

**10. MECHANICS OF FLUIDS**

1. State Pascal's law - Use the law to explain working of a hydraulic press.
2. With an example explain the difference between actual pressure and gauge pressure.
3. What is buoyant force?
4. State Bernoulli's principle - Derive the expression and state all assumptions made.
5. Define the terms viscosity and coefficient of viscosity.
6. Derive an expression for terminal velocity of a sphere of radius  $a$  and mass density  $\rho$  that falls through a fluid of viscosity  $\eta$ .
7. Define surface tension.
8. Show that excess pressure in a bubble of radius  $r$  is  $\rho_2 - \rho_1 = \frac{4T}{r}$  where  $T$  is the surface tension of liquid of bubble.
9. Derive an expression for the height to which a liquid rises in a capillary tube of radius  $r$ , when angle of contact is  $\theta$ .
10. A barrel contains a 0.15 m layer of oil floating on water that is 0.30 m deep. The density of oil is  $600 \text{ kg/m}^3$ .
  - (a) What is the gauge pressure at the oil-water interface?
  - (b) What is the gauge pressure at the bottom of the barrel?
11. The piston of a hydraulic automobile lift is 0.3 m in diameter. What pressure is required to lift a car with a mass of 800 kg?
12. An ore sample weighs 15N in air. When the sample is suspended by a light cord and totally immersed in water, the tension in the chord is 10.8N. Find the total volume and the density of the sample.
13. Find the excess pressure at  $20^\circ \text{C}$  a) inside a large raindrop with radius 1.0mm b) inside a water droplet in fog, with radius 0.01mm given  $T$  for water  $= 72.8 \times 10^{-3} \text{N/m}$ .
14. Water is flowing in a circular pipe of varying cross sectional area, and at all points water completely fills the pipe. a) At one point in the pipe the radius is 0.2m. What is the magnitude of the water velocity at this point if the volume flow rate in the pipe is  $1.20 \text{ m}^3/\text{s}$ ? b) At a second point in the pipe the water velocity has a magnitude of  $3.8 \text{ m/s}$ . What is the radius of the pipe at this point?
15. Air streams horizontally past a small airplane's wings such that the speed is  $70.0 \text{ m/s}$  over the top surface and  $50.0 \text{ m/s}$  past the bottom surface. If the plane has a mass of 700 kg and a wing area of  $9.0 \text{ m}^2$ , what is the net vertical force on the airplane? Density of air is  $1.20 \text{ kg/m}^3$ .
16. In Millikan's oil drop experiment, what is the terminal speed of an uncharged drop of radius  $2 \times 10^{-5} \text{ m}$  and density  $1.2 \times 10^3 \text{ kg/m}^3$ . Take the viscosity of air at the temperature of the experiment to be  $1.8 \times 10^{-5} \text{ Pa.s}$ . How much is the viscous force on the drop at that speed? Neglect buoyancy of the drop due to air.

17. a) What is the largest average velocity of blood flow in an artery of radius  $2 \times 10^{-3} \text{ m}$  if the flow must remain laminar?  
b) What is the corresponding flow rate?  
Given density of blood =  $1.6 \times 10^3 \text{ kg m}^{-3}$   
Viscosity of blood =  $2.084 \times 10^{-3} \text{ Pa.s}$