



# higher education & training

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Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

## **MARKING GUIDELINE**

**NATIONAL CERTIFICATE**

**FLUID MECHANICS N6**

**29 November 2024**

**This marking guideline consists of 8 pages.**

## QUESTION 1

1.1 Particles that flow in an orderly manner, occupying different relative positions in successive cross section.✓✓ (2)

1.2 1.2.1  $Q = A_1 V_1$

$$0,02 = \frac{\pi \times 0,15^2}{4} \times V_1 \checkmark$$

$$V_1 = 1,132 \text{ m/s} \checkmark$$

1.2.2  $Q_3 = A_2 V_2$

$$= \frac{\pi \times 0,05^2}{4} \times 3 \checkmark$$

$$Q_3 = 0,00589 \text{ m}^3/\text{s} \checkmark$$

1.2.3  $Q_1 = Q_2 + Q_3$   
 $0,02 = Q_2 + 0,00589 \checkmark$

$$Q_2 = 0,0141 \text{ m}^3/\text{s} \checkmark$$

1.2.4  $Q_2 = A_3 V_3$

$$0,0141 = \frac{\pi \times 0,1^2}{4} \times V_3 \checkmark$$

$$V_1 = 1,797 \text{ m/s} \checkmark$$

(4 × 2) (8)

1.3 1.3.1 
$$h_{lT} = \frac{4fLV_1^2}{2gd} + \frac{0,5V_1^2}{2g} + \frac{V_1^2}{2g} \checkmark$$

$$= \frac{4 \times 0,005 \times 500 \times V_1^2 \checkmark}{2 \times 9,81 \times 0,16} + \frac{0,5V_1^2}{2 \times 9,81} + \frac{V_1^2}{2 \times 9,81} \checkmark$$

$$= 3,186 V_1^2 + 0,0255 V_1^2 + 0,051 V_1^2 \checkmark \checkmark$$

$$h_{lT} = 3,263 V_1^2 \checkmark$$

(6)

1.3.2  $h_{lT} = 10$   
 $10 = 3,263 V_1^2 \checkmark$

$$V_1 = 0,571 \text{ m/s} \checkmark$$

(2)

1.3.3  $Q = A_1 V_1$

$$= \frac{\pi \times 0,16^2}{4} \times 0,571 \checkmark$$

$$= 0,0115 \text{ m}^3/\text{s} \checkmark$$

$$\begin{aligned}
 1.4 \quad 1.4.1 \quad i &= \frac{hf}{L} \\
 &= \frac{25}{200} \\
 &= 0,125 \checkmark
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 1.4.2 \quad m &= \frac{d}{4} \\
 &= \frac{0,105}{4} \\
 &= 0,0263 \checkmark
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 1.4.3 \quad C &= \sqrt{\frac{2g}{f}} \\
 60 &= \sqrt{\frac{2 \times 9,81}{f}} \checkmark \\
 f &= 0,00545 \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 1.4.4 \quad Q &= AC\sqrt{mi} \\
 \frac{1680}{1000} \checkmark &= \frac{\pi \times d^2}{4} \times 60 \times \sqrt{0,0263 \times 0,125} \checkmark \\
 1,68 &= d^2 \times 2,702 \checkmark \\
 d &= 0,789 \text{ m} \checkmark
 \end{aligned} \tag{4}$$

**[28]**

## QUESTION 2

$$\begin{array}{ll} 2.1 & 2.1.1 \\ & 0,5b + d = \sqrt{2} \times d \\ & 0,5b = 0,414d \end{array}$$

$$b = 0,828d \checkmark$$

$$\begin{aligned} A &= d \left( b + \frac{d}{\tan 45} \right) \checkmark \\ &= d(0,828d + d) \\ &= 0,828d^2 + d^2 \\ &= 1,828d^2 \checkmark \end{aligned}$$

$$\begin{aligned} p &= b + \left( 2 \times \frac{d}{\sin 45} \right) \checkmark \\ &= 0,828d + 2,828d \\ &= 3,656d \checkmark \end{aligned}$$

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

$$\begin{aligned} m &= \frac{1,828d^2}{3,656d} \checkmark \\ &= 0,5d \checkmark \end{aligned}$$

$$Q = AC\sqrt{mi}$$

$$\begin{aligned} 7.5 &= 1,828d^2 \times 50 \times \sqrt{0,5d \times \frac{1}{1700}} \checkmark \\ 56,25 &= 2,457d^5 \checkmark \end{aligned}$$

$$d = 1,870 \text{ m} \checkmark \quad (10)$$

$$\begin{array}{ll} 2.1.2 & b = 0,828d \\ & = 0,828 \times 1,870 \checkmark \\ & = 1,548 \text{ m} \checkmark \end{array}$$

(2)

2.2

$$A_a = \frac{\pi \times 0,019^2}{4}$$

$$= 0,000284 \text{ m}^2$$

$$C_c = \frac{A_a}{A_t}$$

$$= \frac{0,000284}{320 \times 10^{-6}} \checkmark$$

$$= 0,888 \checkmark$$

$$V_t = \sqrt{2 \times 9,81 \times h}$$

$$= \sqrt{2 \times 9,81 \times 56}$$

$$= 33,147 \text{ m/s} \checkmark$$

$$Q_a = V_a \times A_s$$

$$\frac{410}{1000 \times 60} = V_a \times 0,000284 \checkmark$$

$$V_a = 24,061 \text{ m/s} \checkmark$$

$$C_v = \frac{24,061}{33,147}$$

$$= 0,726 \checkmark$$

$$Q_t = A_t \times V_t$$

$$= 320 \times 10^{-6} \times 33,147 \checkmark$$

$$= 0,0106 \text{ m}^3/\text{s} \checkmark$$

$$C_d = \frac{Q_a}{Q_t}$$

$$= \frac{0,00683}{0,0106}$$

$$= 0,644 \checkmark$$

(9)  
[21]

### QUESTION 3

3.1 3.1.1

$$Q = ALSE \frac{N}{60}$$

$$= \frac{\pi \times 0,15^2}{4} \times 0,3 \times 1 \times 1 \times \frac{50}{60} \checkmark$$

$$= 0,00442 \text{ m}^3/\text{s}$$

$$= 4,42 \text{ l/s} \checkmark$$

(2)

3.1.2

$$\eta = \frac{Q_a}{Q_t}$$

$$= \frac{4 \times 10^{-3}}{0,00442} \checkmark$$

$$= 90,5\% \checkmark$$

(2)

$$\begin{aligned}
 3.1.3 \quad \%_{\text{slip}} &= \frac{Q_T - Q_A}{Q_T} \\
 &= \frac{0,00442 - 4 \times 10^{-3}}{0,00442} \checkmark \\
 &= 9,5\% \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 3.1.4 \quad P &= \frac{\rho g Q h}{\eta} \\
 &= \frac{1000 \times 9,81 \times 4 \times 10^{-3} \times 18}{0,8} \checkmark \checkmark \\
 &= 882,9 \text{ W} \checkmark
 \end{aligned}
 \tag{3}$$

- 3.2
- Air slipping into the installation
  - Defects in joints, valves and packings
  - Water slipping out of the installation
  - Pump components being worn
- (Any 3 × 1) (3)

$$\begin{aligned}
 3.3 \quad 3.3.1 \quad U_o &= \frac{\pi D N}{60} \\
 &= \frac{\pi \times 0,7 \times 900}{60} \checkmark \\
 &= 32,987 \text{ m/s} \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 3.3.2 \quad A &= \pi \times D \times w \\
 &= \pi \times 0,7 \times 0,020 \checkmark \\
 &= 0,0440 \text{ m}^2 \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 3.3.3 \quad Q &= a \times V_{fo} \\
 \frac{11}{60} &= 0,0440 \times V_{fo} \checkmark \\
 V_{fo} &= 4,167 \text{ m/s} \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 3.3.4 \quad \tan 18 &= \frac{4,167}{x} \checkmark \\
 x &= 12,825 \text{ m} \checkmark \\
 U_o &= V_{wo} + x \\
 32,987 &= V_{wo} + 12,825 \\
 V_{wo} &= 20,162 \text{ m/s} \checkmark
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 3.3.5 \quad \eta &= \frac{gH}{U_o V_{wo}} \\
 0,7 &= \frac{9,81 \times H}{32,987 \times 20,162} \checkmark \\
 H &= 47,458 \text{ m} \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 3.3.6 \quad P &= \rho g Q h \\
 &= 1000 \times 9,81 \times \frac{11}{60} \times 47,458 \checkmark \\
 &= 85,353 \text{ kW} \checkmark \\
 \eta &= \frac{P_{out}}{P_{in}} \\
 0,7 &= \frac{85,353 \times 10^3}{P_{in}} \\
 P_{in} &= 121,933 \text{ kW} \checkmark
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 3.4 \quad A &= 0,6 \times 0,9 \\
 &= 0,54 \text{ m}^2 \checkmark \\
 Q &= AV \\
 15 &= 0,54 \times V \\
 V &= 27,778 \text{ m/s} \checkmark \\
 S &= P \times L \\
 &= 2 (0,6 + 0,9) \times 30 \\
 &= 90 \text{ m}^2 \checkmark \\
 P &= \frac{K S V^2}{a} \\
 &= 0,0027 \times 90 \times 27,778^2 \times \frac{1}{0,54} \checkmark \\
 P &= 347.228 \text{ Pa} \checkmark
 \end{aligned} \tag{6}$$

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#### QUESTION 4

$$\begin{aligned}
 4.1 \quad 4.1.1 \quad Q &= A_i \times V_i \\
 0,45 &= \frac{\pi \times 0,9^2}{4} \times V_i \\
 V_i &= 0,707 \text{ m/s} \checkmark \\
 Q &= A_o \times V_o \\
 0,45 &= \frac{\pi \times 1,5^2}{4} \times V_o \\
 V_o &= 0,255 \text{ m/s} \checkmark \\
 \frac{P_i}{\rho g} + \frac{V_i^2}{2g} + Z_i &= \frac{P_o}{\rho g} + \frac{V_o^2}{2g} + Z_o + h_E \\
 \frac{P_i}{1000 \times 9,81} + \frac{0,707^2}{2 \times 9,81} + 2 \checkmark &= \frac{-30 \times 10^3}{1000 \times 9,81} + \frac{0,255^2}{2 \times 9,81} + 0 + 24 \checkmark \\
 \frac{P_i}{9810} + 0,0255 + 2 &= -3,058 + 0,00331 + 24 \\
 P_i &= 185,603 \text{ kPa} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 4.1.2 \quad P &= \rho g Q H_E \\
 &= 1000 \times 9,81 \times 0,45 \times 24 \checkmark \\
 &= 105,948 \text{ kW} \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 4.2 \quad 4.2.1 \quad V &= C_v \sqrt{2gh} \\
 &= 0,98 \times \sqrt{2 \times 9,81 \times 282} \checkmark \checkmark & h &= 300 \times 0,94 \\
 & & &= 282 \text{ m} \\
 &= 72,895 \text{ m/s} \checkmark
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 4.2.2 \quad U &= 0,46V \\
 &= 0,46 \times 72,895 \\
 &= 33,532 \text{ m/s} \checkmark \\
 U &= \frac{\pi D N}{60} \\
 33,532 &= \frac{\pi \times 3,5 \times N}{60} \checkmark \\
 N &= 182,975 \text{ r/min} \checkmark
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 4.2.3 \quad Q &= \frac{2590}{3600} \\
 Q &= 0,719 \text{ m}^3/\text{s} \checkmark \\
 P &= \rho Q U (V - U) [1 + n \cos(180 - y)] \\
 &= 1000 \times 0,719 \times 33,532 (72,895 - 33,532) [1 + 0,91 \cos(180 - 160)] \checkmark \\
 &= 1761,639 \text{ kW} \checkmark
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 4.2.4 \quad \eta &= \frac{U}{gh} (V - U) [1 + n \cos(180 - y)] \times 100\% \\
 &= \frac{33,532}{9,81 \times 282} (72,895 - 33,532) (1 + 0,91 \cos 20) \times 100\% \checkmark \checkmark \\
 &= 88,5\% \checkmark
 \end{aligned} \tag{3}$$

[19]

**TOTAL: 100**