

## Edexcel Physics IAL

# Core Practical 2: Use a Falling-Ball Method to Determine the Viscosity of a Liquid

## Practical Notes



## Core Practical 2: Use a Falling-Ball Method to Determine the Viscosity of a Liquid

### Equipment

- Transparent tube filled with washing up liquid
- Spherical objects of a variety of sizes
- Rubber bands
- Metre ruler
- Micrometer screw gauge
- Timer
- Mass balance

### Method

1. Use the mass balance to weigh each sphere and then measure its radius.
2. Calculate the volume of each sphere, and use this and its mass to calculate its density.
3. Attach three rubber bands along the length of the tube - the first should be far enough from the top so that the sphere has reached terminal velocity by the time it reaches it, and the lower two bands should be sufficiently spaced as to allow time intervals to be measured.
4. Place the first sphere into the top of the tube, and start the timer when it reaches the first band.
5. Press the lap function to mark the time that it reaches the second band, and then stop the timer when it reaches the third and final band.
6. If the times are suitable, measure and record the distances between the first and second bands and between the second and third bands.
7. Repeat this with the same sphere 3 times, and then carry out the same process with the other spheres.

### Calculations

- The volume of a sphere is calculated using:
  - $V = \frac{4}{3}\pi r^3$
- The density of a sphere is calculated using:
  - $\text{Density} = \text{Mass}/\text{Volume}$
- Calculate the terminal speed of each sphere between the first and second bands, and then the second and third bands and calculate an average value for each sphere
  - $\text{Speed} = \text{Distance between bands}/\text{Time taken to travel between bands}$



- Use all the recorded data to calculate the viscosity of the liquid using the following formula:
  - $\eta = 2r^2g(\rho - \sigma)/9v$ 
    - $\eta$  = viscosity
    - $\rho$  = density of the sphere
    - $\sigma$  = density of the liquid
    - $r$  = radius of the sphere
    - $v$  = terminal velocity of the sphere

### Notes

- To make retrieving the spheres from the bottom of the tube easier, use steel bearings as your spheres and use a magnet to lift them out.
- If the tubes available are quite short, only use two rubber bands and only measure one time interval.
- Position yourself at eye level to the bands so that the timing is as accurate as possible.
- Light gates wouldn't be an appropriate method of timing for this experiment since the liquid is coloured and the low light levels will make timing unreliable.

### Safety Precautions

- Washing up liquid can be slippery so clean up any spillages immediately and take care to avoid slipping.

