KD EDUCATION ACADEMY [9582701166]

Time : 7 Hour | STD 11 Science Physics | Total Marks : 350

kd 90+ ch- 9 mechanical properties of fluid

*** Choose The Right Answer From The Given Options.[1 Marks Each]** **[29]**

1. A gale blows over the house. The force due to gale on the roof is:
   (A) In the downward direction. (B) In the upward direction.
   (C) Zero. (D) None of the above.

2. What change in surface energy will be noticed when a drop of radius R splits up into 1000 droplets of radius r, surface tension is T.
   (A) $4\pi R^2 T$ (B) $7\pi R^2 T$ (C) $16\pi R^2 T$ (D) $36\pi R^2 T$

3. Application of Bernaull's Theorem can be seen in:
   (A) Dynamic lift of aeroplane. (B) Hydraullic press. (C) Helicopter. (D) None of the above.

4. The angle of contact at the interface of water-glass is 0°, Ethylalcohol-glass is 0°, Mercury-glass is 140° and Methyliodideglass is 30°. A glass capillary is put in a trough containing one of these four liquids. It is observed that the meniscus is convex. The liquid in the trough is:
   (A) Water (B) Ethylalcohol (C) Mercury (D) Methyliodide

5. A spherical liquid drop of radius R is divided into eight equal droplets. If surface tension is T, then work done in the process will be:
   (A) $2\pi R^2 T$ (B) $3\pi R^2 T$ (C) $4\pi R^2 T$ (D) $2\pi R T^2$

6. An ideal fluid flows through a pipe of circular cross-section made of two sections with diameters 2.5cm and 3.75cm. The ratio of the velocities in the two pipes is:
   (A) $9:4$ (B) $3:2$ (C) $\sqrt{3}:\sqrt{2}$ (D) $\sqrt{2}:\sqrt{3}$

7. Why are drops and bubbles spherical?
   (A) Surface with minimum energy.
   (B) Surface with maximum energy.
   (C) High pressure.
   (D) Low pressure.

8. Pressure is a scalar quantity because:
   (A) it is the ratio of force to area and both force and area are vectors.
   (B) It is the ratio of the magnitude of the force to area.
   (C) It is the ratio of the component of the force normal to the area.
   (D) It does not depend on the size of the area chosen.

9. Three liquids of densities d, 2d and 3d are mixed in equal proportion of weights. If density of water is d, then the specific gravity of the mixture is:
   (A) $\frac{11}{7}$ (B) $\frac{18}{11}$ (C) $\frac{13}{9}$ (D) $\frac{23}{18}$

10. Two water pipes of diameters 2cm and 4cm are connected with the main supply line. The velocity of flow of water in the pipe of 2cm diameter is:

(A) 4 times that in the other pipe.
(B) $\frac{1}{4}$ times that in the other pipe.
(C) 2 times that in the other pipe.
(D) $\frac{1}{2}$ times that in the other pipe.

11. Radius of a soap bubble is increased from R to 2R. Work done in this process in terms of surface tension is:

(A) $24\pi R^2 S$ (B) $48\pi R^2 S$ (C) $12\pi R^2 S$ (D) $36\pi R^2 S$

12. Streamline flow is more likely for liquids with:

(A) High density.
(B) High viscosity.
(C) Low density.
(D) Low viscosity.

13. What is the shape when a non-wetting liquid in displaced in a capillary tube?

(A) Concave upwards.
(B) Convex upwards.
(C) Concave downwards.
(D) Convex downwards.

14. The value of surface tension of water is minimum at:

(A) 4°C. (B) 25°C. (C) 50°C. (D) 75°C.

15. When a large bubble rises from the bottom of a lake to the surface, its radius doubles. One atmosphere is equal to that of a column of water of height H. The depth of the lake is:

(A) H. (B) 2H. (C) 7H. (D) 8H

16. A capillary tube of radius R is immersed in water and water rises in it to a height H. Mass of water in capillary tube is M. If the radius of the tube is doubled, mass of water that will rise in capillary will be:

(A) 2M. (B) M. (C) $\frac{M}{2}$ (D) 4M.

17. At which of the following temperatures the value of surface tension of water is minimum?

(A) 4°C. (B) 25°C. (C) 50°C. (D) 75°C.

18. The coefficient of viscosity for hot air is:

(A) Greater than the coefficient of viscosity for cold air.
(B) Smaller than the coefficient of viscosity for cold air.
(C) Same as the coefficient of viscosity for cold air.
(D) Increases or decreases depending on the external pressure.

19. A long cylindrical glass vessel has a small hole of radius r at its bottom. The depth to which the vessel can be lowered vertically in a deep water bath (surface tension T) without any water entering inside is:

(A) $\frac{4T}{r\rho g}$ (B) $\frac{2T}{r\rho g}$ (C) $\frac{3T}{r\rho g}$ (D) $\frac{T}{r\rho g}$

20. Let W be the work done, when a bubble of volume V is formed from a given solution. How much work is required to be done to form a bubble of volume 2V?

(A) W (B) $2W$ (C) $2^{\frac{1}{3}}W$ (D) $4^{\frac{1}{3}}W$

21. An incompressible fluid flows steadily through a cylindrical pipe which has radius 2R at point A and Radius R at point B farther along the flow direction. If the velocity at point A is v, its velocity at point B is:

(A) 2v. (B) v. (C) $\frac{v}{2}$ (D) 4v.

22. With increase in temperature, the viscosity of:

(A) Gases decreases. (B) Liquids increases.

(C) Gases increases. (D) liquids decreases.

23. The work done in increasing the size of a soap film from 10cm × 6cm to 10cm × 11cm is 3×10^{-4}J. The surface tension of the film is:

(A) 1.5×10^{-2} N/m. (B) 3.0×10^{-2} N/m.

(C) 6.0×10^{-2} N/m. (D) 11.0×10^{-2} N/m.

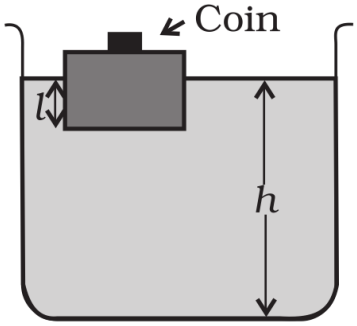
24. The volume of an air bubble becomes three times as it rises from the bottom of a lake to its surface. Assuming atmospheric pressure to be 75cm of mercury and density of water to be $\frac{1}{10}$ of the density of mercury, the depth of the lake is:

(A) 4m. (B) 10m. (C) 15m. (D) 20m.

25. Water stands upto a height h behind the vertical wall of a dam. What is the net horizontal force pushing the dam down by the stream, if width of the dam is σ? (ρ = density of water).

(A) $2h\sigma g$ (B) $\frac{h^2\sigma\rho g}{2}$ (C) $\frac{h^2\sigma\rho g}{4}$ (D) $\frac{h\sigma\rho g}{4}$

26. A wooden block with a coin placed on its top, floats in water as shown in the distance l and h are shown in the figure. After some time the coin falls into the water. Then:



(A) l decreases. (B) h decreases. (C) l increases. (D) h increase.

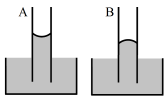
27. Pascal's law states that pressure in a fluid at rest is the same at all points, if:

(A) They are at the same height. (B) They are along same plane.

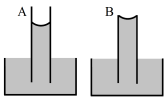
(C) They are along same line. (D) Both (a) and (b).

28. A capillary tube A is dipped in water. Another identical tube B is dipped in soap-water solution. Which of the following shows the relative nature of the liquid columns in the two tubes?

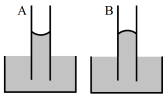
(A)



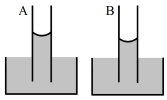
(B)



(C)



(D)



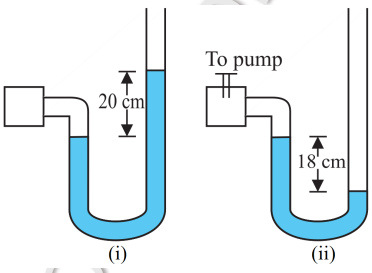
29. A cylindrical vessel is filled with water up to height H. A hole is bored in the wall at a depth h from the free surface of water. For maximum angle h is equal to:

(A) $\frac{H}{4}$ (B) $\frac{H}{2}$ (C) $\frac{3H}{4}$ (D) H

*** Given Section consists of questions of 2 marks each.** **[48]**

30. In a car lift compressed air exerts a force F on a small piston having a radius of $5.0cm$. This pressure is transmitted to a second piston of radius $15cm$ (Fig 9.7). If the mass of the car to be lifted is $1350kg$, calculate F_1. What is the pressure necessary to accomplish this task? $(g = 9.8ms^2)$

31. A manometer reads the pressure of a gas in an enclosure as shown in Fig.(a) When a pump removes some of the gas, the manometer reads as in Fig. (b) The liquid used in the manometers is mercury and the atmospheric pressure is 76cm of mercury. Give the absolute and gauge pressure of the gas in the enclosure for cases (i) and (ii) in units of cm of mercury. How would the levels change in case (i) if 13.6cm of water (immiscible with mercury) are poured into the right limb of the manometer? (Ignore the small change in volume of the gas.)



32. Explain why Hydrostatic pressure is a scalar quantity even though pressure is force divided by area.

33. Why are the wings of an aeroplane rounded outwards while flattened inwards?

34. A small drop of water of surface tension T is squeezed between two clean glass plates so that a thin layer of thickness d and area A is formed between them. If the angle of contact is zero, what is the force required to pull the plates apart.

35. A hydraulic automobile lift is designed to lift cars with maximum mass of 300kg. The area of cross-section of the piston carrying the load is 425cm^2. What maximum pressure would the smaller piston have to bear?

36. A car is lifted by a hydraulic jack that consist of two pistons. The large piston is 1m in diameter and small piston is 10cm in diameter. If W is the weight of the car, how much smaller a force is needed on the small piston to lift the car?

37. In an artery of radius 'a' blood flows with a uniform speed v. If radius of artery becomes $'\frac{3}{4}a'$ due to the accumulation of plague on its inner walls, what will be the flow of the blood through the constriction?

38. What is the significance of:
    i. Wetting agents used by dyers.
    ii. Water proofing agents?
39. Two soap bubbles in vacuum having radii 3cm and 4cm respectively coalesce under isothermal conditions to form a single bubble. What is the radius of the new bubble?
40. A piece of copper having an internal cavity weight 264g in air and 221g in water. Find the volume of the cavity. The density of copper = $8.8gcm^{-3}$.
41. If the excess pressure inside a spherical soap bubble of radius 1cm is balanced by that due to a column of oil of specific gravity 0.9, 1.36mm high. Calculate the surface tension.
42. Two syringes of different cross-sections (without needles) filled with water are connected with a tightly fitted rubber tube filled with water. Diameters of the smaller piston and larger piston are 1.0cm and 3.0cm respectively.
    i. Find the force exerted on the larger piston when a force of 10N is applied to the smaller piston.
    ii. If the smaller piston is pushed in through 6.0cm, how much does the larger piston move out?
43. What is the excess pressure inside a soap bubble that is 5cm in diameter, assuming $0.026Nm^{-1}$ as the surface tension of the soap solution?
44. In rising from the bottom of a lake to the top, the temperature of an air bubble remains unchanged, but its diameter gets doubled. What is the depth of the lake? Given h is the barometric height in metres of mercury of relative density ρ at the surface of the lake.
45. If work required to blow a soap bubble of radius r is W, then what additional work is required to be done to blow it to a radius 3r?
46. What should be the maximum average velocity of water in a tube of diameter 0.5cm. So that the flow is laminar? The viscosity of water is $0.00125Nm^{-2}s$.
47. A liquid drop of radius 4mm breaks into 1000 identical drops. Find the change in surface energy. S = $0.07Nm^{-1}$.
48. A body of mass 6kg is floating in a liquid with $\frac{2}{3}$ of its volume inside the liquid. Find ratio between the density of the body and density of liquid. Take g = $10m/s^2$.
49. Explain why Water on a clean glass surface tends to spread out while mercury on the same surface tends to form drops. (Put differently, water wets glass while mercury does not.)
50. A piece of an alloy of mass 96gm is composed of two metals whose specific gravities are 11.4 and 7.4. If the weight of the alloy is 86gm in water, find the mass of each metal in the alloy.
51. These days people use steel utensils with copper bottom. This is supposed to be good for uniform heating of food. Explain this effect using the fact that copper is the better conductor.
52. Is the bulb of a thermometer made of diathermic or adiabatic wall?
53. A copper wire of cross-sectional area $0.01cm^2$ is under a tension of 20N. Find the decrease in the cross-sectional area. Young's modulus of copper = $1.1 \times 10^{11} N/m^2$ and

Poisson's ratio = 0.32. $\left[\textbf{Hint: } \frac{\triangle \mathrm{A}}{\mathrm{A}} = 2\frac{\triangle \mathrm{r}}{\mathrm{r}}\right]$

*** Given Section consists of questions of 3 marks each.** **[117]**

54. A fully loaded Boeing aircraft has a mass of $3.3 \times 10^5 kg$. Its total wing area is $500 m^2$. It is in level flight with a speed of $960 km/h$. (a) Estimate the pressure difference between the lower and upper surfaces of the wings (b) Estimate the fractional increase in the speed of the air on the upper surface of the wing relative to the lower surface. [The density of air is $p = 1.2 kgm^3 J$

55. At a depth of $1000\ \mathrm{m}$ in an ocean (a) what is the absolute pressure? (b) What is the gauge pressure? (c) Find the force acting on the window of area $20\ \mathrm{cm} \times 20\ \mathrm{cm}$ of a submarine at this depth. the interior of which is maintained at sealevel atmospheric pressure. (The density of sea water is $1.03 \times 10^3 kgm^{-3}$, $g = 10 ms^{-2}$.)

56. Two vessels have the same base area but different shapes. The first vessel takes twice the volume of water that the second vessel requires to fill upto a particular common height. Is the force exerted by the water on the base of the vessel the same in the two cases ? If so, why do the vessels filled with water to that same height give different readings on a weighing scale?

57. A hydraulic automobile lift is designed to lift cars with a maximum mass of 3000kg. The area of cross-section of the piston carrying the load is 425cm^2. What maximum pressure would the smaller piston have to bear?

58. A vertical off-shore structure is built to withstand a maximum stress of 109 Pa. Is the structure suitable for putting up on top of an oil well in the ocean? Take the depth of the ocean to be roughly 3km, and ignore ocean currents.

59. Explain why The angle of contact of mercury with glass is obtuse, while that of water with glass is acute.

60. A capillary tube is attached horizontally to a constant head arrangement. If the radius of the capillary tube is increased by 10% then by what percentage the rate of flow of liquid will change.

61. A big size balloon of mass M is held stationary in air with the help of a small block of mass M/2 tied to it by a light string such that both float in mid air. Describe the motion of the balloon and the block when the string is cut. Support your answer with calculations.

62. A piece of brass (an alloy of copper and zinc) weighs 12.9g in air. When completely immersed in water it weighs 11.3g. What is the volume of copper contained in the alloy? RD of copper and zinc are 8 : 9 and 7.1 respectively. Solving this equation, we get m = 7.61g.

63. A tank 5m high is half-filled with water and then filled to the top with oil of density 0.85g/cc. What is the pressure at the bottom of the tank due to these liquids?

64. Prove that the pressure at a depth h from the free surface of a liquid (P) in a container is $\mathrm{P} = \mathrm{P}_2 + \mathrm{h}\rho\mathrm{g}$, where P, is the atmospheric pressure.

65. What should be the average velocity of water in a tube of diameter 2.0cm so that the flow is laminar? The viscosity of water is 0.001N m^{-2}s.

66. Air is streaming past a horizontal air plane wing such that its speed is 120ms^{-1} over the upper surface and 90ms^{-1} at the lower surface. If the density of air is 1.3kg m^{-3}, find the difference in pressure between the top and bottom of the wing. If wing is 10m long and has an average width of 2m, calculate the gross lift of the wing.

67. A hydraulic automobile lift is designed to lift cars with a maximum mass of 3000kg. The area of cross-section of the piston carrying the load is 425cm^2. What maximum pressure would the smaller piston have to bear?

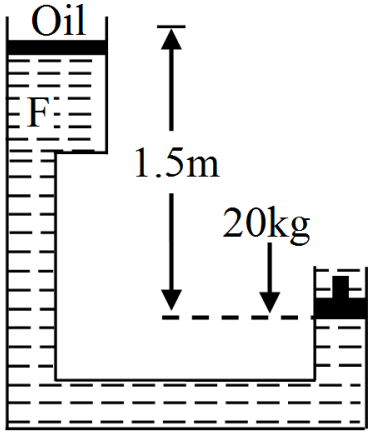
68. An air bubble of volume 1.0cm rises from the bottom of a lake 40m deep at a temperature of 12°C. To what volume does it grow when it reaches the surface which is at a temperature of 35°C?

69. Show that terminal velocity V of a spherical object of radius r, density ρ falling vertically through a viscous fluid of density σ and coefficient of viscosity n is given by:
$V = \frac{2}{9}\frac{(\rho-\sigma)r^2 g}{\eta}$

70. Water rises to a height of 10cm in a certain capillary tube. The level of mercury in the same tube is depressed by 3.42cm. Compare the surface tensions of water and mercury. Specific gravity of mercury is 13.6g/cc and angle of contact for water and mercury are zero and 135° respectively.

71. An ice floats in water with about nine-tenths of its volume submerged. What is the fractional volume submerged for an iceberg floating on a freshwater lake of a (hypothetical) planet whose gravity is ten times that of the earth?

72. The figure adjoining shows a hydraulic press with the larger piston of diameter 35cm at a height of 1.5m relative to the smaller piston of diameter 10cm. The mass on the smaller piston is 20kg. What is the force exerted on the load by the larger piston? The



density of oil in the press is 750kg m^{-3}.

73. Pressure decreases as one ascends the atmosphere. If the density of air is ρ, what is the change in pressure dp over a differential height dh?

74. The sufrace tension and vapour pressure of water at 20°C is 7.28 × 10^{-2}N m^{-1} and 2.33 × 10^3 Pa, respectively. What is the radius of the smallest spherical water droplet which can form without evaporating at 20°C?

75. A liquid drop of diameter 4mm breaks into 1000 droplets of equal size. Calculate the resultant change in surface energy, the surface tension of the liquid is 0.07Nm".

76. A cylindrical vessel of uniform cross-section contains liquid upto a height 'H'. At a depth $'h' = \frac{H}{2}$ below the free surface of the liquid there is an orifice. Using Bernoulli's

theorem, find the velocity of efflux of liquid.

77. What is the pressure inside a drop of mercury of radius 3.0mm at room temperature? Surface tension of mercury at that temperature (20°C) is $4.65 \times 10^{-1} \mathrm{Nm}^{-1}$. The atmospheric pressure is 1.01×10^{5} Pa. Also give the excess pressure inside the drop.

78. A U-tube contains water and methylated spirit separated by mercury. The mercury columns in the two arms are in level with 10.0cm of water in one arm and 12.5cm of spirit in the other. What is the specific gravity of spirit?

79. Derive an expression for the excess of pressure inside a liquid drop.

80. Two soap bubbles of different diameters are in contact with a certain portion common to both the bubbles. What will be the shape of the common boundary as seen from inside the smaller bubble? Support your answer with a neat diagram. Give reason for your answer.

81. Two exactly similar rain drops falling with terminal velocity of $(2)^{\frac{1}{3}} \mathrm{ms}^{-1}$ coalesce to form a bigger drop. Find the terminal velocity of the bigger drop.

82. The sap in trees, which consists mainly of water in summer, rises in a system of capillaries of radius $r = 2.5 \times 10^{-5}$m. The surface tension of sap is $T = 7.28 \times 10^{-2}$N m^{-1} and the angle of contact is 0°. Does surface tension alone account for the supply of water to the top of all trees?

83. A cube of wood floating in water supports a 200g mass resting at the centre of its top face. When the mass is removed, the cube rises 2cm. Find the volume of the cube.

84. What is the pressure inside the drop of mercury of radius 3.00mm at room temperature? Surface tension of mercury at that temperature (20°C) is 4.65×10^{-1}N m^{-1}. The atmospheric pressure is 1.01 × 105Pa. Also give the excess pressure inside the drop.

85. Iceberg floats in water with part of it submerged. What is the fraction of the volume of iceberg submerged if the density of ice is $\rho_{\mathrm{i}} = 0.917 \mathrm{g\ cm}^{-3}$?

86. Calculate the temperature which has same numeral value on celsius and Fahrenheit scale.

87. Why does a metal bar appear hotter than a wooden bar at the same temperature? Equivalently it also appears cooler than wooden bar if they are both colder than room temperature.

88. Find out the increase in moment of inertia I of a uniform rod $\left(\text{coefficient of linear expansion } \alpha\right)$ about its perpendicular bisector when its temperature is slightly increased by $\Delta \mathrm{T}$.

89. 100 g of water is supercooled to -10°C. At this point, due to some disturbance mechanised or otherwise some of it suddenly freezes to ice. What will be the temperature of the resultant mixture and how much mass would freeze? [Sw = 1cal/ g/ °C and L^{W}_{Fusion} = 80cal/ g]

90. A sphere of mass 20kg is suspended by a metal wire of unstretched length 4m and diameter 1mm. When in equilibrium, there is a clear gap of 2mm between the sphere and the floor. The sphere is gently pushed aside so that the wire makes an angle θ with the vertical and is released. Find the maximum value of θ so that the sphere does not

rub the floor. Young's modulus of the metal of the wire is $2.0 \times 10^{11} N/m^2$. Make appropriate approximations.

91. Water near the bed of a deep river is quiet while that near the surface flows. Give reasons.

92. A steel wire of original length 1m and cross-sectional area $4.00 mm^2$ is clamped at the two ends so that it lies horizontally and without tension. If a load of 2.16kg is suspended from the middle point of the wire, what would be its vertical depression? Y of the steel = $2.0 \times 10^{11} N/m^2$ Take g = $10 m/s^2$.

*** Given Section consists of questions of 5 marks each. [140]**

93. In Millikan's oil drop experiment, what is the terminal speed of an uncharged drop of radius $2.0 \times 10^{-5} m$ and density 1.2×10^3 kg m^{-3}. Take the viscosity of air at the temperature of the experiment to be 1.8×10^{-5} Pa s. How much is the viscous force on the drop at that speed ? Neglect buoyancy of the drop due to air.

94. Mercury has an angle of contact equal to 140° with soda lime glass. A narrow tube of radius 1.00mm made of this glass is dipped in a trough containing mercury. By what amount does the mercury dip down in the tube relative to the liquid surface outside? Surface tension of mercury at the temperature of the experiment is 0.465N m^{-1}. Density of mercury = $13.6 \times 10^3 kg\ m^{-3}$.

95. In the previous problem, if 15.0cm of water and spirit each are further poured into the respective arms of the tube, what is the difference in the levels of mercury in the two arms? (Specific gravity of mercury = 13.6)

96. Two narrow bores of diameters 3.0mm and 6.0mm are joined together to form a U-tube open at both ends. If the U-tube contains water, what is the difference in its levels in the two limbs of the tube ? Surface tension of water at the temperature of the experiment is $7.3 \times 10^{-2} N\ m^{-1}$. Take the angle of contact to be zero and density of water to be 1.0 × 103kg/ m^{-3} ($g = 9.8 m/ s^{-2}$) .

97. In deriving Bernoulli's equation, we equated the work done on the fluid in the tube to its change in the potential and kinetic energy.
    a. What is the largest average velocity of blood flow in an artery of diameter 2 × 10–3m if the flow must remain laminar?
    b. Do the dissipative forces become more important as the fluid velocity increases? Discuss qualitatively.

98. The cylindrical tube of a spray pump has a cross-section of $8.0 cm^2$ one end of which has 40 fine holes each of diameter 1.0mm. If the liquid flow inside the tube is 1.5m min^{-1}, what is the speed of ejection of the liquid through the holes?

99.
    a. What is the largest average velocity of blood flow in an artery of radius 2×10 –3m if the flow must remain lanimar?
    b. What is the corresponding flow rate ? (Take viscosity of blood to be 2.084 × 10–3 Pa/ s).

100. What is the excess pressure inside a bubble of soap solution of radius 5.00mm, given that the surface tension of soap solution at the temperature (20°C) is 2.50 × 10–2 Nm^{-}

^{1}? If an air bubble of the same dimension were formed at depth of 40.0cm inside a container containing the soap solution (of relative density 1.20), what would be the pressure inside the bubble? (1 atmospheric pressure is 1.01 × 105Pa).

101. A venturimeter is connected to two points in the mains where its radii are 20cm and 10cm, respectively, and the levels of water column in the tubes differ by 10cm. How much water flows through the pipe per minute?

102. Show that if n equal rain droplets falling through air with equal steady velocity of 10cm s^{-1} coalesce, the resultant drop attains a new terminal velocity of $10n^{2/3}$cm s^{-1}.

103. If a number of little droplets of water of surface tension S, all of the same radius r combine to form a single drop of radius R and the energy released is converted into K.E. Find the velocity acquired by the bigger drop. If the energy released is converted into heat, find the rise in temperature.

104. The manual of a car instructs the owner to inflate the tyres to a pressure of 200k Pa:
    i. What is the recommended gauge pressure?
    ii. What is the recommended absolute pressure?
    iii. If, after the required inflation of the tyres, the car is driven to a mountain peak, where the atmospheric pressure is 10% below that at sea level. What will the tire gauge read?

105. If a number of little droplets of water, each of radius r, coalesce to form a single drop of radius R, and the energy released is converted into kinetic energy then find out the velocity acquired by the bigger drop.

106. What is viscosity? What are the factors affecting viscous force in a liquid flowing in a tube? Derive the relation for the velocity upto which the liquid can have streamlined flow.

107. If a liquid is flowing through a horizontal tube, write down the formula for the volume of the liquid flowing per second through it. Water is flowing through a horizontal tube of radius 2r and length 1m at a rate of 60L/s, when connected to a pressure difference of h cm of water. Another tube of same length but radius is connected in series with this tube and the combination is connected to the same pressure head. Find out the pressure difference across each tube and the rate of flow of water through the combination.

108. Define surface tension and surface energy. Write units and dimensions of surface tension. Also prove that surface energy numerically equal to the surface tension.

109. A plane is in level flight at constant speed and each of its two wings has an area of $25m^2$. If the speed of the air is 180km/ h over the lower wing and 234km/ h over the upper wing surface, determine the plane's mass. (Take air density to be 1kg m^{-3}).

110. Air is streaming past a horizontal air plane wing such that its speed is 120ms^{-1} over the upper surface and 90ms^{-1} at the lower surface. If the density of air is 1.3kg m^{-3}, find the difference in pressure between the top and bottom of the wing. If wing is 10m long and has an average width of 2m, calculate the gross lift of the wing.

111.
    i. What is the phenomenon of capillarity? Derive an expression for the rise of liquid in a capillary tube.
    ii. What will happen if the length of the capillary tube is smaller than the height to which the liquid rises? Explain briefly.

112. The cylindrical tube of a spray pump has a cross-section of 8.0cm^2 one end of which has 40 fine holes each of diameter 1.0mm. If the liquid flow inside the tube is 1.5m min^{-1}, what is the speed of ejection of the liquid through the holes?

113. A 50kg girl wearing high heel shoes balances on a single heel. The heel is circular with a diameter 1.0cm. What is the pressure exerted by the heel on the horizontal floor?

114.
   a. What is the largest average velocity of blood flow in an artery of radius 2×10 –3m if the flow must remain lanimar?
   b. What is the corresponding flow rate ? (Take viscosity of blood to be 2.084 × 10–3 Pa/ s).

115. A thin rod having length L_0 at 0°C and coefficient of linear expansion α has its two ends maintained at temperatures θ_1 and θ_2, respectively. Find its new length.

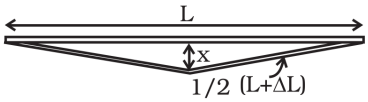
116. One day in the morning, Ramesh filled up 1/ 3 bucket of hot water from geyser, to take bath. Remaining 2/ 3 was to be filled by cold water (at room temperature) to bring mixture to a comfortable temperature. Suddenly Ramesh had to attend to something which would take some times, say 5-10 minutes before he could take bath. Now he had two options:
   i. Fill the remaining bucket completely by cold water and then attend to the work.
   ii. First attend to the work and fill the remaining bucket just before taking bath. Which option do you think would have kept water warmer? Explain.

117. Calculate the stress developed inside a tooth cavity filled with copper when hot tea at temperature of 57°C is drunk. You can take body (tooth) temperature to be 37°C and a = 1.7 × 10^{-5}/°C bulk modulus for copper = 140 × 10^{9}N/ m^2

118. According to Stefan's law of radiation, a black body radiates energy $\sigma = \mathrm{T}^4$ from its unit surface area every second where T is the surface temperature of the black body and $\sigma = 5.67 \times 10^{-8} \mathrm{w/m^2K^4}$ is known as Stefan's constant. A nuclear weapon may be thought of as a ball of radius 0.5m. When detonated, it reaches temperature of 106K and can be treated as a black body.
   a. Estimate the power it radiates.
   b. If surrounding has water at 30C°, how much water can 10% of the energy produced evaporate in 1s?
   $\left[\mathrm{s}_w = 4186.0\mathrm{J/\ kgK\ and\ L}_v = 22.6 \times 10^5 \mathrm{J/\ kg}\right]$
   c. If all this energy U is in the form of radiation, corresponding momentum is $\rho = \frac{\mathrm{U}}{\mathrm{c}}$ How much momentum per unit time does it impart on unit area at a distance of 1km?

119. We would like to make a vessel whose volume does not change with temperature (take a hint from the problem above). We can use brass and iron $\left(\beta_{\mathrm{ubrass}} = 6 \times 10^{-5}/\mathrm{K\ and\ } \beta_{\mathrm{uiron}} = 3.55 \times 10^{-5}\mathrm{K}\right)$ to create a volume of 100cc. How do you think you can achieve this.

120. A rail track made of steel having length 10m is clamped on a raillway line at its two ends. On a summer day due to rise in temperature by 20°C , it is deformed as shown in figure. Find x(displacement of the centre) if $\alpha_{\mathrm{steel}} = 1.2 \times 10^{-5}/^{\circ}\mathrm{C}$.



* Case study based questions [16]

121. Read the passage given below and answer the following questions from 1 to 5. Surface Tension The property due to which the free surface of liquid tends to have minimum surface area and behaves like a stretched membrane is called surface tension. It is a force per unit length acting in the plane of interface between the liquid and the bounding surface i.e., $S = \frac{F}{L}$, where F = force acting on either side of imaginary line on surface and L = length of imaginary line. Surface tension decreases with rise in temperature. Highly soluble impurities increases surface tension and sparingly soluble impurities decreases surface tension.

i. The excess pressure inside a soap bubble is three times than excess pressure inside a second soap bubble, then the ratio of their surface area is:
   a. 9 : 1
   b. 1 : 3
   c. 1 : 9
   d. 3 : 1

ii. Which of the following statements is not true about surface tension?
   a. A small liquid drop takes spherical shape due to surface tension.
   b. Surface tension is a vector quantity.
   c. Surface tension of liquid is a molecular phenomenon.
   d. Surface tension of liquid depends on length but not on the area.

iii. Which of the following statement is not true about angle of contact?
   a. The value of angle of contact for pure water and glass is zero.
   b. Angle of contact increases with increase in temperature of liquid.
   c. If the angle of contact of a liquid anda solid surface is less than 90°, then the liquid spreads on the surface of solid.
   d. Angle of contact depend upon the inclination of the solid surface to the liquid surface.

iv. Which of the following statements is correct?
   a. Viscosity is a vector quantity.
   b. Surface tension is a vector quantity.
   c. Reynolds number is a dimensionless quantity.
   d. Angle of contact is a vector quantity.

v. A liquid does not wet the solid surface if the angle of contact is:
   a. 0°
   b. Equal to 90°
   c. Equal to 45°
   d. Greater than 90°

122. Read the passage given below and answer the following questions from 1 to 3. Bernoulli's Theorem It states that for the streamline flow of an ideal liquid through a tube, the total energy (the sum of pressure energy, the potential energy and kinetic energy) per unit volume remains constant at every cross-section throughout the tube. $P + pgh + \frac{1}{2}pv^2$ = constant or $\frac{P}{pg} + h + \frac{1}{2}\frac{v^2}{g}$ = another constant Here, $\frac{P}{pg}$ =

pressure head; h = potential head and $\frac{1}{2}\frac{v^2}{g}$ velocity head. If the liquid is flowing through a horizontal tube, then h is constant, then according to Bernoulli's theorem, $\frac{P}{pg} + \frac{1}{2}\frac{v^2}{g}$ constant Bernoulli's theorem is based on law of conser - vation of energy.

i. Bernoulli's equation for steady, non-viscous, incompressible flow expresses the:
   a. Conservation of linear momentum
   b. Conservation of angular momentum
   c. Conservation of energy
   d. Conservation of mass

ii. Applications of Bernoulli's theorem can be seen in:
   a. Dynamic lift of aeroplane
   b. Hydraulic press
   c. Helicopter
   d. None of these

iii. A tank filled with fresh water has a hole in its bottom and water is flowing out of it. If the size of the hole is increased, then:
   a. The volume of water flowing out per second will decrease.
   b. The velocity of outflow of water remains unchanged.
   c. The volume of water flowing out per second remains zero.
   d. Both (b) and (c)

123. When some wax is rubbed on a cloth, it becomes waterproof. Explain.

124. When a glass capillary tube is dipped at one end in water, water rises in the tube. The gravitational potential energy is thus increased. Is it a violation of conservation of energy?

----- मनुष्य को हमेशा मौका नही ढूंढना चाहिये,क्योंकि जो आज है वही सबसे अच्छा मौका है। -----