higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T720**(E)**(A1)T

NATIONAL CERTIFICATE

FLUID MECHANICS N6

(8190216)

1 August 2018 (X-Paper)
09:00–12:00

Nonprogrammable calculators may be used.

This question paper consists of 6 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
FLUID MECHANICS N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Show ALL the necessary steps for every calculation. Units must be shown in ALL final answers.
5. Round off your final answers to THREE decimal places.
6. Use g = 9,81 m/s^2.
7. NO sketches in this question paper are drawn to scale.
8. Write neatly and legibly.

QUESTION 1

1.1 Differentiate between the *hydraulic mean depth* and *hydraulic gradient*.

NOTE: Do not use formulae to differentiate. (2)

1.2 Water flows at 4 m/s when entering a pipe with an inlet diameter of 90 mm and an outlet diameter of 150 mm.

Calculate the velocity at exit. (3)

1.3 Refer to the FIGURE 1 below and determine the hydraulic mean depth if the tank is half filled with water.

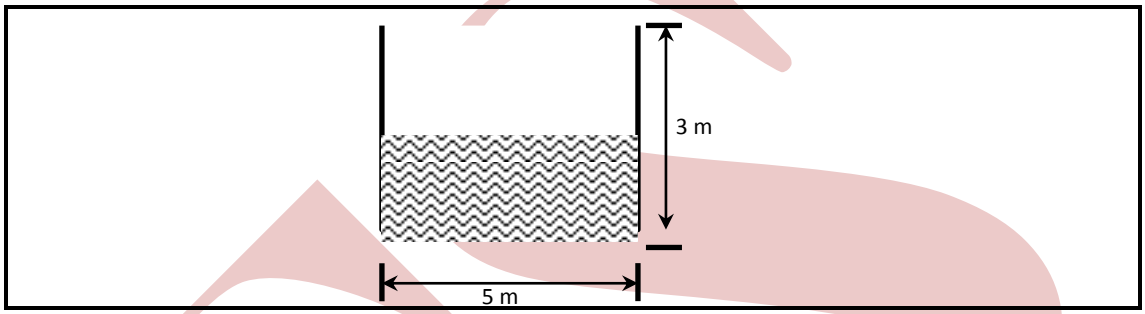


FIGURE 1 (3)

1.4 Refer to the FIGURE 2 below and determine the head loss due to sudden enlargement.

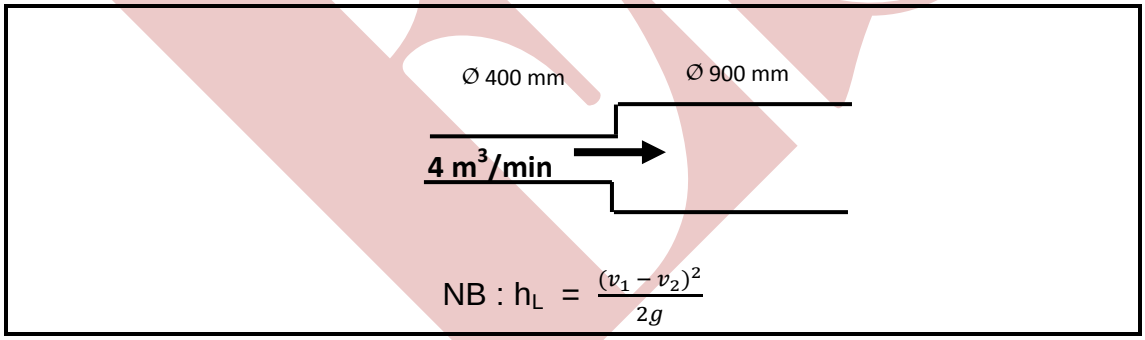


FIGURE 2 (6)

1.5 Two reservoirs are connected by means of a pipe 650 m long and 150 mm in diameter. The surface of the water in the upper reservoir is 25 m above the level of water in the lower reservoir. Take f = 0,002.

Determine the following:

1.5.1 The sum of all the head losses in terms of V_1 (the velocity of water in the pipe) (7)

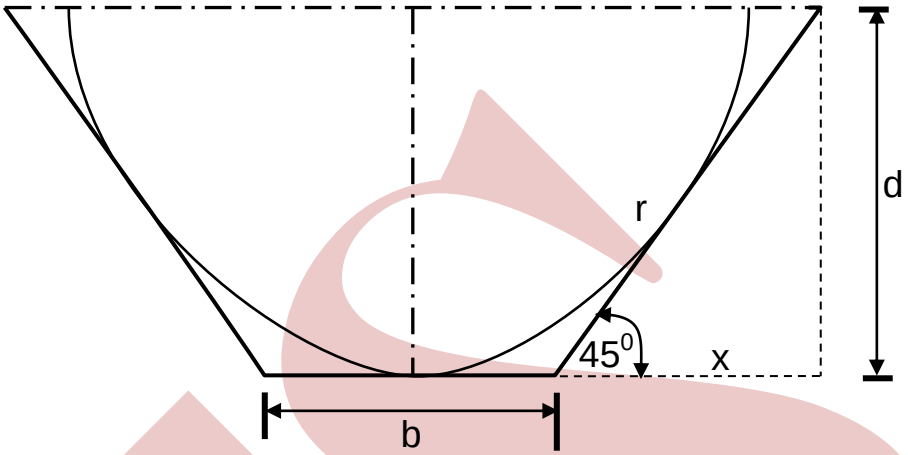
1.5.2 The velocity of water in the pipe (2)

1.5.3 The discharge (2)

[25]

QUESTION 2

2.1 FIGURE 3 below shows a cross section trapezoidal channel with a gradient of 1 in 8 500 that is to be designed to deliver 8 m^3/s of water. Take C as 50 in the Chezy formula, its side slope as 45° and the cross section to be minimum.



HINT: $r = \frac{1}{2}b + x$

FIGURE 3

Determine the following:

2.1.1 The depth (d) of the water flowing (10)

2.1.2 The width (b) of the channel (2)

2.2 A 90° V notch has a coefficient of discharge of 0,7 and the head above the bottom of the notch is 800 mm.

Calculate the quantity of water in l/s. (4)

2.3 A tank, 2,5 m high, standing on the ground, is kept full of water. There is an orifice in its vertical side at a depth h metres below the surface.

Calculate the value of h in order for the jet to strike the ground at a maximum distance of 1,8 m from the tank. The coefficient of velocity is 0,86. (9)

[25]

QUESTION 3

3.1 A pump supplies water at a pressure of 6,5 MN/m^2 to one end of a pipeline. The pipeline is 3,5 km long and has a diameter of 250 mm. Assume f = 0,006 and that maximum power is achieved when the head loss is a quarter of the pressure head.

Calculate the rate of flow in l/s. (7)

3.2 Below are the specifications of a new operating reciprocating pump:

Stroke:	0,45
Plunger diameter:	0,1 m
Suction head:	4,05 m
Delivery head:	31 m
Suction length:	7 m
Delivery length:	35 m
Ha_t:	9,6 m
Pipe diameter:	0,06 m
Pump speed:	35 r/min
Friction factor:	0,01

Calculate the following:

3.2.1 The acceleration head during suction stroke (2)

3.2.2 The acceleration head during delivery stroke (2)

3.2.3 The friction head during suction stroke (2)

3.2.4 The friction head during delivery stroke (2)

3.2.5 The pressure head on the piston:

(a) At the beginning of delivery stroke

(b) At the middle of delivery stroke

(c) At the end of delivery stroke

(3 × 2) (6)

3.3 A fan extracts 8 m^3/s air at a pressure of 200 Pa through a 50 m long circular duct. The coefficient of friction is 0,00445.

Determine the diameter (in mm) of the duct through which the air is flowing. (9)

[30]

QUESTION 4

4.1 In an inward flow reaction turbine, the supply head is 15 m and the maximum discharge is 0,82 m^3/s. The external diameter = 2 (internal diameter) and the velocity of flow is constant and equal to $0{,}17\sqrt{2gh}$. The runner vanes are radial at inlet and the runner rotates at 350 r/min. The hydraulic efficiency is 8% and the vanes occupy 10% of the circumference.

Calculate the following:

4.1.1 The velocity of flow (2)

4.1.2 The theoretical head (2)

4.1.3 Inlet tangential velocity of runner (2)

4.1.4 The guide vane angle (2)

4.1.5 The vane angle at exit for radial discharge (4)

4.1.6 The external and internal diameters (3)

4.2 A single jet Pelton wheel with a head 250 m over the nozzle has its bucket on a circle of 0,8 m diameter. The velocity of the water jet is 67 m/s, and the bucket has a deflecting angle of 160° under maximum efficiency conditions.

NOTE: For maximum efficiency U = 0,5 V.

Calculate the following:

4.2.1 The maximum hydraulic efficiency of the runner (3)

4.2.2 The theoretical speed in r/min for maximum hydraulic efficiency (2)

[20]

TOTAL: 100