# UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, MAY 2019

**COURSE NO**: MC/EL/RN/ES/MR/PE/MN/GL 264
**COURSE NAME**: FLUID MECHANICS
**CLASS**: MC/EL/RN/ES/MR/PE/MN/GL II **TIME:** 3 HRS

Name**:** ___________________________________________ Index Number: ___________________

***Note*****:** Where needed, take **density (*ρ*) of water** and **air** to be **1000 kg/m$^3$** and **1.223 kg/m$^3$** respectively and **acceleration due to gravity (*g*)** to be **9.81 m/s$^2$**. Formula sheets and important fluid property tables are also provided.

## SECTION A

*ANSWER **ALL** QUESTIONS (20 MARKS)*

1. What is a fluid?

2. What is your understanding of Fluid Mechanics?

3. If liquid water at 15$^o$C is flowing in a pipe and the pressure drops to the vapour pressure, what happens in the water?

4. On a single graph show the variation of viscosity of liquid and gas with temperature.

5. $\frac{\mu_{oil\,@\,320K}}{\mu_{oil\,@\,298K}} < 1$, where $\mu$ is the oil viscosity. **TRUE**/**FALSE**

6. Write Darcy-Weisbach equation for head loss due to friction in pipe flows.

7. For a given Reynold's number for a pipe flow, how do you tell if the flow is in laminar, transition or turbulent regime?

8. Outline the steps used to obtain the friction factor, $\lambda$ using the Moody diagram.

9. State any two assumptions made in the derivation of the Bernoulli's equation.

10. What is the difference between minor and major losses?

**SECTION B**

*ANSWER* ***QUESTION 1*** *AND* ***ANY OTHER TWO*** *(60 MARKS)*

**Question 1**

**a.** Using the following partial derivatives, write the correct mathematical representations for types of flow tabulated below $\left(\frac{\partial V_s}{\partial s}=0; \frac{\partial V_s}{\partial s}\neq 0; \frac{\partial V_s}{\partial t}\neq 0; \frac{\partial V_s}{\partial t}=0\right)$:

(*10 Marks*)

| A | B |
|---|---|
| Steady flow | |
| Unsteady flow | |
| Uniform flow | |
| Non-uniform flow | |

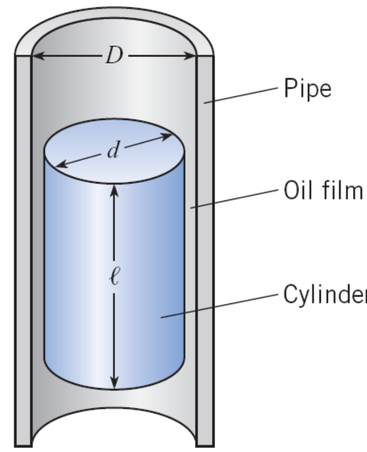


**Fig. Q1b**

**b.** This problem involves a cylinder falling inside a pipe that is filled with oil, as depicted in **Fig. Q1b**. The small space between the cylinder and the pipe is lubricated with an oil film that has viscosity $\mu$. **Derive a formula for the steady rate of descent of a cylinder** with weight $W$, diameter $d$, and length sliding inside a vertical smooth pipe that has inside diameter $D$.

(*12 Marks*)

**c.** Assume that the cylinder is concentric with the pipe as it falls. Use the general formula to find the rate of descent of a cylinder 100 mm in diameter that slides inside a 100.5 mm pipe. The cylinder is 250 mm long and weighs 50 N. Take the viscosity ($\mu$) of the lubricant to be 0.035 Pa-s.

(*8 Marks*)

**d.** The vector $\mathbf{V} = (x^2 - y^2)\boldsymbol{i} - 2xy\mathbf{j}$ represents a two-dimensional velocity field. Is the flow irrotational?

(*10 marks*)

## Question 2

**a.** **i.** What is Manometry?

**ii.** Write the general equation for the pressure difference measured by a manometer between two points 1 and 2.

(*6 Marks*)

**b.** What is the maximum gage pressure in the odd tank shown in **Fig. Q2b**? Where will the maximum pressure occur? What is the pressure force acting on the top (*CD*) of the last chamber on the right-hand side of the tank? Assume $T$ = 10°C.

(*14 Marks*)

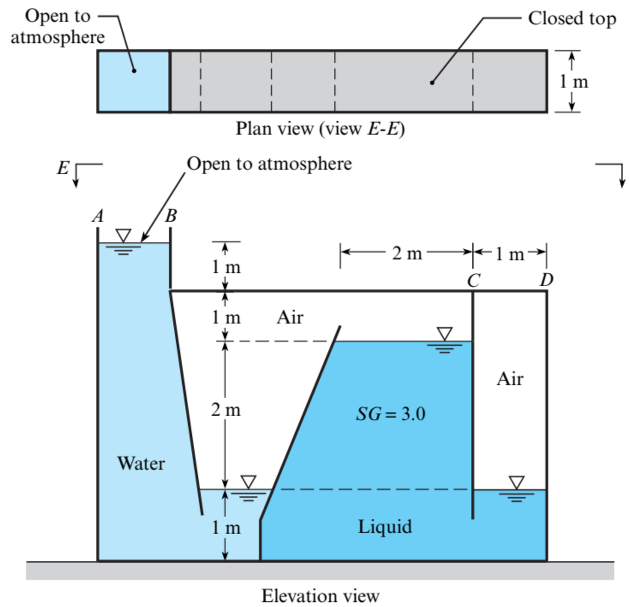


**Fig. Q2b**

## Question 3

**a.** i. Write Euler's equation for pressure variation.

ii. State any two assumptions made in deriving Euler's equation.

(*4 Marks*)

**b.** A tank on a trailer truck is completely filled with gasoline which has a specific weight of 6.60 kN/m$^3$. The truck is decelerating at a rate of 3.05 m/s$^2$. If the tank on the trailer is 6.5 m long and if the pressure at the top rear end of the tank is atmospheric as shown in **Fig. Q3b**:

i. what is the pressure at the top front?

ii. what is the maximum pressure in the tank?

(*16 Marks*)

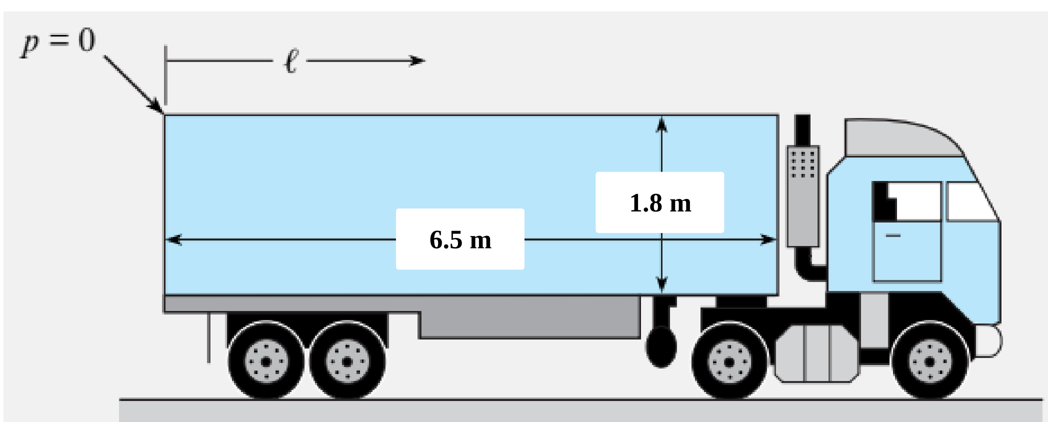


**Fig. Q3b**

**Question 4**

**a.** i. Write Bernoulli's equation along two points **1** and **2** on a streamline.
ii. State any four assumptions made in deriving Bernoulli's equation.

(*6 Marks*)

**b.** Outline four (4) differences between laminar and turbulent flows.

(*6 Marks*)

**c.** Piezometric tubes are tapped into a Venturi section as shown in **Fig. Q4b**. The liquid is incompressible. The upstream piezometric head is 1.2 m, and the piezometric head at the throat is 0.8 m. The velocity in the throat section is thrice as large as in the approach section. Find the velocity in the throat section.

(*8 Marks*)

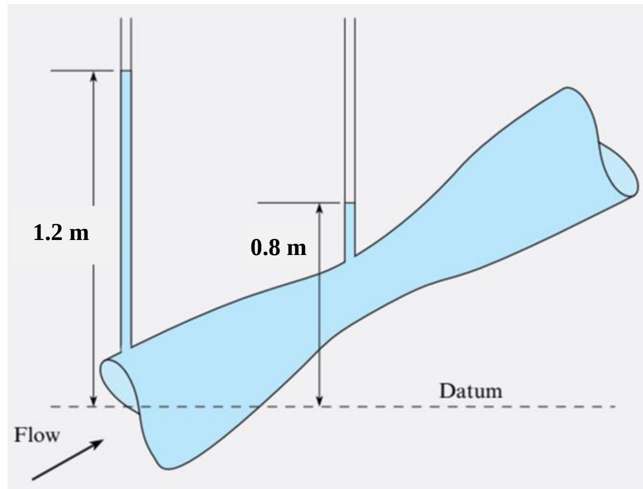


**Fig. Q4b**

**Question 5**

An elliptical gate covers the end of a pipe 4 m in diameter as shown in **Fig. Q5**. If the gate is hinged at the top, what normal force **F** is required to open the gate when water is 10 m deep above the top of the pipe and the pipe is open to the atmosphere on the other side? Neglect the weight of the gate.

(*20 Marks*)

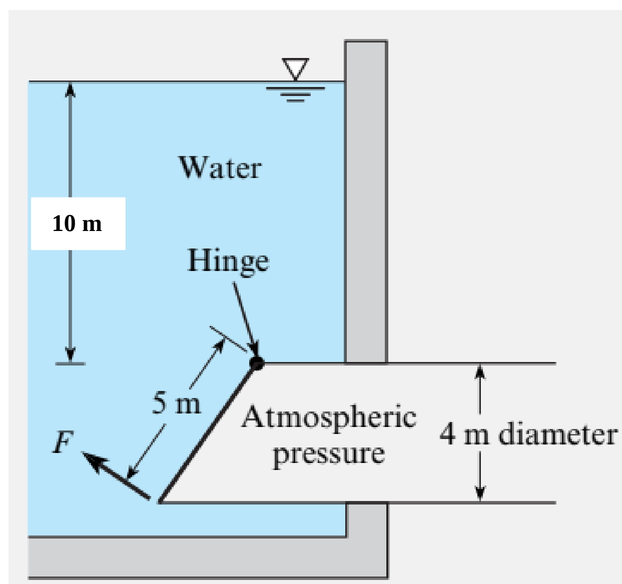


**Fig. Q5**

***Examiners:*** *E. Adaze/S. P Agbomadzi*