College of Engineering & Technology

Department: Mechanical Engineering — Marks: 30
Lecturer: Dr. Rola Afify — Time: 12:30 – 2:00
Course Code: ME464 — Date: 20/7/2013

Name: Model answer

Answer the following questions:

Question one (10 marks)

A) Define:

- Density: mass per unit volume $\rho = \frac{m}{V}$ Kg/m^3

$\rho_w = 1000\ Kg/m^3$

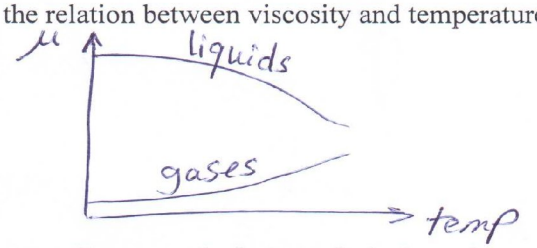
- Bulk modulus of elasticity: $K = \frac{-\Delta P}{\Delta V / V}$

$K = \dots * 10^9$ incomp. Fluid ⇒ large K means big change in pressure causes small change in Volume; small K means small ~ ~ ~ ~ big ~ in vol. (comp. fluid) $K = \dots \times 10^6$

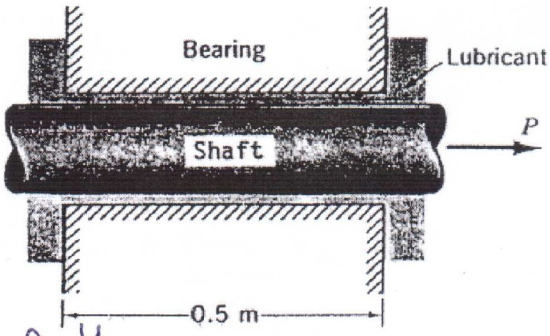
- Kinematic viscosity:

is defined as the ratio of dynamic viscosity to density $\nu = \frac{\mu}{\rho}$ m^2/sec

B) Sketch the relation between viscosity and temperature for a certain fluid.



C) A 25 mm diameter shaft is pulled through a cylindrical bearing as shown in Figure. The lubricant that fills the 0.3 mm gap between the shaft and bearing is oil having a kinematic viscosity of 8×10^{-4} m^2/s and a specific gravity of 0.91. Determine the force P required to pull the shaft at a velocity of 3 m/s. Assume the velocity distribution in the gap is linear.



$d = 25 * 10^{-3}\ m$

$y = 0.3 * 10^{-3}\ m$

$\nu = 8 * 10^{-4}\ m^2/s = \frac{\mu}{\rho}$

$\gamma = 0.91 = \frac{\rho_f}{\rho_w}$

$U = 3\ m/s$

$P = ?? = F_{vis}$

$\mu = \nu \rho = \nu * \gamma * \rho_w$

$F_{vis} = \mu A \frac{U}{y}$

$P = \left[8 * 10^{-4} * 0.91 * 1000\right] * \left(\pi * 25 * 10^{-3} * 0.5\right) * \frac{3}{0.3 * 10^{-3}}$

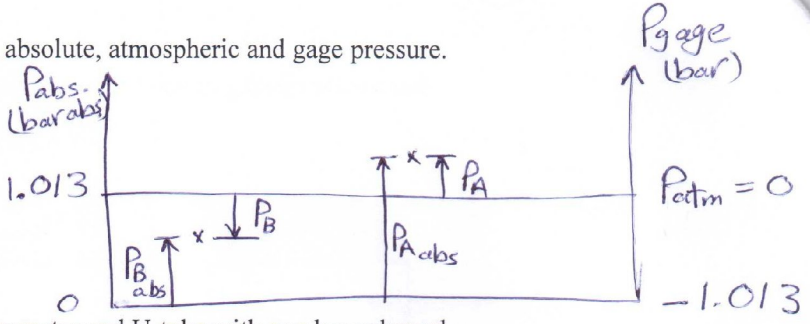
$P = 91\pi$ N

$= 285.88$ N

Question two (11 marks)

A) State the relation between absolute, atmospheric and gage pressure.

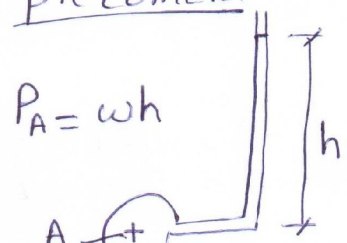
$P_{abs} = P_{gage} + P_{atm}$



B) Differentiate between Piezometer and U-tube with one leg enlarged.

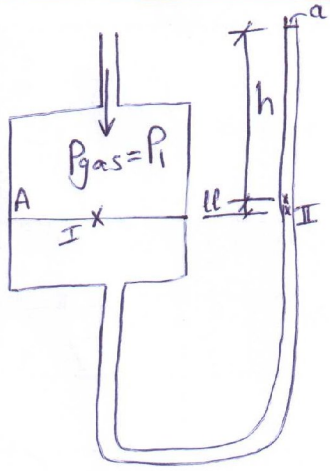
piezometer

$P_A = \omega h$



It Consists of a single vertical tube, It isn't for ① vacuum ② gases ③ short tubes

U-tube with one leg enlarged



Volume = Volume

$A * ll = a * h$

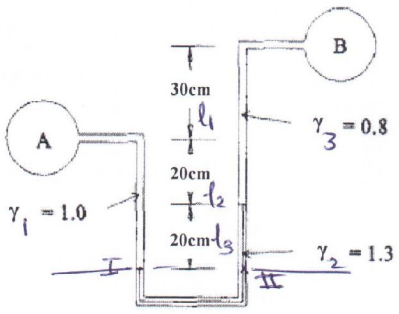
$ll = \frac{a}{A} h = \frac{d^2}{D^2} h$

$P_I = P_{II}$

$P_1 = \rho g ll + \rho g h$

$= \rho g h \left(\frac{d^2}{D^2} + 1\right)$

C) A manometer is connected between two pipelines, A and B shown in figure. What is the pressure difference between A and B expressed as meters of water?



$\gamma = \frac{\rho}{\rho_w}$

$P_I = P_{II}$

$P_A + \rho_1 g(l_2 + l_3) = P_B + \rho_3 g(l_1 + l_2) + \rho_2 * g * l_3$

$P_A - P_B = \rho_3 g(l_1 + l_2) + \rho_2 * g l_3 - \rho_1 g(l_2 + l_3)$

$\Delta P = 0.8 * 1000 * 9.8 (30+20) * 10^{-2} + 1.3 * 1000 * 9.8 * 20 * 10^{-2} - 1 * 1000 * 9.8 * (20+20) * 10^{-2}$

$= 2548$ Pa

$\Delta P = \omega h \quad \therefore h = \frac{\Delta P}{\omega} = \frac{2548}{1000 * 9.8} = 0.26$ m of water

Question three (9 marks)

Write the name of each component in the following Hydraulic circuit