UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING : CIVIL*
SUBJECT	:	**HYDRAULICS 2A**
CODE	:	**CEW2A11**
DATE	:	WINTER EXAMINATION 30 MAY, 2015
DURATION	:	(X-PAPER) 08:30 - 11:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	120

EXAMINER	:	MR LF SHIRLEY MR DT CHABALALA	80609822
MODERATOR	:	DR AM CASSA	2254
NUMBER OF PAGES	:	5 PAGES, 1 FORMULAE SHEET AND 5 ANNEXURES	

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

HAND IN THE QUESTION PAPER WITH YOUR SCRIPT.

INSTRUCTIONS TO CANDIDATES:

ANSWER ALL THE QUESTIONS.

QUESTION 1

1.1 Define an ideal fluid. (2)

1.2 Given that 1 litre of water has a mass of 1 kilogram, show that 1 cubic metre of water weighs 9810 newton. (2)

1.3 State whether the following statement is true or false: The viscosity of a liquid decreases with increase in temperature. (2)

1.4 State Archimedes's Law in words. (2)

1.5 Show that the unit of $p/\rho g$ is metres. (2)

[10]

QUESTION 2

Annexure 1 shows a closed square container fitted with a vertical standpipe. Water fills the container and is to a height of 2,0m in the standpipe.

2.1 Calculate the pressure in kN/m^2 acting on the bottom of the container.

[5]

QUESTION 3

3.1 Calculate the bending moment in kN-m about horizontal axis X-X (into the paper) due to the hydrostatic force acting on the side of the container shown in Annexure 2. The side of the container is 10m long into the paper. (20)

3.2 Draw in the pressure distribution diagram (pdd) on the Annexure to a scale of $1cm = 10kN/m^2$. The Annexure must be handed in with your script. (5)

[25]

QUESTION 4

Calculate the foundation stresses in kN/m^2 underneath the toe and heel of the concrete weir shown in Annexure 3. Assume water seeps through underneath the structure and exits at the toe into the atmosphere. Analyze the forces and moments acting on the structure per metre run of weir into the paper. **[25]**

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

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

QUESTION 5

A circular plate of 1,50 m diameter is immersed in water such that its least and greatest depth below the water surface is 500 mm and 750 mm respectively.

5.1 Calculate the hydrostatic pressure (force) acting on one side of the surface. (4)

5.2 Calculate the depth to the centre of pressure of the above force. (6)

$$F = \gamma \bar{y} A$$

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

$$I = Ak^2$$

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

[10]

QUESTION 6

The depth of flow in a triangular concrete channel with sides making 45° with the horizontal is d. See Annexure 4.

6.1 Write down a mathematical expression for the cross-sectional area of flow in the channel in terms of d; (3)

6.2 Write down a mathematical expression for the wetted perimeter of the flow in the channel in terms of d; (3)

6.3 Write down a mathematical expression for the hydraulic radius of the flow in the channel in terms of d; (2)

6.4 Calculate the average flow velocity in the channel using Manning's formula taking n = 0,0150 and d = 1,250m. The channel falls 1m over a horizontal distance of 2km; (4)

6.5 Calculate the flow in the channel in m^3/s for the conditions given under Question 6.4. (3)

$$v = \frac{1}{n} m^{\frac{2}{3}} i^{\frac{1}{2}}$$
$$m = \frac{A}{P}$$
$$Q = Av$$

[15]

QUESTION 7

Annexure 4 shows a float valve that must cut of the water supply to a water tank when the water in the tank reaches a certain level.

7.1 Calculate the required diameter of the float if the valve is to shut against a maximum inlet pressure of 200 kPa when the float is half submerged. Ignore the weight of the piston and float.

$$Vol_{sphere} = \frac{4}{3}\pi r^3 = \frac{\pi}{6} d^3$$

[10]

QUESTION 8

A compressor takes in air at a flow rate of 30ℓ/s. The air is compressed and leaves the compressor through a 25mm diameter pipe at a velocity of 2,5m/s. If the initial density of the air is $1{,}20 kg/m^3$, calculate the final density.

$$\dot{m}_1 = \dot{m}_2$$

[5]

QUESTION 9

Water flows through a 50mm diameter pipe from a tank as shown in Annexure 5, discharging into the atmosphere.

9.1 Ignoring all energy losses, calculate the flow rate Q in ℓ/s.

$$z + \frac{p}{\rho g} + \frac{v^2}{2g} = Constant$$

[5]

QUESTION 10

A horizontal 200mm x 100mm diameter reducing nozzle conveying water has an inlet gauge pressure of 100kPa and an exit velocity of 10m/s discharging into the atmosphere at the 100mm diameter side.

10.1 Calculate the magnitude of the static and dynamic forces acting on the nozzle. (8)

10.2 If the flow is from the 200mm diameter side to the 100mm diameter side (left to right), is the resultant force acting on the nozzle from left to right or right to left? (2)
[10]

[TOTAL =120]

HAND IN THE QUESTION PAPER WITH YOUR SCRIPT.

Formulae

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

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

$$\gamma = \rho g$$

$$\tau = \frac{F}{A} = \mu \frac{dv}{dy}$$

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

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

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

$$I_{triangle} = \frac{b h^3}{36}$$

$$F = \gamma A \bar{y}$$

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

$$F_h = \gamma A_p \bar{y}$$

$$F_v = \rho g V = \gamma V$$

$$R = \sqrt{F_h^2 + F_v^2}$$

$$\tan^{-1} \Theta = \frac{F_v}{F_h}$$

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

$$I = A k^2$$

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

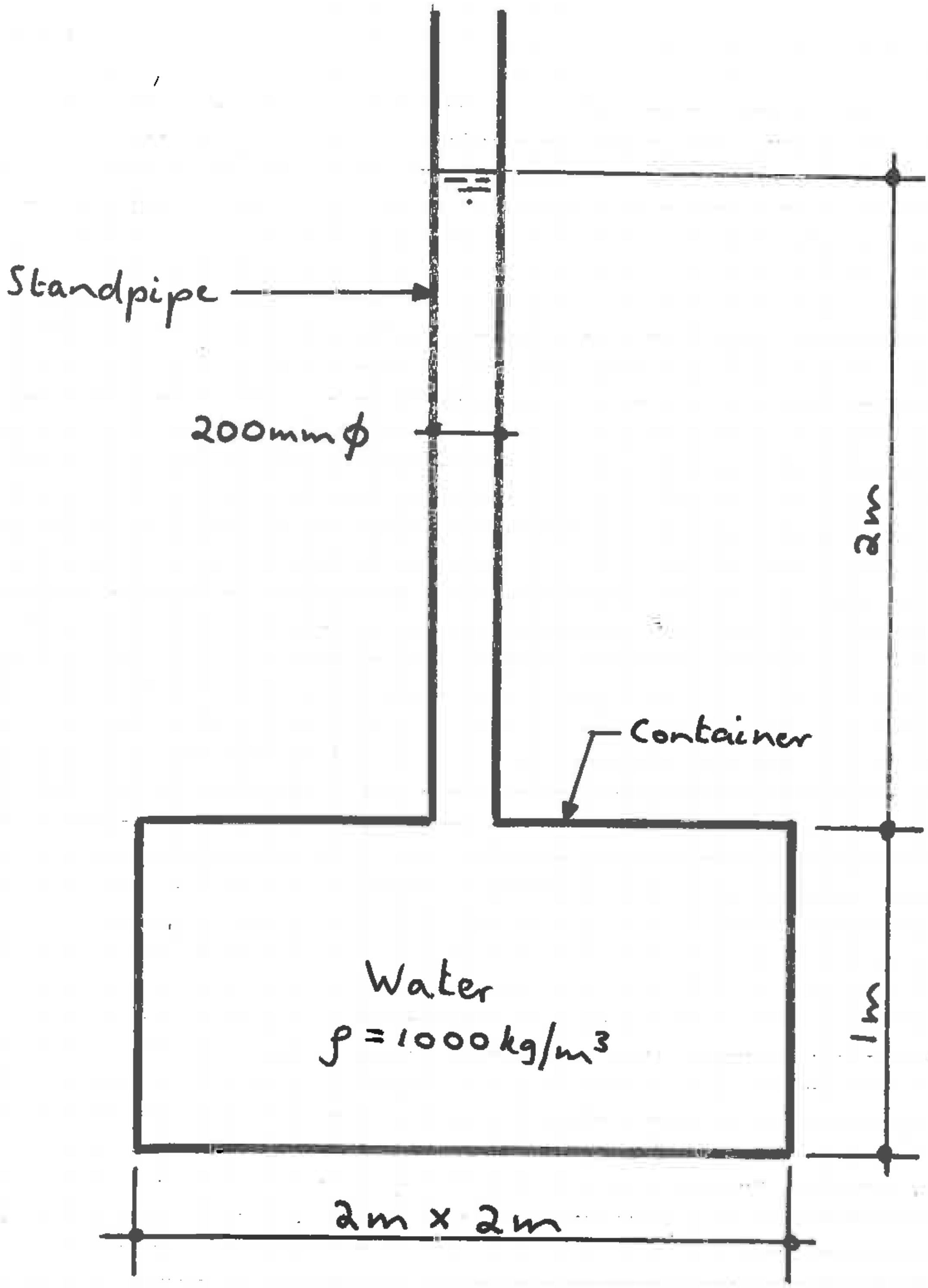
$$v = \frac{1}{n} m^{\frac{2}{3}} i^{\frac{1}{2}}$$

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

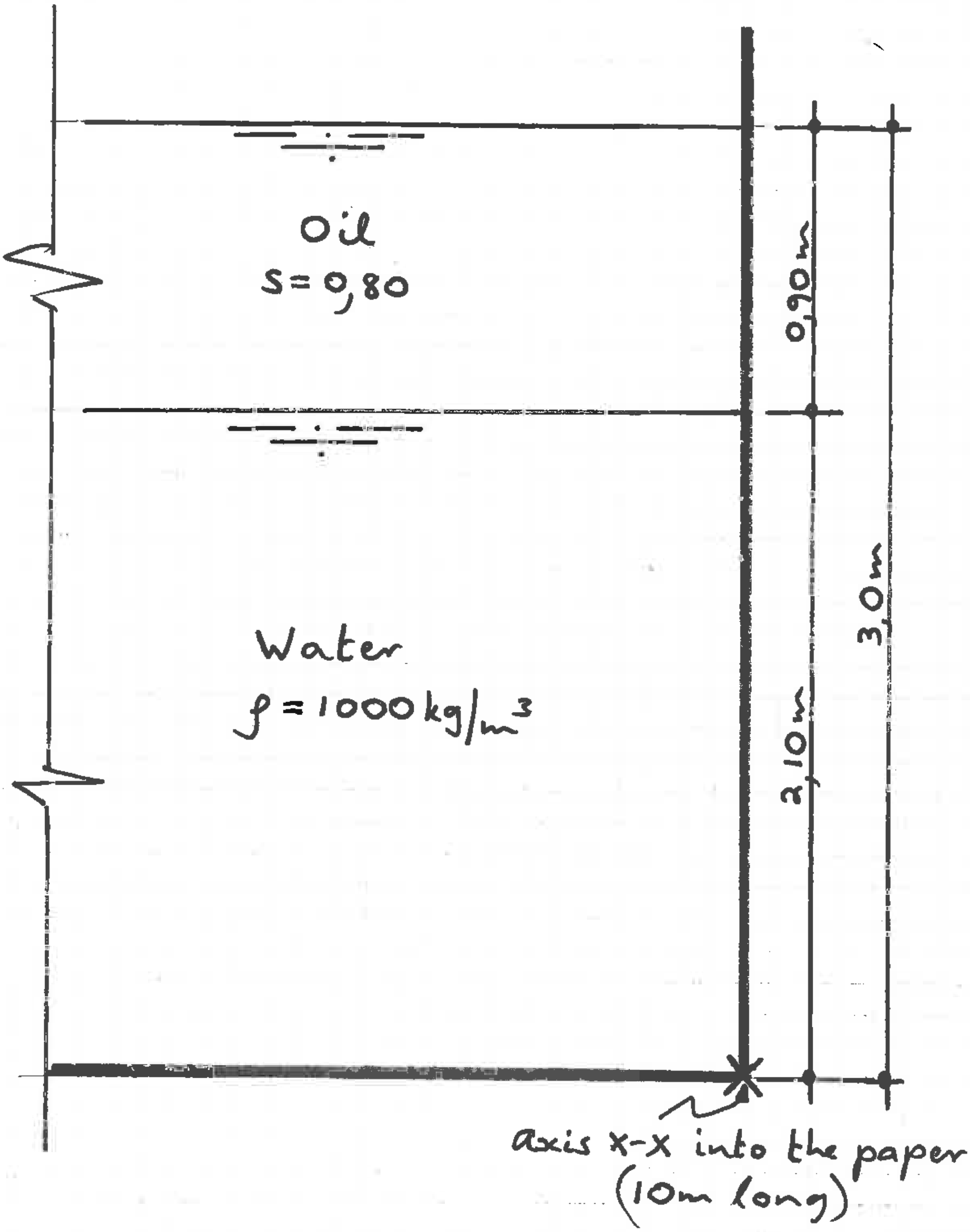
$$f_1 ; f_2 = \pm \frac{F}{A} \pm \frac{My}{I}$$

$$P = \rho g Q H$$

$$Q = av$$

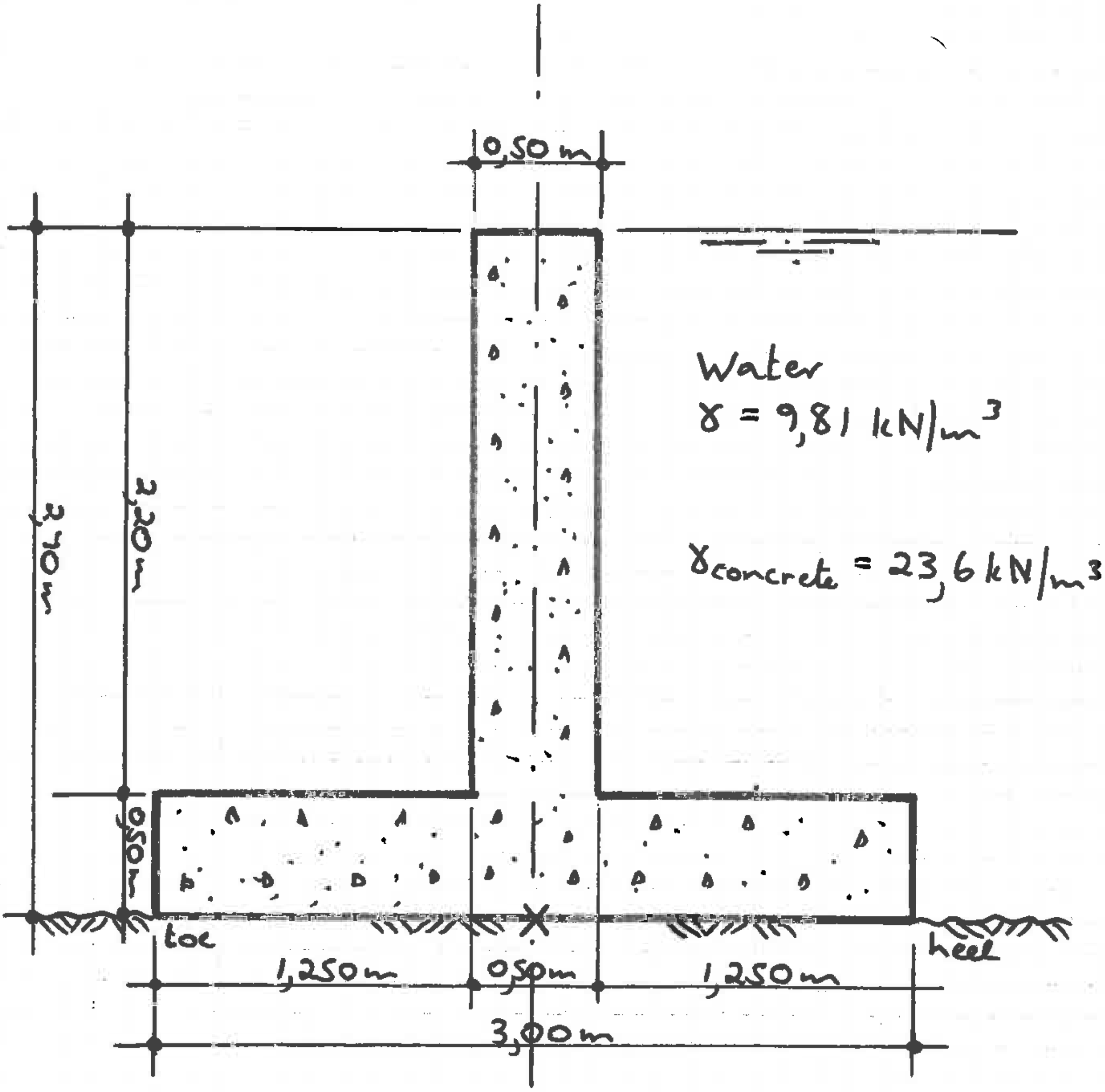


Cross-section through container and standpipe
(n.t.s.)



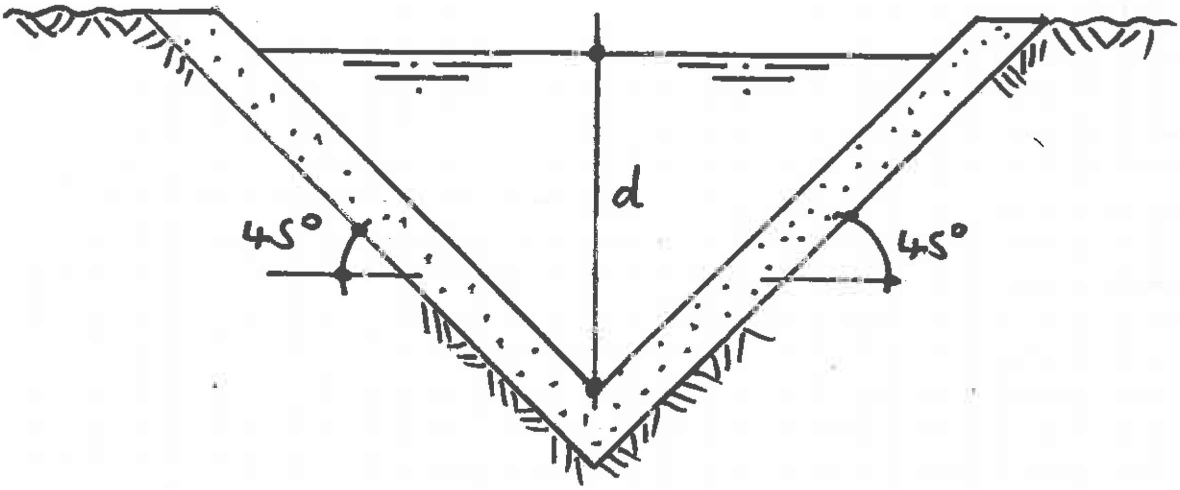
Cross-section through container

Scale 1 in 20

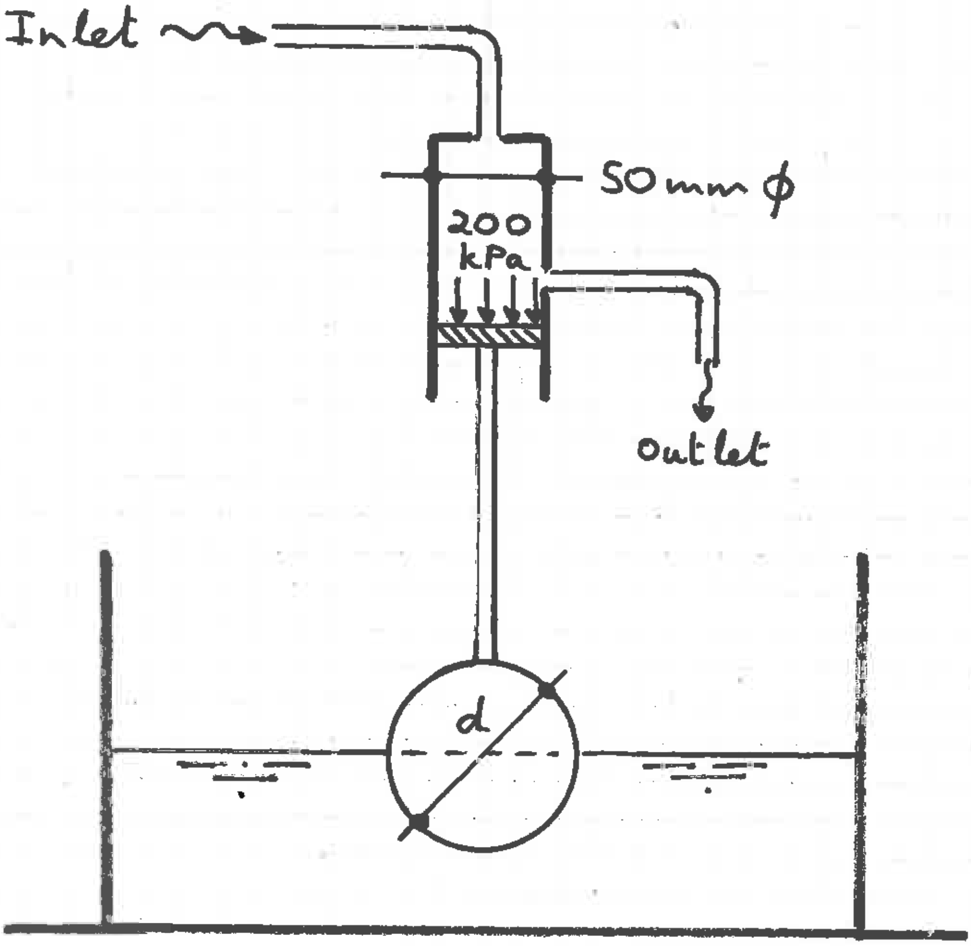


Cross-section through weir

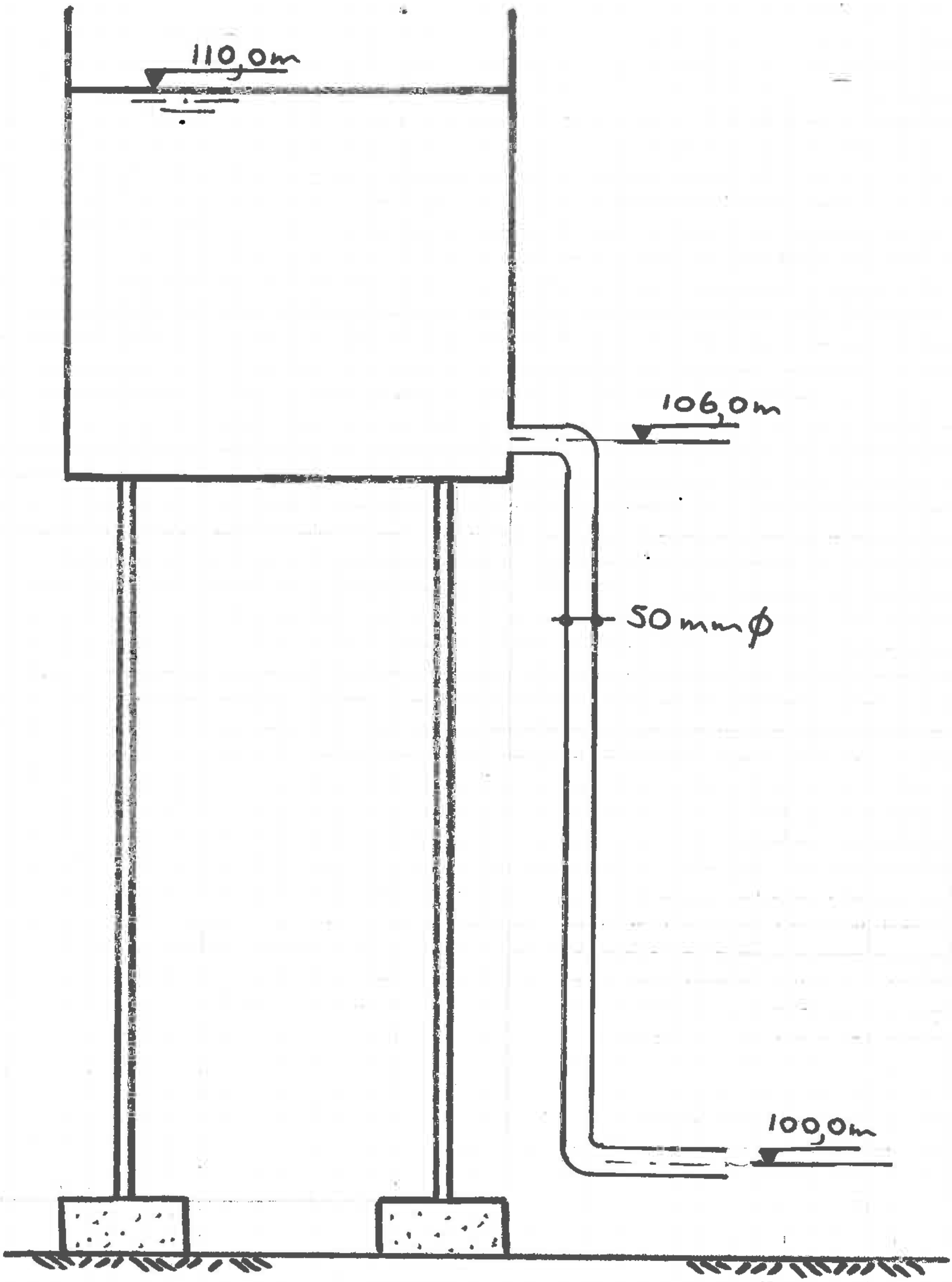
Scale 1 in 25



Cross-section through open channel



Details of float valve (n.t.s.)


110,0m
106,0m
50mm ϕ
100,0m