# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2017/2018

| | | |
|---|---|---|
| COURSE NAME | : | FLUID MECHANICS |
| COURSE CODE | : | BNJ20203 |
| PROGRAMME CODE | : | BNG / BNH / BNK / BNL / BNM |
| EXAMINATION DATE | : | JUNE / JULY 2018 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **FIVE (5)** QUESTIONS ONLY |



THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

**Q1** (a) (i) Define the meaning of no-slip condition and what causes it

(3 marks)

(ii) Distinguish the difference between Newtonian and Non-Newtonian fluids

(3 marks)

(b) Given the surface tension of soap water at 20 °C $\sigma_s$ = 0.025 N/m, determine the gage pressure inside a soap bubble show in **Figure Q1 (b)** of diameter

(i) 0.2 cm at 20 °C

(3 marks)

(ii) 5.0 cm at 20 °C

(3 marks)

(c) Write the primary dimensions of each of the following variables from the field of thermodynamics,

(i) energy, *E*

(1 mark)

(ii) specific energy, *e* = *E/m*

(1 mark)

(iii) power, *W*

(1 mark)

(d) Probably the most well-known (and most misused) equation in fluid mechanics is the Bernoulli equation and the standard form of the Bernoulli equation for incompressible irrotational fluid flow is as below

$$P + \frac{1}{2}\rho V^2 + \rho g Z = C$$

(i) Prove that each additive term in the Bernoulli equation has the same dimensions

(3 marks)

(ii) Express the dimensions of constant, C

(2 marks)

**Q2** (a) Express Pascal's law, and give a real world example of it.

(3 marks)

(b) The pressure of water flowing through a pipe is measured by the arrangement shown in **Figure Q2 (b)**. For the values given, calculate the pressure in the pipe.

(7 marks)

(c) A 4 m long quarter-circular gate of radius 3 m and of negligible weight is hinged about its upper edge *A*, as shown in **Figure Q2 (c)**. The gate controls the flow of water over the ledge at *B,* where the gate is pressed by a spring. Determine the minimum spring force required to keep the gate closed when the water level rises to *A* at the upper edge of the gate.

(10 marks)

**Q3** (a) Discuss the stability of

(i) a submerged body whose center of gravity is above the center of buoyancy.

(2 marks)

(ii) a floating body whose center of gravity is above the center of buoyancy.

(2 marks)

(b) A crane is used to lower weights into the sea (density = 1025 kg/m$^3$) for an underwater construction project shown in **Figure Q3 (b).** Determine the tension in the rope of the crane due to a rectangular 0.4 m x 0.4 m x 3 m concrete block (density = 2300 kg/m$^3$) when it is

(i) Suspended in the air

(4 marks)

(ii) Completely immersed in water.



(3 marks)

(iii) Then, calculate how many percent the weight decrease in the water.

(1 mark)

(c) The hull of a boat has a volume of 150 $m^3$, and the total mass of the boat when empty is 8560 kg. Determine how much load this boat can carry without sinking

(i) in a lake

(4 marks)

(ii) in seawater with a specific gravity of 1.03.

(4 marks)

**Q4** (a) (i) State the Bernoulli equation in **THREE (3)** different ways using energies, pressures and heads.

(3 marks)

(ii) Name **THREE (3)** major assumptions used in the derivation of the Bernoulli equation

(3 marks)

(b) A very large tank contains air at 102 kPa at a location where the atmospheric air is at 100 kPa and 20°C is shown in **Figure Q4 (b)**. Now, a 2 cm of diameter tap is opened.

(i) Determine the maximum flow rate of the air through the hole.

(4 marks)

(ii) Justify your response if air is discharged through a 2 m long, 4 cm diameter tube with a 2 cm diameter nozzle

(2 marks)

(iii) Evaluate the problem the same way if the pressure in the storage tank were 300 kPa

(2 marks)

(c) Air flows through a pipe at a rate of 200 L/s as shown in **Figure Q4 (c)**. The pipe consists of two sections of diameters 20 cm and 10 cm with a smooth reducing section that connects them. The pressure difference between the two pipe sections is measured by a water manometer. Neglecting frictional effects, determine the differential height of water between the two pipe sections. Take the air density to be 1.20 $kg/m^3$.

(6 marks)

**Q5** (a) Define the conservation of momentum principle.

(2 marks)

(b) Write the momentum equation for steady one dimensional flow for the case of no external forces and explain the physical significance of its terms.

(3 marks)

(c) **Figure Q5 (c)** shows a smooth curved vane attached to a rigid foundation. The jet of water, rectangular in section, 75mm wide and 25mm thick, strike the vane with a velocity of 25m/s. Calculate the vertical and horizontal components of the force exerted on the vane and indicate in which direction these components act.

(5 marks)

(d) A reducing elbow is used to deflect water flow at a rate of 14 kg/s in a horizontal pipe upward 30° while accelerating it as depicted in **Figure Q5 (d)**. The elbow discharges water into the atmosphere. The cross sectional area of the elbow is 113 $cm^2$ at the inlet and 7 $cm^2$ at the outlet. The elevation difference between the centers of the outlet and the inlet is 30 cm. The weight of the elbow and the water in it is considered to be negligible. Determine

(i) the gage pressure at the center of the inlet of the elbow and

(4 marks)

(ii) the anchoring force needed to hold the elbow in place.

(6 marks)

**Q6** (a) Describe how head loss related can be related to pressure loss

(1 mark)

(b) For a given fluid, explain how you would convert head loss to pressure loss.

(2 marks)

(c) Water at 10°C ($\rho$ = 999.7 kg/m$^3$ and $\mu$ = 1.307 x 10$^{-3}$ kg/m · s) is flowing steadily in a 0.20 cm diameter, 15 m long pipe at an average velocity of 1.2 m/s. Determine

(i) The pressure drop

(3 marks)

(i) The head loss, and

(2 marks)

(iii) The pumping power requirement to overcome this pressure drop.

(2 marks)

(d) A tank of water empties by gravity through a horizontal pipe into another tank as shown in **Figure Q6 (d)**. There is a sudden enlargement in the pipe. At a certain time, the difference in level is 3 m. Each pipe is 2 m long and has a friction coefficient, $f$ = 0.005. The inlet loss coefficient is 0.3. Calculate the flow rate at this point.

(10 marks)

**- END OF QUESTIONS -**

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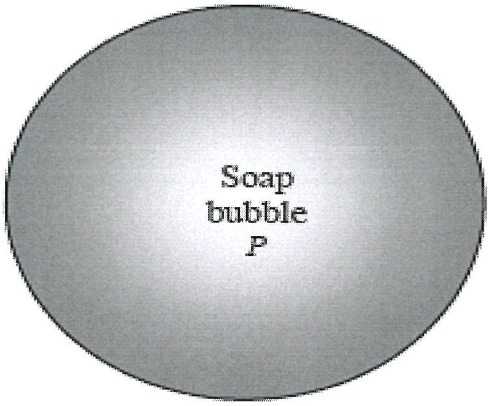


**Figure Q1 (b)**

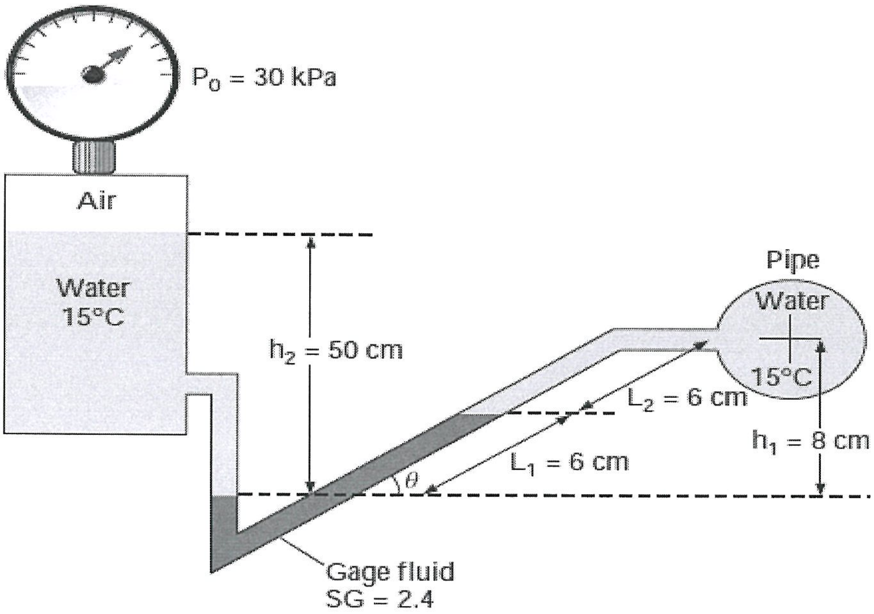


**Figure Q2 (b)**

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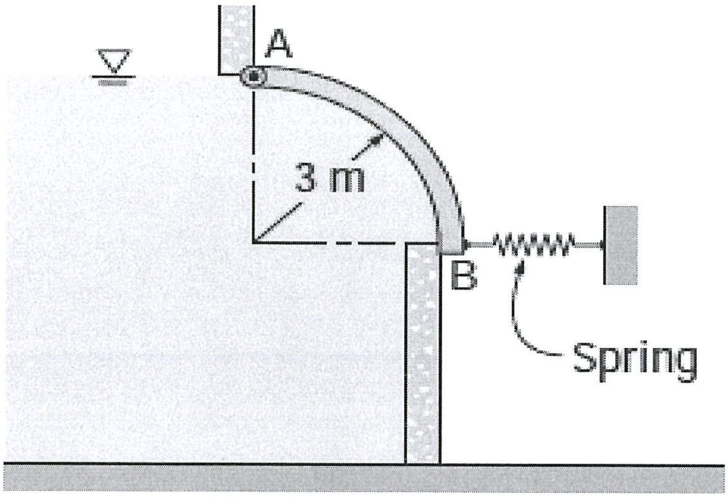


**FIGURE Q2 (c)**

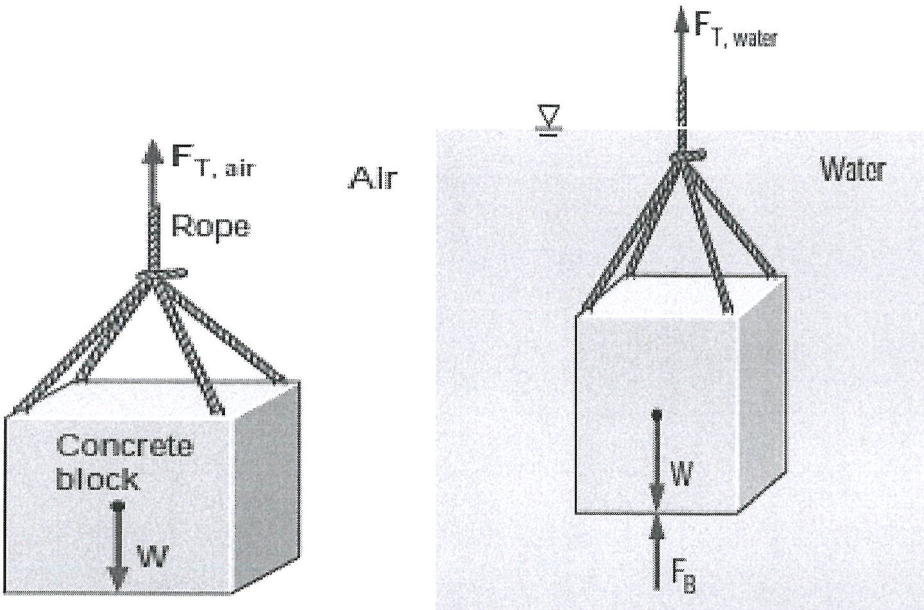


**FIGURE Q3 (b)**

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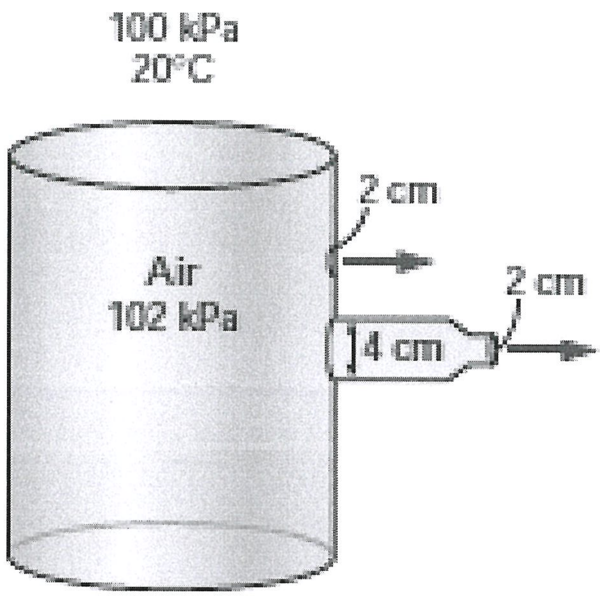


**FIGURE Q4 (b)**

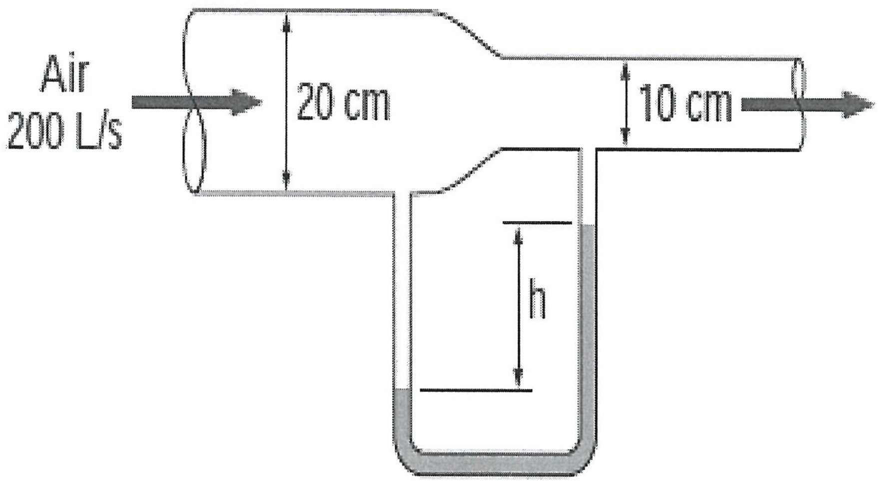


**FIGURE Q4 (c)**

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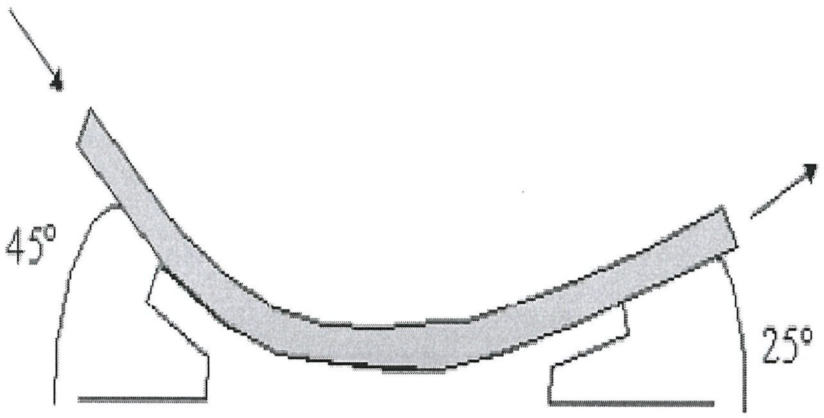


**FIGURE Q5 (c)**

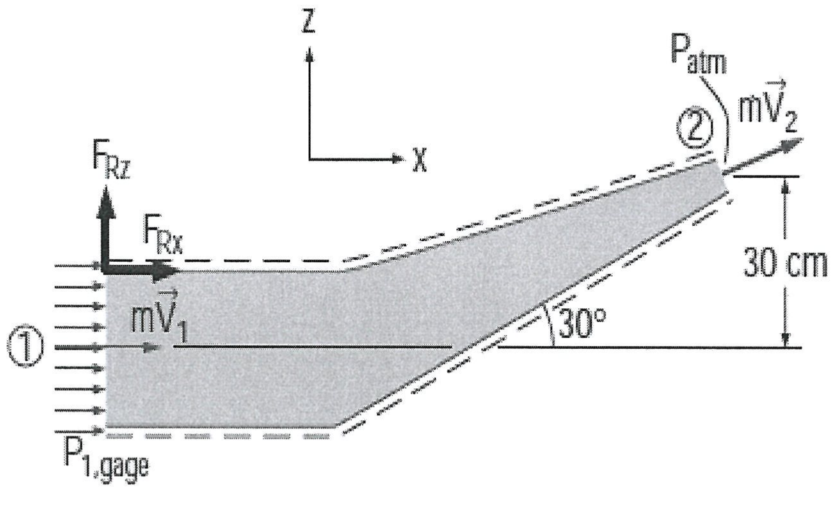


**FIGURE Q5 (d)**

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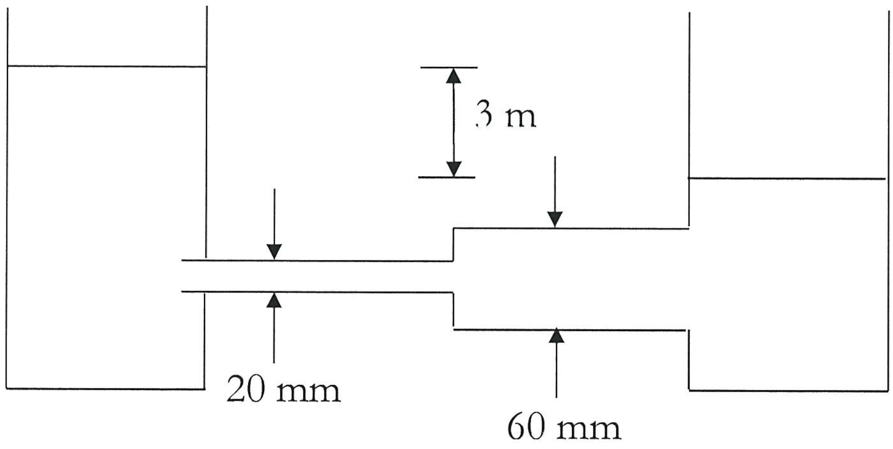


**FIGURE Q6 (d)**

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