# FALLING SPHERE VISCOMETER EXPERIMENT

**FALLING SPHERE VISCOMETER WITH KINEMATICS VISCOSITY MEASUREMENT**
(Falling sphere viscometer)

**The purpose of the experiment:** Viscosity of liquids will be measured using a falling sphere viscometer.

**Description:** The experimental set includes a specially prepared scaled cylinder with a diameter of 40 mm and spheres of two different diameters. Technical information about these spheres is given in the table below.

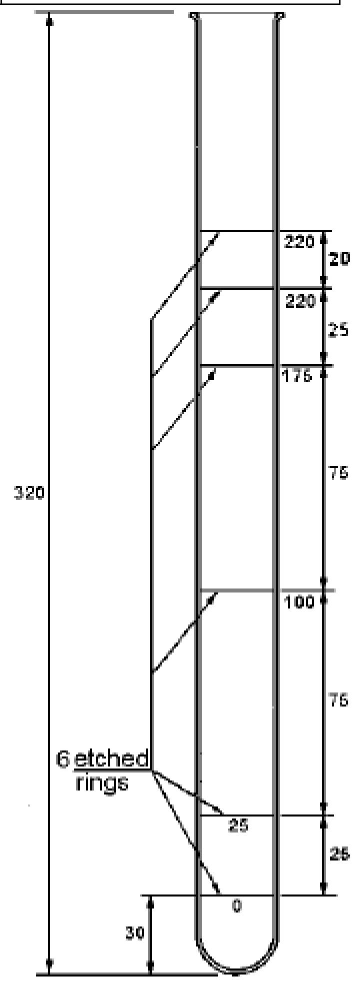
| TABLE: Technical details of the spheres used in the falling sphere viscometer | | | |
|---|---|---|---|
| Sphere diameter (inch) | Density | Mass | Measurement range |
| 1/16 " (1,588 mm) | 7,785 g/ml | 0.0163 g | 1000-37500 centistoke |
| 3/32 " (2,381 mm) | 7,785 g/ml | 0.055g | 2500-85000 centistoke |

**Conducting the experiment:**

- Fill the cylinder with the sample to be tested. While filling the sample, care should be taken not to allow air bubbles to enter the liquid.
- In order to minimize the effects of surface tension, impact, etc., the water level should exceed the uppermost mark (220 mm) by a few cm.
- Measure the water temperature using a suitable thermometer.
- Make sure the test tube is in a vertical position.
- Before using the spheres, clean the surface and moisten it a little with the sample.
- Take the stopwatch in your hand and slowly drop the beads one by one into the hole at the entrance of the tube with the help of tweezers and start taking measurements.
- Measure the time it takes for the spheres to travel a certain distance between two different gauges. The intervals to be measured can be taken as follows:

| |
|---|
| 25-175 mm |
| 0-200 mm |
| 175-100 mm (spheres lots if slow) |

- Repeat the test several times. Continue the experiment until two different tests with the same diameter give 0.5% close results.



All dimensions are in millimetres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- If measurements are inconsistent, the sample may be dirty or heterogeneous, or temperatures may not be consistent.
- After receiving the data, the kinematic viscosity can be calculated as follows:

$$v = \frac{d^2 g(\rho_s - \rho_f)}{18V\rho_f} x F$$

$$F = 1 - 2.104\frac{d}{D} + 2.09\left(\frac{d}{D}\right)^3 - 0.9\left(\frac{d}{D}\right)^5$$

$$F = 1 - 2.104\frac{d}{D} + 2.09\left(\frac{d}{D}\right)^3$$ (For faster results)

| Here; | | |
|---|---|---|
| m | Mass of the sphere | (g) |
| D | Diameter of the sphere | (mm) |
| ρs _ | Density of the sphere | (g/cm $^3$) |
| ρ f | Density of the sample | (g/cm $^3$) |
| V | Falling velocity | (mm/s) |
| g | Gravitational acceleration | mm/s $^2$ |
| F | Faxen factor (As the sphere moves, the test cylinder effect of the wall on the spheroid) | |
| D | Diameter of test cylinder | mm |
| v | Kinematic viscosity | mm $^2$/s |

**Note #1:** The Faxen factor was calculated as 0.9167 for small spheres (1/16") and 0.8751 for large spheres (3/32").

**Note #2:** You can find the dynamic viscosity value of fluids by multiplying the kinematic viscosity with the density value at the same temperature. You can calculate the density of the liquid as given in EXPERIMENT-2.

$$\mu = v\rho$$

| Diameter of the sphere: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Diameter of the cylinder: 40 mm | | | | | | | | | |
| **Measure** | **$H_{net}$** | **t** | **V** | **$\rho_s$** | **$\rho_f$** | **F** | **υ** | **υ** | **μ** |
| # | m | sn | m/s | g/cm³ | g/cm³ | | mm²/s | m²/s | Pa/s |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |


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**QUESTION:** Considering the weight of the sphere, the friction force between the sphere-fluid, the buoyant force of the fluid, etc.; Develop an equation for measuring viscosity.

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