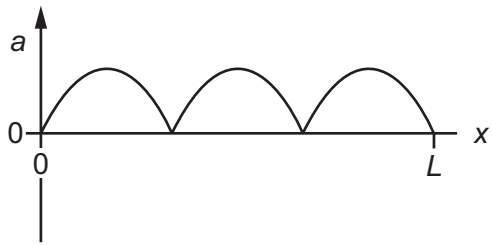

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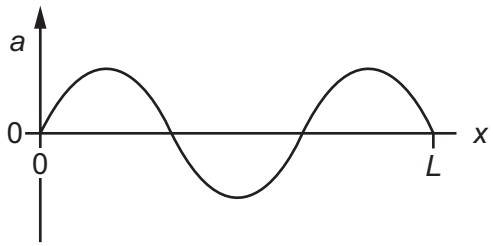
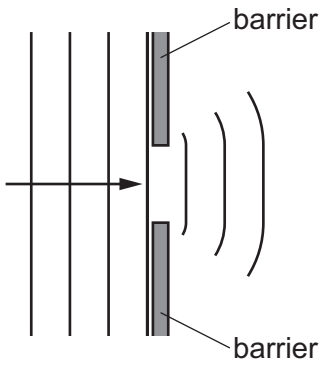


28 A wave on the surface of water passes through a gap between two barriers and is diffracted, as shown.



What happens when the frequency of the wave is halved?

A Less diffraction is observed.

B More diffraction is observed.

C There is no diffraction.

D The same amount of diffraction is observed.

29 Observable interference fringes are produced using light from a double slit. The intensity of the light emerging from each slit is initially the same.

The intensity of the light emerging from one of the slits is now reduced.

How does this affect the interference pattern?

A The bright fringes and the dark fringes all become brighter.

B The bright fringes and the dark fringes all become darker.

C The bright fringes become brighter and the dark fringes become darker.

D The bright fringes become darker and the dark fringes become brighter.

30 A diffraction grating has 4.00×10^5 lines per metre. A beam of light of wavelength 589×10^{-9} m is incident normally on the diffraction grating.

What is the angle between the second-order maximum and the direction of the incident beam of light?

A 13.6° **B** 27.3° **C** 28.1° **D** 56.2°

31 A length of wire RS has a circular cross-section.



At end R of the wire, the cross-sectional area is A.

At end S of the wire, the cross-sectional area is $\frac{A}{2}$.

Charge Q takes time t to pass through end R of the wire. There is a constant electric current in the wire.

How much charge will pass through end S in a time interval of $\frac{t}{4}$?

A $\frac{Q}{8}$ **B** $\frac{Q}{4}$ **C** $\frac{Q}{2}$ **D** Q

32 A power supply is connected to a component by connecting wires of total resistance $4.9\,\Omega$.

The power supply has an output power of 3.6 W and a terminal potential difference of 12 V.

How much thermal energy is dissipated in the connecting wires in a time of 1.0 hour?

A 0.44 J **B** 29 J **C** 1.6 kJ **D** 11 kJ

33 A copper wire is to be replaced by an aluminium alloy wire of the same length and resistance. Copper has half the resistivity of the alloy.

What is the ratio $\frac{\text{diameter of alloy wire}}{\text{diameter of copper wire}}$?

A $\sqrt{2}$ **B** 2 **C** $2\sqrt{2}$ **D** 4

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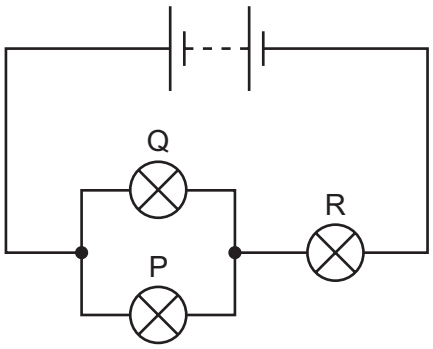
34 Three identical filament lamps, P, Q and R, are connected to a battery of negligible internal resistance, as shown.



The filament wire in lamp Q breaks so that it no longer conducts.

What are the changes in the brightness of lamps P and R?

	lamp P	lamp R
A	brighter	brighter
B	brighter	dimmer
C	dimmer	brighter
D	dimmer	dimmer

35 Which ratio has the same units as electromotive force (e.m.f.)?

A charge per unit energy transferred

B charge per unit time

C energy transferred per unit charge

D energy transferred per unit time

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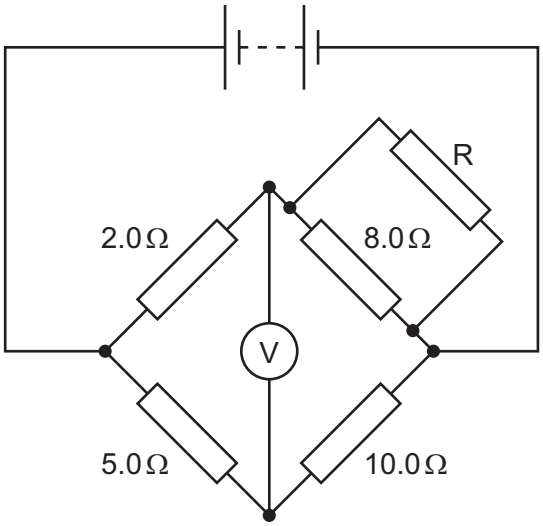
[Turn over

36 A circuit consists of a battery, a voltmeter and five fixed resistors, as shown.



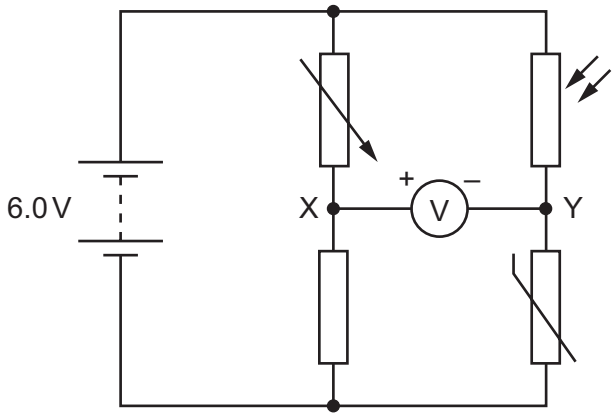
The voltmeter reading is zero.

What is the resistance of resistor R?

A 1.1 Ω **B** 2.1 Ω **C** 4.0 Ω **D** 8.0 Ω

37 A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected to a voltmeter and four other components, as shown.

The voltmeter is connected between points X and Y. The positive terminal of the voltmeter is connected to X and the negative terminal of the voltmeter is connected to Y.



Initially, the resistance of each of the four components is 1.0 kΩ.

Which change, on its own, will cause the voltmeter to show a positive reading?

A Decrease the temperature of the thermistor.

B Increase the resistance of the variable resistor.

C Reduce the intensity of light incident on the light-dependent resistor (LDR).

D Replace the fixed resistor with a 500 Ω resistor.

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38 An α-particle passes close to a gold nucleus and is deflected through an angle greater than 90°.

Which property of the α-particle changes as a result of the deflection?

A charge

B momentum

C nucleon number

D proton number

39 A nucleus of $^{238}_{92}U$ decays in stages by emitting α-particles and β^- particles, eventually forming a nucleus of $^{206}_{82}Pb$.

How many α-particles and how many β^- particles are emitted during the decay chain?

	α-particles	β^- particles
A	8	6
B	8	10
C	16	6
D	16	22

40 Which list of particles contains **only** fundamental particles?

A antineutrino, beta, meson

B baryon, neutrino, positron

C electron, neutrino, alpha

D lepton, quark, positron

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