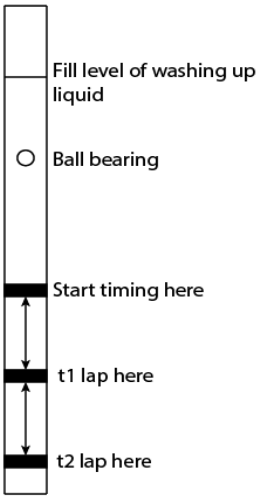
Edexcel Physics A Level

Core Practical 4

Determine the Viscosity of a Liquid

Method



- Zero a mass balance with a 250cm^3 measuring cylinder on top
- Pour washing up liquid up to the 200cm^3 mark, record the mass and determine the density of the liquid using:

$$Density = \frac{Mass}{Volume}$$

- Measure the mass of the ball bearing using a top pan balance
- Measure diameter of the ball bearing with micrometer (at several positions and find average). Halve the diameter to get radius. Find volume of ball:

$$Volume = \frac{4}{3}\pi r^3$$

- Calculate density of the ball bearing
- Place elastic bands along the measuring cylinder 10cm apart, measured with a ruler
- Drop the ball into the cylinder (use forceps to hold it securely)
- Start the stopwatch when the ball touches the top of the washing up liquid, lap when the bottom of the ball just passes a rubber band
- Record these 2 times (t_1 and t_2)
- Repeat two more times with the same radius sphere
- Repeat procedure for ball bearing with the same mass but varying radii
- For each radius, find average t_1 and t_2, calculate velocities, v_1 and v_2 and average to find v_{avg} for each radius
- For each radius (where ρ_s is density of the ball bearing, and ρ_l is density of liquid) find the viscosity η;

$$\eta = \frac{2(\rho_s - \rho_l)g}{9v_{avg}}r^2$$

- Average the viscosity values to find mean viscosity

Safety

- Spilled liquid can make it easier to slip on floors so mop up any spills
- Use gloves if allergic to liquid
- Wear goggles to avoid splashes in eye

Evaluation

- Keep temp roughly the same as it may change the viscosity of oil
- Ensure the lap timer is hit for constant parts of the ball (i.e. right at the bottom of the ball)
- Larger distance between elastic bands will lower percentage uncertainty, but there will still be a high uncertainty in time due to human reaction time.
- Light gates and data loggers can be used to eliminate uncertainty due to reaction time
- Strong magnet could be used to remove ball bearings from the tube
- If ball falls close to wall, repeat reading since the flow will no longer be laminar
- If velocity at second band higher than first band, ball bearing might not have reached terminal velocity when you started timing, so move bands further down tube and try again