

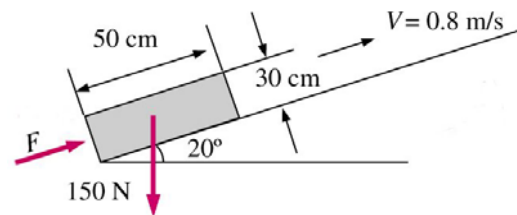
**10.303 & 14.301 Fluid Mechanics**  
**Homework Assignment #2 Fall 2006**

**More Fluid Properties**

1. Consider the following two-part question:
  - a. Explain briefly what is meant by the term *cavitation*.
  - b. When water at 90 C flows through a converging section of pipe, the pressure is reduced in the direction of flow (due to the increase in kinetic energy). Estimate the minimum absolute pressure that can be developed without causing cavitation.
2. Determine the height water will rise due to capillary action in a clean 0.25 in diameter glass tube. What will be the height if the diameter is reduced to 0.01 in? Assume a water temperature of 70 F for both cases.
3. The viscosity of blood is to be determined from measurements of shear stress,  $\tau$ , and the rate of shearing strain,  $du/dy$ , obtained from a small blood sample tested in a suitable viscometer. Based on the data given below, determine if the blood is a Newtonian or non-Newtonian fluid. Explain how you arrived at your answer.

$\tau$ (N/m <sup>2</sup> )	0.04	0.06	0.12	0.18	0.30	0.52	1.12	2.10
$du/dy$ (s <sup>-1</sup> )	2.25	4.50	11.25	22.5	45.0	90.0	225	450

4. A 50 cm x 30 cm x 20 cm block weighing 150 N is to be moved at a constant velocity of 0.8 m/s on an inclined surface with a 20° tilt to the horizontal as shown in the sketch. For these conditions, the block-incline surface has a friction coefficient of  $f = 0.27$ , where the friction force along the incline is given by  $F_f = f \cdot F_n$ , with  $F_n$  being the force normal to the incline.



- a. Determine the force  $F$  in the direction parallel to the incline that needs to be applied to achieve this condition.
- b. If a 0.4 mm thick oil film with a dynamic viscosity of 0.012 Pa-s is applied between the block and inclined surface, determine the percent reduction in the force required to achieve the 0.8 m/s velocity. Assume a linear velocity profile in the oil gap.

5. A thin 20 cm x 20 cm flat plate is pulled at 1 m/s horizontally through a 3.6 mm thick oil layer ( $\mu_{oil} = 0.027$  Pa-s) sandwiched between two plates. One of the plates is stationary and the other is moving at a constant velocity of 0.3 m/s as shown in the sketch. Assuming that the velocity in each oil layer varies linearly, determine the force,  $F$ , that needs to be applied on the plate to maintain this motion.

