UM - SJTU Joint Institute

Physics Laboratory I

VP141

Exercise II

Measurement of Fluid Viscosity

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June 27, 2017

1 Introduction

The objective of the exercise is to measure the fluid viscosity, an important property of fluids, using Stoke's method.

To analyze the free body diagram of a spherical object moving in a fluid, we find that the viscous force, the buoyancy force and the weight, where the first two forces act upwards and the last one acts downwards.

The magnitude of a drag force is related to the shape and speed of the objective as well as to the internal friction in the fluid. We use coefficient η to quantify the internal friction in the fluid. Hence we build a model for the drag force (viscous force) in an infinite volume of a liquid.

$$F_1 = 6\pi\eta v R$$

The magnitude of the buoyancy force is

$$F_2 = \frac{4}{3}\pi R^3 \rho_1 g,$$

where ρ_1 is the density of the fluid and g is the acceleration due to gravity. The weight of the object is

$$F_3 = \frac{4}{3}\pi R^3 \rho_2 g,$$

where ρ_2 is the density of the object. Since the three forces balance each other, then

$$F_1 + F_2 = F_3.$$

Assuming that the object will be moving with constant speed v_t, we find from the equation that

$$\eta = \frac{2}{9} g R^2 \frac{\rho_2 - \rho_1}{v_t}.$$