UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

PHYSICS **9702/01**

Paper 1 Multiple Choice **May/June 2009**

1 hour

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

9311393880

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, 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.

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.

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,	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19}\,\text{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\,\text{J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\,\text{kg}$
rest mass of electron,	$m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$
rest mass of proton,	$m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$
molar gas constant,	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
the Avogadro constant,	$N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$
acceleration of free fall,	$g = 9.81\,\text{m s}^{-2}$

Formulae

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

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

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

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

hydrostatic pressure, $p = \rho gh$

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

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

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

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

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

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

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

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

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

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

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

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

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

1 Which statement, involving multiples and sub-multiples of the base unit metre (m), is correct?

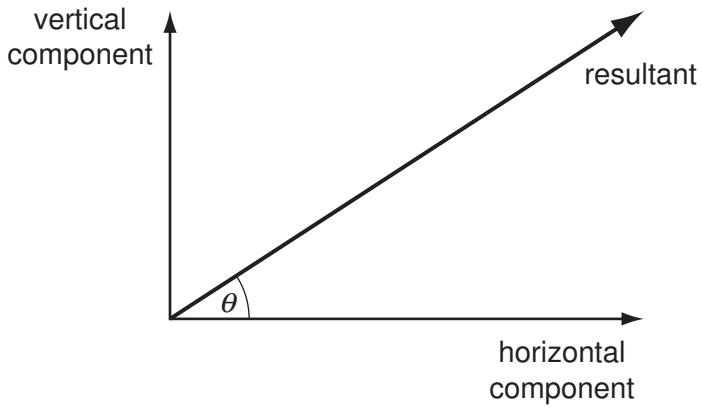
A $1\,\text{pm} = 10^{-9}\,\text{m}$

B $1\,\text{nm} = 10^{-6}\,\text{m}$

C $1\,\text{mm} = 10^{6}\,\mu\text{m}$

D $1\,\text{km} = 10^{6}\,\text{mm}$

2 The diagram shows a resultant force and its horizontal and vertical components.

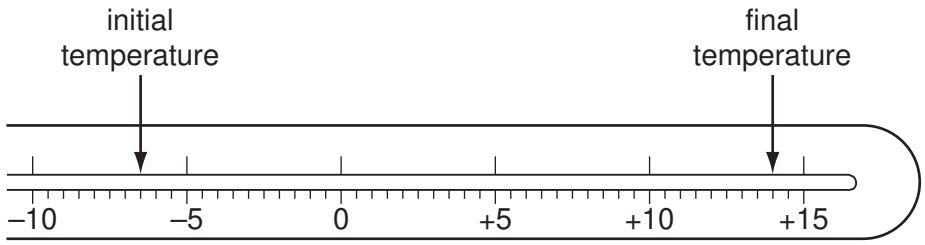


The horizontal component is 20.0 N and $\theta = 30°$. What is the vertical component?

A 8.7 N **B** 10.0 N **C** 11.5 N **D** 17.3 N

Space for working

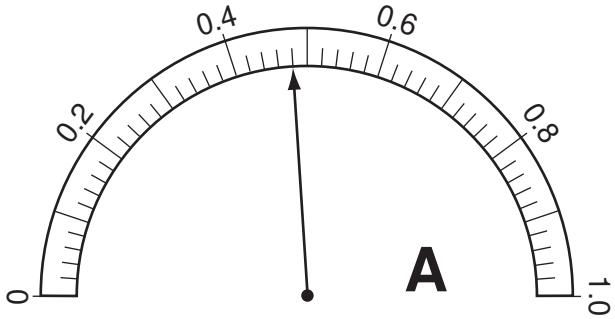
3 The diagram shows the stem of a Celsius thermometer marked to show initial and final temperature values.



What is the temperature change expressed to an appropriate number of significant figures?

A 14 °C **B** 20.5 °C **C** 21 °C **D** 22.0 °C

4 The diagrams show digital voltmeter and analogue ammeter readings from a circuit in which electrical heating is occurring.

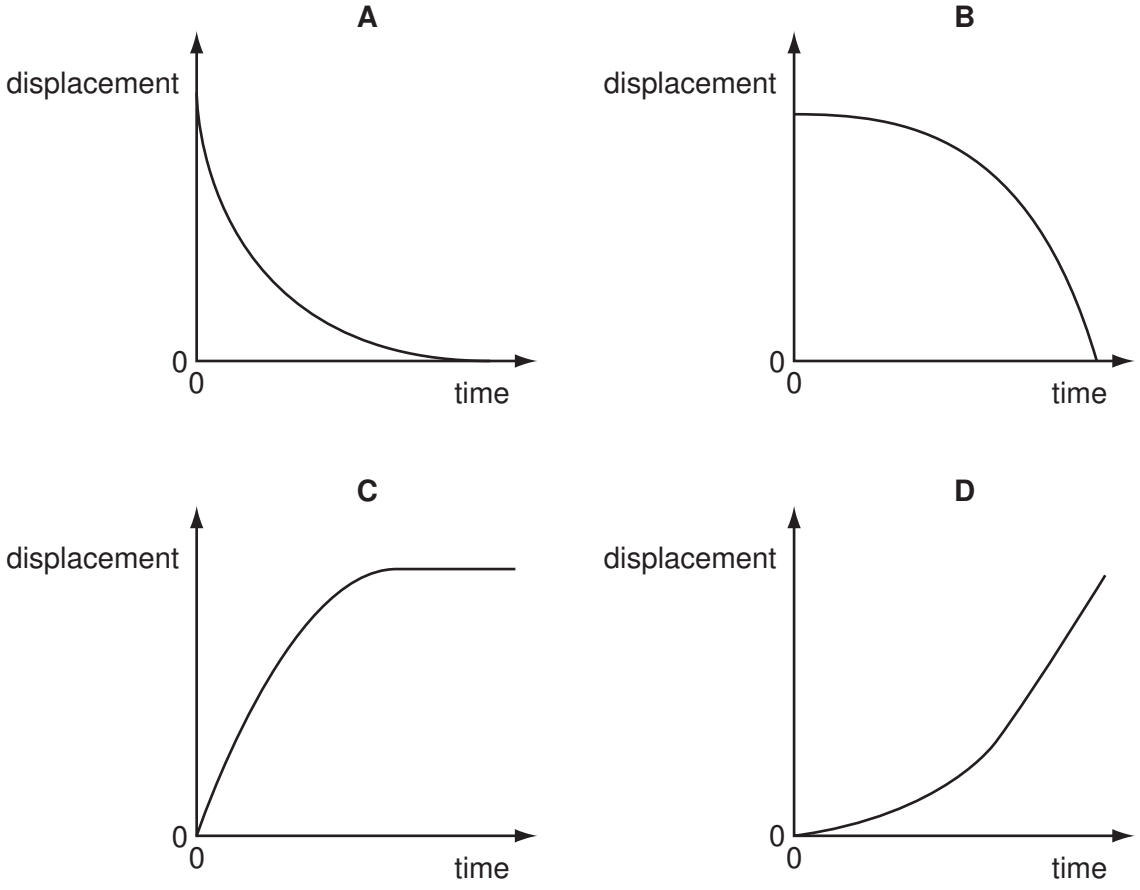


What is the electrical power of the heater?

A 0.53 W **B** 0.58 W **C** 530 W **D** 580 W

Space for working

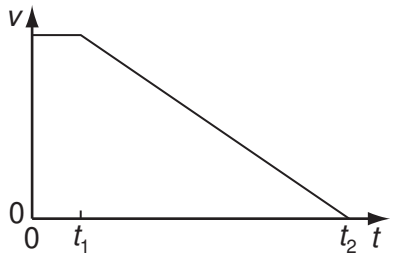
5 Which displacement-time graph best represents the motion of a falling sphere, the initial acceleration of which eventually reduces until it begins to travel at constant terminal velocity?



Space for working

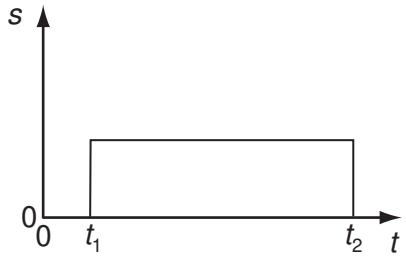
6 When a car driver sees a hazard ahead, she applies the brakes as soon as she can and brings the car to rest.

The graph shows how the speed v of the car varies with time t after she sees the hazard.

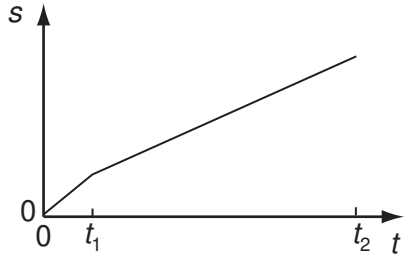


Which graph represents the variation with time t of the distance s travelled by the car after she has seen the hazard?

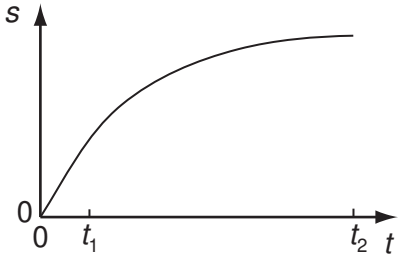
A



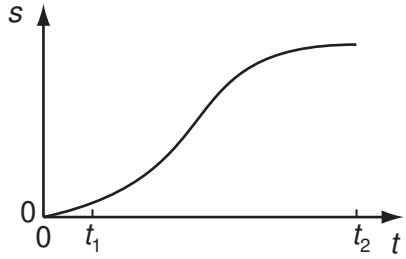
B



C



D



Space for working

7 Which statement about Newton's laws of motion is correct?

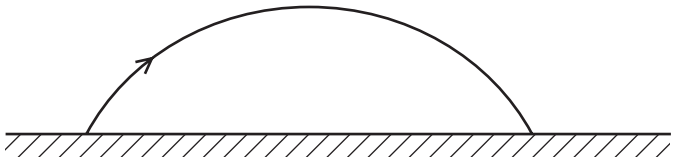
A The first law follows from the second law.

B The third law follows from the second law.

C Conservation of energy is a consequence of the third law.

D Conservation of linear momentum is a consequence of the first law.

8 The diagram shows the path of a golf ball.

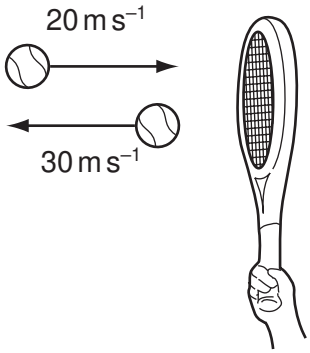


Which row describes changes in the horizontal and vertical components of the golf ball's velocity, when air resistance forces are ignored?

	horizontal	vertical
A	constant deceleration	constant acceleration downwards
B	constant deceleration	acceleration decreases upwards then increases downwards
C	constant velocity	constant acceleration downwards
D	constant velocity	acceleration decreases upwards then increases downwards

Space for working

9 A tennis ball of mass 100 g is struck by a tennis racket. The velocity of the ball is changed as shown.

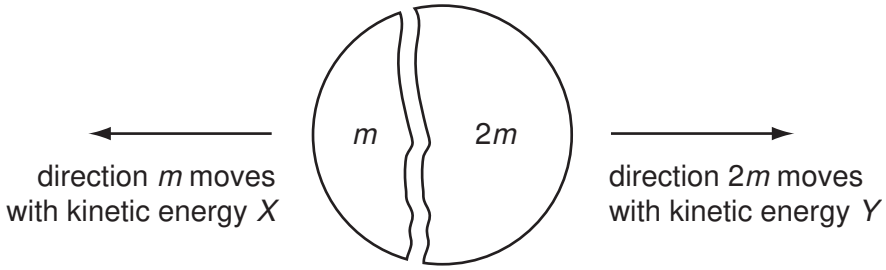


What is the magnitude of the change in momentum of the ball?

A 1 kg m s^{-1} **B** 5 kg m s^{-1} **C** 1000 kg m s^{-1} **D** 5000 kg m s^{-1}

10 A stationary body explodes into two components of masses m and $2m$.

The components gain kinetic energies X and Y respectively.

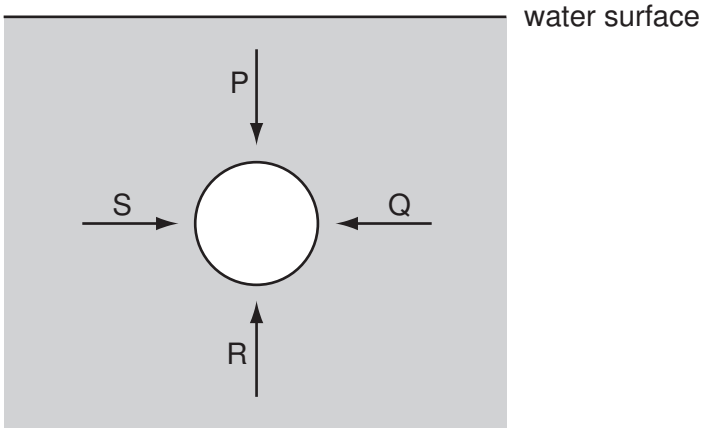


What is the value of the ratio $\frac{X}{Y}$?

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** $\frac{2}{1}$ **D** $\frac{4}{1}$

Space for working

11 The diagram represents a sphere under water. P, Q, R, and S are forces acting on the sphere, due to the pressure of the water.



Each force acts perpendicularly to the sphere's surface. P and R act in opposite directions vertically. Q and S act in opposite directions horizontally.

Which information about the magnitudes of the forces is correct?

A P < R ; S = Q

B P > R ; S = Q

C P = R ; S = Q

D P = R = S = Q

Space for working

12 An object, made from two equal masses joined by a light rod, falls with uniform speed through air.

The rod remains horizontal.

Which statement about the equilibrium of the system is correct?

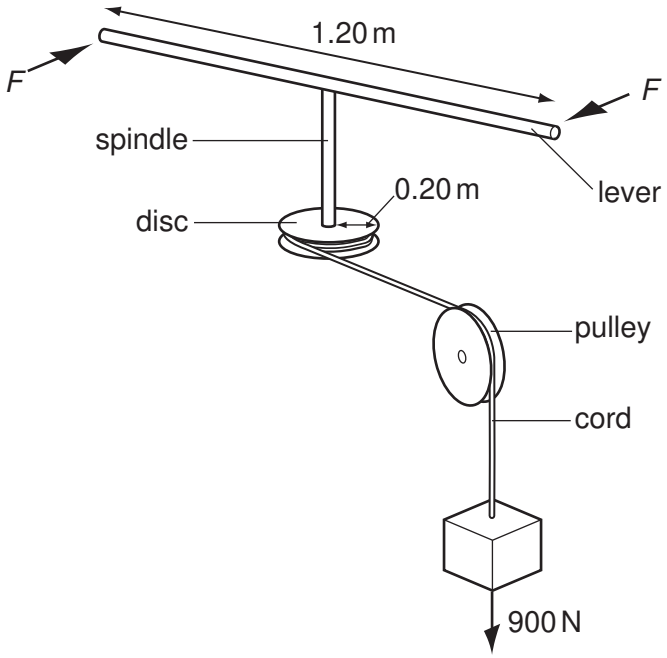
A It is not in equilibrium because it is falling steadily.

B It is not in equilibrium because it is in motion.

C It is not in equilibrium because there is a resultant torque.

D It is in equilibrium because there is no resultant force and no resultant torque.

13 A spindle is attached at one end to the centre of a lever 1.20 m long and at its other end to the centre of a disc of radius 0.20 m. A cord is wrapped round the disc, passes over a pulley and is attached to a 900 N weight.



What is the minimum force *F*, applied to each end of the lever, that could lift the weight?

A 75 N **B** 150 N **C** 300 N **D** 950 N

Space for working

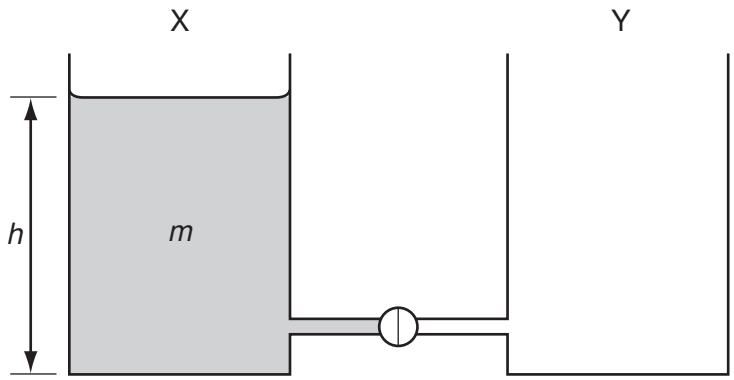
14 The forward motion of a motor-boat is opposed by forces F which vary with the boat's speed v in accordance with the relation $F = kv^2$, where k is a constant.

The effective power of the propellers required to maintain the speed v is P.

Which expression relates k, P and v?

A $k = \frac{P}{v}$ **B** $k = \frac{P}{v^2}$ **C** $k = \frac{P}{v^3}$ **D** $k = \frac{P}{v^4}$

15 The diagram shows two identical vessels X and Y connected by a short pipe with a tap.



Initially, X is filled with water of mass m to a depth h, and Y is empty.

When the tap is opened, water flows from X to Y until the depths of water in both vessels are equal.

How much potential energy is lost by the water during this process? (g = acceleration of free fall)

A 0 **B** $\frac{mgh}{4}$ **C** $\frac{mgh}{2}$ **D** mgh

Space for working

16 Which row best describes how the molecules move in solids, in liquids and in gases?

	solids	liquids	gases
A	fixed in position	only vibrate	move about freely
B	slowly in all directions	quickly in all directions	very quickly in all directions
C	vibrate about mean position	vibrate and move about	move about freely
D	vibrate in one direction only	vibrate in two directions	vibrate in all three directions

17 Water can exist in three states: solid, liquid or vapour. Transitions between these states can involve melting, freezing, evaporation or boiling.

Under conditions of constant pressure, which transition can occur over a range of temperatures rather than at one fixed temperature?

A boiling

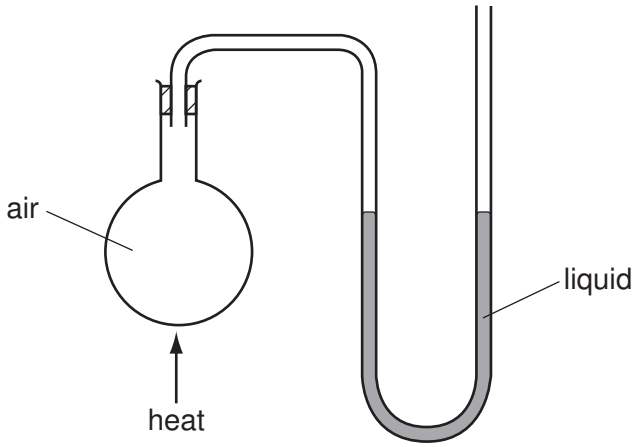
B evaporation

C freezing

D melting

Space for working

18 The diagram shows a flask connected to a U-tube containing liquid. The flask contains air at atmospheric pressure.



The flask is now gently heated and the liquid level in the right-hand side of the U-tube rises through a distance h. The density of the liquid is ρ.

What is the increase in pressure of the heated air in the flask?

A $h\rho$ **B** $\frac{1}{2}h\rho g$ **C** $h\rho g$ **D** $2h\rho g$

19 Four materials are formed into rods of the same dimensions.

At room temperature, which can sustain the largest plastic deformation?

A the ductile material aluminium

B the brittle material carbon

C the brittle material glass

D the ductile material steel

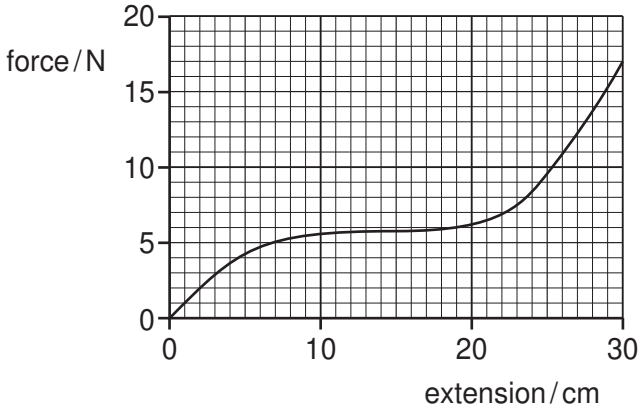
Space for working

20 Two steel wires P and Q have lengths l and $2l$ respectively, and cross-sectional areas A and $\frac{A}{2}$ respectively. Both wires obey Hooke's law.

What is the ratio $\frac{\text{tension in P}}{\text{tension in Q}}$ when both wires are stretched to the same extension?

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** $\frac{2}{1}$ **D** $\frac{4}{1}$

21 A rubber band is stretched by hanging weights on it and the force-extension graph is plotted from the results.



What is the best estimate of the strain energy stored in the rubber band when it is extended 30 cm?

A 2.0 J **B** 2.6 J **C** 5.1 J **D** 200 J

Space for working

22 Diffraction is the name given to the

A addition of two coherent waves to produce a stationary wave pattern.

B bending of waves round an obstacle.

C change of direction when waves cross the boundary between one medium and another.

D splitting of white light into colours.

23 Which wave properties change when light passes from air into glass?

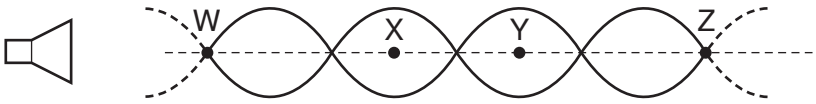
A colour and speed

B frequency and wavelength

C speed and wavelength

D wavelength and colour

24 The diagram represents the pattern of stationary waves formed by the superposition of sound waves from a loudspeaker and their reflection from a metal sheet (not shown).



W, X, Y and Z are four points on the line through the centre of these waves.

Which statement about these stationary waves is correct?

A An antinode is formed at the surface of the metal sheet.

B A node is a quarter of a wavelength from an adjacent antinode.

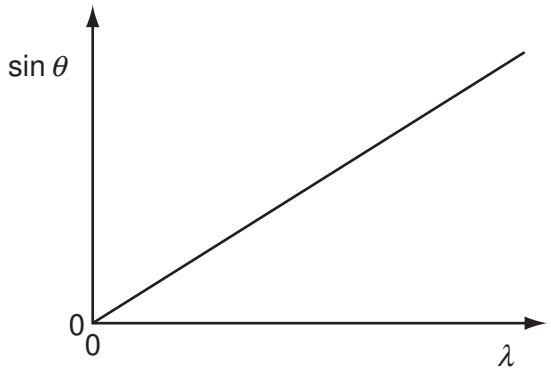
C The oscillations at X are in phase with those at Y.

D The stationary waves oscillate at right angles to the line WZ.

Space for working

25 A diffraction grating with N lines per metre is used to deflect light of various wavelengths λ.

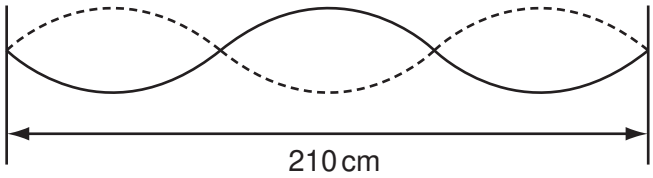
The diagram shows a relation between the deflection angles θ for different values of λ in the n^{th} order interference pattern.



What is the gradient of the graph?

A Nn **B** $\frac{N}{n}$ **C** $\frac{n}{N}$ **D** $\frac{1}{Nn}$

26 A stationary wave of frequency 80.0 Hz is set up on a stretched string of length 210 cm.

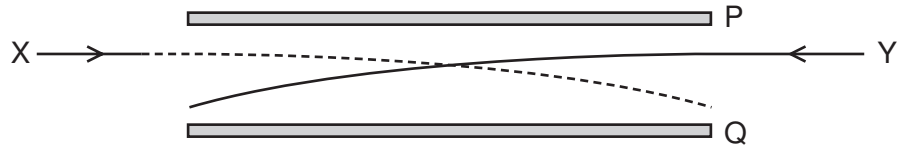


What is the speed of the waves that produce this stationary wave?

A $56.0\,m\,s^{-1}$ **B** $112\,m\,s^{-1}$ **C** $5600\,m\,s^{-1}$ **D** $11\,200\,m\,s^{-1}$

Space for working

27 The diagram shows the paths of two charged particles, X and Y, during their passage between a pair of oppositely charged metal plates, P and Q.



The plates are charged such that the electric field between them is directed from Q to P.

Which charges on X and Y will produce the observed paths?

	X	Y
A	–	–
B	–	+
C	+	–
D	+	+

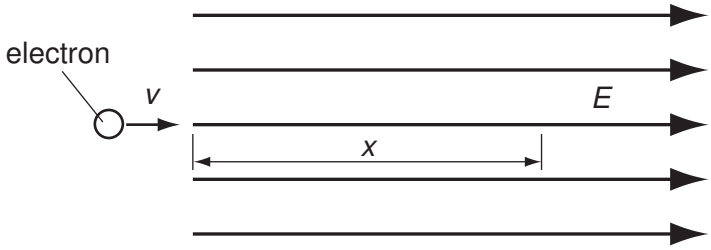
28 There is a potential difference between a pair of parallel plates.

Which values of potential difference and separation of the plates will produce an electric field strength of the greatest value?

	potential difference	separation
A	$2V$	$2d$
B	$2V$	$\frac{d}{2}$
C	$\frac{V}{2}$	$2d$
D	$\frac{V}{2}$	$\frac{d}{2}$

Space for working

29 The diagram shows an electron, with charge e, mass m, and velocity v, entering a uniform electric field of strength E.



The direction of the field and the electron's motion are both horizontal and to the right.

Which expression gives the distance x through which the electron travels before it stops momentarily?

A $x = \frac{mv}{E}$ **B** $x = \frac{mv}{Ee}$ **C** $x = \frac{mv^2}{2E}$ **D** $x = \frac{mv^2}{2Ee}$

30 Which amount of charge, flowing in the given time, will produce the largest current?

	charge / C	time / s
A	4	$\frac{1}{4}$
B	4	1
C	1	4
D	$\frac{1}{4}$	4

Space for working

31 A 12 V battery is charged for 20 minutes by connecting it to a source of electromotive force (e.m.f.). The battery is supplied with 7.2×10^4 J of energy in this time.

How much charge flows into the battery?

A 5.0 C **B** 60 C **C** 100 C **D** 6000 C

32 What is meant by the electromotive force (e.m.f.) of a cell?

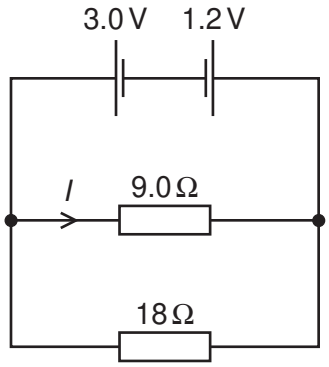
A The e.m.f. of a cell is the energy converted into electrical energy when unit charge passes through the cell.

B The e.m.f. of a cell is the energy transferred by the cell in driving unit charge through the external resistance.

C The e.m.f. of a cell is the energy transferred by the cell in driving unit charge through the internal resistance of the cell.

D The e.m.f. of a cell is the amount of energy needed to bring a unit positive charge from infinity to its positive pole.

33 Two cells of e.m.f. 3.0 V and 1.2 V and negligible internal resistance are connected to resistors of resistance 9.0 Ω and 18 Ω as shown.

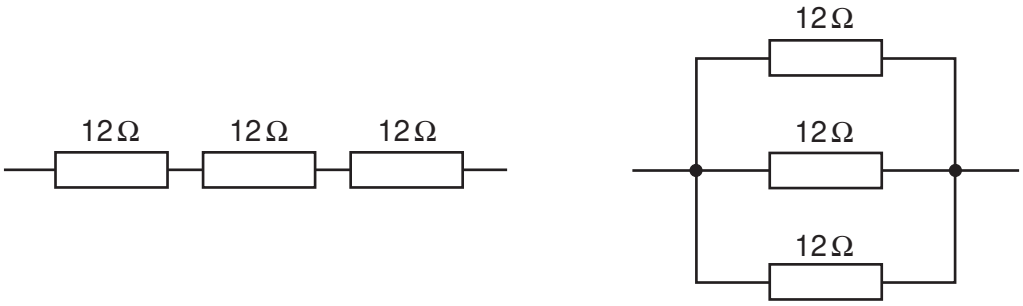


What is the value of the current I in the 9.0 Ω resistor?

A 0.10 A **B** 0.20 A **C** 0.30 A **D** 0.47 A

Space for working

34 Six identical 12 Ω resistors are arranged in two groups, one with three in series and the other with three in parallel.



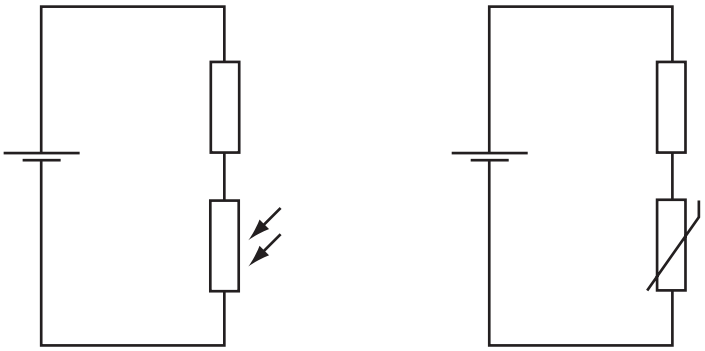
series parallel

What are the combined resistances of each of these two arrangements?

	series	parallel
A	4.0 Ω	0.25 Ω
B	4.0 Ω	36 Ω
C	36 Ω	0.25 Ω
D	36 Ω	4.0 Ω

Space for working

35 The diagrams show a light-dependent resistor in circuit P, and a thermistor in circuit Q.



circuit P circuit Q

How does the potential difference across the fixed resistor in each circuit change when both the brightness of the light on the light-dependent resistor and the temperature of the thermistor are increased?

	circuit P	circuit Q
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

36 How do the nucleon (mass) number and proton (atomic) number of two isotopes of an element compare?

	nucleon number	proton number
A	different	different
B	different	same
C	same	different
D	same	same

Space for working

37 Nuclear decay is both spontaneous and random.

When the count rate of a radioactive isotope is measured, the readings fluctuate.

Which row describes what the fluctuations demonstrate?

	spontaneous nature	random nature
A	no	no
B	no	yes
C	yes	no
D	yes	yes

38 Which two nuclei contain the same number of neutrons?

A $^{12}_{6}C$ and $^{14}_{6}C$

B $^{16}_{7}N$ and $^{15}_{8}O$

C $^{23}_{11}Na$ and $^{24}_{12}Mg$

D $^{32}_{14}Si$ and $^{32}_{15}P$

Space for working

39 The calcium nuclide $^{42}_{20}Ca$ is formed by beta decay.

What are the nucleon (mass) number and proton (atomic) number of the unstable nuclide that underwent beta decay to form the calcium nuclide?

	nucleon number	proton number
A	41	19
B	41	21
C	42	19
D	42	21

40 When boron-11 ($^{11}_{5}B$) is bombarded with α-particles, a new nucleus is formed and a neutron is released.

Which nuclear equation could represent this reaction?

A $^{11}_{5}B + {}^{1}_{1}He \rightarrow {}^{11}_{6}C + {}^{1}_{0}n$

B $^{11}_{5}B + {}^{2}_{2}He \rightarrow {}^{12}_{7}N + {}^{1}_{0}n$

C $^{11}_{5}B + {}^{4}_{2}He \rightarrow {}^{14}_{6}C + {}^{1}_{1}n$

D $^{11}_{5}B + {}^{4}_{2}He \rightarrow {}^{14}_{7}N + {}^{1}_{0}n$

Space for working