HWA CHONG INSTITUTION
JC2 Preliminary Examinations
Higher 2

CANDIDATE NAME		CT GROUP	20S
CENTRE NUMBER		INDEX NUMBER	

PHYSICS

9749/01

Paper 1 Multiple Choice

20 September 2021

60 minutes

Additional Materials: Optical Mark Sheet

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, CT, NRIC or FIN number on the optical mark sheet (OMS). Shade your NRIC or FIN in the spaces provided.

There are **thirty** 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 OMS.

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.

The use of an approved scientific calculator is expected, where appropriate.

IMPORTANT NOTICE

Questions set on the Common Last Topic of the syllabus do not form part of the assessment. They will not be marked by the Examiners.

Do **not** answer the following questions:

Questions 29 and 30 on page 16.

Turn to these questions and cross them out by drawing a line through these questions.

The total time allowed for this Question Paper has not been changed.

The total mark for this Question paper is now **28**.

Data

speed of light in free space,
$c = 3.00 \times 10^{8}$ m s^{-1}

permeability of free space,
$\mu_o = 4\pi \times 10^{-7}$ H m^{-1}

permittivity of free space,
$\varepsilon_o = 8.85 \times 10^{-12}$ F m^{-1}
$\approx (1/(36\pi)) \times 10^{-9}$ F m^{-1}

elementary charge,
$e = 1.60 \times 10^{-19}$ C

the Planck constant,
$h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant,
$u = 1.66 \times 10^{-27}$ kg

rest mass of electron,
$m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton,
$m_p = 1.67 \times 10^{-27}$ kg

molar gas constant,
$R = 8.31$ J K^{-1} mol^{-1}

the Avogadro constant,
$N_A = 6.02 \times 10^{23}$ mol^{-1}

the Boltzmann constant,
$k = 1.38 \times 10^{-23}$ J K^{-1}

gravitational constant,
$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

acceleration of free fall,
$g = 9.81$ 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	$W = p\,\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\phi = -\frac{Gm}{r}$
temperature	$T/\text{K} = T/\,^{\circ}\text{C} + 273.15$
pressure of an ideal gas	$P = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean kinetic energy of a molecule of an ideal gas	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_o \sin \omega t$
velocity of particle in s.h.m.	$v = v_o \cos \omega t$ $= \pm \omega \sqrt{(x_o^2 - x^2)}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential	$V = \frac{Q}{4\pi\varepsilon_o r}$
alternating current / voltage	$x = x_o \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_o N I}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_o n I$
radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

1 Which of the following estimates is realistic?

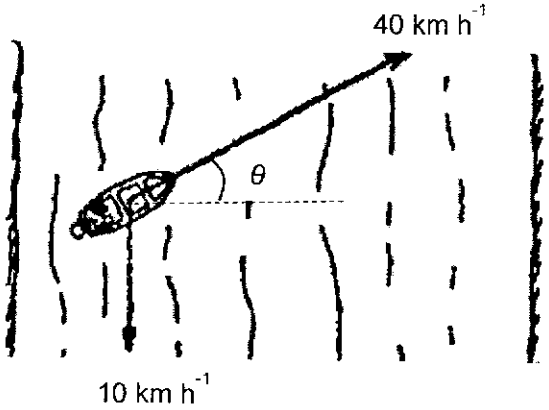
A The kinetic energy of a bus travelling on an expressway is 50 000 J.

B The upthrust on a ping-pong fully submerged in water is 0.3 N.

C The power of a domestic light bulb is 300 W.

D The energy of a microwave photon is 6.63×10^{-26} J.

2 The diagram shows the top view of a motorboat crossing a river. The water current causes the motorboat to drift at a speed of 10 km h^{-1} downstream, along the length of the river.



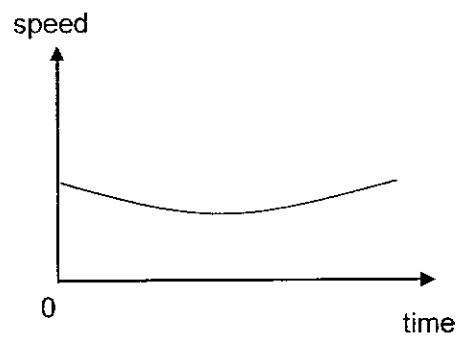
If the engine drives the motorboat at a speed of 40 km h^{-1} relative to the water, what should the angle θ be in order for the motorboat to (a) take the shortest path to the opposite shore and (b) take the shortest time to reach the opposite shore?

	(a)	(b)
A	14°	14°
B	14°	0°
C	0°	14°
D	0°	0°

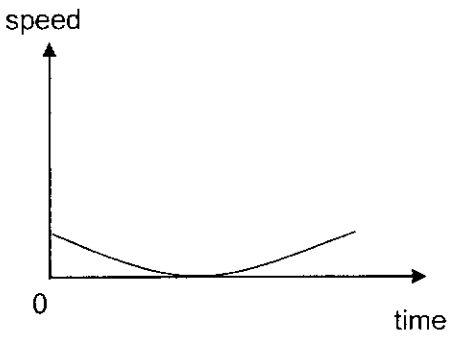
3 A projectile is shot into the air at an angle 45° above the horizontal. Air resistance is negligible.

Which of the following graphs best represents the variation of its speed with time?

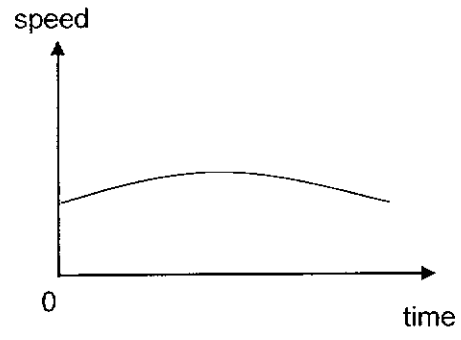
A



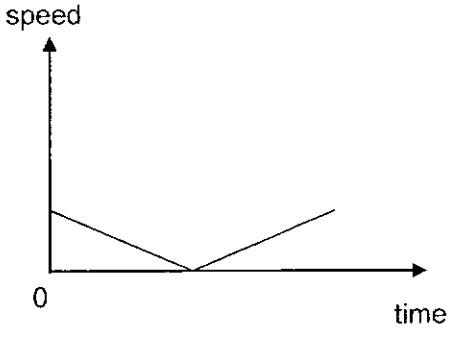
B



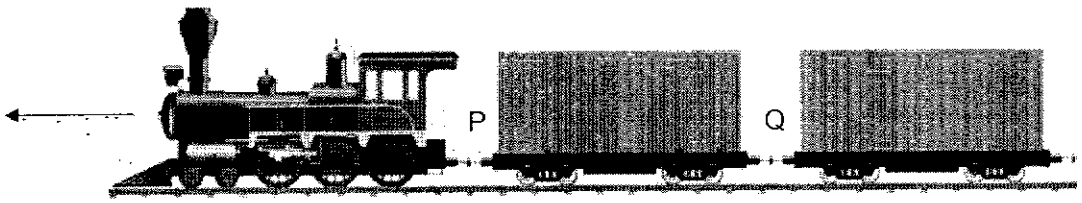
C



D



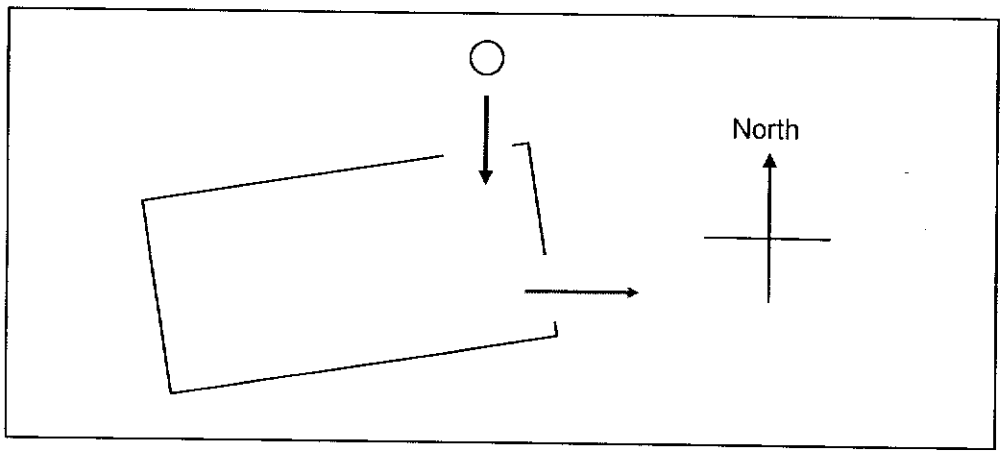
4 The diagram shows an engine and carriages accelerating as they leave the station.



The engine has a mass of $2M$, and each carriage has a mass M. Assume that resistive force is negligible. If the tension in the coupling P is F, then the tension in the coupling Q is

A F B $F/2$ C $F/3$ D $F/4$

5 The figure below shows the top view of an empty box resting on a smooth horizontal surface. A ball moving in a southward direction, enters the box and makes multiple elastic collisions with the box before exiting in an eastward direction.



top view

Which of the following statements best describes the motion of the box after the ball exits from it?

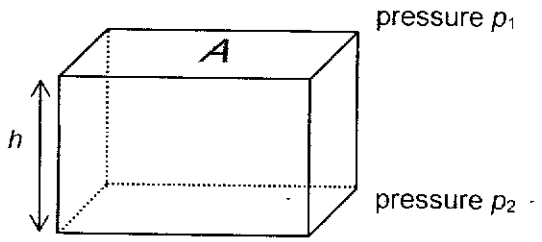
A The box moves in a westward direction.

B The box moves in a southward direction.

C The velocity of the box has both southward and eastward components.

D The velocity of the box has both southward and westward components.

6 A solid block of material of density ρ, height h and horizontal surface area A is immersed in a liquid. The pressures of the liquid at the upper and lower surfaces are p_1 and p_2 respectively.



Which of the following is an expression for the upthrust on the block?

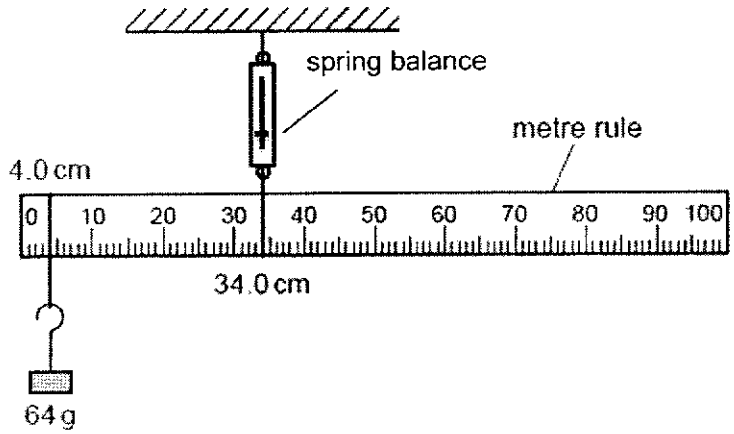
A $Ah\rho g$

B $Ah\rho g + p_1A$

C p_2A

D $p_2A - p_1A$

7 A non-uniform metre rule is pivoted at the 34.0 cm mark, as shown.



The rule balances when a 64 g mass is hung from the 4.0 cm mark and the spring balance shows a reading of 200 g.

At which mark is the centre of mass of the rule located?

A 48.1 cm **B** 50.0 cm **C** 64.1 cm **D** 66.0 cm

8 A small mass is tied to a light inextensible string. The mass is hung onto a fixed spring balance. The spring balance reads 50 g. (Fig. 8.1)

The mass is then displaced from the vertical at an angle 30° and released from rest. (Fig. 8.2)

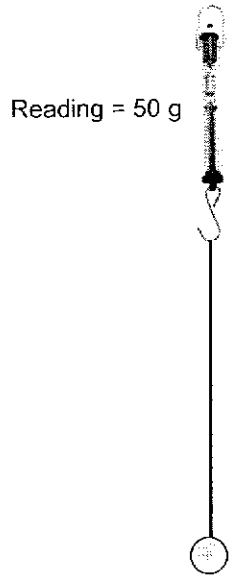


Fig. 8.1

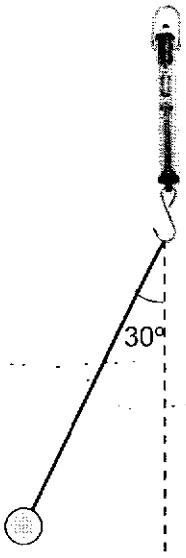


Fig. 8.2

Fig. 8.3

The reading on the balance when the mass is at the lowest point of its motion (Fig. 8.3) is

A = 50 g **B** < 50 g **C** > 50 g **D** = 0 g

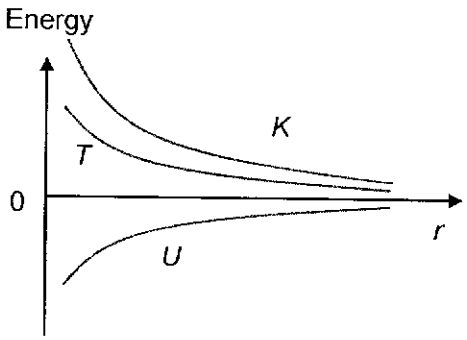
9 The Earth may be assumed to be an isolated uniform sphere of radius 6400 km.

At what height above the Earth's pole will the acceleration of free fall decrease by 1%?

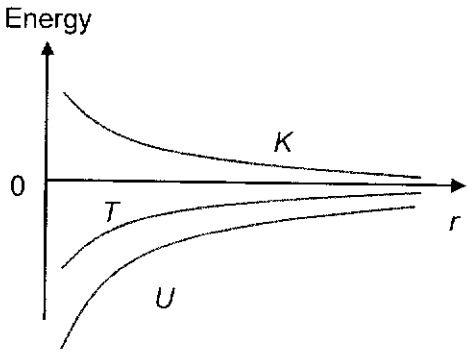
A 32 km **B** 65 km **C** 80 km **D** 1253 km

10 Which of the following sets of graphs best represents the variation of the total energy (T), the kinetic energy (K) and the gravitational potential energy (U) of an orbiting satellite with distance r from the centre of Earth?

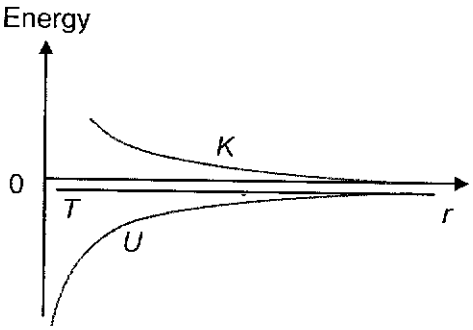
A



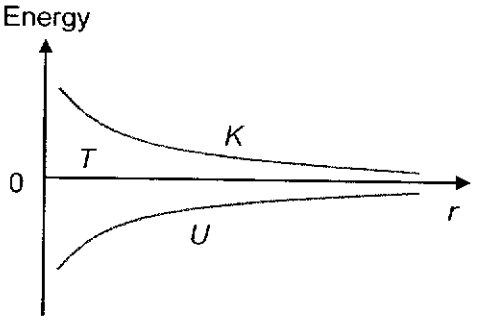
B



C



D



11 Which statement about internal energy is correct?

A When the internal energy of a system is increased, its temperature always rises.

B The internal energy of a system can be increased without transfer of energy by heating.

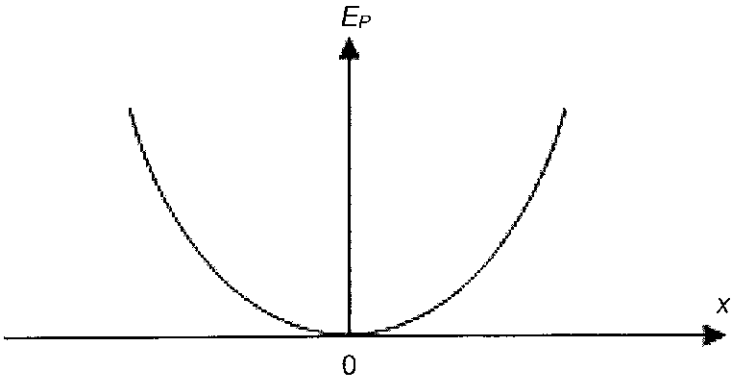
C When two systems have the same internal energy, they must be at the same temperature.

D The internal energy of a system is the sum of the heat transferred to the system and the work done on the system.

12 An ideal gas is initially at 127°C. It is then heated until the r.m.s. speed of its molecules becomes doubled. The increase in temperature is

A 381 °C **B** 508 °C **C** 1200 °C **D** 1600 °C

13 The graph shows the variation of potential energy E_p of a body with its displacement x from a fixed point O.



Which feature of the graph indicates that the net force on the body is always directed towards O?

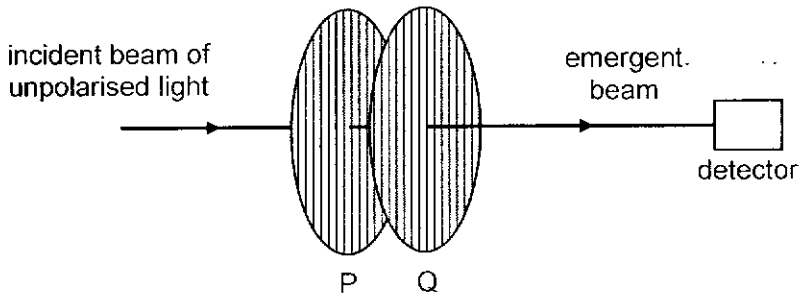
A The graph passes through the origin.

B The graph is symmetrical about the vertical axis.

C The potential energy increases as the body moves away from O.

D The value of the potential energy is always positive.

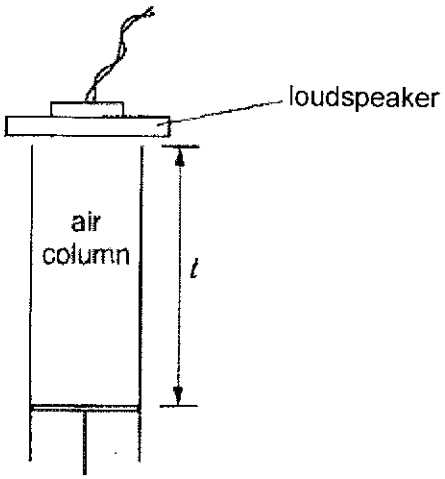
14 Two sheets of polaroid P and Q are placed such that their planes of polarisation are parallel as shown. A beam of unpolarised light passes through them and is incident on the detector. The intensity detected is I.



Which of the following is a possible angle through which Q can be rotated such that the intensity detected is reduced by 30%?

A 213° **B** 226° **C** 237° **D** 253°

15 A sound wave of a constant wavelength is continuously transmitted from a loudspeaker into an air column. The length l of the air column is slowly increased from zero.



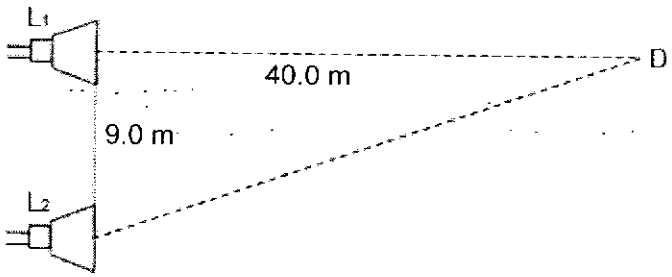
When l reaches certain values, the sound heard from the air column increases greatly. l is found to be 15 cm when the sound increases greatly for the third time.

Assume that the end correction is negligible, what is the wavelength of the sound wave?

A 7.5 cm **B** 10 cm **C** 12 cm **D** 20 cm

16 Two loudspeakers L_1 and L_2, placed 9.0 m apart, as shown in the diagram, are driven by a common oscillator.

As the frequency of the oscillator increases from zero, the detector at D, placed 40.0 m directly in front of L_1, recorded a series of maximum and minimum signals.



If the speed of sound is 330 m s^{-1}, at what frequency is the first minimum detected?

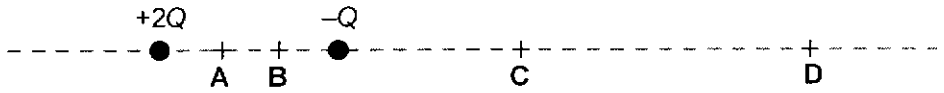
A 165 Hz **B** 330 Hz **C** 495 Hz **D** 660 Hz

17 A space shuttle orbits at a height of 330 km above the surface of the Earth. It carries two panels separated by a distance of 24 m. The panels reflect light of wavelength 500 nm towards a telescope on the Earth's surface, which has an aperture diameter of 85 mm.

Which of the following is correct?

	Can the two images be resolved in the telescope?	Angular separation of two sources as measured from aperture / rad
A	Yes	5.9×10^{-6}
B	Yes	7.3×10^{-5}
C	No	5.9×10^{-6}
D	No	7.3×10^{-5}

18 Two charges +2Q and −Q are situated as shown below.
At which point is the resultant electric field strength due to the two charges zero?

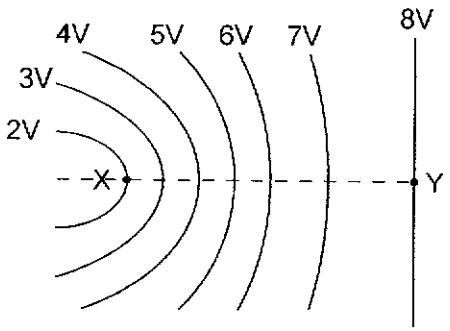


19 Two identical spherical drops of water, each carrying a charge of $+3.0 \times 10^{-11}$ C and with an electric potential of 500 V on its surface, combine to form a single spherical drop.

What is the approximate potential on the surface of the new drop formed?

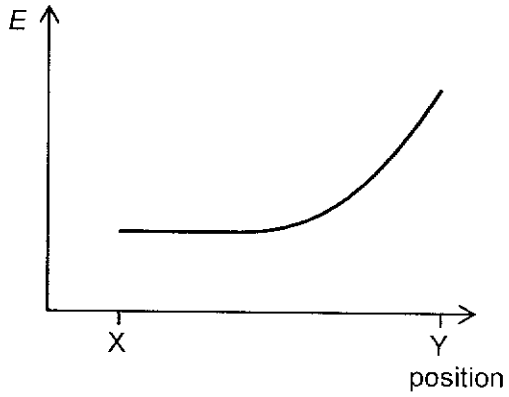
A 1000 V **B** 790 V **C** 540 V **D** 500 V

20 The diagram below shows some equipotential lines in the region of an electric field.

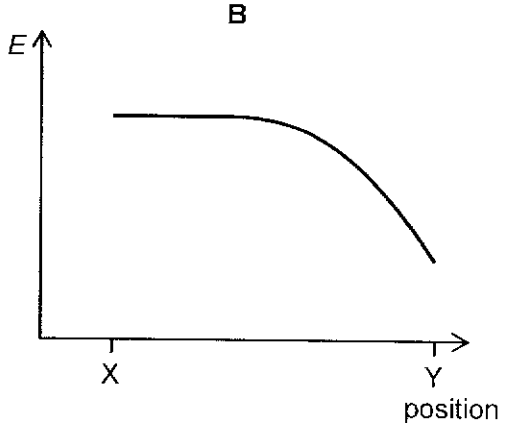


Which graph best shows the magnitude E of the electric field strength along the line XY?

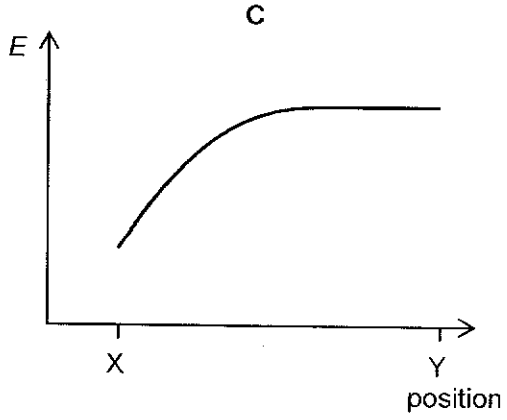
A



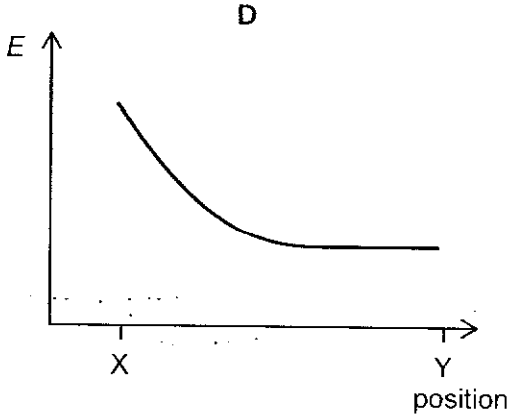
B



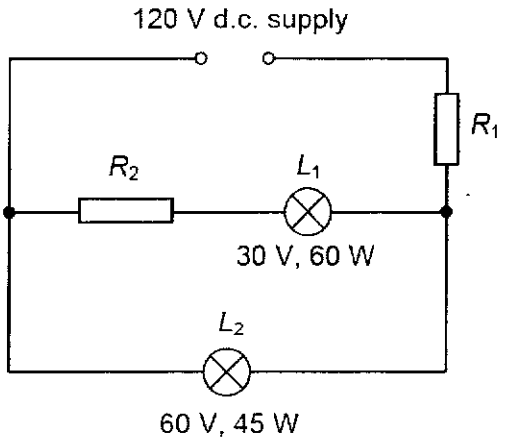
C



D



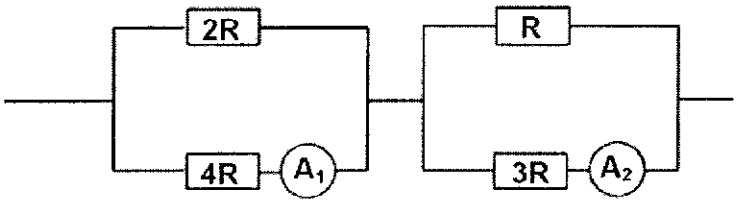
21 Two filament lamps L_1 and L_2 rated "30 V, 60 W" and "60 V, 45 W" respectively are connected across a 120 V d.c. supply of negligible internal resistance.



What is the value of the resistance R_1 if both the lamps are operating at their rated powers?

A 15 Ω **B** 22 Ω **C** 30 Ω **D** 80 Ω

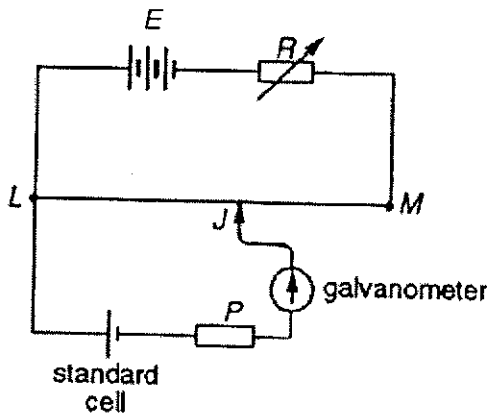
22 The circuit shown in the diagram below is connected to a power supply.



If ammeter A_1 reads 6.0 A, what is the reading on ammeter A_2?

A 13.5 A **B** 6.0 A **C** 4.5 A **D** 2.3 A

23 No balance point can be found for the potentiometer shown below.



Which of the following may allow a balance point to be found?

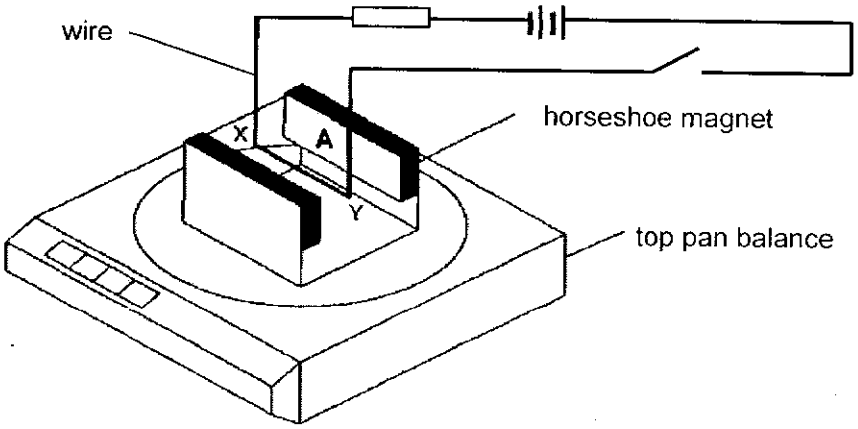
A increasing the resistance of the rheostat *R*.

B replacing the resistance wire LM with one of higher resistance.

C reversing the polarity of the driver cell *E*.

D replacing the resistor P with one of higher resistance.

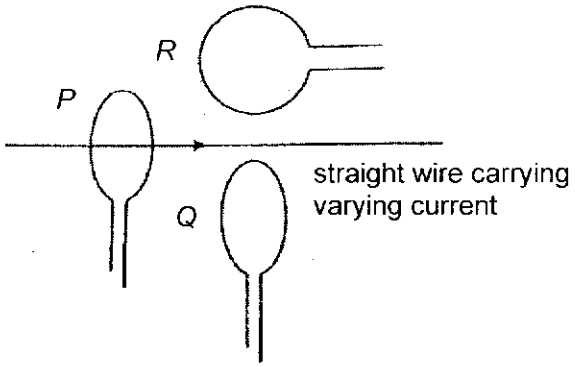
24 A horseshoe magnet rests on a top-pan balance with a wire XY situated between the poles of the magnet. The wire is part of the circuit as shown. When the switch is closed, the reading on the balance increases.



Which one of the following correctly gives the direction of the magnetic force on wire XY and the magnetic pole of face **A** of the horseshoe magnet?

	Direction of magnetic force on wire XY	Magnetic pole of face **A** of the horseshoe magnet
A	Upwards	North pole
B	Upwards	South pole
C	Downwards	North pole
D	Downwards	South pole

25 Three identical circular coils P, Q and R are placed near a long straight wire that carries a varying current. The planes of coils P and Q are perpendicular to the wire that passes through the centre of coil P. Coil R and the wire lie in the same plane.



Which of the coils will develop an e.m.f. across the ends?

A P only

B Q only

C R only

D P and Q only

26 Fig. 26 (a) shows conducting coil Q suspended from the ceiling directly above conducting coil P which is placed on a horizontal table. The variation of current I in coil Q with time t is shown in Fig. 26 (b).

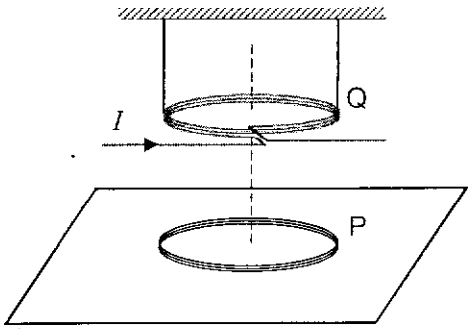


Fig. 26 (a)

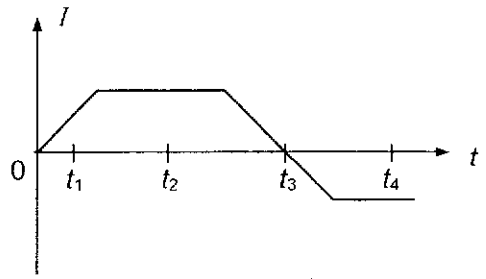


Fig. 26 (b)

Given that the weight of coil P is W, and the normal contact force acting on coil P by the table is N, which of the following is correct?

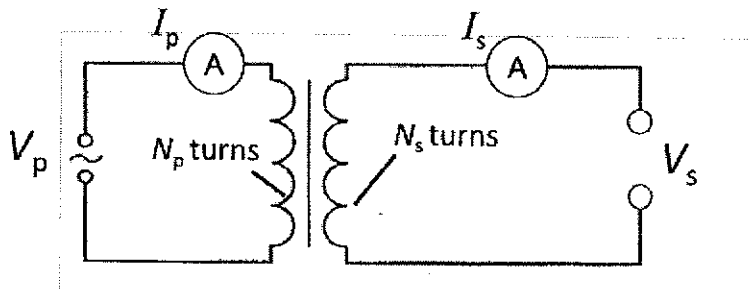
A At t_1, $N < W$

B At t_2, $N > W$

C At t_3, $N = W$

D At t_4, $N < W$

27 In a laboratory experiment to test a transformer, a student used the circuit as shown to take measurements.



Two of the data entries are missing from the student's table below:

V_p / V	I_p / mA	N_p turns	V_s / V	I_s / mA	N_s turns
240	2.0	?	?	50	50

Assuming the transformer is 100% efficient, what should the missing data entries be?

	N_p turns	V_s / V
A	25	9.6
B	25	480
C	1250	9.6
D	1250	6000

28 A moving electron of mass m and a photon have the same energy E.

The ratio of the wavelengths associated with them, $\frac{\lambda_{electron}}{\lambda_{photon}}$ is

A $\left(\frac{E}{2m}\right)^{\frac{1}{2}}$ **B** $c(2mE)^{\frac{1}{2}}$ **C** $\frac{1}{c}\left(\frac{2m}{E}\right)^{\frac{1}{2}}$ **D** $\frac{1}{c}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

29 Radon-222 ($^{222}_{86}Ra$) is a radioactive gas that decays randomly with a decay constant of 7.55×10^{-3} hour^{-1}.

The activity of radon gas in a sample of 4.80×10^{-3} m^3 of air taken from a building is 0.600 Bq.

Find the number of radon atoms in 1.00 m^3 of the air.

A 125

B 1.66×10^4

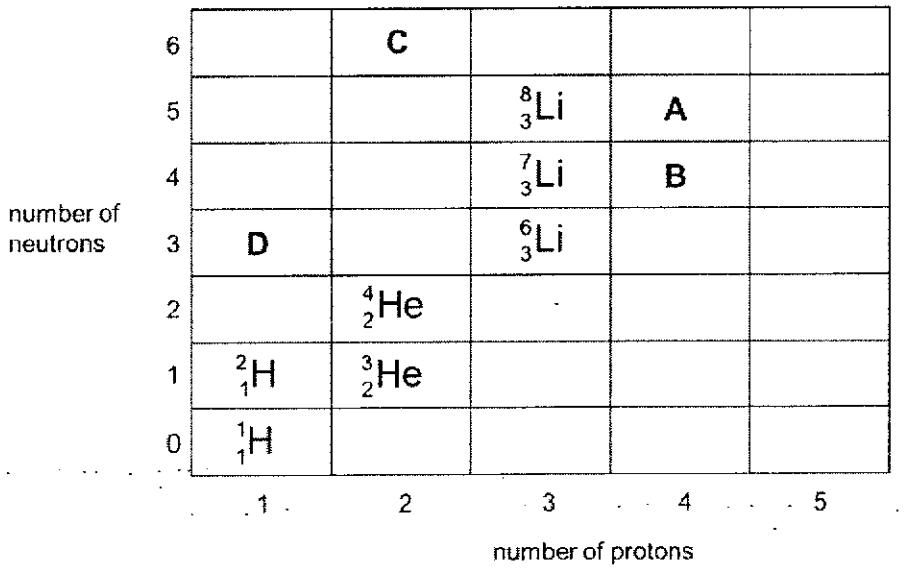
C 2.86×10^5

D 5.96×10^7

30 The grid shows a number of nuclides arranged according to the number of protons (x-axis) and the number of neutrons (y-axis) in each.

A nucleus of the nuclide $^{8}_{3}Li$ decays by emitting a β - particle.

What is the resulting nuclide?



END OF PAPER

2021 C2 Preliminary Examination H2 Physics Paper 1 Suggested Solutions

1	B	6	D	11	B	16	A	21	B	26	C
2	B	7	A	12	C	17	B	22	C	27	C
3	A	8	C	13	C	18	D	23	B	28	D
4	B	9	A	14	A	19	B	24	A	29	D
5	D	10	B	15	C	20	B	25	C	30	B

1 B Diameter of a ping-pong is 40 mm, so radius is 2 cm.

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(0.02)^3 = 3.35\times10^{-5}\ \text{m}^3$$

$$U = V\rho g = 3.35\times10^{-5}\times1000\times9.81 = 0.33\ \text{N}$$

A Let's take a small 1 tonne (10 000 kg) bus moving at 70 km h^{-1} (19.44 m s^{-1}).

$$\text{KE} \approx \frac{1}{2}(10000)(19)^2 = 1.8\ \text{MJ}$$

C A domestic bulb is around 25 to 100 W.

D Energy of a typical microwave photon = hc / λ
= $(6.63 \times 10^{-34})(3.00 \times 10^{8})$ / (3×10^{-2}) = 6.63×10^{-24} J.

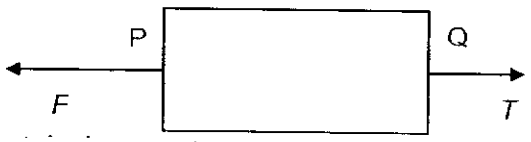
2 B Shortest path is perpendicularly across. Hence resultant velocity should be in this direction. To "eliminate" the downstream effect, $40\sin\theta = 10$, which gives θ of 14°.
Shortest time requires that the perpendicular velocity be largest. Hence θ = 0.

3 A The speed of the projectile should be decreasing to a non-zero minimum on reaching the top of its flight then increasing as it as it returns to the level where it is launched.

Only A satisfies the description of the variation of speed.

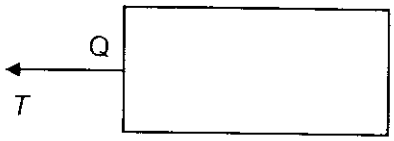
Note that the speed is the magnitude of the resultant of the vertical and horizontal velocities. This graph is rarely plotted.

4 B The train components share the same acceleration, *a* to the left.
Consider the middle carriage:



By N2L, $F - T = Ma$

Consider the last carriage:



By N2L, $T = Ma$

Thus $F - T = T \quad \Rightarrow \quad T = F/2$

5 D By applying PCM in East-West direction,
The total momentum of system before and after multiple collisions should be equal to zero.
Thus, after the ball has exited the box, momenta in East-West direction of both box and ball will be of opposite directions.
If the ball moves east, the box will move west.
Only option D is possible.

6 D $p_2 > p_1$
Upthrust is the product of the pressure difference and the cross-sectional area.
$U = p_2A - p_1A = (p_2 - p_1)\,A = Ah\rho_L g$

where ρ_L = density of the liquid (which is not provided in the question!)

7 A Since the system is in equilibrium, the mass of the non-uniform rule can be found as 200 g – 64 g = 136 g.

Taking moments about 34.0 cm mark,
$136 \times d = 64 \times (34 - 4)$
$d = 14.1$ cm

Hence centre of mass = 34.0 + 14.1 = 48.1 cm.

8 C In Fig. 9., the vector sum of the tension force and the weight provides **the centripetal force** to allow the mass to move in circular motion.
$T - mg = ma_c$
$T = (mg + ma_c) > mg$
The tension force pulling the mass upwards is equal and opposite to the tension force pulling the balance downward. (Both form the tension in the string)
The balance reading is given by $T / g > m$ i.e. > 50 g

9 A
At the pole, $g = \dfrac{GM}{R^2}$ ----------(1)

At height h, $0.99g = \dfrac{GM}{(R+h)^2}$ ----------(2)

$\dfrac{(2)}{(1)}$ $\quad 0.99 = \dfrac{R^2}{(R+h)^2}$

$$R + h = \frac{R}{\sqrt{0.99}}$$

$$h = \left(\frac{1}{\sqrt{0.99}} - 1\right)(6400) = 32 \text{ km}$$

10 B For a satellite of mass m in orbit at distance r from Earth of mass M
its KE can expressed as $K = GMm / 2r$, i.e. K is proportional to $1/r$.
its GPE $U = - GMm / r = - 2K$
its total energy $T = - GMm / 2r = - K$

11 B Internal energy is the sum of a random distribution of kinetic and potential energies associated with the molecules of a system.

A is false during the change in states of the matter. However, the converse is true; i.e. when the temperature increases, internal energy increases.

B is true when work is done on the system.

C is false in general.
Consider the two separate gases (e.g. hydrogen and helium) having different amount in moles but same internal energy, they have different average kinetic energies, and hence different temperatures.

D is false. It should be the change (increase) of internal energy, not the internal energy itself.

12 C $\frac{1}{2} m c^2 = \frac{3}{2} kT$ where T is thermodynamic temperature, c is the r.m.s. speed.

$$\frac{T_f}{T_i} = \frac{c_f^2}{c_i^2}$$

$$\frac{T_f}{127 + 273_i} = \frac{(2c_i)^2}{c_i^2}$$

$$T_f = 1600\text{K}$$

$$\Delta T = 1600 - 400 = 1200\text{K or } 1200^\circ\text{C}$$

13 C Since the graph shows that U increases as the body moves away from the equilibrium position, by applying $F = -\mathrm{d}U/\mathrm{d}x$ to the graph, it is shown that force F acts in the opposite direction to displacement x, ie force is directed towards O.

14 A Using Malus' law,

$$0.7I_0 = I_0 \cos^2\theta$$

$$\theta = 33^\circ, (180^\circ + 33^\circ)$$

$$\theta = 213^\circ$$

15 C When a loud sound is heard for the 3rd time:

$$l = \frac{5}{4}\lambda$$

$$15 = 1.25\lambda$$

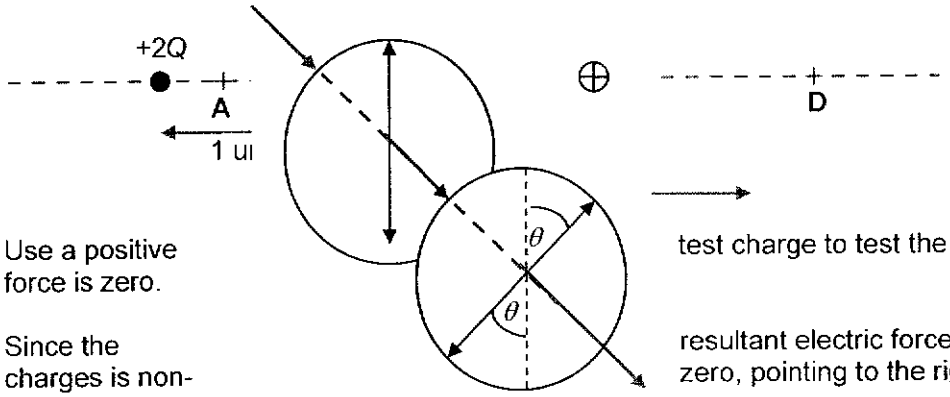
$$\lambda = 12\text{ cm}$$

16 A Path difference = 1 m
For the first minimum, path difference = $\lambda/2$ = 1 m
λ = 2 m

$v = f\lambda$
$330 = f(2)$
$f = 165$ Hz

17 B $s = r\theta$
$\theta = s/r = 24/330\,000 = 7.3 \times 10^{-5}$
Min resolution = $\lambda/b = 5.9 \times 10^{-6}$ rad < 7.3×10^{-5} rad

18 D



Use a positive test charge to test the point where electric force is zero.

Since the resultant electric force between the charges is non-zero, pointing to the right - eliminate A and B.

On the right side, the positive test charge experiences a rightward repulsive force due to +2Q and a leftward attractive force due to –Q. Let the neutral point be distance x from –Q.

$$\frac{1}{4\pi\varepsilon_0}\left(\frac{2Q}{(1+x)^2}+\frac{-Q}{x^2}\right)=0$$

$$2x^2=(1+x)^2$$

$$x^2-2x-1=0$$

$$x = 2.4 \text{ units}$$

Thus, the best answer is D.

Alternatively, test position C:

E due to +2Q $\propto$ 2Q/ 2^2 = Q/2
E due to –Q $\propto$ Q/ 1^2 = Q

Thus they can't cancel one another.

19 B Volume of each drop = $\frac{4}{3}\pi r^3$

When combined,

$$2\left(\frac{4}{3}\pi r^3\right)=\frac{4}{3}\pi r_c^{\,3}$$

$r_c = \sqrt[3]{2}r$

for each sphere: $V=\frac{Q}{4\varepsilon_0\pi r}=500\text{V}$

when combined,

potential at surface $V' = \frac{2}{\sqrt[3]{2}}(500) = 790\text{V}$

20 B $|E| = \frac{dV}{dr}$ or gradient of the V-r graph.

From 2V to 6V, $|E| = \frac{\Delta V}{\Delta r}$ is constant. From 6V to 8V, the distance Δr between same potential difference (ΔV = 1V) gets larger, thus $|E|$ decreases.

21 B Current through L_1 = 60 / 30 = 2.0 A
Current through L_2 = 45 / 60 = 0.75 A
Current throug R_1 = 2.75
R_1 = 60/2.75 = 22 Ω

22 C Current through 4R = 6.0 A

Current through 4R = 0.5 x (current through 2R)

Current through 2R = 12 A

Total current = 12 + 6 = 18 A

Total current through R and 3 R = 18 A

Current through R = 3 x (current through 3R)

Current through 3 R = 18 / 4 = 4.5 A

23 B The p.d. across LM is less than e.m.f. of the standard cell. Thus, if resistance of LM increased, its p.d. will increase to a value beyond e.m.f. of the standard cell, resulting in a balance point.

24 A As the top pan balance's reading increases when there is a current in direction YX in the wire, there must be a force pushing the horseshoe magnet down against the balance. By Newton's 3rd Law, the magnetic force on the wire must be upwards. (There is a repulsion force between the wire and magnet)
By applying FLHR on the wire, the direction of magnetic flux density due to the horseshoe magnet can be determined to be coming out of face A. Thus, face A of the horseshoe magnet must be a North pole.

25 C Direction of magnetic flux density due to current in straight wire is determined by using RHGR.
Plane of coils *P* and *Q* is parallel to the magnetic flux density due to current in straight wire, thus no magnetic flux link with coils *P* and *Q*.
Plane of coil *R* is perpendicular to the magnetic flux density due to current in straight wire. Thus as the current in wire varies, there will be rate of change of magnetic flux linkage with coil *R*. Hence an e.m.f. is induced across the ends of coil *R*.

26 C At t_1, increasing current in coil Q causes increase in B field generated by Q.
The induced emf in coil P is proportional to the rate of increase in magnetic flux at P. By Lenz's Law, induced current in P flows to generate a magnetic field to oppose the increase in magnetic flux.
That results in repulsion of the two coils. Due to the downward magnetic force on coil P, the normal contact force, *N* will now have the magnitude of (magnetic force + *W*), greater than *W*.

At t_2 and t_4, $N = mg$ since there is no change in flux, there is no induced emf or current.

At t_3, although there is induced current in P, there is no current in Q,
thus there is no magnetic interaction, $N = W$.

27 C $\frac{I_s}{I_p} = \frac{N_p}{N_s}$ and $\frac{N_p}{N_s} = \frac{V_p}{V_s}$

$\frac{50}{2} = \frac{N_p}{50} \rightarrow N_p = 1250$ turns

$\frac{N_p}{N_s} = \frac{V_p}{V_s} \rightarrow V_s = V_p \frac{N_s}{N_p} = 240\left(\frac{50}{1250}\right) = 9.6$ V

28 D Let p be the momentum of the electron.

kinetic energy of electron $E = \frac{p^2}{2m} \quad \Rightarrow p = \sqrt{2mE}$

de Broglie wavelength: $\lambda_{electron} = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

Energy of a photon $E = \frac{hc}{\lambda_{photon}} \quad \Rightarrow \lambda_{photon} = \frac{hc}{E}$

$\frac{\lambda_{electron}}{\lambda_{photon}} = \frac{h}{\sqrt{2mE}} \times \frac{E}{hc} = \frac{1}{c}\sqrt{\frac{E}{2m}}$

29 D Activity in 1.00 m^3 of the air: $0.600 / 4.8 \times 10^{-3} = 125$ Bq

$A = \lambda N \rightarrow N = \frac{A}{\lambda} = \frac{125}{7.55 \times 10^{-3} / 3600} = 5.96 \times 10^7$ Radon atoms

Option A: Students may have thought that the activity is equivalent to the number of radon atoms.
Option B: Students did not convert hour into second for the decay constant.

$A = \lambda N \rightarrow N = \frac{A}{\lambda} = \frac{125}{7.55 \times 10^{-3}} = 1.66 \times 10^4$

Option C: Students did not determine the activity in 1.00 m^3 of the air.

$A = \lambda N \rightarrow N = \frac{A}{\lambda} = \frac{0.600}{7.55 \times 10^{-3} / 3600} = 2.86 \times 10^5$

30 B ${}^{8}_{3}\text{Li} \rightarrow {}^{8}_{4}\text{X} + {}^{0}_{-1}\beta$, the nuclide X will have **4** protons and 4 neutrons.