higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

POWER MACHINES N5

6 December 2023

This marking guideline consists of 9 pages.

Copyright reserved

QUESTION 1

1.1 1.1.1 C
1.1.2 D
(2 × 1) (2)

1.2 1.2.1 blades
1.2.2 condenser
1.2.3 governor
(3 × 1) (3)
[5]

QUESTION 2

2.1 $P_1V_1 = mRT_1$✓

$m = \frac{(128)(2)}{(0{,}287)(294)}$ ✓

$m = 3{,}034\ kg$✓ (3)

2.2 $\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma}$✓

$\frac{2}{V_2} = \left(\frac{270}{128}\right)^{\frac{1}{1{,}301}}$✓✓

$V_2 = 1{,}127\ m^3$✓ (4)

2.3 $P_2V_2 = mRT_2$✓

$T_2 = \frac{(270)(1{,}127)}{(3{,}034)(0{,}297)}$✓✓

$T_2 = 349{,}454\ K$✓

Alternative:

$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$ ✓

$T_2 = (294)\left(\frac{270}{128}\right)^{\frac{1{,}301-1}{1{,}301}}$ ✓✓

$T_2 = 349{,}417\ K$✓ (4)

Copyright reserved

2.4 $\gamma = \frac{C_p}{C_v}$

$C_p = 1{,}301C_v$✓

$R = C_p - C_v$

$0{,}287 = 1{,}301C_v - C_v$

$C_v = 0{,}953\ \frac{kJ}{kg.K}$✓ (2)

2.5 $\Delta U = mC_v(T_2 - T_1)$✓

$\Delta U = (3{,}034)(0{,}953)(349{,}417 - 294)$✓

$\Delta U = 160{,}233\ kJ$✓ (3)

2.6 $WD = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$✓✓

$WD = \frac{(128)(2) - (270)(1{,}127)}{1{,}301 - 1}$✓

$WD = 160{,}432\ kJ$✓

Alternative

$WD = \frac{mR(T_1 - T_2)}{\gamma - 1}$✓✓

$WD = \frac{(3{,}034)(0{,}287)(294 - 349{,}417)}{1{,}301 - 1}$✓

$WD = 160{,}314\ kJ$✓ (4)
[20]

QUESTION 3

3.1 $h_{su} = h_g + C_p(t_{ss} - t_s)$✓

$h_{su} = 2797 + (2{,}1)(285 - 213{,}6)$✓

$h_{su} = 2946{,}94\ \frac{kJ}{kg}$✓ (3)

3.2 $V_{su} = \frac{n-1}{n}\left(\frac{h_{su} - 1941}{P}\right)$✓

$V_{su} = \frac{1{,}3 - 1}{1{,}3}\left(\frac{2946{,}94 - 1941}{2050}\right)$✓

$V_{su} = 0{,}113\ \frac{m^3}{kg}$✓ (3)

3.3 $U = h - PV$✓

$U = 2946{,}94 - (2050)(0{,}113)$✓

$U = 2714{,}75\ \frac{kJ}{kg}$✓ (3)

3.4 $h_{wet} = h_f + xh_{fg}$✓

$\frac{4800}{2} = 845 + x(1945)$✓✓

$x = 0{,}799$

$x = 0{,}8$✓

$Alternative$
$h_{wet} = h_f + xh_{fg}$✓

$4800 = [845 + x(1945)]2$✓✓

$x = 0{,}799$

$x = 0{,}8$✓ (4)

3.5 $V = xV_g$

$V = (0{,}8)(0{,}1317)(2)$✓

$V = 0{,}2107\ m^3$✓ (2)

3.6 $U = h - PV$✓

$U = 4800 - (1500)(0{,}2107)$✓

$U = 4484{,}4\ \frac{kJ}{kg}$✓

$Alternative$

$U = h - PV$✓

$U = 2400 - (1500)(0{,}1052)$✓

$U = 2242{,}2\ \frac{kJ}{kg} \times 2kg$

$U = 4484{,}4\ kJ$✓ (3)

Copyright reserved

3.7 $h_{dry} = mh_g$
$h_{dry} = 2{,}5 \times 2772$✓
$h_{dry} = 6930\ kJ$✓

$Alternative$

$h_{dry} = m(h_f + h_{fg})$
$h_{dry} = 2{,}5(739 + 2033)$✓
$h_{dry} = 6930\ kJ$✓ (2)
[20]

QUESTION 4

4.1 4.1.1 $P = (B_m - M_m)\frac{101{,}325}{760}$

$P = (740 - 660)\frac{101{,}325}{760}$✓

$P = 10{,}666\ kPa$✓ (3)

4.1.2 $P = P_a + P_s$

$10{,}666 = P_a + 4$

$P_a = 6{,}666\ kPa$✓

$T_a = 302\ K$✓

$P_aV_a = mRT_a$

$V_a = \frac{(0{,}08)(0{,}289)(302)}{(6{,}666)}$✓✓

$V_a = 1{,}047\ \frac{m^3}{s}$✓ (5)

4.2 4.2.1 $HCV = CV_C.C + CV_{H_2}.\left(H_2 - \frac{O_2}{8}\right) + CV_S.S$✓

$HCV = (34)(0{,}83) + (142)\left(0{,}07 - \frac{0{,}07}{8}\right) + (9)(0{,}03)$✓✓

$HCV = 37{,}188\ \frac{MJ}{kg}$✓ (4)

4.2.2 $LCV = HCV - 9h_{fg.}H_2$✓

$LCV = 37{,}188 - (9)(2{,}453)(0{,}07)$✓

$LCV = 35{,}643\ \frac{MJ}{kg}$✓ (3)
[20]

QUESTION 5

5.1 5.1.1 $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}$ ✓

$$P_2 = P_1\left(\frac{T_2}{T_1}\right)^{\frac{n}{n-1}}$$

$$P_2 = (110)\left(\frac{400}{288}\right)^{\frac{1,2}{1,2-1}}$$ ✓

$P_2 = 789{,}583\ kPa$ ✓ (3)

5.1.2 $WD = \frac{n}{n-1}P_1V_e\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$ ✓

$$WD = \frac{1,2}{1,2-1}(110)(15)\left[\left(\frac{789{,}583}{110}\right)^{\frac{1,2-1}{1,2}} - 1\right] \times \frac{min}{280r}$$ ✓✓✓

$WD = 13{,}75\ kJ$ ✓ (5)

5.2 $m\omega^2 h = (m + M)g$ ✓

$0{,}8\omega^2 h = (0{,}8 + 2{,}5)9{,}8$ ✓

$\omega = \sqrt{\frac{40{,}425}{h}}$ ✓

$h = 0{,}25\cos 30^o$
$h = 0{,}216\ m$

Sleeve rise and sleeve drop:

$h_1 = 0{,}217 - \left(\frac{0{,}025}{2}\right)$

$h_1 = 0{,}2045\ m$ ✓

$h_2 = 0{,}217 + \left(\frac{0{,}025}{2}\right)$

$h_2 = 0{,}2295\ m$ ✓

$\omega_1 = \sqrt{\frac{40{,}425}{0{,}2045}}$

$\omega_1 = 14{,}059\ \frac{rad}{s}$ ✓

$\omega_2 = \sqrt{\frac{40{,}425}{0{,}2295}}$

$\omega_2 = 13{,}272\ \frac{rad}{s}$✓

$\omega = 2\pi\frac{N}{60}$

$\omega = 2\pi\frac{180}{60}$ ✓

$\omega = 18{,}849\ \frac{rad}{s}$✓

$sensitivity = \frac{\omega}{\omega_2 - \omega_1}$✓

$sensitivity = \frac{18{,}849}{14{,}059 - 13{,}272}$ ✓

$sensitivity = 23{,}95$✓ (12)

[20]

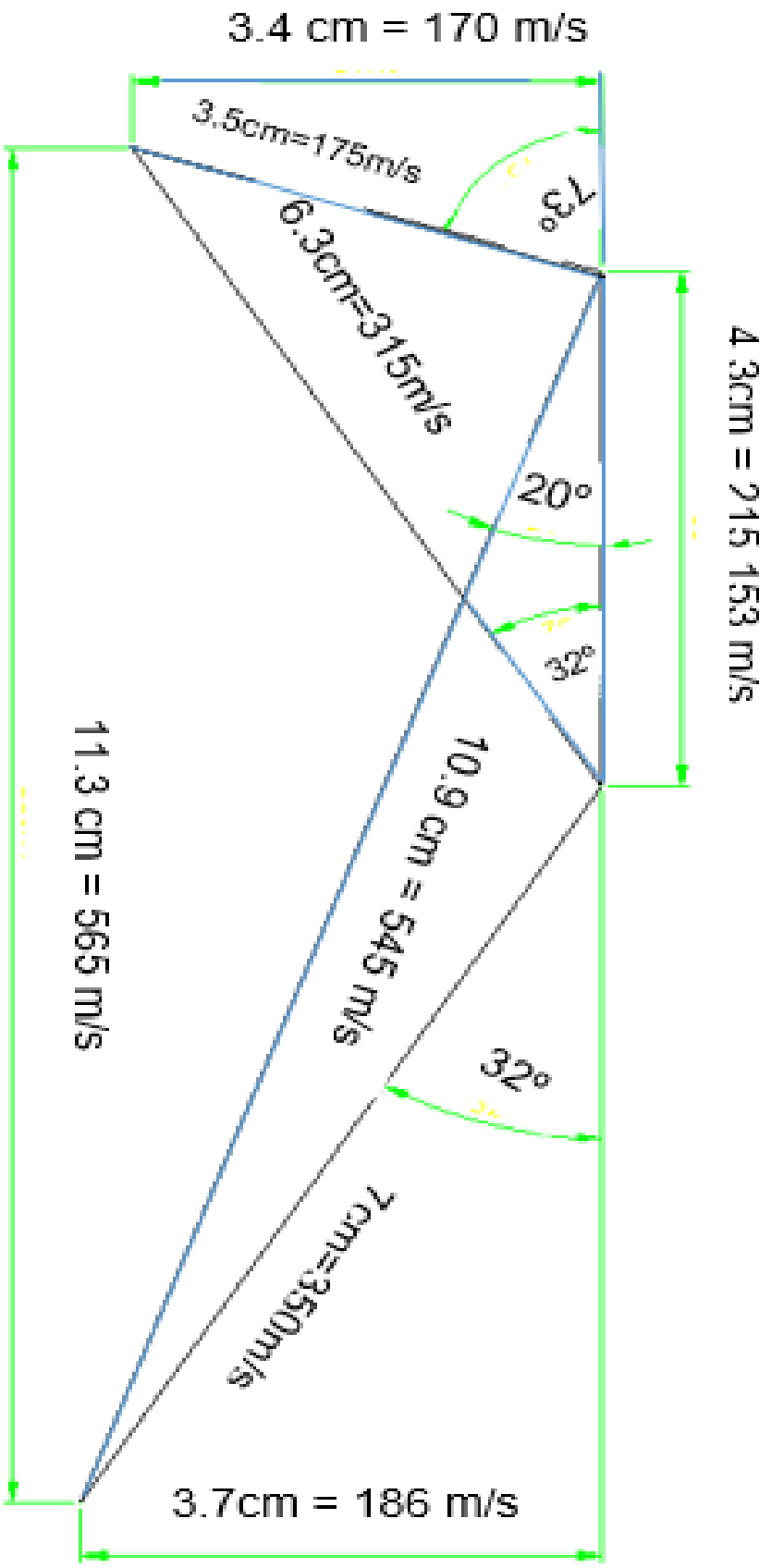
QUESTION 6

6.1 6.1.1 $U = \pi DN$✓

$U = \pi(0{,}84)\left(\frac{4900}{60}\right)$✓

$U = 215{,}513\ m/s$✓ (3)

6.1.2


3.4 cm = 170 m/s
3.5cm=175m/s
73°
6.3cm=315m/s
4.3cm = 215 153 m/s
20°
32°
11.3 cm = 565 m/s
10.9 cm = 545 m/s
32°
7cm=350m/s
3.7cm = 186 m/s

(10)

6.2 6.2.1 $Cfi = 3.7\ cm \times 50 = 186\ \ m/s$ (2)

6.2.2 $Cwe = 1{,}03\ cm \times 50 = 51.5\ m/s$ (2)

6.2.3 $F = m(Cfi - Cfe)$✓

$F = (3{,}2)(186 - 170)$✓

$F = 51.2\ N$✓ (3)

[20]

TOTAL: 100

Copyright reserved