UNIVERSITY OF BOLTON

SCHOOL OF BUILT ENVIRONMENT & ENGINEERING

BENG (HONS) MECHANICAL ENGINEERING/ BENG (HONS) AUTOMOBILE ENGINEERING/

SEMESTER 2 EXAMINATIONS 2009/2010

THERMOFLUIDS

MODULE NO: AME1031

Date: Wednesday, 2 June 2010 **Time: 2.00 – 4.00 p.m.**

INSTRUCTIONS TO CANDIDATES:

There are SIX questions on this paper

Answer ANY FOUR questions.

All questions carry equal marks.

CANDIDATES REQUIRE:

Formula Sheet

Take density of water = 1000 kg/m^3

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Q1 a) State the difference between liquids and gases. (8 marks)

b) The device shown in Figure Q1b has a free moving piston between the two chambers. The initial total volume A & B are equal with V_a=100m^3/kg and V_b = 50m^3/kg. If the piston is moved so that x is one-fourth of the entire length, determine the final specific volumes of chambers A and B. Take the total volume V = 1m^3. (12 marks)

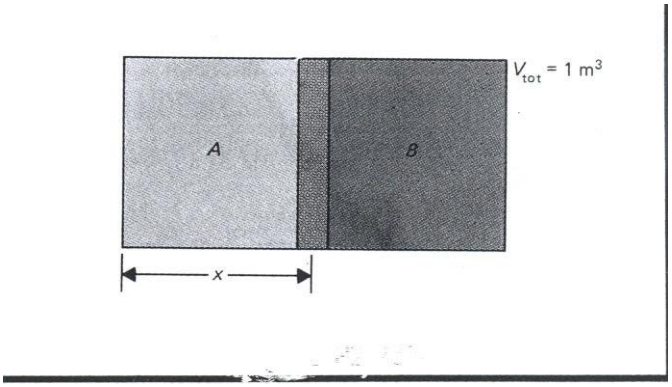

Figure Q1b

c) A mass of 5kg is placed on a planet whose gravitational force is 10 times that of the earth. What is its weight on this planet? (5 marks)

Total 25 marks

Please turn the page

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Q2 a) Use Figure Q2a to show that the height of fluid $h = \frac{4\sigma \cos \vartheta}{\rho g d}$

Where σ = surface tension
ϑ = angle of contact
ρ = fluid density
d = diameter of tube (13 marks)

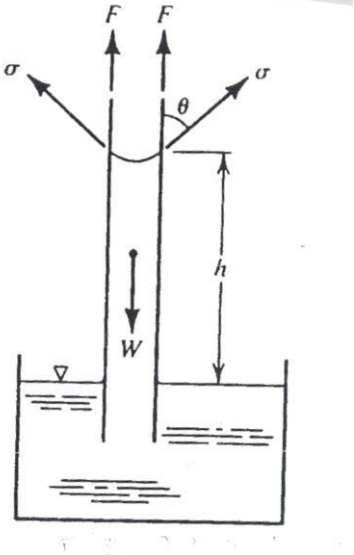

Figure Q2a

b) Define and explain the causes of surface tension. (6 marks)

c) What does capillarity mean and how does capillarity action work? (6 marks)

Total 25 marks

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Q3 a) Explain why the viscosity of a liquid decreases while that of a gas increases with temperature rise. (5 marks)

b) A liquid compressed in a cylinder has a volume of 1000 cm^3 at 1 MPa and a volume of 995 cm^3 at 2 MPa. What is its bulk modulus of elasticity. (5 marks)

c) Figure Q3c shows two plates Δy apart, the lower one fixed and the upper one free to move under the action of a mass of 25g. If the fluid between the plates is caster oil with viscosity 650 x 10^3 Ns/m^2 and the area of contact of the upper plate with the oil is 0.75 m^2. Find the velocity of the upper plate when the distance separating the plates is 1cm. (15 marks)

Total 25 marks

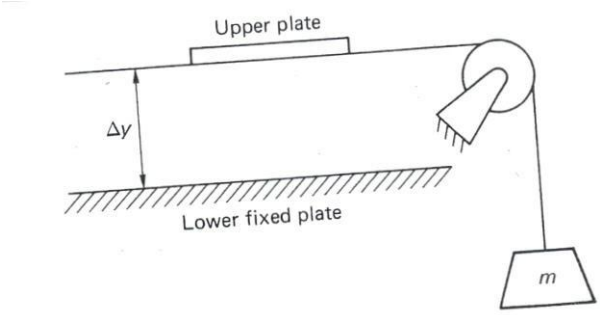

Figure Q3c

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Q4 a) Kerosene flowing in a pipe has a pressure drop of 55.16 kPa across an orifice as shown in Figure Q4a. What will be the height of the mercury deflection in the differential manometer?

Take specific volume of kerosene as 1.67 x 10^{-3} m^3/kg and specific gravity of mercury as 13.6. (13 marks)

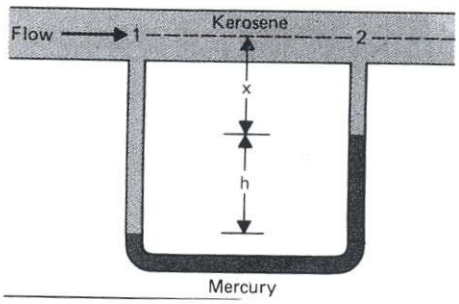

Figure Q4a

b) Calculate the difference in pressure between points A and B in Figure Q4b. (12 marks)

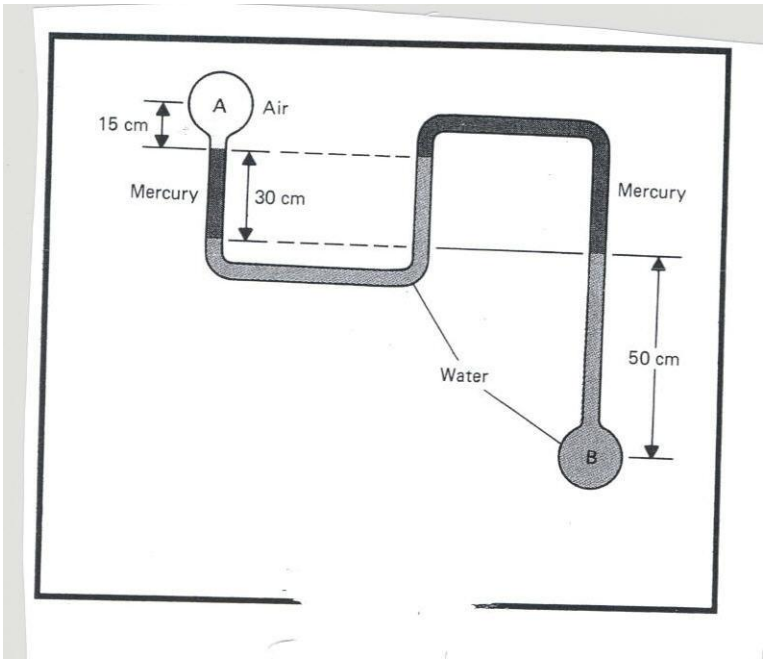

Figure Q4b

Total 25 marks

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Q5 a) Define and state the limitations of Bernoullis' theorem. (8 marks)

b) A horizontal venturi meter with a throat diameter of 50mm is placed in a pipe of 120mm diameter. The pipe conveys oil of density 800 kg/m^3 and the difference in level of mercury in a U-tube manometer is 220mm. The coefficient of discharge of the meter is 0.98. Calculate the volume flow rate of oil.

(17 marks)

Total 25 marks

Q6 a) A nozzle has an exit diameter of 15mm and discharges water into the atmosphere. The gauge pressure behind the nozzle is 400 kPa. The coefficient of velocity is 0.98 and there is no contraction of the jet. The jet hits a stationary flat plate normal to its direction. Determine the force on the plate. Take the density of water 1000kg/m^3. Assume the velocity of approach into the nozzle is negligible. (15 marks)

b) In the compression stroke of an internal combustion engine the heat rejected to the cooling water is 45 kJ/kg and the work input is 90 kJ/kg.

Calculate the change in specific internal energy of the working fluid stating whether it is a gain or a loss. (10 marks)

Total 25 marks

END OF QUESTIONS

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Formulae Sheet

$$P = F/A$$

$$\rho = m/v$$

$$\dot{m} = \rho A V$$

$$P = P_g + P_{atm}$$

$$P = \rho gh$$

$$\textit{Bulk Modulus } \beta = -\frac{dP}{dv/v}$$

$$\tau = \mu \, du/dy$$

$$h = \frac{4\sigma}{\rho g s d}$$

$$Z_1 + \frac{P_1}{\rho g} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\rho g} + \frac{V_2^2}{2g}$$

$$V_1 = \sqrt{\frac{2g\,h\left(\frac{\rho_L}{\rho} - 1\right)}{\left(\frac{a_1}{a_2}\right)^2 - 1}}$$

$$Q - W = \Delta U + \Delta PE + \Delta KE$$

$$W = \int P dV$$

$$P V^n = C$$

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$$W = \frac{P_1 V_1 - P_2 V_2}{n - 1}$$

$$W = P\,(v_2 - v_1)$$

$$W = PV \ln\left(\frac{V_2}{V_1}\right)$$

$$Q = C_d A \sqrt{2gh}$$

$$V_1 = C\sqrt{2g\ h_2\left(\frac{\rho g_m}{\rho g} - 1\right)}$$

$$\sum F = \frac{\Delta M}{\Delta t} = \Delta \dot{M}$$

$$F = \rho\, Q V$$

$$Re = V\, L\, \rho/\mu$$