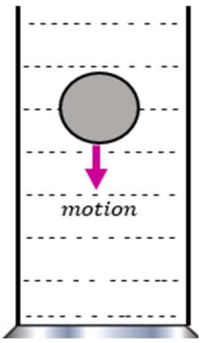
d. A parachutist with mass of 80Kg is undergoing a free fall. The viscous force applied to him is $F = kv^2$, where v is the velocity measured relative to the air. If the value of the constant $k = 0.27Ns^2m^{-2}$, find the terminal velocity of the parachutist. 2

e. Castor oil at 20° C has a coefficient of viscosity 2.42 Nsm^{-2} and a density 940 kgm^{-3}. Calculate the terminal velocity of steel ball of radius 2.0 mm falling under gravity in the oil, taking the density of steel as 7800 kgm^{-3}. [Ans: 0.025 ms^{-1}]

13. a. Define terminal velocity?
    b. What is the nature of graph between terminal velocity of a spherical body and the square of its radius?
    c. Two metal sphere of different diameter are dropped into a viscous liquid at a time, which one reaches the bottom fast?
14. Two spherical rain drops of equal size are falling vertically through air with a terminal velocity of 0.150 ms^{-1}. What would be the terminal velocity if these two drops were to coalesce to from a larger spherical drop? [Ans: 0.238 ms^{-1}]
15. A sphere of radius 'a' moving through a fluid of density ρ with high velocity v experiences a retarding force F given by $F=ka^x \rho^y v^z$, where k is a non-dimensional coefficient. Use the method of dimensions to find the values of x, y and z [Ans: 2, 1, 2]
16. The experiment on viscosity in your physics laboratory, when you drop spherical steel balls in a glycerin medium, the downward acceleration is greatly reduced, and finally gains the terminal velocity.



    a. What is terminal velocity? 1
    b. What is the reason behind the decrease in downward acceleration? Explain with number of possible forces acting on the ball. 2
    c. Drive the expression for the terminal velocity. Explain how it is related to the coefficient of viscosity of glycerin. 3
    d. If two steel balls of 5 mm and 6 mm diameters are dropped at the same time in glycerin, find which one ball reaches the bottom first why that happens? Compare the terminal velocity of the balls. 2

Poiseuille's formula

17. a. Using dimensional considerations, deduce Poiseuille's formula for the flow of a liquid through capillary tube.
    b. A liquid flows through a pipe of 10^{-3} m radius and 0.1 m length under a pressure of 10^{-3} Nm^{-2}. Calculate the rate of flow and speed of the liquid coming out of the pipe. The coefficient of viscosity of the liquid is 1.25 x 10^{-3} Deca poise. [Ans:1 ms^{-1}]

Poiseuille's formula + Continuity equation + Bernoulli's theorem

18. Water is flowing in a pipe with a varying cross-sectional area, and at all points the water completely fills the pipe. At point one the cross-sectional area of the pipe is 0.070 m^2, and the magnitude of the fluid velocity is 3.50 ms^{-1}. (a) What is the fluid speed at points in the pipe where the cross-sectional area is (i) 0.150 m^2? (i) 0.047 m^2? (b) Calculate the volume of water discharged from the open end of the pipe in 1.00 hour. [Ans: 1.63 ms^{-1} 5.21 ms^{-1}, 882 m^3 h^{-1}]

[Hint: Volume rate of liquid discharged, $\frac{V}{t} = A \times v$]

19. Water is flowing in a circular pipe with varying cross-sectional area, and at all points the water completely fills the pipe. At one point in the pipe, the radius is 0.150 m. What is the speed of the water at this point if the volume flow rate in the pipe is 1.20 m^3s^{-1}? [Ans: 17.0 ms^{-1}]