



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

POWER MACHINES N6

18 August 2025

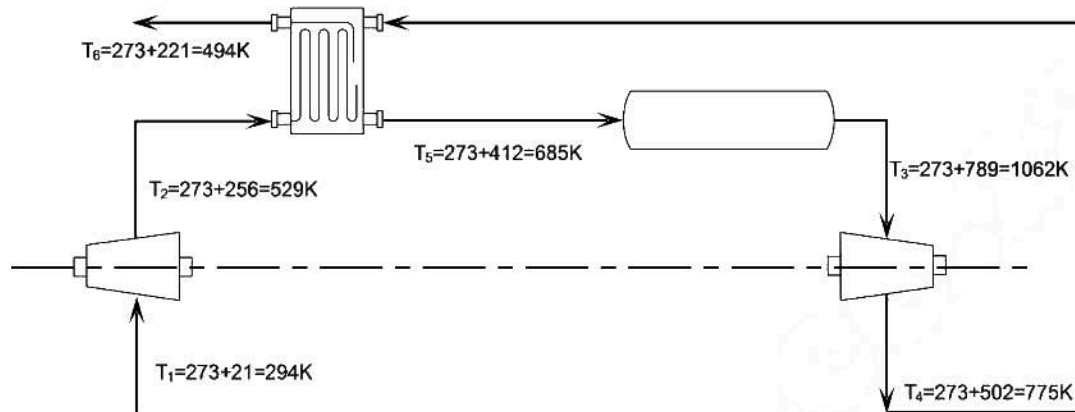
This marking guideline consists of 8 pages.

✓ = 1 mark

✓^{1/2} = 1/2 mark

QUESTION 1

1.1



$$\begin{aligned}
 P_c &= mC_p (T_2 - T_1) \quad \checkmark \\
 &= 7 \times 1,005 (529 - 294) \quad \checkmark \\
 &= 1\,653,225 \text{ kW} \quad \checkmark
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 1.2 \quad P_t &= mC_p (T_4 - T_3) \quad \checkmark \\
 &= 7 \times 1,005 (775 - 1\,062) \quad \checkmark \\
 &= -2\,019,045 \text{ kW} \quad \checkmark
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 1.3 \quad P_{cc} &= mC_p (T_3 - T_5) \quad \checkmark \\
 &= 7 \times 1,005 (1\,062 - 685) \quad \checkmark \\
 &= 2\,652,195 \text{ kW} \quad \checkmark
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 1.4 \quad \eta_{th} &= \frac{P_t - P_c}{P_{cc}} \times 100\% \\
 &= \frac{2\,019,045 - 1\,653,225}{2\,652,195} \times 100 \quad \checkmark \quad \text{OR} \quad \eta_{th} = \frac{T_3 - T_4 - T_2 + T_1}{T_3 - T_5} \times 100\% \\
 &= 13,793\% \quad \checkmark \quad \quad \quad = \frac{1\,062 - 775 - 529 + 294}{1\,062 - 685} \times 100\% \\
 & \quad \quad \quad = 13,793\%
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 1.5 \quad \eta_{H.E.} &= \frac{T_5 - T_2}{T_4 - T_6} \times 100\% \quad \checkmark \\
 &= \frac{685 - 529}{775 - 494} \times 100\% \quad \checkmark \\
 &= 28,159\% \quad \checkmark
 \end{aligned}
 \tag{3}$$

1.6

$$T_4' = T_3 \left(\frac{P_4}{P_3} \right)^{\left(\frac{\gamma-1}{\gamma} \right)} \quad \checkmark$$

$$= 1\,062 \left(\frac{1}{5} \right)^{\left(\frac{0,4}{1,4} \right)} \quad \checkmark$$

$$= 670,531\text{K} \quad \checkmark$$

(3)

1.7

$$\eta_t = \frac{T_3 - T_4}{T_3 - T_4'} \times 100\% \quad \checkmark$$

$$= \frac{1\,062 - 775}{1\,062 - 670,531} \times 100\% \quad \checkmark$$

$$= 73,314\% \quad \checkmark$$

(3)
[20]

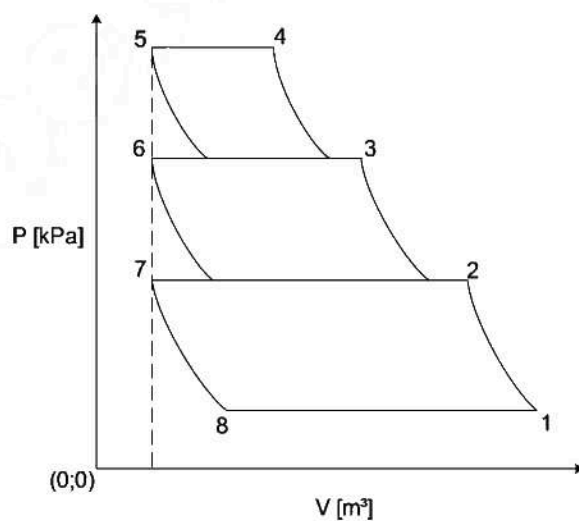
QUESTION 2

2.1

$$P_1 V_{e1} \times N = mRT_1 \quad \checkmark$$

$$105 \times V_{e1} \times 300 = 16 \times 0,287 \times 294 \quad \checkmark$$

$$V_{e1} = 0,043\text{m}^3 / \text{cycle} \quad \checkmark$$



(3)

2.2

2.2.1

$$P_2 V_{e2} \times N = mRT_2 \quad \checkmark$$

$$(105 \times 4) \times V_{e2} \times 300 = 16 \times 0,287 \times 294 \quad \checkmark$$

$$V_{e2} = 0,010\,7\text{m}^3 / \text{cycle} \quad \checkmark$$

(3)

2.2.2

$$V_s = \frac{\pi}{4} D^2 L \quad \checkmark$$

$$= \frac{\pi}{4} \times 0,24^2 \times 0,296 \quad \checkmark$$

$$= 0,013\,4\text{m}^3 / \text{cycle} \quad \checkmark$$

(3)

$$\begin{aligned}
 2.2.3 \quad \eta_{vol.} &= \frac{V_{e2}}{V_{s2}} \times 100\% \\
 &= \frac{0,0107}{0,0134} \times 100\% \quad \checkmark \\
 &= 79,851\% \quad \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 2.2.4 \quad \eta_{vol.2} &= 1 - \frac{V_{c2}}{V_{s2}} \left[\left(r_{ps} \right)^{\left(\frac{1}{n} \right)} - 1 \right] \quad \checkmark \\
 0,79851 &= 1 - \frac{V_{c2}}{0,0134} \left[\left(4 \right)^{\left(\frac{1}{1,32} \right)} - 1 \right] \quad \checkmark \\
 V_{c2} &= 0,00145 m^3 / cycle \quad \checkmark
 \end{aligned} \tag{3}$$

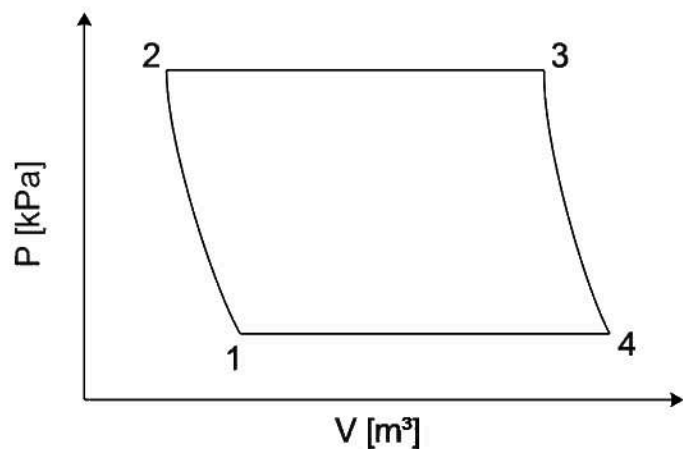
$$\begin{aligned}
 2.2.5 \quad V_2 &= V_{c2} + V_{s2} \\
 &= 0,00145 + 0,0134 \quad \checkmark \\
 &= 0,01485 m^3 / cycle \quad \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 2.3 \quad P &= \frac{xn}{n-1} \dot{m} R T_1 \left[\left(r_{ps} \right)^{\left(\frac{n-1}{n} \right)} - 1 \right] \quad \checkmark \\
 &= \frac{3 \times 1,32}{0,32} \times \frac{16}{60} \times 0,287 \times 294 \left[\left(4 \right)^{\left(\frac{0,32}{1,32} \right)} - 1 \right] \quad \checkmark \checkmark \\
 &= 111,223 kW \quad \checkmark
 \end{aligned} \tag{4}$$

[20]

QUESTION 3

$$\begin{aligned}
 3.1 \quad T_1 &= T_2 \left(\frac{P_1}{P_2} \right)^{\left(\frac{\gamma-1}{\gamma} \right)} \quad \checkmark \\
 &= 471 \left(\frac{110}{490} \right)^{\left(\frac{0,4}{1,4} \right)} \quad \checkmark \\
 &= 307,361 K \quad \checkmark
 \end{aligned}$$



$$\begin{aligned}
 3.2 \quad T_3 &= T_1 + \Delta T \\
 &= 307,361 + 420 \quad \checkmark \\
 &= 727,361 K \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 3.3 \quad Q_{2-3} &= mC_p(T_3 - T_2) \quad \checkmark \\
 &= 1 \times 1,005(727,361 - 471) \quad \checkmark \\
 &= 257,643 \text{ kJ / kg} \quad \checkmark
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 3.4 \quad T_4 &= T_3 \left(\frac{P_4}{P_3} \right)^{\left(\frac{\gamma-1}{\gamma} \right)} \quad \checkmark \\
 &= 727,361 \left(\frac{110}{490} \right)^{\left(\frac{0,4}{1,4} \right)} \quad \checkmark \\
 &= 474,655 \text{ K} \quad \checkmark
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 3.5 \quad Q_{4-1} &= mC_p(T_1 - T_4) \quad \checkmark \\
 &= 1 \times 1,005(307,361 - 474,655) \quad \checkmark \\
 &= -168,13 \text{ kJ / kg} \quad \checkmark
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 3.6 \quad C_v &= \frac{C_p}{\gamma} \\
 &= \frac{1,005}{1,4} \quad \checkmark \\
 &= 0,718 \text{ kJ / kg.K} \quad \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 3.7 \quad R &= C_p - C_v \\
 &= 1,005 - 0,718 \quad \checkmark \\
 &= 0,287 \text{ kJ / kg.K} \quad \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 3.8 \quad \eta &= \frac{Q_{rec.} - Q_{rej.}}{Q_{rec.}} \times 100\% & \eta &= 1 - \frac{Q_{rej.}}{Q_{rec.}} \times 100\% & \eta &= 1 - \left(\frac{P_1}{P_2} \right)^{\left(\frac{\gamma-1}{\gamma} \right)} \\
 &= \frac{257,643 - 168,13}{257,643} \times 100\% \quad \checkmark & \text{OR } \eta &= 1 - \frac{168,13}{257,643} \times 100\% & \text{OR } \eta &= 1 - \left(\frac{110}{490} \right)^{\left(\frac{0,4}{1,4} \right)} \\
 &= 34,743\% \quad \checkmark & &= 34,743\% & &= 34,743\%
 \end{aligned} \tag{2}$$

[20]

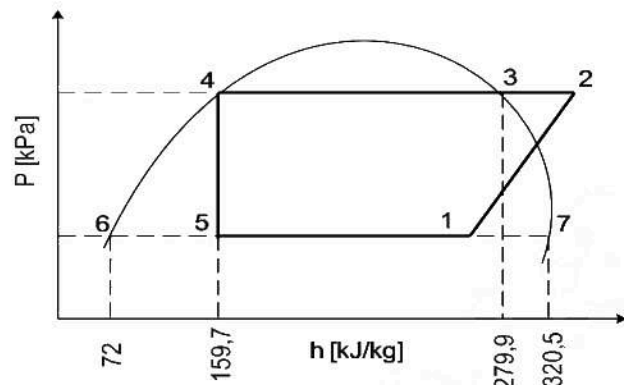
QUESTION 4

4.1

$$\eta_{vol.} = \frac{V_e}{V_s} \times 100\%$$

$$0,9 = \frac{V_e}{1\,500 \times 10^{-6}} \times 100\% \quad \checkmark$$

$$V_e = 0,001\,35 m^3 \quad \checkmark$$



(2)

4.2

$$V_e = \frac{V_g \times m_r \times x_1}{N} \quad \checkmark$$

$$0,001\,35 = \frac{0,012\,2 \times m_r \times 0,9}{122} \quad \checkmark$$

$$m_r = 15 kg / min \quad \checkmark$$

(3)

4.3

$$P_c = \frac{m_r \times WD}{\eta_{mech.}} \quad \checkmark$$

$$(9,25 \times 60) = \frac{15 \times WD}{0,9} \quad \checkmark$$

$$WD = 29,6 kJ / min \quad \checkmark$$

(3)

4.4

$$h_1 = h_6 + x_1(h_7 - h_6) \quad \checkmark$$

$$= 72 + 0,9(320,5 - 72) \quad \checkmark$$

$$= 295,65 kJ / kg \quad \checkmark$$

(3)

4.5

$$WD = h_2 - h_1$$

$$29,6 = h_2 - 295,65 \quad \checkmark$$

$$h_2 = 325,25 kJ / kg \quad \checkmark$$

(2)

4.6

$$h_2 = h_3 + C_p(T_2 - T_3) \quad \checkmark$$

$$325,25 = 279,9 + 1,814(T_2 - 298) \quad \checkmark$$

$$T_2 = 323,138 K \quad \checkmark$$

$$= 50,138^\circ C \quad \checkmark$$

(4)

4.7

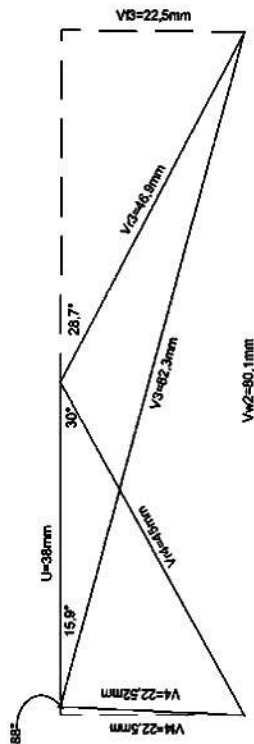
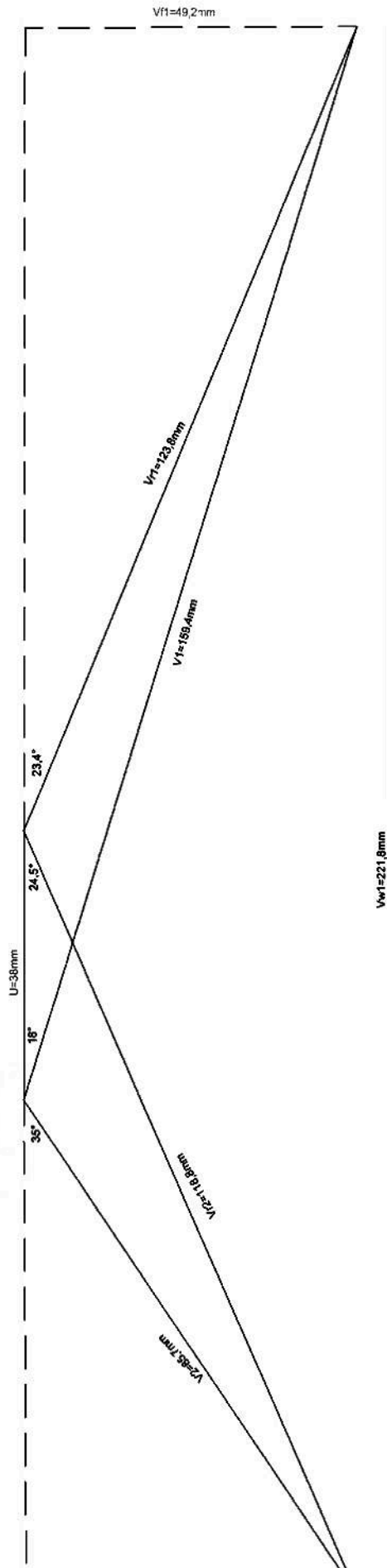
$$Q_{con.} = m_r(h_2 - h_4) \quad \checkmark$$

$$= 15(325,25 - 159,7) \quad \checkmark$$

$$= 2\,483,25 kJ / min \quad \checkmark$$

(3)

5.1



½ mark for each correct length and angle up to a maximum of 5 marks per diagram.

Allow a tolerance of up to $\pm 1^\circ$ for angles and ± 2 mm for lengths of lines

5.2	5.2.1	$V_2 = 85,7 \times 4 = 342,8 \text{ m/s} \quad \checkmark$	(1)
	5.2.2	$V_3 = 82,3 \times 4 = 329,2 \text{ m/s} \quad \checkmark$	(1)
	5.2.3	$\theta_1 = 23,4^\circ \quad \checkmark$	(1)
	5.2.4	$\phi_1 = 24,5^\circ \quad \checkmark$	(1)
	5.2.5	$\theta_2 = 28,7^\circ \quad \checkmark$	(1)
	5.2.6	$\alpha_1 = 18^\circ \quad \checkmark$	(1)
	5.2.7	$\alpha_2 = 15,9^\circ \quad \checkmark$	(1)
	5.2.8	$P = mUV_{WT}$ $= 1 \times 152(221,8 + 80,1) \times 4 \quad \checkmark$ $= 183\,555,2 \text{ J/kg} \quad \checkmark$ $183,556 \text{ kJ/kg} \quad \checkmark$	(3) [20]

TOTAL: 100