



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

FLUID MECHANICS N5

7 August 2026

This marking guideline consists of 6 pages.

QUESTION 1

1.1 It is the ratio of the dynamic viscosity of a fluid to its density. (1)

1.2 1.2.1
$$v = \frac{\pi d N}{60} = \frac{\pi \times 0,09 \times 2010}{60} \checkmark = 9,472 \text{ m/s} \checkmark$$
 (2)

1.2.2
$$P = Fv$$

$$\Rightarrow F = \frac{P}{v} = \frac{960}{9,472} \checkmark = 101,351 \text{ N} \checkmark$$
 (2)

1.2.3
$$F = \frac{\mu A v}{t}$$

$$\Rightarrow \mu = \frac{F t}{A v} = \frac{101,351 \times 0,15 \times 10^{-3}}{0,227 \times 9,472} \checkmark = 7,071 \times 10^{-3} \text{ Pa.s} \checkmark$$
 (2)

1.2.4
$$\nu = \frac{\mu}{\rho} = \frac{7,071 \times 10^{-3}}{850} = 8,318 \times 10^{-6} \text{ m}^2/\text{s} \checkmark$$
 (1)
[8]

QUESTION 2

2.1
$$v_{actual} = C_v \times \sqrt{\frac{2 g h_{man} (\rho_{manometer} - \rho_{water})}{\rho_{water}}}$$

$$= 0,97 \times \sqrt{\frac{19,62 \times 0,07 (13600 - 1023)}{1023}} \checkmark = 3,986 \text{ m/s} \checkmark$$

2.2
$$v_{mean} = v_{actual} h_{man} = 3,986 \times 0,07 \checkmark = 0,279 \text{ m/s} \checkmark$$

2.3
$$Q_{actual} = A v_{actual} = \frac{\pi \times 0,12^2}{4} \times 3,986 \checkmark = 0,045 \text{ m}^3/\text{s} \checkmark$$
 (3 × 2) **[6]**

QUESTION 3

3.1 3.1.1 A hydraulic actuator is a mechanical device used to convert pressurized hydraulic fluid energy (usually oil) into powerful, controlled mechanical energy motion (linear or rotational)✓ for heavy lifting, pushing, or rotating action.✓ (2)

3.1.2 A weight-loaded accumulator is a mechanical device used to store pressurised fluid energy confined in a cylinder of a hydraulic system using heavy weights,✓ storing this fluid energy during low fluid energy demand and then releasing the fluid energy back to the hydraulic system during high fluid energy demand by realising pressure.✓

3.2

$$From, P = \frac{F}{A}$$

$$F_{forward} = \frac{8 \times 10^6 \times \pi \times 0,12^2}{4} \checkmark = 90,478 \text{ kN} \checkmark$$

$$F_{return} = \frac{8 \times 10^6 \times \pi \times (0,12^2 - 0,035^2)}{4} \checkmark = 82,781 \text{ kN} \checkmark$$

$$\Delta F = F_{forward} - F_{return} = 90,478 - 82,781 \checkmark = 7,697 \text{ kN} \checkmark$$

(7)
[12]

QUESTION 4

4.1

$$\bar{x} = draught + r_{window} = 5,2 + 0,3 \checkmark = 5,5 \text{ m} \checkmark$$

$$F = \rho g A \bar{x} = \left((1,024 \times 1000 \checkmark) \times 9,81 \times \frac{\pi}{4} \times 0,6^2 \times 5,5 \right) \checkmark = 15,622 \text{ kN} \checkmark$$

(5)

4.2

$$\bar{h} = \frac{I_G \times \sin^2 \theta}{A \times \bar{x}} + \bar{x}$$

$$\bar{h} = \left[\frac{\left(\frac{\pi}{4} \times 0,6^4 \right) \times \sin^2 90}{\left(\frac{\pi}{4} \times 0,6^2 \right) \times 5,5} + 5,5 \right] \checkmark = \left[\left(\frac{0,6^2 \times 1}{5,5} \right) \checkmark + 5,5 \right] \checkmark = 5,566 \text{ m} \checkmark$$

(4)
[9]

QUESTION 5

5.1

$$W_{oil\ barrel} = F_{buoyancy}$$

$$\rho_{oil\ barrel} \times g \times V_{oil\ barrel} = \rho_{fresh\ water} \times g \times V_{fresh\ water} \checkmark$$

$$720 \times 9,81 \times \frac{\pi}{4} \times 3,2^2 \times 2,8 \checkmark = 1000 \times 9,81 \times \frac{\pi}{4} \times 3,2^2 \times draught \checkmark$$

$$draught = 2,016 \text{ m} \checkmark$$

(4)

5.2

$$GM = BM - BG = \frac{I}{V_{displaced}} - BG = \left[\frac{\left(\frac{\pi \times 3,2^4}{64} \right) \checkmark}{\left(\frac{\pi}{4} \times 3,2^2 \times 2,016 \right) \checkmark} - 1,008 \right] \checkmark$$

$$= -0,691 \text{ m} \checkmark \text{ (negative, therefore unstable} \checkmark \text{)}$$

(5)
[9]

QUESTION 6

6.1

$$Q_{\phi 420} = A_{\phi 420} v_{\phi 420}$$

$$\Rightarrow v_{\phi 420} = \frac{4 \times \left(\frac{2300 \times 10^{-3}}{60} \right)}{\pi \times 0,42^2} \checkmark = 0,277 \text{ m/s} \checkmark$$

(2)

$$6.2 \quad Q_{\phi 215} = A_{\phi 215} v_{\phi 215}$$

$$\Rightarrow v_{\phi 215} = \frac{4 \times \left(\frac{2300 \times 10^{-3}}{60} \right)}{\pi \times 0,215^2} \checkmark = 1,056 \text{ m/s} \checkmark \quad (2)$$

$$6.3 \quad h_v = \frac{v_{\phi 215}^2 - v_{\phi 420}^2}{2g} = \frac{1,056^2 - 0,277^2}{19,62} \checkmark = 52,926 \text{ mm} \checkmark \quad (2)$$

$$6.4 \quad \frac{P_{\phi 420}}{\rho g} + \frac{v_{\phi 420}^2}{2g} + Z_{\phi 420} + \sum H_{loss} = \frac{P_{\phi 215}}{\rho g} + \frac{v_{\phi 215}^2}{2g} + Z_{\phi 215} \checkmark$$

$$\frac{380 \times 10^3}{9810} + \frac{0,277^2}{19,62} + 0 - 0,41 \checkmark = \frac{P_{\phi 215}}{9810} + \frac{1,056^2}{19,62} + 6 \checkmark$$

$$38,736 - 0,052926 + 0 - 0,41 - 9 \checkmark = \frac{P_{\phi 215}}{9810} \checkmark$$

$$P_{\phi 215} = 287,169 \text{ kPa} \checkmark \quad (6)$$

[12]

QUESTION 7

- 7.1 7.1.1 A U-shaped tube manometer is an instrument that is used to measure or gauge the pressure difference between two energy points within a pipeline of fluid flowing system, ✓ and uses a column of mercury in a U-shaped tube to measure the pressure head. ✓
- 7.1.2 A mercury barometer is an instrument that is used to measure or gauge the atmospheric pressure for defined ambient conditions, ✓ using a column of mercury in a sealed inverted glass tube. ✓
- (2 × 2) (4)

$$7.2 \quad 7.2.1 \quad h_{water} = h_{Hg} \left(\frac{\rho_{merc}}{\rho_{water}} - 1 \right)$$

$$= \left[0,7 \times \left(\frac{13600}{1000} - 1 \right) \right] \checkmark = 8,82 \text{ m} \checkmark$$

$$7.2.2 \quad Q_{pipe} = A_{pipe} v_{pipe} = \left(\frac{\pi}{4} \times 0,32^2 \right) \times \sqrt{19,62 \times 8,82} \times 1000 \checkmark$$

$$= 1057,971 \text{ litres/sec} \checkmark$$

$$7.2.3 \quad C_Q = \frac{Q_{theoretical}}{Q_{actual}} = \frac{1057,97}{1064,406} \checkmark = 0,99 \checkmark$$

(3 × 2) (6)

[10]

QUESTION 8

$$8.1 \quad (L/d)_{system} = (L/d)_{pipe} + 2(L/d)_{bend} + (L/d)_{valve} + (L/d)_{exit}$$

$$\begin{aligned} \left(\frac{L}{d}\right)_{system} &= \frac{L}{d} + 2\left(\frac{k}{4f}\right)_{bend} + \left(\frac{k}{4f}\right)_{valve} + \left(\frac{k}{4f}\right)_{exit} \checkmark \\ &= \frac{40}{0,04} + 2\left(\frac{0,8}{4 \times 0,042}\right) + \left(\frac{10}{4 \times 0,042}\right) + \left(\frac{0,5}{4 \times 0,042}\right) \checkmark \\ &\quad (1000 + 9,524 + 59,524 + 2,976) \checkmark = 1072,024 \checkmark \end{aligned} \quad (4)$$

$$\begin{aligned} 8.2 \quad \frac{P_1}{\rho g} + \frac{v_1^2}{2g} + Z_1 - \frac{4f v_{pipe}^2}{2g} \times \left(\frac{l}{d}\right)_{system} &= \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2 \\ \frac{P_1}{\rho g} + \frac{v_1^2}{2g} + 0 - \frac{4 \times 0,042 \times v_{pipe}^2}{19,62} \times 1072,024 \checkmark &= \frac{P_2}{\rho g} + \frac{v_{pipe}^2}{19,62} - 30 \checkmark \\ -9,179 v_{pipe}^2 &= 50,968 \times 10^{-3} v_{pipe}^2 - 30 \checkmark \\ v_{pipe} &= \sqrt{\frac{30}{(50,968 \times 10^{-3} + 9,179)}} = 1,803 \text{ m/s} \checkmark \\ Q_{pipe} = Av = \frac{\pi}{4} \times 0,04^2 \times 1,803 &= 2,266 \text{ litres/s} \checkmark \end{aligned}$$

(6)
[10]

QUESTION 9

$$9.1 \quad C_c = \frac{d_{jet}^2}{d_{theo}^2} = \left(\frac{29,136}{36}\right)^2 \checkmark = 0,655 \checkmark$$

$$C_Q = \frac{Q_{jet}}{Q_{theo}} = \frac{1,481}{\frac{\pi \times 0,036^2}{4} \times \sqrt{19,62 \times 78}} \checkmark = 0,62 \checkmark$$

$$C_v = \frac{C_Q}{C_c} = \frac{0,62}{0,655} \checkmark = 0,947 \checkmark \quad (6)$$

$$9.2 \quad H_{loss} = H - \frac{v_{jet}^2}{2g} = 78 - \frac{(0,947 \times \sqrt{19,62 \times 78})^2}{19,62} \checkmark = 8,045 \text{ m} \checkmark$$

$$\text{Alternatively: } H_{loss} = H(1 - C_v^2) = 78(1 - 0,947^2) \checkmark = 8,049 \text{ m} \checkmark \quad (2)$$

[8]

QUESTION 10

$$10.1 \quad \dot{m} = \rho Q = \rho A v = (1000 \times 1,035) \times \frac{\pi}{4 \times 1000} \times 0,15^2 \times 8,95 \times 3600 \checkmark$$

$$= 589,303 \text{ tonnes/hr} \checkmark \quad (2)$$

$$10.2 \quad Q = A v = \frac{\pi}{4} \times 0,15^2 \times 8,95 \times 3600 \checkmark = 569\,374,399 \text{ litres/hour} \checkmark \quad (2)$$

$$10.3 \quad \frac{P_1}{\rho g} + \frac{v_1^2}{2g} + Z_1 - \sum H_{loss} = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2$$

$$\frac{450 \times 1000}{(1035 \times 9,81)} + \frac{v_1^2}{2g} + 0 - 2,6 \checkmark = \frac{P_2}{(1035 \times 9,81)} + \frac{v_2^2}{2g} + 3 \checkmark$$

$$\Rightarrow P_2 = (44,32 - 2,6 - 3) \times 1035 \times 9,81 \checkmark = 393,141 \text{ kPa} \checkmark \quad (4)$$

[8]

QUESTION 11

$$11.1 \quad H_S = H_s + H_d = 6,8 + 18,2 \checkmark = 25 \text{ m} \checkmark$$

$$11.2 \quad V_{total} = A \times H_S = \frac{\pi \times 0,12^2}{4} \times 25 \checkmark = 282,743 \times 10^{-3} \text{ m}^3 \checkmark$$

$$11.3 \quad P_{total} = \rho g H_S = 9810 \times 25 \checkmark = 245,25 \text{ kPa} \checkmark$$

$$11.4 \quad WD_{total} = \rho g \frac{V_{total}}{time} H_S = 9810 \times 25 \times \frac{282,743 \times 10^{-3}}{35} \checkmark = 1981,221 \text{ J/min} \checkmark$$

(4 × 2) **[8]**

TOTAL: 100