



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY
DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL DIPLOMA

IN

MECHANICAL ENGINEERING

MODULE: Fluid Mechanics

**PAPER NO: 539/23/M10
539/15/S10**

DURATION: 3 Hours

NOVEMBER / DECEMBER 2025 EXAMINATION

REQUIREMENTS

1. Answer booklet
2. Formulae booklet
3. Non programmable scientific calculator

INSTRUCTIONS TO CANDIDATE

1. Answer any five (5) questions of your choice.
2. Each question carries 20 marks.
3. Start each question on a new page.

QUESTION 1

- a) Define the following terms as used in Fluid Mechanics;
- i) Ideal fluid (2 marks)
 - ii) Specific weight (2 marks)
 - iii) Bulk modulus of elasticity (2 marks)
 - iv) Newtonian fluids (2 marks)
 - v) Atmospheric pressure (2 marks)
- b) Determine the kinematic viscosity of an oil having a density of 981 kg/m^3 . The shear stress at a point in oil is 0.2452 N/m^2 and velocity gradient at that point is 0.2 per second. (10 marks)

QUESTION 2

A rectangular orifice 0.9m wide and 1.2m deep is discharging water from a vessel. The top edge of the orifice is 0.6m below the water surface in the vessel. Calculate the discharge through the orifice if coefficient of discharge is 0.6 and the percentage error, if the orifice is treated as a small orifice. (20 marks)

QUESTION 3

- a) For an isothermal condition in a perfect gas, show that the variation of pressure with altitude is given by the following expression.

$$\frac{P_2}{P_1} = e^{-\frac{g}{RT}(Z_2 - Z_1)} \quad (10 \text{ marks})$$

- b) A pontoon of 1500 tonnes displacement is floating in water. A weight of 20 tonnes is moved through a distance of 6m across the deck of pontoon, which tilts the pontoon through an angle of 5° . Find the metacentric height of the pontoon. (10 marks)

QUESTION 4

A 30cm diameter pipe, conveying water, branches into two pipes of diameters 20cm and 15cm respectively. If the average velocity in the 30cm diameter pipe is 2.5 m/s . Find the discharge in this pipe.

Also determine the velocity in the 15cm pipe if the average velocity in the 20cm diameter pipe is 2 m/s . (20 marks)

QUESTION 5

A sluice gate in Fig Q5 consists of a quadrant of a circle of radius 1.5m pivoted at its centre O. Its centre of gravity is at G. When the water is level with the pivot O and the width of the gate is 3m, calculate;

- The magnitude of resultant force on the whole gate. (15 marks)
- The direction of the resultant force with respect to the horizontal. (5 marks)

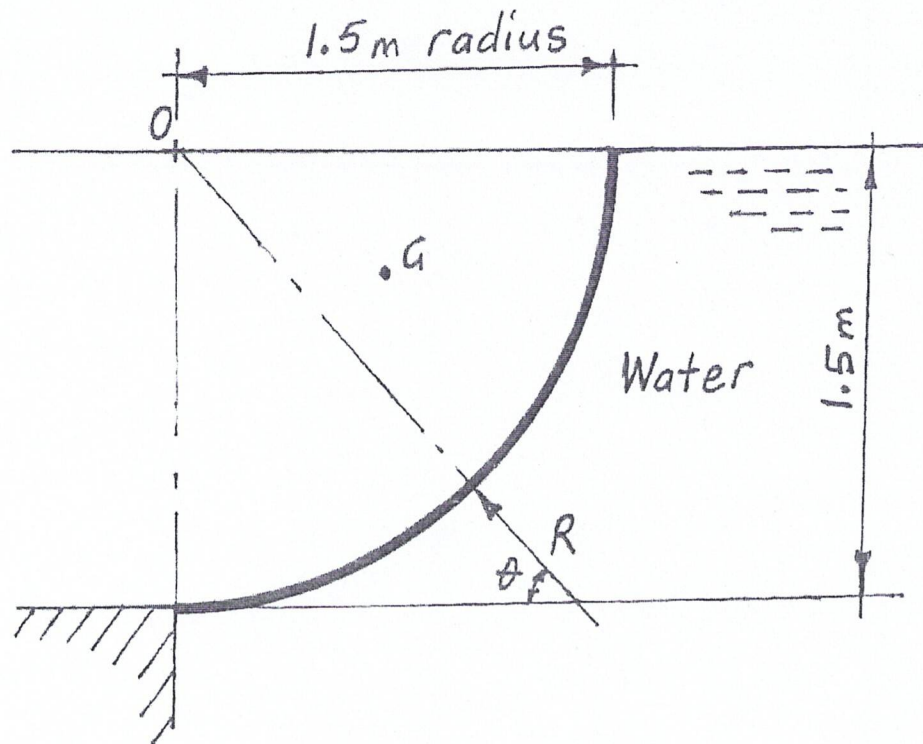


Fig Q5

QUESTION 6

A horizontal venturi meter with inlet and throat diameters 30cm and 15cm respectively is used to measure the flow of water. The reading of differential manometer connected to the inlet and the throat is 20cm of mercury.

Determine the rate of flow, using the coefficient of discharge as 0.98.

(20 marks)

QUESTION 7

A pipeline 0.225m in diameter and 1580m long has a slope of 1 in 200 for the first 790m and 1 in 100 for the next 790m. The pressure at the upper end of the pipeline is 107.91kPa and at the lower end is 53.955kPa.

Taking $f = 0.032$, determine the discharge through the pipe.

(20 marks)

QUESTION 8

- a) Write down any four (4) assumptions made in the derivation of Bernoulli's equation. (4 marks)
- b) A pipe of diameter 400mm carries water at a velocity of 25m/s. The pressures at points A and B are given as $29.43 \times 10^4 \text{N/m}^2$ and $22.56 \times 10^4 \text{N/m}^2$ respectively while the datum head at A and B are 28m and 30m. Find the difference of head between A and B. (16 marks)

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