Viscosity

10. a. Why stirred liquid comes to rest after some time? 1
    b. A square metal plate of 10cm side moves parallel to another plate with a velocity of $10cms^{-1}$, both plates immersed in water. if the viscous force is 200dyne and viscosity of water is 0.01 poise, what is their distance apart? [0.05cm] 2
    c. A flat plate of area $0.1m^2$ is placed on a flat surface and is separated from it by a film of oil 10^{-5}m thick whose coefficient of viscosity is $1.5Nsm^{-2}$. Calculate the force required to cause the plate to slide on the surface at a constant speed of $1mms^{-1}$. [15N] 2
    d. There is a $1\ mm$ thick layer of glycerin between a flat plate of area $100cm^2$ and a big plate. If the coefficient of viscosity of glycerin is $1\ Kg/(ms)$, then how much force is required to move the plate with a velocity of $7\ cm/S$? 2

11. a. What is meant by streamline flow? Two streamlines can't cross each other. Why? 2
    b. State and explain the equation of continuity in fluid dynamics. 2
    c. Water is flowing in a non-uniform tube. At a point the radius is x cm and velocity is v cm/s. Write how can you determine the velocity of water at another point? Mention the principle involved here. 2
    d. Write down Newton's formula for viscosity. Write the unit and dimension of the coefficient of viscosity. 2
    e. A metal plate of area $2.5cm^2$ is placed on a $0.25 \times 10^{-3}\ m$ thick layer of castor oil at 20°C. If a force of $2.5N$ is needed to move the plate with a velocity $3 \times 10^{-2}\ m/s$, calculate the coefficient of viscosity of castor oil. 3

12. a. Write Poiseuille's equation. Is the formula applicable for an ideal fluid? Explain. 2
    b. Using dimensional considerations, deduce Poiseuille's formula for the flow of a liquid through capillary tube. 2
    c. Glycerin flows steadily through a horizontal tube of length $1.5m$ and radius $1cm$. If the amount of glycerin collected per second at one end is $4.0 \times 10^{-3}Kgs^{-1}$, what is the difference between the two ends of the tube? (Density of glycerin $= 1.3 \times 10^3 Kgm^{-3}$ and viscosity of glycerin$= 0.83\ Nsm^{-2}$). 2
    d. Water flows steadily through a horizontal pipe of varying cross-section at the rate of 20 liters per minute. Determine the velocity of water at a point where diameter is $4cm$. 2

[Hint: Rate of flow: $V = Av$]

$Volume = A \times l \qquad \therefore \frac{Volume}{time} = \frac{A\ l}{t} \implies$ **Volume rate:** $V = A \times v$

    e. In giving a patient a blood transfusion, the bottle is set up so that the level of blood is 1.3m above needle, which has an internal diameter of 0.36mm and is 3 cm in length. If 4.5 cm^3 of blood passes through the needle in one minute, calculate the viscosity of blood. The density of blood is $1020kgm^{-3}$. 2
    f. A hose pipe of diameter 1cm is 20cm long. The pressure difference between the ends of the pipe is 6.5×10^{-4} Nm^{-2}. Calculate the volume of water flow per second. (Viscosity of water = $10^{-3}NSm^{-2}$) 2
    g. Two tube A and B of length 200cm and 50cm have radii 0.2 mm and 0.4mm respectively. If a liquid passing through the two tubes is entering A at a pressure of 90 cm of mercury and leaving B at a pressure 76 cm of mercury, determine the pressure at the junction of A and B. 3
    h. Glycerin flows steadily through a horizontal tube of length $1.5m$ and radius $1cm$. If the amount of glycerin collected per second at one end is $4.0 \times 10^{-3}Kgs^{-1}$, what is the difference between the two ends of the tube? (Density of glycerin $= 1.3 \times 10^3 Kgm^{-3}$ and viscosity of glycerin$= 0.83\ Nsm^{-2}$). 2

13. a. The diameter of water falling from a tap can be observed decreasing as it falls towards the ground, why? Explain this on the basis of suitable principle. 2
    b. Plot the graph of variation of velocity with cross section area of water flow. 1
    c. Two spherical raindrops of equal size fall vertically through the air with a specific terminal velocity. If these two drops were to coalesce to form a single drop and fall with a new terminal velocity, explain how the terminal velocity of the new drop compares to the original terminal velocity. 2