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Note

- This questions paper consists of 50 questions.
- Answer all the questions.
- In each of the questions 1 to 50, pick one of the alternatives (1), (2), (3), (4), (5) which is correct of most appropriate.
- Mark on the number corresponding to your choice in the answer sheet provided.
- Further instructions are given on the back of the answer sheet. follow them carefully.

$g = 10 Nkg^{-1}$

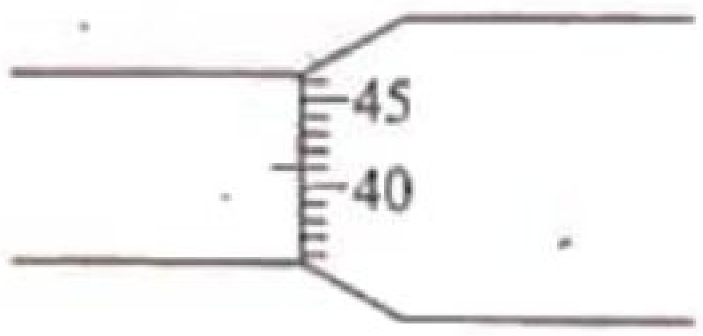
(01) Which of the following pair of physical quantities has the same dimensions ?

(1) work and force (2) Torque and angular momentum
(3) Specific Heat capacity and power (4) Power and Efficienoy
(5) Work and Energy

(02) The density of mercury is $13600 \, kgm^{-3}$. When it is expressed in $mgcm^{-3}$ the value is,

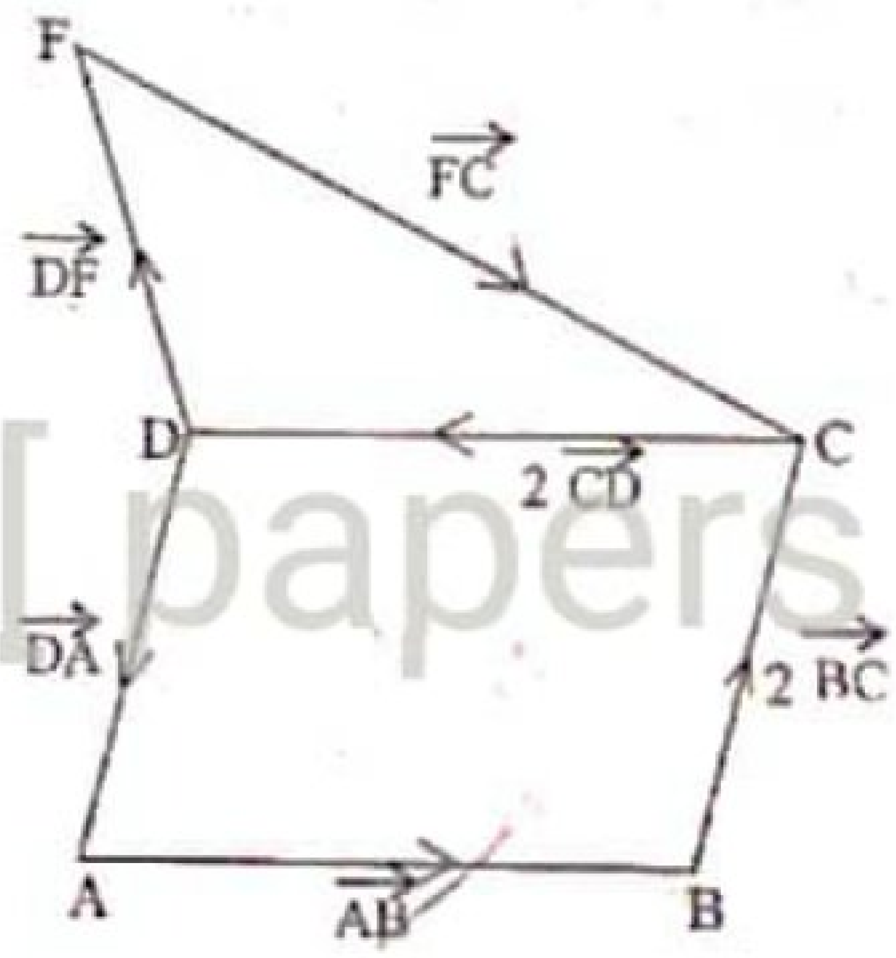
(1) 1.36×10^{-8} (2) 1.36×10^{-2} (3) 1.36×10^{2} (4) 1.36×10^{4} (5) 1.36×10^{7}

(03) As shown in the figure micrometer screw gauge with a zero error has 50 divisions in the circular scale. When it rotates two rounds the spindle moves 1 mm ahead. A reading of 2.40 mm has been obtained using this instrument. The correct value of that reading would be,



(1) 2.22 mm (2) 2.31 mm (3) 2.49 mm
(4) 2.58 mm (5) 2.62 mm

(04) The resultant of the system of vectors shown in the figure is,



(1) $\overrightarrow{AF}$
(2) $\overrightarrow{BC}$
(3) $\overrightarrow{CD}$
(4) $\overrightarrow{CA}$
(5) $2\overrightarrow{BD}$

(05) The variation between time (t/s) and displacement (x/m) of an object which executes in a SHM is given by the equation $x = 0.12 \sin(2.5t + \pi/2)$. The maximum velocity of the object would be, (ms^{-1})

(1) 0.048 (2) 0.12 (3) 0.19 (4) 0.30 (5) 2.5

(06) Which of the following statements made regarding Electro Magnetic waves is true?

(1) EM waves propagate at a velocity of $3 \times 10^8 ms^{-1}$

(2) Although EM waves propagate through transparent media, they do not propagate translucent media.

(3) EM waves propagate in a medium at a slower velocity than they propagate in the free space.

(4) The wave length of blue of visible light is shorter than that of violet.

(5) When EM waves are arranged in order of increasing frequency, they are, Ultra Violet rays, visible light, Infrared rays and X rays.

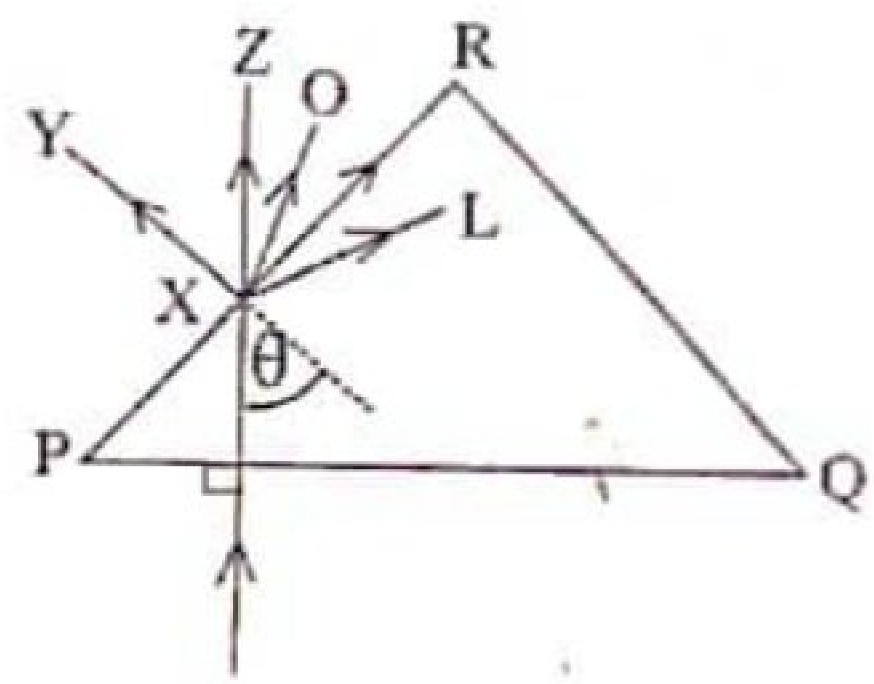
(07) The potential energy of a spring having spring constant $5000 Nm^{-1}$ is 36 J. The force on the spring is,

(1) 150 N (2) 300 N (3) 600 N (4) 800 N (5) 1200 N

(08) Root mean square velocity of an ideal gas at 27 °C is V_1. When the gas is heated to 927 °C, its root mean square velocity is V_2. The ratio of $\left(\frac{V_1}{V_2}\right)$ is equal to,

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

(09) A narrow beam of white light falls normally on the face PQ of a prism as shown in the figure. The angle (θ) formed by this light bean when incident on the PR surface is **equal** to the value of the critical angle of glass-air interface for **yellow** light. The direction of travel of the blue component of white light would be,



(1) XY (2) XZ (3) XO

(4) XR (5) XL

(10) The diagram shows the variation of volume (v) and absolute temperature (T) for an ideal gas at two constant pressures (P_1 and P_2). Which of the following relationship about P_1 and P_2 is correct?

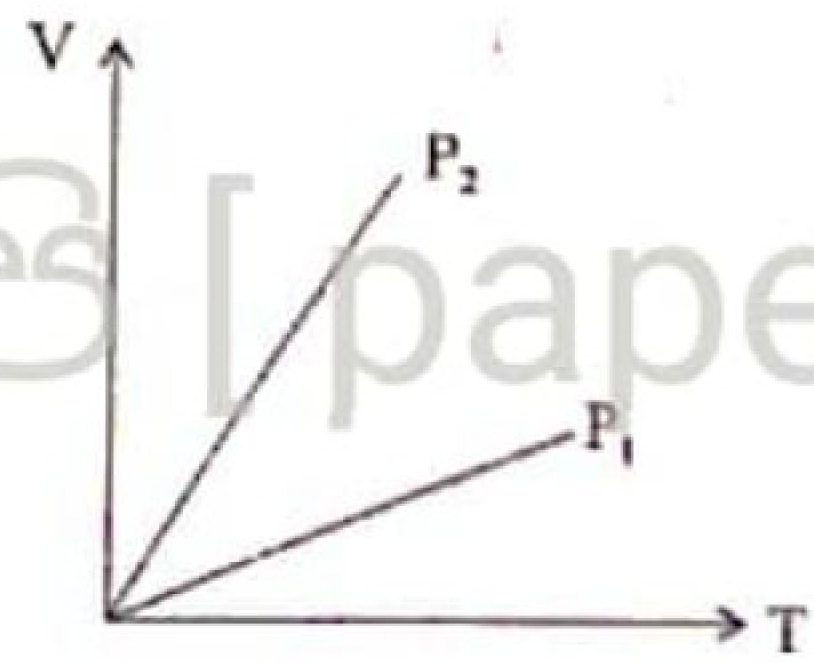
(1) $P_1 > P_2$

(2) $P_1 < P_2$

(3) $P_1 = P_2$

(4) $P_1 \geq P_2$

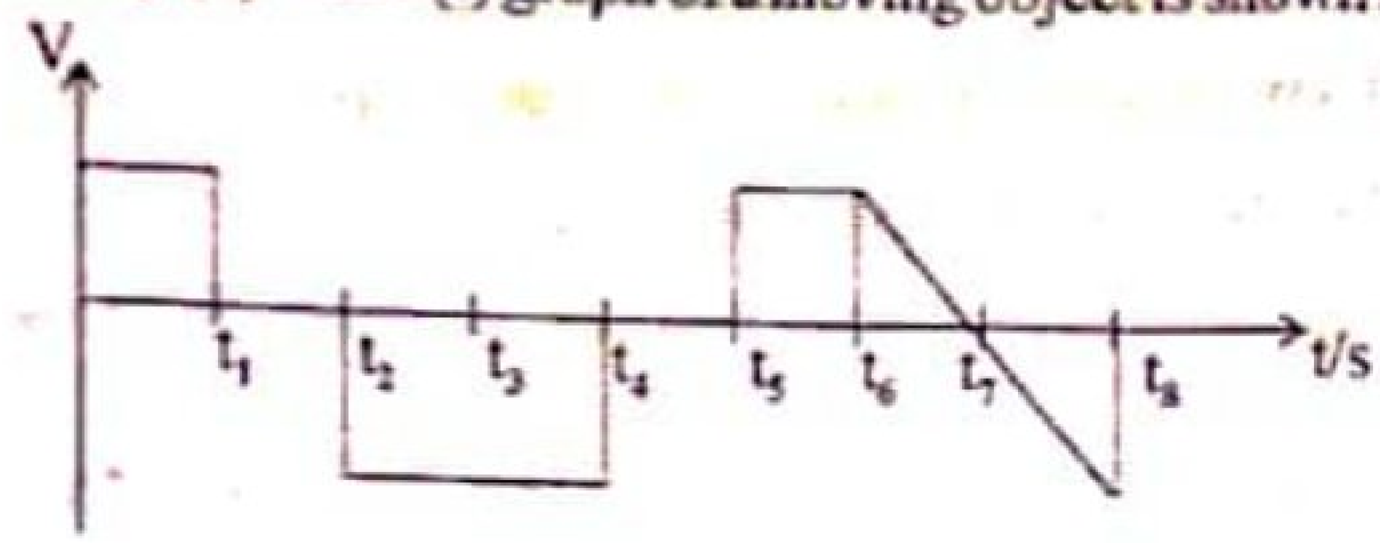
(5) $P_1 \leq P_2$



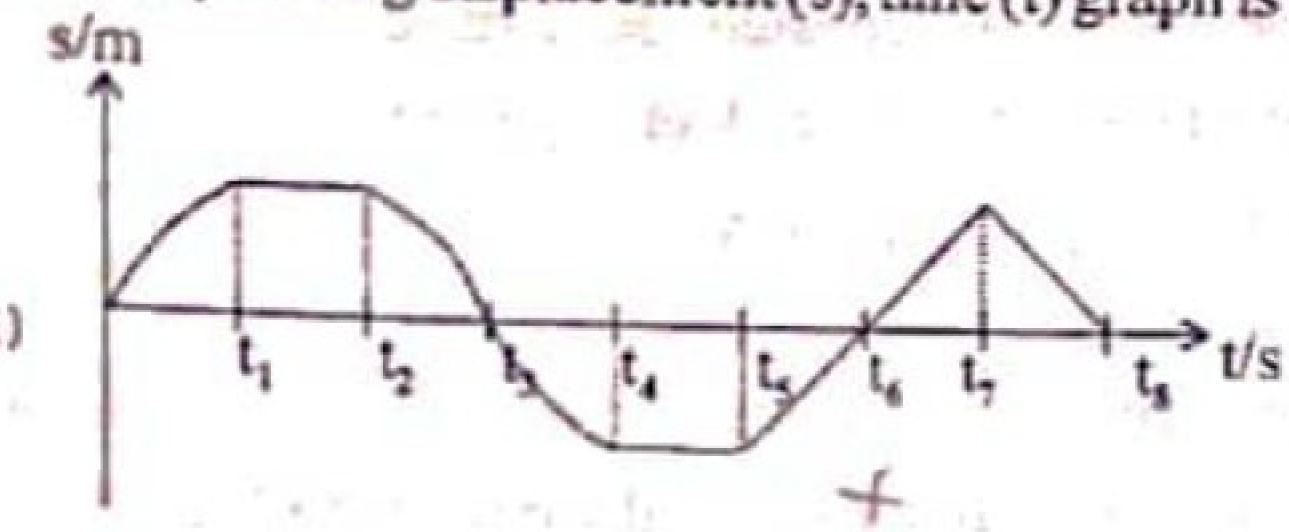
(11) A clear large image of an object, placed at a distance of 20 cm from a convex lense is formed on a screen. When this lens is moved 20 cm towards the screen, a small clear image is formed on the screen. Focal length of the lens is given by,

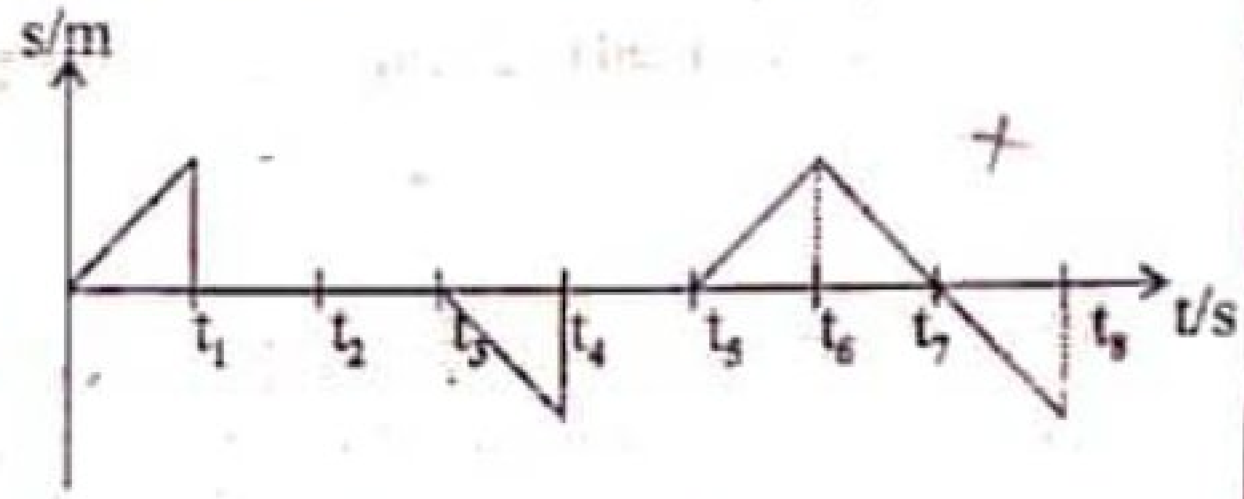
(1) $\frac{10}{3}$ cm (2) $\frac{20}{3}$ cm (3) $\frac{40}{3}$ cm (4) $\frac{50}{3}$ cm (5) 20 cm

(12) The velocity (v) - time (t) graph of a moving object is shown in the diagram below.

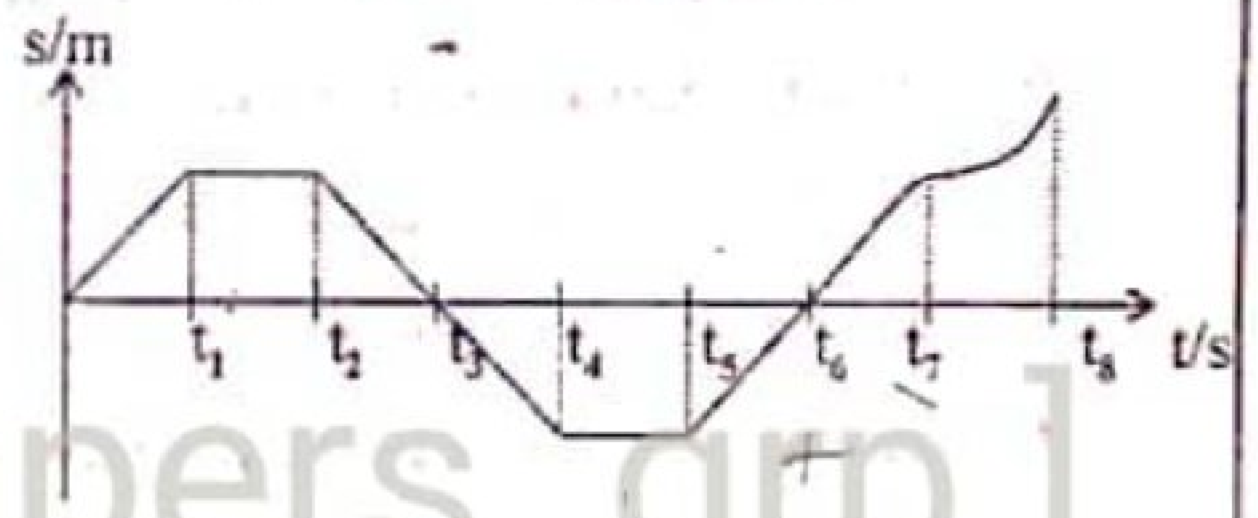


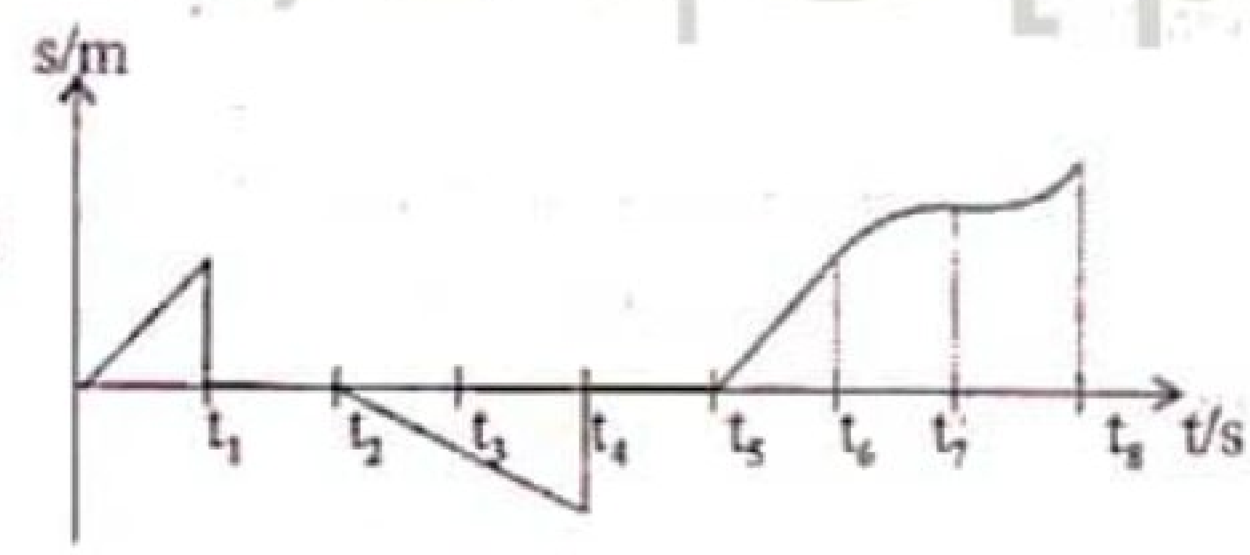
The corresponding displacement (s), time (t) graph is best represented by,

(1)


(2)


(3)


(4)


(5)


(13) A car travels with a uniform acceleration on a straight horizontal road. It travels 21 m in the 8th second and 25 m in the 10th second. The displacement travelled by the car **in the** 15th second would be (m),

(1) 35 (2) 45 (3) 196 (4) 202 (5) 225

(14) Consider the following statements about three energies E_1, E_2 and E_3 (where $E_1 < E_2 < E_3$) relavent to a three level laser system.

(a) The wavelength of the emitted laser photons is $\frac{hc}{E_3 - E_1}$

(b) Excited atoms will be only in the energy level E_2

(c) The stimulated emission will happen between energy levels E_1 and E_2 releasing the laser photons

of the above the true statement/s is/are,

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

(15) Two identical copper and steel rods are connected at 40 °C to form a single rod. The length and diameter of each rod are 50 cm and 3.0 mm respectively. When the temperature of the composite rod is increased to 240 °C the increase in its length would be, ($\alpha_{Cu} = 2 \times 10^{-5}\,°C^{1}$ and $\alpha_{steel} = 1.2 \times 10^{-5}\,°C^{1}$)

(1) 0.28 cm (2) 0.30 cm (3) 0.32 cm (4) 0.34 cm (5) 0.36 cm

(16) When a metal block was attached to one end of a sonometer wire and made to resonate with a tunning fork at the fundamental note, the distance between the two bridges was 30 cm. When the metal block was completely immersed in water and the experiment was repeated, the distance between the two bridges was reduced to 25 cm. The relative density of the metal of the block is given by,

(1) 3.27 (2) 4.0 (3) 5.5 (4) 6.0 (5) 6.8

(17) When observing an object through the eye, the eye lens and the carnea act as a compound lens. When observing an object at the infinity the eye lens acts as a converging lens with a power of +50D. Which of the following expressions is true, (The diameter of eye - ball is 25 mm)

(1) Cornea acts as a converging lens of focal length 10 cm.
(2) Cornea acts as a converging lens of focal length 20 cm.
(3) Cornea acts as a diverging lens of focal length 10 cm.
(4) Cornea acts as a diverging lens of focal length 20 cm.
(5) Cornea acts as a converging lens of focal length 40 cm.

(18) A ball is projected vertically upwards form the outside of a house near the wall. It takes 0.4 s to pass from the bottom level to the top level of a window of height 2 m. The height from the floor to the bottom horizontal level of the window is 24 m. The projectile velocity of the ball is, (ms^{-1})

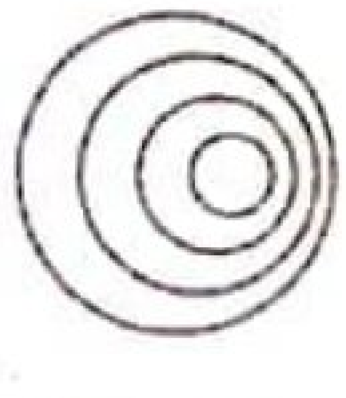
(1) 3 (2) 7 (3) 9 (4) 23 (5) 26

(19) Which of the following choice represents the correct mach number and the corresponding wave pattern?

MN = 1

(1) 

MN = 1.2

(2) 

MN = 0

(3) 

MN = 0.3

(4) 

MN = 0.9

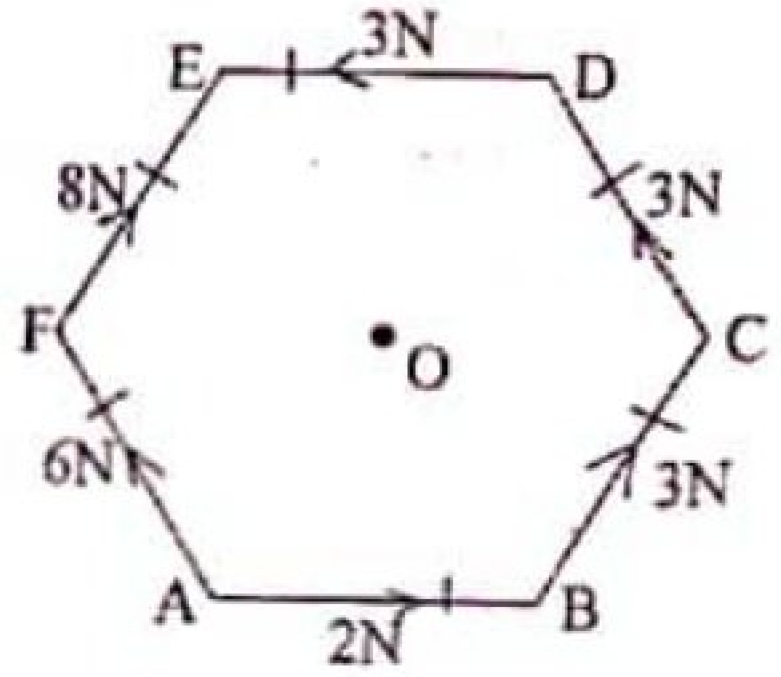
(5) 

(20) A man hears the sound emitted by an ice cream truck at a sound intensity level of 10 dB. The distance between the man and the truck is 1 m. How far away from the lorry does the man have to walk for him to hear the sound intensity as 2 dB?

(1) $10^{0.4}$ (2) $10^{0.8}$ (3) $10^{0.4} - 1$ (4) $10^{0.8} - 1$ (5) $10^{2} - 1$

(21) A hexagon ABCDEF of side length 1 m can be rotated about its centre (O). Fores act along its sides as shown in the figure. The distance from A to the line of action of the resultant force of the system would be,

(1) 0.30
(2) 0.35
(3) 0.50
(4) 0.55
(5) 1.10



(22) Two trains A and B facing each other travel along a straight railway track with velocities U ms^{-1} and Vms^{-1}. When the distance between them is **d km** a bird files from A to B and again from B to A. The bird continuously flys like this untill the two trains collide each other. The total distance travelled by the bird when the two trains collide is, $(W > V > U)$

(1) $\frac{dw}{w-u}$ (2) $\frac{dw}{w-v}$ (3) $\frac{dw}{u+v}$ (4) $\frac{dw}{v-u}$ (5) $\frac{du}{v+w}$

(23) A vessel made of a metal with linear expansivity $2 \times 10^{-6}\ {}^{\circ}C^{-1}$ is completely filled with a liquid of volume expansivity $6.0 \times 10^{-6}\ {}^{\circ}C^{-1}$. When the container is heated,

(1) The liquid overflows from the container.
(2) The liquid level in the container drops.
(3) The liquid level remains unchanged.
(4) The change in liquid level in the container depends on the nature of the metal and the liquid.
(5) The change in liquid level depends on the room temperature.

(24) Consider the following statements made regarding the formation of standing waves.

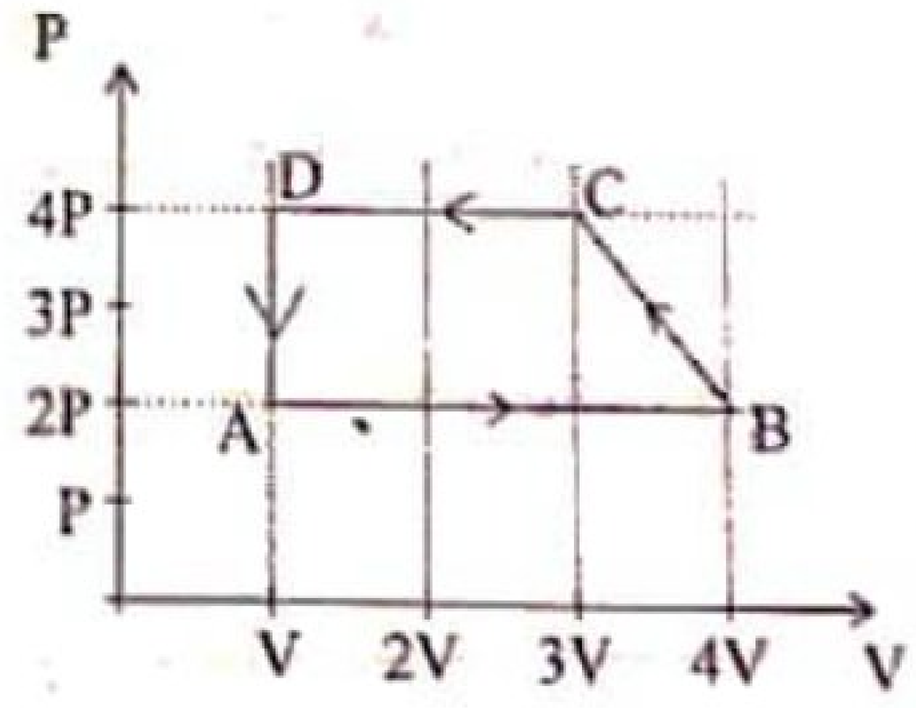
(A) Standing waves are formed by superimposing an incident wave and a reflected wave.
(B) It is sufficient that two waves with equal amplitudes travelling in the opposite direction in the same medium, to produce standing waves.
(C) Standing waves can only be created from transverse waves.

of the above the true statement/s is/are,

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

(25) An ideal gas undergoes a cyclic process as shown in the P-V curve. The work done, though the process from ABCDA is given by,

(1) 1 PV (2) 5 PV
(3) 8 PV (4) 12 PV
(5) 14 PV



(26) A doctor recommended that a person with an eye defect should wear a lens with a power of + 0.4 D. The type of the lens and the type of the eye defect would be,

	focal length	Type of the lens	Eye defect
(1)	40 cm	concave	short sightedness
(2)	40 cm	convex	long sightedness
(3)	250 cm	convex	short sightedness
(4)	250 cm	convex	long sightedness
(5)	250 cm	concave	short sightedness

(27) Two identical transvers pluses with 180° phase difference travel in the opposite directions along a string. Which of the following statements is true ?

(1) When they are superimpose the total energy remains **only** as kinetic energy.

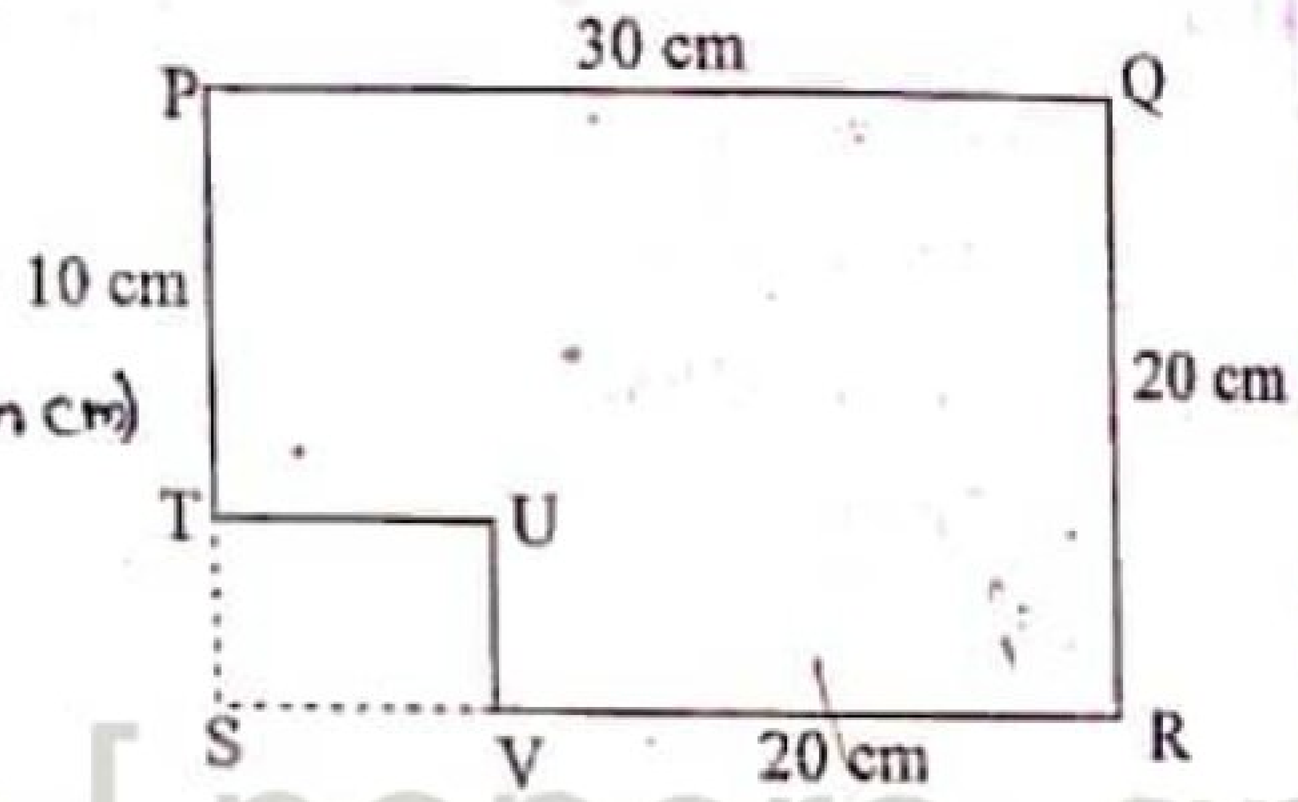
(2) When they are superimpose the total energy remains **only** as potential energy.

(3) **Until** they are superimpose the total energy remains **only** as potentral energy.

(4) When they meet each other the mechanical energy becomes heat and sound.

(5) When they meet each other they are reflected.

(28) A potion STUV has been removed form a uniform rectangular metal laminar PQRS as show in the figure. The distances from the sides SP and SR to the centre of gravity of the remaining potion could be respectively, (in cm)



(1) 14, 9 (2) 15, 10

(3) 18, 12 (4) 17, 11

(5) 19, 13

(29) It is necessary to Calibrate the celcias scales of two different models of mercury - glass thermometers. The temperature of melting ice and boiling water under atmosphere pressure have been used as lower fixed point and upper fixed point respectively. Consider the statements made regarding those two temperatures.

(A) When measuring the room temperature, the readings of the two thermometers may not be the same.

(B) Both thermometers should show the temperature of the boiling point of water at atmospheric pressure as 100°C.

(C) Sensitivity of the two thermometers may not be the same.

of the above the true statement/s is/are,

(1) Only A (2) Only B (3) Only B and C

(4) Only A and C (5) All A, B and C

(30) For the heat removal process in a nuclear power plant, water enters at a temperature of θ_1 °C and leaves at a temperature of θ_2 °C. This flowing water removes heat at a rate of H per minute. If the SHC of water is C, rate of flow of water is given by $kg\,s^{-1}$.

(1) $\dfrac{60\ H}{C \times (\theta_2 - \theta_1)}$ (2) $\dfrac{H}{C\ (\theta_2 - \theta_1)\ 60}$ (3) $\dfrac{H}{60 \times C\ (\theta_2 - \theta_1)}$

(4) $\dfrac{H\ (\theta_2 - \theta_1)}{C \times 60}$ (5) $\dfrac{C \times (\theta_2 - \theta_1) \times 60}{H}$

(31) A telescope consisting of two lenses of focal lengths 50 cm and 5 cm is arranged to observe an object at a distance of 200 m away from object lens. If the final image is formed at the least distance of distinct vision, the angular magnification of the telescope would be,

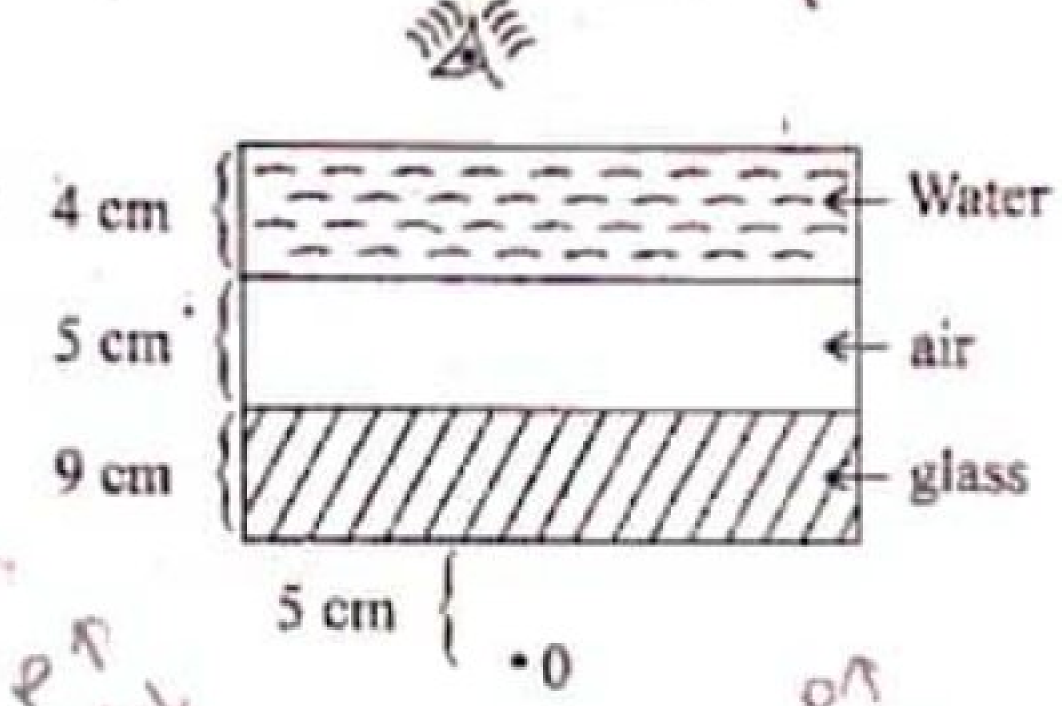
(1) 2 (2) 4 (3) 6 (4) 8 (5) 16

(32) As shown in the figure an object is viewed in the air above the water level. The apparent displacement of the image is given by ($n_g = 3/2$, $n_w = 4/3$ $n_a = 1$)

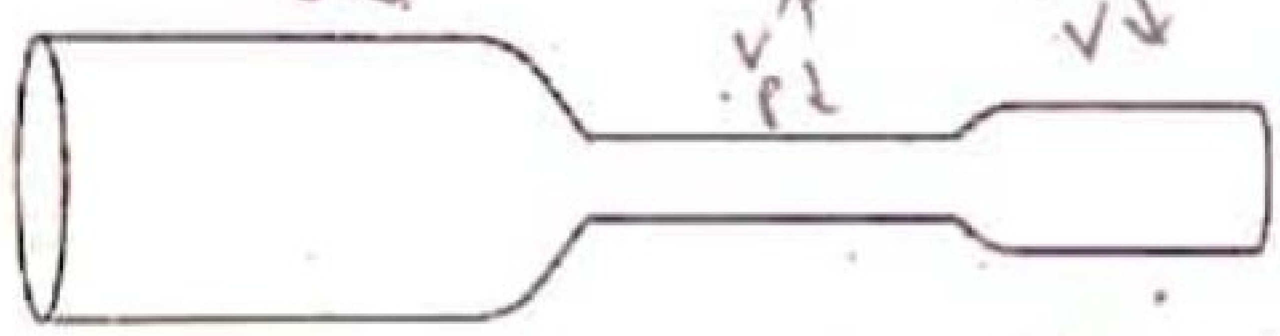
(1) 4 cm (2) 9 cm

(3) 13 cm (4) 14 cm

(5) 18 cm

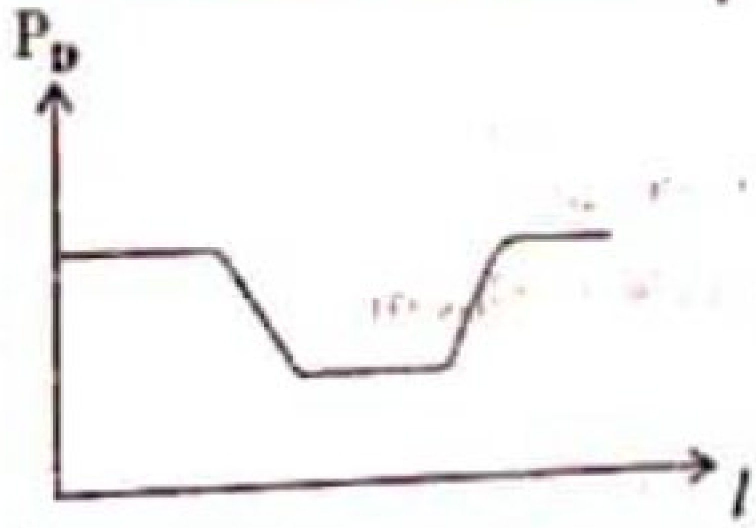


(33) An incompressible, Non viscouses steady, laminar flow of a liquid flows through the tube as shown in the figure. The graph which depicts the variation between length of the tube (l) and dynamic pressure of the liquid (P_D) would be,



(1)

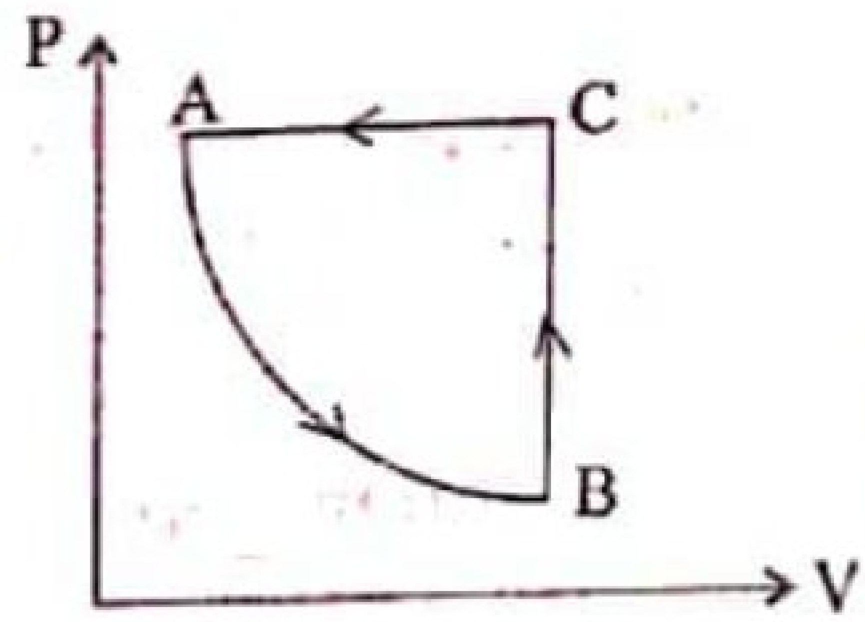

(2)


(3)


(4)


(5)


(34) A gas in a closed container undergoes a cyclic process ABCA as shown in the figure. Consider the following statements,



(a) Temperature increases from A to B and decreases form B to C.

(b) The work done from A to B is positive and work done from B to C is negative.

(c) Temperature remains constant from A to B whereas temperature decreases from C to A.

(d) Work from B to C is zero and it is negative from C to A.

of the above the true statement/s is/are,

(1) Only a and b (2) Only c and d (3) Only a, c and d

(4) Only a and d (5) All a, b, c and d

(35) A string having linear density (m) and length (l) is subjected to a tension (T). It's fundamental frequency is f. It is required to obtained a straight linear graph that passes through the origin. Which of the following pairs of quantities are suitable for this?

(1) between f and l when T is constant (2) between f^2 and T when l is constant

(3) between f and T^2 when l is constant (4) between f^2 and 1/T when l is constant

(5) between f^2 and l when T is constant

(36) A solid sphere of moment of inertia 0.01 kgm^2 and mass 0.7 kg is dropped from rest from the top of a rough plane, inclined an angle of 30° to the horizontal. The angular velocity attained by the ball, as it rolls without slipping and moves down a distance of 2 m along the inclined plane, would be,

(Moment of inertia of a sphere of mass M and radius r is given by $= \frac{2}{5} Mr^2$)

(1) $10\sqrt{2}$ $rads^{-1}$ (2) 20 $rads^{-1}$ (3) $20\sqrt{2}$ $rads^{-1}$

(4) $10\sqrt{\frac{14}{7}}$ $rads^{-1}$ (5) $10\sqrt{\frac{7}{7}}$ $rads^{-1}$

(37) A ray of light whose angle of incident i and angle of refraction r is refracted from a medium A to a medium B. Velocity of light in A and B are V_A and V_B respectively. The variation between Sin r and Sin i is as shown in the figure. Also consider $\frac{V_A}{V_B} = \sqrt{3}$. The value of θ is given by,

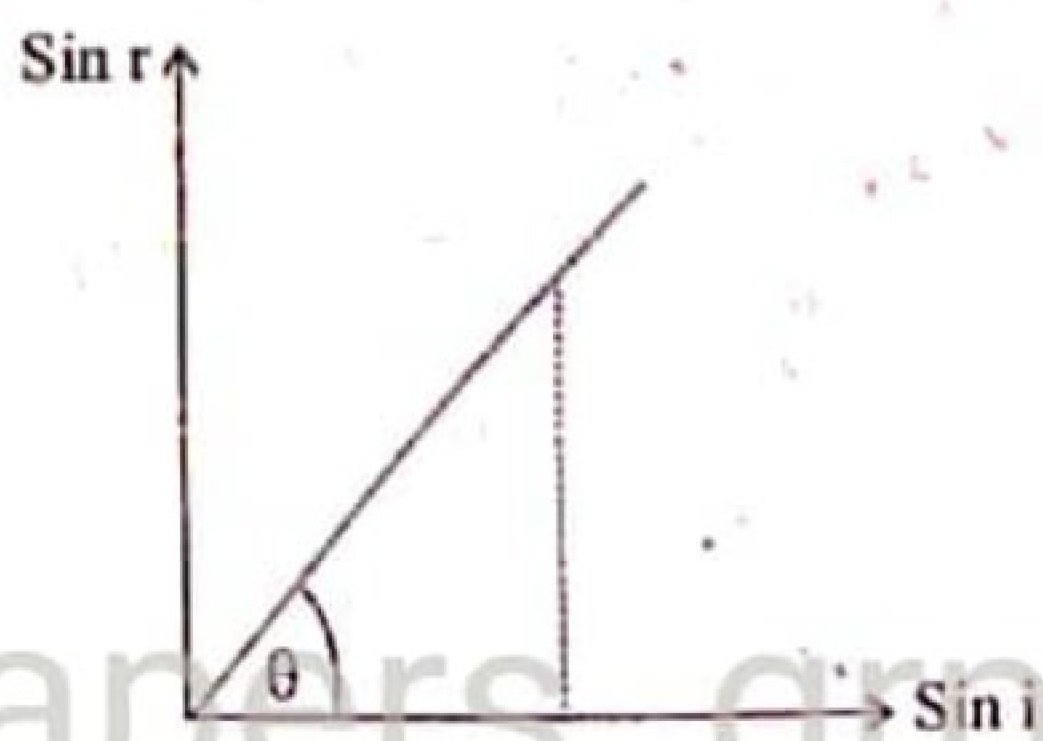
(1) 30°

(2) 45°

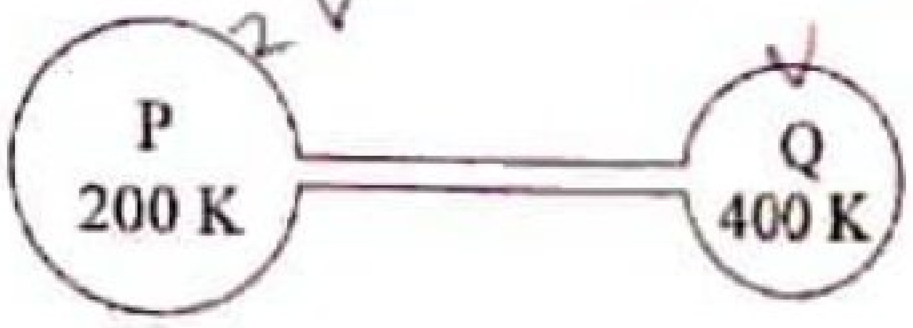
(3) 60°

(4) 75°

(5) 85°



(38) Volume of the bulb P is twice that of Q in the figure. The system contain an ideal gas. The system is in thermal equilibrium at the temperatures shown in the figure. Mass of the gas in P is m. Mass of the gas in Q is given by,



(1) m (2) $\frac{m}{2}$ (3) $\frac{m}{4}$ (4) $\frac{m}{8}$ (5) $\frac{m}{16}$

(39) A metal block (X) of mass 2 m, at 100 °C is made to contact with another metal block (Y) of mass m at 0 °C. Heat is exchanged between X and Y with out any heat loss to the environment. If $C_Y = 8\,C_X$, what is the final equilibrium temperature of the two blocks? (C_X and C_Y are specific heat capacities of the metals of X and Y respectively.)

(1) 10 °C (2) 20 °C (3) 30 °C (4) 40 °C (5) 50 °C

(40) Consider the following statements made regarding Newton's laws.

(A) According to Newton's first law an object must remain at rest if no external unbalanced force acts on it.

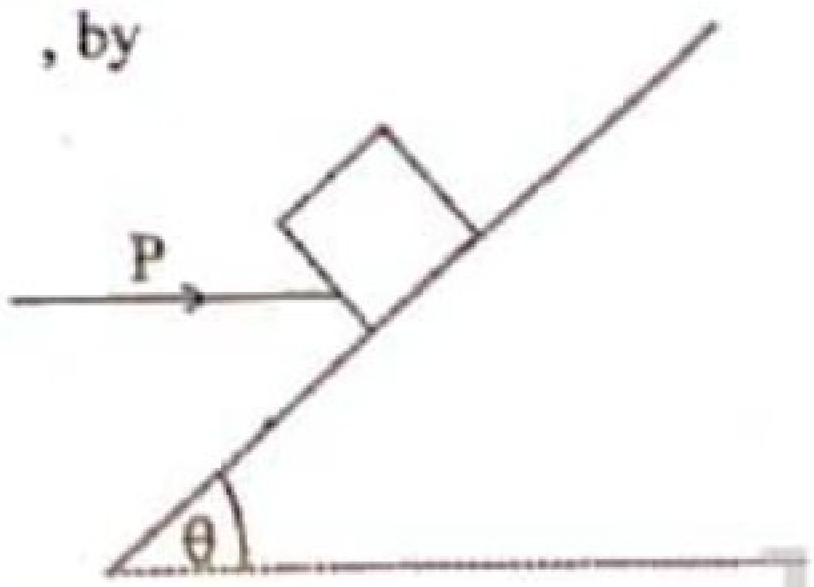
(B) Newton's second law does NOT hold in inertial frames of reference

(C) When an object is placed on a table both the weight of the object (mg) and the normal reaction exerted from the table (R) are the action and reaction expressed by Newton's 3rd law.

of the above the true statement/s is/are,

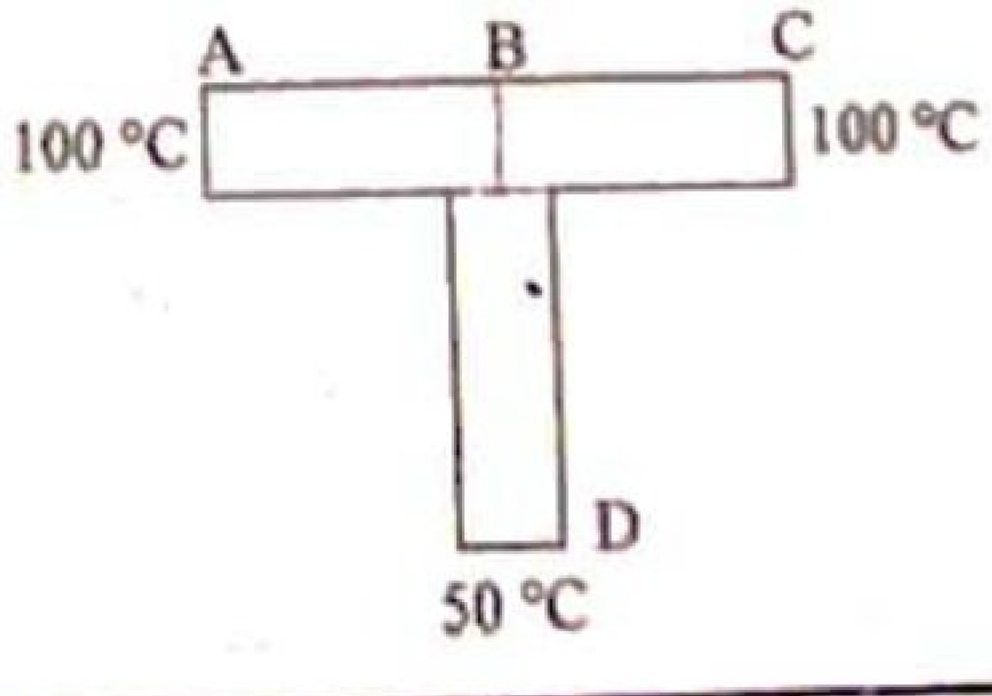
(1) Only A (2) Only A and B (3) Only A and C
(4) Only B and C (5) All A, B and C

(41) As shown in the figure an object of mass (m) is kept in equilibrium state on a rough inclined plane having static co-efficient of friction μ, by means of a horizontal force of P. Maximum value of P would be,



(1) $mg(\tan\theta - \mu)$ (2) $mg(\tan\theta + \mu)$
(3) $mg(\sin\theta + \mu)$ (4) $mg(\mu - \tan\theta)$
(5) $mg(\sin\theta + \mu\cos\theta)$

(42) The ends of a frame consisting of three identical coated metal rods AB, BD and BC are maintained at temperatures 100 °C, 50 °C and 100 °C respectively as shown in the figure. At the steady state, the temperature at B would be,



(1) $83\frac{1}{3}$ °C (2) 75 °C (3) $70\frac{1}{3}$ °C
(4) $63\frac{1}{3}$ °C (5) 60 °C

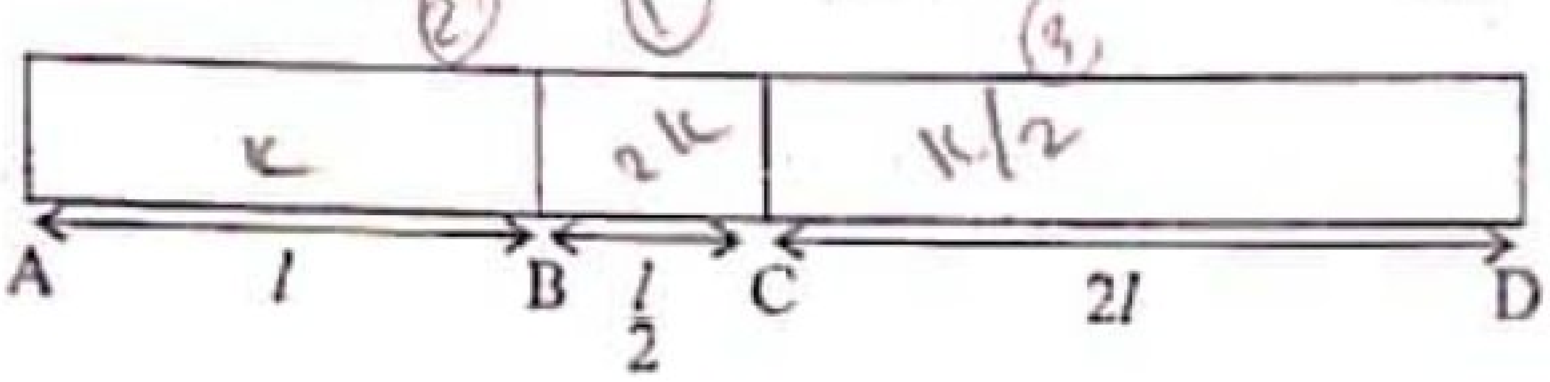
(43) A compound microscope with a focal length of 2 cm and 5 cm has a magnification of 18. At which distance the object should be kept from the object length to observe the image in the normal adjustment? (Least distance of distinct vision is 25 cm)

(1) 2 cm (2) 2.7 cm (3) 4.7 cm (4) 5 cm (5) 5.2 cm

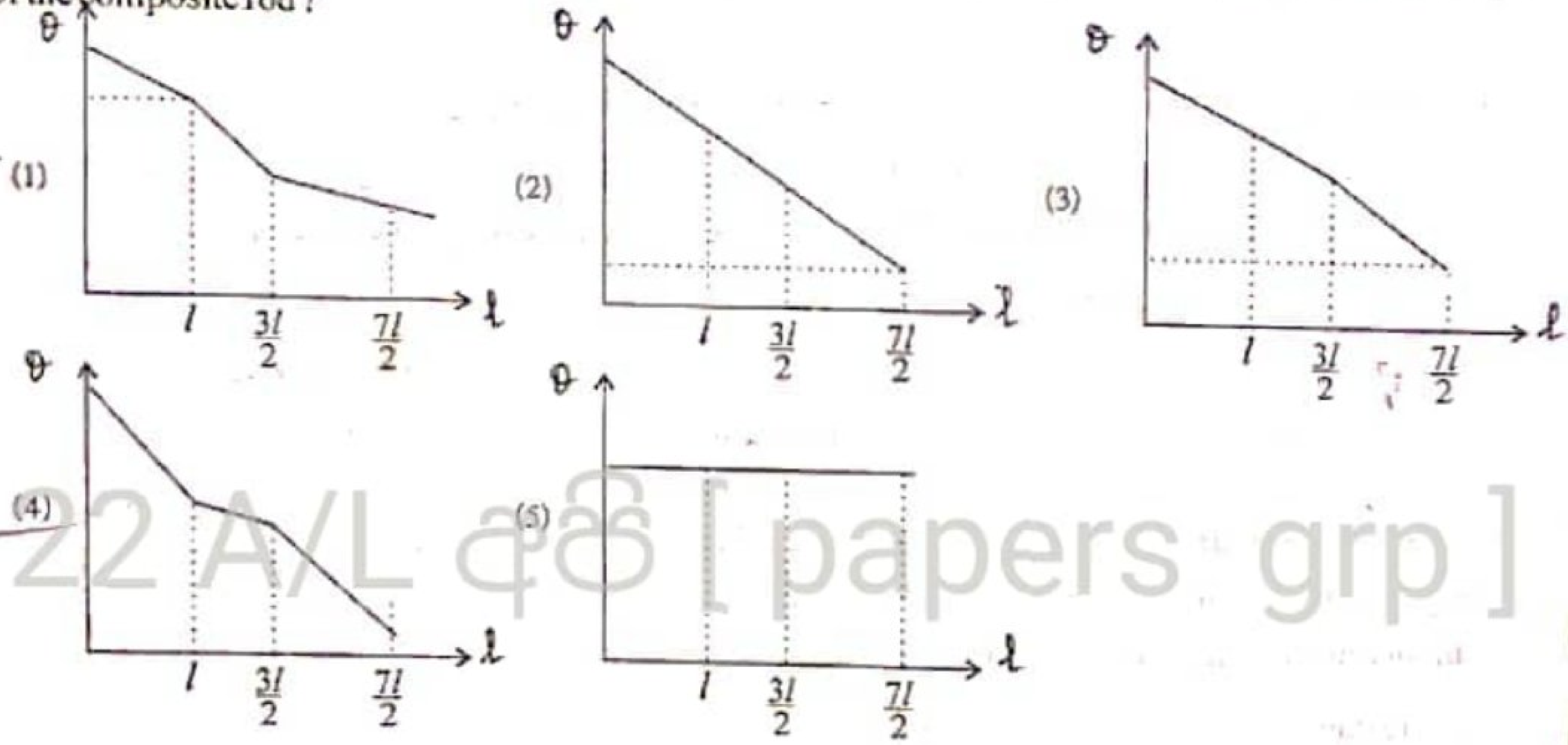
(44) A substance with mass m and specific heat capacity C is maintained at a temperature of T. Another substance with mass m/2 and specific heat capacity 2 C is maintained at temperature of 2 T. When the two substances are mixed each other the maximum temperature of the system would be (No heat Loss to the environment)

(1) $\left(\frac{2}{3}\right)T$ (2) $\left(\frac{3}{2}\right)T$ (3) $\left(\frac{3}{5}\right)T$ (4) $\left(\frac{8}{5}\right)T$ (5) $\left(\frac{5}{7}\right)T$

(45)



The figure shows three roads AB, BC and CD with the same cross section, connected to each other having mal conductivities K, 2K and K/2 respectively. A steady flow of heat flows from A to D. Which of the following graphs best represent the variation between temperature change along with the length of the composite rod?



(46) To measure the angle of a prism using a spectrometer the readings obtained by observing the reflected images of from the faces of the prism are shown as follows.

Position I	316° 6′	136° 10′
Position II	76°	256° 8′

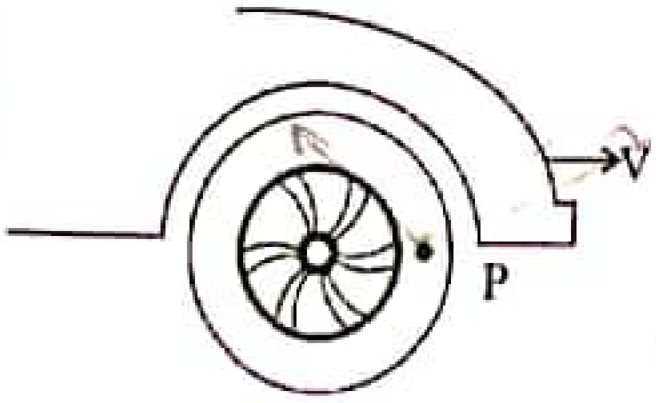
The prism angle is,

(1) 59° 56′ (2) 59° 57′ (3) 59° 58′ (4) 59° 59′ (5) 60°

(47) An object of mass 4 kg is projected upwards along the plane with a velocity of 6 ms^{-1} from the lower end of a rough plane inclined 30° to the horizontal. The object travels a distance of 8 m along the inclined place, comes to rest and returns to the starting point with a velocity of 2 ms^{-1}. The co-efficient of kinetic friction between the object and the plane is given by,

(1) 0.10 (2) 0.20 (3) 0.25 (4) 0.40 (5) 0.50

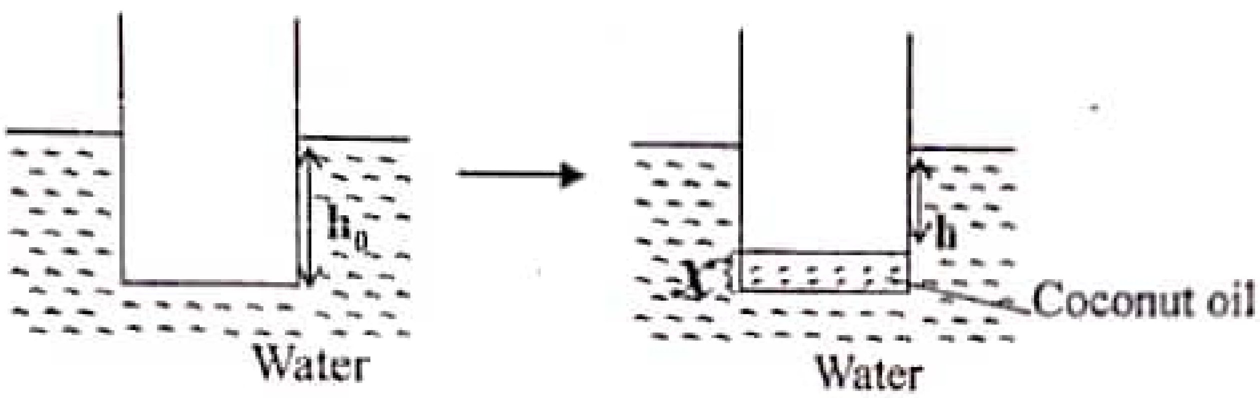
(48) As shown in the figure, a car is moving ahead at a velocity of V. The wheels of the car are rolling without slipping. At a certain instant the velocity of point P relative to the car is,



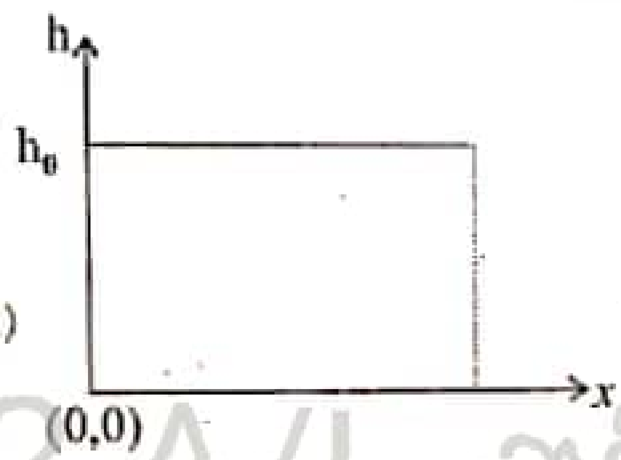
(1) $\overrightarrow{V}$ (2) $\nearrow\sqrt{2}V$ (3) $\downarrow V$

(4) $\searrow\sqrt{2}V$ (5) $\uparrow V$

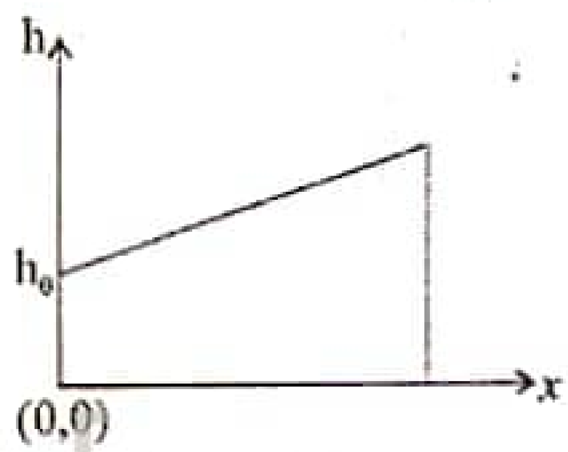
(49) As shown in the figure coconut oil is added to a container with a uniform cross section which is floating in water, untill it is completely submerged in the water. The correct graph showing the variation between the height of coconut oil (x) and the height between the water level and the coconut level would be (h),



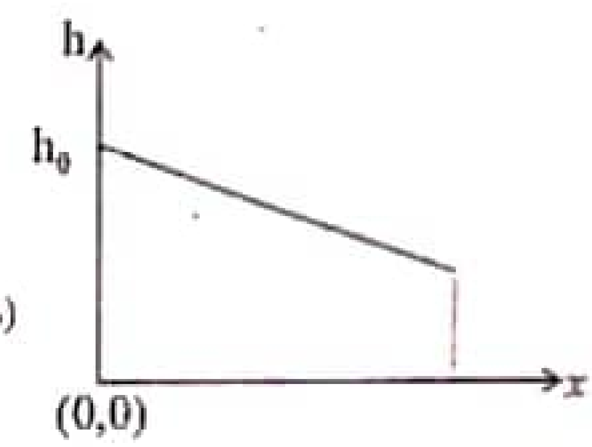
(1)



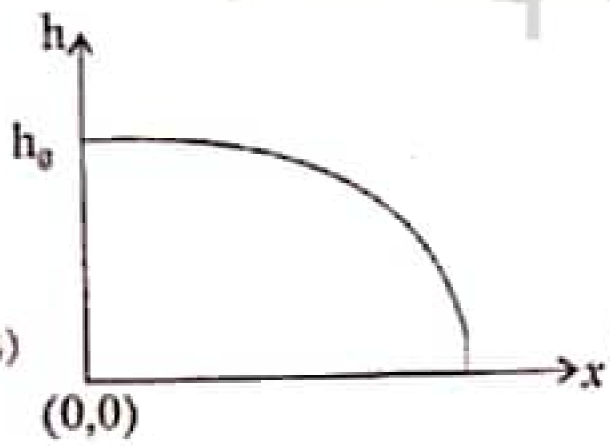
(2)



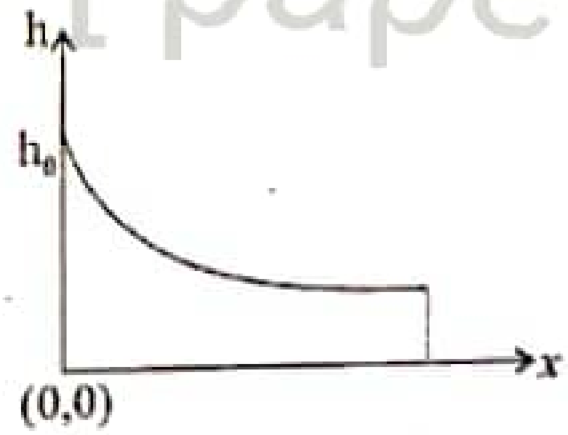
(3)



(4)

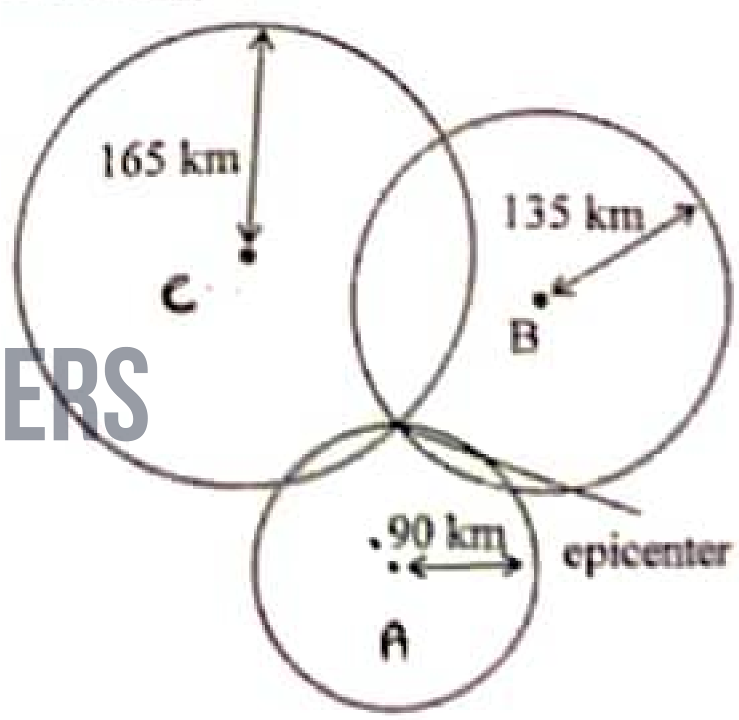


(5)



(50) The figure below shows how the epicenter of an earth quake was found by observing on the data of 3 detecting centors according to the triangulation method used in seismology.

The following distances have been calculated according to the charge in time taken (Δt) for P waves and S waves to reach the 3 centers A, B and C Velocity of P. waves is 5 kms^{-1} and that of S is 3 kms^{-1}. The correct choice which represents the difference in time taken by P and S waves to reach centres. A, B and C respectively.



(1) 6 S, 9 S, 11 S (2) 12 S, 18 S, 22 S

(3) 6 S, 18 S, 22 S (4) 18 S, 27 S, 33 S

(5) 30 S, 45 S, 55 S

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DEVI BALIKA VIDYALAYA - COLOMBO

First Term Test - May 2023

Grade 13

භෞතික විද්‍යාව II
Physics II

01 S II

Part B - Essay

Answer 02 questions only.

$g = 10\ Nkg^{-1}$

(05) A rocket can be defined as a chamber of compressed gas under pressure. An opening on the chamber allows gas to flows out, providing a push for the rocket to move towards the opposite direction. A balloon can be given as the best example for this. Air inside a balloon is compressed by its rubber walls. Air is pushed backwards so that forces on each side are in equilibrium. When the opening of the balloon is released, air flows out through it and the balloon is pushed towards the opposite direction.

The gas flows out of space rockets is produced by burning fuel. The fuel can either be in solid or liquid form or it can be a combination of both. In order to lift the rocket to a launching door or to change its speed or direction, an unbalanced force should be applied. Thrust of a rocket engine depends on the mass of fuel burnt and the speed of the flow of gas.

Motion of the rocket is equal and opposite to the direction of the thrust of the engine.

(a) State the mechanical principales related to the launching of the rocket.

(b) At the star observation night camp organized by the Astronomy club, a toy rocket was made of a plastic bottle. The bottle is half filled with water, and the other half is filled with air under high pressure.

From the small opening at the bottom water flows out at the speed of V. Density of water is ρ. Radius of the opening is r.

(i) Calculate the water mass flowing out of the opening in 1s.

(ii) What is the rate of change of momentum of water ?

(iii) If the total mass of the rocket is m, calculate the acceleration at that instance.

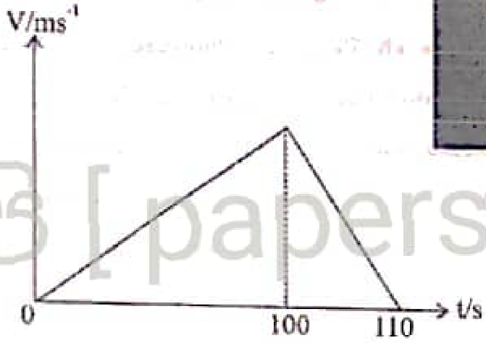
(iv) If the speed of flow of water from the small opening at the bottom is $12\ ms^{-1}$ diameter of the opening is 2 cm, and the total mas of the rocket is 1.2 kg, calculate the acceleration relevant to b (iii). Density of water is $1000\ kgm^{-3}$ $(\pi = 3)$

(c) The following velocity - time graph depicts the take off of a space shuttle from earth surface.

The first part of the graph shows the acceleration of the shuttle due to the force created on the nozzle when fuel is burnt. Second part shows the motion under gravity. (Assume that there is no air resistance on the shuttle by atmosphere.)

Loss of mass when fuel is burnt is negligible.

Calculate the acceleration the shuttle gained by burning the fuel..



(d) If a certain instrument is released from the shuttle at the end of 50 s.

(i) Calculate the velocity of the shuttle after 50 s.

(ii) Find the maximum height from ground the instrument reaches.

(iii) Find the time the instrument takes to reach the maximum height.

(iv) Find the time taken to reach the ground after obtaining the maximum height.

(v) Draw velocity - time and displacement - time graphs for the time duration after releasing the instrument until it reaches the ground for the following situations.

When observed by an observer on ground.

When observed by an observer in the shuttle.

(06) (a) Doppler Effect is when there is a relative motion between the source and the observer towards or from each other, the observer observes a different frequency from the real frequency of the source. This frequency is called the apparent frequency and is calculated by the equation given below.

$$\text{Apparent frequency (f)} = \frac{\text{Velocity of the wave relative to the observer (V)}}{\text{Wave length of the wave relative to the observer } (\lambda)}$$

(i) Name the types of waves according the direction of the vibration of the wave particles. Mention the type of wave among them where Doppler Effect could occur.

(ii) Give two example where Doppler effect does not occur even if there is relative motion between the source and the observer.

(iii) Copy the following chart to your answer sheet. Mention how Doppler's Effect occurs in the following instances

Motion of the source	Motion of the observer	Velocity of the wave relative to the observer (V) (Increase/ Decreases/ No change)	Wave length of the wave relative to the observer. (λ) (Increase/ Decreases/ No change)	Apparent frequency (f) (Increase/ Decreases/ No change)
Away from the observer	still			
still	Away from the source			
Towards the observer	still			
still	Towards the source			
Away from the observer	Away from the source			

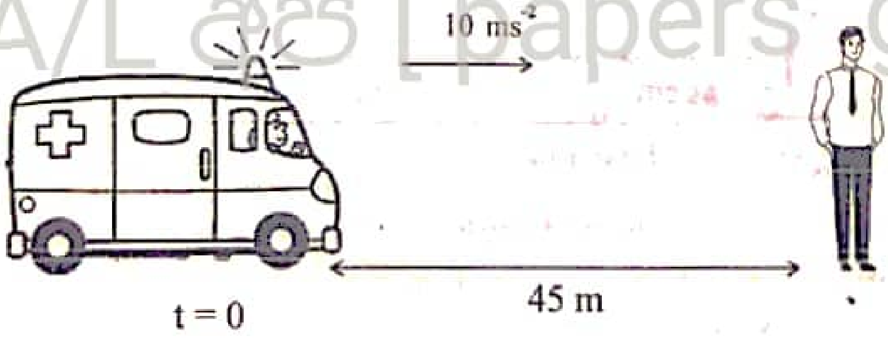
(b) An ambulance is moving towards a mountain at a velocity of U_A sounding a siren of frequency f_0 A motorcar with a velocity of U_M is following the ambulance. Velocity of sound in air is V.

(i) Derive an expression for the apparent frequency (f_1) of the siren of the ambulance as percieved by the driver of the motorcar using U_A , U_M , V and f_0

(ii) If the siren sound of the ambulance reflects after hitting the mountain, derive an expression for the apparent frequency f_2 the driver of motorcar perceives using U_A , U_M , V and f_2

(iii) If $U_A = 144\ kmh^{-1}$, $U_M = 72\ kmh^{-1}$, $V = 340\ ms^{-1}$ and $f_0 = 1500$ Hz Calculate the apparent frequencies f_1 and f_2 the driver hears.

(c) The ambulance while sounding the siren at 1500 Hz starts its motion from still along a linear road. It accelerates at an acceleration of $10\ ms^{-2}$. The ambulance moves towards an observer 45 m standing at a distance of 45 m, and passes him. (Velocity of sound in air is $340\ ms^{-1}$)



(i) Calculate the apparent frequency perceived by the observer at each instance.

$t = 0, 1, 2, 3, 4, 5$

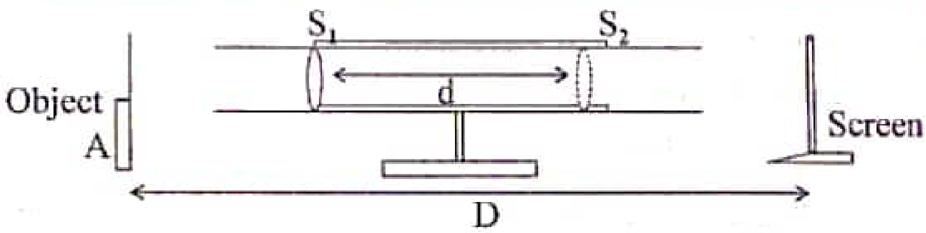
(ii) Plot a graph for apparent frequency perceived by the observer vs time, for the duration of start of motion of the ambulance until the ambulance passes the observer.

07 (a) (i) Identify the focal length of a lens.

(ii) Draw the ray diagram for forming the image of an object of height h, placed vertically on the axis between the focus and the centre of curvature of a convex lens.

(iii) Hence obtain an expression for the linear magnification of the image.

(b) A group of students determined the focal length of a convex lens place in a tube as shown below. The lens can be moved in the tube. The image of the object is formed on a screen.



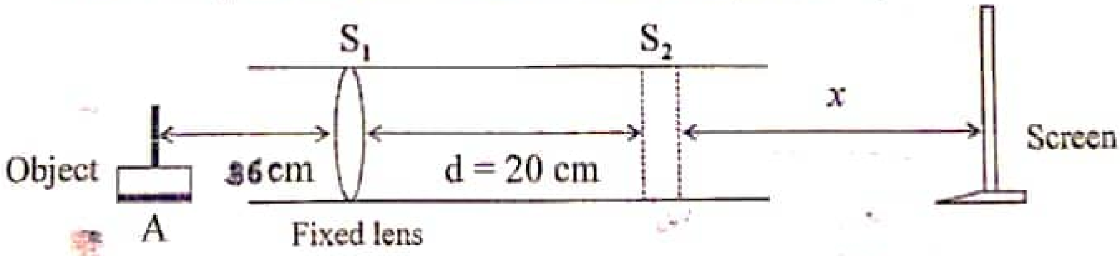
(i) Two images of the object can be formed on the screen at two different positions of the lens (S_1 and S_2). Explain this.

(ii) Here, the distance between the object and the screen is D, the distance between the two positions of the lens is d and the focal length of the lens is f_1 ; show that $f_1 = \dfrac{D^2 - d^2}{4D}$

(iii) If D = 80 cm, d = 40 cm, calculate f_1

(iv) Find the multiplication of the linear magnifications in the above two instances in (i)

(c) For a decoration, images are formed using a tube as shown above. The convex lens is fixed at S_1 in this deco. Another lens can be adjusted at S_2



The image of an object of height 10 cm is obtained on to the screen. For this, the object is placed 36 cm away from the lens S_1 as shown above. The distance between S_1 and S_2 is 20 cm. Focal length of the lens at S_2 is 10 cm.

(i) What type is the lens S_2 ?

(ii) Calculate the image distance of the lens S_1 .

(iii) Find the distance x between the screen and S_2.

(iv) Their requirement is to form an enlarged image of the object on the screen. Would they be able to do it? Explain by calculations.

(d) Draw the ray diagram of forming final image assuming the object A is a point object.

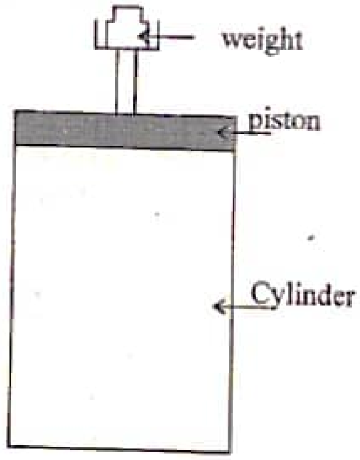
08) Answer either part (A) or part (B)

08(A) (a) State Boil's Law and Charle's Law.

(b) Obtain the ideal gas equation using Boil's Law and Charle's Law.

(c) A certain volume of O_2 gas at temperature 0 °C is filled inside a cylindrical container using a light, frictionless airtight piston. Pressure inside the cylinder was increased by 20% of the initial pressure while keeping the temperature a constant. Calculate the percentage change of the volume of the gas.

(d) The following diagram shows a laboratory setup of a cylindrical container with O_2 gas trapped inside using a light air-tight piston. Temperature of the gas is 27°C. The weight kept on the piston is used to change the force exerted on the piston. Cross-sectional area of the piston is $4 \times 10^{-4}\ m^2$. There is no weight on the piston at the beginning. Then a mass of 0.8 kg is kept on the piston. Then the volume was $12 \times 10^{-4}\ m^3$. Atmospheric pressure is $1 \times 10^5\ Nm^{-2}$ and $R = 8.31\ J\ mol^{-1}\ K^{-1}$



(i) What is the internal pressure inside the container at this instance ?

(ii) What is the amount of O_2 mols inside the container ?

(iii) Obtain an equation for the root mean square velocity of the gas atoms, using temperature, molar mass and R.

(iv) Hence obtain the root mean square speed of O_2 (r.a.m = 32)

(v) 0.02 mol of N_2 gas was added to the container while keeping the above weight. The temperature was kept a constant. Find the partial pressure of N_2 gas.

(vi) If the temperature was raised upto 127 °C in the (v) above, what would be the final volume of the system.

08(B) (a) Define the "specific latent heat of fusion" and "specific latent heat of vapourisation".

(b) A layer of ice at 0 °C has formed on the surface of water at 0 °C in a cylinder of radius 50 cm. Volume of water in the container is 20 *l* and mass of the ice layer is 600 kg. A beam of heat radiation is incident on the whole layer of ice perpendicularly. Intensity of this heat radiation is 82.5 kWm^{-2}. Suppose that the container is well lagged. ($\pi = 3$)

(i) Assume that the ice block absorbs heat only from the heat radiation and efficiency of absorbing heat is 40%. find the rate of melting of ice..

(ii) If heat is supplied for 2 hours, calculate the mass of water and ice in this system.

(iii) Suppose that the whole amount of ice block is melted by supplying steam instead of heat radiation. Calculate the minimum mass of steam required for this process.

(c) A metallic container with cube shape is completely filled with water at room temperature 30 °C. Volume of the container is 1 l and each surface has a thickness of 4 cm.

Radiation of heat is made to fall on each surface of the cube with the above intensity 82.5 kWm^{-2}. Then heat transferred to water with an efficiency of 80%. (conductivity of the material of the container is 300 $Wm^{-1}K^{-1}$)

(i) Find the time taken by water to heat up to 100 °C.

(ii) What is the rate of producing steam in the container ?

(iii) Calculate the internal length of the container.

(iv) Calculate the mean area perpendicular to the direction of transferring heat inside the container.

(v) What is the temperature of the external surface of the container when steam is produced ?

(vi) Due to collecting water in the container over a long period of time, there's a layer of silt (mud) of thickness 1mm inside the container. The external temperature of the container was kept in the same value. The temperature difference between the internal and external of the container was 9/10 from the previous, when making steam. Calculate the heat conductivity of silt. (Assume that the mean cross sectional areas perpendicular to the direction of heat transference along the container and silt is the same)

Specific heat capacity of water	$= 4200\ Jkg^{-1}\ K^{-1}$
Specific latent heat of fusion of ice	$= 3.3 \times 10^5\ Jkg^{-1}$
Specific latent heat of vapourisation of water	$= 2.26 \times 10^6\ Jkg^{-1}$
Density of water	$= 1000\ kgm^{-3}$