



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

FLUID MECHANICS N5

8 July 2022

This marking guideline consists of 10 pages.

Full mark: ✓**Half mark:** ✓**QUESTION 1**

- 1.1 1.1.1 The sum of the amount of fluid energy flowing into a system boundary remains the same✓ as the sum of the amount of fluid energy leaving through the end of the system, provided no fluid energy is added or removed from the system.✓
- 1.1.2 It is defined as the ratio of the absolute (or dynamic)✓ viscosity of a fluid substance to the density of the same fluid substance.✓
- 1.1.3 It is a property of a fluid used to measure✓ or determine the ability of any fluid substance to resist any intensity of compression which tends to change its surface shape or boundary when a force of pressure is applied to it.✓
- (3 × 2) (6)
- 1.2 In a closed system the fluid is completely contained or confined within a system boundary like a hydraulic actuator, car braking system, refrigeration system, etc. In an open system the fluid is allowed to flow through the system, like a hydraulic turbine, hydraulic pumps, etc.
- (2 + 2) (4)
- 1.3 1.3.1
$$m = \rho Q$$

$$\rho = \frac{m}{Q}$$

$$\therefore \frac{200 \times 10^{-3} \times 60}{18 \times 10^{-3}}$$

$$\therefore 666,667 \text{ kg/m}^3$$
- 1.3.2
$$W = mg$$

$$\therefore 200 \times 10^{-3} \times 9,81 \checkmark$$

$$\therefore 1,962 \text{ N/s}$$
- 1.3.3
$$\rho_{\text{relative}} = SG = \frac{\rho_{\text{oil}}}{\rho_{\text{water}}}$$

$$\therefore \frac{666,667}{1\,000}$$

$$\therefore 0,667$$

$$1.3.4 \quad \omega = \rho g \checkmark 666,667 \times 9,81 \checkmark 6,54 \text{ kN/m}^3 \checkmark$$

Alternative :

$$\omega = \frac{W}{V}$$

$$\checkmark \frac{200 \times 10^{-3} \times 9,81}{\left(\frac{18 \times 10^{-3}}{60} \right)}$$

$$\checkmark 6,54 \text{ kN/m}^3 \checkmark$$

$$1.3.5 \quad \nu = \frac{\mu}{\rho}$$

$$\checkmark \frac{0,235}{666,667}$$

$$\checkmark 352,5 \times 10^{-6} \text{ m}^2/\text{s} \checkmark$$

(5 × 2) (10)
[20]

QUESTION 2

2.1 2.1.1 It is a mechanical device✓ or tool used to measure the atmospheric pressure under atmospheric conditions.✓

2.1.2 It is a device or tool used to measure the pressure difference between two points in a fluid-flowing system,✓ neither of which is necessary atmospheric pressure. The column or leg will be filled with a suitable fluid.✓

2.1.3 It is a mechanical device✓ or tool used to measure the pressure difference between the pressure of a fluid and the surrounding atmospheric pressure.✓

(3 × 2) (6)

2.2 2.2.1

$$P_{\text{plunger}} = P_{\text{ram}}$$

$$\frac{F_{\text{plunger}}}{A_{\text{plunger}}} = \frac{F_{\text{ram}}}{A_{\text{ram}}}$$

$$F_{\text{plunger}} = \frac{2000 \times 9,81 \times 18^2}{60^2}$$

$$\checkmark 1,766 \text{ kN} \checkmark$$

(3)

$$2.2.2 \quad MA = \frac{F_{plunger}}{F_{plunger}}$$

$$= \frac{1,766}{13}$$

$$= 0,136 \text{ kN} \quad (2)$$

$$2.2.3 \quad P_{plunger} = \frac{F_{plunger}}{A_{plunger}}$$

$$= \frac{1,766 \times 4}{\pi \times 0,018^2}$$

$$= 6,94 \text{ kPa} \quad (2)$$

$$2.2.4 \quad SV_{ram} = A_{ram} \times SL_{ram}$$

$$= \frac{\pi \times 0,06^2}{4} \times 0,15$$

$$= 424,115 \times 10^{-6} \text{ m}^3 \quad (2)$$

$$2.2.5 \quad SV_{plunger} = SV_{ram}$$

$$n \times A_{plunger} \times SL_{plunger} = A_{ram} \times SL_{ram}$$

$$6 \times 18^2 \times SL_{plunger} = 60^2 \times 150$$

$$SL_{plunger} = \frac{60^2 \times 150}{6 \times 18^2}$$

$$= 277,778 \text{ mm} \quad (3)$$

$$2.2.6 \quad MA = \frac{SL_{lever}}{SL_{plunger}}$$

$$SL_{lever} = 277,778 \times 13$$

$$= 3611,114 \quad (2)$$

[20]

QUESTION 3

3.1	3.1.1	True		
	3.1.2	False		
	3.1.3	False		
	3.1.4	True		
	3.1.5	True		
			(5 × 1)	(5)
3.2	3.2.1	$-i = x + \frac{d}{2} i \quad 2,5 + \frac{3}{2} i \quad 4 \text{ m}$		(2)
	3.2.2	$F_{\text{hydro-oil}} = \rho g A \times i \quad 950 \times 9,81 \times \frac{\pi \times 3^2}{4} \times 4 i \quad 263,503 \text{ kN}$		(2)
	3.2.3	$-i = \frac{I_G \sin^2 \theta}{A \times x + x \quad i \quad h} \left(\frac{\pi \times 3^4}{64} \right) \sin^2 90 + 4 i \quad 4,141 \text{ m}$		(3)
3.3	3.3.1	$F_{\text{dry-ice}} = B$ $m_{\text{dry-ice}} = \rho V_{\text{displaced}}$ $10 \times 10^{-3} = 1000 \times 0,625 \times V_{\text{dry-ice}}$ $V_{\text{dry-ice}} = \frac{10 \times 10^{-3}}{1000 \times 0,625}$ $i \quad 16 \times 10^{-6} \text{ m}^3$		
	3.3.2	$F_{\text{ice}} = B$ $m_{\text{ice}} - 4 \% m_{\text{ice}} = \rho V_{\text{displaced}}$ $0,96 \times (10 \times 10^{-3}) = 1000 \times 0,04$ $\text{draught} = \frac{0,96 \times (10 \times 10^{-3})}{1000 \times 0,04}$ $i \quad 0,24 \times 10^{-3} \text{ mm}$	(2 × 4)	(8)
				[20]

QUESTION 4

4.1 4.1.1 Flow is said to be lamina when each particle✓ of a fluid flows smoothly alongside its neighbours without interfering with their flow paths.✓

4.1.2 Flow is said to be turbulent when the flow of the fluid is accompanied✓ by indiscriminate eddy current alongside its neighbours with interference with their flow paths.✓

4.1.3 In any fluid-flowing system, the sum of all fluid energies in the system✓ at any given two points is said to remain constant provided that no fluid energy is added or removed from the system.✓

(3 × 2) (6)

4.2 4.2.1 $Q = A v_{\text{pipeline}} v_{\text{pipeline}} = \frac{4 \times 10,923 \times 10^{-3}}{\pi \times 0,05^2} \hat{=} 5,563 \text{ m/s}$ (2)

4.2.2 $h f_{\text{system}} = \frac{4 f v^2 l}{2 g d} \hat{=} \frac{4 \times 0,0012 \times 300 \times 5,563^2}{19,62 \times 0,05} \hat{=} 45,427 \text{ m}$ (2)

4.2.3 Using Bernoulli's energy equation:

$$E_i - h f_{\text{system}} = E_o \frac{P_i}{\rho g} + \frac{v_i^2}{2g} + Z_i - h f_{\text{system}} = \frac{P_o}{\rho g} + \frac{v_o^2}{2g} + Z_o \Rightarrow \frac{P_i}{\rho g} = \frac{P_o}{\rho g} + h f_{\text{system}}$$

$$\frac{P_i}{0,83 \times 1000 \times 9,81} = \frac{0,72 \times 10^6}{0,83 \times 1000 \times 9,81} + 45,427$$

$$P_i = 133,854 \times 8142,3$$

$$\hat{=} 1,09 \text{ MPa} \quad (4)$$

4.2.4 $E_{\text{suction}} = \frac{P_i}{\rho g} + \frac{v_i^2}{2g} + Z_i$

$$\hat{=} \frac{1,09 \times 10^6}{830 \times 9,81} + \frac{5,563^2}{19,62}$$

$$\hat{=} 135,446 \text{ m} \quad (2)$$

4.2.5

$$E_{suction} = \frac{P_i}{\rho g} + \frac{v_i^2}{2g} + Z_i$$

$$\hookrightarrow \frac{0,72 \times 10^6}{830 \times 9,81} + \frac{5,563^2}{19,62}$$

$$\hookrightarrow 90,004 \text{ m}$$

(2)

4.2.6

$$\eta_{hydraulic} = \frac{E_{discharge}}{E_{suction}} \times 100 \%$$

$$\hookrightarrow \frac{90,004}{135,446} \times 100 \%$$

$$\hookrightarrow 66,45 \%$$

(2)

[20]**QUESTION 5**

5.1 5.1.1 It is a mechanical device or tool used to measure the volumetric rate of flow within a fluid-flowing system✓ with the aid of the pressure difference between two points (i.e. entrance and throat).✓

5.1.2 It is an opening or hole situated on the base side of a tank✓ which is used to allow or discharge fluid out of the tank.✓

5.1.3 A pitot tube is a device or tool used to measure the velocity of flow✓ in a fluid-flowing system between two energy points.✓

(3 × 2)

(6)

5.2 5.2.1 $Q_{entrance} = Q_{throat}$... continuity of flow principle

$$A_e v_e = A_t v_t$$

$$\frac{v_e}{v_t} = \frac{\left(\frac{\pi d_t^2}{4} \right)}{\left(\frac{\pi d_e^2}{4} \right)}$$

$$\frac{v_e}{v_t} = \frac{200^2}{450^2}$$

$$\hookrightarrow 0,198$$

(3)

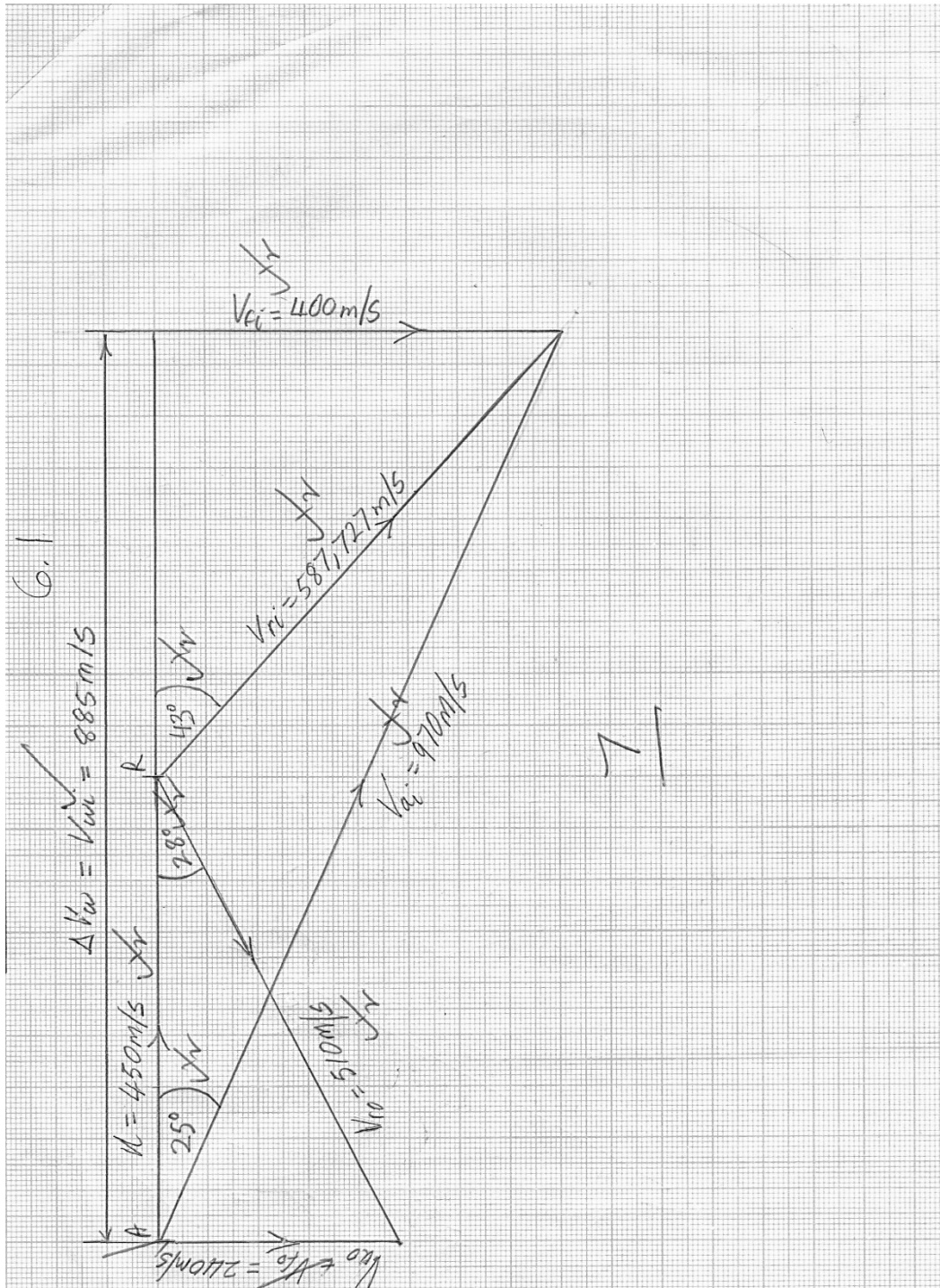
$$\begin{aligned}
 5.2.2 \quad & \frac{P_e}{\rho g} - \frac{P_t}{\rho g} = h_{\text{mech}} \left(\frac{\rho_{\text{mercury}}}{\rho_{\text{substance}}} - 1 \right) \\
 & \frac{\Delta P}{1000 \times 0,85 \times 9,81} = 0,4 \left(\frac{13\,600}{1\,000 \times 0,85} - 1 \right) \\
 & \Delta P = 6 \times 850 \times 9,81 \\
 & \hookrightarrow 50,031 \text{ kPa}
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 5.2.3 \quad & E_e - \sum H_{\text{losses}} = E_t \\
 & \frac{P_e}{\rho g} + \frac{v_e^2}{2g} + Z_e - \sum H_{\text{losses}} = \frac{P_t}{\rho g} + \frac{v_t^2}{2g} + Z_t \\
 & \frac{\Delta P}{\rho g} + Z_e - Z_t - \frac{v_t^2 - v_e^2}{2g} \\
 & \frac{50,031 \times 10^3}{850 \times 9,81} - 0,85 = \frac{v_t^2 - (0,198 v_e)^2}{19,62} \\
 & 0,961 v_t^2 = 19,62 (6 - 0,85) \\
 & v_t = \sqrt{\frac{101,043}{0,961}} \\
 & \hookrightarrow 10,254 \text{ m/s}
 \end{aligned} \tag{5}$$

$$\begin{aligned}
 5.2.4 \quad & Q_{\text{actual}} = C_Q \times Q_t \\
 & \hookrightarrow 0,945 \times \frac{\pi \times 0,2^2}{4} \times 10,254 \times 60 \\
 & \hookrightarrow 304,421 \times 10^{-3} \times 60 \\
 & \hookrightarrow 18,265 \text{ l/min}
 \end{aligned} \tag{3}$$

[20]

6.1



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- 6.2 6.2.1 $\theta = 25^\circ$ (1)
- 6.2.2 $C_{ai} = 970 \text{ m/s}$ (1)
- 6.2.3 $m = \rho A C_{ai} = \rho \times \frac{\pi d_n^2}{4} \times C_{ai}$
 $d_n = \sqrt{\frac{75 \times 4}{60 \times \pi \times 970}}$
 $\hookrightarrow 40,507 \text{ mm}$ (2)
- 6.2.4 $u = \frac{\pi DN}{60}$
 $N = \frac{450 \times 60}{\pi \times 2,54}$
 $\hookrightarrow 3383,609 \text{ r/min}$ (2)
- 6.2.5 $\varphi = 28^\circ$ (1)
- 6.2.6 Yes, there is an axial thrust $\vee$ turbulane experienced by the turbine
 $\hookrightarrow$ the velocity diagram:
 $\Delta C_f = C_{fo} - C_{fi} \hookrightarrow -400 + 240 \hookrightarrow 160 \text{ m/s (opposite direction)}$ (3)
- 6.2.7 $P_{\text{turbine}} = m \times \Delta C_w \times u$
 $\hookrightarrow \frac{75 \times (0 + 885) \times 450}{60}$
 $\hookrightarrow 497,813 \text{ kW}$ (3)

[20]**TOTAL: 100**