| Class | Index Number | Name |
|---|---|---|
| 24S | | |

**ST. ANDREW'S JUNIOR COLLEGE**
**JC 2 2025**
**Preliminary Examination**

**PHYSICS, Higher 2** **9749/01**

Paper 1 Multiple Choice **19th September 2025**
**1 hour**

Additional Materials: Multiple Choice Answer Sheet

**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil..
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and Civics Group the Answer Sheet in the spaces provided.

There are **thirty** 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.

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.

| For Examiner's Use | |
|---|---|
| Total | / 30 |

This document consists of **19** printed pages including this page.

## 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$^{-1}$ |
| | $= (1/(36\pi)) \times 10^{-9}$ 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 | $p = \rho g h$ |
| 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 translational kinetic energy of an ideal gas molecule | $E = \frac{3}{2}kT$ |
| displacement of particle in s.h.m. | $x = x_o \sin \omega t$ |
| velocity of particle in s.h.m. | $v = v_0 \cos \omega t$ |
| | $v = \pm\omega\sqrt{x_0^2 - x^2}$ |
| 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 | $V = \frac{Q}{4\pi\varepsilon_0 r}$ |
| alternating current/voltage | $x = x_o \sin \omega t$ |
| magnetic flux density due to a long straight wire | $B = \frac{\mu_0 I}{2\pi d}$ |
| magnetic flux density due to a flat circular coil | $B = \frac{\mu_0 NI}{2r}$ |
| magnetic flux density due to a long solenoid | $B = \mu_0 nI$ |
| radioactive decay | $x = x_o \exp(-\lambda t)$ |
| decay constant | $\lambda = \frac{\ln 2}{t_{1/2}}$ |

## Answer all questions.

**1** The Clausius-Clapeyron equation for measuring relative vapour pressure of a gas $\frac{P}{P_o}$ , at a temperature T is as follows:

$$\frac{P}{P_o} = e^{-\frac{\Delta H}{R}\left(\frac{1}{T}-\frac{1}{T_o}\right)}$$

where $\Delta H$ is the enthalpy of vaporization, $R$ is the molar gas constant, $P$ and $P_o$ are the final and initial pressures and $T_o$ is the initial temperature of a gas.

Which of the following has the same units as $\Delta H$?

**A** energy per mole

**B** molar gas constant

**C** temperature

**D** no units

**2** A student made a series of measurements of the diameter $d$ of a wire using four micrometer screw gauges A, B, C and D. The table shows the measurements taken.

If the actual diameter of the wire was 1.49 mm, which micrometer screw gauge produced a set of readings that could be described as accurate but not precise?

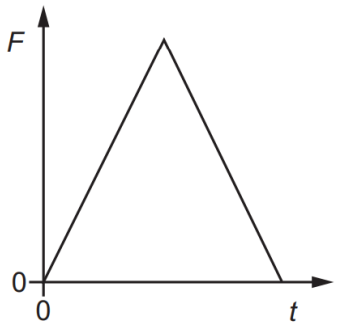
| micrometer screw gauge | Readings $d$ / mm | | | |
|---|---|---|---|---|
| **A** | 1.49 | 1.46 | 1.52 | 1.50 |
| **B** | 1.48 | 1.58 | 1.51 | 1.40 |
| **C** | 1.35 | 1.37 | 1.42 | 1.42 |
| **D** | 1.32 | 1.37 | 1.41 | 1.50 |

**3** Two cars, initially next to each other and at rest, accelerate in the same straight line at different uniform rates. After 3 s, they are 36 m apart.

If they continue to accelerate at the same rate, how far apart will they be 5 s after they started?

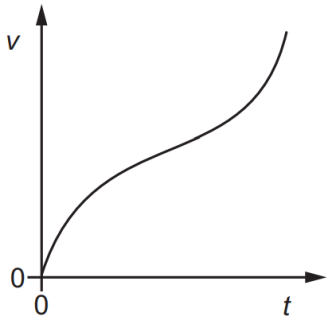
**A** 60 m **B** 96 m **C** 100 m **D** 256 m

**4** A golf club hits a golf ball. The graph shows how the force $F$ on the ball varies with time $t$.

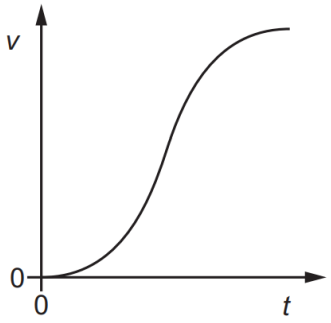



Which graph shows how the velocity $v$ of the ball varies with time $t$?

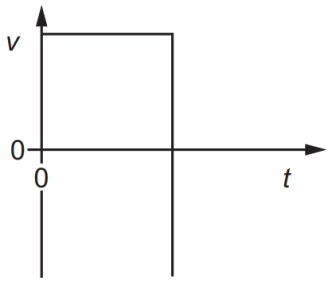
**A**



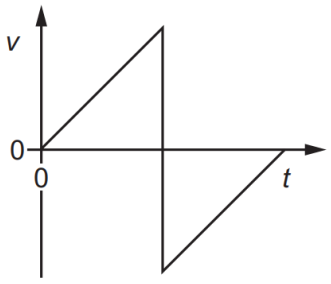

**B**




**C**




**D**



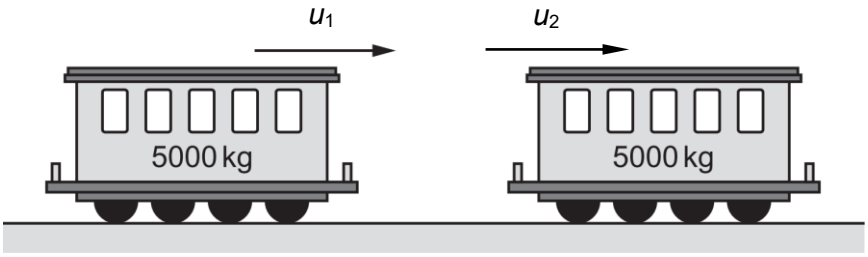
**5** A stream of water from a hose travels horizontally at speed $v$. The stream strikes a brick wall and falls vertically down it without splashing.

The stream of water is a cylinder of cross-sectional area $A$. The water has density $\rho$.

Which expression is the force exerted on the wall by the water?

**A** $\frac{1}{2}A\rho v^2$ **B** $A\rho v^2$ **C** $\frac{3}{2}A\rho v^2$ **D** $2A\rho v^2$

**6** Two train carriages each of mass 5000 kg roll toward one another on a horizontal frictionless track. One is travelling at a velocity of $u_1$ and the other at a velocity of $u_2$, as shown.

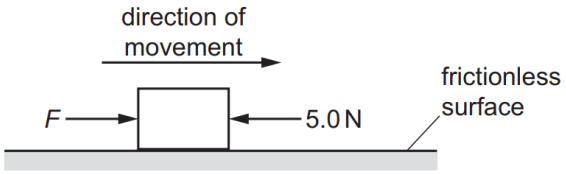



They collide and join together and have a final speed of 0.50 m s$^{-1}$ towards the right after the collision. During the collision, 11 250 J of kinetic energy was lost.

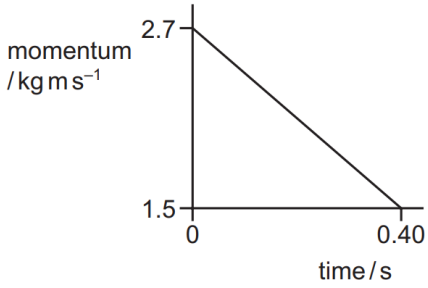
Taking rightward to be positive, what is $u_2$?

**A** − 2.0 m s$^{-1}$ **B** − 1.0 m s$^{-1}$ **C** 1.0 m s$^{-1}$ **D** 2.0 m s$^{-1}$

**7** A block is moving along a horizontal frictionless surface. A constant force $F$ and a constant resistive force of 5.0 N act on the block as it is moving in the direction of the force $F$, as shown.



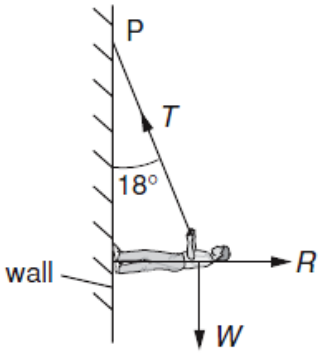

The graph shows the variation with time of the momentum of the block.




What is the magnitude of force $F$?

**A** 2.0 N **B** 4.2 N **C** 5.8 N **D** 8.0 N

**8** A climber is supported by a light rope on a vertical wall as shown.

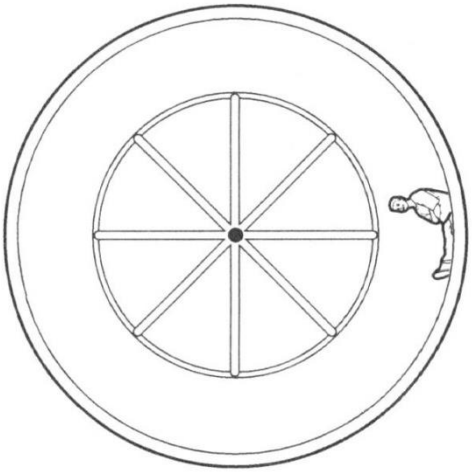



The weight $W$ of the climber is 520 N and the reaction force $R$ acts at right angles to the wall. The climber is in equilibrium.

Which row shows the value of the tension $T$ in the rope and $R$?

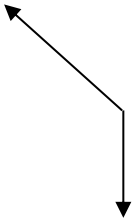
| | $T$ / N | $R$ / N |
|---|---|---|
| **A** | 500 | 150 |
| **B** | 500 | 480 |
| **C** | 550 | 170 |
| **D** | 550 | 520 |

**9** On a fairground ride, passengers are rotated in a vertical circle at a constant angular speed. A passenger is shown in the diagram when he is at the side of the circle.

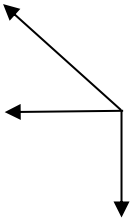


Which of the following diagrams best illustrates the forces acting on the passenger in this position?

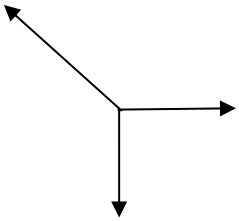
**A**



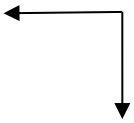
**B**



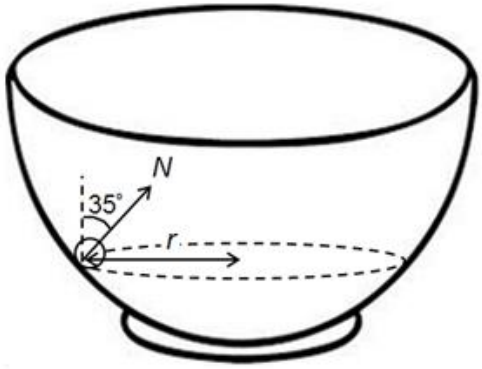
**C**



**D**



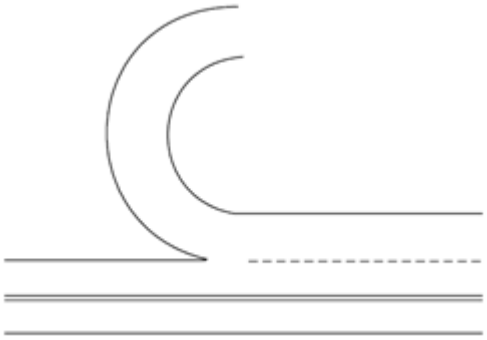
**10** A small glass marble is moving in a horizontal circle round the inside surface of a smooth bowl. Its angular velocity is 8.0 rad $s^{-1}$ and the normal reaction *N* acting on the marble is inclined at 35° to the vertical as shown.




What is the radius *r* of the horizontal circle?

**A** 0.050 m **B** 0.070 m **C** 0.090 m **D** 0.11 m

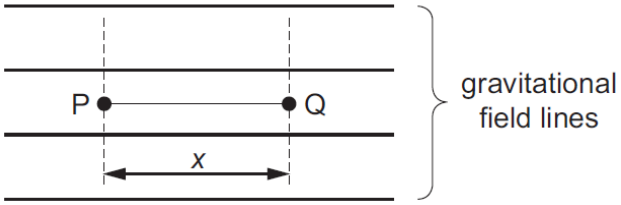
**11** Many highway entrance and exit roads are circular and designed for cars moving at 50 km $h^{-1}$.



To design a similar road for a speed of 100 km $h^{-1}$ the engineers should increase the radius of the circular section by a factor of

**A** $\sqrt{2}$ **B** 2 **C** 3 **D** 4

**12** A mass $m$ is situated in a uniform gravitational field.

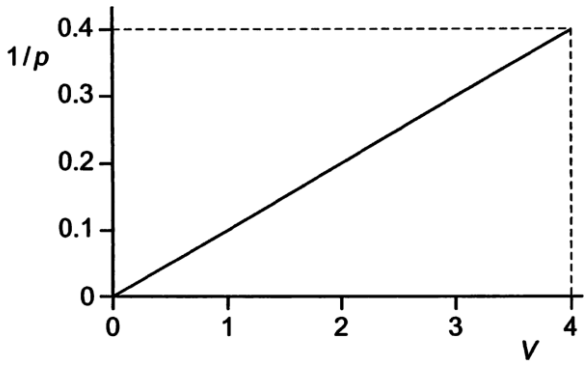



When the mass moves through a displacement $x$, from P to Q, it loses an amount of potential energy $E$.

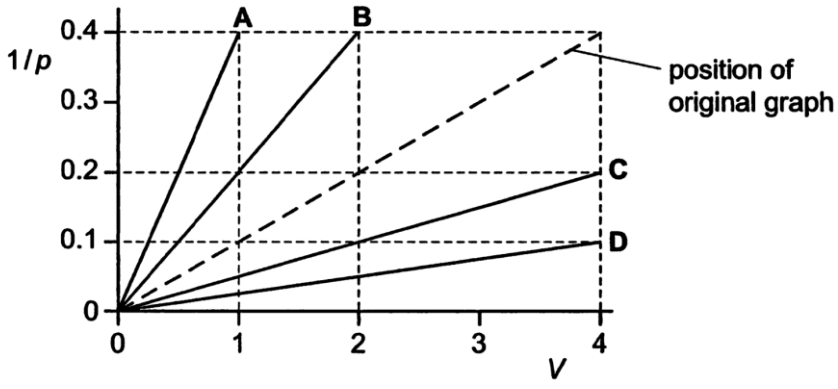
Which row correctly specifies the magnitude and the direction of the acceleration due to gravity in this field?

| | magnitude | direction |
|---|---|---|
| **A** | $\frac{E}{mx}$ | → |
| **B** | $\frac{E}{mx}$ | ← |
| **C** | $\frac{E}{x}$ | → |
| **D** | $\frac{E}{x}$ | ← |

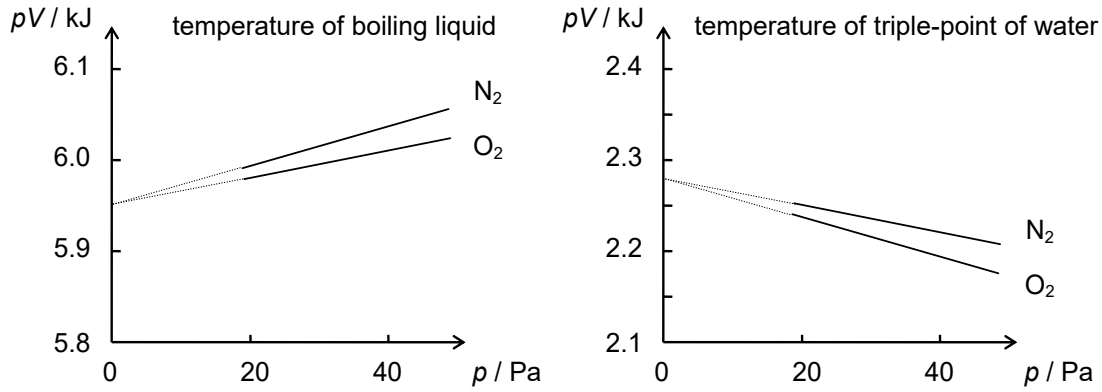
**13** A fixed amount of an ideal gas has pressure $p$ and volume $V$. The graph shows the variation of $1/p$ with $V$ at a constant temperature.




The amount of gas and the thermodynamic temperature are both halved. Which line will be produced?



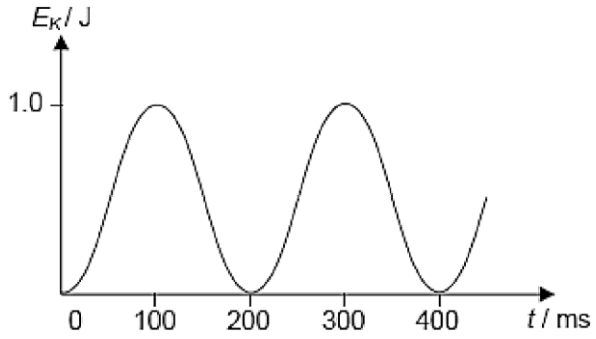
**14** The graphs below show how $pV$ varies with $p$, for a sample of nitrogen gas and oxygen gas at the temperature of a boiling liquid and at the temperature of the triple point of water in a constant volume gas thermometer.




Which of the following is the probable thermodynamic temperature of the boiling liquid?

**A** 2.6 K **B** 13.5 K **C** 373 K **D** 714 K

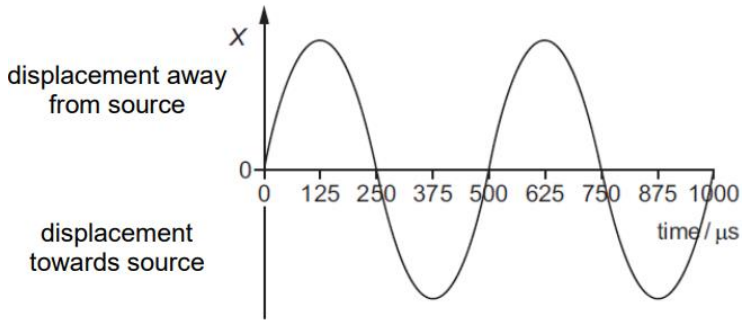
**15** A particle of a mass of 90.0 g undergoes simple harmonic motion. The graph below shows the variation of its kinetic energy, $E_K$ with time, $t$.




What is the maximum acceleration of the particle?

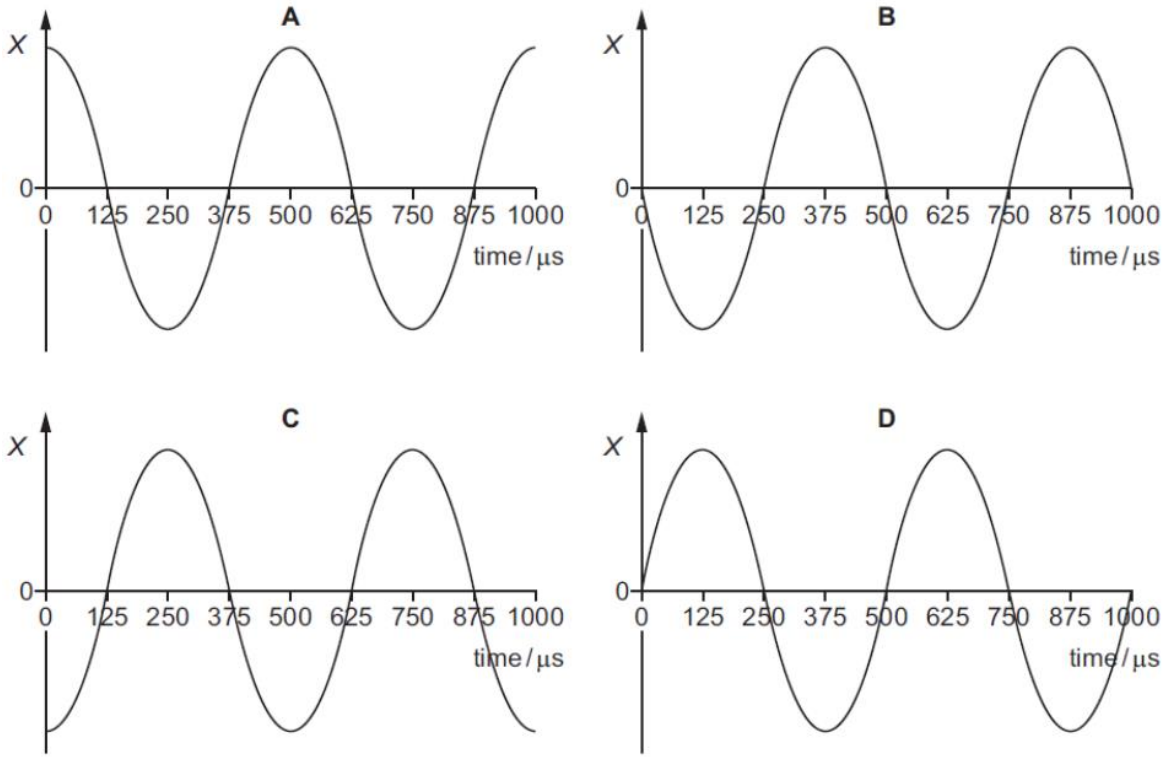
**A** 0.074 m $s^{-2}$ **B** 0.148 m $s^{-2}$ **C** 37 m $s^{-2}$ **D** 74 m $s^{-2}$

**16** The graph shows the variation with time of the displacement X of an air particle as a continuous sound wave passes through the air.



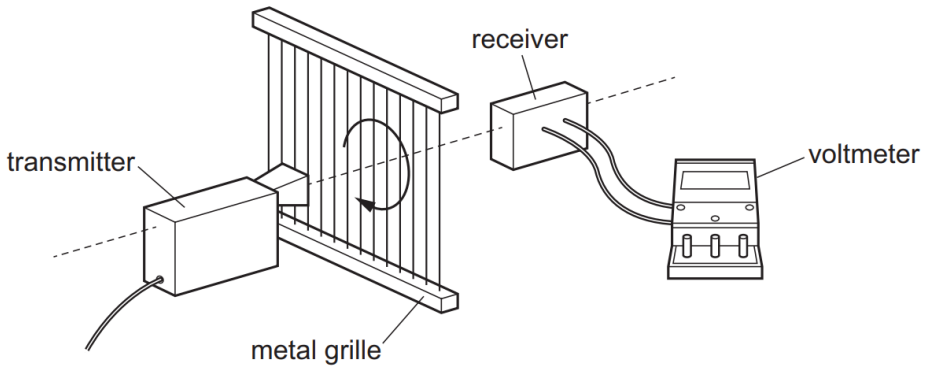

The speed of sound in the air is 330 m $s^{-1}$. All the graphs below have the same scales for the time axes as the graph above.

What is the displacement-time graph for another particle that is 0.04125 m away in the direction of the wave motion from this particle?



**17** A student investigates the polarisation of microwaves. The microwaves from the transmitter are vertically polarised. A metal grille acts as a polarising filter when placed between the microwave transmitter and the receiver. The reading on the voltmeter is proportional to the intensity of microwaves transmitted through the grille.

When the transmission axis of the grille is vertical, the voltmeter reads 3.50 V.

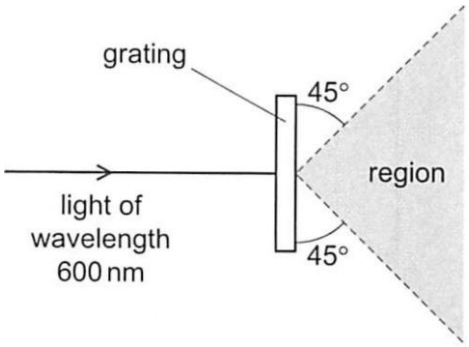



The grille is then rotated through an angle $\theta$. The voltmeter now reads 2.20 V.

What is $\theta$?

**A** 37.5° **B** 39.0° **C** 51.0° **D** 52.5°

**18** A parallel beam of light of wavelength 600 nm is incident normally on a diffraction grating. The grating has 500 lines per millimetre.




How many beams of coherent light emerge from the grating within the shaded region shown in the diagram?

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

**19** 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?

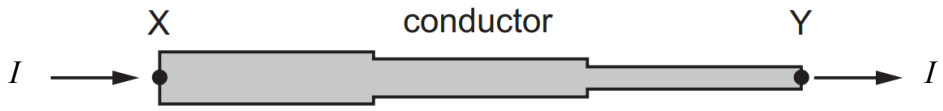
**A** Decrease the frequency of the wave.

**B** Decrease the time period of the wave.

**C** Decrease the width of the slit.

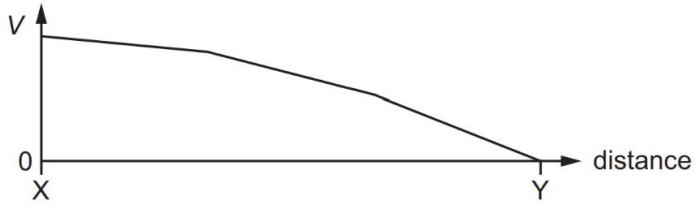
**D** Increase the wavelength of the wave.

**20** A conductor consists of three wires connected in series. The wires are all made of the same metal but have different cross-sectional areas. There is a current $I$ in the conductor.

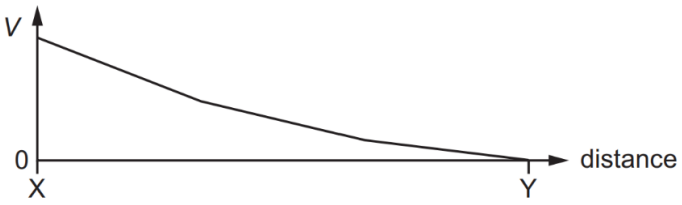



Point Y on the conductor is at zero potential. Which graph best shows the variation of potential $V$ with distance along the conductor?

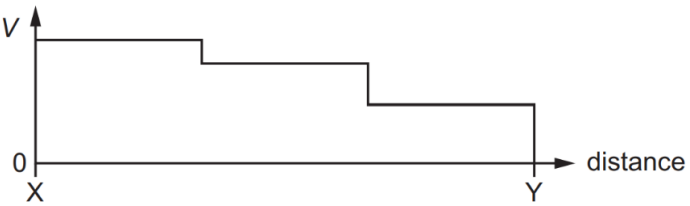
**A**



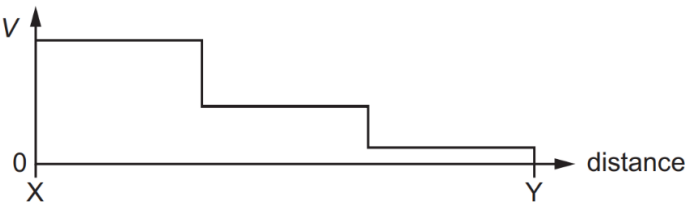

**B**




**C**



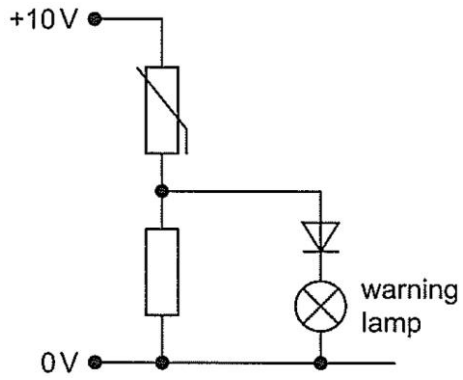

**D**



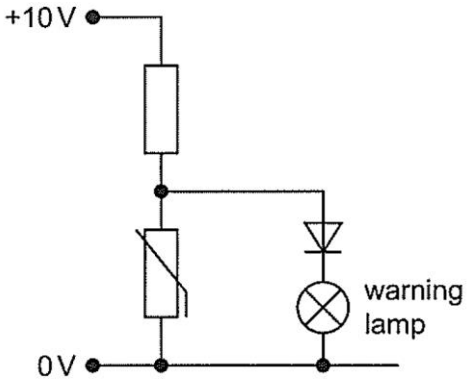
**21** A circuit is needed which switches on a warning lamp when the temperature of a thermistor is too high.

Which of the following circuits is suitable?

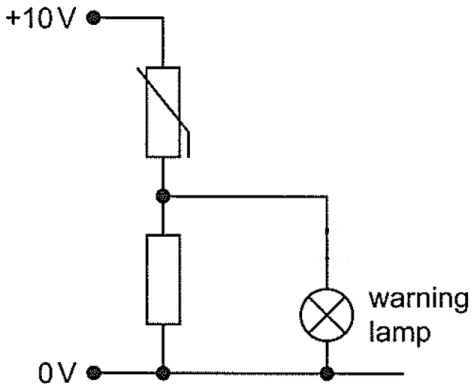
**A**



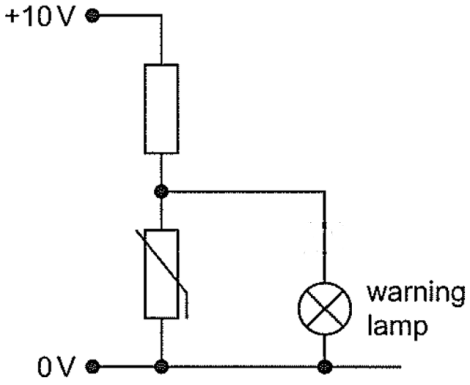

**B**




**C**



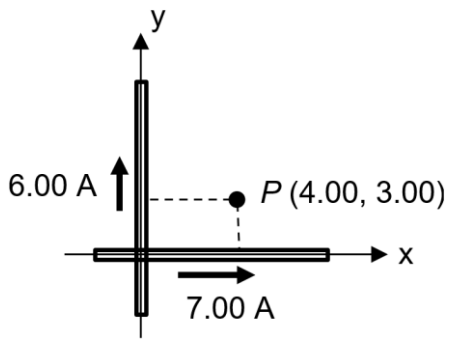

**D**



**22** Two charges +2*Q* and -*Q* are situated as shown below.

At which point can the resultant potential due to the two charges be zero?

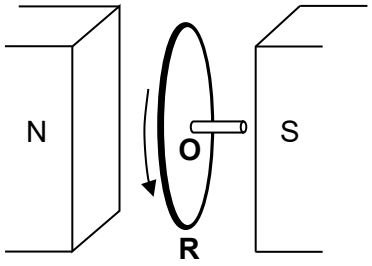

**23** A wire carries a 7.00 A current along the x-axis and another wire carries a 6.00 A current along the y-axis, as shown below.




Which of the following shows the magnetic flux density at point *P*, located at x = 4.00 m, y = 3.00 m?

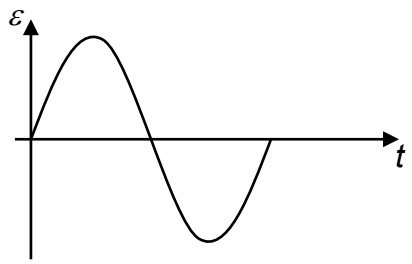
| | Magnetic flux density / T | Direction |
|---|---|---|
| **A** | $1.67 \times 10^{-7}$ | out of page |
| **B** | $1.67 \times 10^{-7}$ | into page |
| **C** | $7.67 \times 10^{-7}$ | out of page |
| **D** | $7.67 \times 10^{-7}$ | into page |

**24** The figure below shows a copper disc rotating steadily about its centre O in a uniform magnetic field between two bar magnets. The magnetic field is acting perpendicularly to the disc.

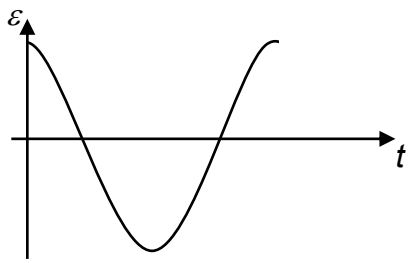



Which of the following graphs correctly shows the variation of the induced e.m.f. $\varepsilon$ between the centre **O** and a point **R** on the rim of the disc with time $t$?

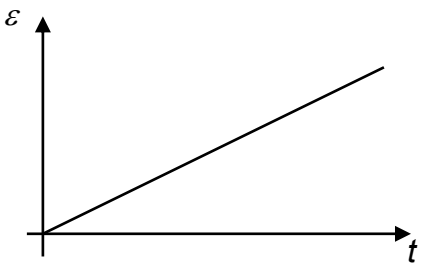
**A**



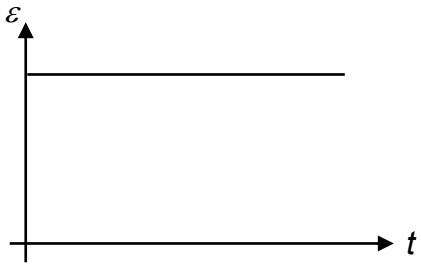

**B**



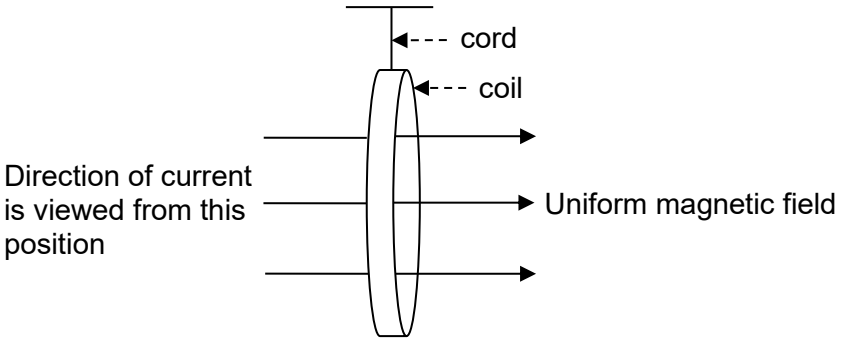

**C**




**D**



**25** A rigid conducting coil has 100 turns and a cross-sectional area of $8.0 \times 10^{-3}$ $m^2$. It is freely suspended by a non-conducting cord. A uniform magnetic field is directed at right angles to the plane of the loop as shown in the figure.




The magnetic flux density of the uniform magnetic field is changed steadily from 20 mT to 80 mT over a period of 4.0 s.

What is the direction of the induced current as viewed from the position indicated in the figure and the average e.m.f. induced in the coil during this time?

| | Direction of induced current | Magnitude of induced e.m.f. / V |
|---|---|---|
| **A** | clockwise | $1.6 \times 10^{-2}$ |
| **B** | anti-clockwise | $1.6 \times 10^{-2}$ |
| **C** | clockwise | $1.2 \times 10^{-2}$ |
| **D** | anti-clockwise | $1.2 \times 10^{-2}$ |

**26** A generator produces a current of 60 A r.m.s. at a voltage of 120 V r.m.s. The voltage is stepped up to 4500 V r.m.s. by an ideal transformer and transmitted through a power line of total resistance 1.0 Ω.

What percentage of the power is lost in the transmission line?

**A** 0.048 % **B** 0.036 % **C** 0.024 % **D** 0.018 %

**27** A metal surface is illuminated with a beam of monochromatic electromagnetic radiation. By the photoelectric effect, photoelectrons may be emitted from the metal surface.

Which statement about the photoelectrons is correct?

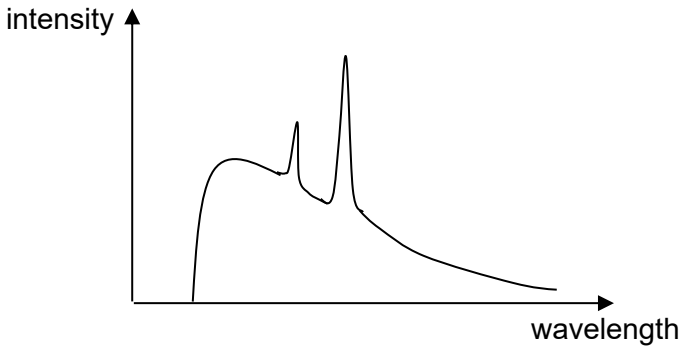
**A** No emission of photoelectrons occurs if the radiation is of a very low intensity.

**B** Photoelectrons are emitted only if the wavelength of the radiation is greater than a minimum value.

**C** The maximum speed of the photoelectrons emitted increases when the intensity of the radiation increases at constant frequency.

**D** The rate of emission of photoelectrons decreases when the frequency of the radiation increases at constant intensity.

**28** The following graph shows the spectrum of X-rays emitted from an X-ray tube.




If the potential difference between the target and cathode is increased, which one of the following combinations represents a possible change in wavelength and intensity of the peaks?

| | wavelength | intensity |
|---|---|---|
| **A** | remain the same | Increase |
| **B** | decrease | remain the same |
| **C** | remain the same | remain the same |
| **D** | decrease | increase |

**29** The rest-masses of deuteron ${}^{2}_{1}H$ , proton and neutron are 2.0150u, 1.0086u and 1.0097u respectively. Which one of the following reactions takes place so that the deuteron may disintegrate to a proton and neutron?

**A** Releasing a photon of energy 2 MeV.

**B** Releasing a photon of energy 3 MeV.

**C** Capturing a photon of energy 2 MeV.

**D** Capturing a photon of energy 3 MeV.

**30** In a therapy unit, patients are given treatment from a certain radioactive source. This source has a half-life of 4 years. A particular treatment requires 10 minutes of irradiation when the source is first used.

How much time is required for this treatment, using the same source, 2 years later?

**A** 7 minutes **B** 12 minutes **C** 14 minutes **D** 20 minutes

**End of Paper**

# JC2 H2 Physics 2025 Preliminary Exam

## Paper 1 Solutions

| Qn | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans | A | B | C | B | B | B | A | C | A | D |

| Qn | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans | D | A | A | D | D | C | A | D | B | A |

| Qn | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans | A | C | A | D | D | B | D | A | D | C |

**1 Ans: A**

$[\Delta H] = [RT] = J\ mol^{-1}\ K^{-1} \times K = J\ mol^{-1}$

**2 Ans: B**

Option C and D is out as they can be seen to be inaccurate. Option A and B, each has average value of 1.4925, which is accurate. But Option B is less precise than Option A.

**3 Ans: C**

After 3 s, $x_2 - x_1 = (u_1t + \frac{1}{2} a_1t^2) - (u_2t + \frac{1}{2} a_2t^2)$

$36 = (0 + \frac{1}{2} a_1(3^2) - (0 + \frac{1}{2} a_2(3^2))$

$a_1 - a_2 = 8$

After 5 s, $x_2' - x_1' = \frac{1}{2} a_1(5^2) - \frac{1}{2} a_2(5^2)$

$= \frac{1}{2} (5^2)(a_1 - a_2)$

$= \frac{1}{2} (5^2)(8)$

$= 100$ m

**4 Ans: B**

Acceleration-time graph is similar to the force-time graph.
Acceleration is the gradient of v-t graph.

Since acceleration is (i) always positive, (ii) increases and decreases,
therefore gradient of v-t is also always positive, and increases and decreases.

**5 Ans: B**

Change in momentum = final – initial = 0 – mv

Force = rate of change in momentum

$= \frac{mv}{t} = \frac{V\rho}{t} = \frac{AL\rho v}{t} = A\rho v^2$

**6 Ans: B**

Taking rightward to be positive,

$5000u_1 + 5000u_2 = 10000(0.50)$

$u_1 + u_2 = 1$ --- (1)

and $\frac{1}{2}(5000)u_1^2 + \frac{1}{2}(5000)u_2^2 = \frac{1}{2}(10000)(0.5^2) + 11250$

$u_1^2 + u_2^2 = 5$ --- (2)

Solving the simultaneous equation, we get either

- $u_1 = -1.0$ m s$^{-1}$ and $u_2 = 2.0$ m s$^{-1}$, OR
- $u_1 = 2.0$ m s$^{-1}$ and $u_2 = -1.0$ m s$^{-1}$

The first set of answers is rejected because in this case, the carriages are moving away from each other at the start and will never collide.

Hence, only the second set of answers is possible. Therefore, $u_2 = -1.0$ m s$^{-1}$.

**7 Ans: A**

From the graph, the resultant force = gradient of graph = −3.0 N
Since the block is slowing down, net force is towards the left.
Hence, F is smaller than 5.0 N by 3.0 N.
Therefore F = 5.0 – 3.0 = 2.0 N.

**8 Ans: C**

$$T\cos 18° = W$$

$$T = \frac{520}{\cos 18°} = 550 \text{ N}$$

$$T\sin 18° = R$$

$$R = \frac{520}{\cos 18°}(\sin 18°) = 170 \text{ N}$$

**9 Ans: A**

One force is the resultant of the normal contact force and friction. The other force is the weight.
The overall resultant must provide a horizontal centripetal force towards the centre of circle.

**10 Ans: D**

Vertical component of N = weight *mg*
Horizontal component of N provides centripetal force = $mr\omega^2$
Solve the simultaneous equations to find *r*.

**11 Ans: D**

$F = mv^2/r$
For same F and m, $v^2 \propto r$
$r_1 / r_2 = (100/50)^2 = 4$
$r_1 = 4\ r_2$

**12 Ans: A**

Since $\Delta\phi = \frac{E}{m}$, magnitude of g = $\frac{\Delta\phi}{x} = \frac{E}{mx}$

Potential at P > potential at Q since mass loses potential energy as it moves from P to Q.
Hence, direction of g is from P to Q, higher potential to lower potential.

**13 Ans: A**

$pV = nRT$

$\frac{1}{p} = \frac{1}{nRT} V$, hence, gradient = $\frac{1}{nRT}$

When $n$ and $T$ are both halved, gradient = $\frac{1}{\frac{n}{2} R \frac{T}{2}} = 4 \frac{1}{nRT}$,

Therefore the new gradient is 4 times that of the original graph.

**14 Ans: D**

Gases behave ideally when pressure is low.
Hence, consider the $pV$ values when $p = 0$.

From the graph, when $p = 0$, $(pV)_{\text{boiling liquid}} = 5.95$ kJ and $(pV)_{\text{triple-point}} = 2.275$ kJ

Using the equation, $\frac{T_{\text{boiling liquid}}}{T_{\text{triple point}}} = \frac{(pV)_{\text{boiling liquid}}}{(pV)_{\text{triple point}}}$

$\frac{T_{\text{boiling liquid}}}{273.16} = \frac{5.95}{2.275}$

$T_{\text{boiling point}} = 714$ K

**15 Ans: D**

Key thing to remember is, period of oscillation = 2 × period of energy-time graph
Therefore, period of oscillation = $400 \times 10^{-3}$ s
Hence, $\omega = 2\pi / T = 15.708$ rad $s^{-1}$

Also, max U = 1.0
$\frac{1}{2} m x_0^2 \omega^2 = 1.0$
$\frac{1}{2} (0.0900)(x_0^2)(15.708^2) = 1.0$
$x_0 = 0.300$

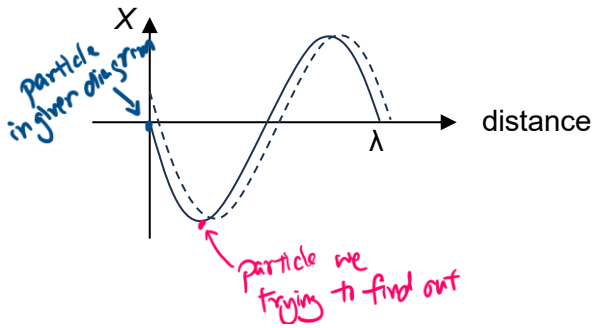
Hence, max $a = x_0\omega^2 = 74$ m $s^{-2}$

**16 Ans: C**

From the diagram, period = 500 μs
Frequency = 2000 Hz
Wavelength = 330 / 2000 = 0.165 m
At 0.04125 m away, the particle we are trying to find out is ¼ λ away

From the given displacement-time graph, we know that
- the air particle is at equilibrium position at t = 0 s.
- it is moving in the positive direction a small time t after 0 s.

Hence, the displacement-distance graph is:




Therefore, the particle we are trying to find out
- starts at negative amplitude at t = 0 s
- moving up a small time after 0 s.

Therefore, answer is C.

**17 Ans: A**

Using Malus's Law, $I = I_0 \cos^2 \theta$,

Initially when polariser is vertical: $I_1 = I_0 \cos^2 0°$
After polariser is rotated by θ: $I_2 = I_0 \cos^2 \theta$

Hence, $I_2 / I_1 = \cos^2 \theta$
and $I_2 / I_1 = V_2 / V_1 = 2.20 / 3.50 = 0.6286$

Therefore, $\cos \theta = \sqrt{0.6286} = 0.7928$
$\theta = 37.5°$

**18 Ans: D**

$d = 10^{-3} / 500 = 2.0 \times 10^{-6}$
$d \sin 45° = n\lambda$
$(2.0 \times 10^{-6}) \sin 45° = n(600 \times 10^{-9})$
$n = 2.36$

Hence, max order = 2
Max number of bright fringes = 2 + 2 + 1 = 5

**19 Ans: B**

$\sin \theta = \lambda / b$
To decrease θ, either decrease λ or increase b.
Hence, decreasing period increases frequency, and hence decreases λ.

**20 Ans: A**

Resistance, $R = \frac{\rho l}{A}$ and potential drop across each wire $V = IR = I\left(\frac{\rho l}{A}\right) = I\rho\left(\frac{l}{A}\right)$

Since current and resistivity are constants, the potential drop increases with distance from X (i.e. length of wire in this case), and the smaller the cross-sectional area *A*, the larger is the drop per unit length of wire. So the last segment has the largest potential drop per unit length.

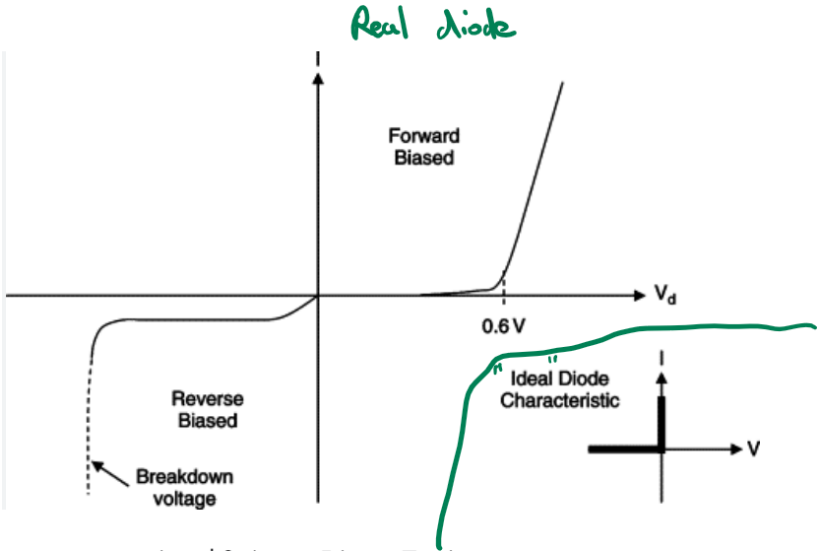
**21 Ans: A**

Since the thermistor's resistance decreases as its temperature increases, in accordance with the potential divider principle, the potential difference (p.d.) across it decreases with increasing temperature.

The thermistor and the fixed resistor are in series thus their potential differences add up to 10 V. Therefore the p.d. across the fixed resistor increases as the p.d. across the thermistor decreases due to increase in temperature.

When the p.d. across the fixed resistance exceeds the threshold p.d. of the diode (normally around 0.3 – 0.7 V) the diode becomes forward biased and current starts to flow downwards through the lamp to light it up.

Option C is wrong as the lamp will light up immediately regardless of temperature. (It will get brighter as the temperature increases.)




**22 Ans: C**

Resultant potential is determined through the scalar sum hence the direction of field is irrelevant. As |V| α $|\frac{Q}{r}|$, the potential at **C** due the +2*Q* charge is equal in magnitude and opposite sign to that due to the -*Q* charge, as it is twice the charge and twice the distance from **C**, hence, the sum of their potential will be zero.

**23 Ans: A**

Magnetic flux density due to horizontal wire = $\frac{\mu_o I}{2\pi d}$

$= \frac{(4\pi \times 10^{-7})(7.00)}{2\pi(3.00)}$

= 4.67 x $10^{-7}$ T, out of the page

Magnetic flux density due to vertical wire = $\frac{\mu_o I}{2\pi d}$

$= \frac{(4\pi \times 10^{-7})(6.00)}{2\pi(4.00)}$

= 3.00 x $10^{-7}$ T, into the page

Resultant B = 1.67 x $10^{-7}$ T out of the page.

**24 Ans: D**

Constant rate of cutting of flux $\Rightarrow$ constant emf induced between centre and rim.

**25 Ans: D**

By Lenz's law, since the external B-field increases, the induced B setup by the induced current will be in opposite direction to the external field. At the front of the loop, current will be going upwards $\Rightarrow$ use this to deduce direction of induced current.

Use $\varepsilon = \frac{\Delta\Phi}{\Delta t} = \frac{N(\Delta B)(A)}{\Delta t}$ to get the magnitude of the induced emf.

**26 Ans: B**

$V_p I_p = V_s I_s$

$I_s = \frac{120x60}{4500} = 1.6A$

Percentage power lost = $= \frac{I_s^2 R}{P_{total}} = \frac{1.6^2 x1.0}{120x60} x100\% = 0.036\%$

**27 Ans: D**

Option A is incorrect because photoelectric effect can occur even for very low intensity but sufficiently high frequency radiation (above the threshold frequency $f_0$).

Option B is incorrect because photoelectrons are emitted only if the frequency of radiation is greater than a minimum frequency known as threshold frequency $f_0$; since $\lambda_0 = \frac{c}{f_0}$, the wavelength of the radiation must be <u>smaller</u> than the threshold wavelength, which is instead a <u>maximum</u> value.

Option C is incorrect because the maximum kinetic energy and thus speed of the photoelectrons is independent of intensity but depends on the frequency of radiation and work function of the metal, as given by $hf = \Phi + E_{k,max}$.

Option D is correct since $I = \frac{N_P}{t}\frac{hf}{A}$, at constant intensity and increased frequency, the rate of photons incident on the metal decreases, the lesser the rate of emission of photoelectrons.

**28 Ans: A**

Since the target is unchanged, the wavelengths of the peaks will remain the same.
However, with an increase in the p.d. between the target and cathode, the target will be bombarded with electrons of higher energy. These electrons will have a higher chance to remove an inner shell electron from the target, resulting in more de-excitations between energy levels and hence higher intensity of the peaks.

**29 Ans: D**

Total mass of reactant is less than total mass of products, so energy has to be supplied for the reaction to take place.

Energy supplied = (1.0086 +1.0097 −2.0150) u $c^2$ / ($1.6 \times 10^{-19}$) = 3 MeV

**30 Ans: C**

When the source is first used:
Total number of disintegrations = $A_0 \times 10\ mins$ --- (1)

2 years later:
$A_2 = (\frac{1}{2})^{2/4} A_0 = (\frac{1}{2})^{0.5} A_0 = 0.7071\ A_0$

Total number of disintegrations = $A_2 \times t$
Total number of disintegrations = $0.7071\ A_0 \times t$ --- (2)

(2) = (1):
$0.7071\ A_0 \times t = A_0 \times 10\ mins$
$t$ = 14.1 mins