UNIVERSITY OF JOHANNESBURG

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| **PROGRAM** | : | NATIONAL DIPLOMA<br>*ENGINEERING : CIVIL* |
| **SUBJECT** | : | **HYDRAULICS 2A** |
| **CODE** | : | **CEW2A11** |
| **DATE** | : | WINTER SSA EXAMINATION<br>27 JULY 2016 |
| **DURATION** | : | (SESSION 2) 11:30 – 14:30 |
| **WEIGHT** | : | 40 : 60 |
| **TOTAL MARKS** | : | 100 |

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| **EXAMINER** | : | MR LF SHIRLEY | 80609822 |
| **MODERATOR** | : | MR J DATELING | 2254 |
| **NUMBER OF PAGES** | : | 5 PAGES, 1 FORMULAE SHEET AND 4 ANNEXURES | |

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| **INSTRUCTIONS** | : | ANY TYPE OF POCKET CALCULATOR PERMITTED. |
| **REQUIREMENTS** | : | NONE |

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**HAND IN THE QUESTION PAPER WITH YOUR SCRIPT.**

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**INSTRUCTIONS TO CANDIDATES:**

ANSWER ALL THE QUESTIONS.

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**QUESTION 1**

1.1 In one sentence, state what you understand by the viscosity of a liquid. (1)

1.2 Write down the mathematical relationship between pressure head and intensity of pressure for liquids. (1)

1.3 What do you understand by gauge pressure? (2)

1.4 A differential manometer is used to measure the ......?...... in pressure between two hydraulic systems. (1)

1.5 In the formula $F_v = \rho g V$ for the vertical force acting on a submerged curved surface, V stands for ...?.... . (1)

1.6 State Archimedes' principle in words. (3)

1.7 Complete the following sentence dealing with the momentum of a flowing liquid:
*The sum of all the external forces acting on a fluid in a control volume in a certain direction equals ......?...... .* (3)

1.8 Complete the following sentence dealing with Bernoulli's principle:
*For steady incompressible inviscid flow along a streamline the total energy......?...... .* (2)

1.9 What do you understand by uniform flow? (2)

1.10 What are barometers used for? (1)

1.11 Is the statement that water is 100 times more compressible than steel, true or false? (1)

1.12 An atmospheric pressure of 90kPa can support a column of water ...... ?...... m tall in a water barometer. (2)

**[20]**

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## QUESTION 2

A 5-kg block slides down a smooth inclined surface as shown in Figure 1. The thin gap 0,5 mm wide between the block and the surface is filled with honey with a dynamic viscosity of 2,50 $Ns/m^2$. The area of contact between the block and the honey is 0,20 $m^2$.

2.1 Find the terminal sliding velocity of the block, assuming a linear velocity distribution in the gap.

**[10]**

## QUESTION 3

Figure 2 shows a vertical cross-section through a reinforced concrete water retaining structure to a scale of 1 in 25. Taking the specific weight of water as 10$kN/m^3$, determine the following:

3.1 The hydrostatic pressure intensity at the water surface; (1)

3.2 The hydrostatic pressure intensity at the bottom of the sloping wall; (1)

3.3 Draw in the pressure intensity distribution diagram on the Figure for the sloping wall. Use a scale of 1 cm = 10$kN/m^2$. Hand in the Figure with your script. (3)

3.4 The average hydrostatic pressure intensity on the sloping wall in $kN/m^2$; (2)

3.5 The length of the sloping wall that is in contact with the water; (2)

3.6 The hydrostatic force acting on the sloping wall in kN per m run; (2)

3.7 The length of the lever arm of the above force about point A; (2)

3.8 The moment of the above force about point A per m run. (2)

**[15]**

## QUESTION 4

A horizontal underwater steel pipeline to convey gas must be laid 25m deep (measured to the centreline of the pipe) in a fresh water lake. The fresh water has a density of 1000kg/m$^3$. The outside diameter of the pipeline is 450mm and has a wall thickness of 5mm. The pipeline will be anchored on the bottom of the lake at intervals of 5m by means of concrete anchor blocks. See Figure 3.

4.1 Calculate the dry mass of the steel pipeline per m length. Take the density of steel as 7900kg/m$^3$. (4)

4.2 Calculate the dry weight of the steel pipeline per m length. (2)

4.3 Calculate the buoyancy force acting on the submerged pipe per m length. (5)

4.4 Calculate the vertical force that the submerged pipeline exerts on each anchor block. (4)

4.5 What is the magnitude of the hydrostatic pressure acting round the outside of the submerged pipeline? (2)

4.6 What should the minimum volume of each concrete anchor block be? Take the dry weight of concrete as 22,6kN/m$^3$. (3)

**[20]**

## QUESTION 5

A vertical circular gate in a horizontal pipe through a concrete dam wall has its centerline at a depth of 6,350m below the water surface. The gate is 1,50m in diameter. See Figure 4.

5.1 Determine the total horizontal hydrostatic pressure (force) on the circular gate; (3)

5.2 Determine the depth to the centre of pressure. (5)

5.3 If the gate can rotate about a horizontal axis through its centre, what is the moment about this axis due to the hydrostatic force? (2)

**[10]**

## QUESTION 6

A horizontal 150mm x 100mm diameter nozzle conveying water has an inlet gauge pressure of 200kPa and an exit velocity of 10m/s discharging into the atmosphere. Ignore energy losses. See Figure 5.

6.1 Calculate the magnitude of the force in the flange bolts required to hold the nozzle in place due to the fact that the water in the nozzle is under pressure. (4)

6.2 Calculate the magnitude of the force in the flange bolts required to hold the nozzle in place due to the fact that the flow velocity of the water in the nozzle changes. (4)

6.3 Is the resultant force in the flange bolts a tensile (pull) or compressive force? (2)

**[10]**

## QUESTION 7

An open channel has a cross-section as shown in Figure 6. The depth of flow is 1,50m. The channel slopes at 1 in 1000 in the longitudinal direction.

7.1 Calculate the cross-sectional area of flow in $m^2$; (5)

7.2 Calculate the length of the wetted perimeter in m; (3)

7.3 Calculate the hydraulic radius in m; (2)

7.4 Calculate the average flow velocity in the channel in m/s using Manning's formula taking n = 0,0150. (3)

7.5 Calculate the discharge in $m^3/s$. (2)

**[15]**

**[TOTAL = 100]**

**HAND IN THE QUESTION PAPER WITH YOUR SCRIPT.**

# Formulae

$$p = \rho g h = \gamma h$$

$$p = \frac{F}{A}$$

$$\gamma = \rho g$$

$$\tau = \frac{F}{A} = \mu \frac{U}{t}$$

$$\nu = \frac{\mu}{\rho}$$

$$I_{rect} = \frac{1}{12} b d^3$$

$$F = \rho g \bar{y} A$$

$$\bar{h} = \frac{k^2 \sin^2 \theta}{\bar{y}} + \bar{y}$$

$$F_v = \rho g V$$

$$BM = \frac{I}{V}$$

$$I = A k^2$$

$$I_{circle} = \frac{\pi D^4}{64}$$

$$z_1 + \frac{p_1}{\rho g} + \frac{v_1^2}{2g} + h_p \quad = \quad z_2 + \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + h_l$$

$$v = \frac{1}{n} m^{\frac{2}{3}} i^{\frac{1}{2}}$$

$$m = \frac{A}{P}$$

$$F = \rho Q (v_2 - v_1) = m (v_2 - v_1)$$

$$f_1 ; f_2 = \pm \frac{F}{A} \pm \frac{My}{I}$$

$$P = \rho g Q H$$

HYDAULICS II - CEW2A11 ANNEXURE 1

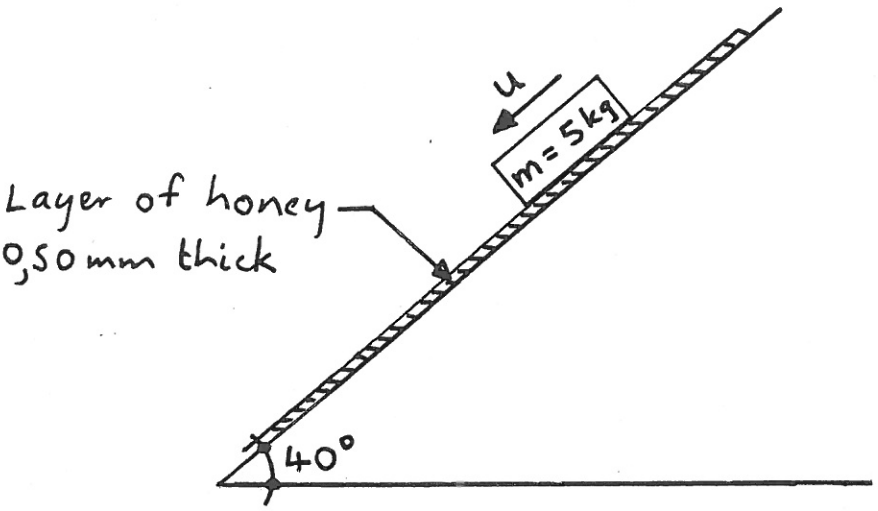


Figure 1

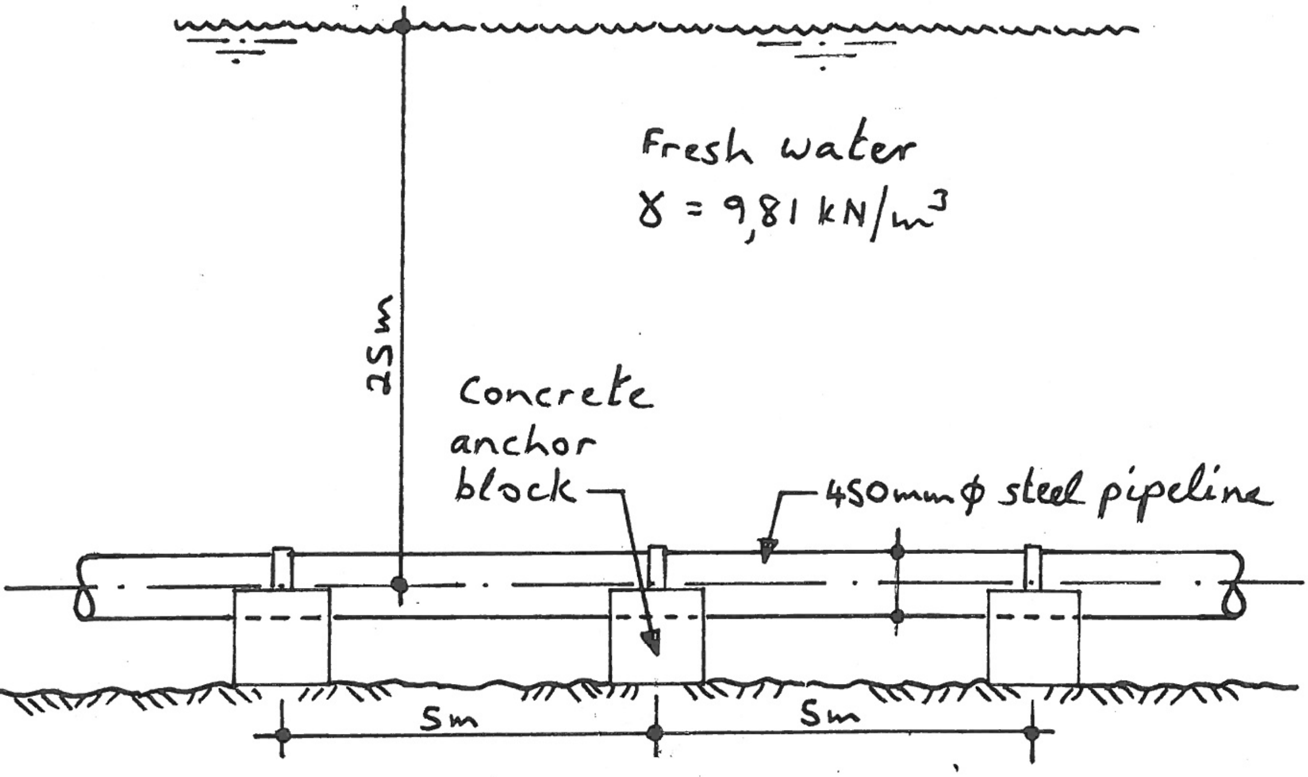


Figure 3 Not to scale

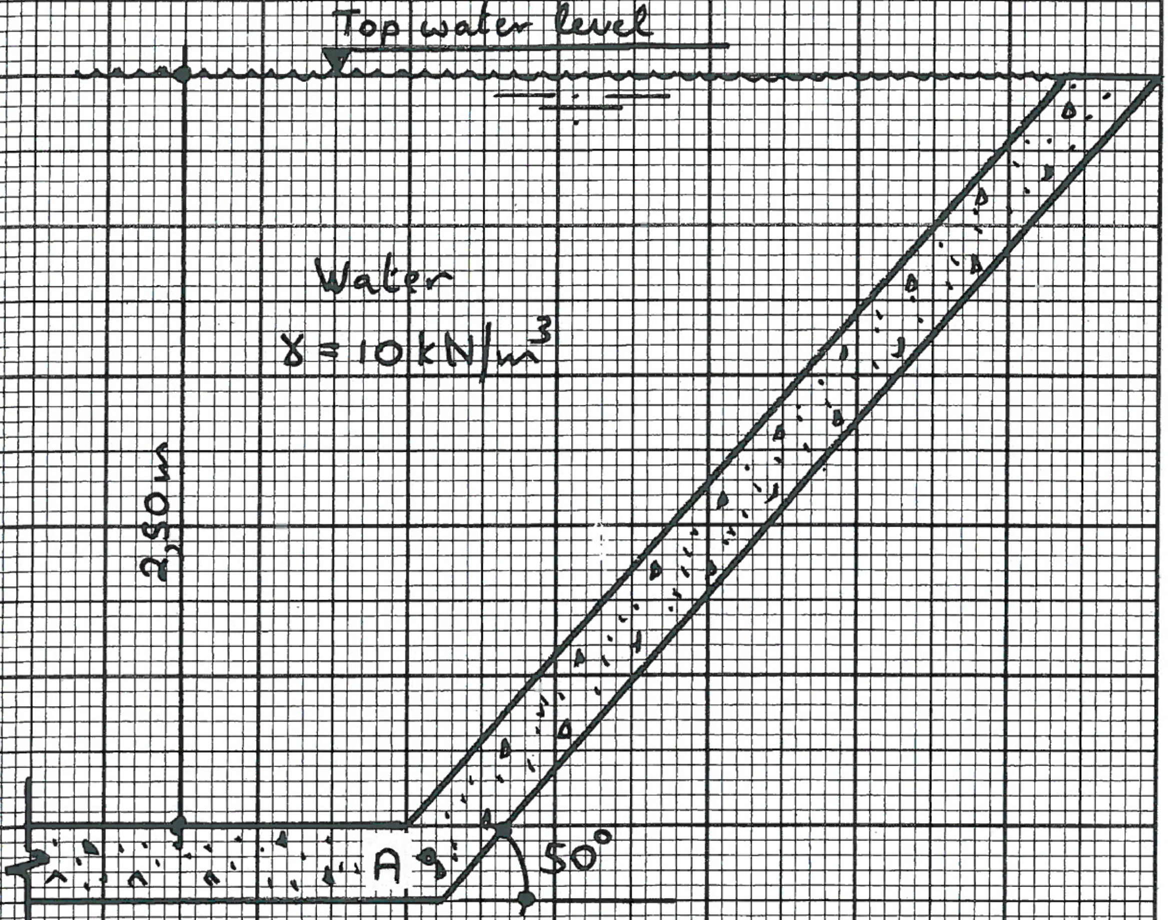


FIGURE 2

Cross-section through water retaining structure

Scale : 1 in 25

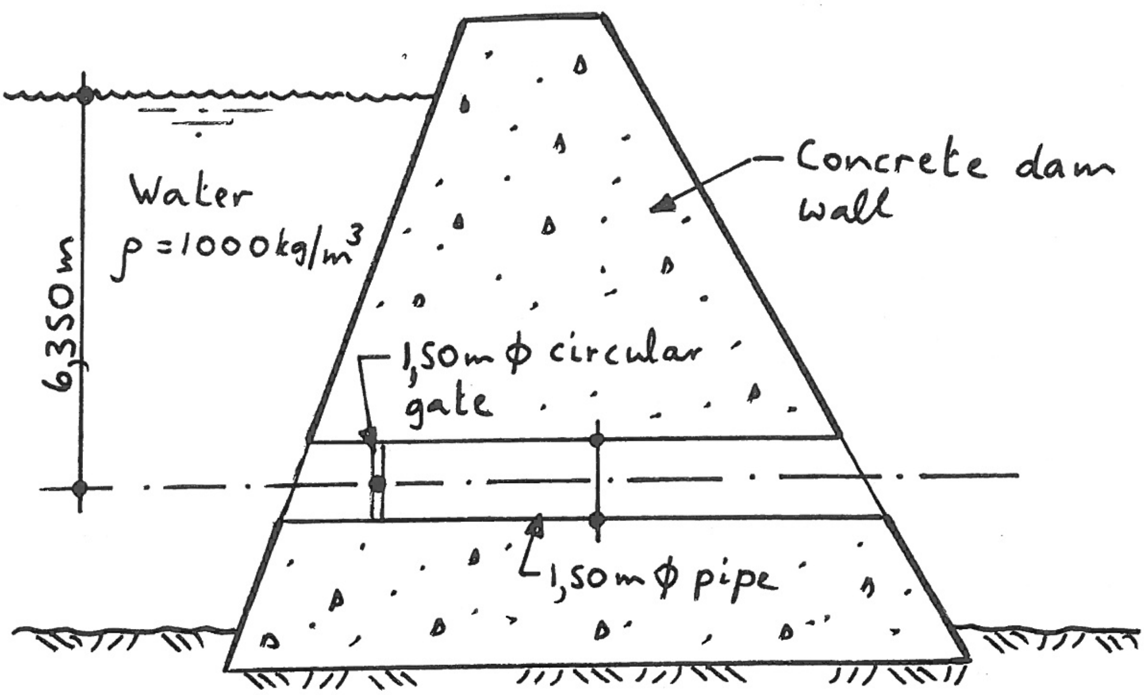


Figure 4
n.t.s.

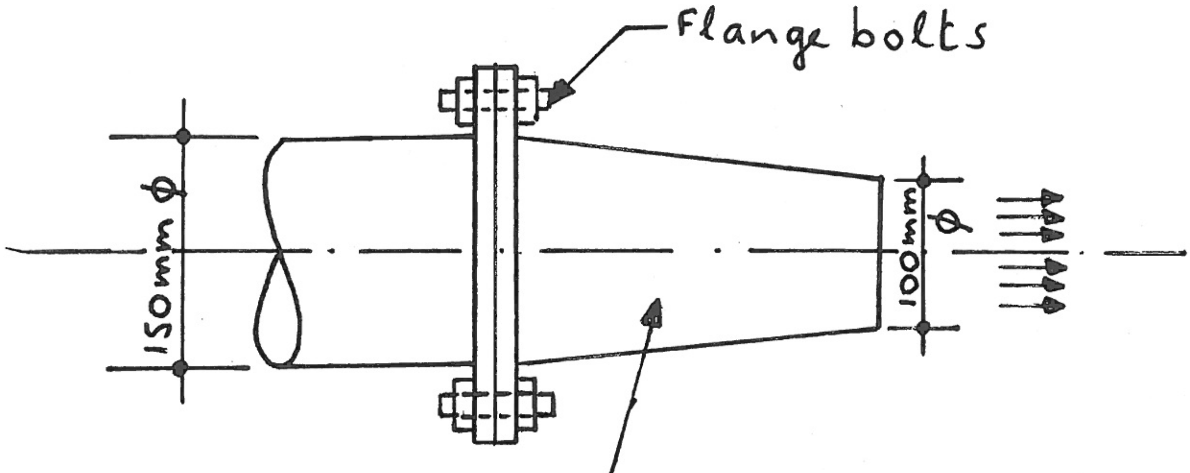


Figure 5
n.t.s.

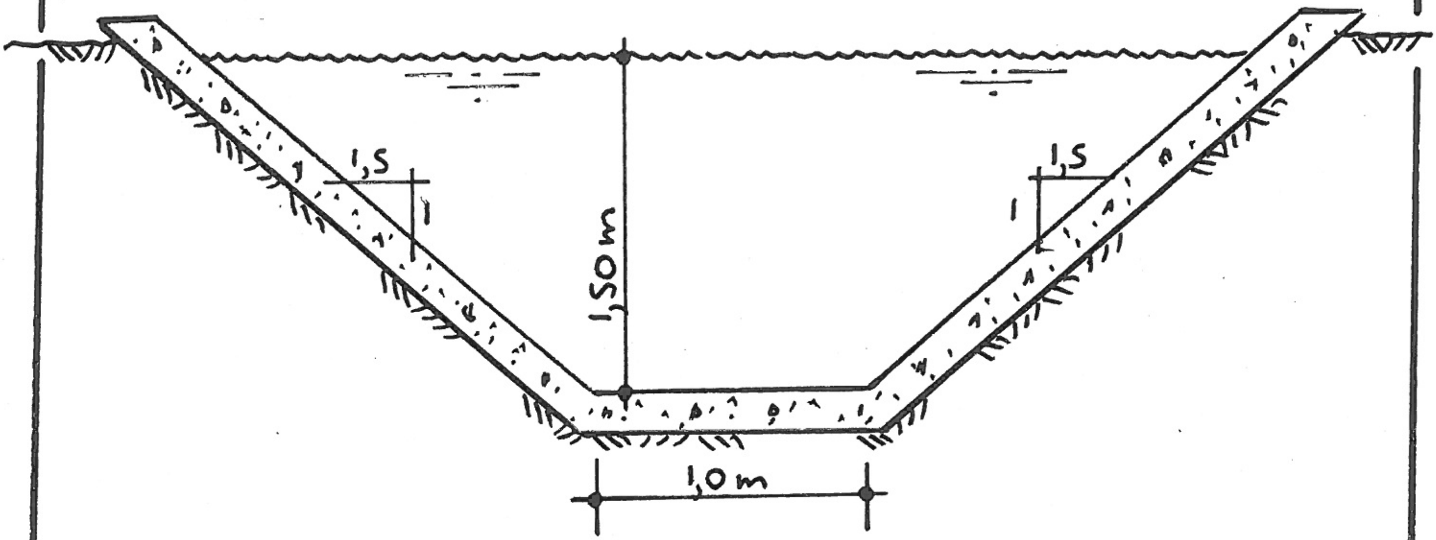


Figure 6
n.t.s