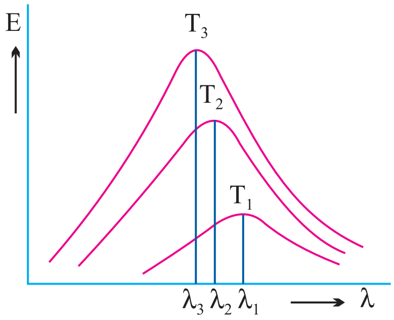
- A body is heated at different temperature and Energy of radiation is plotted against wavelength is plotted for different temperature we get following curves.



- These curves show

  (i) Energy is not uniformly distributed in the radiation spectrum of black body.

  (ii) At a given temperature the intensity of radiations increases with increase in wavelength, becomes maximum at particular wavelength and further increase in wavelength leads to decrease in intensity of heat radiation.

  (iii) Increase in temperature causes increase in energy emission for all wavelengths.

  (iv) Increase in temperature causes decrease in λ_m, where λ_m is wavelength corresponding to highest intensity. This wavelength λ_m is inversely pre-operational to the absolute temperature of the emitter. $\lambda_m T = b$

  where b is a constant and this equation is known as Wein's displacement law. $b = 0.2896 \times 10^{-2}$ *mk* for black body and is known as Wien's constant.

Very Short Answer Questions (1 Mark)

1. Why do spring balances show wrong readings after they have been used for a long time ?

2. Why do we prefer steel to copper in the manufacture of spring ?

3. Draw stress-strain curve for elastomers (elastic tissue of Aorta)

4. How are we able to break a wire by repeated bending ?

5. What is the value of bulk modulus for an incompressible liquid ?

6. Define Poisson's ratio ? Does it have any unit ?

7. What is elastic fatigue ?

8. Why is it easier to swim in sea water than in the river water ?

9. Railway tracks are laid on large sized wooden sleepers. Why ?

10. The dams of water reservoir are made thick near the bottom. Why ?

11. Why is it difficult to stop bleeding from a cut in human body at high altitude ?

12. The blood pressure in human is greater at the feet than at the brain. Why ?

13. Define coefficient of viscosity and write its SI unit.

14. Why machine parts get jammed in winter ?

15. Why do the clouds float in the sky ?

16. Antiseptics have low surface tension. Why ?

17. What will be the effect of increasing temperature on (i) angle of contact (ii) surface tension ?

18. For solids with elastic modulus of rigidity, the shearing force is proportional to shear strain. On what factor does it depend in case of fluids ?

19. How does rise in temperature effect (i) viscosity of gases (ii) viscosity of liquids ?

20. Explain why detergents should have small angle of contact ?

21. Write the dimensions of coefficient of viscosity and surface tension.

22. Obtain a relation between SI unit and cgs unit of coefficient of viscosity.

23. Explain, how the use of parachute helps a person jumping from an aeroplane.

24. Why two ships moving in parallel directions close to each other get attracted ?

25. Why the molecules of a liquid lying near the free surface possess extra energy ?

26. Why is it easier to wash clothes in hot water soap solution ?

27. Why does mercury not wet glass ?

28. Why ends of a glass tube become rounded on heating ?

29. What makes rain coats water proof ?

30. What happens when a capillary tube of insufficient length is dipped in a liquid ?

31. Does it matter if one uses gauge pressure instead of absolute pressure in applying Bernoulli's equation ?

32. State Wein's displacement law for black body radiation.

33. State Stefan Boltzmann law.

34. Name two physical changes that occur on heating a body.

35. Distinguish between heat and temperature.

36. Which thermometer is more sensitive a mercury or gas thermometer ?

37. Metal disc has a hole in it. What happens to the size of the hole when disc is heated ?

38. Name a substance that contracts on heating.

39. A gas is free to expand what will be its specific heat ?

40. Is the bulb of a thermometer made of diathermic or adiabatic wall ?

41. What is the absorptive power of a perfectly black body ?

42. At what temperature does a body stop radiating ?

43. If Kelvin temperature of an ideal black body is doubled, what will be the effect on energy radiated by it ?

44. In which method of heat transfer does gravity not play any part ?

45. Give a plot of Fahrenheit temperature versus Celsius temperature.

46. Why birds are often seen to swell their feather in winter ?

47. A brass disc fits snugly in a hole in a steel plate. Should we heat or cool the system to loosen the disc from the hole.

Short Answer Type Questions (2 Marks)

48. State Hooke's law. Deduce expression for Young's modulus of material of a wire of length '*l*', radius of cross-section '*r*' loaded with a body of mass M producing an extension Δl in it.

49. A wire of length *l* area of cross-section A and Young's modulus Y is stretched by an amount *x*. What is the work done ?

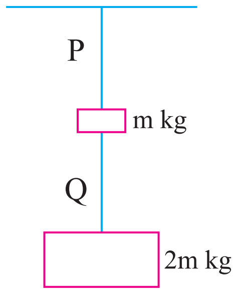
50. Prove that the elastic potential energy per unit volume is equal to $\frac{1}{2} \times$ stress $\times$ strain.

51. Define the term bulk modulus. Give its SI unit. Give the relation between bulk modulus and compressibility.

52. Define shear modulus. With the help of a diagram explain how shear modulus can be calculated.

53. Which is more elastic steel or rubber. Explain.

54. Two wires P and Q of same diameter are loaded as shown in the figure. The length of wire P is L *m* and its Young's modulus is Y N/m^2 while length of wire Q is twice that of P and its material has Young's modulus half that of P. Compute the ratio of their elongation.



55. In case of emergency, a vacuum brake is used to stop the train. How does this brake works ?

56. Define surface tension and surface energy. Obtain a relation between them.

57. State and prove Torricelli's theorem for velocity of efflux.

58. Using dimensional method obtain, Stoke's law expression for viscous force $F = 6\pi \eta a v$.

59. The fig (a) & (b) refer to the steady flow of a non-viscous liquid which of the two figures is incorrect ? Why ?

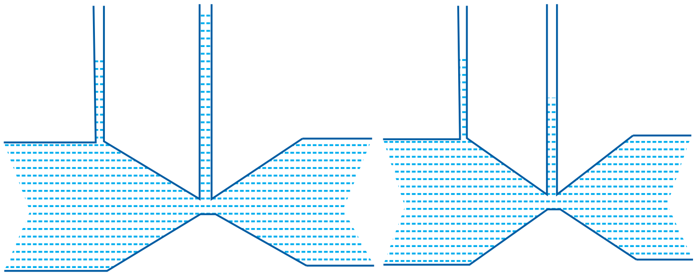
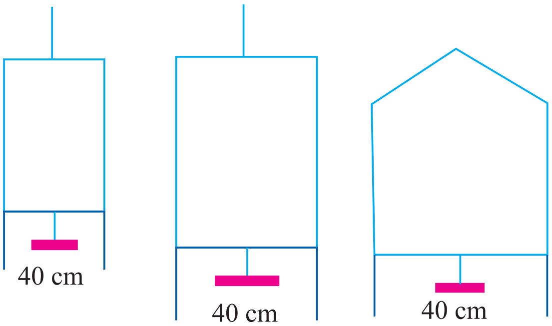


fig (a) fig (b)

60. The fig. below shows a thin liquid supporting a small weight 4.5×10^{-2} N. What is the weight supported by a film of same liquid at the same temperature in fig. (b) & (c). Explain your answer.



(a) (b) (c)

61. Two soap bubbles of different diameter 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 and justify your answer.

62. During blood transfusion the needle is inserted in a vein where gauge pressure is p_g and atmospheric pressure is p. At what height must the blood container be placed so that blood may just enter the vein. Given density of blood is p.

63. Why we cannot remove a filter paper from a funnel by blowing air into narrow end.

64. On a hot day, a car is left in sunlight with all windows closed. Explain why it is considerably warmer than outside, after some time ?

65. A capillary tube is dipped first in cold water and then in hot water. Comment on the capillary rise in the second case.

66. If a drop of water falls on a very hot iron, it does not evaporate for a long time. Why ?

67. The earth without its atmosphere would be inhospitably cold. Why ?

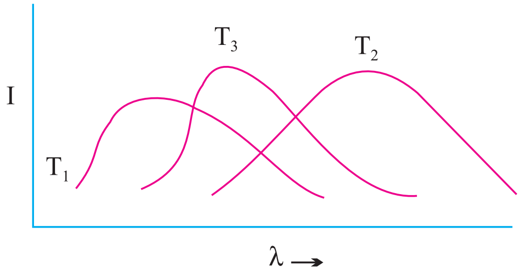
68. The coolant used in chemical or in a nuclear plant should have high specific heat. Why ?

69. A sphere, a cube and a disc made of same material and of equal masses heated to same temperature of 200ºC. These bodies are then kept at same lower temperature in the surrounding, which of these will cool (i) fastest, (ii) slowest, explain.

70. (a) Why pendulum clocks generally go faster in winter and slow in summer.

(b) Why the brake drums of a car are heated when it moves down a hill at constant speed.

71. The plots of intensity versus wavelength for three black bodies at temperature T_1, T_2 and T_3 respectively are shown.



Arrange the temperature in decreasing order. Justify your answer.

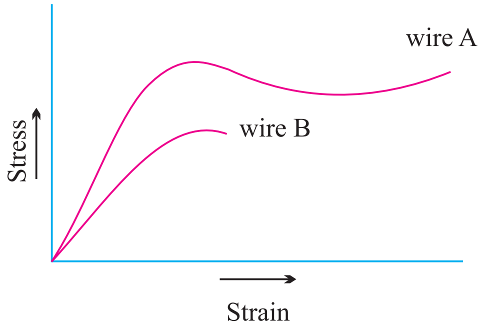
72. The triple point of water is a standard fixed point in modern thermometry. Why ? Why melting point of ice or boiling point of water not used as standard fixed points.

Short Answer Type Questions (3 Marks)

73. The knowledge of elasticity useful in selecting metal ropes show its use, in cranes for lifting heavy loads, when rope of steel is used (Elastic limit 30×10^7 Nm^{-2}) if load of 10^5 kg is to be lifted.

What should be the radius of steel rope ? What should we do to increase flexibility of such wire ?

74. Stress-strain curve for two wires of material A and B are as shown in Fig.



(a) which material in more ductile ?

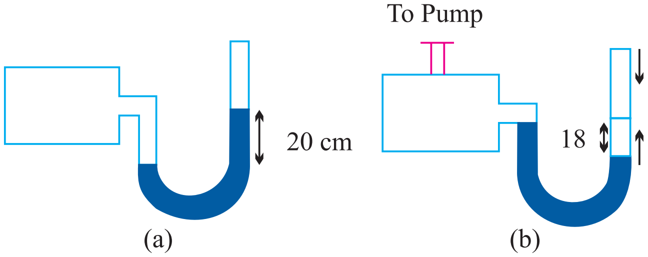
(b) which material has greater value of young modulus ?

(c) which of the two is stronger material ?

(d) which material is more brittle ?

75. State Pascal's law for fluids with the help of a neat labelled diagram explain the principle and working of hydraulic brakes.

76. A manometer reads the pressure of a gas in an enclosure as shown in the fig. (a) when some of the gas is removed by a pump, the manometer reads as in fig (b). The liquid used in manometer is mercury and the atmospheric pressure is 76 cm of mercury, (i) Give absolute and gauge pressure of the gas in the enclosure for cases (a) and (b).



77. How would the levels change in (b) if 13.6 cm of H_2O (immersible with mercury) are poured into the right limb of the manometer in the above numerical.

78. Define Capillarity and angle of contact. Derive an expression for the ascent of a liquid in a capillary tube.

79. The terminal velocity of a tiny droplet is *v*. N number of such identical droplets combine together forming a bigger drop. Find the terminal velocity of the bigger drop.

80. Two spherical soap bubble coalesce. If v be the change in volume of the contained air, A is the change in total surface area then show that 3PV + 4AT = 0 where T is the surface tension and P is atmospheric pressure.

81. Give the principle of working of venturi-meter. Obtain an expression for volume of liquid flowing through the tube per second.

82. 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 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.

83. Two vessels have the same base area but different shapes. The first vessels 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 ? Why do the vessels filled to same height give different reading on weighing scale.

84. A liquid drop of diameter D breaks up into 27 tiny drops. Find the resulting change in energy. Take surface tension of liquid as σ.

85. Define the coefficients of linear expansion. Deduce relation between it and coefficient of superficial expansion and volume expansion.

86. Describe the different types of thermometers commonly used. Used the relation between temperature on different scales. Give four reasons for using mercury in a thermometer.

87. Two rods of different metals of coefficient of linear expansion α_1 and α_2 and initial length l_1 and l_2 respectively are heated to the same temperature. Find relation in α_1, α_2, l_1 and l_2 such that difference between their lengths remain constant.

88. Explain why :

(a) a body with large reflectivity is a poor emitter.

(b) a brass tumbler feels much colder than a wooden tray on a chilly day.

89. Draw a graph to show the anomalous behaviour of water. Explain its importance for sustaining life under water.

90. A brass wire 1.8 *m* long at 27ºC is held taut with little tension between two rigid supports. If the wire is cooled to a temperature of – 39ºC, what is the tension developed in the wire, if its diameter is 2.0 mm ? Coefficient of linear expansion of brass = $2.0 \times 10^{-50}C^{-1}$, Young's modulus of brass = 0.91×10^{11} Pa.

91. Define (i) Specific heat capacity (ii) Heat capacity (iii) Molar specific heat capacity at constant pressure and at constant volume and write their units.

92. What is latent heat ? Give its units. With the help of a suitable graph, explain the terms latent heat of fusion and latent heat of vaporisation.

93. What is the effect of pressure on melting point of a substance ? What is regelation. Give a practical application of it.

94. What is the effect of pressure on the boiling point of a liquid. Describe a simple experiment to demonstrate the boiling of H_2O at a temperature much lower than 100ºC. Give a practical application of this phenomenon.

95. State and explains the three modes of transfer of heat. Explains how the loss of heat due to these three modes is minimised in a thermos flask.

96. Define coefficient of thermal conductivity. Two metal slabs of same area of cross-section, thickness d_1 and d_2 having thermal conductivities K_1 and K_2 respectively are kept in contact. Deduce expression for equivalent thermal conductivity.

Long Answer Type Questions (5 Marks)

97. Draw and discuss stress versus strain graph, explaining clearly the terms elastic limit, permanent set, proportionality limit, elastic hysteresis, tensible strength.

98. Show that there is always an excess pressure on the concave side of the meniscus of a liquid. Obtain an expression for the excess pressure inside (i) a liquid drop (ii) soap bubble (iii) air bubble inside a liquid.

99. State and prove Bernoullis theorem. Give its limitation. Name any two application of the principle.

100. Define terminal velocity. Obtain an expression for terminal velocity of a sphere falling through a viscous liquid. Use the formula to explain the observed rise of air bubbles in a liquid.

101. On what factors does the rate of heat conduction in a metallic rod in the steady state depend. Write the necessary expression and hence define the coefficient of thermal conductivity. Write its unit and dimensions.

102. Show graphically how the energy emitted from a hot body varies with the wavelength of radiation. Give some of salient points of the graph.

103. What is meant by a block body. Explain how a black body may be achieved in practice. State and explain Stefan's law ?

104. State and prove Pascal's law of transmission of fluid pressure. Explain how is Pascal's law applied in a hydraulic lift.

105. Discuss energy distribution of black body radiation spectrum and explain Wein's displacement law of radiation and Stefan's law of heat radiation.

NUMERICALS

106. An aluminium wire 1 m in length and radius 1 mm is loaded with a mass of 40 kg hanging vertically. Young's modulus of Al is 7.0×10^{10} N/m^2. Calculate (a) tensile stress (b) change in length (c) tensile strain and (d) the force constant of such a wire.

107. The average depth of ocean is 2500 m. Calculate the fractional compression $\left(\frac{\Delta V}{V}\right)$ of water at the bottom of ocean, given that the bulk modulus of water is 2.3×10^9 N/m^2.

108. A force of 5×10^3 N is applied tangentially to the upper face of a cubical block of steel of side 30 cm. Find the displacement of the upper face relative to the lower one, and the angle of shear. The shear modulus of steel is 8.3×10^{10} pa.

109. How much should the pressure on one litre of water be changed to compress it by 0.10%.

110. Calculate the pressure at a depth of 10 m in an Ocean. The density of sea water is 1030 kg/m^3. The atmospheric pressure is 1.01×10^5 pa.

111. In a hydraulic lift air exerts a force F on a small piston of radius 5 cm. The pressure is transmitted to the second piston of radius 15 cm. If a car of mass 1350 kg is to be lifted, calculate force F that is to be applied.

112. How much pressure will a man of weight 80 kg *f* exert on the ground when (i) he is lying and (2) he is standing on his feet. Given area of the body of the man is 0.6 m^2 and that of his feet is 80 cm^2.

113. The manual of a car instructs the owner to inflate the tyres to a pressure of 200 *k* pa. (a) What is the recommended gauge pressure ? (b) What is the recommended absolute pressure (c) 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 tyre gauge read ?

114. Calculate excess pressure in an air bubble of radius 6 mm. Surface tension of liquid is 0.58 N/m.

115. Terminal velocity of a copper ball of radius 2 mm through a tank of oil at 20ºC is 6.0 cm/s. Compare coefficient of viscosity of oil. Given $p_{cu} = 8.9 \times 10^3$ kg/m^3, $\rho_{oil} = 1.5 \times 10^3$ kg/m^3.

116. Calculate the velocity with which a liquid emerges from a small hole in the side of a tank of large cross-sectional area if the hole is 0.2 m below the surface liquid ($g = 10$ ms^{-2}).

117. A soap bubble of radius 1 cm expands into a bubble of radius 2 cm. Calculate the increase in surface energy if the surface tension for soap is 25 dyne/cm.

118. A glass plate of 0.2 m^2 in area is pulled with a velocity of 0.1 m/s over a larger glass plate that is at rest. What force is necessary to pull the upper plate if the space between them is 0.003 m and is filled with oil of η 0.01 Ns/m^2.

119. The area of cross-section of a water pipe entering the basement of a house is 4×10^{-4} m^2. The pressure of water at this point is 3×10^5 N/m^2, and speed of water is 2 m/s. The pipe tapers to an area of cross section of 2×10^{-4} m^2, when it reaches the second floor 8 m above the basement. Calculate the speed and pressure of water flow at the second floor.

120. A large bottle is fitted with a siphon made of capillary glass tubing. Compare the times taken to empty the bottle when it is filled (i) with water (ii) with petrol of density 0.8 cgs units. The viscosity of water and petrol are 0.01 and 0.02 cgs units respectively.

121. The breaking stress for a metal is 7.8×10^9 Nm^{-2}. Calculate the maximum length of the wire made of this metal which may be suspended without breaking. The density of the metal = 7.8×10^{-3} kg m^{-3}. Take $g = 10$ N kg^{-1}.

122. Two stars radiate maximum energy at wavelength, 3.6×10^{-7} m and 4.8×10^{-7} *m* respectively. What is the ratio of their temperatures ?

123. Find the temperature of 149ºF on kelvin scale.

124. A metal piece of 50 g specific heat 0.6 cal/gºC initially at 120ºC is dropped in 1.6 kg of water at 25ºC. Find the final temperature or mixture.

125. A iron ring of diameter 5.231 m is to be fixed on a wooden rim of diameter 5.243 m both initially at 27ºC. To what temperature should the iron ring be heated so as to fit the rim (Coefficient of linear expansion of iron is $1.2 \times 10^5 k^{-1}$?

126. 100 g of ice at 0ºC is mixed with 100 g of water at 80ºC. The resulting temperature is 6ºC. Calculate heat of fusion of ice.

127. Calculate heat required to convert 3 kg of water at 0ºC to steam at 100ºC. Given specific heat capacity of $H_2O = 4186$ J $kg^{-1}k^{-1}$ and latent heat of steam $= 2.256 \times 10^6$ J/kg.

128. Calculate the stress developed inside a tooth cavity that filled with copper. When hot tea at temperature 57ºC is drunk. You can take body (tooth) temperature to be 37ºC and $\alpha = 1.7 \times 10^{-5}$/ºC bulk modules for copper $= 140 \times 10^9$ Nm^{-2}.

129. A body at temperature 94ºC cools to 86ºC in 2 min. What time will it take to cool from 82ºC to 78°C. The temperature of surrounding is 20ºC.

130. A body re-emits all the radiation it receives. Find surface temperature of the body. Energy received per unit area per unit time is 2.835 watt/m^2 and $\alpha = 5.67 \times 10^{-8}$ W m^{-2} k^{-4}.

MULTIPLE CHOICE QUESTIONS (MCQs)

131. A spring is stretched by applying a load to its free end. The strain produced in the spring is

(a) Volumetric (b) Shear

(c) Longitudinal & Shear (d) Longitudinal

132. The maximum load a wire can withstand without breaking, when its length is reduced to half of its original length, will

(a) be double (b) be half

(c) be for times (d) remain same

133. A rigid bar of Mass M is supported symmetrically by three wires each of length L. Those at each end one of Copper and the middle one is of iron. The ratio of their diameters, if each is to have the same tension, is equal to

(a) $\frac{Ycopper}{Yiron}$ (b) $\sqrt{\frac{Yiron}{Ycopper}}$

(c) $\frac{Y^2\ iron}{Y^2\ copper}$ (d) $\frac{Yiron}{Ycopper}$

134. A mild steel wire of Length 2L and cross sectional Area A is stretched well within elastic limit, horizontally between two pillars. A man m is suspended from the mid point of the wire strain in the wire is

(a) $\frac{x^2}{2L^2}$ (b) $\frac{x}{L}$

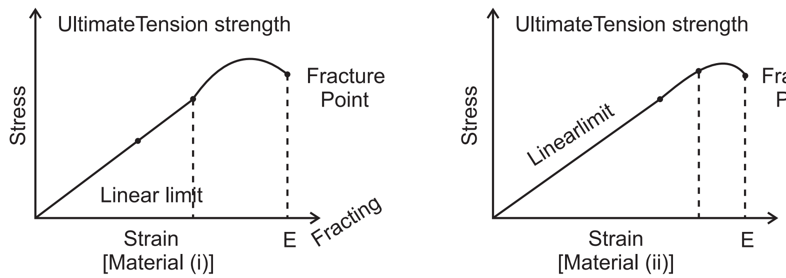
(c) $\frac{x^2}{L}$ (d) $\frac{x^2}{2L}$

135. For an ideal liquid : (More than one option may be correct)

(a) the bulk modulus is infinite (b) the bulk modulus is zero

(c) the shear modulus is infinite (d) the shear modulus is zero

136. The stress strain graph for this materials are shown figure. (Assume scale is same for both graph)



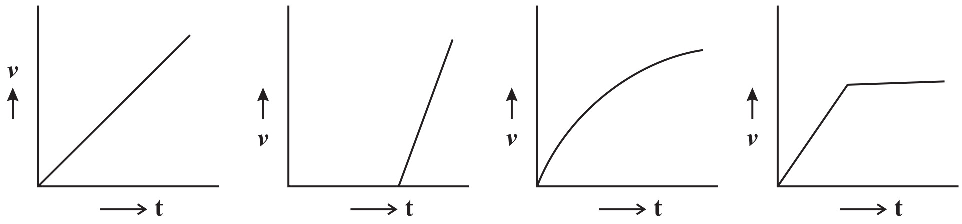
(a) Material (ii) is more elastic than material (i) and hence material (ii) is more brittle.

(b) Material (i) & (ii) have the same elasticity and the same brittleness.

(c) Material (ii) is elastic over the larger region of strain as compared to (i)

(d) Material (ii) is more brittle than material (i)

137. The tall cylinder is filled with viscous oil. A round pebble is dropped from the top with zero initial velocity. From the plot shown in fig. indicate the one that represents the velocity (v) of the pebble as function of time (t)



(a) (b) (c) (d)

138. An ideal fluid flow through a pipe of circular cross section made of two sections with diameters 2.5 cm & 3.75 cm. The ratio of the velocities in the two pipes is

(a) 9 : 4 (b) 3 : 2

(c) $\sqrt{3} : \sqrt{2}$ (d) $\sqrt{2} : \sqrt{3}$

139. The angle of contact at the interface of water glass is 0°, Ethylolcohal–glass is 0°, Merecing–glass is 140° & Methyl iodide-glass is 30°. A glass capillary is put its a trough containing one of these for liquids. It is observed that the meniscus is convex. The liquid in the trough is

(a) Water (b) Ethylalcohol

(c) Mercury (d) Methyl iodide

140. A bimetallic strip is made of aluminum & steel $(\alpha_{Al} > \alpha_{steel})$. On heating the strip will

(a) remain straight

(b) get twisted

(c) will bend with aluminum on concave side

(d) will bend with steel on concave side.

141. A Uniform Metallic Rod rotates about its perpendicular bisector with constant angular speed. If it is heated uniformly to raise its temperating slightly

(a) Its speed of rotation increases

(b) Its speed of rotation decreases

(c) Its speed of rotation remains same

(d) Its speed increases because its moment of Inertia decreases.

142. As the temperating is increases, the time period of pendulum

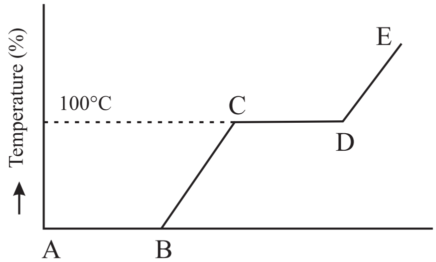
(a) increases as its effective length increases even though its centre of man (CM) still reaming at the centre of the bob

(b) decreases as its effective length increases even though its CM still remains at the centre of the bob

(c) increases as its effective length increases due to shifting of CM below the centre of the bob

(d) decreases as its effective length remains same but the CM shifts above the centre of the bob.

143. Refer to the plot of temperating versus time showing the changes in the state of ice on heating (not of scale)



Which of the following is correct :

(a) The region AB represents ice & water in thermal equilibrium

(b) At B water stats boiling

(c) At C all the water gets converted into steam

(d) C-D represents water & steam in equilibrium at boiling point.

144. A student records the initial length l, change in temperature ΔT and change in length Δl of a rod as follows :

S.No.	l (m)	ΔT (°C)	Δl (m)
1	2	10	4×10^{-4}
2	1	10	4×10^{-4}
3	2	20	2×10^{-4}
4	3	10	6×10^{-4}

If the first observation is correct. Choose the correct answer about 2nd, 3rd & 4th observations

(a) 2nd observation correct (b) 3rd observation correct

(c) 4th observation correct (b) 4th observation incorrect

145. The approximate depth of an ocean is 2700 m. The compressibility of water is 45.4×10^{-11} Pa^{-1} and density of water is 10^3 kg/m^3. What fractional compression of water will be obtained at the bottom of the ocean?

(a) 1.0×10^{-2} (b) 1.2×10^{-2}

(c) 1.4×10^{-2} (d) 0.8×10^{-2}

146. The Young's Modulus of steel is twice that of brass. Two wires of same length and of same area of cross-section; one of steel and another of brass are suspended from the same roof. If then the weights added to the steel and brass wires must be in the ratio of

(a) 1 : 1 (b) 1 : 2

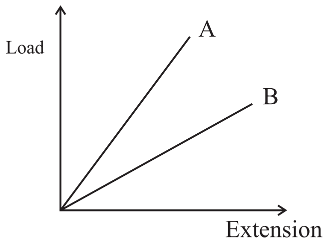
(c) 2 : 1 (d) 4 : 2

147. Two rods of different materials having coefficients of thermal expansion α_1 , α_2 and Young's Moduli Y_1, Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of the rods. If $\alpha_1 : \alpha_2 = 2 : 3$, the thermal stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to

(a) 2 : 3 (b) 1 : 1

(c) 3 : 2 (d) 4 : 9

148. In the given figure; if the dimension of the two wires are the same and materials are different. Young's modulus is



(a) More for A than B (b) More for B than A

(c) Equal for A & B (d) None of these

149. The two ends of a metal rod are maintained at temperatures 100°C and 110°C. The rate of heat flow in the rod is found to be 4.0 J/s. If the ends are now maintained at temperatures 200°C and 210°C, the rate of flow of heat will be

(a) 16.8 J/s (b) 8.0 J/s

(c) 4.0 J/s (d) 44.8 J/s

150. Steam at 100°C is passed into 20 g of water at 10°C, then water acquires a temperating of 80°C, the man of water present will be [Take specific heat of water = 1 cal g^{-1} $°C^{-1}$ and Latent heat of steam = 540 cal g^{-1}]

(a) 24 g (b) 31.5 g

(c) 42.5 g (d) 22.5 g

ASSERTION - REASON BASED QUESTIONS

Direction:- In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not correct explanation of assertion..

(c) If assertion is true, but reason is false.

(d) If both assertion and reason are false.

1. Assertion : The size of hydrogen balloon increases as it rises in the air.

Reason : The material of balloon can be easily stretched.

2. Assertion : Stress is the internal force per unit area of a body.

Reason : Rubber is more elastic than steel.

3. Assertion : A rigid body can be elastic.

Reason : If force is applied on rigid body, it's dimension may change.

4. Assertion : Transverse sound waves does not occurs in gases.

Reason : Gases can not sustain shearing strain.

5. Assertion : The shape and size of rigid body remain unaffected under the effect of external forces.

Reason : The distance between two particles remains constant in rigid body.

6. Assertion : A lead is more elastic than rubber.

Reason : If same load is applied on the lead and rubber wire of same cross-sectional area, the strain of lead is very much less than that of rubber.

7. Assertion : Bulk modulus of elasticity B represents incompressibility of the material.

Reason : $B = \frac{-\Delta PV}{\Delta V}$ where symbols have their usual meaning.

8. Assertion : The bridges declared unsafe after long use.

Reason : Elastic strength of bridges losses with time.

9. Assertion : Young's modulus for a perfectly plastic body is zero.

Reason : For perfectly plastic body restoring force is zero.

10. Assertion : Strain is a unit less quantity.

Reason : Strain is equivalent to force.

11. Assertion : The blood pressure in human is greater at the feet than at brain.

Reason : Pressure of liquid at any point is proportional to height, density of liquid and acceleration due to gravity.

12. Assertion : The velocity increases, when water flowing in a broader pipe enter a narrow pipe.

Reason : According to equation of continuity, product of area of cross-section and velocity is constant.

13. Assertion : The velocity of fall of a man jumping with a parachute first increases and then becomes constant.

Reason : The constant velocity of fall of man is called terminal velocity.

14. Assertion : The velocity of flow of a liquid is smaller when pressure is larger and vice versa.

Reason : According to Bernoulli's theorem for the stream line flow of an ideal fluid, the total energy per unit mass remains constant.

15. Assertion : Sudden fall of pressure at a place indicate storm.

Reason : Air flows from higher pressure to lower pressure.

16. Assertion : To empty an oil tank, two holes are made.

Reason : Oil will come out of two holes, so it will be emptied faster.

17. Assertion : A rain drop after falling through some height attains a constant velocity.

Reason : At constant velocity, the viscous drag is just equal to it's weight.

18. Assertion : The water rises higher in a capillary table of small diameter than in the capillary tube of large diameter.

Reason : Height through which liquid rises in a capillary tube is inversely proportional to the diameter of the capillary tube.

CASE STUDY BASED QUESTIONS

Q1. Bernoulli's theorem, in fluid dynamics, relation among the pressure, velocity and elevation in a moving fluid (liquid or gas), the compressibility and viscosity of which are negligible and the flow of which is steady, or laminar. Bernoulli's principle is applicable on those non-viscous liquids which have laminar or stream lined flow. It means that a liquid in which its particles exert no force on each other i.e. the speed of all particles of the liquid is same.

Answer the following questions (any four)

(i) Bernoulli's principle is based on the conservation of

(a) momentum (b) energy and momentum both

(c) mass (d) energy

(ii) Water is following through a horizontal pipe in a streamline flow, at the narrowest part of the pipe

(a) both pressure and velocity remains constant.

(b) velocity is maximum and pressure is minimum.

(c) both the pressure and velocity are maximum.

(d) both the pressure and velocity are minimum.

(iii) In houses for away from municipal water tanks often find it difficult to get water on the top floor. This happens because

(a) water wets the pipe.

(b) the pipes are not of uniform diameter.

(c) the viscosity of water is high.

(d) of loss of pressure during the flow of water.

(iv) In which of the following types of flows is the Bernoulli's theorem strictly applicable

(a) streamline and rotational (b) turbulent and rotational

(c) turbulent and irrotational (d) streamline and irrotational

(v) Viscosity of gases

(a) decreases with increases in temperature

(b) independent of temperature

(c) increases with increase in temperature

(d) may increase or decrease depend on nature of gas

Q2. Ram was doing an experiment in physics lab to find co-efficient of viscosity of glycerine. In this experiment the drop lead shots in the tube filled with glycerine. Find the velocity of lead shots then using Stoke's law he found the viscosity of the glycerine. The formula used by him was

$$\eta = \frac{2}{q}\frac{r^2}{v}(\rho - \sigma)\, g$$

Answer the following questions (do any four)

(i) Stokes force does not depend up on

(a) radius of the object

(b) viscosity of the medium

(c) viscosity of the object

(d) acceleration due to gravity.

(ii) A steel ball is dropped in glycerine tube of large length, then

(a) the ball stops after some time

(b) the speed of ball keeps on increasing

(c) the ball attains constant velocity after sometime

(d) none of the above.

(iii) A sphere of mass 'm' and radius 'r' is falling in one column of glycerine. Terminal velocity attained by falling object is proportional to

(a) r^2 (b) $\frac{1}{r}$ (c) r (d) $\frac{1}{r^2}$

(iv) The ratio of terminal velocities of two drops of radii R and $\frac{R}{2}$ is

(a) 2 (b) 1 (c) $\frac{1}{2}$ (d) 4

(v) S.I. unit of co-efficient of viscosity is

(a) poise (b) deca poise (c) dimensionless (d) erg.

Q3. Surface tension is the tendency of fluid surfaces to shrink into the minimum surface area possible. Intermolecular forces such as Van der Waals Force draw the liquid particles together. The ratio of the surface force F to the length L along which the force acts.

T = F/L Where, F is the force per unit length

L is the length in which force act

T is the surface tension of the liquid

Answer the following questions (do any four)

(i) If T is the surface tension of the soap solution, the amount of work done in blowing a soap bubble from diameter D to a diameter 2D is

(a) $2\pi D^2T$ (b) $4\pi D^2T$

(c) $6\pi D^2T$ (d) πD^2T

(ii) If the surface a liquid is plane, then the angle of contact of the liquid with the walls of the container is

(a) acute angle

(b) obtuse angle

(c) 90°

(d) 0°

(iii) When a soap bubble is charged

(a) it contracts

(b) it expands

(c) it does not undergo any change in size

(d) none of these

(iv) If common salt is dissolved in water, then the surface tension of saltwater is

(a) increased

(b) decreased

(c) not changed

(d) first increased then decrease

(v) A drop of oil is placed on the surface of the water. Which of the following statements is correct?

(a) it will remain on it as a sphere

(b) it will spread as a thin layer

(c) it will partly be as spherical droplets and partly as thin films

(d) it will float at the distorted drop on the water surface

ANSWERS

VERY SHORT ANSWERS (1 MARK)

1. This is due to elastic fatigue.
2. Because steel is more elastic than copper as its Young's modulus is more than that of copper.
4. Repeated bending of wire decreases elastic strength and therefore it can be broken easily.
5. $K = \frac{\text{stress}}{\text{strain}} = \frac{\text{stress}}{0} = \infty$ (Infinity)
6. Poisson's ratio is the ratio of lateral strain to the longitudinal strain. It has no units.
7. It is the loss in strength of a material caused due to repeated alternating strains to which the material is subjected.
8. The density of sea water is more than the density of river water, hence sea water gives more up thrust for the same volume of water displaced.
9. This spreads force due to the weight of the train on a larger area and hence reduces the pressure considerably and in turn prevents yielding of the ground under the weight of the train.
10. Pressure exerted by liquid column = hpg so as 'h' increases p increases so to with stand high pressure dams are made thick near the bottom.
11. The atmospheric pressure is low at high altitudes. Due to greater pressure difference in blood pressure and the atmospheric pressure, it is difficult to stop bleeding from a cut in the body.
12. The height of blood column is quite large at feet than at the brain, hence blood pressure at feet is greater.
14. In winter *i.e.,* at low temperature the viscosity of lubricants increases.
15. Due to zero terminal velocity.
16. They have to spread over a large area.
17. Angle of contact increases with increase of temperature while surface tension generally decreases with increase of temperature.
18. Rate of Shear Strain.

19. Viscosity of gases increases while viscosity of liquid decreases.

20. Detergents should have small angle of contact so that they have low surface tension and greater ability to wet a surface. Further as $h = \frac{2T\cos\theta}{rpg}$ *i.e.*, θ is small cos θ will be large so *h i.e.,* penetration will be high.

21. $[\eta] = [M^1L^{-1}T^{-1}]$

$[T] = [M^1L^{-2}L^0]$

22.

$$\text{c.g.s unit of } \eta = \text{poise}$$

$$\text{S.I. Unit of } \eta = \text{poiseuille or deca poise}$$

$$1 \text{ poise} = 1 \text{ g cm}^{-1} \text{ s}^{-2} = 10^{-1} \text{ kg m}^{-1} \text{ s}^{-1}$$

$$= 0.1 \text{ poiseuille}$$

23. Viscous force on the parachute is large as $F = 6\pi \eta r v$, $F \alpha r$, so its terminal velocity becomes small so the person hits the ground with this small velocity and does not get injured.

24. According to Bernoulli's theorem for horizontal flow $P + \frac{1}{2}pv^2 = \text{constant.}$

As speed of water between the ships is more than outside them pressure between them gets reduced & pressure outside is more so the excess pressure pushes the ships close to each other therefore they get attracted.

25. The molecules in a liquid surface have a net downward force (cohesion) on them, so work done in bringing them from within the body of liquid to the surface increases surface energy.

26. Hot water soap solution has small surface tension therefore can remove the dirt from clothes by wetting them effectively.

27. Mercury does not wet glass because of larger cohesive force between Hg-Hg molecules than the adhesive forces between mercury-glass molecules.

28. When glass is heated, it melts. The surface of this liquid tends to have a minimum area. For a given volume, the surface area is minimum for a sphere. This is why the ends of a glass tube become rounded on heating.

29. The angle of contact between water and the material of the rain coat is obtuse. So the rain water does not wet the rain coat.

30. When a capillary tube of insufficient length is dipped in a liquid, the radius of curvature of the meniscus increase so that *hr* = constant. That is pressure on concave side becomes equal to pressure exerted by liquid column so liquid does not overflow.

31. No. Unless the atmospheric pressures at the two points where Bernoulli's equation is applied, are significantly different.

34. Volume and electrical resistance.

36. Gas thermometer is more sensitive as coefficient of expansion of Gas is more than mercury.

37. Expansion is always outward, therefore the hole size increased on heating.

38. Ice

39. Infinity

40. The temperature above which molar heat capacity of a solid substance becomes constant.

41. One.

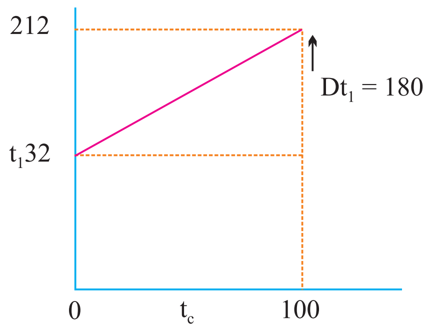
42. At oK.

43. $E \alpha T^4 \therefore \frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{2T_1}{T_1}\right)^4 = 16$

$\therefore E_2 = 16\, E_1$

44. In conduction and radiation.

45.



46. When birds swell their feathers, they trap air in the feather. Air being a poor conductor prevents loss of heat and keeps the bird warm.

47. The temp, coefficient of linear expansion for brass is greater than that for steel. On cooling the disc shrinks to a greater extent than the hole, and hence brass disc gets lossened.

SHORT ANSWERS (2 MARKS)

49. Restoring force in extension $x = F = \frac{AYx}{L}$

Work done in stretching it by $dx = dw = F.dx$

Work done in stretching it from zero to $x = W = \int dw = \int_0^x F dx$

$$W = \int_0^x \frac{AYx}{L} dx = \frac{1}{2}\frac{AYx^2}{L}$$

50.

$$\text{Energy Density} = \frac{\text{Energy}}{\text{Volume}} = \frac{\frac{1}{2}\frac{AY}{L}x^2}{AL}$$

$$= \frac{1}{2}\left(\frac{AYx}{L}\right)\frac{x}{L}$$

$$= \frac{1}{2}\frac{F}{A} \times \frac{x}{L} \qquad \left[\because Y = \frac{FL}{Ax}\right]$$

$$= \frac{1}{2}\text{stress} \times \text{strain}$$

53.

$$Y_s = \frac{F}{A}\frac{I}{\Delta I_s}$$

$$Y_r = \frac{F}{A}\frac{I}{\Delta I_r}$$

For same force applied to wires made of steel & rubber of same length and same area of cross section

$$\Delta I_s < \Delta I_r$$

$$\frac{Y_s}{Y_r} = \frac{\Delta I_r}{\Delta I_s} > 1$$

$\therefore$ $$Y_s > Y_r$$

54. ΔI_p $$= \frac{3mg}{A} \times \frac{L}{Y}$$

ΔI_Q $$= \frac{2mg}{A} \cdot \frac{2L}{Y/2} = \frac{8mg}{A}\frac{L}{Y}$$

$$\therefore \qquad \frac{\Delta I_p}{\Delta I_q} = \frac{3}{8}$$

55. Steam at high pressure is made to enter the cylinder of vacuum brake. Due to high velocity, pressure decreases in accordance with Bernoulli's principle. Due to this decrease in pressure, the piston gets lifted. Consequently brake gets lifted.

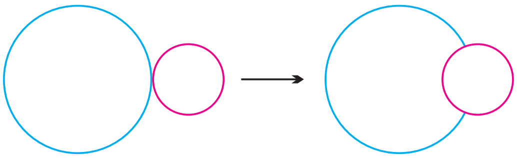
59. Fig. (a) incorrect.

At the constriction, the area of cross section is small so liquid velocity is large, consequently pressure must be small so height of liquid must be less.

60. The weight supported by (b) and (c) are same as that in (a) and is equal to 4.5×10^{-2} N.

The weight supported = 2 σ *l*, where σ is surface tension and *l* is the length which is same in all the three cases, hence weight supported is same.

61.



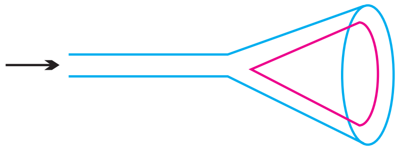
When seen from inside the smaller bubble the common surface will appear 2T concave as (1) the pressure (excess) = $\frac{2T}{R}$ will be greater for concave surface & as R is small for the smaller bubble, the pressure will be greater.

62.

$$P_g = pgh$$

$$h = \frac{P_g}{pg}$$

63.



When air is blown into the narrow end its velocity in the region between filter paper and glass increases. This decreases the pressure. The filter paper gets more firmly held with the wall of the tunnel.

64. Glass transmits 50% of heat radiation coming from a hot source like sun but does not allow the radiation from moderately hot bodies to pass through it.

65. We know that $h = \frac{2S\cos\theta}{r\rho g}$

Surface tension of hot water is less than the surface tension of cold water. Moreover, due to thermal expansion the radius of the capillary tube will increase in hot water. Due to both reasons, the height of capillary rise will be less in hot water as compared to cold water.

66. A vapour film is formed between water drop and the hot iron. Vapour being a poor conductor of heat makes the water droplet to evaporate slowly.

67. Due to green house effect, the presence of atmosphere prevents heat radiations received by earth to go back. In the absence of atmosphere radiation will go back at night making the temperature very low and inhospitable.

68. So, that it absorbs more heat with comparatively small change in temperature and extracts large amount of heat.

69. Rate of energy emission is directly proportional to area of surface for a given mass of material. Surface area of sphere is least and that of disc is largest. Therefore cooling of (i) disc is fastest and (ii) sphere is slowest.

70. (a) Time period of pendulum = T = $2\pi\sqrt{\frac{l}{g}}$ or $T \times \sqrt{l}$

In winter I becomes shorter so its time period reduces so it goes faster. In summer I increases resulting in increase in time period so the clock goes slower.

(b) When the car moves down hill, the decrease in gravitational potential energy is converted into work against force of friction between brake shoe and drum which appears as heat.

71. According to wein's displacement law, λmt = Constant

$\lambda_1 < \lambda_3 < \lambda_2$

$T_1 > T_3 > T_2$

72. The melting point of ice as well as the boiling point of water changes with change in pressure. The presence of impurities also changes the melting and boiling points. However the triple point of water has a unique temperature and is independent of external factors. It is that temperatures at which water, ice & water vapour co-exist that is 273. 16 K and pressure 0.46 cm of Hg.

ANSWERS FOR SHORT QUESTIONS (3 MARKS)

73. The ultimate stress should not exceed elastic limit of steel (30×10^7 N/m^2)

$$U = \frac{F}{A} = \frac{Mg}{\pi r^2} = \frac{10^5 \times 9.8}{\pi r^2} = 30 \times 10^7$$

$\therefore$ $r = 3.2$ cm

So to lift a bad of 10^4 kg, crane is designed to withstand 10^5 kg. To impart flexibility the rope is made of large number of thin wires braided.

74. (a) Wire with larger plastic region is more ductile material A.

(b) Young's modulus is $\frac{\text{Stress}}{\text{Strain}}$

$\therefore Y_A > Y_B$

(c) For given strain, larger stress is required for A than that for B.

$\therefore$ A is stronger than B.

(d) Material with smaller plastic region is more brittle, therefore B is more brittle than A.

76. (i) In case (a) Pressure head, $h = +20$ cm of Hg

Absolute Pressure = $P + h = 76 + 20 = 96$ cm of Hg.

Gauge Pressure = $h = 20$ cm of Hg.

In case (b) Pressure Head $h = -18$ cm of Hg

Absolute Pressure = $76 - 18 = 58$ cm of Hg

Gauge Pressure = $h = -18$ cm of Hg

77. as

$$h_1 p_1 g = h_2 p_2 g$$

$$h_1 \times 13.6 \times g = 13.6 \times 1 \times g$$

$$h_1 = 1 \text{ cm}$$

Therefore as 13.6 cm of H_2O is poured in right limb it will displace Hg level by 1 cm in the left limb, so that difference of levels in the two limbs will become 19 cm.

79.

$$v = \frac{2}{9}\left[\frac{g(\sigma-\rho)r^2}{\eta}\right]$$

$$\Rightarrow \quad \frac{v}{r^2} = \frac{2g}{9\eta}(\sigma-\rho) \quad ...(1)$$

Similarly, $$\frac{v'}{R^2} = \frac{2g}{9\eta}(\sigma-\rho) \quad ...(2)$$

Divididng 1 by 2,

$$\frac{v}{v'} = \frac{r^2}{R^2} \Rightarrow v' = v\left(\frac{R}{r}\right)^2$$

If N drops coalesce, then

Volume of one big drop = Volume of N droplets

$$\frac{4}{3}\pi R^3 = N\left(\frac{4}{3}\pi r^3\right)$$

$$R = N^{1/3}r$$

∴ Terminal velocity of bigger drop

$$= \left(\frac{R}{r}\right)^2 \times v \text{ from equation (1)}$$

$$= N^{2/3}\,v \text{ from equation (2)}$$

80. Let P_1 & P_2 be the pressures inside the two bubbles, then

$$P_1 - P = \frac{4T}{r_1} \Rightarrow P_1 = P + \frac{4T}{r_1}$$

$$P_2 - P = \frac{4T}{r_2} \Rightarrow P_2 = P + \frac{4T}{r_2}$$

When bubbles coalesce

$$P_1V_1 + P_2V_2 = PV \quad ...(1)$$

∴ The pressure inside the new bubble

$$P = P + \frac{4T}{r}$$

Substituting for P, P_1 & P_2 in equation (1)

$$\left(P+\frac{4T}{r_1}\right)\frac{4}{3}\pi r_1^3+\left(P+\frac{4T}{r_2}\right)\frac{4}{3}\pi r_2^3=\left(P+\frac{4T}{r}\right)\frac{4}{3}\pi r^3$$

or $$\frac{4}{3}\pi P(r_1^3+r_2^3-r^3)+\frac{16\pi T}{3}[r_1^2+r_2^2-r^2]=0$$

Given change in volume,

$$V=\frac{4}{3}\pi r_1^3+\frac{4}{3}\pi r_2^3-\frac{4}{3}\pi r^3 \qquad ...(3)$$

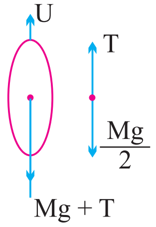
Change in Area

$$4\pi r_1^2+4\pi r_2^2-4\pi r^2 \qquad ...(4)$$

Using equation (3) and (4) in (2), we get

$$PV+\frac{4T}{3}A = 3\ PV+4TA=0$$

82. Free block diagram of balloon and block shown below :



When the balloon is held stationary in air, the forces acting on it get balance

Up thrust = Wt. of Balloon + Tension in string

$$U = Mg + T$$

M for the small block of mass $\frac{M}{2}$ floating stationary in air

$$T = \frac{M}{2}g$$

$$\therefore \qquad U = Mg+\frac{M}{2}g=\frac{3}{2}Mg$$

When the string is cut T = 0, the small block begins to fall freely, the balloon rises up with an acceleration '*a*' such that

$$U-Mg = Ma$$

$$\frac{3}{2}Mg - Mg = Ma$$

$$a = \frac{g}{2} \text{ in the upward direction.}$$

83. (i) As the two vessels have liquid to same height and the vessels have same base area, the force exerted = pressure × base area will be same as pressure

$$= h\,p\,g.$$

(ii) Since the volume of water in vessel 1 is greater than in vessel (2) the weight of water = volume × density × *h*, so weight of first vessel will be greater than the water in second vessel.

84. Radius of larger drop $= \frac{D}{2}$

Radius of each small drop= r

$$27 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(\frac{D}{2}\right)^2 \Rightarrow r = \frac{D}{6}$$

Initial surface area of large drop $4\pi\left(\frac{D}{2}\right)^2 = \pi D^2$

Final surface area of 27 small drop

$$= 27 \times 4\pi r^2 = 27 \times 4\pi\frac{D^2}{36} = 3\pi D^2$$

$\therefore$ Change in energy = Increase in area × σ

$$= 2\pi D^2\sigma$$

87.

$$I_1^1 = I_1\,[1 + \alpha_1\,(t_2 - t_1)]$$

$$I_2^1 = I^1\,[1 + \alpha_2\,(t_2 - t_1)]$$

Given that the difference in their length remain constant

$$\therefore \quad I_2^1 - I_1^1 = I_2 - I_1$$

$$I_2\,[1 + \alpha_2\,(t_1 - t_1)] - I_1\,[1 + \alpha_1\,(t_2 - t_1)] = I_2 - I_1$$

$$\therefore \quad I_2\alpha_2 = I_1\alpha_1$$

90. Here $I = 1.8$ m, $t_1 = 27°C$, $t_2 = -39°C$

$$r = \frac{2.0}{2} = 1.0 \text{ mm} = 1.0 \times 10^{-3} \text{ m}$$

$$r = 2.0 \times 10^{-5} \text{ °C}^{-1}, Y = 0.91 \times 10^{11} \text{ Pa}$$

As $$\Delta I = I\alpha(t_2 - t_1)$$

∴ Strain, $$\frac{\Delta I}{I} = \alpha(t_2 - t_1)$$

Stress = Strain × Young's modulus = $\alpha(t_2 - t_1) \times Y$

$= 2.0 \times 10^{-5} \times (-39 - 27) \times 0.91 \times 10^{11} = 1.2 \times 10^{8}$ Nm^{-2}

[Numerically]

Tension developed in the wire = Stress × Area of cross-section

= Stress × $pr^2 = 1.2 \times 10^8 \times 3.14 \times (1.0 \times 10^{-3})^2 = 3.77 \times 10^2$ N .

96. Definition of coefficient of thermal conductivity.

In steady state the heat passing in unit time through the rod remain same that is

$$\frac{Q}{t} = \frac{K_1A(T_1 - T)}{d_1} = \frac{K_2A(T - T_2)}{d_2} = \frac{KA(T_1 - T_2)}{d_1 + d_2}$$

where k is the coefficient of thermal conductivity

Also $$T_1 - T_2 = (T_1 - T) + (T - T_2)$$

∴ $$\frac{d_1 + d_2}{kA} = \frac{d_1}{K_1A} + \frac{d_2}{K_2A}$$

∴ $$\frac{d_1 + d_2}{kA} = \frac{d_1}{K_1} + \frac{d_2}{K_2} = \frac{K_2d_1 + K_1d_2}{K_1K_2}$$

∴ $$K = \frac{K_1K_2(d_1 + d_2)}{K_2d_1 + K_1d_2}$$

ANSWERS FOR NUMERICALS

106. (a) Stress $= \frac{F}{A} = \frac{mg}{\pi r^2} = \frac{40 \times 10}{\pi \times (1 \times 10^{-3})^2} = 1.27 \times 10^8\ N/m^2$

(b) $\Delta L = \frac{FL}{AY} = \frac{40 \times 10 \times 1}{\pi \times (1 \times 10^{-3})^2 \times 7 \times 10^{10}} = 1.8 \times 10^{-3}\ m$

(c) Strain $= \frac{\Delta L}{L} = \frac{1.8 \times 10^{-3}}{1} = 1.8 \times 10^{-3}$

(d) $F = Kx = K\Delta L$, K = Force constant

$K = \frac{\Delta F}{L} = \frac{40 \times 10}{1.8 \times 10^{-3}} = 2.2 \times 10^5\ N/m$

107. Pressure exerted at the bottom layer by water column of height h is

$$P = h\rho g = 2500 \times 1000 \times 10$$
$$= 2.5 \times 10^7\ N/m^{-2}$$
$$= \text{Stress}$$

Bulk modulus $K = \frac{\text{Stress}}{\text{Strain}} = \frac{P}{\Delta V/V}$

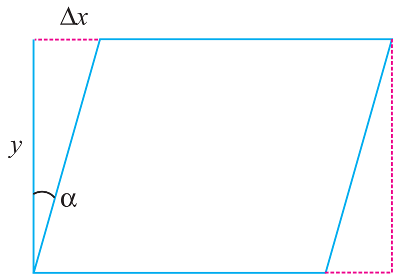
$$\frac{\Delta V}{V} = \frac{P}{K} = \frac{2.5 \times 10^7}{2.3 \times 10^9} = 1.08 \times 10^{-2}$$
$$= 1.08\%$$

108. Area A of the upper face $= (0.30)^2\ m^2$

The displacement Δx of the upper face relative to the lower one is given by

$$\Delta x = \frac{yF}{\eta A}, \quad \therefore \eta = \frac{F/A}{\Delta x / y}$$

$$\frac{0.30 \times 5 \times 10^3}{8.3 \times 10^{10} \times (0.30)^2} = 2 \times 10^{-7}\ m$$



∴ Angle of shear α is given by

$$\tan\alpha = \frac{\Delta x}{y}$$

$$\alpha = \tan^{-1}\left(\frac{\Delta x}{y}\right)$$

$$= \tan^{-1}\left(\frac{2\times10^{-7}}{0.30}\right) = \tan^{-1}(0.67\times10^{-6})$$

109. $V = 1 \text{ litre} = 10^{-3}\ m^3$

$$\frac{\Delta V}{V} = 0.10\% = \frac{0.10}{100} = 0.001$$

$$K = \frac{P}{\Delta V/V} \Rightarrow P = \frac{K\Delta V}{V} = 2.2\times10^9\times0.001$$

$$P = 2.2\times10^6\ Nm^{-2}$$

110. Pressure at a depth of 10 m $= h\rho g$

$$= 10\times1030\times10 = 1.03\times10^5\ N/m^2$$

ATM. pressure $= 1.01\times10^5$ pa.

Total pressure at a depth of 10 m $= 1.03\times10^5 + 1.01\times10^5$

$$= 2.04\times10^5 \text{ pa}$$

111. $$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_1 = F_2\frac{A_1}{A_2} = F_2\left(\frac{\pi r_1^2}{\pi r_2^2}\right)$$

$$F_1 = 1350 \times 9.8 \left(\frac{5 \times 10^{-2}}{15 \times 10^{-2}} \right)^2$$

$$= 1470 \text{ N.}$$

112. (i) When man is lying $P = \frac{F}{A} = \frac{80 \times 9.8}{0.6} = 1.307 \times 10^3 \text{ N/m}^{-2}$

(ii) When man is standing then $A = 2 \times 80 \text{ cm}^2 = 160 \times 10^{-4} \text{ m}^2$

$$P = \frac{80 \times 9.8}{160 \times 10^{-4}} = 4.9 \times 10^4 \text{ Nm}^{-2}$$

113. (a) Pressure Instructed by manual = $P_g = 200 \text{ K } P_a$

(b) Absolute Pressure = $101\ k\,P_a + 200\ k\,P_a = 301\ k\,P_a$

(c) At mountain Peak Pa' is 10% less

$$P_a' = 90\ k\,P_a$$

If we assume absolute pressure in tyre does not change during driving then

$$P_g = P - P_a' = 301 - 30 = 211\ k\,P_a$$

So the tyre will read 211 $k\,P_a$, pressure.

114. Excess pressure in soap bubble = $p = \frac{4T}{r} = \left(\frac{4 \times 0.58}{6 \times 10^{-3}} \right)$

$$= 387 \text{ Nm}^{-2}$$

115.

$$v_t = \frac{2}{9} \left[\frac{g(\sigma - \rho) r^2}{\eta} \right]$$

$$\eta = \frac{2}{9} \left[\frac{9.8 \times (8.9 \times 10^3 - 1.5 \times 10^3)(2 \times 10^{-3})^2}{6 \times 10^{-2}} \right]$$

$$= 1.08 \text{ kg m}^{-1} \text{ s}^{-1}$$

116. From Torricelli theorem, velocity of efflux

$$\upsilon = \sqrt{2gh}$$

$$= \sqrt{2 \times 10 \times 0.2}$$

$$= 2 \text{ m/s}$$

117. Surface energy per unit area is equal to surface tension.

$$\begin{aligned} E &= \text{increase in surface area} \times ST \\ &= 4\pi\,(2^2 - 1^2) \times 2.5 \\ &= 4\pi \times 3 \times 2.5 \\ &= 1.02 \times 10^3 \text{ erg} \end{aligned}$$

118.

$$\begin{aligned} F &= \eta A \frac{dv}{dy} \\ &= 0.01 \times 0.2 \times \frac{0.1}{0.003} = 66.7 \times 10^{-3}\,\text{N} \end{aligned}$$

119. Since $A_1 v_1 = A_2 v_2$

$$v_2 = \frac{2 \times 4 \times 10^{-4}}{2 \times 10^{-4}} = 4\,\text{m/s}$$

Using Bernoulli's Theorem

$$P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2) + \rho g(h_1 - h_2)$$

$\therefore$ $v_2 > v_1$

$h_2 > h_1$

$$= 3 \times 10^5 + \frac{1}{2}(1000)[(2)^2 - (4)^2] - 1000 \times 9.8 \times 8$$

$$= 2.16 \times 10^5\ \text{N/m}^2$$

120. The volume of liquid flowing in time t through a capillary tube is given by

$$V = Qt = \frac{\pi P r^4 t}{8\eta l} = \frac{\pi h \rho g r^4 t}{8\eta l}$$

$\therefore$ For Water,

$$V_1 = \frac{\pi h \rho_1 g r^4 t_1}{8 l \eta_1}$$

For Petrol,

$$V_2 = \frac{\pi h \rho_2 g r^4 t_2}{8 l \eta_2}$$

But $V_1 = V_2$

$$\therefore \quad \frac{\pi h \rho_1 g r^4 t_1}{8 l \eta_1} = \frac{\pi h \rho_2 g r^4 t_2}{8 l \eta_2}$$

or $$\frac{t_1}{t_2} = \frac{\eta_1}{\eta_2}\times\frac{\rho_1}{\rho_2} = \frac{0.01}{0.02}\times\frac{0.8}{0.02} = 0.4$$

121. Breaking stress = Maximum stress that the wire can withstand

$$= 7.8 \times 10^9 \text{ Nm}^{-2}$$

When the wire is suspended vertically, it tends to break under its own weight.

Let its length be I and cross-sectional area A.

$$\text{Weight of wire} = mg = \text{volume} \times \text{density} \times g = Al\rho g$$

$$\text{Stress} = \frac{\text{Weight}}{A} = Al\rho g/A = l\rho g$$

For the wire not to break, $l\rho g$ = Breaking stress = 7.8×10^9 Nm^{-2}

$$\therefore \quad l = \frac{7.8\times10^9}{\rho g} = \frac{7.8\times10^9}{7.8\times10^3\times10} = 10^5 \text{ m.}$$

122. By Wein's Displacement Law

$$\lambda_m T = \lambda'_m T'$$

$$\frac{T}{T'} = \frac{\lambda'_m}{\lambda_m} = \frac{4.8\times10^{-7}}{3.6\times10^{-7}}$$

$$= \frac{4}{3}$$

123. $$\frac{F-32}{180} = \frac{T-273}{100}$$

$$\frac{149-32}{180} = \frac{T-273}{100} \Rightarrow \frac{117}{9} = T-273$$

$$T = 286\ k$$

124. $m_1c_1(\theta_1 - \theta) = m_2c_2(\theta - \theta_2)$

$$\therefore \quad c_2 = 1 \text{ cal/gm}^{\circ}\text{C}$$

$$\therefore \quad 50 \times 0.6 \times (120-\theta) = 1.6 \times 10^3 \times 1 \times (\theta - 25)$$

$$\theta = 26.8^{\circ}\text{C}$$

125.

$$d_2 = d_1 [1 + \alpha \Delta t]$$

$$5.243 = 5.231 [1 + 1.2 \times 10^{-5} (T - 30)]$$

$$\left[\frac{5243}{5231} - 1\right] = 1.2 \times 10^{-5} (T - 300)$$

$$T = 191 + 300 = 491\ k = 218°C$$

126. ice at 0° C → water at 0° C → water at 6° C

$$m_1 c_1 (80 - 6) = m_2 L + m_2 c_2 (6 - 0)$$

$$100 \times 1 \times 74 = 100\ L + 100 \times 1 \times 6$$

$$L = (1 \times 74) - 6$$

$$= 68 \text{ cal/g.}$$

127. Heat required to convert H_2O at 0° to H_2O at 100° $= m_1 c_1 t$

$$= 30 \times 4186 \times 100$$

$$= 1255800 \text{ J}$$

Heat required to convert H_2O at 100°C to steam at 100°C is = mL

$$= 3 \times 2.256 \times 10^6$$

$$= 6768000 \text{ J}$$

$$\text{Total heat} = 8023800 \text{ J}$$

128.

$$\text{Thermal stress} = K x \text{ strain} = \frac{K\Delta V}{V}$$

Now,

$$\gamma = \frac{\Delta V}{V\Delta T} \text{ or } \frac{\Delta V}{V} = \gamma \Delta T$$

$$\text{Thermal stress} = K\gamma\Delta T = 3K\alpha\Delta T \qquad [\because \gamma = 3\alpha]$$

$$= 3 \times 140 \times 10^9 \times 1.7 \times 10^{-5} \times 20$$

$$= 1.428 \times 10^8 \text{ Nm}^2$$

HINTS AND SOLUTION (MCQ)

131. (c) Longitudinal & shear.

132. (d) Breaking force = breaking stress × area of cross section of wire ie it is independent of length of its wire till area of cross-section of wire is constant.

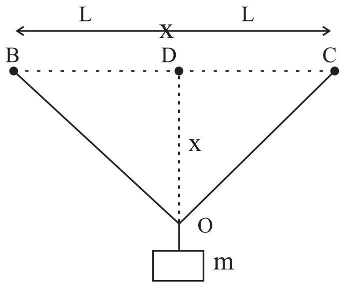
133. (b)

$$Y = \frac{F}{\pi\left(\frac{D}{2}\right)^2} \times \frac{1}{\left(\frac{\Delta\ell}{\ell}\right)} = \frac{4F\ell}{\pi D^2 \Delta\ell}$$

$$\Rightarrow D = \sqrt{\frac{4F\ell}{\pi \Delta\ell Y}} \quad \text{or} \quad D \propto \sqrt{\frac{1}{Y}}$$

$$\text{Hence } \frac{D \text{ copper}}{D \text{ iron}} = \sqrt{\frac{Y \text{ iron}}{Y \text{ copper}}}$$

134. (a) Increase in length = BO+ OC – BC



or $\Delta L = 2BO - 2L$

$$\Delta L = 2\,(L^2 + x^2)^{1/2} - 2L$$

$$\Delta L = 2L\left[1 + \frac{x^2}{L^2}\right]^{1/2} - 2L$$

$$\Delta L = 2L\frac{x^2}{2L^2} = \frac{x^2}{L^2}$$

$$\text{So strain} = \frac{\Delta L}{2L} = \frac{x^2}{L \times 2L} = \frac{x^2}{2L^2}$$

135.(a&d) Ideal liquid does not compress easily $\Delta V = 0$ so β & α. A liquid cannot sustain tangential force i.e. strain is infinite for a shear stress Hence G = 0.

136.(c&d) From graph it is clear that ultimate strength of the material (ii) is greater than that of material (i). Therefore the elastic behaviour of material (ii) is over a larger region of strains as compared to material (i).

If the fracting point E is closer to ultimate strength point, than the material is brittle.

137. (c) When a round pebble is dropped from the top of a tall cylinder, filled with viscous oil the pebble acquires terminal velocity after some time. Hence option (c) correct.

138. (a) According to Equation of continuity

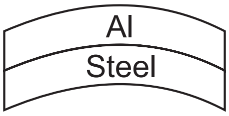
$$a_1 v_1 = a_2 v_2$$

or

$$\frac{v_1}{v_2} = \frac{a_2}{a_1} = \frac{\pi d_2^2/4}{\pi d_1^2/4} = \left(\frac{d_2}{d_1}\right)^2 = \left(\frac{13.75}{2.5}\right)^2 = \frac{9}{4}$$

139. (c) Meniscus is convex upwards if angle contact is obtuse.

140. (d) Give $\alpha_{Al} > \alpha_{steel}$ so on heating aluminum strip will expander more than that of steel strip. So aluminum strip will bead more on convex side & steel strip on concave side.



141. (b) When a metallic rod is heated it expands. Its M.I about perpendicular bisector increases. So according to Law of conservation of angular Momentum, its angular speed (w) decrease. as $I_1 \omega_1 = I_2 \omega_2$.

142. (a) With increase in temperating; the effective length (ℓ) of the simple pendulum increases even though its CM still remains at the centre of bub. So As $T = 2\pi\sqrt{\frac{l}{g}}$ or $T \alpha \sqrt{\ell}$ so T increases as temperature increase.

143.(a&d) In the given graph, the region AB represents no change the temperature with time. It means ICE & water are in thermal equilibrium.

144. (c) From I[st] observation :

$$\alpha = \frac{\Delta\ell}{\ell\,\Delta T} = \frac{4\times 16^{-4}}{2\times 10} = 2\times 10^{-5}\ °C^{-1}$$

So From 2[nd] observation $= \Delta\ell = \alpha\,\ell\,\Delta T = (2\times 10^{-5})\times 1\times 10 = 2\times 10^{-4}$ m (Incorrect)

From 3[rd] observation $= \Delta\ell = \alpha\,\ell\,\Delta T = (2\times 10^{-5})\times 2\times 20 = 8\times 10^{-4}$ m (Incorrect)

From 4[th] observation $= \Delta\ell = \alpha\,\ell\,\Delta T = (2\times 10^{-5})\times 3\times 10 = 6\times 10^{-4}$ m (Correct)

145. (b) $B = \frac{P}{(\Delta v / v)}$ or $\frac{\Delta v}{v} = \frac{P}{B}$

$\frac{\Delta v}{v} = h\rho g \times K$ as $p = h\rho g$, $B = \frac{1}{K}$

$\frac{\Delta v}{v} = 2700 \times 10^3 \times 9.8 \times 45.4 \times 10^{-11}$

$= 1.2 \times 10^{-2}$

146. (c) Here $Y_S = 2Y_B$, $\frac{Y_S}{Y_B} = \frac{2}{1}$

Let W_S & W_B the weights hanged to steel & brass wires

$\ell_S = \ell_B = \ell$; $A_B = A_S = A$, $\Delta\ell_S = \Delta\ell_B = \Delta\ell$

$Y = \frac{W\ell}{A\Delta\ell}$ or $\Delta\ell = \frac{W\ell}{AY}$

as $\Delta\ell_S = \Delta\ell_B$

$\therefore \frac{W_S\,\ell}{AY_S} = \frac{W_B\,\ell}{AY_B}$

$\frac{W_S}{W_B} = \frac{Y_B}{Y_B} = \frac{2}{1}$

147. (c) Expansion in the rod due to rise in temp = Compression in rod.

For the first rod $\Delta\ell_1 = \alpha_1\,\ell_1\,\Delta\theta$

Compression in the rod $\Delta\ell_1 = \frac{-F}{A}\frac{\ell_1}{Y_1}$

or the length of the rod remains unchanged

$\alpha_1\,\ell_1\,\Delta\theta = \frac{-F\,\ell_1}{A\,Y_1}$

or

$\alpha_1\,\Delta\theta = \frac{-F}{A\,Y_1}$ --- (i)

Similarly for second rod

$\alpha_2\,\Delta\theta = \frac{-F}{A\,Y_2}$ --- (ii)

$\frac{\alpha_1}{\alpha_2} = \frac{Y_2}{Y_1}$ or $\frac{Y_1}{Y_2} = \frac{\alpha_2}{\alpha_1} = \frac{3}{2}$

148. (a) As slope of the graph $\propto$ Young's Modules

149. (c) As we know $\frac{d\theta}{dt} \propto (T_2 - T_1)$ or $\frac{d\theta}{dt} = K(T_2 - T_1)$

Case (i) $\frac{d\theta_1}{dt} = k(110-100) = k \times 10$ ---(i)

Case (ii) $\frac{d\theta_2}{dt} = k(210-200) = k \times 10$ ---(ii)

From (i) & (ii) $\frac{d\theta_1}{dt} = \frac{d\theta_2}{dt} = 4.0 \text{ J/s}$

150. (d) Heat gain by water = heat loss by steam

$20 \times 1 \times (80 - 100) = m \times 540 + m \times 1 \times (100 - 80)$

$1400 = 560\ m$

$m = \frac{1400}{560} = 2.5\ g$

Total mass of water = 20 + 2.5 = 22.5 g

ASSERTION - REASON BASED ANSWERS

1. (b)	2. (b)	3. (d)	4. (b)	5. (a)	6. (a)
7. (a)	8. (a)	9. (a)	10. (c)	11. (a)	12. (a)
13. (b)	14. (a)	15. (a)	16. (c)	17. (a)	18. (a)

SOLUTION

1. (b) The size of balloon increase because outside pressure is extremely low at high attitudes. So volume increases, but reason is not the correct explanation of assertion.

2. (b) Both are true but reason is not correct explanation of the assertion.

3. (d) An ideal rigid body with definite and unchanging shape.

4. (b) In gases, sound waves are always longitudinal because gases cannot sustain shearing strain.

5. (a) In rigid body size and shape of the body remains same.

6. (a) both statements are true.

7. (a) both statements are true.

8. (a) due to alternating strains, it losses it's elastic strength. Due to which the amount of strain in the bridge for given strain becomes large and ultimately, the bridge may collapse.

9. (a) $$y = \frac{\text{stress}}{\text{strain}}, \qquad \text{stress} = \frac{\text{restoring force}}{\text{area}}$$

As restoring force is zero. i.e. y = 0

10. (c) Strain is the ratio of change in dimensions of the body to the original dimensions. Because this is a ratio, therefore it is dimensionless quantity.

11. (a) Height of the blood column in the human body is more at feet than the brain as $p = heg$, therefore the blood exerts more pressure at the feet than at the brain.

12. (a) In stream line flow of a liquid, according to equation of continuity, av = constant, where 'a' is area of cross-section and 'v' is velocity. So, as area of cross-section decreases, therefore the velocity 'u' of water increases.

13. (b) As a man jumps out from a height in air with a parachute, it's velocity increases first because the gravity pull dominates the viscous drag and buoyancy of air which opposes the motion. As the velocity increases, the viscous drag of air also increases and soon a stage is reached where viscous drag and buoyancy of air balances the gravity pull. Then the man with a parachute falls with constant velocity called terminal velocity.

14. (a) According to Bernoulli's theorem, $P + \frac{1}{2}\rho v^2$ = constant.

i.e. when velocity is large, the pressure is less in a stream line flow of an ideal fluid through a horizontal tube.

15. (a)

16. (c) When two holes are made in the tin, air keeps on entering through the other hole. Due tot this pressure inside the tin does not become less than atmospheric pressure which happens if only one hole is made.

17. (a)

18. (a) The height of capillary rise is inversely proportional to radius of capillary tube i.e. $h \propto \frac{1}{r}$

So for smaller 'r' the value of 'h' is higher.

CASE STUDY BASED ANSWERS

1. i. (d)
   ii. (b)
   iii. (d)
   iv. (d)
   v. (c)

2. i. (d)
   ii. (c)
   iii. (a)
   iv. (d)
   v. (b)

3. i. (c)
   ii. (d)
   iii. (b)
   iv. (a)
   v. (b)

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