Viscosity of liquid

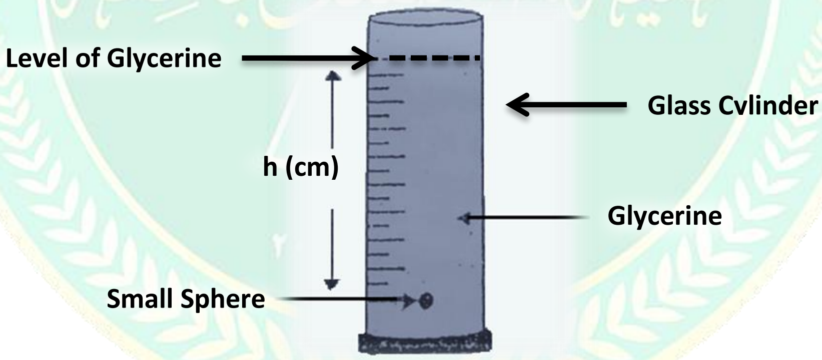
Purpose: To determine the viscosity of medium by using a small sphere falls with a constant terminal velocity.

Apparatus:

1. A long glass tube about (50 cm) long closed at one end.
2. Glycerine.
3. Meter scale.
4. Small sphere.
5. Rubber bands.
6. Magnet.
7. Stop-Watch.

Method:

1. Adjust the distance between the rubber bands.
2. Record the distance (h) between them (About 30 cm).
3. Drop a sphere centrally down the tube and with stop-watch find the time it takes to traverse the distance between the rubber bands.
4. Obtain two values of the time of fall.
5. Repeat the experience for the different values of (h) and obtain two values of the time of fall for each new distance apart.



Readings:

Distance between the rubber bands h (cm)	Time of fall		
	T1 (Sec)	**T2** (Sec)	T mean (Sec)

Plot a graph with value of (h cm) as ordinates against the corresponding values of T (Sec).

From the graph calculate the terminal velocity.

Slope = h/T = velocity (cm/sec).

To deduce the velocity (ɳ) for liquid, use the following equation:

$$\eta = \frac{g(\rho - \sigma).d^2}{18.V}$$

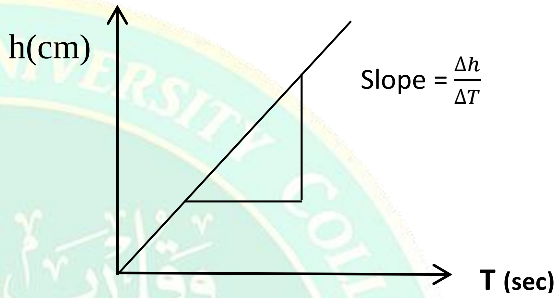
$g = 980$ cm/sec^2.

ρ = Density of sphere = 7.8 gm/cm^3.

σ = Density of liquid = 1.231 gm/cm^3.

d = Diameter of sphere.

V = Velocity (slope).



Medical Applications:

Equation is valid only for spherical particles, however we can use it as a guide to the behavior of particles with a more complicated shape.

In some forms of diseases such as rheumatic fever, rheumatic heart disease and gout, the red blood cells clump together and the effective radius increase, thus an increased sedimentation velocity occurs. In other diseases such as hemolytic jaundice and sickle cell anemia, the red blood cells change shape or break. The radius decreases, thus the rate of sedimentation of these cells is slower than normal. Determining the sedimentation rate of red blood cells is a simple routine clinical laboratory test.

A related medical test that also depends on Eq. is the determination of the hematocrit, the percent of red blood cells in the blood. Since the sedimentation velocity is proportional to the gravitational acceleration, it can be greatly enhanced if the acceleration is increased. We can increase (g) by means of a centrifuge, which provides an effective acceleration $g_{eff} = 4\mu^2 f^2 r$, where (f) is the rotation rate in revolutions per second and (r) is the position on the radius of the centrifuge where the solution is located.

Since the packing of the red blood cells takes place in the centrifuge, the hematocrit obviously depends upon the radius of the centrifuge and the speed and duration of centrifugation. The increase of any of these leads to more dense packing of the red blood cells or a smaller hematocrit. One standard method utilizes centrifugation for (30) min at (300) rpm with (r = 22 cm) a normal hematocrit is (40) to (60) a value lower than (40) indicates anemia, and a high value may indicate polycythemia vera.