Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/12**

Paper 1 Multiple Choice **October/November 2024**

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.

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

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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 A physical quantity consists of a magnitude and a unit.

Which row does **not** show a correct combination of a quantity and its unit?

	quantity	unit
A	mass	gram
B	length	metre
C	charge	ampere
D	temperature	kelvin

2 A small car travels in a town.

What is a reasonable estimate of the kinetic energy of the car?

A 5×10^4 J **B** 5×10^7 J **C** 5×10^{10} J **D** 5×10^{13} J

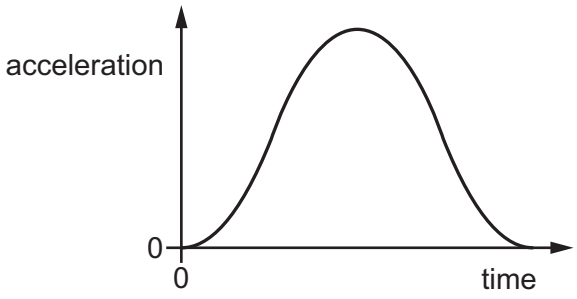
3 A solid bar has a square cross-section. Its length is measured as 50.0 ± 0.2 cm and its width is measured as 2.00 ± 0.01 cm.

These values are used to calculate the volume of the bar.

What is the percentage uncertainty in the calculated volume?

A ±0.21% **B** ±0.22% **C** ±0.90% **D** ±1.4%

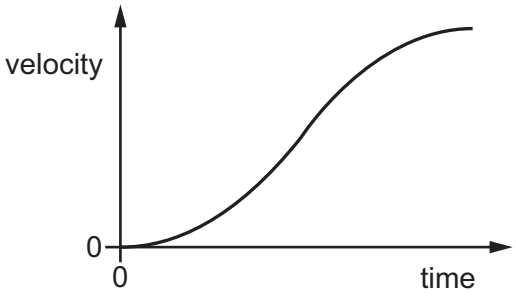
4 The graph shows how the acceleration of an object moving in a straight line varies with time.



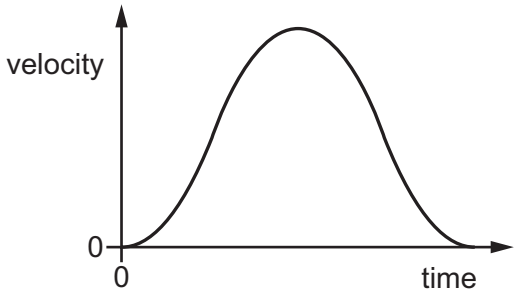
The object starts from rest.

Which graph shows the variation with time of the velocity of the object over the same time interval?

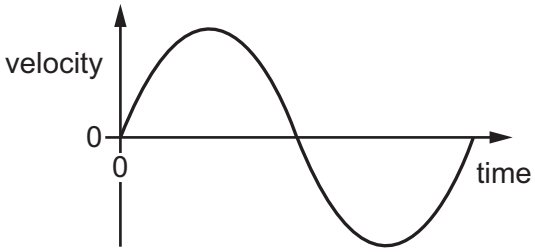
A



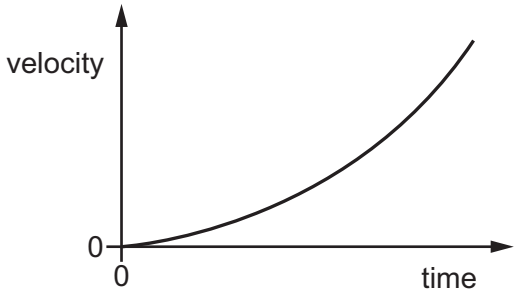
B



C



D



5 A stone falls vertically from rest. Air resistance is negligible.

What is the speed of the stone when it has fallen through a distance of 0.40 m?

A $2.0\,m\,s^{-1}$ **B** $2.8\,m\,s^{-1}$ **C** $3.9\,m\,s^{-1}$ **D** $7.8\,m\,s^{-1}$

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6 A ball is thrown horizontally off a tall building. The ground is horizontal. Air resistance is negligible.

Which statement about the motion of the ball is correct?

A The acceleration of the ball is always at right angles to the path of the ball.

B The ball follows a circular path until it hits the ground.

C The ball has constant acceleration.

D The ball's time in the air is proportional to the velocity at which the ball is thrown.

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

Assume that the two objects form an isolated system.

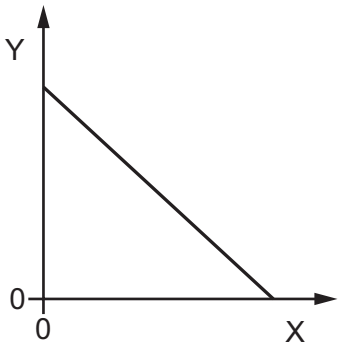
Which row shows the possible values of total momentum and total kinetic energy for the system before and after the collision?

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

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[Turn over

8 The graph shows how a quantity Y varies with a quantity X for an object falling vertically at its terminal velocity towards the surface of the Earth.



Which quantities could X and Y represent?

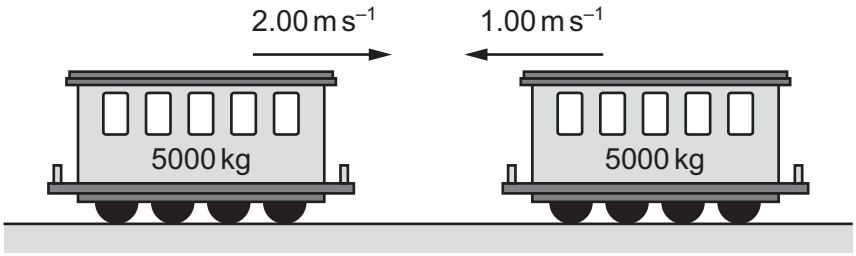
	X	Y
A	time	acceleration
B	time	height above surface
C	distance moved	kinetic energy
D	distance moved	velocity

9 A ball of mass 2.0 kg travels horizontally with a speed of 4.0 m s^{-1}. The ball collides with a wall and rebounds in the opposite direction with a speed of 2.8 m s^{-1}. The time of the collision is 150 ms.

What is the average force exerted on the wall?

A 16 N **B** 37 N **C** 53 N **D** 91 N

10 Two train carriages each of mass 5000 kg roll toward one another on a horizontal frictionless track. One is travelling at a speed of 2.00 m s^{-1} and the other at a speed of 1.00 m s^{-1}, as shown.



They collide and join together.

What is the kinetic energy lost during the collision?

A 1250 J **B** 7500 J **C** 11 250 J **D** 12 500 J

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11 Which single condition **must** apply for an object to be in equilibrium?

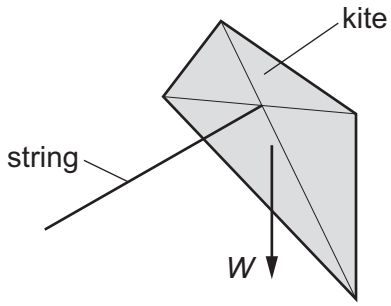
A The object has a constant non-zero acceleration.

B The object is stationary.

C There are no forces acting on the object.

D The resultant force acting on the object is zero.

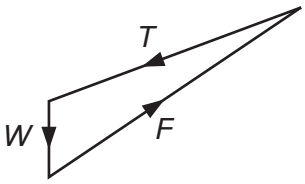
12 A kite is in equilibrium at the end of a string, as shown.



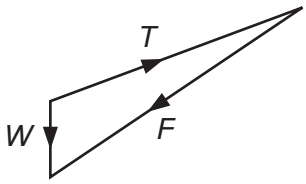
The kite has three forces acting on it: the weight *W*, the tension *T* in the string, and the force *F* from the wind.

Which vector diagram represents the forces acting on the kite?

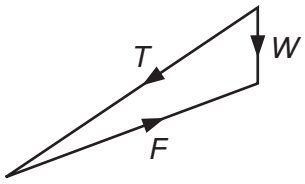
A



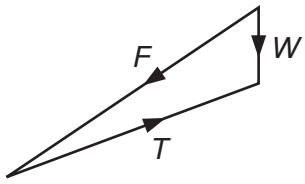
B



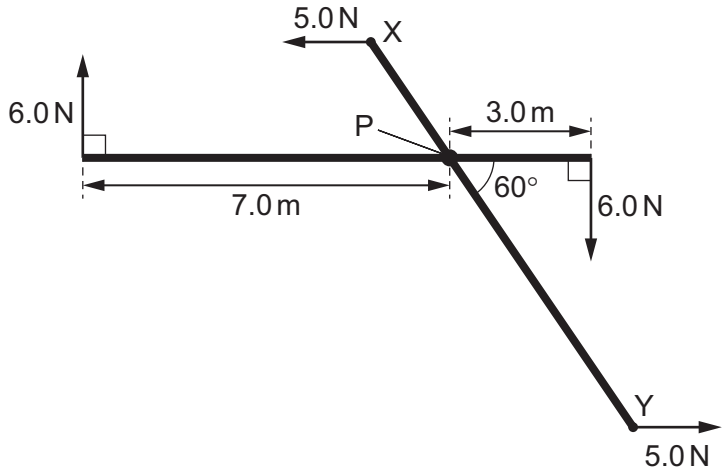
C



D



13 Four forces act about a point P, as shown.



The forces act in the same plane and produce no resultant moment about point P.

What is the length XY?

A 6.9 m **B** 12 m **C** 14 m **D** 24 m

14 A rectangular block of lead of density 1.13×10^4 kg m^{-3} has sides of length 12.0 cm, 15.0 cm and 10.0 cm.

What is the maximum pressure the block can exert when resting on a table?

A 1.13 kPa **B** 1.70 kPa **C** 11.1 kPa **D** 16.6 kPa

15 What is the definition of power?

A work done in one second

B work done in unit time

C work done per second

D work done per unit time

16 A model car travels at a constant velocity of 12 m s^{-1} in a straight horizontal line. The input power to the engine of the car is 800 W. The efficiency of the engine is 60%.

What is the total horizontal resistive force on the car?

A 27 N **B** 40 N **C** 67 N **D** 110 N

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17 Which statement represents the principle of conservation of energy?

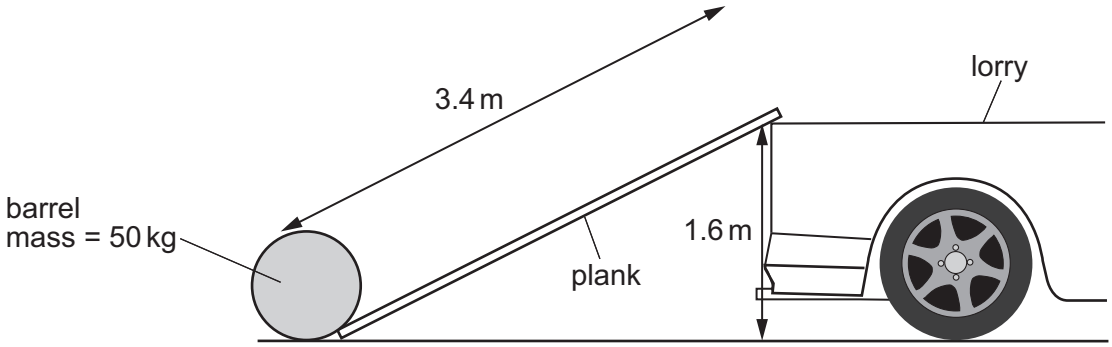
A Energy cannot be used faster than it is created.

B The supply of energy is limited, so energy must be conserved.

C The total energy in a closed system is constant.

D The total energy input to a system is equal to the useful energy output.

18 A barrel of mass 50 kg is loaded onto the back of a lorry 1.6 m high by pushing it up a frictionless plank 3.4 m long.



What is the minimum work done?

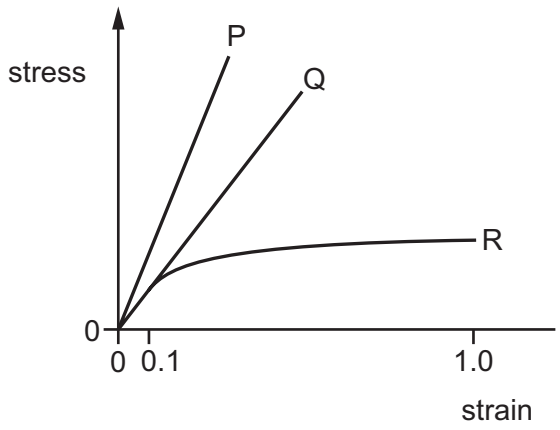
A 80 J **B** 170 J **C** 780 J **D** 1700 J

19 What is a unit for stress?

A $kg\,m^{-1}\,s^{-2}$ **B** $kg\,m^{-2}\,s^{-2}$ **C** $N\,m^{-1}$ **D** $N\,m$

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20 The graph shows the relationship between stress and strain for three wires of the same linear dimensions but made from different materials.



Which statements are correct?

1 The extension of P is approximately twice that of Q for the same stress.

2 The ratio of the Young modulus for P to that of Q is approximately two.

3 For strain less than 0.1, R obeys Hooke's law.

A 1, 2 and 3 **B** 1 and 3 only **C** 2 and 3 only **D** 2 only

21 Four solid steel rods equally support an object weighing 10 kN. Each rod is of length 2.0 m and cross-sectional area 250 mm^2. The weight of the object causes the rods to contract by 0.10 mm. The rods obey Hooke's law.

What is the Young modulus of steel?

A $2.0 \times 10^8 \, N\,m^{-2}$

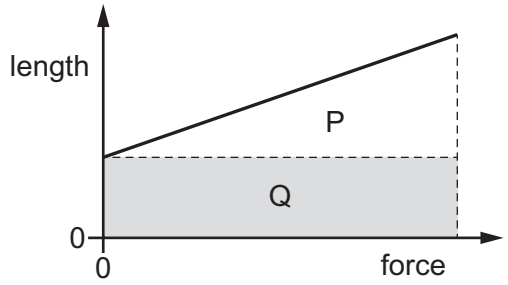
B $2.0 \times 10^{11} \, N\,m^{-2}$

C $8.0 \times 10^8 \, N\,m^{-2}$

D $8.0 \times 10^{11} \, N\,m^{-2}$

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22 The graph shows how the length of a spring varies with the force applied to it. Two areas P and Q are labelled.



Which area represents the work done in stretching the spring?

A area P

B area Q

C area P + area Q

D area Q – area P

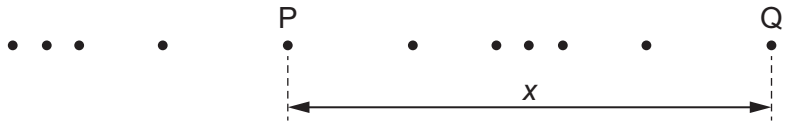
23 A horizontal beam of vertically polarised light of amplitude *A* is incident normally on a polarising filter. The transmission axis of the filter is at an angle of 50° to the vertical.

What is the amplitude of the light in the beam after it has passed through the filter?

A 0.17*A* **B** 0.41*A* **C** 0.64*A* **D** 0.80*A*

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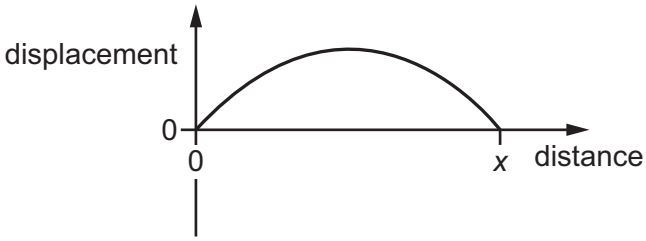
24 A progressive longitudinal sound wave moves through air. The diagram shows the positions of the air particles along part of the wave at one instant.



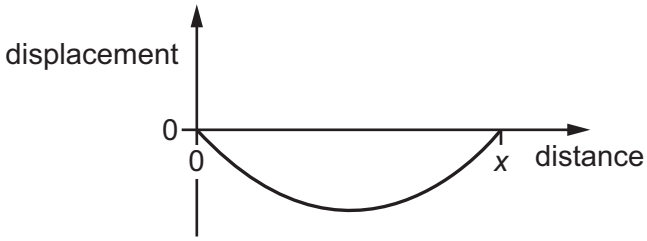
Point Q is a distance x from point P.

Which graph shows the variation of the displacement of the air particles with distance from P along the wave?

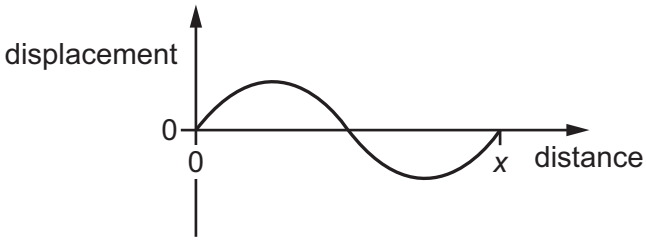
A



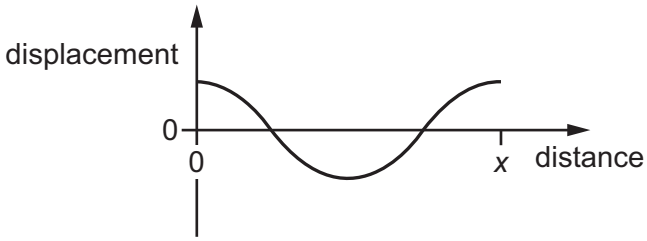
B



C



D



25 An electromagnetic wave in free space has a frequency of 3.0×10^{16} Hz.

Which row gives the principal region of this wave and an example of an electromagnetic wave with a lower frequency?

	principal region	wave with lower frequency
A	infrared	visible light
B	infrared	X-rays
C	ultraviolet	visible light
D	ultraviolet	X-rays

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26 A source of sound emits waves of a constant frequency. The source moves at a constant speed in a straight line relative to a stationary observer.

Which velocity of the source gives the smallest observed frequency?

	speed / m s^{-1}	direction
A	5	away from observer
B	10	away from observer
C	15	towards observer
D	20	towards observer

27 What could describe the time-base of a cathode-ray oscilloscope (CRO)?

A the frequency per division on the screen

B the number of divisions on the screen per unit frequency

C the number of divisions on the screen per unit time

D the time per division on the screen

28 What happens when two waves superpose at a point?

A Their amplitudes are added together.

B Their displacements are added together.

C Their frequencies are added together.

D Their velocities are added together.

29 An electromagnetic wave is diffracted as it passes through a single slit. The width of the slit is larger than the wavelength of the wave.

Which change will decrease the amount of diffraction of the wave?

A Decrease the frequency of the wave.

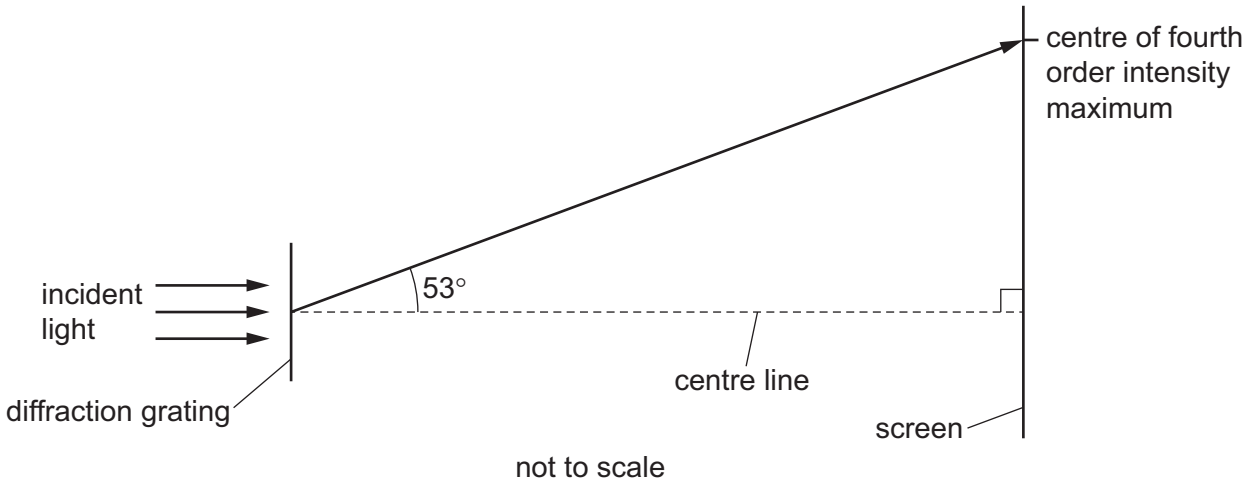
B Decrease the time period of the wave.

C Decrease the width of the slit.

D Increase the wavelength of the wave.

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30 The diagram shows visible light incident normally on a diffraction grating.



A pattern of intensity maxima forms on the screen. A line connecting the centre of the fourth order intensity maximum with the centre of the diffraction grating forms an angle of 53° with the centre line. The grating has a line spacing of 2.7×10^{-6} m.

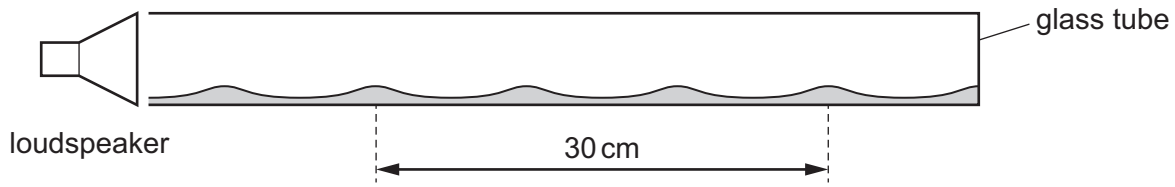
What is the wavelength of the incident light?

A 4.1×10^{-7} m **B** 5.4×10^{-7} m **C** 1.6×10^{-6} m **D** 2.2×10^{-6} m

31 A horizontal glass tube, closed at one end, has a layer of dust laid inside it on its lower side. Sound is emitted from a loudspeaker that is placed near the open end of the tube.

The frequency of the sound is varied and, at one frequency, a stationary wave is formed inside the tube so that the dust forms small heaps.

The distance between four heaps of dust is 30 cm.



The speed of sound in the air in the tube is 330 m s^{-1}.

What is the frequency of the sound emitted by the loudspeaker?

A 1650 Hz **B** 2200 Hz **C** 3300 Hz **D** 6600 Hz

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32 There is a current in a resistor for a short time interval.

Which statement about the total charge that passes through the resistor is correct?

A It can take any value.

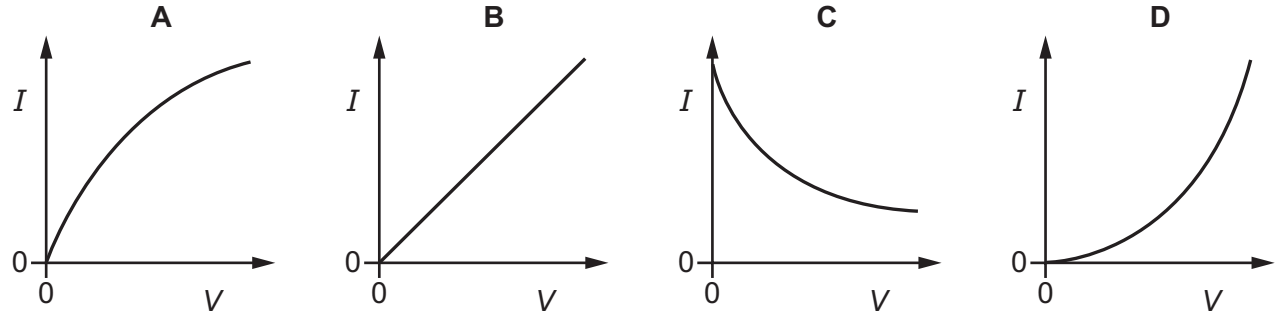
B It is an integer multiple of the elementary charge.

C It is the elementary charge.

D It is the rate of flow of the current.

33 The potential difference V across a filament lamp is slowly raised from zero to its normal operating value.

Which graph represents the variation with V of the current I in the lamp?



34 An electric current of 12 A is in a wire of length 0.35 m.

The average drift speed of the free electrons (charge carriers) in the wire is $5.0 \times 10^{-4}\,\text{m s}^{-1}$.

How many free electrons are in the wire?

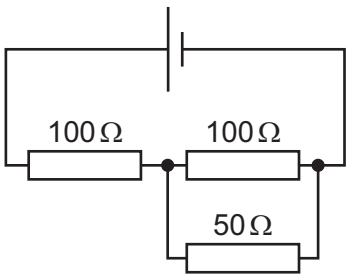
A 1.3×10^{16} **B** 5.3×10^{22} **C** 1.5×10^{23} **D** 4.3×10^{23}

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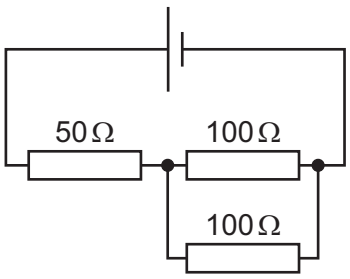
35 Three resistors are connected to a cell of negligible internal resistance.

Which circuit has a combined resistance of 100 Ω?

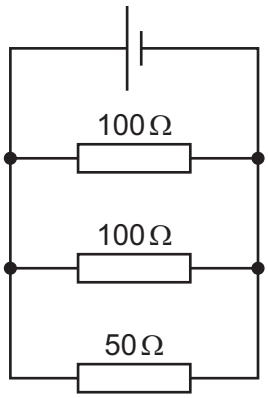
A



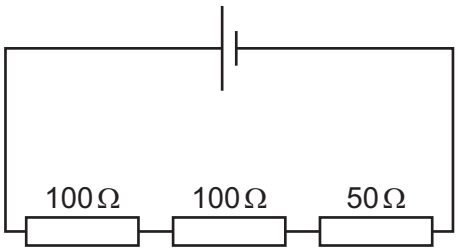
B



C



D



36 Each of Kirchhoff's laws is a statement based on the conservation of a physical quantity.

Which quantity is conserved in each law?

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

37 A cell with electromotive force (e.m.f.) 1.50 V delivers a current of 0.26 A to a resistor of resistance 5.0 Ω connected between its terminals.

What is the internal resistance of the cell?

A 0.04 Ω **B** 0.20 Ω **C** 0.39 Ω **D** 0.77 Ω

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38 What is **not** a quark flavour?

A charm

B meson

C strange

D up

39 How many down quarks are in a nucleus of hydrogen-3, $^{3}_{1}H$?

A 2 **B** 3 **C** 4 **D** 5

40 An isotope of boron decays to beryllium by β^+ emission.

Which particle is emitted in addition to the β^+ particle?

A antineutrino

B electron

C neutrino

D neutron

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