0.1 Introduction to Fluid Dynamics

0.1.1 Question 1

a

Let us start with the equation for viscosity:

$$\tau = \mu \frac{\partial u_y}{\partial x} \tag{1}$$

Rearranging the following equation for $\partial u_y / \partial x$ gives us:

$$\frac{\partial u_y}{\partial x} = \frac{\tau}{\mu}$$

Inputting our variables:

$$\frac{\partial u_y}{\partial x} = \frac{0.4}{5} = 0.08 \text{ s}^{-1}$$

b

We need to find the shear stress exerted by the block on the oil, found using the following equation:

$$\tau = \frac{F_t}{A} \tag{2}$$

The force that the block exerts tangentially on the oil covered inclined plane surface is given by:

$$F_t = 10 \cdot g \cdot sin(20) \text{ N}$$

The area of contact between the oil and the block is

$$A = 0.1 \text{ m}^2$$

Inputting into equation (2):

$$\tau = 100 \cdot g \cdot sin(20)$$

We are told the velocity distribution through the oil is linear and hence can make the following simplification:

$$\frac{\partial u_x}{\partial y} = \frac{u_{block}}{D}$$

$$\tau = \mu \frac{u_{block}}{D}$$

$$u_{block} = \frac{\tau D}{\mu}$$

$$u_{block} = \frac{100 \cdot 9.81 \cdot sin(20) \cdot 1 \times 10^{-4}}{5}$$

$$u_{block} = 0.0067 \ \mathrm{m\,s^{-1}}$$

0.1.2 Question 2