higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

FLUID MECHANICS N6

(8190216)

6 August 2019 (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. Sketches must be large, neat and fully labelled.
5. Round off final answers to THREE decimals where necessary.
6. Diagrams and sketches are not drawn to scale.
7. Use g = 9,81 m/s^2.
8. Write neatly and legibly.

QUESTION 1

1.1 Define *laminar flow.* (2)

1.2 What is meant by the *wetted perimeter* of a pipe? (1)

1.3 Every minute 820 litres of oil with a relative density of 0,89 leaves a pipe with a diameter of 360 mm in diameter to accumulate in a container as shown in FIGURE 1.

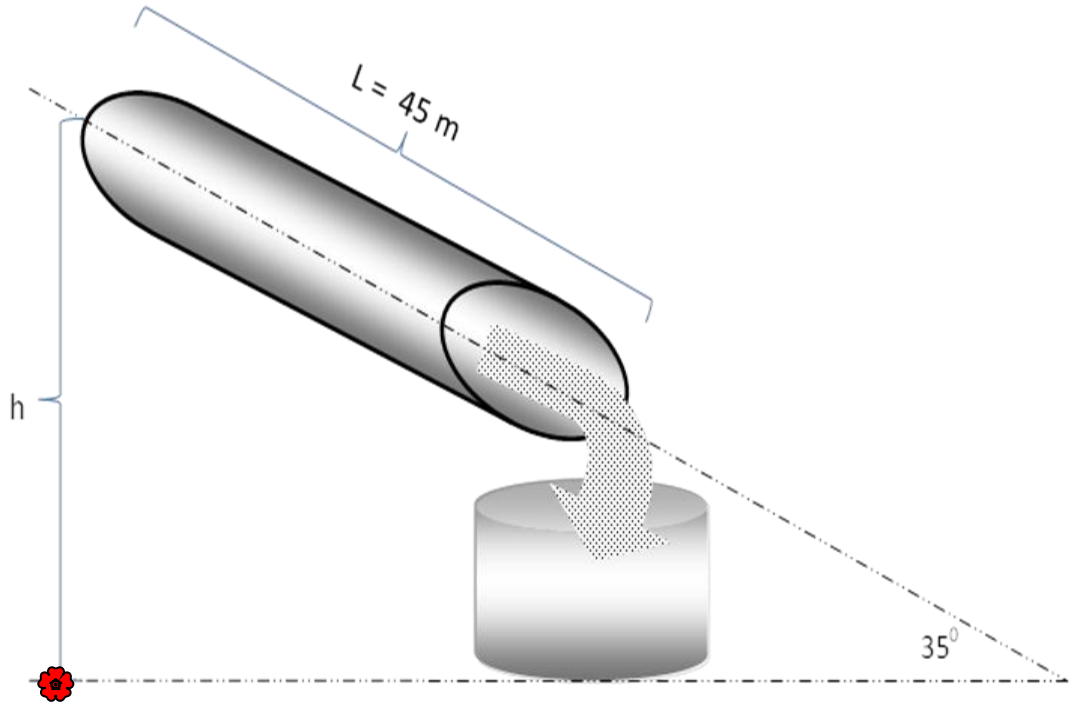

FIGURE 1

Calculate the following:

1.3.1 Discharge in m^3/s

1.3.2 Rubbing surface area if the pipe is 45 m in length

1.3.3 Cross-sectional area

1.3.4 Height (h)

1.3.5 Speed at which oil flows in the pipe

(5 × 2) (10)

1.4 A horizontal pipeline with a diameter of 350 mm discharges 288 cubic metres of water per hour. A reducing piece is inserted at the end of the pipeline which reduces the diameter uniformly and gradually to a diameter of 150 mm.

Calculate the pressure difference between the two pipe sections with diameters of 350 mm and 150 mm respectively. Ignore friction. (7)

1.5 A steel pipe with a diameter of 400 mm and a length of 1,5 km discharges water at 2,37 m^3/min. The friction factor (f) for the pipe is 0,02.

Use Chezy's formula and calculate the head loss due to friction. (9)
[29]

QUESTION 2

2.1 The cross section of an open V-shaped channel shown in FIGURE 2 is filled with water. The gradient of the channel is 1 in 2 550 and C in the Chezy formula is 50. The maximum depth of the channel is 1 650 mm.

Calculate the discharge in ℓ/s.

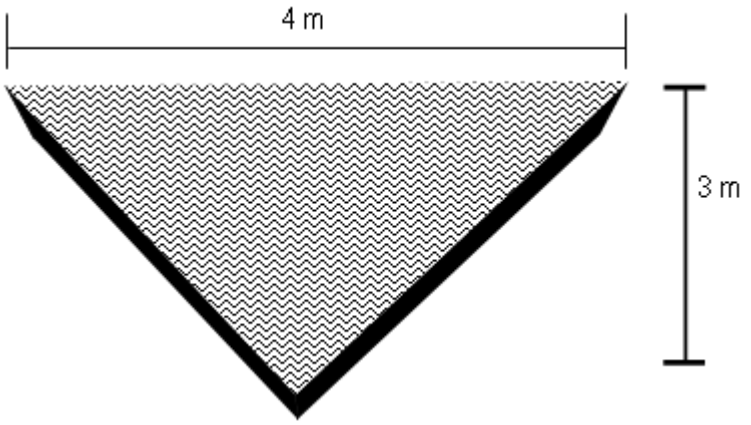

FIGURE 2 (9)

2.2 A 90° V-notch has a coefficient of discharge of 0,8.

Calculate the quantity of water in m^3/s flowing over the notch if the observed head above the bottom of the notch is 895 mm. (3)

2.3 A circular orifice, 50 mm in diameter, is made in the vertical side of a tank.

A jet falls vertically through 0,77 m while moving horizontally through 1,87 m. The discharge of water is 0,24 m^3/s:

Calculate the following:

2.3.1 Horizontal reaction of the jet on the tank (5)

2.3.2 Head of water above the orifice if the coefficient of velocity is 0,98 (2)

2.3.3 Theoretical discharge in ℓ/s (3)
[22]

QUESTION 3

3.1 Name TWO groups into which fans are classified. (2)

3.2 The pressure required to overcome the friction in the duct of a fan is 180 Pa. It extracts air through a 750 mm diameter duct 60 m long.

Calculate the quantity of air extracted through this duct. Take k in Atkinson's formula as 0,005. (6)

3.3 Two similar single-acting plunger pumps, each capable of delivering 42 300 litres of water per hour, are connected in parallel so that they operate through a common delivery pipeline. The static head is 206 m and when one pump operates alone, the total pressure head is 258,5 m. Assume the same friction factor for all the pipes as well as uniform harmonic motion for the plungers and a pump efficiency of 85%.

Calculate the power required for each of the following:

3.3.1 One pump operating by itself (4)

3.3.2 Both pumps operating simultaneously (6)

3.4 What is the operational difference between the *centrifugal* and the *reciprocating* pump? (2)

3.5 Define the following terms associated with a reciprocating pump:

3.5.1 Relative velocity

3.5.2 Absolute velocity

(2 × 1) (2)

3.6. During a 24-hour day a centrifugal pump has to deliver 12,24 mℓ of water through a 450 mm diameter level pipeline 26 km long. The pump is coupled directly to an electric motor. The coefficient of friction for the pipe is 0,007 and the overall efficiency of the pump and drive is 78%.

Calculate the power required to overcome pipe friction. (6)

[28]

QUESTION 4

4.1 The diameter across the tips of the top vane of an inward-flow turbine is 1,2 m while the diameter across the bottom of the vanes is 0,6 m. The speed of the turbine wheel is 300 r/min. Water is supplied at 36 m/s through the fixed vanes which have an angle of 30° to the wheel tangent. At the inlet the water leaves the wheel with an absolute velocity of 3 m/s at an angle of 120° to the wheel tangent.

Analytically determine each of the following:

4.1.1 Velocity of whirl at inlet and outlet of turbine (4)

4.1.2 Vane angles at entry of moving vanes to ensure water enters and leaves without shock (8)

4.2 A single-jet Pelton wheel with a head of 245 m over the nozzle has its buckets on the circle of 0,9 m diameter. The deflecting angle of the buckets is 160° and the coefficient of velocity for the nozzle is 0,97.

Calculate each of the following:

4.2.1 Theoretical speed in r/min for maximum efficiency (6)

4.2.2 Maximum hydraulic efficiency of the runner (3)

[21]

TOTAL: 100