

බස්නාහිර පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව  
Department of Education Westerns Province

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2025  
General Certificate of Education (Adv. Level) Examination, 2025  
Final Term Test - Grade 13

භෞතික විද්‍යාව I  
Physics I

01 E I

පැය දෙකයි  
Two hours

**Instruction :**

- \* This question paper consists of 50 questions in 10 pages.
- \* Answer **all** the questions.
- \* Write your **Index Number** in the space provided in the answer sheet.
- \* Read the Instructions given on the back of the answer sheet carefully.
- \* In each of the questions 1 to 50, pick one of the alternative form (1), (2), (3), (4), (5) which is **correct or most appropriate and mark your response on the answer sheet with a cross (×) in accordance with the instructions given on the back of the answer sheet.**

**Use of calculators is not allowed.**

$$(g = 10ms^{-2})$$

1. Choose the expression that gives different dimensions of the following statements.
 

(1) Pressure $\times$ Volume	(2) Voltage $\times$ Charge
(3) Plank constant $\times$ Frequency	(4) Mass $\times$ Specific Latent Heat
(5) Stress $\times$ Strain	
  
2. When a fixed mass of an ideal gas in a constant volume container is kept at the triple point , the Pressure is  $P_{tr}$  .When the pressure of the container reads as  $P$  the temperature is,
 

(1) $273.16 \left( \frac{P-P_{tr}}{P} \right) K$	(2) $273.16 \left( \frac{P-P_{tr}}{P_{tr}} \right) K$	(3) $273.16 \left( \frac{P}{P_{tr}} \right) K$
(4) $273.16 \left( \frac{P_{tr}}{P} \right) K$	(5) $273.16 \left( \frac{P+P_{tr}}{P_{tr}} \right) K$	
  
3. For real images formed by a convex lens of focal length  $f$ , the variation of image distance  $v$  with object distance  $u$  is shown by curve  $A$  in the graph. Line  $B$  is drawn through the origin making an angle of  $45^\circ$  with the x-axis. The coordinates of the point  $P$ , where  $A$  and  $B$  intersect,
 

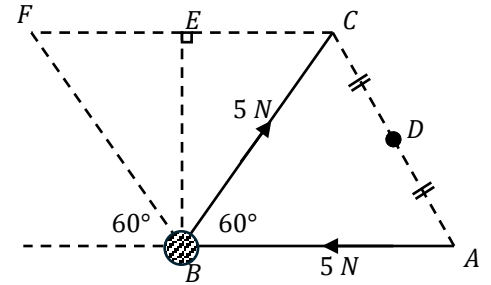
(1) $\left( \frac{f}{2}, \frac{f}{2} \right)$	(2) $(f, f)$	(3) $(2f, 2f)$	(4) $\left( \frac{3f}{2}, \frac{3f}{2} \right)$	(5) $(4f, 4f)$
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4. Consider the following statements about producing beats.
  - (A) Produced by sounding two notes of identical frequencies and slightly different amplitudes together.
  - (B) Can be explained by the Principle of Superposition.
  - (C) When two sound waves of in phase are meets together a loud sound can be heard.

The true statements are,

- (1) Only (A) (2) Only (B) (3) Only (C)  
 (4) Only (A) and (B) (5) Only (B) and (C)

5. Two forces of each  $5\text{ N}$  act on an object in the directions shown in the figure. The resultant force on the object and the direction it moves are,

- (1)  $5\sqrt{3}\text{ N}$ ,  $\overrightarrow{BD}$  direction. (2)  $5\sqrt{3}\text{ N}$ ,  $\overrightarrow{BF}$  direction.  
 (3)  $5\text{ N}$ ,  $\overrightarrow{BE}$  direction. (4)  $5\text{ N}$ ,  $\overrightarrow{BF}$  direction.  
 (5)  $2.5\text{ N}$ ,  $\overrightarrow{BE}$  direction.



6. When a mass of  $1.6\text{ kg}$  is hung at one end of a sonometer wire passing over a frictionless pulley, the wire resonates with a tuning fork when the distance between the knife edges is  $20\text{ cm}$ . The  $1.6\text{ kg}$  mass is then replaced by a mass of  $M\text{ kg}$  and with the same tuning fork resonance is obtained at  $25\text{ cm}$  resonance length. The value of  $M$  is,

- (1)  $12.8\text{ kg}$  (2)  $2.5\text{ kg}$  (3)  $2.4\text{ kg}$  (4)  $2.0\text{ kg}$  (5)  $1.8\text{ kg}$

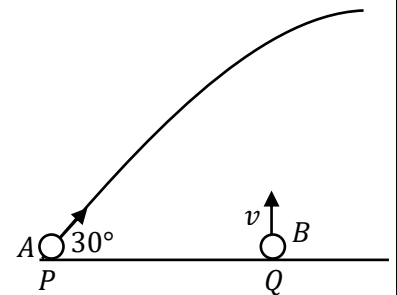
7. The factors of the frictional force between two layers of a flowing viscose fluid depend on are,  
 (A) Common area between the liquid layers.  
 (B) Pressure difference between the liquid layers.  
 (C) Velocity gradient between the liquid layers.

The true statements are,

- (1) Only (A). (2) Only (A) and (B) (3) Only (B) and (C)  
 (4) Only (A) and (C) (5) All (A), (B) and (C).

8.  $P$  and  $Q$  are two points on a horizontal plane. An object  $A$  is projected from  $P$  at an angle of  $30^\circ$  to the horizontal. At the same instant another object  $B$  is projected vertically upwards from  $Q$  with a velocity  $v$ . If  $A$  and  $B$  collide, the velocity of  $A$  projected is,

- (1)  $4v$  (2)  $3v$  (3)  $2v$   
 (4)  $\sqrt{2}v$  (5)  $v$



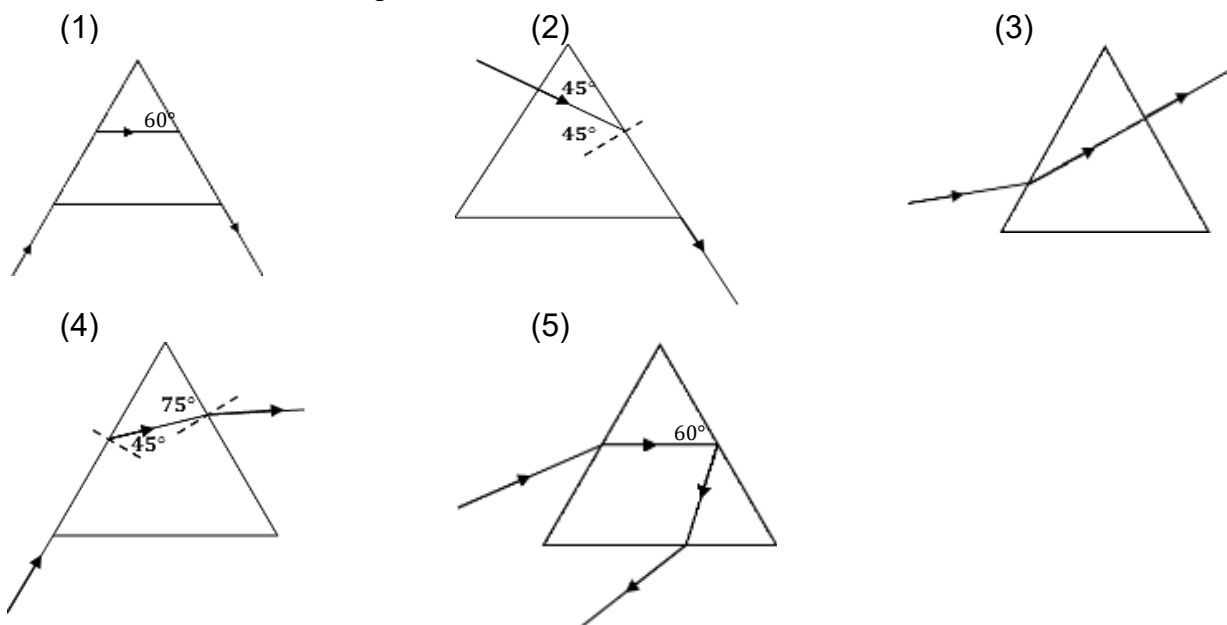
9. The Sun, whose surface temperature is  $6000\text{ K}$ , emits solar radiation with a maximum intensity at a wavelength of  $0.5\ \mu\text{m}$ . A filament bulb with identical radiating properties emits radiation with a maximum intensity at a wavelength of  $2\ \mu\text{m}$ . The temperature of the filament is,  
 (1)  $24000\text{ K}$  (2)  $6000\text{ K}$  (3)  $3000\text{ K}$  (4)  $2000\text{ K}$  (5)  $1500\text{ K}$

10.  ${}_{13}^{27}\text{Al} + {}_0^1n \rightarrow {}_{11}^{24}\text{Na} + x$

The particle  $x$  emitted in the above radioactive emission is,

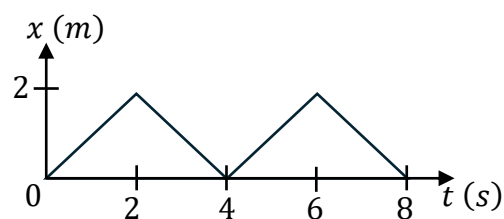
- (1) an  $\alpha$  particle (2) a  $\beta$  particle (3) an electron  
 (4) a proton (5) a neutrino

11. Select the diagram that correctly shows the path of a light ray passing through an equilateral prism made of glass with a refractive index of  $\sqrt{2}$ , placed in air.



12. The figure shows the displacement – time curve of an object of mass  $0.4 \text{ kg}$ . The impulse force acting on the object is,

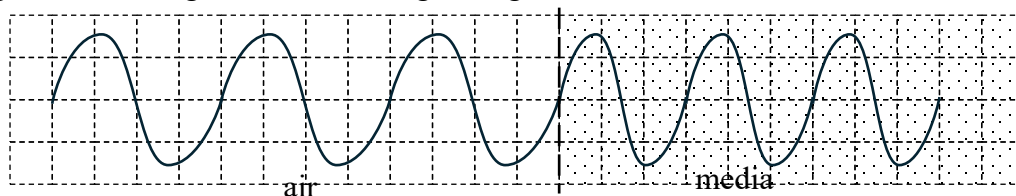
- (1)  $1.6 \text{ N s}$       (2)  $0.8 \text{ N s}$       (3)  $0.4 \text{ N s}$   
 (4)  $0.2 \text{ N s}$       (5) zero



13. A siren at a lighthouse emits sound at a frequency of  $5.0 \text{ kHz}$ . The sound is heard at a frequency of  $5.5 \text{ kHz}$  by a boat  $A$  approaching the lighthouse, and at a frequency of  $6.0 \text{ kHz}$  by another boat  $B$  coming from a different direction. If the speeds of  $A$  and  $B$  are  $v_A$  and  $v_B$  respectively, the ratio  $\frac{v_A}{v_B}$  is equal to,

- (1)  $\frac{1}{2}$       (2)  $\frac{4}{3}$       (3)  $\frac{12}{11}$       (4)  $\frac{11}{6}$       (5)  $\frac{6}{5}$

14. Figure shows a light wave travelling through a media  $X$ . The refractive index of the media  $X$  is,

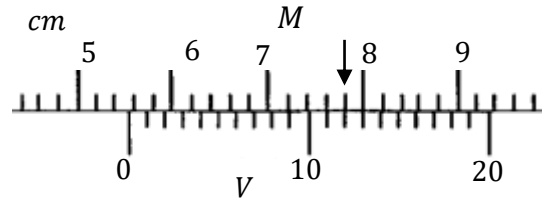


- (1)  $\frac{5}{4}$       (2)  $\frac{4}{3}$       (3)  $\frac{3}{2}$       (4)  $\frac{7}{4}$       (5)  $\frac{8}{5}$

15. Among the fundamental forces through which natural interactions occur, the phenomenon associated with the **weak nuclear force**,

- (1) the emission of a  $\beta$  particle from a radioactive nucleus.  
 (2) the existence of nucleons within the atomic nucleus.  
 (3) the presence of an electrostatic force around a stationary charge.  
 (4) the presence of a magnetic field around a moving charge.  
 (5) the existence of electrons around the nucleus of an atom.

16. The least count of a Vernier caliper is  $0.1 \text{ mm}$ . In this caliper, 20 divisions on the vernier scale (V) coincide with 19 divisions on the main scale (M). The positions of the main scale and the vernier scale for a certain measurement are shown in the figure. The reading shown in the figure is,

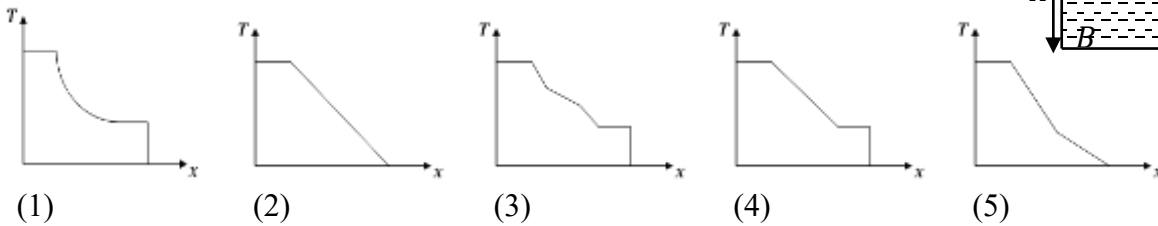
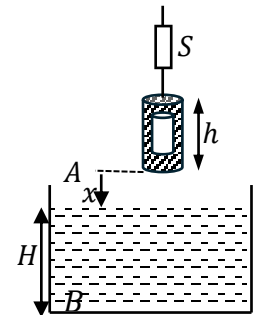


- (1)  $5.212 \text{ cm}$       (2)  $5.32 \text{ cm}$       (3)  $5.412 \text{ cm}$       (4)  $5.52 \text{ cm}$       (5)  $6.32 \text{ cm}$

17. A wooden wheel with a diameter of  $1.002 \text{ m}$  needs to have a rim of diameter  $1.000 \text{ m}$  at  $30^\circ\text{C}$  fitted around the perimeter of it. The coefficient of linear expansion for iron is  $1.25 \times 10^{-5} \text{ }^\circ\text{C}^{-1}$ . The temperature to which the iron rim must be heated is,

- (1)  $160 \text{ }^\circ\text{C}$       (2)  $190 \text{ }^\circ\text{C}$       (3)  $130 \text{ }^\circ\text{C}$       (4)  $463 \text{ }^\circ\text{C}$       (5)  $200 \text{ }^\circ\text{C}$

18. A solid cylindrical object with a hollow cavity is hung by a spring balance  $S$  and lowered gradually from point  $A$  to point  $B$  at the bottom of a tank filled with water. The cylinder can sink in the water without floating. Choose the graph that correctly shows how the reading of the spring balance varies with the distance  $x$  from point  $A$  to point  $B$  traveled by the bottom of the cylinder. (Assume  $H > h$ )



19. Two objects  $A$  and  $B$ , are moving along a straight path with uniform velocities and are initially at a certain distance from each other. When the velocities of  $A$  and  $B$  are in opposite directions, they approach each other by  $4 \text{ m}$  per each second. When their velocities are in the same direction, they approach each other by  $0.4 \text{ m}$  per each second. If the speed of  $A$  is greater than that of  $B$ , velocities of  $A$  and  $B$  are ,

- (1)  $4.4 \text{ ms}^{-1}, 3.6 \text{ ms}^{-1}$       (2)  $2.2 \text{ ms}^{-1}, 1.8 \text{ ms}^{-1}$       (3)  $4 \text{ ms}^{-1}, 0.4 \text{ ms}^{-1}$   
 (4)  $2 \text{ ms}^{-1}, 0.2 \text{ ms}^{-1}$       (5)  $2.2 \text{ ms}^{-1}, 0.4 \text{ ms}^{-1}$

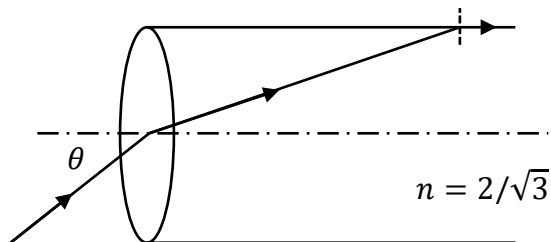
20. The number of nuclei in a radioactive sample  $S_1$  with an activity of  $2 \times 10^{-3} \text{ Bq}$  is twice the number of nuclei in a radioactive sample  $S_2$  with an activity of  $4 \times 10^{-3} \text{ Bq}$ . If the half-life of  $S_1$  is 4 years, the half-life of  $S_2$  is,

- (1) 1 years      (2) 2 years      (3) 4 years      (4) 8 years      (5) 16 years

21. The period of oscillation of a simple pendulum on the Earth surface is  $T_1$ . If the period of oscillation of the same simple pendulum is  $T_2$  when it is at a height equal to the radius of the Earth  $R$  from the Earth's surface, then the value of  $T_2/T_1$  is,

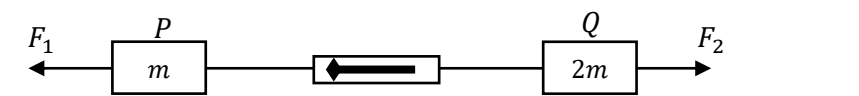
- (1) 1      (2) 2      (3)  $\sqrt{2}$       (4) 4      (5)  $2\sqrt{2}$

22. A ray of light is incident at an angle  $\theta$  on the center of the flat face of a solid cylinder with a refractive index of  $2/\sqrt{3}$ . After refraction, the light ray travels along the curved surface of the cylinder without emerging into the air. The value of  $\sin\theta$  is,



- (1)  $\frac{1}{2\sqrt{3}}$       (2)  $\frac{1}{\sqrt{3}}$       (3)  $\frac{\sqrt{3}}{2}$       (4)  $\frac{1}{\sqrt{2}}$       (5)  $\frac{1}{2}$

23. Two blocks,  $P$  and  $Q$ , of masses  $m$  and  $2m$  respectively, are connected by a light spring balance and placed on a smooth horizontal surface. Two horizontal forces,  $F_1$  and  $F_2$  ( $F_1 > F_2$ ), act on  $P$  and  $Q$ , respectively. The system moves with a constant acceleration to the left. The reading of the spring balance is,



- (1)  $\frac{2F_1 - F_2}{3}$       (2)  $\frac{2(F_1 - F_2)}{3}$       (3)  $\frac{2F_1 + F_2}{3}$       (4)  $\frac{F_1 + 2F_2}{3}$       (5)  $\frac{F_1 - F_2}{3}$

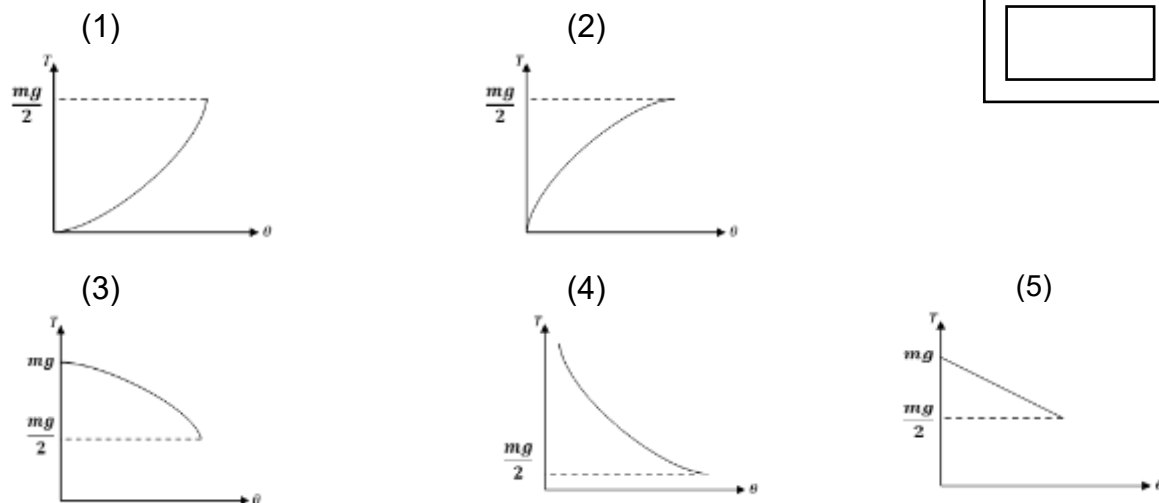
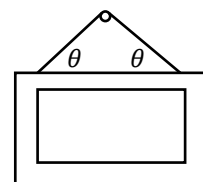
24. When a string is stretched by  $1\text{ mm}$ , the work done is  $2\text{ J}$ . Another string made of the same material but having twice the diameter and half the length of the first string is also stretched by  $1\text{ mm}$ . Then, the work done is,

- (1)  $0.25\text{ J}$       (2)  $2\text{ J}$       (3)  $4\text{ J}$       (4)  $8\text{ J}$       (5)  $16\text{ J}$

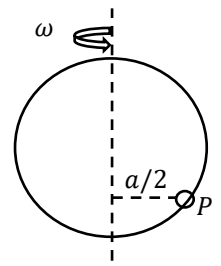
25. A wheel of mass  $M$  and radius  $R$  rolls forward along a horizontal surface, without slipping. The rotational kinetic energy of the wheel is 40% of the total kinetic energy. The moment of inertia of the wheel is,

- (1)  $\frac{2}{5}MR^2$       (2)  $\frac{2}{3}MR^2$       (3)  $\frac{3}{5}MR^2$       (4)  $\frac{1}{3}MR^2$       (5)  $\frac{1}{2}MR^2$

26. The figure shows a picture hanging by a light, inelastic string. The correct graph showing how the tension in the string ( $T$ ) varies with the angle  $\theta$  is,

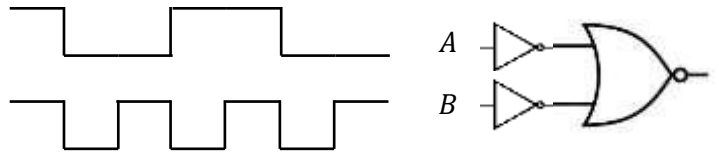


27. A bead  $P$  is attached to a smooth ring of radius  $a$ . The ring rotates with an angular velocity  $\omega$  about a vertical diameter. Then, the bead remains stationary relative to the ring at the position shown in the figure. The value of  $\omega^2$  is equal to,



- (1)  $\frac{2a}{\sqrt{3}g}$                       (2)  $\frac{2g}{\sqrt{3}a}$                       (3)  $\frac{2g}{a}$   
 (4)  $\frac{\sqrt{3}g}{a}$                       (5)  $\frac{\sqrt{3}a}{2g}$

28. A logic circuit and its input signals  $A$  and  $B$  are shown in the figure.



The output signal is,

- (1)                      (2)   
 (3)                      (4)   
 (5)

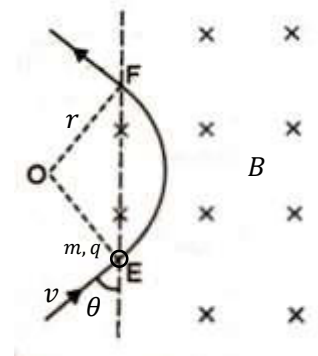
29. Consider the following statements about an amplifier circuit using a transistor with a current gain of  $\beta$ .

- (A) The collector current satisfies the equation  $I_c = \beta I_b$ .  
 (B) The transistor operates in the saturated region.  
 (C) The collector resistance  $R_C$  should be selected so that  $V_C = \frac{V_{CC}}{2}$ .

The true statements are,

- (1) Only (A)                      (2) Only (A) and (B)                      (3) Only (B) and (C)  
 (4) Only (A) and (C)                      (5) All (A), (B) and (C)

30. A particle of mass  $m$  and charge  $q$  enters a region with a uniform magnetic field of flux density  $B$  at point  $E$  with a velocity  $v$  making an angle  $\theta$  with the area of the field as shown in the figure. It leaves the magnetic field at point  $F$ . The distance between  $E$  and  $F$  is,

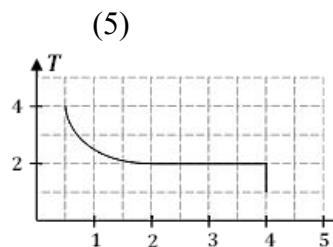
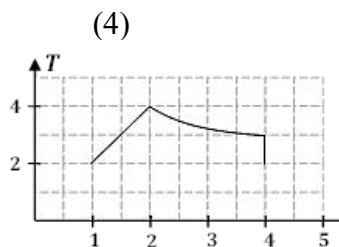
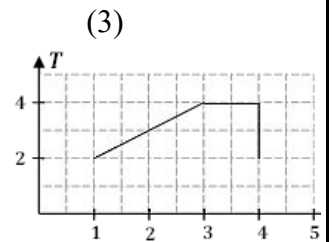
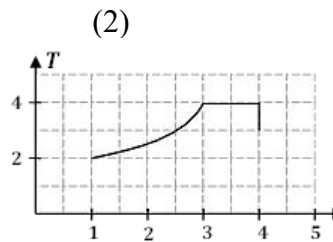
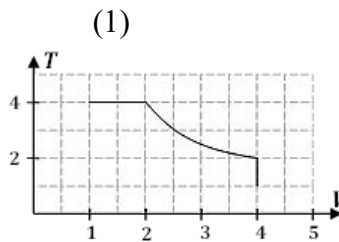
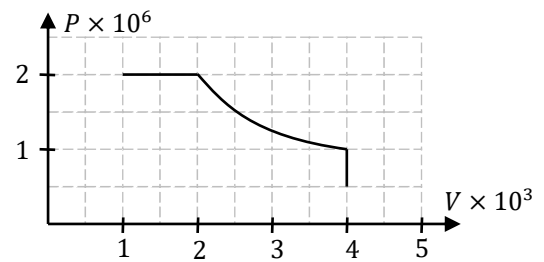


- (1)  $\frac{mv^2 \cos \theta}{Bq}$                       (2)  $\frac{mv^2 \sin \theta}{Bq}$                       (3)  $\frac{2mv \cos \theta}{Bq}$   
 (4)  $\frac{2mv \sin \theta}{Bq}$                       (5)  $\frac{2m \sin \theta}{Bqv}$

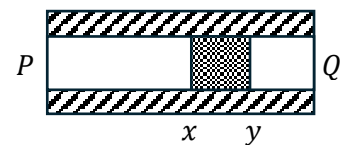
31. A large number of small liquid drops each of radius  $a$  combine to form a single larger drop of radius  $b$ . The liquid has density  $d$  and surface tension  $T$ . If the energy released in the process is completely converted into the kinetic energy of the larger drop, the velocity of the larger drop is,

- (1)  $\sqrt{\frac{T}{\rho} \left( \frac{1}{a} - \frac{1}{b} \right)}$                       (2)  $\sqrt{\frac{2T}{\rho} \left( \frac{1}{a} - \frac{1}{b} \right)}$                       (3)  $\sqrt{\frac{3T}{\rho} \left( \frac{1}{a} - \frac{1}{b} \right)}$                       (4)  $\sqrt{\frac{6T}{\rho} \left( \frac{1}{a} - \frac{1}{b} \right)}$                       (5)  $\sqrt{\frac{8T}{\rho} \left( \frac{1}{a} - \frac{1}{b} \right)}$

32. The PV curve for a fixed mass of gas in a closed vessel is shown in the figure. Choose the correct graph that shows how the temperature varies with volume for this system.

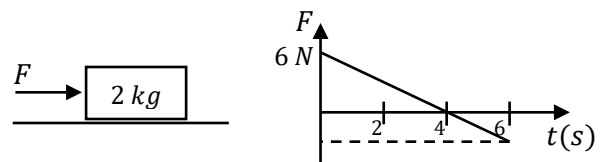


33. A fully lagged metal rod  $PQ$ , which has an  $XY$  section with low thermal conductivity, is shown in the figure. The two ends  $P$  and  $Q$  are maintained at different constant temperatures. In the steady state, which of the following does not affect the temperature difference between  $X$  and  $Y$ ?



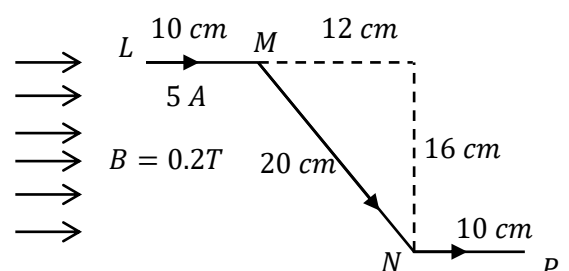
- (1) temperature difference between  $P$  and  $Q$  .
- (2) The material metal rod made of
- (3) The material  $XY$  made of .
- (4) The distance between  $X$  and  $Y$ .
- (5) The distance from  $P$  to  $XY$

34. A horizontal force that varies with time, as shown in the graph, is applied to a  $2\text{ kg}$  object initially at rest on a horizontal smooth surface. At the end of 6 seconds, the kinetic energy of the object is,



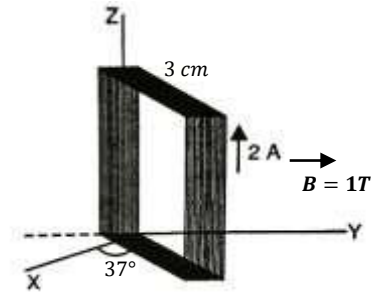
- (1)  $9\text{ J}$
- (2)  $27\text{ J}$
- (3)  $20.25\text{ J}$
- (4)  $40.5\text{ J}$
- (5)  $182.25\text{ J}$

35. As shown in the figure, a light conducting wire carrying a current of  $5\text{ A}$  is placed, in a magnetic field with a magnetic flux density of  $0.2\text{ T}$  perpendicular to the plane of the paper. The net force acting on the wire is,



- (1)  $0.40\text{ N}$
- (2)  $0.32\text{ N}$
- (3)  $0.20\text{ N}$
- (4)  $0.16\text{ N}$
- (5)  $0.12\text{ N}$

36. A rectangular coil of 100 turns and dimensions  $3\text{ cm} \times 4\text{ cm}$  is hinged along the  $z$  axis as shown in the figure. A magnetic field of flux density  $1\text{ T}$  is applied in the direction of the  $y$  axis, and a current of  $2\text{ A}$  is passed through the coil. When the coil makes an angle of  $37^\circ$  to the  $x$  axis, what is the torque acting on the coil?



( $\sin 37 = 0.6$ ,  $\cos 37 = 0.8$ )

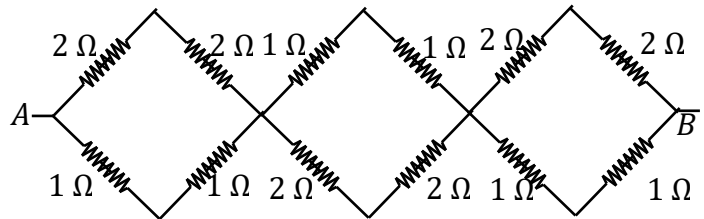
- (1)  $0.144\text{ Nm}$       (2)  $0.180\text{ Nm}$       (3)  $0.192\text{ Nm}$
- (4)  $0.240\text{ Nm}$       (5)  $0.280\text{ Nm}$

37. It is given that, the saturated vapor density is  $23\text{ g/m}^3$  at  $25^\circ\text{C}$  and  $26\text{ g/m}^3$  at  $27^\circ\text{C}$ . The relative humidity of a room with a volume of  $100\text{ m}^3$  was 60% at  $25^\circ\text{C}$ . After placing a water container inside the room for some time, the room had been saturated and at that moment the temperature was  $27^\circ\text{C}$ . The mass of water that evaporated from the container is,

- (1)  $920\text{ g}$       (2)  $1380\text{ g}$       (3)  $1680\text{ g}$       (4)  $2600\text{ g}$       (5)  $1220\text{ g}$

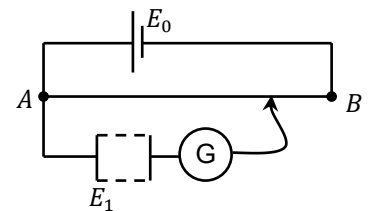
38. Equivalent resistance between  $A$  and  $B$  is,

- (1)  $6\ \Omega$       (2)  $4\ \Omega$       (3)  $\frac{40}{9}\ \Omega$
- (4)  $\frac{9}{4}\ \Omega$       (5)  $\frac{4}{9}\ \Omega$



39. Following potentiometer circuit was set-up to determine the e.m.f. of a cell. It was observed that the galvanometer always deflected in the same direction. Consider the following statements regarding a possible fault in the circuit.

- (A) The e.m.f. of cell  $E_1$  may be smaller than the potential difference between points  $A$  and  $B$ .
- (B) The secondary circuit may be disconnected at point  $A$ .
- (C)  $E_1$  and  $E_0$  may have been connected facing opposite directions.

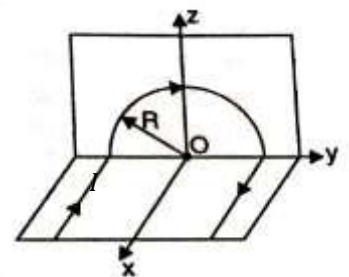


The true statements are,

- (1) Only (A)      (2) Only (A) and (B).      (3) Only (B) and (C).
- (4) Only (A) and (C)      (5) All (A), (B) and (C).

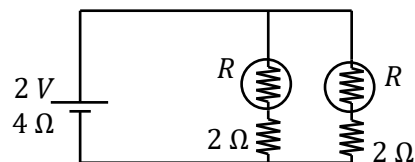
40. An infinitely long conducting wire is bent so that it forms a semicircular section of radius  $R$ . The semicircular part is positioned vertically, while the long straight parallel sections—perpendicular to its plane—are placed on a horizontal plane. A current  $I$  is passed through the wire. The resultant magnetic flux density at the center is

- (1)  $\frac{\mu_0 I}{4R} \left[ 1 + \frac{2}{\pi} \right]$       (2)  $\frac{\mu_0 I}{4e} \left[ 1 + \frac{2}{\pi} \right]$       (3)  $\frac{\mu_0 I}{4R} \left[ 1 + \frac{4}{\pi} \right]$
- (4)  $\frac{\mu_0 I}{4R} \sqrt{1 + \frac{4}{\pi^2}}$       (5)  $\frac{\mu_0 I}{2R} \sqrt{1 + \frac{4}{\pi^2}}$



41. For what value of  $R$  in this circuit, is the output power delivered by the cell maximum?

- (1)  $2 \Omega$             (2)  $4 \Omega$             (3)  $6 \Omega$   
 (4)  $8 \Omega$             (5) zero



42. In a small tank containing  $5 \text{ kg}$  of a certain liquid, two  $100 \text{ W}$  electric bulbs with a light efficiency of  $40\%$  are lit. The heat capacity of the tank walls can be neglected, and the rate of heat loss to the surroundings is  $5 \text{ W}$ . If the temperature of the liquid rises from  $25^\circ\text{C}$  to  $30^\circ\text{C}$  in  $5 \text{ minutes}$ , the specific heat capacity of the liquid is,

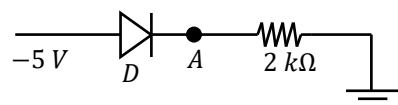
- (1)  $1380 \text{ Jkg}^{-1}\text{C}^{-1}$             (2)  $660 \text{ Jkg}^{-1}\text{C}^{-1}$             (3)  $900 \text{ Jkg}^{-1}\text{C}^{-1}$   
 (4)  $1439.8 \text{ Jkg}^{-1}\text{C}^{-1}$             (5)  $1500 \text{ Jkg}^{-1}\text{C}^{-1}$

43. One end of a resonance tube is open, and the other end can be used either closed or open. In either case, the fundamental resonance frequency of the air column is  $150 \text{ Hz}$ . Which of the following is **not** a natural frequency of this air column,

- (1)  $300 \text{ Hz}$             (2)  $450 \text{ Hz}$             (3)  $750 \text{ Hz}$             (4)  $800 \text{ Hz}$             (5)  $1050 \text{ Hz}$

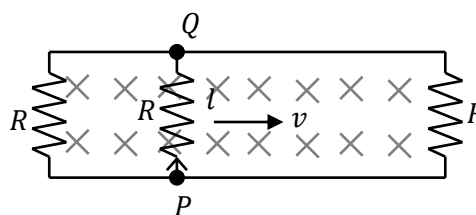
44. In the circuit below  $D$  is a Si diode. The Voltage of  $A$  is,

- (1)  $0 \text{ V}$             (2)  $-5 \text{ V}$             (3)  $-4.3 \text{ V}$             (4)  $-2.5 \text{ V}$             (5)  $0.7 \text{ V}$



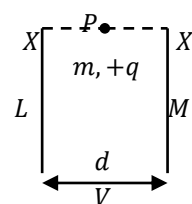
45. Two resistors of resistance  $R$  are connected using two long conducting rails to form a rectangular loop. A conductor  $PQ$  of length  $l$  and resistance  $R$  is placed on the two rails, and it is moved with a velocity  $v$  as shown in the figure. If the loop is placed in a uniform magnetic field of flux density  $B$ , the current ( $I$ ) flowing through  $PQ$  is,

- (1)  $\frac{Blv}{3R}$             (2)  $\frac{Blv}{2R}$             (3)  $\frac{Blv}{R}$             (4)  $\frac{2Blv}{3R}$             (5)  $\frac{2Blv}{R}$



46. Two long vertical parallel plates  $L$  and  $M$  are separated by a distance  $d$ , and a potential difference  $V$  exists between them. A particle of mass  $m$  and charge  $+q$  is released from rest at point  $P$ , which is top and middle point between the plates  $L$  and  $M$ . How far vertically from  $X$  will the particle strike the plate?

- (1)  $\frac{mgd^2}{2Vq}$             (2)  $\frac{mgd}{2Vq}$             (3)  $\sqrt{\frac{mgd}{2Vq}}$             (4)  $\sqrt{\frac{md^2}{Vq}}$             (5)  $\frac{mg}{2Vq}$



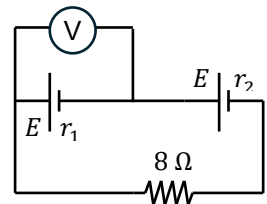
47. Inside a hollow tetrahedron (solid with four face) , there are four  ${}^4_2\text{He}$  ions. Outside the tetrahedron, there are 8 positrons ( $\beta^+$ ). The permittivity of the medium is  $\epsilon$ , and the charge of an electron is  $e$ . The amount of effective electric flux passing through one face of the tetrahedron is,

- (1)  $+\frac{14e}{\epsilon}$       (2)  $+\frac{10e}{\epsilon}$       (3)  $+\frac{8e}{\epsilon}$       (4)  $+\frac{4e}{\epsilon}$       (5)  $\frac{2e}{\epsilon}$

48. A 1 kg of iron with a specific heat capacity of  $445 \text{ J kg}^{-1} \text{ K}^{-1}$  is used to make a horseshoe. A blacksmith heats the horseshoe to  $1100^\circ\text{C}$  and then places it into a container with 1 kg of water at  $20^\circ\text{C}$ . The latent heat of vaporization of water is  $2.25 \times 10^5 \text{ J kg}^{-1}$ , specific heat capacity of water is  $4200 \text{ J kg}^{-1} \text{ K}^{-1}$  and the heat capacity of the container is  $800 \text{ J }^\circ\text{C}^{-1}$ . If heat loss to the surroundings can be neglected, the mass of water that will vaporize is,

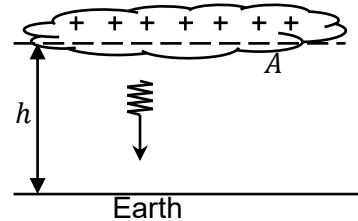
- (1) 200 g      (2) 480 g      (3) 1978 g      (4) 682 g      (5) 150 g

49. In the circuit shown in the figure, the internal resistances of the two cells are  $r_1$  and  $r_2$ . If the reading of the ideal voltmeter connected across the cell having internal resistance  $r_1$  is zero, which of the following relationship is correct?



- (1)  $8 = r_1 + r_2$       (2)  $8 = \frac{r_1 r_2}{r_1 + r_2}$       (3)  $8 = r_1 - r_2$   
 (4)  $8 = r_2 - r_1$       (5)  $8 = \frac{r_1}{r_2}$

50. A charged cloud with an effective area  $A$ , located at a height  $h$  above the ground, produces a lightning strike to the Earth that carries a current  $I$  for a duration of  $t$  , totally discharging the cloud. The cloud–Earth system can be considered as a parallel-plate capacitor. The permittivity of air is  $\epsilon$ . Just before the lightning strike occurs, the magnitude of the electric field intensity between the cloud and the ground is,



- (1)  $\frac{Ith}{A\epsilon}$       (2)  $\frac{It}{A\epsilon}$       (3)  $\frac{It}{A\epsilon h}$       (4)  $\frac{ItA\epsilon}{h^2}$       (5)  $\frac{A\epsilon}{It h^2}$

\* \* \*

බස්නාහිර පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව  
 Department of Education Western Province

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2025  
 General Certificate of Education (Adv. Level) Examination, 2025  
 Final Term Test – Grade 13

භෞතික විද්‍යාව II  
 Physics II

01 E II

පැය තුනයි  
 Three Hours

අමතර කියවීම් කාලය - මිනිත්තු 10 යි  
 Additional Reading Time - 10 minutes

Use **additional reading time** to go through the question paper, select the questions and decide on the questions that you give priority in answering.

Index No. : .....

**Important :**

- \* This question paper consists **16** pages.
- \* This question paper comprises of **two** parts. Part **A** and Part **B**. The time allotted for **both** parts is **three hours**.
- \* Use of calculators is **not** allowed.

**Part A – Structured Essay**  
 (pages 2 – 8)

Answer **all** the questions on this paper itself. Write your answers in the space provided for each question. Note that the space provided is sufficient for your answers and that extensive answers are not expected.

**Part B - Essay**  
 (pages 9 – 16)

This part contains **six** questions, of which, **four** are to be answered. Use the papers supplied for this purpose.

- \* At the end of the time allotted for this paper, tie the **two parts together** so that **Part A** is **on top** of **Part B** before handing them over to the Supervisor.
- \* You are permitted to remove **only Part B** of the question paper from the Examination Hall.

**For Examiners' Use Only**

**For the second paper**

Part	Question Nos.	Marks Awarded
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
	8	
	9(A)	
	9(B)	
	10(A)	
	10(B)	
Total	In numbers	
	In words	

Code Numbers

Marking Examiner 1	
Marking Examiner 2	
Marks checked by	
Supervised by	

**Part A – Structured Essays**  
Answer **all the four** questions in **this paper itself**  
( $g = 10ms^{-2}$ )

1.

(a) Write an expression for the pressure at the bottom of a beaker which is filled with liquid of density  $\rho$  to a height  $h$ .( if any additional symbols are used identify them)

.....  
.....

(b) If the atmospheric pressure before an experiment is indicated as  $76Hgcm$  what does it mean?

.....

(c) A complete diagram of a U tube that is used to compare densities of two immiscible liquids is given below. Initially if water is added to a height of about half of the tube height, then the other liquid is added from one arm so that the volume of the liquid is above the water volume.

(i) Draw and label the point of intersection and the menisci of the two liquids clearly.

(ii) What is the diameter of the U tube in the school laboratory that is used for the experiment?

.....

(iii) To minimize the percentage error what is the minimum height at which the liquid height should be maintained at?

.....

(iv) The reading should not be taken as soon as the liquid is added. What is the reason for this?

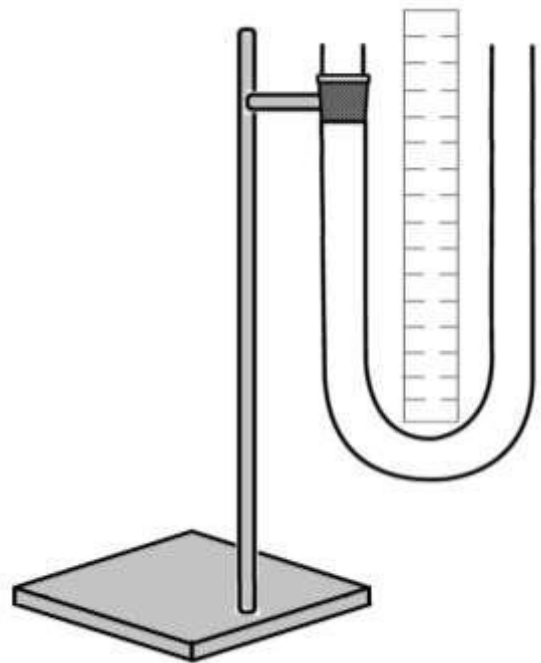
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(v) When using this apparatus to find the relative density of the liquid what are three readings that you should take?

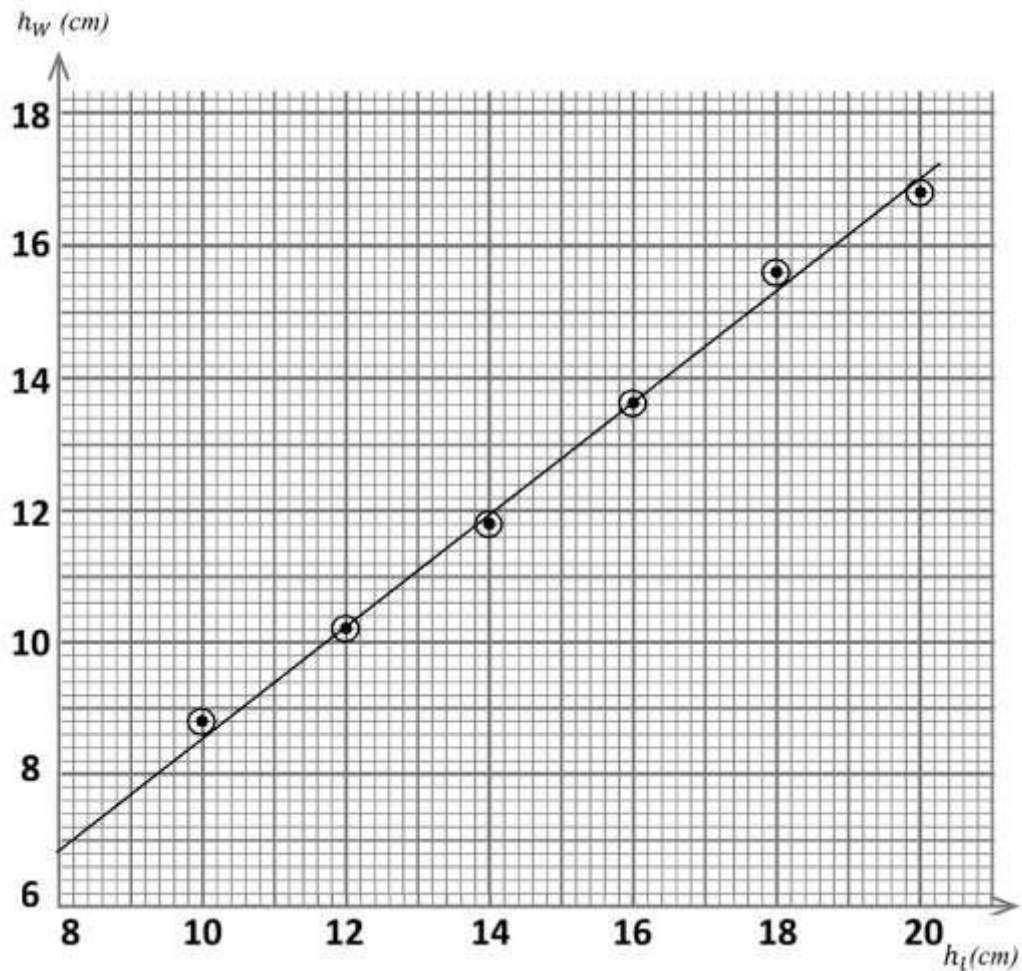
- 1) ..... – ( $x_1$ )
- 2) ..... – ( $x_2$ )
- 3) ..... – ( $x_3$ )

(vi) Write down two expressions for the pressure ( $P_l$ ) due to the liquid column ( $h_l$ ) and the pressure ( $P_w$ ) due to the water column ( $h_w$ ) at the common interface using the above readings ( $x_1, x_2, x_3$ ). (Consider water density as  $\rho_w$  and liquid density as  $\rho_l$ )

- 1) .....
- 2) .....



(vii) Given below is the  $h_l$  vs  $h_w$  graph drawn by a student using the readings obtained from the above experiment.



1) Calculate the gradient using the given information.

.....

.....

.....

2) Calculate the relative density of the liquid (density of water is  $1000 \text{ kgm}^{-3}$ )

.....

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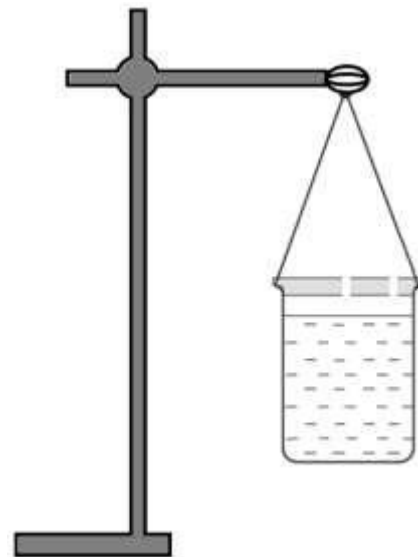
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(viii) For an experiment like this where the densities are compared mention two disadvantages of using a U tube?

- 1) .....
- .....
- 2) .....
- .....

2. Given below is a diagram that shows the setup used to find the specific heat capacity of a liquid with a heat capacity less than that of water using Newton's cooling law.



a) According to Newton's law of cooling, write down three factors on which the rate of heat loss from a heated object depends

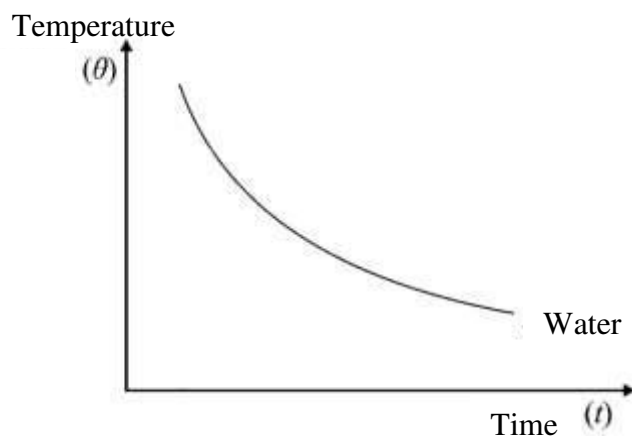
- 1) .....
- 2) .....
- 3) .....

b) Draw and label a measuring instrument and an item that is essential for this experiment on the above diagram.

c) A student stated that this experiment should be done for both liquids separately and that the same conditions must be maintained during each experiment. Mention two actions you can take within a school laboratory to maintain the same conditions.

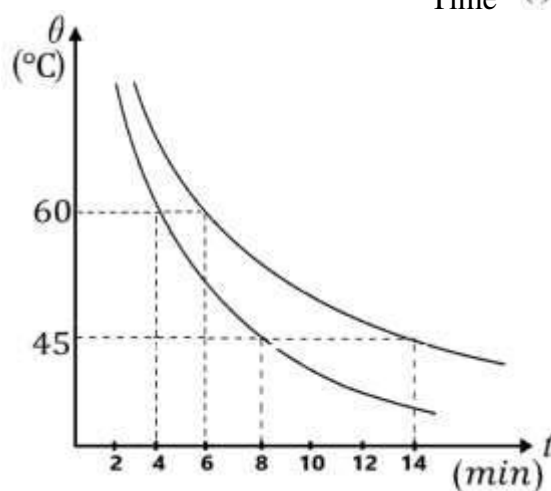
- 1) .....
- .....
- 2) .....
- .....

d) In the graph given below the cooling curve obtained for water has been shown. Accordingly draw and indicate the rough shape of the cooling curve for the liquid in the same graph.



e) Using the information given below

- Mass of the empty calorimeter and stirrer  
=  $10 \times 10^{-3} \text{ kg}$
- Mass of water, calorimeter and stirrer  
=  $30 \times 10^{-3} \text{ kg}$
- Mass of the calorimeter, stirrer and liquid  
=  $26 \times 10^{-3} \text{ kg}$
- Specific heat capacity of water  
=  $4.2 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
- Specific heat capacity of copper  
=  $0.4 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$



- (i) Calculate the rate of heat loss from the calorimeter with water

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- (ii) Using the answer above, find the specific heat capacity of the liquid.

.....

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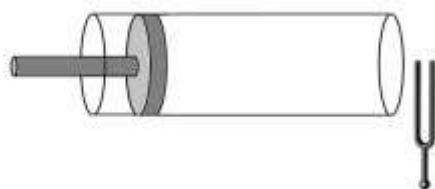
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- f) At the end of the experiment, it was suggested by the students to use a glass beaker or a cup made of heat-insulating material instead of the copper calorimeter to conduct the experiment. State in the table whether or not those containers can be used and the reason for that.

	Can be used/cannot be used	Reason
Glass beaker		
Cup from insulating material		

3. Stationary waves are formed when the air column inside a one end open tube is vibrated. In this air column the velocity of sound in air is given by  $V = \sqrt{\frac{\gamma RT}{M}}$  ( $\gamma$  – Ratio of the principle specific heat capacities of air,  $R$  – Universal gas constant,  $T$  – Absolute temperature,  $M$  – Molar mass) A group of students have planned an experiment to find  $\gamma$  using a glass tube with a moveable piston used to close one end and a set of tuning forks in the laboratory.



- a) Draw the standing wave pattern that occurs when the air column vibrates at the fundamental frequency through the tube. Include the end correction ( $e$ ) clearly.

b) Write an expression for the wavelength ( $\lambda$ ) of the fundamental tone when the effective length of the tube is  $l$

.....

c) Using the expression obtained in (b) above, write an expression for the velocity of sound waves in air in terms of  $l, e$  and the fundamental frequency  $f$

.....

d) Obtain an equation for  $l$  using the expression given above for the velocity of sound waves in air and the expression for (c).

.....

.....

.....

e) Arrange the above equation so that you can find the ratio between the principle specific heat capacities of air using a graphical method.

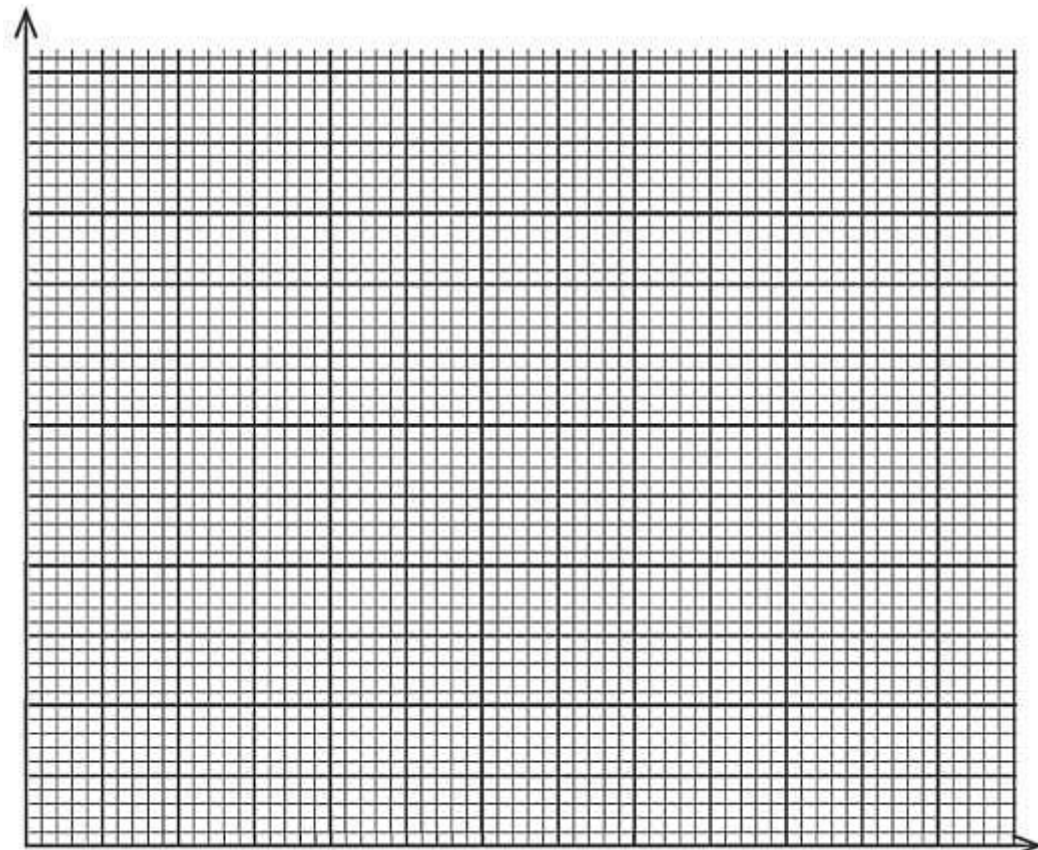
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f) Draw the graph by correctly labeling the axes using the readings in the table below

$\frac{1}{f} \times 10^{-3}(s)$	2.25	2.50	2.75	3.00	3.25
$l (cm)$	18.50	20.50	22.75	24.75	27.00



g) Write down two points to find the gradient (indicate these two points by the arrow-heads on the graph)

A – (..... , .....)

B – (..... , .....)

h) Calculate the gradient.

.....  
 .....  
 .....

i) Calculate  $\gamma$ , if the molar mass of air is  $30 \text{ gmol}^{-1}$ , room temperature is  $20^\circ\text{C}$  and the universal gas constant is  $8.3 \text{ mol}^{-1} \text{ K}^{-1}$ .

.....  
 .....  
 .....  
 .....  
 .....

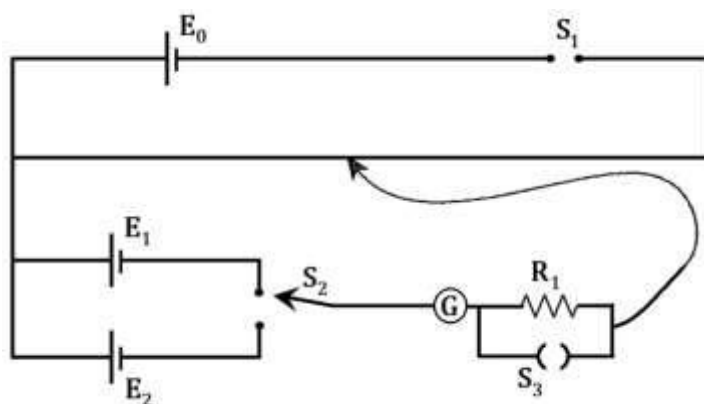
j) A student says the interception of the graph he obtained is  $(- 0.80 \text{ cm})$ . Which quantities' value is that ?

.....

4.

(a) Cut off the wrong answers.

For  $E_0$  (**dry cell / accumulator**) is more suitable. For  $S_1$  (**Tap / Plug**) key is used. For  $R_1$  resistance ( **$100\Omega$  /  $5\text{k}\Omega$** ) is more suitable.  $S_2$  is a two way key. Near the equilibrium point  $S_3$  should be (**open / closed**).



(b) Using a standard cell for  $E_1$ , the value of  $E_2$  can be calculated.

1) Write a characteristic that a standard cell should have.

.....  
 .....

2) Write an expression for the potential gradient ( $K$ ) using  $E_1$  and the balance length  $l_1$ .

.....  
 .....

3) If the balance length for  $E_2$  is  $l_2$ , write an expression for the value of  $E_2$  in terms of  $E_1$ ,  $l_1$  and  $l_2$ .

.....  
 .....

(c) What is the effect on the practical if  $E_0$  is larger?

.....  
 .....

(d) Draw in the figure how Indicator of the galvanometer can see when no current flows.



(e) Can this galvanometer be used for the above experiment? Give reasons.

.....  
 .....

(f) 1. What is end correction?

.....  
 .....

2. The balance length for  $E_1$  is given as  $4\text{cm}$ . What is the effect of end correction on that reading ?

.....  
 .....

3. Write down a possible course of action to avoid it.

.....  
 .....

(g)  $E_1$  is a Weston cell with  $1.018\text{V}$  e.m.f. The balance length for a Weston cell is  $42\text{ cm}$ .

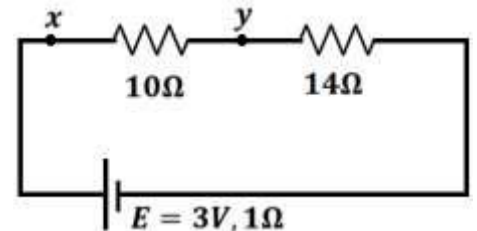
1. Calculate the potential gradient.

.....  
 .....

2. If the length of the potentiometer wire is  $2\text{m}$ , find the maximum e.m.f. that can be measured with it.

.....  
 .....

3. Calculate the balance length when the potentiometer is connected between the  $xy$  terminals of this circuit by removing the  $E_1, E_2$  cells in the above circuit.



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 .....

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 .....

බස්නාහිර පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව  
Department of Education Westerns Province

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2025  
General Certificate of Education (Adv. Level) Examination, 2025  
Final Term Test – Grade 13

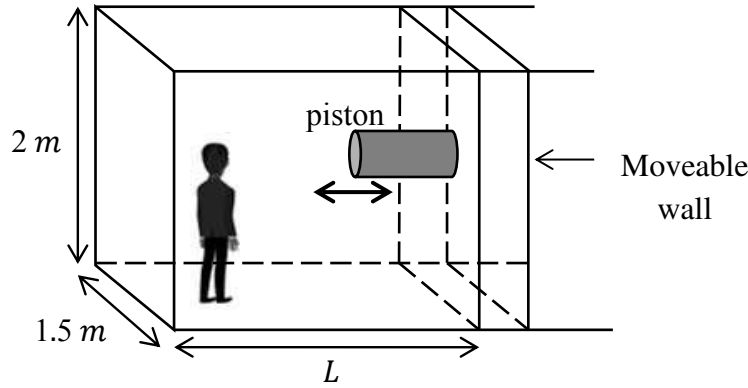
භෞතික විද්‍යාව II  
Physics II

Part B - Essay

01 E II

Answer four questions only  
( $g = 10 \text{ ms}^{-2}$ )

5. A group of students designed the diving tank shown below to observe the rocks and silt/mud layer at the bottom of a lake. It is gently lowered onto the water surface of the lake by means of a large boat. Artificial oxygen supply is internally produced for this tank. Only one student can stay inside the chamber at a time, and its internal volume can be changed by means of a horizontally movable piston. The chamber is designed so that water cannot enter it. All frictional forces can be neglected.



The chamber is made of transparent glass, and the volume of water displaced by its walls and piston can be neglected.

- (a)
- If the total mass of the diving tank together with the student is  $1500 \text{ kg}$ , calculate the submerged height of the diving tank when it is released into the water. At the beginning,  $L = L_0 = 4 \text{ m}$ . The density of water is  $1000 \text{ kg m}^{-3}$ .
  - Find the distance and direction which the piston must be moved for the diving tank to be completely submerged below the water surface.
  - If the resultant resistive force on the wall caused by the pressure exerted by water is  $200 \text{ N}$ , find the minimum force that must be applied to move the piston outward.
- (b)
- To move the diving tank toward the bottom of the lake with an acceleration of  $1 \text{ m s}^{-2}$ , what should be the internal length ( $L_1$ ) maintained inside the tank?
  - What is the practical problem arises about  $L_1$  calculated in (b)(i)?
- (c)
- After completing the observations, the total mass of the collected materials from the lake bottom is  $2500 \text{ kg}$ . Then the volume of the diving tank is adjusted to  $7 \text{ m}^3$ , and it is expected to rise back to the water surface. Neglecting water resistance, calculate its acceleration.
  - If the depth of the lake at that location is  $25 \text{ m}$ , find the velocity of the tank when it reaches the water surface, assuming it starts from rest. ( $\sqrt{15} \approx 3.9$ )

6.

(a)

- (i) Write down the Cartesian sign convention used for the refraction of light rays through lenses.
- (ii) ray diagrams showing the formation of images by a concave lens for the following two cases, with a ray incident with an inclination to the principal axis
  - (I) For a real object
  - (II) For a virtual object
- (iii) What is the principle that explains the two ray diagrams above?

- (b) For a physics demonstration, a device is constructed using a combination of a convex and a concave lens, as shown in the figure below. It consists of a convex lens with a focal length  $f_1$  and a concave lens with a focal length  $f_2$ . The distance ( $x$ ) between the two lenses can be varied. A mechanical system is used for this adjustment.

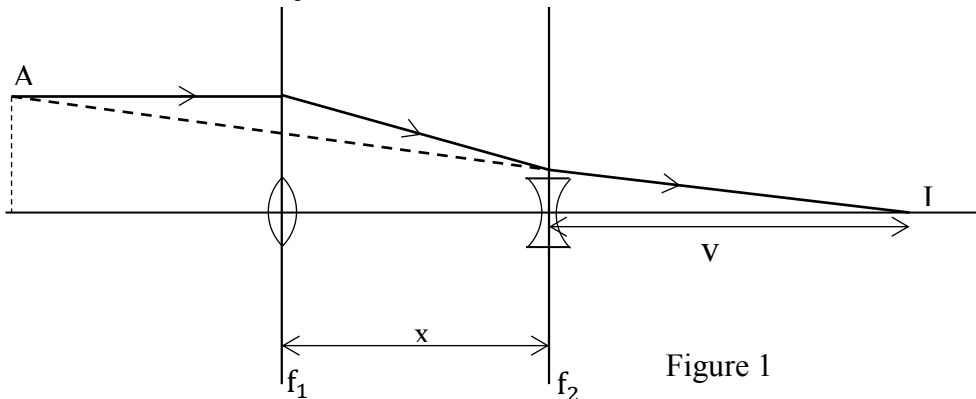


Figure 1

- (i) What is the inequality that must be satisfied between  $f_1$  and  $x$  in order to form a real image at  $I$ ?
- (ii) When the light ray converging through the convex lens passes through the concave lens, find the distance from the concave lens to the final image

A ray diagram drawn by a student to find the effective focal length of the lens combination is shown in Figure 2 below. A parallel light ray incident on the convex lens at a height  $y_0$  above the principal axis enters the concave lens at a height  $y$  above the principal axis.

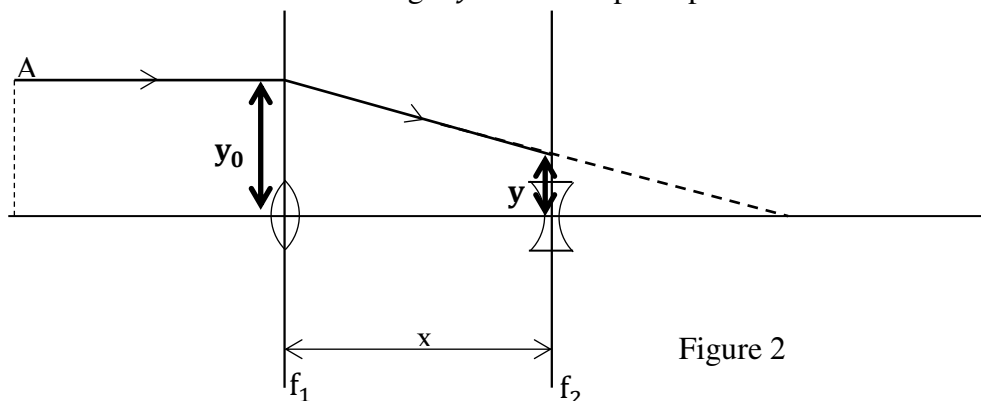


Figure 2

- (iii) By considering right-angled triangles or trigonometric ratios, derive an expression for  $y$  in terms of  $y_0$ ,  $f_1$ , and  $x$ .

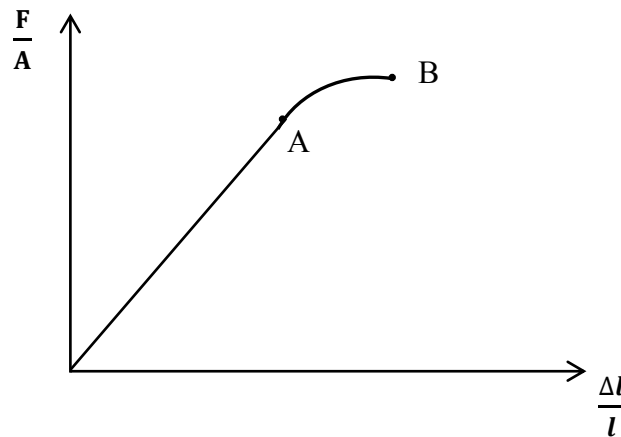
- (c) When the ray emerging from the concave lens (shown in Figure 1 above) that forms the final image  $I$  is extended backward (toward the left), it intersects the incident ray at point  $A$ . The effective focal length ( $f$ ) of the lens combination is defined as the distance along the principal axis from  $A$  to  $I$ .

Show that this focal length satisfies the relationship  $\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_2} + \frac{x}{f_1 f_2}$

(d)

- (i) If  $f_1 = 10 \text{ cm}$ ,  $f_2 = 20 \text{ cm}$ , and  $x$  can vary from 0 to 6 cm, find the minimum and maximum focal lengths of this setup.
- (ii) State one practical situation where this device could be usefully applied after improvement.

7. The graph given below has been drawn using the commonly used symbols  $\left(\frac{\Delta l}{l}\right)$  vs  $\left(\frac{F}{A}\right)$ .



(a)

- (i) Identify  $\left(\frac{\Delta l}{l}\right)$  and  $\left(\frac{F}{A}\right)$ .
- (ii) Identify the points A and B
- (iii) Write an equation using  $\left(\frac{\Delta l}{l}\right)$  and  $\left(\frac{F}{A}\right)$ . If you use any other symbols identify them

(b) It can be observed that tall coconut trees are uprooted during strong winds. To prevent this a steel cable tied to the upper part of the coconut tree binds it to another strong tree. To bind a certain coconut tree two steel cables of similar lengths of 25 m and cross sectional areas of  $0.8 \text{ cm}^2$  and  $0.5 \text{ cm}^2$  are joined together in series to form a 50 m long stretched composite wire after it is tied. (Consider that an additional length of both wires in two ends of the composite cable has used to tie the wire. Neglect the effect of that for the calculations. The young's modulus of steel is  $2 \times 10^{11} \text{ N m}^{-2}$  and the stress of steel at its proportional limit is  $2.5 \times 10^8 \text{ N m}^{-2}$ .)

(c)

- (i) The wire with which cross-sectional area would reach the proportional limit first? Give reasons for your answer.
- (ii) In this situation what is the maximum tensile force that can be exerted on the composite wire without it exceeding its proportional limit?

(d)

- (i) Which of the two wires would break during a strong wind?
- (ii) If the breaking stress of steel is  $3.1 \times 10^8 \text{ N m}^{-2}$ , then what is the tensile force on the wire at the moment it breaks?

(e)

- (i) Suggest a different method in which these two wires (each of length 25 m) can be used to withstand a higher amount of tensile force?
- (ii) If the both ends of each wire are tied together so that the two wires are parallel to each other and the composite wire is 25 m in length then what is the maximum tensile force that this composite wire can withstand without exceeding its proportional limit ?

## 8. Read the following passage and answer the questions.

The construction of space stations is a field that has been successfully developed in the modern era. The International Space Station (ISS) is currently known as a large artificial satellite kept in lower Earth orbit, capable of accommodating several people. It can also be described as a spacecraft. Around 15 countries' space agencies have contributed to its construction. The main purpose of building the ISS is to use it as a research laboratory where experiments in biology, human biology, physics, astronomy, and other fields can be conducted under microgravity conditions. It is also used as a testing laboratory for instruments that are to be used in future space missions.

At present, another space station has been proposed to be built at a distance of 3600 *km* above the Earth's surface, and it is expected to orbit around the Earth.

To transport materials required for its construction, an external energy equal to the difference between the gravitational potential energy at the station's orbit and that on the Earth's surface must be supplied. Energy generation in space stations is entirely achieved through solar energy (solar panel arrays). Solar panels are fixed to the body of the station, and the total surface area of these panels is about 500  $m^2$ .

(a)

- (i) In which region above the Earth is the International Space Station located?
- (ii) State two main objectives of constructing the International Space Station.
- (iii) If the acceleration due to gravity at the Earth's surface is  $g$ , the universal gravitational constant is  $G$  the mass of the Earth is  $M$ , and the radius of the Earth is  $R$ , show that  $g = \frac{GM}{R^2}$

(b)

- (i) Taking the radius of the Earth as 6400 *km* and the acceleration due to gravity at the Earth's surface as  $10 \text{ m s}^{-2}$ , find the tangential (orbital) velocity of the proposed space station that is to orbit around the Earth.
- (ii) If the distance from the Earth's surface to the orbit of the space station is  $h$ , express the gravitational potential energy of a body of mass  $m$  in the station's orbit in terms of  $G, M, R, h$  and  $m$ .
- (iii) When the same mass  $m$  is on the Earth's surface, write an expression for its gravitational potential energy in terms of  $G, M, R$ , and  $m$ .
- (iv) Show that the minimum energy that must be supplied for a body of mass  $m$  to just reach the orbit of the space station is  $\frac{GMmh}{R(R+h)}$ .
- (v) Using your answers to (a) (iii) and (b) (iv), show that the minimum energy that must be supplied for a body of mass  $m$  to just reach the orbit of the space station is  $\frac{mgRh}{(R+h)}$
- (vi) Using the data given in the passage, calculate the minimum energy that must be supplied for a small spacecraft with astronauts and equipment of total mass of 10,000 *kg* to reach the orbit of the space station.

(c)

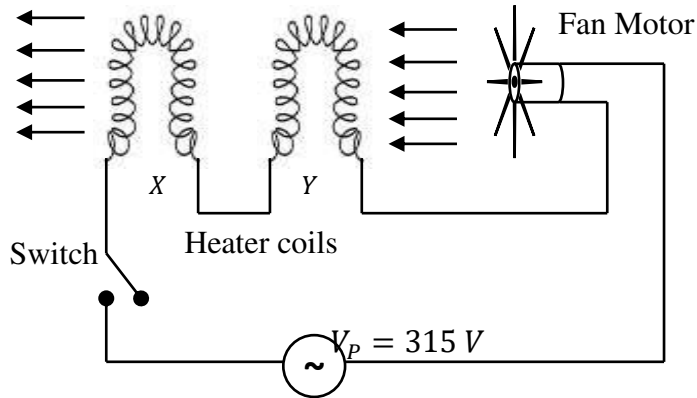
- (i) Without changing the orbit of the space station, find the additional energy required for the same spacecraft of mass 10,000 *kg* to dock with the space station.
- (ii) After docking, the astronauts and the equipment from the spacecraft move into the space station. Does the new tangential velocity of the space station change after this process? Explain your answer.

- (d) Assume that sunlight falls perpendicularly on the solar panels attached to the body of the space station, and that solar energy is incident uniformly at an intensity of  $2000 \text{ W m}^{-2}$  for a period of 6 hours. Find the total electrical energy produced during this time if the efficiency of the solar panels is 90%.

**9. Answer either part (A) or Part (B) only.**

**Part (9A)**

A school student has designed the circuit shown in the following Figure of a hair dryer to produce a stream of hot air.



This circuit is supplied with alternating voltage having a peak value of  $315 V$ .  $X$  and  $Y$  are two identical heating coils. The speed of the fan blades is directly proportional to the current passing through the motor.

- (a)
- What is meant by root mean square voltage ( $V_{rms}$ ) ?
  - Write the relationship between root mean square voltage ( $V_{rms}$ ) and the corresponding peak voltage ( $V_p$ ).
  - Calculate the corresponding root mean square voltage for the circuit given above.  
(Take  $\sqrt{2} \approx 1.4$ )
- (b)
- The heating coils are made of nichrome, which has a resistivity of  $10^{-6} \Omega m$  at  $25^\circ C$ . If a heating coil is made from a wire of length  $0.4 m$  and cross-sectional area  $10^{-8} m^2$ , calculate the resistance of one heating coil at  $25^\circ C$ .
  - State the importance of connecting the motor in series with the two heating coils.
  - Calculate the current flowing through the circuit if the effective resistance of the motor is  $20 \Omega$ .
  - Find the total power dissipated by the heating coils.
- (c)
- Calculate the power of the motor.
  - Into what forms of energy does the electrical energy supplied to the motor transformed when it operates?
- (d) During the operation of the hair dryer, the temperature of the heating coils rises up to  $200^\circ C$  and reaches a steady level.
- Write an expression for the resistance  $R$  of a conductor at a temperature  $\theta^\circ C$ , in terms of its resistance  $R_0$  at  $0^\circ C$  and its temperature coefficient of resistance  $\alpha$ .
  - Calculate the new resistance of a heating coil when its temperature rises to  $200^\circ C$ . The temperature coefficient of resistance for nichrome is  $4 \times 10^{-4} ^\circ C^{-1}$ . (Consider that  $\frac{108}{101} \approx 1.07$  for your calculations)
  - Explain qualitatively what happens to the speed of the fan blades due to the increase in temperature of the heating coils.

(e)

- (i) Let the angular velocities of the fan blades at 25 °C and 200 °C be  $\omega_{25}$  and  $\omega_{200}$ , respectively, and let the corresponding equivalent resistances of the circuit be  $R_{25}$  and  $R_{200}$ . Show that
- $$\omega_{200} = \omega_{25} \left( \frac{R_{25}}{R_{200}} \right)$$
- (ii) Show that, the speed of the fan blades decreases by approximately 10% , due to the increase in temperature up to 200 °C. Consider that  $\frac{1}{1.07} \approx 0.9$

**Part (9B)**

A Zener diode is used in a circuit to maintain (or regulate) a constant voltage across a load resistor.

(a)

- (i) Under which biased condition should a Zener diode be connected with the voltage source?  
 (ii) A step-down transformer converts a 220 V, 50 Hz alternating voltage into a voltage of 10 V (peak).

Draw the bridge rectifier circuit connected to the secondary terminals of the above transformer.

- (iii) When four identical silicon diodes (each with a barrier potential of 0.7 V) are used in the rectifier, draw the output voltage–time graph of the rectifier without a smoothing capacitor. Indicate the relevant units and values on the axes of your graph.

(b)

- (i) Draw the modified circuit showing how a smoothing capacitor should be connected to the output of the rectifier. (It is not necessary to draw the full bridge.)  
 (ii) Draw the circuit diagram showing how a Zener diode should be connected for voltage regulation. (It is not necessary to draw the full bridge.)

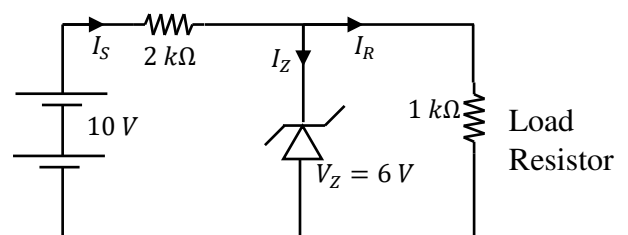
(c)

- (i) After connecting the Zener diode for voltage regulation, sketch a graph to show how the final output voltage varies with time.  
 (ii) What is the advantage of using a capacitor with a large capacitance value for the smoothing capacitor?  
 (iii) When a smoothing capacitor is used, what is the maximum Reverse biased Voltage that may appear across a diode?

(d) A voltage regulator circuit made using a Zener diode is shown in the figure.

To obtain a constant voltage of 6 V across the load resistor, a Zener diode with a Zener voltage of 6 V is used. The supply voltage is 10 V.

- (i) Find the current drawn from the supply ( $I_s$ ).  
 (ii) Find the current through the load ( $I_R$ ).  
 (iii) Find the current through the Zener diode ( $I_Z$ ).  
 (iv) Calculate the power dissipated in the Zener diode.



**10. Answer either part (A) or Part (B) only.****Part (10A)**

Cement blocks are a basic building unit used in construction. For this purpose, a mixture of cement, sand, and crushed black-rocks (quarry dust) is well mixed with water, poured into a mold, compressed mechanically, and then dried in air.

- (a) Write an expression for relative humidity in terms of the density of water vapor contains in a closed chamber and the density of saturated water vapor at the same temperature.
- (b) On rainy days, the cement blocks produced in a factory are stored in a closed chamber to remove moisture. The chamber has a length, width, and height of  $5\text{ m}$ ,  $4\text{ m}$ , and  $3\text{ m}$ , respectively. Initially the temperature of the chamber is  $27^\circ\text{C}$ , and the relative humidity is  $75\%$ . Before the cement blocks are placed inside, the absolute humidity should be reduced. A dehumidifier is used to remove water vapor from the air.
- Given that the absolute humidity of air saturated with water vapor at  $27^\circ\text{C}$  is  $32\text{ g/m}^3$ . Find the maximum mass of water vapor that can exist in the chamber before removing any water vapor.
  - Find the mass of water vapor present in the chamber when the relative humidity is  $75\%$  at  $27^\circ\text{C}$  (before operating the dehumidifier).
  - After the dehumidifier is operated, the relative humidity decreases to  $40\%$ . Find the mass of water vapor remaining in the chamber at that stage.
  - Hence, find the mass of water vapor removed by the dehumidifier.
- (c) After reducing the humidity as described above, the dehumidifier is removed, and the chamber is used to store cement blocks on rainy days. Inside the chamber, the cement blocks are stored on a flat metal plate mounted on a weighing scale fixed to the floor. The reading of the scale is electronically displayed on a screen located outside the chamber.
- The mass of one freshly made (moist) cement block is  $5\text{ kg}$ , and 100 such blocks are placed inside the chamber. In this chamber, the moisture of the cement blocks is not completely removed but is reduced to some extent only. Using a rough sketch, show how the reading of the scale changes with time.
  - What is the initial reading of the scale just after placing the cement blocks in the chamber?
  - If the temperature of the chamber is maintained at  $27^\circ\text{C}$ , find the maximum mass of water vapor that can be removed from the cement blocks.
  - What is the final reading of the scale after the moisture has been reduced as described above?
  - State whether this method of removing moisture from the cement blocks is effective or not, and give reasons for your answer.

**Part (10B)**

In the electromagnetic spectrum of the Sun, the wavelength of red colour is approximately  $700 \text{ nm}$ , while the wavelength of violet colour is approximately  $400 \text{ nm}$ . By passing sunlight through a filter, it can be separated into a spectrum of mono-coloured light.

(a)

- (i) Draw a circuit diagram of a suitable photovoltaic cell used to study the photoelectric current produced when electromagnetic radiation falls on a photo-cathode.
- (ii) When violet light is incident on the photo-cathode, the stopping potential is  $0.05 \text{ V}$ . Calculate the maximum kinetic energy  $K_{\text{max}(V)}$  of the emitted electrons. (Given: charge of an electron is  $1.6 \times 10^{-19} \text{ C}$ )
- (iii) Calculate the work function of the material of the photo-cathode. (Given: Planck's constant,  $h = 6.6 \times 10^{-34} \text{ Js}$ )
- (iv) Show that no current flows through the circuit when red light is incident on the same photo-cathode.

(b)

- (i) There are three photo-cathode materials named  $X, Y$  and  $Z$  whose work functions are  $2.1 \times 10^{-19} \text{ J}$ ,  $3.5 \times 10^{-19} \text{ J}$ , and  $5.0 \times 10^{-19} \text{ J}$ , respectively. Identify which material(s) will not produce a photoelectric current under illumination with either violet or red light. Give reasons for your answer.
- (ii) For a metal that can emit photoelectrons when illuminated by both red and violet light, state which color produces electrons with the higher maximum kinetic energy.
- (iii) Calculate that maximum kinetic energy in b(ii).
- (iv) If the maximum photoelectric currents observed for violet and red light are  $250 \mu\text{A}$  and  $400 \mu\text{A}$  respectively, sketch a graph of current versus potential difference ( $V$ ) for both colors on the same set of axes.
- (v) Does each photon incident on the photo-cathode release only one electron? Give reasons for your answer.

\* \* \*