



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE FLUID MECHANICS N6

11 February 2022

This marking guideline consists of 6 pages.

QUESTION 1

- 1.1 1.1.1 $\frac{Pr_A}{\rho g} + \frac{v_A^2}{2g} + z_A = \frac{Pr_B}{\rho g} + \frac{v_1^2}{2g} + z_B + \frac{4flv_1^2}{2gd} + \frac{0,5v_1^2}{2g} \checkmark$
- $$12\frac{1}{2} = \frac{v_1^2}{2 \times 9,81} \frac{1}{2} + \frac{4 \times 0,04 \times 300 \times v_1^2}{2 \times 9,81 \times 0,2} \frac{1}{2} + \frac{0,5v_1^2}{2 \times 9,81} \checkmark \frac{1}{2}$$
- $$v_1 = 0,987 \text{ m/s} \checkmark$$
- $$Q = 0,987 \times \frac{\pi \times 0,3^2}{4} = 0,0698 \text{ m}^3/\text{s} \checkmark$$
- $$= 69,793 \text{ l/s} \checkmark \quad (6)$$
- 1.1.2 $S = \pi d L$
 $= \pi \times 0,2 \times 300 \checkmark$
 $= 188,496 \text{ m}^2 \checkmark \quad (2)$
- 1.1.3 $A = \frac{\pi}{4} d^2$
 $= \frac{\pi}{4} (0,2)^2 \checkmark$
 $= 0,0314 \text{ m}^2 \checkmark \quad (2)$
- 1.1.4 $m = \frac{d}{4}$
 $= \frac{0,2}{4} \checkmark$
 $= 0,05 \text{ m} \checkmark \quad (2)$
- 1.2 1.2.1 The velocity of flow in the siphon:

$$h_f = \frac{4flv^2}{2 \times g \times d}$$

$$10 = \frac{4 \times 0,04 \times 1100 \times v^2}{2 \times 9,81 \times 0,5} \checkmark$$

$$= 0,746 \text{ m/s} \checkmark \quad (2)$$
- 1.2.2 The discharge through the siphon:
 $Q = V \times A$
 $= 0,746 \times \frac{\pi}{4} 0,5^2 \checkmark$
 $= 0,147 \text{ m}^3/\text{s} \checkmark \quad (2)$
- 1.2.3 $\frac{Pr_A}{\rho g} + \frac{v_A^2}{2g} + z_A = \frac{Pr_C}{\rho g} + \frac{v_C^2}{2g} + z_C + h_L \checkmark \quad (5)$

$$\frac{101,3}{9,81} \checkmark = \frac{Pr_C}{9,81} + \frac{0,746^2}{2 \times 9,81} \checkmark + 3 + \frac{4 \times 0,04 \times 300 \times 0,746^2}{2 \times 9,81 \times 0,5} \checkmark$$

$$Pr_C = 44,837 \text{ kPa} \checkmark$$

1.3

$$h_f = \frac{4f_1 l v_1^2}{2g d_1} \checkmark + \frac{4f_2 l v_2^2}{2g d_2} \checkmark + \frac{(v_1 - v_2)^2}{2g} \checkmark$$

(3)
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QUESTION 2

$$\begin{aligned}
 2.1 \quad 2.1.1 \quad A &= 3 \times 3 = 9 \text{ m}^2 \checkmark \\
 P &= 3(3) = 9 \text{ m} \checkmark \\
 m &= \frac{9}{9} \checkmark \\
 &= 1 \checkmark \\
 C &= \frac{87}{1 + \frac{k}{\sqrt{m}}} \\
 &= \frac{87}{1 + \frac{0,4}{\sqrt{1}}} \checkmark \\
 &= 62,143 \checkmark \\
 V &= C \sqrt{mi} \\
 &= 62,143 \sqrt{1 \times 1,25 \times 10^{-3}} \checkmark \\
 V &= 2,197 \text{ m/s} \checkmark
 \end{aligned}$$

$$i = \frac{1}{800} = 1,25 \times 10^{-3}$$

(8)

$$\begin{aligned}
 2.1.2 \quad Q &= V \times A \\
 &= 2,197 \times 9 \checkmark \\
 &= 19,774 \text{ m}^3/\text{s} \checkmark
 \end{aligned}$$

(2)

$$\begin{aligned}
 2.2 \quad V_A &= \sqrt{\frac{gx^2}{2y}} \\
 &= \sqrt{\frac{9,81 \times 4,3^2}{2 \times 3,1}} \checkmark \\
 &= 5,4089 \text{ m/s} \checkmark \\
 V_A &= C_v \sqrt{2gh} \\
 5,4089 &= 0,9 \sqrt{2 \times 9,81 \times h} \checkmark \\
 h &= 1,841 \text{ m} \checkmark
 \end{aligned}$$

(4)

$$\begin{aligned}
 2.3 \quad 2.3.1 \quad \frac{kW_2}{kW_1} &= \left(\frac{N_2}{N_1} \right)^3 \\
 &= \left(\frac{320}{500} \right)^3 \times 6 \times 10^3 \checkmark \\
 kW_2 &= 1,573 \text{ kW} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 2.3.2 \quad \frac{Q_2}{Q_1} &= \frac{N_2}{N_1} \\
 Q_2 &= \frac{320}{500} \times 7 \checkmark \\
 &= 4,48 \text{ m}^3/\text{s} \checkmark
 \end{aligned}$$

$$2.3.3 \quad \frac{Wg_2}{Wg_1} = \left(\frac{N_2}{N_1} \right)^2$$

$$= \left(\frac{320}{500} \right)^2 \times 35 \checkmark$$

$$Wg_2 = 14,336 \text{ m} \checkmark$$

(3 × 2) (6)
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QUESTION 3

3.1 $P = \rho gh$

$$h = \frac{5 \times 10^6}{10^3 \times 9,81} \checkmark$$

$$= 509,684 \text{ m} \checkmark$$

$$h_f = \frac{1}{4} \times 509,684 \checkmark$$

$$= 127,421 \text{ m} \checkmark$$

$$h_f = \frac{f l Q^2}{3 d^5}$$

$$Q = \sqrt{\frac{127,421 \times 3 \times 0,3^5}{0,006 \times 200}} \checkmark$$

$$= 0,774 \text{ m}^3/\text{s} \checkmark$$

$$= 774,083 \text{ l/s} \checkmark$$

(7)

3.2 3.2.1

$$Ha_s = \frac{l}{g} \times \frac{D^2}{d^2} \times \omega^2 R$$

$$= \frac{8}{9,81} \times \frac{(0,2)^2}{(0,07)^2} \times \left(\frac{2\pi \times 45}{60} \right)^2 \times \frac{0,55}{2} \checkmark$$

$$= 40,654 \text{ m} \checkmark$$

(2)

3.2.2

$$Ha_d = \frac{l}{g} \times \frac{D^2}{d^2} \times \omega^2 R$$

$$= \frac{45}{9,81} \times \frac{(0,2)^2}{(0,07)^2} \times \left(\frac{2\pi \times 45}{60} \right)^2 \times \frac{0,55}{2} \checkmark$$

$$= 228,677 \text{ m} \checkmark$$

(2)

3.2.3

$$Hf_s = \frac{4fl}{2gd} \left[\left(\frac{D^2}{d^2} \right) \omega R \right]^2$$

$$= \frac{4 \times 0,02 \times 8}{2 \times 9,81 \times 0,07} \left[\left(\frac{0,2^2}{0,07^2} \right) \times \left(\frac{2\pi \times 45}{60} \right) \times \frac{0,55}{2} \right]^2 \checkmark$$

$$= 52,15 \text{ m} \checkmark$$

(2)

3.2.4

$$= \frac{4fl}{2gd} \left[\left(\frac{D^2}{d^2} \right) \omega R \right]^2$$

$$= \frac{4 \times 0,02 \times 45}{2 \times 9,81 \times 0,07} \left[\left(\frac{0,2^2}{0,07^2} \right) \times \left(\frac{2\pi \times 45}{60} \right) \times \frac{0,55}{2} \right]^2 \checkmark$$

$$= 293,347 \text{ m} \checkmark$$

(2)

3.2.5

$$\begin{aligned} \text{(a)} &= H_{at} + h_d + H_{ad} \\ &= 10,6 + 41 + 228,677 \checkmark \\ &= 280,277 \text{ m} \checkmark \end{aligned}$$

$$\begin{aligned} (b) &= H_{at} + h_d + H_{fd} \\ &= 10,6 + 41 + 293,347 \checkmark \\ &= 344,947 \text{ m } \checkmark \end{aligned}$$

(2 × 2)

(4)

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3.3 3.3.1 $H_{\text{sep}} = H_{\text{at}} - h_s - h_{\text{fs}}$
 $3 = 11 - 4 - h_{\text{fs}} \checkmark$
 $h_{\text{fs}} = 4 \text{ m} \checkmark$
 $h_f = \frac{4flv^2}{2gd}$
 $4 = \frac{4 \times 0,005 \times 6 \times v^2}{2 \times 9,81 \times 0,12} \checkmark$
 $v = 8,859 \text{ m/s} \checkmark$
 $Q = \text{ALSEN}/60$
 $8,859 \times \frac{\pi}{4} 0,12^2 = \frac{\pi}{4} 0,19^2 \times 0,6 \times 1 \times 1 \times \frac{N}{60} \checkmark$
 $= 353,374 \text{ r/min} \checkmark$ (6)

3.3.2 $H_{\text{sep}} = H_{\text{at}} - h_s - h_{\text{as}}$
 $3 = 11 - 4 - h_{\text{as}} \checkmark$
 $H_{\text{as}} = 4 \text{ m} \checkmark$
 $H_{\text{as}} = \frac{l}{g} \times \frac{D^2}{d^2} \times \omega^2 R$
 $4 = \frac{6}{9,81} \times \frac{(0,19)^2}{(0,12)^2} \times \left(\frac{2\pi \times N}{60} \right)^2 \times \frac{0,6}{2} \checkmark$
 $= 28,16 \text{ r/min} \checkmark$ (4)
[29]

QUESTION 4

4.1 4.1.1 $h = 90 \times 0,88 \checkmark$
 $= 79,2 \text{ m} \checkmark$ (2)

4.1.2 $V_A = \sqrt{2gh}$
 $V_A = \sqrt{2 \times 9,81 \times 79,2} \checkmark$
 $= 39,42 \text{ m/s} \checkmark$ (2)

4.1.3 $\cos \theta = \frac{V_{wi}}{V_A}$
 $\cos 30^\circ = \frac{V_{wi}}{39,42} \checkmark$
 $V_{wi} = 34,138 \text{ m/s} \checkmark$ (2)

4.1.4 $\sin 62^\circ = \frac{12,6}{V_{ri}} \checkmark$
 $V_{ri} = 14,27 \text{ m/s} \checkmark$
 $V_{ro} = 14,27 \times 0,904 \checkmark$
 $= 12,9 \text{ m/s} \checkmark$ (4)

4.2 4.2.1 $\eta = \frac{P_{out}}{P_i} \times 100\%$

$P_{in} = \frac{4000}{0.96} = 4166,667 \text{ kW} \checkmark$

$h = 245 \times 0,93 \checkmark = 227,85 \text{ m} \checkmark$

$Q = \frac{4166,667 \times 10^3}{1000 \times 9,81 \times 227,85} \checkmark = 1,864 \text{ m}^3/\text{s} \checkmark$

$V_i = C_v \sqrt{2gh}$
 $= 0,97 \times \sqrt{2 \times 9,81 \times 227,85} \checkmark$
 $= 64,855 \text{ m/s} \checkmark$

$\frac{\pi}{4} \times d_j^2 = \frac{0,932}{64,855} \checkmark$
 $d_j = 0,135 \text{ m} \checkmark$ (10)

4.2.2 $U = \frac{\pi D N}{60}$
 But $U = 0,5 \times 64,855 \checkmark = 32,428 \text{ m/s} \checkmark$
 $D = \frac{32,428 \times 60}{\pi \times 300}$
 $= 2,064 \text{ m} \checkmark$ (4)

4.2.3 $h_f = \frac{f l Q^2}{3 d^5} \checkmark$
 $17,15 = \frac{0,007 \times 600 \times 1,864^2}{3 d^5} \checkmark$
 $d = 777,251 \text{ mm} \checkmark$ (3)

[27]

TOTAL: 100