දකුණු පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව
தென் மாகாணக் கல்வித் திணைக்களம்
Southern Provincial Department of Education

අධ්‍යාපන පොදු සහතික පත්‍ර (උසස් පෙළ), 12 ශ්‍රේණිය, අවසාන වාර පෙරහුරු පරීක්ෂණය, 2023 මාර්තු
General Certificate of Education (Adv. Level), Grade 12 Third Term Pilot Test, March

භෞතික විද්‍යාව I Physics I	01	E	I	පැය දෙකයි Two hours

Instructions :

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

Use of calculation is not allowed.

($g = 10\ N\ kg^{-1}$)

01. Which of the following five quantities have dimensions different from the other four?

(1) Energy per unit volume

(2) Force on a unit area

(3) Angular momentum of a unit mass

(4) Pressure at a point in a flowing fluid

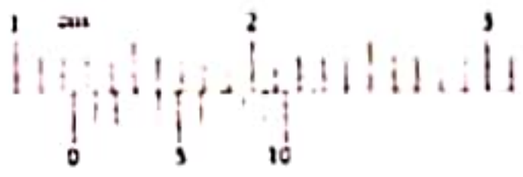
(5) Product of potential and charge per unit volume.

02. The velocity V, of water waves depends on its wavelength λ, the density of water ρ and the acceleration due to the gravity g. Which of the following gives the correct relationship between these quantities?

(1) $V^2 \propto \lambda^{-1} g^{-1} \rho^{-1}$ (2) $V^2 \propto \lambda g$

(3) $V^2 \propto \lambda g \rho$ (4) $V^2 \propto \lambda^3 g^{-1}$ (5) $V^2 \propto \lambda^3 g^{+1} \rho^{-1}$

03. What is the reading shown in the figure?



(1) 1.24 cm (2) 1.34 cm

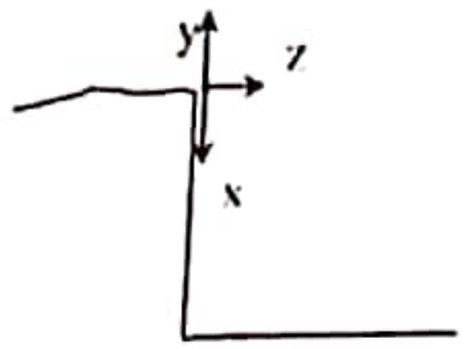
(3) 1.04 cm (4) 1.30 cm (5) 1.25 cm

04. A body moving in a straight line covers first ¼ the distance with a uniform speed u_1 and remaining ¾ distance with a uniform speed u_2 . What is the average speed (u) of the entire motion?

(1) $u = \frac{u_1 + u_2}{2}$ (2) $u = \frac{2u_1 u_2}{u_1 + u_2}$

(3) $u = \frac{3u_1 u_2}{3u_1 + u_2}$ (4) $u = \frac{4u_1 u_2}{3u_1 + u_2}$ (5) $u = \frac{4u_1 u_2}{u_1 + 3u_2}$

05. An object X is released from rest from the top of a vertical mountain of height h from the horizontal ground. At the same time an object Y is projected vertically upwards with a velocity of u and an object Z is projected horizontally with a velocity of u^2.



(1) All the three objects X, Y, and Z fall on the ground at the same time.

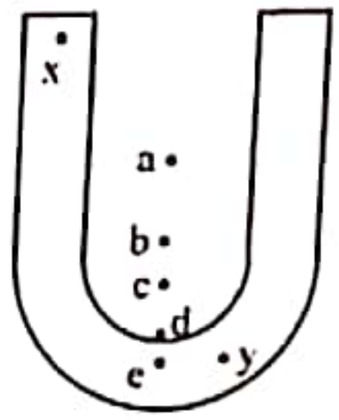
(2) X and Y fall on the ground at the same time and Z later.

(3) X and Z fall on the ground at the same time and Y later.

(4) X first, then Y and finally Z fall on the ground.

(5) X first, then Z and finally Y fall on the ground.

06. The figure shows a U shape lamina made of a plate of uniform thickness and density. When it is hung from point X, it is in equilibrium so that the line joining the points X and Y is vertical. The most suitable point that represents the center of gravity of the lamina is,



(1) a (2) b (3) c
(4) d (5) e

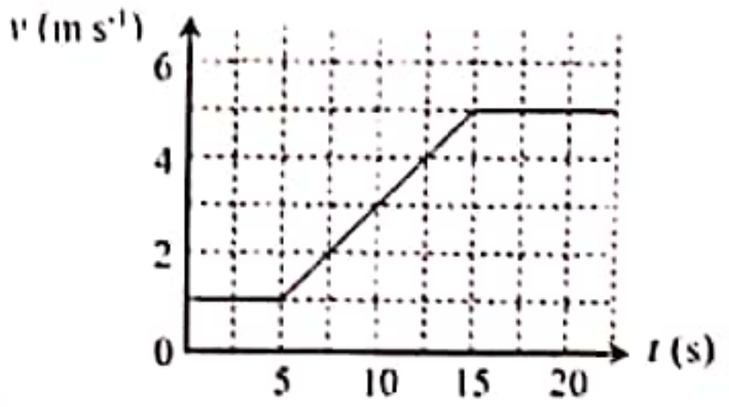
07. X and Y are two perpendicular directions. An object moving with velocity u in direction X explodes into two unequal fragments. The mass of the larger fragment is three times as the smaller fragment. If the explosion gave the smaller fragment a velocity of u to the X direction and velocity of $\sqrt{3}\,u$ to the Y direction. What is the angle between the directions of motion of the two fragments?

(1) 45° (2) 60° (3) 90° (4) 120° (5) 135°

08. An object is in equilibrium under four non parallel forces acting on it, when it satisfies which of the following requirements?

(1) If the set of forces is coplanar.
(2) If all the forces pass through one point.
(3) If the resultant force of the set of forces is zero.
(4) If any force is equal to the resultant of the other forces.
(5) If the algebraic sum of the moments of the forces about a point is zero.

09. This graph shows the variation of velocity (v) versus time (t) when a force is applied on an object of mass 5 kg on a rough horizontal surface. The force applied on the object during the first 5 seconds is 3N. If it is which of the following correctly represents the forces applied on the object during the period from 5s to 15 s and the period after 15 s respectively?

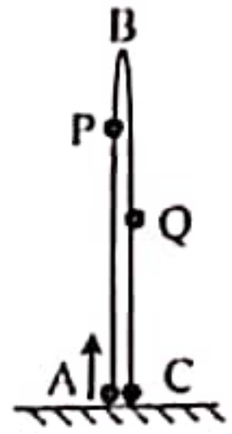


(1) 3 N, 3 N (2) 4 N, 3 N (3) 5 N, 3 N
(4) 5 N, 4 N (5) 5 N, 5 N

10. A block of wood of relative density 0.8 floats in water and submerged a certain volume. The volume of the block above the surface of the water by its total volume is,

(1) 0.2 % (2) 0.8 % (3) 20 % (4) 40 % (5) 80 %

16. The motion of a. body is projected vertically upwards at A on a horizontal ground, moves to its maximum height B and then falls back on the ground (c) is shown in the figure. The velocities of the object at points P and Q in the motion are v_1 and v_2 respectively. and the accelerations are a_1 and a_2 respectively. Which of the following answer is correct?



(1) $v_1 > 0, v_2 > 0, a_1 > 0, a_2 > 0$
(2) $v_1 < 0, v_2 > 0, a_1 < 0, a_2 > 0$
(3) $v_1 > 0, v_2 < 0, a_1 < 0, a_2 > 0$
(4) $v_1 > 0, v_2 < 0, a_1 < 0, a_2 < 0$
(5) $v_1 < 0, v_2 < 0, a_1 < 0, a_2 > 0$

17. Which of the following statememts are correct regarding the uses of dimensional analysis?

(a) Constants or dimensionless quantities of equations cannot be found using the method of dimensional analysis.

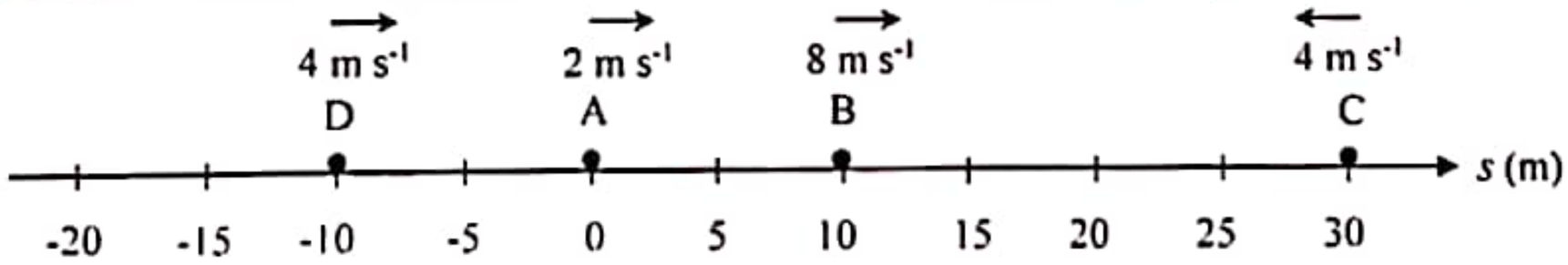
(b) Equations or expressions with more than one quantity can be derived.

(c) Dimensional analysis can be used to convert units

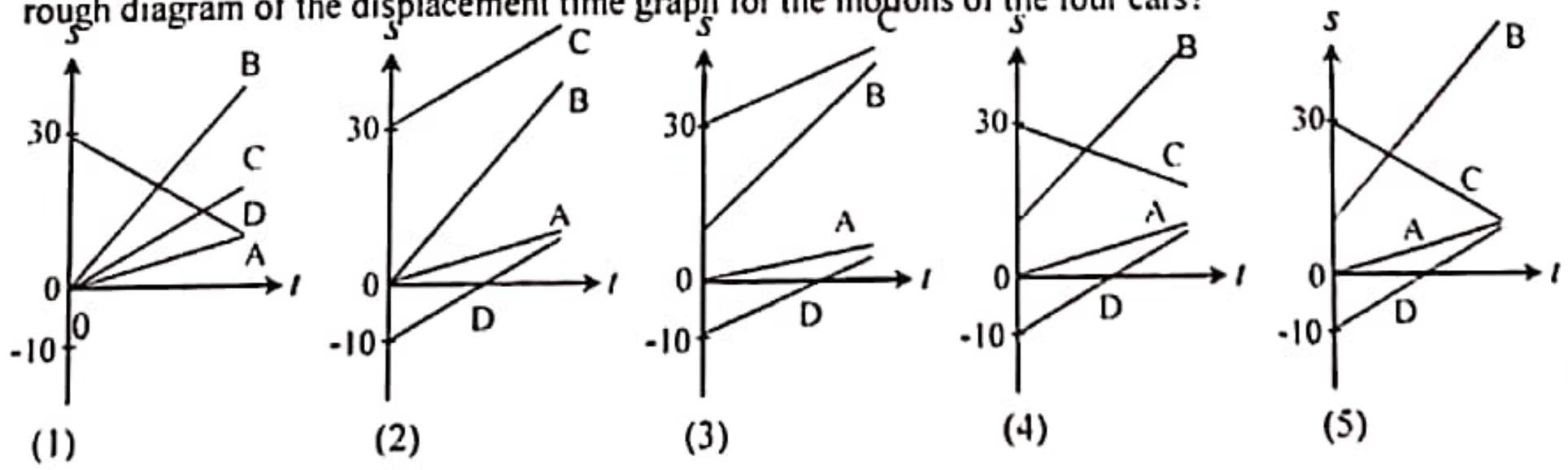
(d) An equation having sum of several terms can be built up using dimensional analysis.

(1) a, b and c
(2) a and c
(3) b and d
(4) a, b, and d
(5) a, b, c and d

18. The figure below shows four objects A, B, C and D located initially on the displacement line.



The four object start their motion with given speeds and move with the same uniform speeds to the given directions from the same positions at the same time. Which of the following correctly shows the rough diagram of the displacement time graph for the motions of the four cars?



19. A light ray entering along one surface of a equilateral prism places in a vaccum emerge along the other surface. When the prism was immersed in certain liquid the ray that entered along the surface was emerged from the other surface perpendicular to that surface. What is the absolute refractive index of the substance?

(1) 1.21
(2) 1.73
(3) 1.51
(4) 2.00
(5) 2.50

20. Two waves of wavelength 2 m and 2.02 m are traveling at the same speed and superimposing produce 2 beats per second. What is the speed of the wave?

(1) 400 m s^{-1} (2) 404 m s^{-1} (3) 402 m s^{-1} (4) 406 m s^{-1} (5) 306 m s^{-1}

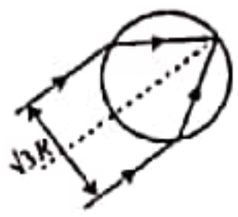
21. When the fundamental mode of a stretched string is 300 Hz, its tension is T. Find the fundamental Frequency when the tension is increased by 21%.

(1) 285 Hz (2) 310 Hz (3) 300 Hz (4) 315 Hz (5) 330 Hz

22. A ray of light entering a spherical liquid drop of radius R as shown in the figure has the incident ray and the emergent ray parallel to each other. The deviation of the ray on partial reflection is.

(1) 30^0 (2) 60^0 (3) 120^0

(4) 150^0 (5) 180^0



23. To maximize the magnification of the image from a compound microscope.

(A) The focal lengths of both eye piece lens and objective lens should have smaller values.

(B) The lens of smaller focal length should be used for eye piece.

(C) The normal adjustment of the compound microscope should be used.

True of the above statements is.

(1) A only (2) A and B only

(3) A and C only (4) B and C only

(5) All A, B, and C

24. When two objects of weight W_0 are suspended from a non - light rod AB suspended by a light string. the system is in equilibrium as shown in the figure (P). When two objects of weight W_1 and W_2 are hung instead of the two objects of weight W_0 the system is at rest as shown in figure (Q)

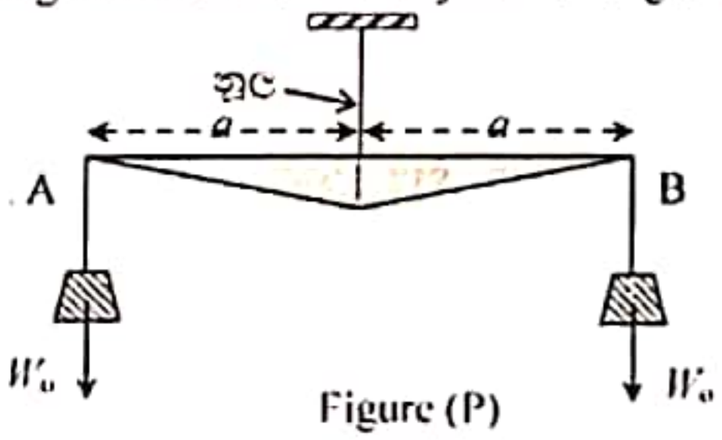


Figure (P)

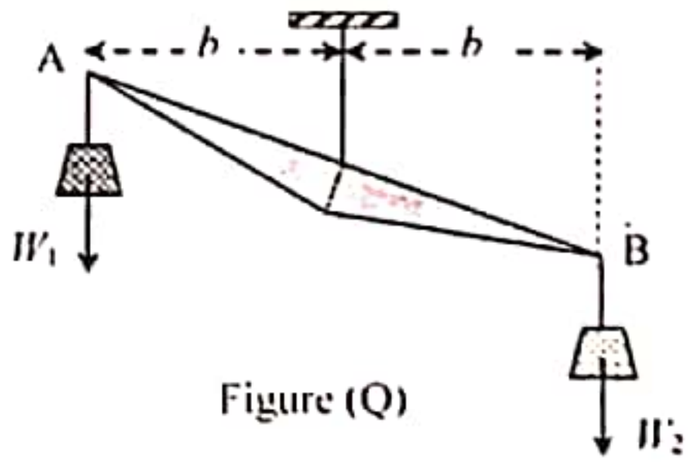


Figure (Q)

According to the above information given in the figures, which of the following is true?

(1) $W_1 = W_2 = W_0$ (2) $W_1 = W_2$ (3) $W_1 = \frac{a}{b} W_0$ (4) $W_1 > W_2$ (5) $W_1 < W_2$

25. If the speed of the sound in a gas at 17 °C is V, then find the temperature at which the speed of sound in this gas is 2V.

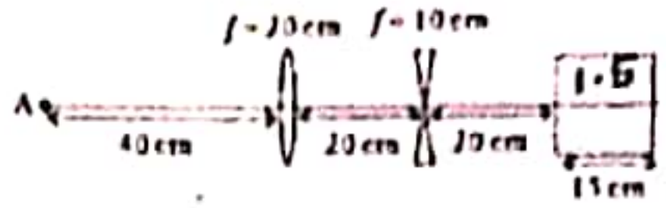
(1) 68 °C (2) 34 °C (3) 200 °C (4) 600 °C (5) 887 °C

26. A convex lens, a concave lens and a blockof glass with parallel sides is placed in air so that they are having a single axis(uniaxial). The image formed by the two lenses and the glass block is from the concave lens is,

(1) 20 cm to the left (2) 20 cm to the eight

(3) 15 cm to the left (4) 15 cm to the right

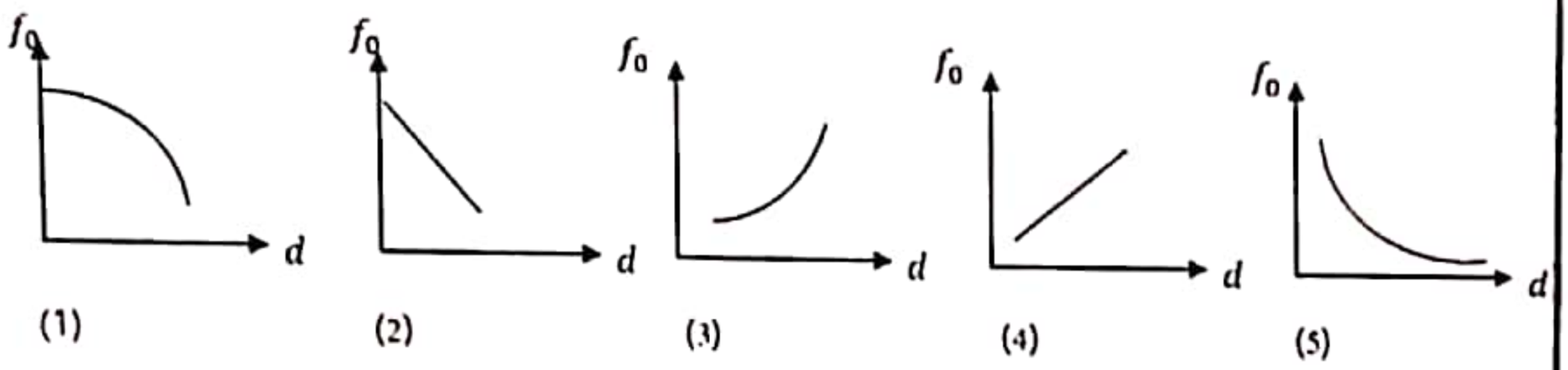
(5) 5 cm to the left



27. The speed of propagation of a transverse wave of wavelength λ and time period T is.

(1) λT (2) $\lambda T/2$ (3) $\lambda T/4$ (4) λ/T (5) T/λ

28. The variation of the fundamental frequency of a stretched string with the diameter of the string represents by.



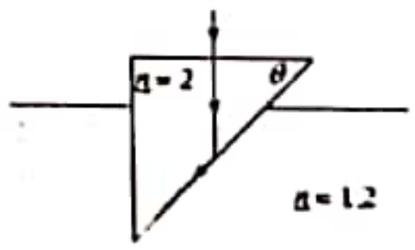
(1) (2) (3) (4) (5)

29. For the ray to travel as shown in the figure, the value of angle θ should be.

(1) $\theta = \cos^{-1}\left(\frac{3}{5}\right)$ (2) $\theta = \sin^{-1}\left(\frac{4}{5}\right)$

(3) $\theta = \sin^{-1}\left(\frac{3}{4}\right)$ (4) $\theta = \tan^{-1}\left(\frac{4}{3}\right)$

(5) $\theta = \tan^{-1}\left(\frac{3}{4}\right)$



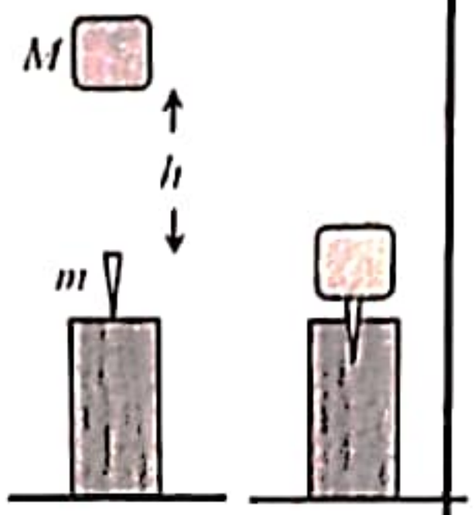
30. A resonance tube open at both ends emits a fundamental lone of frequency 420 Hz. If one and of the tube is closed, the frequency of the fundamental tone will be,

(1) 105 Hz (2) 210 Hz (3) 315 Hz (4) 420 Hz (5) 840 Hz

31. A car of mass 500 kg moves down a hill with uniform velocity when the engine is switched off and is in free motion. The maximum speed the car can travel along the road which was an inclined hill of angle 12° to the horizontal is 54 km h^{-1}. What is the power of the eat?
(Consider tan 12° = sin 12° = 0.2 and cos 12° = 0.98)

(1) 19.8 kW (2) 29.7 kW (3) 39.6 kW (4) 59.4 kW (5) 106.9 kW

32. A metal hammer of mass M is released from rest at the height of h on an iron wedge of mass m fixed to a log as shown in the figure. If the hammer does not bounce after it collides with the wedge and the wedge with the hammer sinks a distance x into the log the mean resistant force exerted by the log against the motion of the wedge is R and its value is given by,



(1) $R = \frac{Mgh}{x} + (M+m)g$ (2) $R = \frac{Mgh}{x} + mg$ (3) $R = \frac{(2M+m)gh}{2x}$

(4) $R = \frac{(M+m)gh}{x}$ (5) $R = \frac{Mgh}{x}$

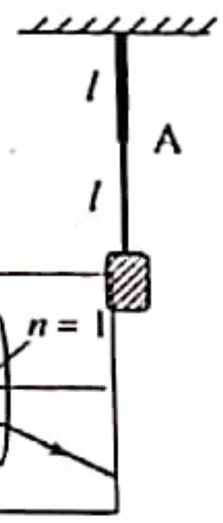
33. If the total number of antinodes is n and the wave length is λ of a stretched string fixed at two ends, the length of that string is given by,

(1) $n\lambda/2$ (2) $(n-1)\lambda/2$ (3) $2\lambda n$ (4) $2\lambda(n-1)$ (5) $(n+1)\lambda/2$

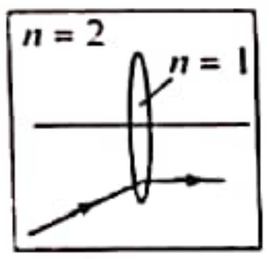
34. A length of a composite string made by tying together a thicker string of mass m and a thin string of mass m_o , is $2l$. One end is tied to a fixed point and an object of mass M is suspended from the other free end. What will be the tension (T) at point (A) where the two strings are connected?

(1) $T = Mg$ (2) $T = (M+m_o)g$

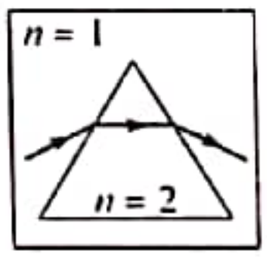
(3) $T = (m_o + \frac{M}{2})g$ (4) $T = (\frac{M+m_o}{2})g$ (5) $T = (M + \frac{m_o}{2})g$



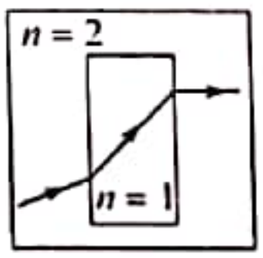
35. Which of the following ray diagram is incorrect?



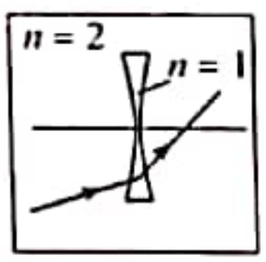
(1)



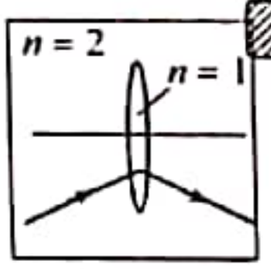
(2)



(3)

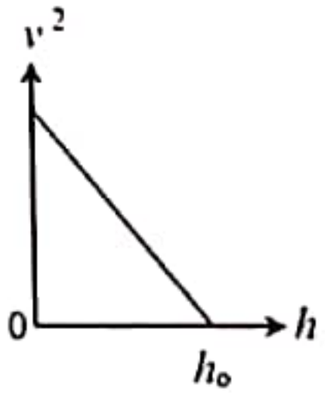


(4)

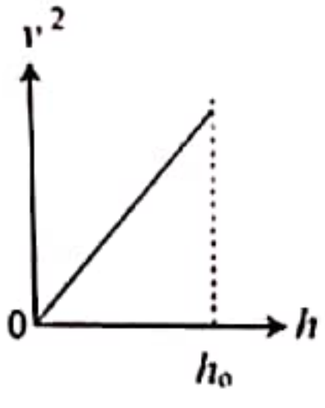


(5)

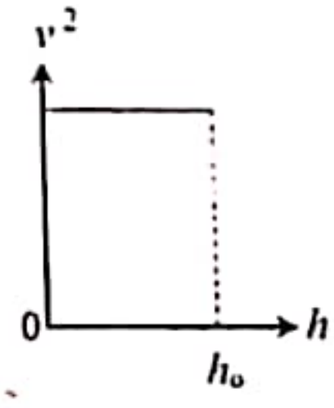
36. The maximum height of motion of an object projected vertically upwards is h_o. Which of the following graphs correctly shows the variation of the velocity (v) of the object with the vertical height (h) during the motion form the moment of projection to the maximum height?



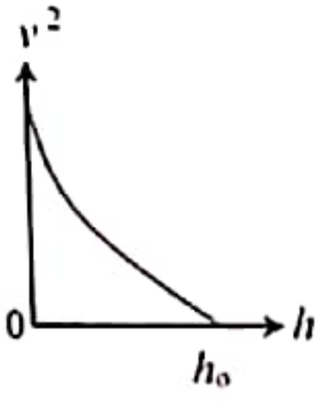
(1)



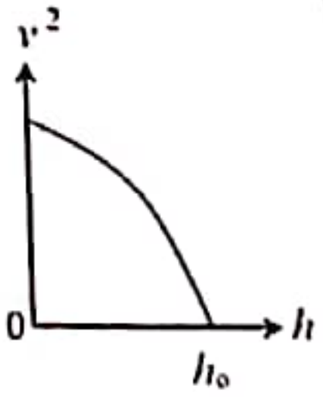
(2)



(3)



(4)



(5)

37. The variation of each properties reative to the each other when two light rays red and green travel through a transparent medium is given below. The incorrect answer is.

	Speed	Wavelength	Deviation	Critical Angle	Refractive index
Red	greater	greater	lesser	lesser	Lesser
Green	lesser	lesser	greater	greater	Greater
	(1)	(2)	(3)	(4)	(5)

38. If the temperature of a rod of length L is increased by 50°C , the length of the rod expands by 0.1%. The area expansion of this rod material is,

(1) $1 \times 10^{-5}\ ^{\circ}C^{-1}$ (2) $2 \times 10^{-5}\ ^{\circ}C^{-1}$

(3) $3 \times 10^{-5}\ ^{\circ}C^{-1}$ (4) $4 \times 10^{-5}\ ^{\circ}C^{-1}$

(5) $5 \times 10^{-5}\ ^{\circ}C^{-1}$

39. Light entering a glass prism of absolute refractive index 1.5 placed in air. The speed at which a light ray travels through the prism is (speed of light in air is $3 \times 10^{8}\ m\ s^{-1}$)

(1) $0.5 \times 10^{8}\ m\ s^{-1}$ (2) $1 \times 10^{8}\ m\ s^{-1}$

(3) $1.5 \times 10^{8}\ m\ s^{-1}$ (4) $2 \times 10^{8}\ m\ s^{-1}$

(5) $3 \times 10^{8}\ m\ s^{-1}$

40. A rough hollow cylinder of internal radius r rotates about a vertical axis with its axis vertical. A particle in contact with the inner surface of the cylinder has mass m. If the particle has not fallen down when the minimum rate of rotation is n revolutions per second, find the co – efficient of friction between the particle and cylinder wall.

(1) $g/r\,n^2$ (2) $g/4r\,n^2$ (3) $g/\pi^2 r\,n^2$ (4) $g/4\pi\,r^2\,n^2$ (5) $g/4\pi^2 r\,n^2$

41. Consider the following statements about the speed of sound in air.

(A) Speed of sound in a metal at a given temperature is greater than in air.

(B) Speed of sound increases as temperature and humidity increase.

(C) Speed of sound depends on the frequency of the sound wave.

From the above statements,

(1) only A is true

(2) only B is true

(3) only A and B are true

(4) only A and C are true

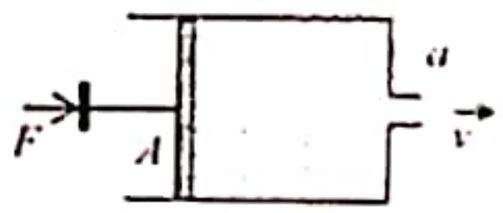
(5) A ,B and C all are true

42. An object of volume V suspended from a spring balance has an apparent mass M_1 when the object is fully immersed in a liquid of density ρ at temperature θ_1 and apparent mass of M_2 when it is fully immersed in the liquid same as above at temperature θ_2 . The linear expansion of the material of the object is α and the volume expansion of the liquid where the object immersed is γ .The value of $(M_2 - M_1)$ is.

(1) $\frac{(\gamma-3\alpha)(\theta_2-\theta_1)V\rho}{1+\gamma(\theta_2-\theta_1)}$ (2) $\frac{(1+3\alpha)(\theta_2-\theta_1)V\rho}{1+\gamma(\theta_2-\theta_1)}$

(3) $\frac{(\gamma+3\alpha)(\theta_2-\theta_1)V\rho}{1+3\alpha(\theta_2-\theta_1)}$ (4) $\frac{(\gamma+3\alpha)(\theta_2-\theta_1)V\rho}{\gamma(\theta_2-\theta_1)}$ (5) $\frac{(3\alpha-\gamma)(\theta_2-\theta_1)V\rho}{1+\gamma(\theta_2-\theta_1)}$

43. A liquid of density ρ is contained in a cylinder having a piston as shown in the figure. The cross - sectional area of the piston is A and he cross sectional area of the hole opposite to it is a If a constant force F applied to the piston causes the fluid to flow out of the hole at a constant speed v find the rate of work done by the force F.



(1) $\frac{1}{2}a\rho v^3(1-\frac{a^2}{A^2})$ (2) $\rho a\rho v^3(1-\frac{A^2}{a^2})$

(3) $\frac{1}{2}A\rho v^3(1+\frac{a^2}{A^2})$ (4) $\frac{1}{2}a\rho v^3(1+\frac{a^2}{A^2})$ (5) $\frac{1}{2}A\rho v^3(1-\frac{A^2}{a^2})$

44. A solid cylinder of moment of inertia 8kgm^2 is rotated about its axis at an angular velocity of 600 rad s^{-1} and brought to rest by a constant torque of 160 Nm. What is the time taken for it to come to the rest from the moment the torque is applied?

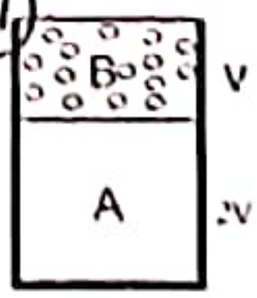
(1)50 s (2) 45 s (3) 40 s (4) 30 s (5) 20 s

45. A certain thermometer A has a thermometric value of 20 a at 0 °C and a thermometric value of 70 a at 100 °C. When another thermometer B shows a thermometric value of 10b the thermometer A shows it as 30 a and when the thermometer B shows thermometric value of 40b, the thermometer A shows it as 120 a. Find the temperature when the thermometer B shows he thermometric value 50b.

(1) 70 °C (2) 150 °C (3) 200 °C (4) 260 °C (5) 300 °C

46. If two immiscible liquids o volume v and 2v each completely fill the volume of the vessel as shown in the figure. then if the liner expansion of the material of the vessel is α, the volume expansion of the liquid A is γ_A and the volume expansion of the liquid B is γ_B, find the overflowing volume of the liquid from the vessel when the temperature of the system is increased by $\Delta\theta$.

(Consider The liquid B is not completely removed from the vessel)



(1) $(2\gamma_A + \gamma_B - 3\alpha)V\Delta\theta$ (2) $(2\gamma_A + \gamma_B - 9\alpha)V\Delta\theta$

(3) $(\gamma_A + \gamma_B - 3\alpha)V\Delta\theta$ (4) $(\gamma_A + \gamma_B - 9\alpha)V\Delta\theta$

(5) $(2\gamma_A + \gamma_B - 6\alpha)V\Delta\theta$

47. A cylindrical tank of mass m and cross sectional area A is filled to a height h with a liquid of density ρ and placed on a smooth horizontal surface. Near to the bottom of the tank there is a small hole of cross sectional area a on the vertical wall. What is the initial acceleration of the tank on the surface when the liquid starts to flow out of the hole?

(1) $\frac{ah\rho g}{Ah\rho+m}$ (2) $\frac{2ah\rho g}{Ah\rho+m}$ (3) $\frac{Ah\rho g}{ah\rho+m}$ (4) $\frac{(Ah\rho+m)g}{ah\rho}$ (5) $\frac{(Ah\rho+m)g}{2ah\rho}$

48. Consider the following expressions on the Kelvin (K) and Celsius (°C) scales.

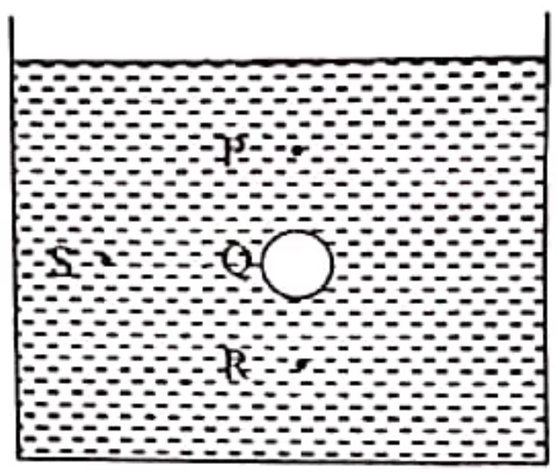
(A) A Kelvin thermodynamic temperature unit is 1/273. 15 of the temperature of the triple point of water.

(B) There is no magnitude difference in temperatures when expressing in Kelvin or Celsius scales.

(C) There are no negative (−) values in the Kelvin scale.

(1) Only B is correct
(2) Only A and B are correct
(3) Only B and C are correct
(4) Only A and C are correct
(5) A, B, and C all are correct

49. A spherical solid object in a compressible fluid floats at Q and is in equilibrium. If Q and S are two points at the same horizontal level consider the following statements.



(A) When the object is brought to the position P it remains in equilibrium at the new position.

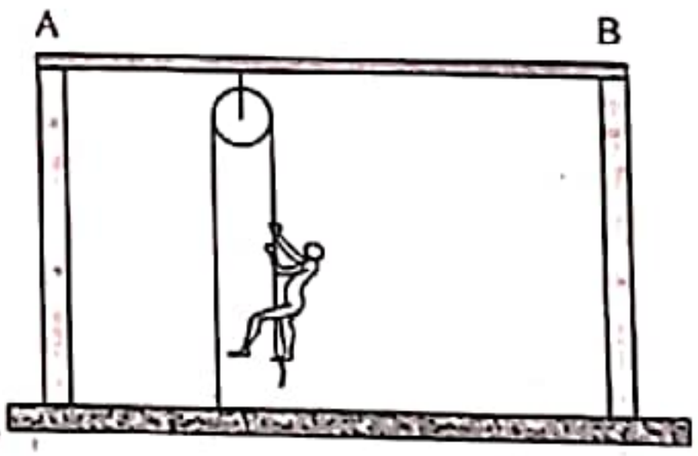
(B) When the object is brought to the position R it returns to the position Q.

(C) When the object is brought to the position S, it remains in equilibrium at the new position.

Which of the above statement/s is/are true?

(1) A only (2) B only (3) C only (4) A and C only (5) B and C only

50. A uniform beam of mass 60 kg is supported horizontally on two poles placed vertically on horizontal ground. A light pulley is hung from the end A of the beam at a distance of 1/3 of its length as shown in the figure. One end of the light string send over the pulley is tied to the ground and the string is vertical. If a child of mass 50 kg hanging from the other end of the string moves up the string with a uniform acceleration of 2 m s^{-2}. The reactions on the beam by the two poles at the ends beam by the two poles at the ends A and B respectively are,



(1) 400 N, 200 N
(2) 700 N, 500 N
(3) 1 100 N, 600 N
(4) 1 100 N, 700 N
(5)1200 N, 600 N

Do not write any mark this column

Part A Structured Essay

01. (a) Some of the instruments used for measuring length in the laboratory are given below.

A. Meter ruler
B. Micrometer screw gauge
C. Spherometer
D. Vernier caliper
E. travelling microscope

- Here the circular scale of the micrometer screw gauge is divided in to 50 divisions and its pitch is 0.5 mm
- The circular scale in the spherometer has 100 divisions and its pitch is 1 mm
- In the Vernier caliper 10 vernier divisions coincide with 9 main scale divisions.
- The main scale of the traveling microscope divided into $\frac{1}{2}$ mm divisions. Its 49 divisions of the main scale coincide with 50 vermnier divisions.

(b) Find the least counts of each instrument.

.....

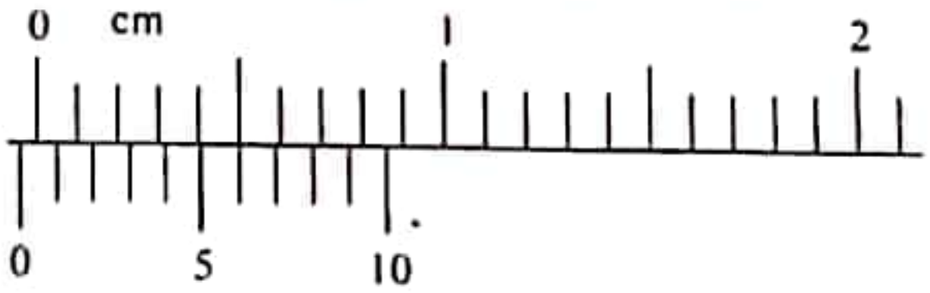
.....

.....

.....

(c) The figures given below show that the arrangements in order to find whether there is a zero error. Find the zero errors of each instance.

(i) In the Vernier caliper



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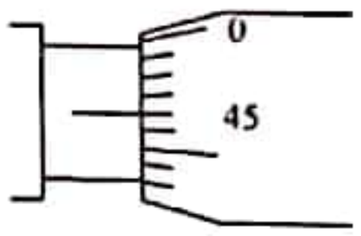
(ii) In the micro meter screw gauge.



.....

(d) Find the values corresponding to the minimum length that can be accurately measured by each instrument to abtain the most accurate value assuming a minimum percentage error of 1%

(i) Meter ruler

.....

(ii) Venire caliper

.....

(iii) Micrometer screw gauge

.....

(see page 3)

(iv) Spherometer

.....

(v) Travelling microscope.

.....

(e) Mention an error that occurs in relation to the person and the instrument when getting the readings using the meter ruler, and mention how to avoid that error.

(i) Personal Error .....

How to avoid it .....

.....

(ii) Instrumental error .....

How to avoid it .....

.....

(f) A hollow unform glass sphere has a small hole to insert the depth measuring pin of the vernier caliper as shown in the figure. You are asked to find the internal (hollow) diameter of the sphere using the vernier caliper.

(i) The zero error of the instrument affects in measuring depth. What is the reason for having that error?

.....

(ii) How do you find it?

.....

.....

(g) The figures below show the scale readings in relation to two measurements taken by a student using a vernier caliper to find the internal diameter (d) of the hollow sphere and the thickness of the hollow wall(x). (Note that the vernier caliper has no zero error)

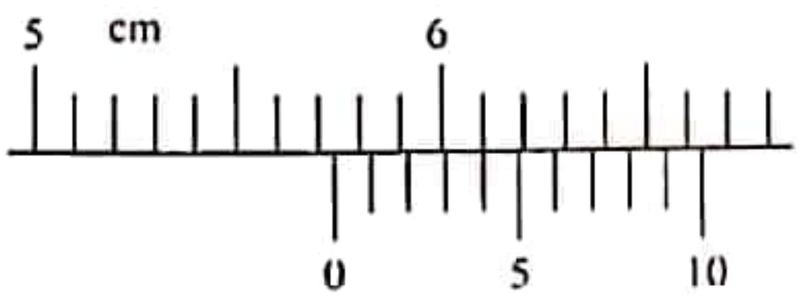


Figure (1)

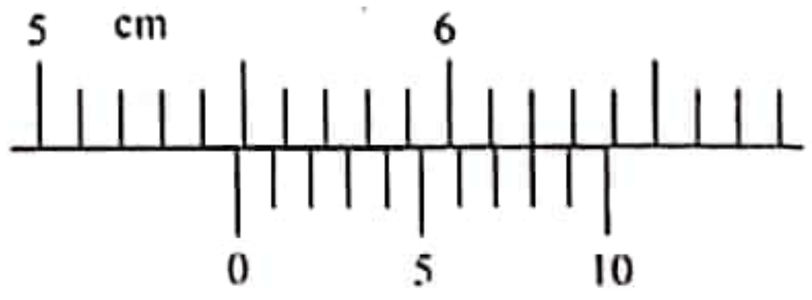


Figure (2)

(i) Write the reading shown in the figure (1) .....

(II) Write the reading shown in the figure (2) .....

(iii) Find the thickness of the hollow sphere (x)

.....

(see page 4)

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(iv) Find the internal diameter of the hole.

.....

.....

(h) A strudent says that when measuring using a vernier caliper where there is a zero error the effect of the zero error can be minimized by taking several measurements for each quantity and taking their mean.

(i) Do you agree with that statement? .....

(ii) Explain.

.....

02. The llowing figure shows an experimental set up made to find the relative density of an oil using the Hare' s apparatus in the laboratory.

(a) What other materials or equipment are required in addition to the equipment' shown here?

.....

(b). If. ρ_w – density of water ρ_o – density of oil

h_w - height of the water column from the pointer

h_o - height of the oil column from the pointer

x_w - height of the pointer on the water

x_o - height of the pointer on the oil

Write an equation that shows the relationship between these quantities.

.....

(c). Re – arrange the above equation in order to find the Relative density of the oil using a graphical method.

.....

.....

(d). Readings taken by a student during this experiment are given below.

h_o (cm)	4.5	7.0	9.5	14.5	22.0
h_w (cm)	2.0	4.0	6.0	10.0	16.0

Another student says that he cannot be satisfied with the readings obtained by the student.

(i). Do you agree with his opinion or not?

.....

(ii). Give two reasons for your answer in (a) above.

.....

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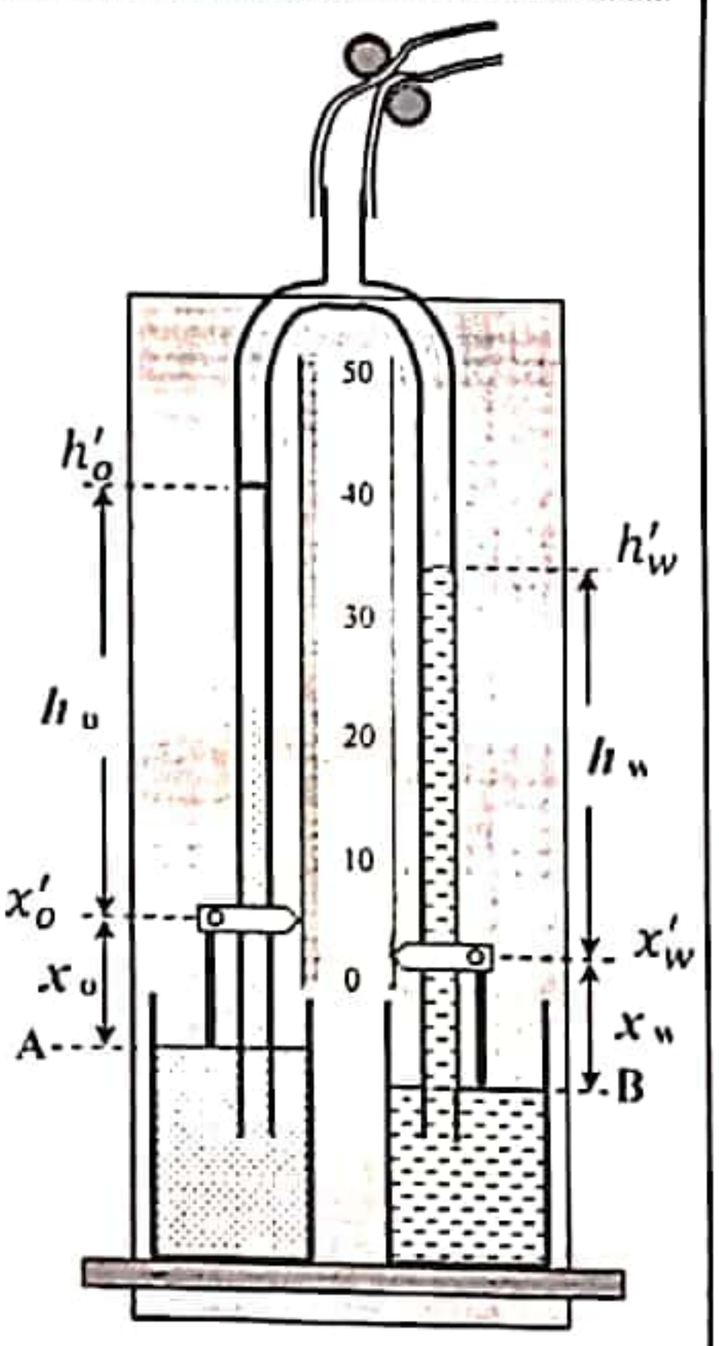

(see page 5)

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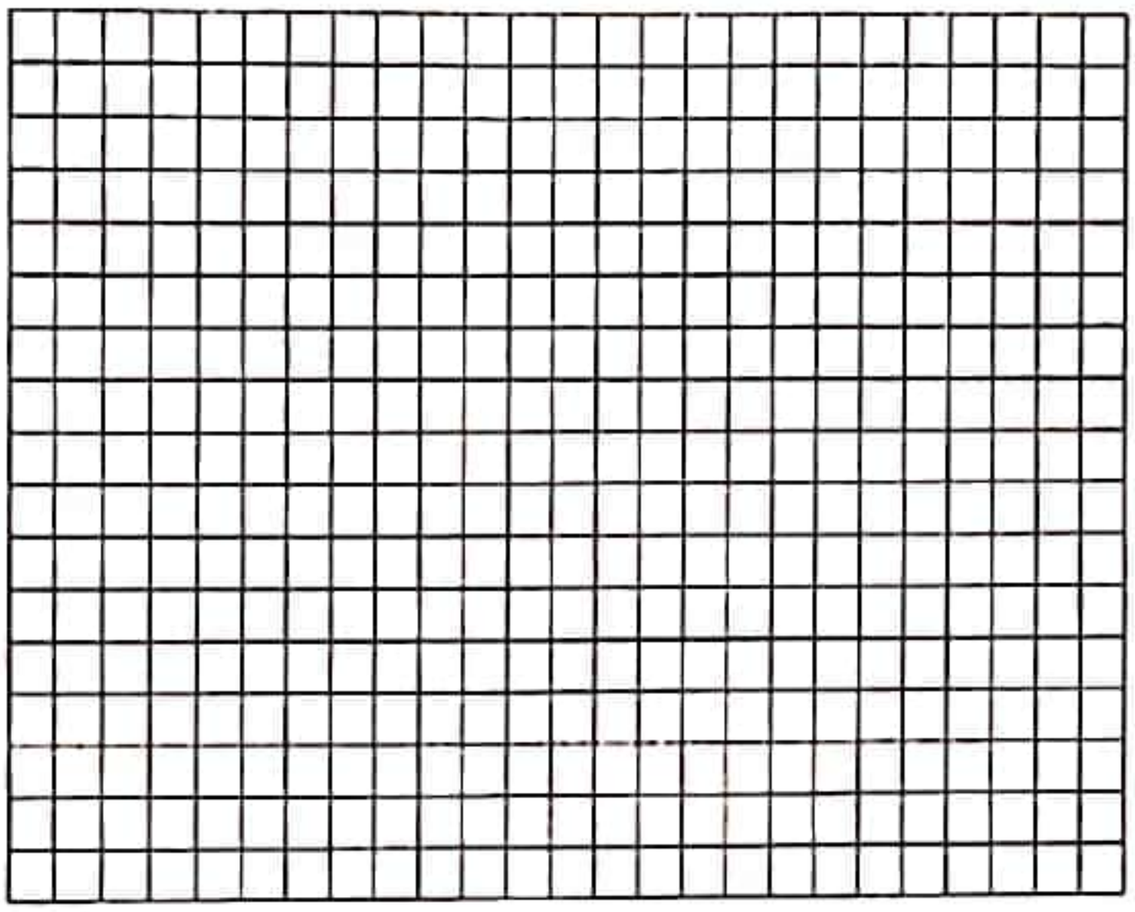
(e). Draw a suitable graph in the space given below to find the relative density of the oil using the above readings.



(f). Calculate relative density of the oil using the graph you drew.

.....

.....

(g). After raising the required amount of liquid columns, what should be done before measuring the heights of the liquid columns?

.....

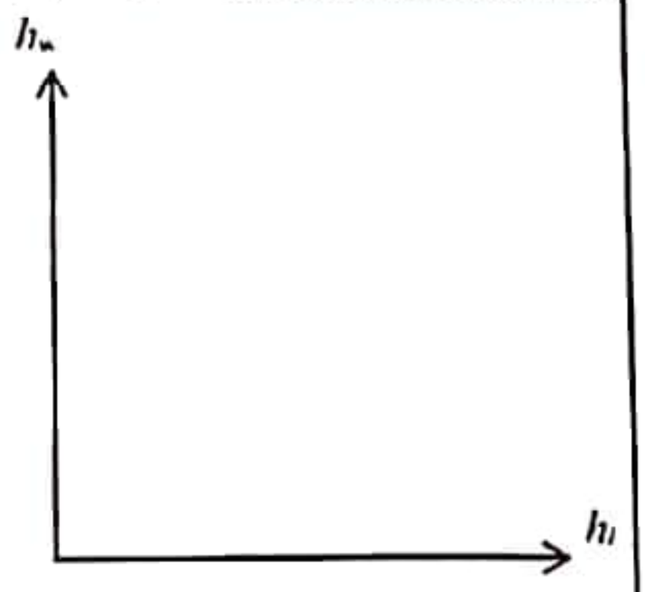
.....

(h). Tubes with what type of diameters should be used for this Hare's apparatus? Give reasons for your answer.

.....

.....

(i). To find the relative density using the Hare's apparatus readings were taken for an oil less dense than water and then for a liquid denser than water. If the heights of the two pointers of this here's apparatus are equal, draw the two graphs for the two liquids in the same axes showing the variation of the height (h_w) of the water column with the height (h_l) of the liquid columns. (Use a continuous line for a liquid of higher density and a dotted line for a liquid of lower density.)



(j). Tubes should be cleaned before use the hare's apparatus. Write down the steps you follow to clean the tubes.

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(see page 6)

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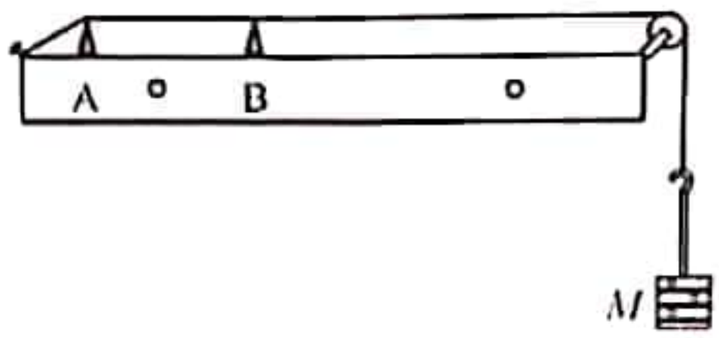
03. (a) A student in expected to find frequency of a tuning fork using the sonometer. The sonometer used for the experiment is given below.



(i) The fundamental mode of resonance is used in this experiment what is the reason for this?

.....

.....

(ii) Where is the best place to keep the vibrated tuning fork?

.....

Briefly state the reason for that.

.....

.....

(iii) Where is the best place to keep the paper rider? What is the reason for that?

.....

.....

(iv) When the string vibrated for the fundamental mode draw the wave pattern formed between the bridges A and B in the figure above.

(v) How do you experimentaly find the resonance length of the string when it is vibrated for the fundamental mode?

.....

.....

(vi) If the mass hung is M, the mass of a unit length is m and the length between A and B is l when it resonates for the fundamental, derive an expression for the frequency, f of the tuning fork.

.....

.....

(vii) Re arrange the above expression in order to get a straight line graph to find the frequency of the tuning fork.

.....

.....

(viii) Draw a sketch of the graph you expect there.

(see page 7)

(ix) Show that how to find the frequency of the tuning fork using the graph.

.....

.....

(x) The Co- ordinates of the two points chosen for the gradient of a graph drawn are (1.5, 125) and (3.5, 375) here *l is measured in* cm and *M, in* kg . Calculate the gradient of the graph.

.....

.....

(a) The student intends to modify the experiment to find the relative density of a piece of iron of mass M_0 by a non – graphical method using the above sonometer and the frequency discovered tuning fork. He also uses a water container for this.

(i) Describe how he performs this experiment.

.....

.....

(ii) The reasings he obtained are l_1 and l_2, obtain an expression for the relative density (s)

.....

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for the real images.

04. You are asked to determine the focal length of a convex lens by drawing a suitable graph, you are provided with the following equipment and items for that .

Convex lens, Lens holder, White screen, Suitable pins and a meter ruler.

(a) Draw the diagram representing all the items you need to do experiment on the table.

(see page 8)

(b) It is desirable to know a rough value for a creation data related to a given item before placing the items needed to the experiment?

(i) What is this data?

.....

(ii) Describe a simple method to obtain it.

.....

.....

(iii) Mark that data in the diagram drawn.

(c) What is the purpose of using a white screen in this experiment?

.....

.....

(d) Sketch in the same figure how a ray reaches the eye from a point near the midpoint of the pinhole placed as the object.

(e) Write down the experimental method by which the position of the image is obtained.

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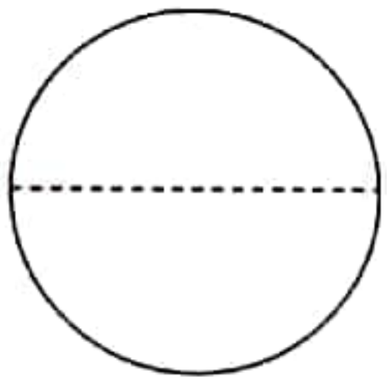
(f) When the object is placed between F and 2F draw how the image and object pin can be seen in the visible field in the space given below.



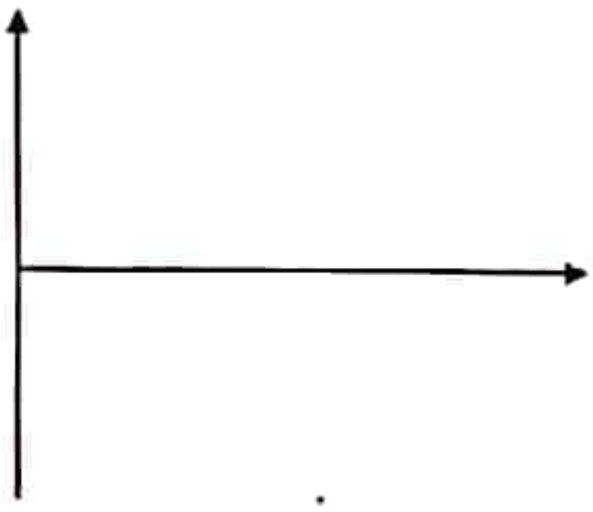
(g) (i) Write down the lens equation you use.

.....

(ii) Re - arrange the above equation in order to find the focal length using a graphical method.

.....

(iii) Draw a sketch of the graph you get and explain the way of finding the focal length.



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(see page 9)

(h) Following are the readings in cm for object distance (u) taken by two students.

Readings taken by the student A - 20, 40, 60, 80, 100

Readings taken by the student A - 20, 25, 33, 50, 100

(i) Which student's readings is the most appropriate readings from the readings above.

.....

(ii) Explain the reason for your choice in (i) above.

.....

.....

.....

(j) What technique could be used to draw an accurate graph if another student could get only three readings due to insufficient time?

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Part B – Essay Type

Answer four questions only.

05. The motion of a rocket is an example for a motion of which mass decreases with time. Total mass of the rocket includes mass of fuel too.

When the fuel in the rocket undergoes combustion warm gases produced here are injected vertically downwards rapidly and the rocket is caused to move upwards. Therefore the mass of rocket decreases with time.

A rocket which is kept ready to leave the initial launching pad is given in figure I. At t = 0 its axis is vertical and mass of the rocket is M. As shown in fig II, at (t = t s) mass of the rocket is m and its velocity is v.

The rate of releasing gas is m_o due to combustion, velocity of the warm gas being released relative to rockets is u. As shown in fig III at $(t) = t + \Delta t$ mass of the rocket and its velocity are $m - \Delta m$ and $v + \Delta v$. The mass of warm gas released in Δts is Δm (Assume air resistance on the rocket in motion is negligible)

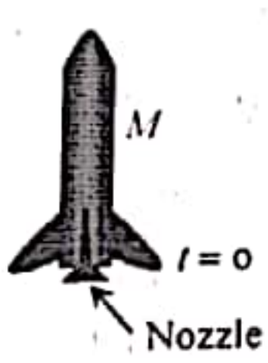


fig. (1)

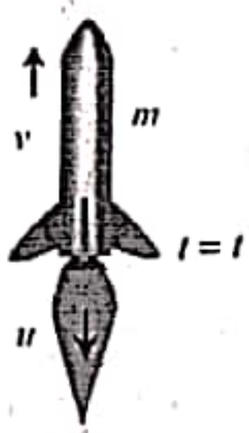


fig (2)

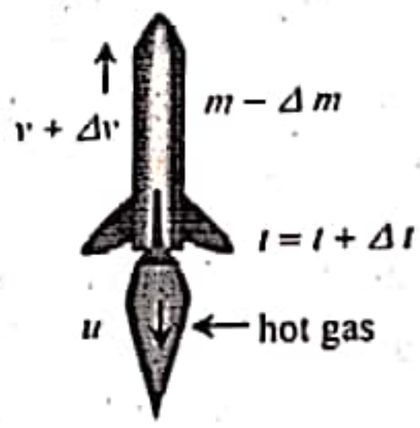


fig (3)

(a) (i) State newton's law about motion

(ii) Express the principle of conservation of linear momentum.

(iii) Obtain an expression for the velocity of warm air relative to the earth (as shown in fig 3)

(iv) Write an expression for the linear momentum of the rocket as shown in fig (2)

(v) Obtain an expression for the total momentum of the hot air released in Δt seconds and the rocket.

(vi) By using the expression obtained in (iv) and (v) prove that $m\Delta v = \Delta m.u$.

(vii) Hence prove that the compressive farce on the rocket is m_0u

(viii) How does the rocket obtain the force in (vii)

(ix) Mark the farces acting on the rocket in fig (2)

(x) Obtain an expression for acceleration of the rocker in fig (2)

(see page 11)

(b) At the beginning at ($t = 0$) mass of the rochet with fuel is 500 kg whereas mass of the fuel is 450 kg velocity of the hot air being released rélative to rocket is 2 km s^{-1}

(i) What is the rate at which fuel met be burnt m_0 so that rocket wuld jost be lifted from the launching.

(ii) What is the rate at which fuel must be burnt so that rocket could achieve initial acceleration of 20 m s^{-2}

(c) Variation of velocity of rocker with time is given by the equation. $v = 2.3u \log_{10}\left(\frac{M}{m}\right) - gt$ Where

M Total mass of racket at $t = 0$

m Total mass of rocket at $t = t$

u Velocity of hot air being released relative to the rocket.

(i) If $m_o = 10$ kg s^{-1} how long does the rocket move using fuel.

(ii) Calculate maximum velocity of rocket by using the above rocket equation.

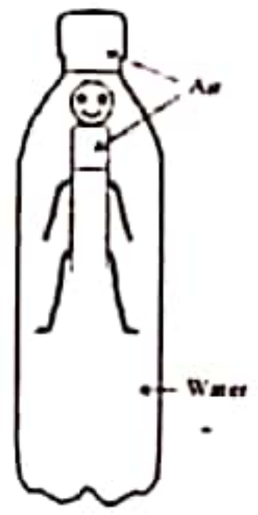
(iii) Sketch v – t graph of the motion of the rocket.

06. (a) State Archimedes principle

(b) The figure shows an apparatus known as "Archimedes swimmer" made by a student in order to exhibit in an exhibition.

(i) What happens to swimmer when the plastic bottle is compressed

(ii) What is the relevant principle or law for the hydrostatics applying here.



(c) Two types of hydrometers used in our day to day life is given in the figure. What is the advantage of the hydrometer (y) over the hydrometer (x)

(d) The hydrometer given in figure (X) consists of a uniform tube of length 30 cm. At both the ends there are two hemispherical parts. External radius of the tube is 18 mm. Mass of the glass tube is 35 g (Except for the Pb pellets and wax) Mass of wax is 1g, upper length of the tube above B is 2 cm. AB is a calibrated range. In order to measure relative density within range (0.700 - 2.000) It is calibrated.

(i) What are the values at positions A and B out of 0.700 and 2.000.

(ii) Calculate the mass of Pb pellets put into the tube.

(iii) What is the length of range AB ?

(iv) Is AB linear scale or not? Justify your answer.

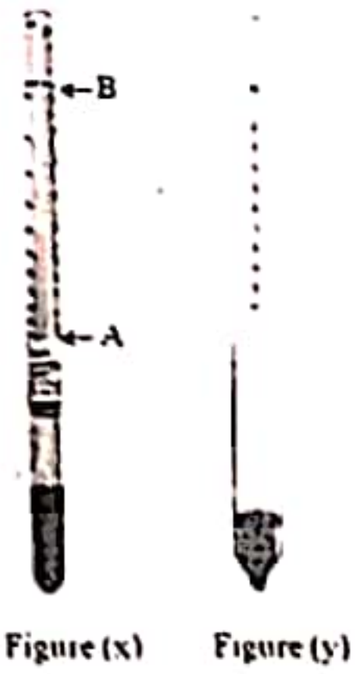


Figure (x) Figure (y)

(e) If relative density of the liquid is σ and the vertical height of the tube submerged in the liquid is h, sketch a graph of variation of h against σ.

(see page 12)

07. Form of a wave takes an important place among the various methods of propagation of energy in space. If a certain source and an observer are at rest, Frequency of the waves received by the observer is the original frequency of the source. But if there is a relative motion between them, a change in frequency occurs. It is explained by the Doppler Effect.

(a) According to the classification of waves, sound waves are,

(i) Transverse waves or longitudinal waves?

(ii) Mechanical waves or electromagnetic waves?

(b) (i) What is the frequency range which human ear is sensitive?

(ii) What is the range of intensity level which human ear is sensitive?

(c) A firecracker explodes in the sky in a carnival. Assume that the sound energy emitted by it spreads through the space in all directions uniformly and the reflection by the ground is negligible.

(i) If the power generated by the explosion is P, write down an expression for sound intensity, I_A near a observer A who is 640 m away in terms of P.

(ii) If $I_A = 0.1\ W\ m^{-2}$, find the sound intensity I_B at a place located 160 m away from the place of explosion.

(iii) Calculate the sound intensity level heard by the observer A in dB

(Threshold of hearing, $I_0 = 10^{-12}\ W\ m^{-2}$)

(iv) If both sound intensity and the sound intensity level when another firecracker is exploded in a separate place in sky are 3 times the previous explosion. What is the sound intensity in dB in that place due to the initially exploded firecracker (log 3 = 0.48.)

(d) A radar instrument is operated in the above carnival. Radar waves of wave length λ_o is emitted by it. Take the speed of the waves in air as c.

(i) Derive an expression for the time t taken by a wave front situated at a distance λ_o from a aircraft which is approaching the instrument at a speed u.

(ii) Derive an expression for the wave length λ of the wave reflected by the aircraft in terms of λ_o c and u.

(iii) If the frequency of the wave emitted by the instrument is f_o, write down an expression for the frequency f' which is received by the aircraft by that wave.

(iv) Write down an expression for the frequency f'' received by the instrument from the wave reflected from the aircraft.

(v) When the waves emitted from the radar towards the aircraft travelling at speed u is reflected from the aircraft and received by the radar again the change occurred in frequency is called as Doppler Frequency f_d .

If $u <<< C$ show that $f_d = \frac{2uf_o}{C}$

(see page 13)

(vi) If the frequency of the wave emitted to the aircraft is $f_o = 25 \times 10^8$ Hz and the Doppler Frequency $f_d = 1000$ Hz, find the speed at which aircraft is travelling $(C = 3 \times 10^8 \text{ m s}^{-1})$

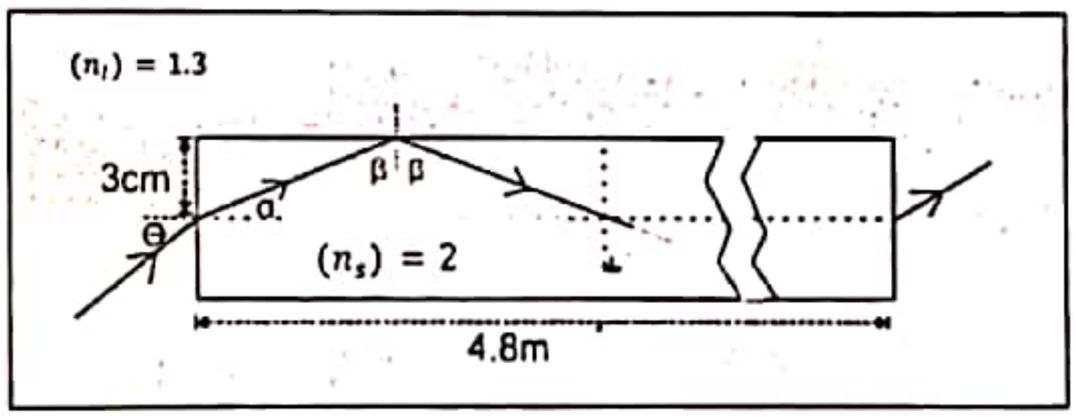
08. (a) (i) Explain the critical angle.

(ii) Considering two transparent media if the refractive index of the rare medium is n_1 and the refractive index of the dense medium is n_2, write an expression for the critical angle C with respect to the media, using these symbols.

(iii) Mentions two requirements to be satisfied for the total internal reflection of light.

(iv) Mention two instances where the total internal reflection of light is used or observed in day today life.

(b) The figure below shows a cross section of a direct solid cylinder of radius 3 cm. made of a solid transparent medium of refractive index (n_s) of 2, placed in a transparent liquid of refractive index (n_l) of 1.3 with respect to red colour. A light ray falls at an angle inclined to the center at one end enters the cylinder, undergoes several total internal reflections and emerges the center at the other end.
($\sin 40^0\, 30' = 13/20$, $\sin 67^0 20' = 12/13$, $\sin 30^0 = 1/2$, $\sin 90^0 = 1$, The speed of the light in vacuum $= 3 \times 10^8 \text{ m s}^{-1}$)



(i) Separate the refractive indices according to the rare and dense media
Rare and Dense. Rare - Dense .

(ii) Find the critical angle C with respect to the two media relevant to the red color.

(iii) Using a suitable method to prove that total internal reflection occurs within the cylinder for any incident angle (θ) of the ray of red light falls as shown in the figure.

(iv) Calculate the number of times that the total internal reflections occurs within the cylinder when the value of θ is $67^0\, 20'$ (length of the cube is 4.8 m)

(v) Find the path length of the reflected light ray inside the cylinder.

(vi) Find the speed of propagation of red light in solid medium.

(vii) Find the time taken by the red light ray to enter and exit the cylinder.

(see page 14)

09. (a) (i) Write down the equation of kinetic theory of gasses and introduce its symbols.

(ii) Using above equation and the ideal gas equation, obtain an expression for the root mean square speed of an ideal gas molecule.

(iii) Show that the mean kinetic energy E, of a gas molecule can be written as $E = \frac{3}{2}kT$

(Here K is the Boltzmann Constant) 300 m^3

(b) (i) If the internal volume of the air balloon which is filled by air of pressure 1×10^5 Pa and 27 °C . Find the mass of air in the balloon.

(Molar mass of air is 30 g mol^{-1} and $R = 8.3$ J K^{-1} mol^{-1} take $\frac{1}{83} = 0.012$)

(ii) Find the root mean square speed of an air molecule inside the balloon.

(iii) Find the mean kinetic energy of an air molecule in the balloon.
(Consider $N_A = 6 \times 10^{23}$ mol^{-1} in here)

(iv) When the temperature is increased up to 37 °C from 27 °C and 1×10^5 Pa pressure in balloon of volume 300 m^3, what is the mass of air removed from the balloon?
(Assume that the volume of the balloon is constant)

(v) Calculate the upthrust by the air outside at (27°C) on the the balloon.
(Density of air is 1.2 kg m^{-3})

(vi) If the mass of the balloon without air inside is 60 kg . What should be the temperature inside the balloon so that it could just be lifted?

(vii) If a child of mass 30 kg enters the balloon, to what temperature should the balloon be heated for the balloon to move upward?

10. (a) State Newton's Cooling law and state the conditions it is valid.

(b) State the factors which affect the rate of loss of heat to the environment from a hot object.

(c) State the factors affecting the cooling rate of a hot object.

(d) Show that the rate of cooling is directly proportional to the excess temperature between the object and the environment. Use usual symbols for relevant theories.

(e) When 200 g of water and 180 g of a liquid whose specific heat capacity is 4 000 J kg^{-1} k^{-1} is heated upto 70 °C using an aluminum calorimeter in two instances and from the two cooling curves obtained, time taken to reduce the temperature from 65 °C to 45 °C for water is 345 s and 300 s for liquid. Mass of the calorimeter is 100 g and the specific heat capacity of water is 4 200 J kg^{-1} K^{-1}

(i) State the reason for heating both water and liquid upto the same 70 °C temperature.

(ii) Find the specific heat capacity of the aluminum in the temperature range 65 °C and 45 °C .

(iii) What are the assumptions you made in the above calculation?

(f) 80 cm^3 of a liquid whose density is 900 kg m^{-3} was put on to a calorimeter and heated by a heater immersed in the liquid. Colorimeter and all of its contents achieved a steady temperature of 55 °C, If the temperature of the system began to drop at a rate 1.2 °C min^{-1} when the heater is removed.

(i) What is the initial rate of loss of heat of the system if the power of the heater is 9 W ?

(ii) Time taken to drop the temperature from 55 °C to 45 °C was 10 min.
What is the rate of decreasing temperature?

(iii) Find the surrounding temperature.

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