PHYSICS **9702/1**

PAPER 1 Multiple Choice

MAY/JUNE SESSION 2002

1 hour

Candidates answer on the question paper.
Additional materials:
    Multiple Choice answer sheet
    Soft clean eraser
    Soft pencil (Type B or HB is recommended)

TIME   1 hour

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, Centre number and candidate number on the answer sheet in the spaces provided unless this has already been done for you.

There are **forty** questions in 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 very carefully the instructions on the answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

This question paper consists of 19 printed pages and 1 blank page.

UNIVERSITY *of* CAMBRIDGE
Local Examinations Syndicate

[Turn over

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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
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,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
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,	$\phi = -\dfrac{Gm}{r}$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$
	$v = \pm \omega \sqrt{(x_0^2 - x^2)}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \dfrac{Q}{4\pi\epsilon_0 r}$
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,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho g h$
pressure of an ideal gas,	$p = \frac{1}{3}\dfrac{Nm}{V}<c^2>$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \dfrac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \dfrac{3H_0{}^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \dfrac{\rho v r}{\eta}$
drag force in turbulent flow,	$F = Br^2 \rho v^2$

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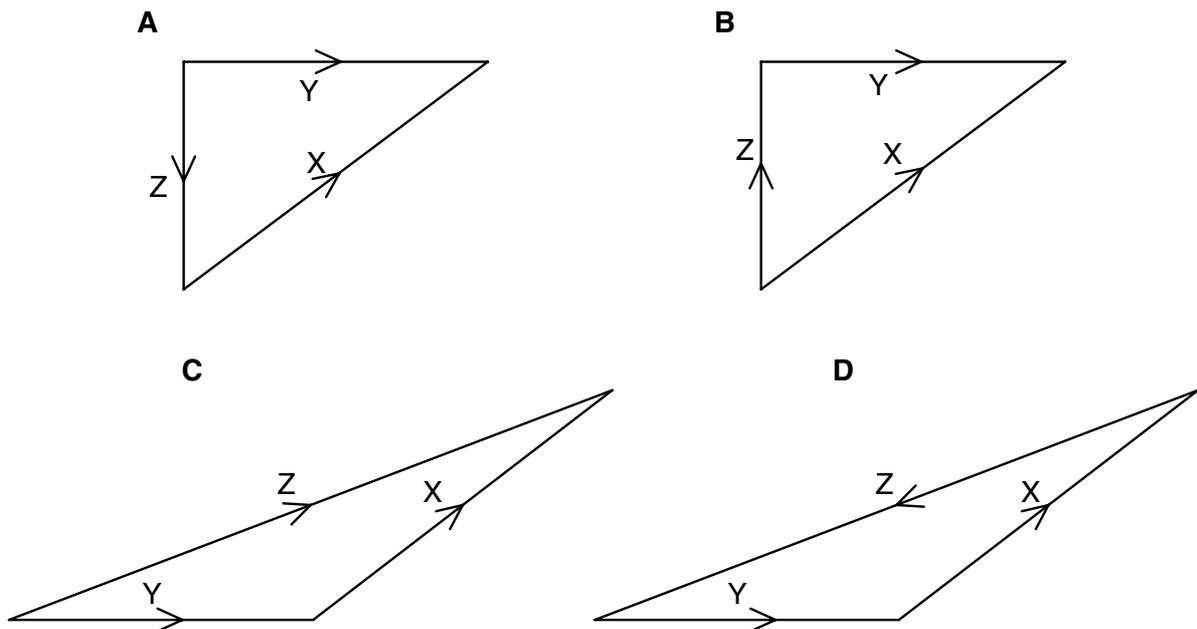
1   Which of the following pairs of units are both SI base units?

    A   ampere, degree celsius

    B   ampere, kelvin

    C   coulomb, degree celsius

    D   coulomb, kelvin

2   The diagram shows two vectors X and Y.
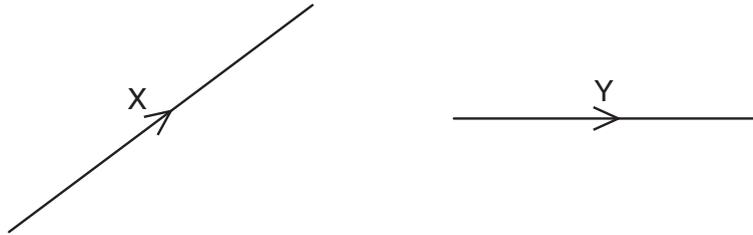


In which vector triangle does the vector Z show the magnitude and direction of vector X – Y?

3   Which formula could be correct for the speed v of ocean waves in terms of the density ρ of sea-water, the acceleration of free fall g, the depth h of the ocean and the wavelength λ?

A $v = \sqrt{g\lambda}$ **B** $v = \sqrt{\dfrac{g}{h}}$ **C** $v = \sqrt{\rho g h}$ **D** $v = \sqrt{\dfrac{g}{\rho}}$

4 A student measures the time t for a ball to fall from rest through a vertical distance h. Knowing that the equation $h = \frac{1}{2} gt^2$ applies, the student plots the graph shown.
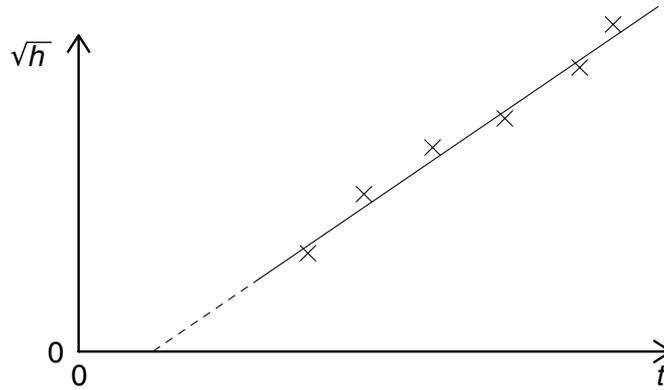
Which of the following is an explanation for the intercept on the t axis?

A Air resistance has not been taken into account for larger values of h.

B There is a constant delay between starting the timer and releasing the ball.

C There is an error in the timer that consistently makes it run fast.

D The student should have plotted h against t^2.

5 The power loss P in a resistor is calculated using the formula $P = V^2/R$.

The uncertainty in the potential difference V is 3% and the uncertainty in the resistance R is 2%.

What is the uncertainty in P?

A 4%   **B** 7%   **C** 8%   **D** 11%

[Turn over

**6** The graph relates to the motion of a falling body.
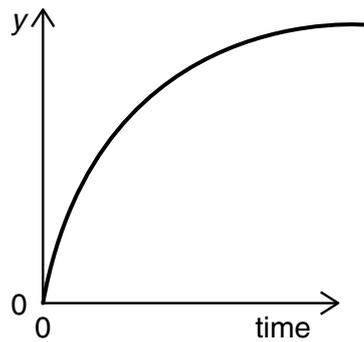
Which is a correct description of the graph?

A y is distance and air resistance is negligible

B y is distance and air resistance is not negligible

C y is speed and air resistance is negligible

D y is speed and air resistance is not negligible

7 Which graph represents the motion of a car that is travelling along a straight road with a uniformly increasing speed?
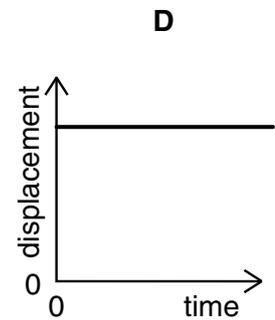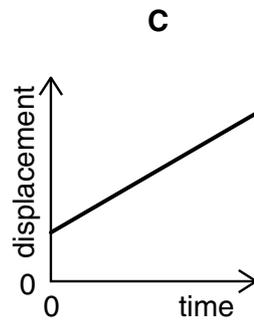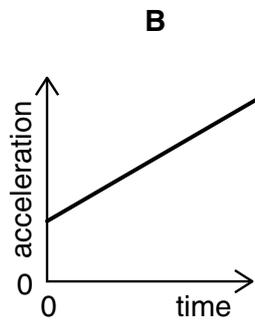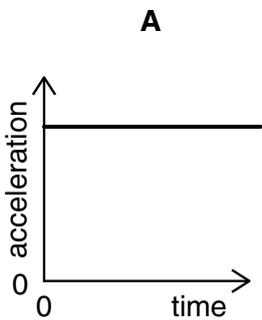
8 A stone is thrown upwards from the top of a cliff. After reaching its maximum height, it falls past the cliff-top and into the sea.

The graph shows how the vertical velocity v of the stone varies with time t after being thrown upwards. R and S are the magnitudes of the areas of the two triangles.
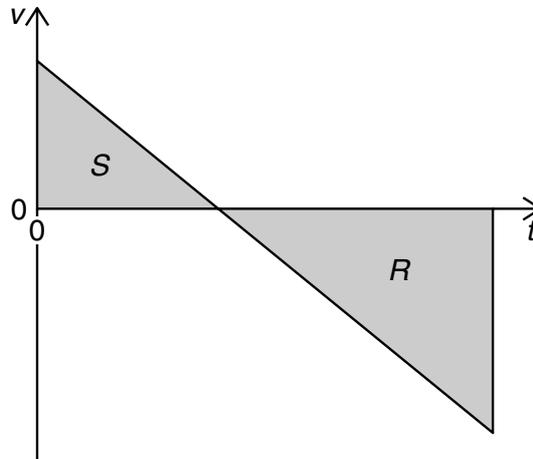
What is the height of the cliff-top above the sea?

A R **B** S **C** $R + S$ **D** $R - S$

9 Two similar spheres, each of mass m and travelling with speed v, are moving towards each other.


The spheres have a head-on elastic collision.

Which statement is correct?

A   The spheres stick together on impact.

B   The total kinetic energy after impact is mv^2.

C   The total kinetic energy before impact is zero.

D   The total momentum before impact is $2mv$.

[Turn over

10 A wooden block of mass 0.60 kg is on a rough horizontal surface. A force of 12 N is applied to the block and it accelerates at 4.0 m s^{-2}.
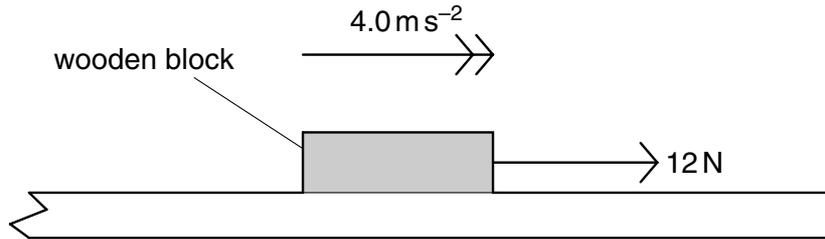
What is the magnitude of the frictional force acting on the block?

A   2.4 N

B   9.6 N

C   14 N

D   16 N

11 A body, initially at rest, explodes into two masses M_1 and M_2 that move apart with speeds v_1 and v_2 respectively.

What is the ratio $\dfrac{v_1}{v_2}$?

A $\dfrac{M_1}{M_2}$ B $\dfrac{M_2}{M_1}$ C $\left(\dfrac{M_1}{M_2}\right)^{\frac{1}{2}}$ D $\left(\dfrac{M_2}{M_1}\right)^{\frac{1}{2}}$

12 A submarine descends vertically at constant velocity. The three forces acting on the submarine are viscous drag, upthrust and weight.

Which relationship between their magnitudes is correct?

A   weight < drag

B   weight = drag

C   weight < upthrust

D   weight > upthrust

13 A ruler of length 0.30 m is pivoted at its centre. Equal and opposite forces of magnitude 2.0 N are applied to the ends of the ruler, creating a couple as shown.

2.0 N

50°

ruler

pivot

50°

2.0 N
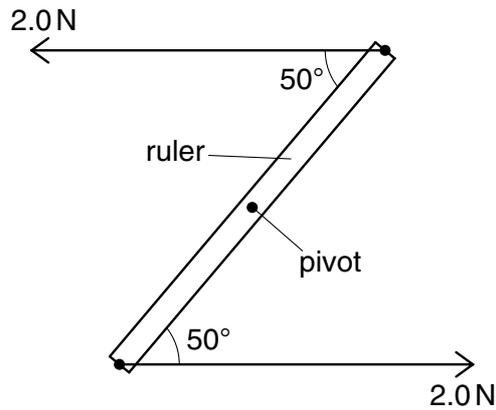
What is the magnitude of the torque of the couple on the ruler when it is in the position shown?

A   0.23 Nm   B   0.39 Nm   C   0.46 Nm   D   0.60 Nm

14 A cylindrical block of wood has a cross-sectional area A and weight W. It is totally immersed in water with its axis vertical. The block experiences pressures p_t and p_b at its top and bottom surfaces respectively.

Which of the following expressions is equal to the upthrust on the block?

A $(p_b - p_t)A + W$

B $(p_b - p_t)$

C $(p_b - p_t)A$

D $(p_b - p_t)A - W$

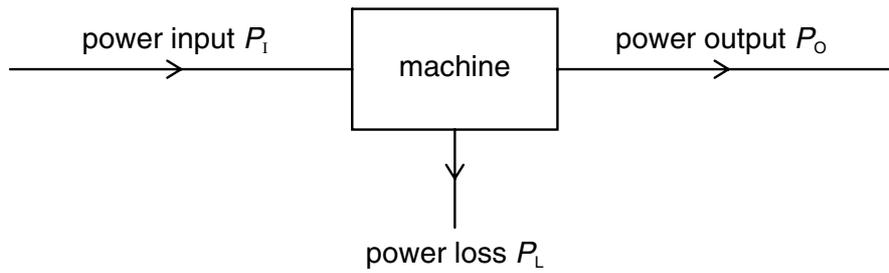15 The vector diagram shows three coplanar forces acting on an object at P.

3 N

P

4 N

4 N
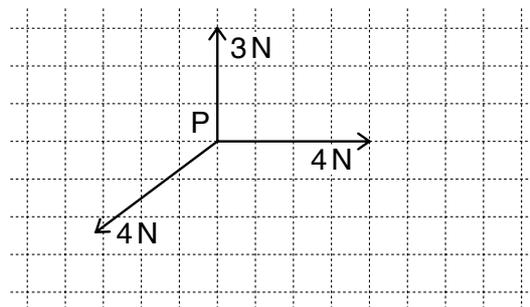
The magnitude of the resultant of these three forces is 1 N.
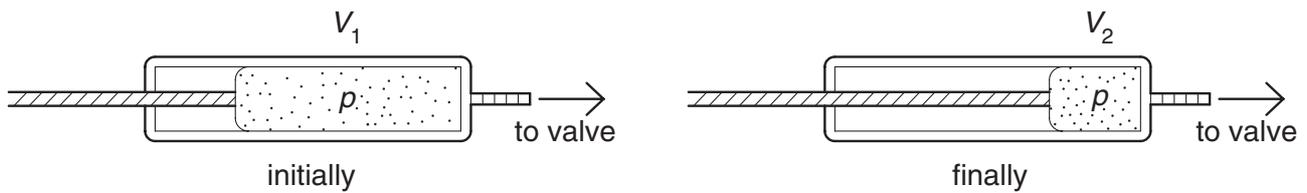
What is the direction of this resultant?

A   ↓   B   ↘   C   ↙   D   ↗

[Turn over

16 Power is transferred through a machine as shown.

What is the efficiency of the machine?

A $\dfrac{P_I}{P_O + P_L}$ **B** $\dfrac{P_L}{P_I}$ **C** $\dfrac{P_L}{P_O}$ **D** $\dfrac{P_O}{P_I}$
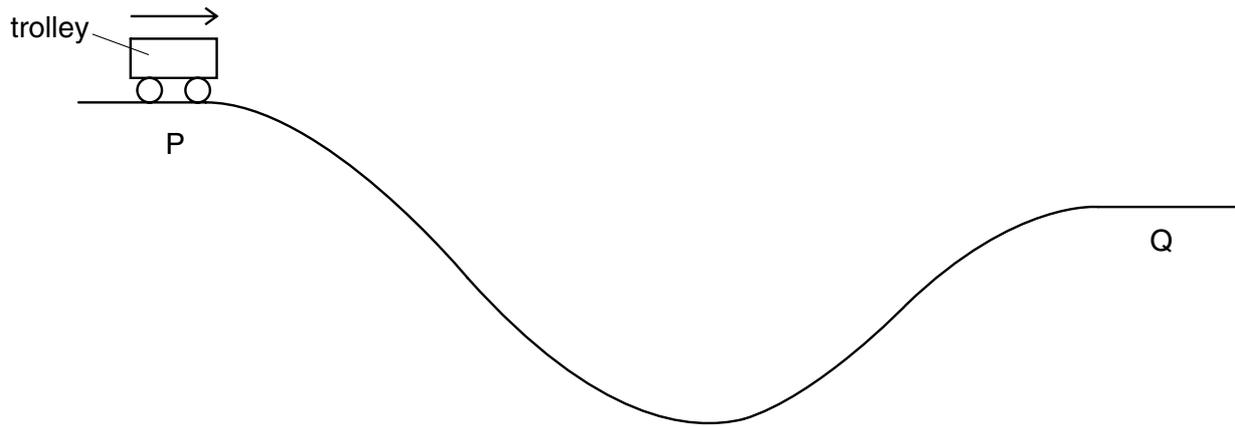
17 Air in a bicycle pump is forced through a valve at a constant pressure p. In one stroke of the pump the volume of air in the pump chamber is reduced from V_1 to V_2.

What is the work done on this air in one stroke of the pump?

A $\dfrac{p(V_1 + V_2)}{2}$

B $p(V_1 + V_2)$

C $p(V_1 - V_2)$

D pV_1

18 A trolley runs from P to Q along a track. At Q its potential energy is 50 kJ less than at P.

At P, the kinetic energy of the trolley is 5 kJ. Between P and Q the work the trolley does against friction is 10 kJ.

What is the kinetic energy of the trolley at Q?

A 35 kJ

B 45 kJ

C 55 kJ

D 65 kJ

19 To travel at a constant speed, a car engine provides 24 kW of useful power. The driving force on the car is 600 N.

At what speed does it travel?

A $2.5\,\mathrm{m\,s^{-1}}$

B $4.0\,\mathrm{m\,s^{-1}}$

C $25\,\mathrm{m\,s^{-1}}$

D $40\,\mathrm{m\,s^{-1}}$

20 For a given liquid at atmospheric pressure, which process can occur at any temperature?

A boiling

B evaporation

C melting

D solidification

[Turn over

21 A mass of a liquid of density ρ is thoroughly mixed with an equal mass of another liquid of density 2ρ. No change of the total volume occurs.

What is the density of the liquid mixture?

A $\dfrac{4}{3}\rho$ **B** $\dfrac{3}{2}\rho$ **C** $\dfrac{5}{3}\rho$ **D** 3ρ

22 Which of the following correctly defines the terms *stress*, *strain* and *Young modulus*?

	stress	strain	Young modulus
A	(force) x (area)	(extension) x (original length)	(stress) / (strain)
B	(force) x (area)	(extension) / (original length)	(stress) x (strain)
C	(force) / (area)	(extension) / (original length)	(stress) / (strain)
D	(force) / (area)	(extension) x (original length)	(stress) x (strain)

23 A wire is stretched by 8 mm when a load of 60 N is applied.

What will be the extension of a wire of the same material having four times the cross-sectional area and twice the original length, when the same load is applied?

A   2 mm   **B**   4 mm   **C**   8 mm   **D**   16 mm

24 The tension in a spring of natural length l_0 is first increased from zero to T_1, causing the length to increase to l_1. The tension is then reduced to T_2, causing the length to decrease to l_2 (as shown).
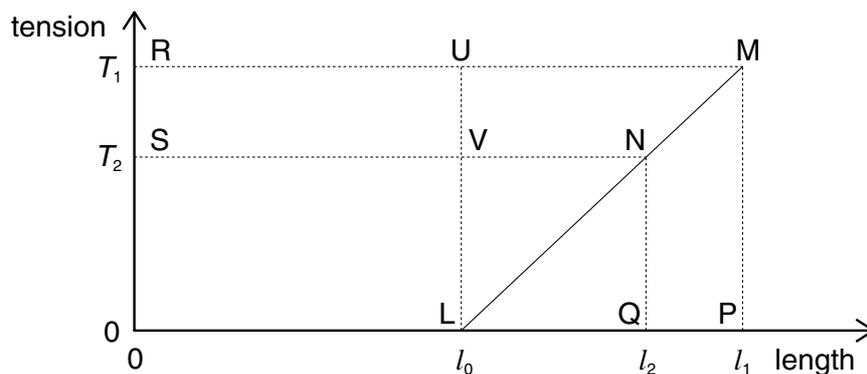

Which area of the graph represents the work done by the spring during this reduction in length?

A   MLP   **B**   MNQP   **C**   MNSR   **D**   MPLU

25 Which of the following summarises the change in wave characteristics on going from infra-red to ultraviolet in the electromagnetic spectrum?

	frequency	speed (in a vacuum)
A	decreases	decreases
B	decreases	remains constant
C	increases	remains constant
D	increases	increases

26 The diagram shows a cathode-ray oscilloscope trace of a sound wave. The time-base is calibrated at $2.0\,ms\,cm^{-1}$.
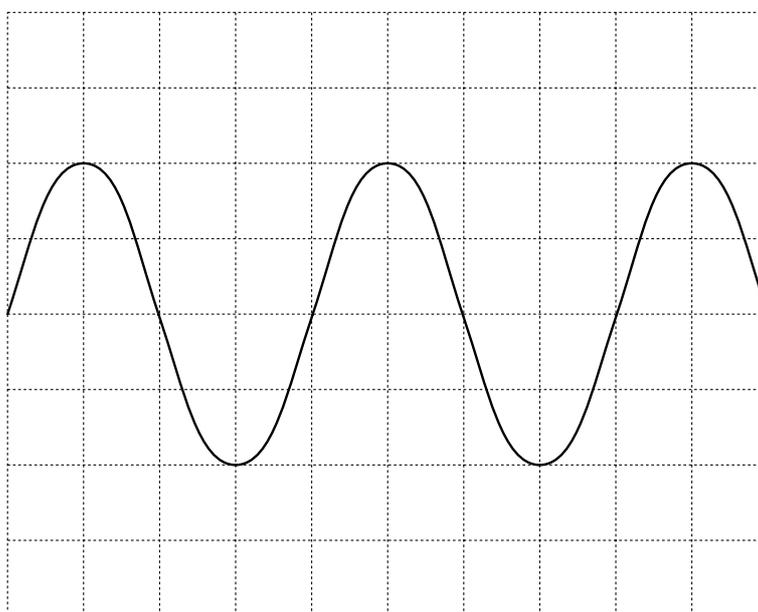
What is the frequency of the sound wave?

A   62.5 Hz   **B**   125 Hz   **C**   250 Hz   **D**   500 Hz

27 Which statement correctly relates the intensity of a sound wave to the vibrations of the molecules?

A   intensity α amplitude

B   intensity α (amplitude)^2

C   intensity α displacement

D   intensity α (displacement)^2

[Turn over

28 The diagram shows an experiment which has been set up to demonstrate two-source interference, using microwaves of wavelength λ.
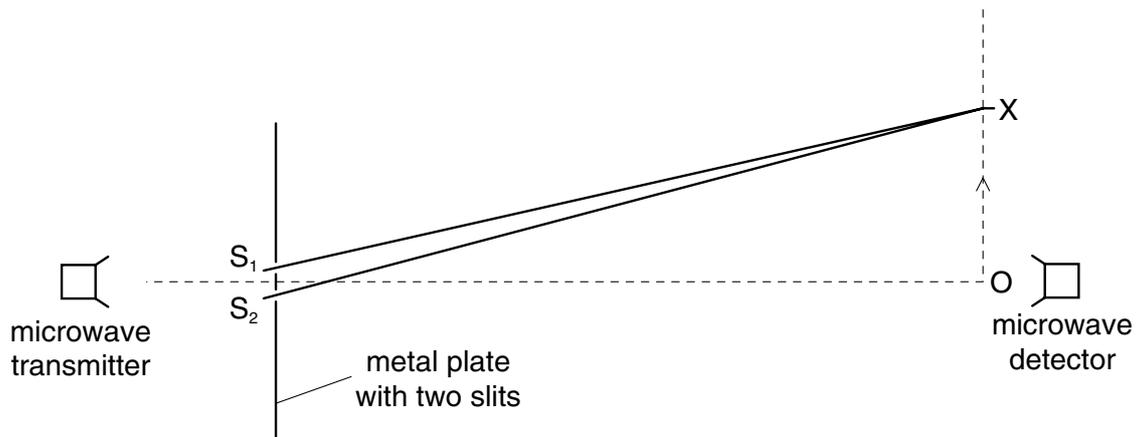
The detector is moved from O in the direction of the arrow. The signal detected decreases until the detector reaches the point X, and then starts to increase again as the detector moves beyond X.

Which equation correctly determines the position of X?

A OX = λ/2 **B** OX = λ **C** $S_2X - S_1X = \lambda$/2 **D** $S_2X - S_1X = \lambda$

29 Two progressive waves of frequency 300 Hz are superimposed to produce a stationary wave in which adjacent nodes are 1.5 m apart.

What is the speed of the progressive waves?

A 100 m s^{-1} **B** 200 m s^{-1} **C** 450 m s^{-1} **D** 900 m s^{-1}

30 The graphs show the variation with potential difference V of the current I for three circuit elements.


graph X
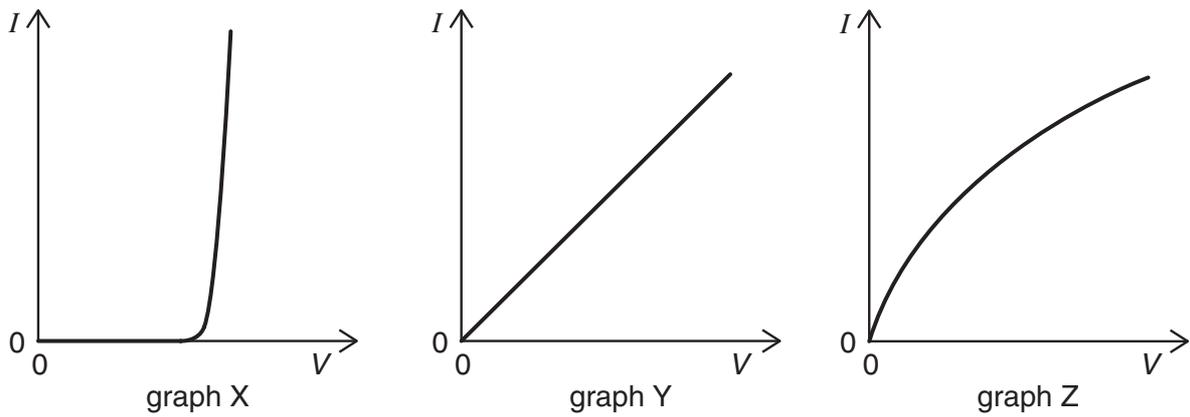
graph Y

graph Z

The three circuit elements are a metal wire at constant temperature, a semiconductor diode and a filament lamp.

Which row of the table correctly identifies these graphs?

	metal wire at constant temperature	semiconductor diode	filament lamp
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

[Turn over

31 In the circuit below, the battery converts an amount E of chemical energy to electrical energy when charge Q passes through the resistor in time t.
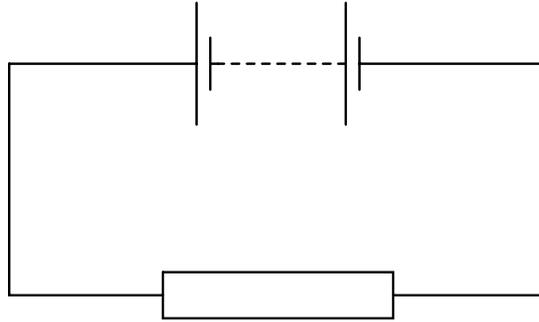
Which expressions give the e.m.f. of the battery and the current in the resistor?

|	e.m.f.	current
A	EQ	Q/t
B	EQ	Qt
C	E/Q	Q/t
D	E/Q	Qt

32 The filament of a 240 V, 100 W electric lamp heats up from room temperature to its operating temperature. As it heats up, its resistance increases by a factor of 16.

What is the resistance of this lamp at room temperature?

A 36 Ω **B** 580 Ω **C** 1.5 kΩ **D** 9.2 kΩ

33 The diagrams show connected wires which carry currents I_1, I_2, I_3 and I_4.

The currents are related by the equation $I_1 + I_2 = I_3 + I_4$.

To which diagram does this equation apply?
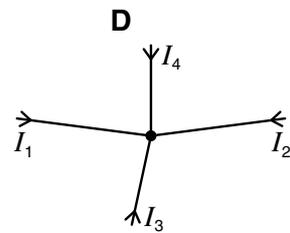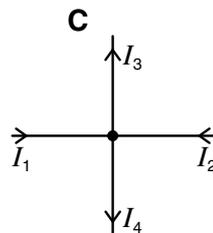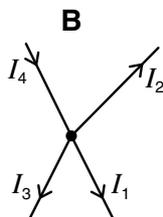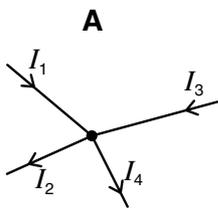
34 When four identical lamps P, Q, R and S are connected as shown in diagram 1, they have normal brightness.
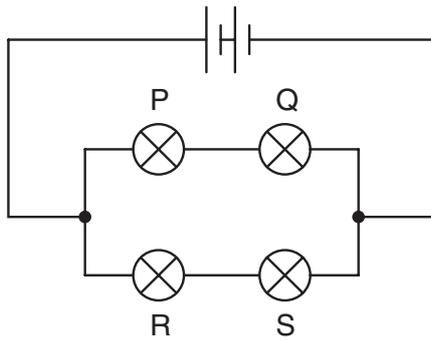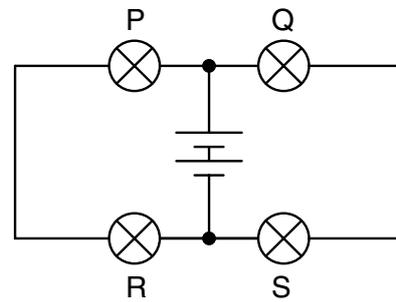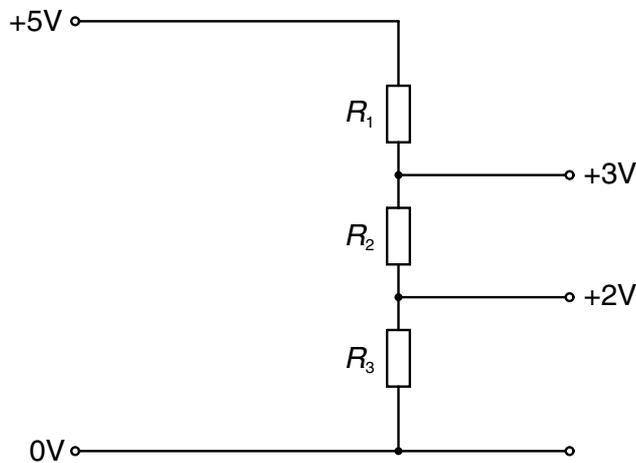

diagram 1   diagram 2

When the four lamps are connected as shown in diagram 2, which statement is correct?

A   The lamps do not light.

B   The lamps are less bright than normal.

C   The lamps have normal brightness.

D   The lamps are brighter than normal.

35 A potential divider is used to give outputs of 2 V and 3 V from a 5 V source, as shown.

What are possible values for the resistances R_1, R_2 and R_3?

	$R_1/k\Omega$	$R_2/k\Omega$	$R_3/k\Omega$
A	2	1	5
B	3	2	2
C	4	2	4
D	4	6	10

[Turn over

36 Which path shows a possible movement of an electron in the electric field shown?
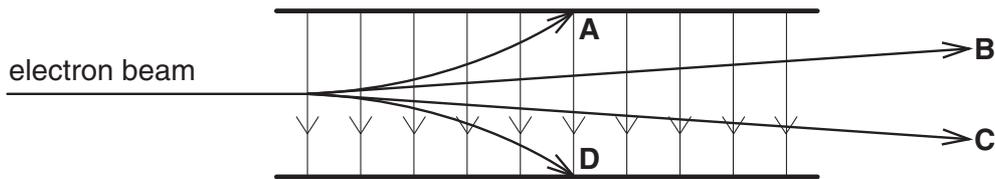
37 Two parallel conducting plates are connected to a battery, one plate to the positive terminal and the other plate to the negative. The plate separation is gradually increased, the plates remaining connected to the battery.

Which graph shows how the electric field E between the plates depends on the plate separation x?
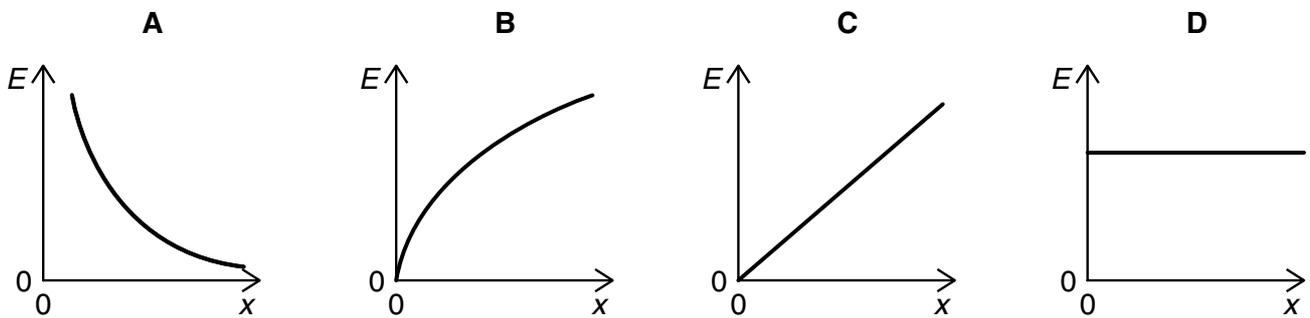
38 Which set of radioactive emissions corresponds to the descriptions given in the table headings?

	high-speed electrons	high-speed helium nuclei	high-frequency photons
A	α	β	γ
B	α	γ	β
C	β	α	γ
D	β	γ	α

39 The nucleus of one of the isotopes of nickel is represented by $^{60}_{28}$Ni.

Which line in the table correctly describes a neutral atom of this isotope?

	number of protons	number of neutrons	number of orbital electrons
A	28	32	28
B	28	60	28
C	60	28	28
D	60	32	32

40 A nucleus of bohrium $^{x}_{y}$Bh decays to mendelevium $^{255}_{101}$Md by a sequence of three α-particle emissions.

bohrium $^{x}_{y}$Bh $\longrightarrow$ dubnium $+ \alpha$

$\quad\quad\quad\quad\quad\quad\;\; \longrightarrow$ lawrencium $+ \alpha$

$\quad\quad\quad\quad\quad\quad\quad\quad\;\; \longrightarrow$ mendelevium $^{255}_{101}$Md $+ \alpha$

How many neutrons are there in a nucleus of $^{x}_{y}$Bh?

A 267

B 261

C 160

D 154

20

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