



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

POWER MACHINES N5

8 April 2026

This marking guideline consists of 5 pages.

QUESTION 1

- 1.1 $p_1 v_1^\gamma = p_2 v_2^\gamma \checkmark \Rightarrow p_2 = 100 \left(\frac{0,082}{0,0054 \checkmark} \right)^{1,4} = 4\,508,04 \text{ kJ} \checkmark$
- $W_{1-2} = \frac{p_2 v_2 - p_1 v_1}{\gamma - 1} \checkmark = \frac{4\,508,04 \times 0,0054 - 100 \times 0,082}{1,4 - 1} = 40,36 \checkmark \text{ kJ} \checkmark$ (6)
- 1.2 $W_{3-4} = p_3(\Delta V) \checkmark = p_4(v_4 - v_3) = 6\,200(0,0125 \checkmark - 0,0054 \checkmark) = 44,02 \text{ kJ} \checkmark$ (4)
- 1.3 $v_3 = 0,0054 \times 1\,000 \checkmark = 5,4 \text{ l} \checkmark$ and $v_5 = 0,082 \times 1\,000 \checkmark = 82 \text{ l} \checkmark$ (4)
- 1.4 $0,515 \checkmark \text{ kJ/kg.K} \checkmark$ (adiabatic process) (2)
- 1.5 0 (adiabatic process) (1)
- 1.6 $Q_{cp} = Q_{3-4} = c_p \checkmark (T_4 - T_3 \checkmark)$
 $Q_{cv} = Q_{2-3} = c_v \checkmark (T_3 - T_2)$ **OR** $Q_{cv} = Q_{5-1} = c_v(T_1 - T_5)$ (3)
[20]

QUESTION 2

- 2.1 The ratio of the induced volume $\checkmark$ to the swept volume $\checkmark$ (2)
- 2.2 2.2.1 $v_c = v_3 = 0,56 \text{ l} \checkmark$
 $v_{del} = v_{2-3} = 4,2 \text{ l} \checkmark$
 $v_s = v_{1-3} = 16,5 \text{ l} \checkmark$
 $v_{ind} = v_{4-1} = 15 \text{ l} \checkmark$
 $v_{cyl} = v_c + v_s = 0,56 + 16,5 = 17,06 \text{ l} \checkmark$ (5)
- 2.2.2 $\eta_{vol} = 1 - \frac{v_c}{v_s} \left[r_p^{\frac{1}{n}} - 1 \right] \checkmark = 1 - \frac{0,56 \checkmark}{16,5} \left[3,8^{\frac{1}{1,3}} - 1 \right] = 0,9392 \checkmark$ (3)
- 2.2.3 $P_{ind} = \frac{n p_1 v_{ind}}{n - 1} \left[r_p^{\frac{n-1}{n}} - 1 \right] \checkmark = \frac{1,3 \times 100 \times 15 \times 260 \checkmark}{0,3 \times 60 \checkmark \times 1\,000 \checkmark} \times \left[(3,8)^{\frac{0,3}{1,3}} - 1 \right]$
 $= 10,163 \text{ kW} \checkmark$ (5)
[15]

QUESTION 3

3.1 3.1.1 False

3.1.2 False

(2 × 1) (2)

3.2 3.2.1 $H_{ai} = m_a c_a T_1 = 20 \times 1,02 \times (18 + 273) = 5\,936,4 \text{ kJ/s}$ ✓

$H_{ao} = m_a c_a T_2 = 20 \times 1,02 \times (18 + 22 + 273) = 6\,385,2 \text{ kJ/s}$ ✓ (6)

3.2.2 $h_f = 264 \frac{\text{kJ}}{\text{kg}}$ ✓

$h_{ex} = h_f + x h_{fg} = 1\,008 + 0,914 \times 1\,794 = 2\,647,716 \frac{\text{kJ}}{\text{kg}}$ ✓

$EE = \frac{m_s(h_{ex} - h_{in})}{2\,257 m_F} = \frac{90(2\,647,716 - 264)}{2\,257 \times 10} = 9,505$ ✓ (6)

3.2.3 By interpolation:

$$h_{sup} = h_1 + (t - t_l) \left[\frac{h_h - h_l}{t_h - t_l} \right] = 2\,858 + (280 - 250) \left[\frac{2\,995 - 2\,858}{300 - 250} \right]$$

$$= 2\,940,2 \frac{\text{kJ}}{\text{kg}}$$
 ✓

OR

$h_{sup} = \frac{3}{5} \times 137 + 2\,858 = 2\,940,2 \frac{\text{kJ}}{\text{kg}}$ ✓

$h_f @ 21,1^\circ\text{C} = 89 \frac{\text{kJ}}{\text{kg}}$ ✓

$\eta = \frac{m_s(h_{ex} - h_{in})}{CV \times m_F} = \frac{90(2\,940,2 - 89)}{39 \times 10^3 \times 10} = 65,797\%$ ✓

(6)
[20]

QUESTION 4

Working on a per-minute basis:

Heat lost by steam:

$$Q_s = m_s (h_1 - h_2) \checkmark$$

$$= \frac{10\,800}{60} [145 - (183 + 0,92 \times 2\,398)] \checkmark = 403\,948,8 \frac{\text{kJ}}{\text{min}} \checkmark$$

Heat received by cooling water:

$$Q_w = 0,814 Q_s = 0,814 \checkmark \times 403\,948,8 = 328,814 \times 10^3 \frac{\text{kJ}}{\text{min}} \checkmark$$

Amount of cooling water that will be required:

$$Q_s = m_w c_{pw} (t_2 - t_1) \checkmark \Rightarrow m_w = \frac{328,814 \times 10^3}{4,2 \times 22,8 \checkmark} = 3\,433,734 \checkmark \frac{\text{kg}}{\text{min}}$$

$$\rho = \frac{m_w}{v_w} \checkmark \Rightarrow v_w = \frac{3\,433,734}{992 \checkmark} = 3,461 \checkmark \frac{\text{m}^3}{\text{min}}$$

Amount of cooling water per tube (pt):

$$v_{pt} = av = \frac{\pi}{4} \times 0,0178^2 \times 1,39 \checkmark \times 60 = 0,02075 \checkmark \frac{\text{m}^3}{\text{min}}$$

Number of tubes the condenser will require:

$$n = \frac{v_w}{v_{pt}} \checkmark = \frac{3,461}{0,02075} = 167 \checkmark \text{ tubes}$$

[15]

QUESTION 5

5.1 $h = \sqrt{l^2 - r^2} = \sqrt{0,25^2 - 0,15^2} = 0,2 \checkmark m$

$$\omega = \sqrt{\frac{g}{h}} \checkmark = \sqrt{\frac{9,81}{0,2}} = 7,004 \checkmark \frac{rad}{s}$$

$$F = mr\omega^2 \checkmark = 2 \times 0,15 \checkmark \times 7,004^2 = 14,72 N \checkmark \quad (6)$$

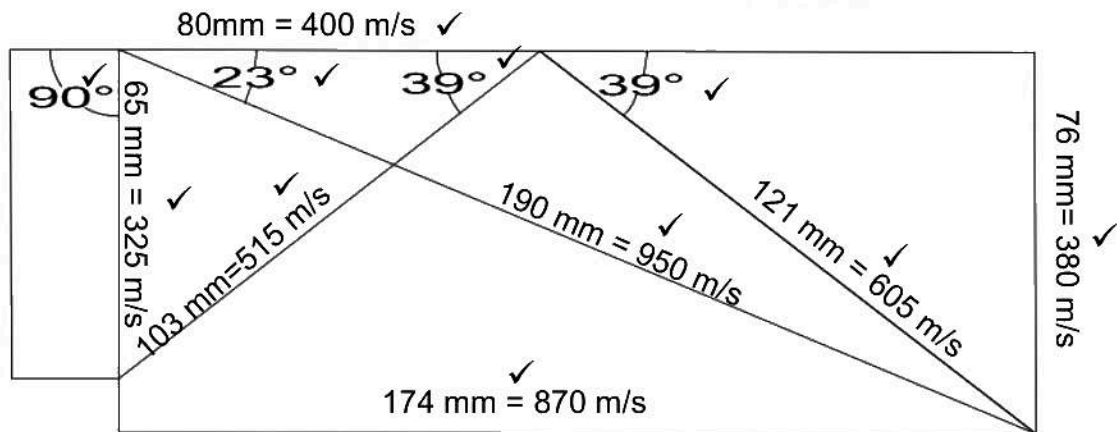
5.2 5.2.1 False

5.2.2 False

5.2.3 True

(3 × 1) (3)

5.3



(11)
[20]

QUESTION 6

- 6.1
- It is dangerous to wildlife (especially birds).
 - Wind is not always available.
 - Wind turbines are noisy.
 - It has a high initial cost (manufacturing, transportation and installation).
 - Wind farms are usually located in far-flung locations. (Any 3 × 1) (3)

6.2 $P_{sol} = AG\eta n \checkmark = 8\,000 \times 1,5 \times 0,2 \times 0,75 = 1,8 \checkmark MW$

$$P_{sol} = \frac{E_{DC}}{t} \checkmark \Rightarrow E_{DC} = 1,8 \times 10^6 \times 8 \times 320 = 4,608 \checkmark GWh$$

$$n = \frac{E_{AC}}{E_{DC}} \checkmark \Rightarrow E_{AC} = 0,75 \times 4,608 = 3,456 \checkmark GWh \checkmark$$

(7)
[10]

TOTAL: 100