



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANOTECHNICS N6

4 August 2025

This marking guideline consists of 9 pages.

QUESTION 1

$$1.1 \quad \sin\left(\frac{25^\circ}{2}\right) = \frac{R-r}{65}$$

$$r = R - 65 \sin 12,5^\circ \checkmark$$

$$r = 175 - 65 \sin 12,5^\circ \checkmark$$

$$r = 161 \text{ mm} \checkmark$$

$$R_f = \frac{R+r}{2}$$

$$= \frac{0,175 + 0,161}{2} \checkmark$$

$$R_f = 168 \text{ mm} \checkmark$$

$$T = \frac{\mu \times F_A \times R_f}{\sin \theta}$$

$$F_A = \frac{T \times \sin \theta}{\mu \times R_f}$$

$$F_A = \frac{210 \times \sin 12,5^\circ}{0,2 \times 0,168} \checkmark$$

$$= 1\,352,74 \text{ N} \checkmark$$

(6)

$$1.2 \quad P_{max} = \frac{F_A}{2\pi(R-r)r}$$

$$= \frac{1\,352,74}{2\pi(0,175-0,161)0,161} \checkmark$$

$$P_{max} = 95,5 \text{ kPa} \checkmark$$

(2)

[8]

QUESTION 2

$$2.1 \quad \frac{T_1}{T_2} = e^{\mu\theta}$$

$$\frac{T_1}{T_2} = e^{(0,3)\left(\frac{225}{57,3}\right)} \checkmark$$

$$\frac{T_1}{T_2} = 3,25$$

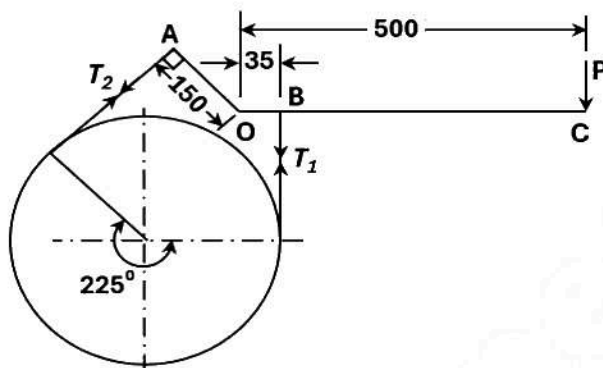
$$T_1 = 3,25T_2 \checkmark$$

$$T_B = (T_1 - T_2)r$$

$$350 = (3,25T_2 - T_2)(0,175) \checkmark$$

$$T_2 = 889,72 \text{ N} \checkmark$$

$$T_1 = 2\,889,72 \text{ N} \checkmark$$

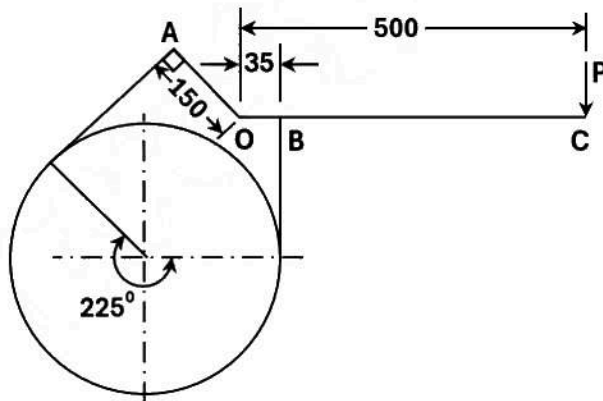


Taking moments about fulcrum O:

$$P \times 0,5 = T_2 \times 0,15 - T_1 \times 0,035 \checkmark$$

$$P \times 0,5 = (889,72 \times 0,15) - (2\,889,72 \times 0,035) \checkmark$$

$$P = 64 \text{ N} \checkmark$$



(8)

$$2.2 \quad P \times 0,5 = (T_2 \times OA) - (T_1 \times OB) \checkmark$$

$$T_2 \times OA = T_1 \times OB \checkmark$$

$$OA = \frac{T_1 \times OB}{T_2}$$

$$= \frac{2\,889,72 \times 0,035}{889,72} \checkmark$$

$$= 114 \text{ mm} \checkmark$$

For the brake to be self-locking, P must be equal to zero.

(4)

QUESTION 3

$$\begin{aligned}
 3.1 \quad P &= \frac{2\pi N}{60} \\
 T_{pinion} &= \frac{37 \times 10^3 \times 60}{2\pi \times 1850} \checkmark \\
 &= 190,986 \text{ Nm} \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 3.2 \quad PCD_{pinion} \times N_{pinion} &= PCD_{gear} \times N_{gear} \\
 0,12 \times 1850 &= 0,34 \times N_{gear} \checkmark \\
 N_{gear} &= 652,941 \checkmark \\
 T_{gear} &= \frac{P \times 60}{2\pi N} = \frac{37 \times 10^3 \times 60}{2\pi \times 652,941} \checkmark \\
 &= 541,127 \text{ N} \checkmark
 \end{aligned}$$

Alternative method:

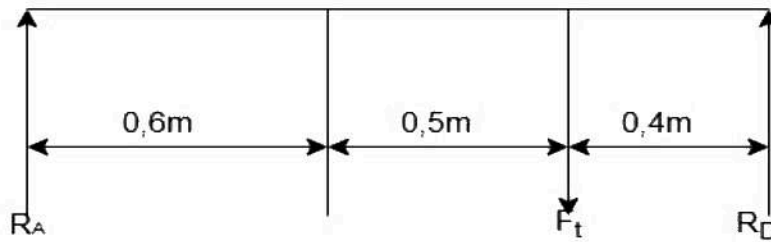
$$\begin{aligned}
 T_{pinion} \times N_{pinion} &= T_{gear} \times N_{gear} \checkmark \\
 T_{gear} &= \frac{T_{pinion} \times N_{pinion}}{N_{gear}} \checkmark \\
 &= \frac{190,986 \times 1850}{652,941} \checkmark \\
 &= 541,127 \text{ Nm} \checkmark
 \end{aligned} \tag{4}$$

$$\begin{aligned}
 3.3 \quad F_t &= \frac{\text{torque} \times 2}{PCD} \\
 &= \frac{190,986 \times 2}{0,12} \checkmark \\
 &= 3181,1 \text{ N} \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 3.4 \quad F_r &= F_t \times \tan \alpha \\
 &= 3181,1 \tan 20^\circ \checkmark \\
 &= 1158,517 \text{ N} \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 3.5 \quad \frac{T_1}{T_2} &= e^{\mu\theta} \\
 &= e^{(0,3)\left(\frac{189}{57,3}\right)} \\
 T_1 &= 2,69T_2 \checkmark \\
 T &= (T_1 - T_2)R \\
 541,127 &= (2,69T_2 - T_2)(0,225) \checkmark \\
 T_2 &= 1423,082 \checkmark \\
 T_1 &= 3828,091 \checkmark
 \end{aligned} \tag{4}$$

3.6



Take moments about R_A :

Sum of clockwise moments = sum of anti – clockwise moments

$$(F_t \times 1,1) = (R_D \times 1,5) \checkmark$$

$$\frac{3\,181,1 \times 1,1}{1,5} \checkmark$$

$$R_D = 2\,334,273\,N \checkmark$$

Take moments about R_D :

Sum of clockwise moments = sum of anti – clockwise moments

$$R_A \times 1,5 = (F_t \times 0,4) \checkmark$$

$$R_A = \left(\frac{3\,181,1 \times 0,4}{1,5} \right) \checkmark$$

$$R_A = 848,83\,N \checkmark$$

(5)
[19]

QUESTION 4

4.1

$$I = mk^2$$

$$= (1\,550)(0,41)^2$$

$$= 260,55\,kg \cdot m^2 \checkmark$$

$$\omega_1 = \frac{2\pi N}{60}$$

$$= \frac{2\pi(135)}{60}$$

$$= 14,14\,rad/s \checkmark$$

$$T_a = (T_{TOTAL} - T_R)$$

$$= 68 - 18$$

$$= 50\,Nm \checkmark$$

$$\omega_2 = \omega_1 + \alpha t$$

$$14,14 + 0,192(3 \times 60)$$

$$48,68\,rad/s \checkmark$$

$$\alpha = \frac{T_a}{I}$$

$$= \frac{50}{260,55}$$

$$= 0,192\,rad/s^2 \checkmark$$

$$N_2 = \frac{\omega_2 \times 60}{2\pi}$$

$$= \frac{48,68 \times 60}{2\pi}$$

$$= 464,88\,r/min \checkmark$$

$$\begin{aligned}
 4.2 \quad P &= T \times \omega_{average} \\
 &= T \times \frac{\omega_1 + \omega_2}{2} \checkmark \\
 &= 68 \times \left(\frac{14,14 + 48,68}{2} \right) \\
 &= 2\,135,58 \, \omega \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 4.3 \quad \alpha &= \frac{T}{I} \\
 &= \frac{18}{260,55} \\
 &= 0,069 \, \text{rad/s}^2 \checkmark \\
 \omega_2 &= \omega_1 + \alpha t \\
 0 &= 14,14 + 0,069 \times t \checkmark \\
 t &= 204,92 \, \text{s} \checkmark \\
 t &= 3,42 \, \text{min} \checkmark
 \end{aligned}
 \tag{4}$$

[12]

QUESTION 5

$$\begin{aligned}
 5.1 \quad I_m &= mr^2 \\
 &= 800 \times 0,2^2 \\
 &= 32 \, \text{kg.m}^2 \checkmark \\
 I_2 &= 400 + 32 = 432 \, \text{kg.m}^2 \checkmark \\
 T\alpha_2 &= I_2 \alpha_2 \\
 432 \times 1,5 &= 646 \, \text{Nm} \checkmark
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 5.2 \quad \alpha_1 &= \alpha_2 \times \frac{N_1}{N_2} \checkmark \\
 &= 1,5 \times \frac{1\,050}{300} \checkmark \\
 &= 5,25 \, \text{rad/s}^2 \checkmark \\
 T_\alpha &= I \times \alpha \\
 &= 180 \times 5,25 \\
 &= 945 \, \text{Nm} \checkmark
 \end{aligned}
 \tag{4}$$

$$\begin{aligned}
 5.3 \quad T_{input} &= T\alpha_1 + \frac{T\alpha_2}{\frac{GR}{3,5}} \checkmark \\
 &= 945 + \frac{648}{3,5} \checkmark \\
 &= 1\,130,143 \, \text{Nm} \checkmark
 \end{aligned}
 \tag{3}$$

[10]

QUESTION 6

6.1
$$\begin{aligned} F_r &= mR \\ &= 500 \times 10^3 \times 0,004 \\ &= 20\,000\text{ N} \checkmark \end{aligned}$$

$$\begin{aligned} F_g &= mg \times \text{incline} \\ &= (500 \times 10^3 \times 9,81) \times \frac{1}{100} \checkmark \\ &= 49\,050\text{ N} \\ \alpha &= 49,05\text{ kN} \checkmark \end{aligned}$$

$$\begin{aligned} \alpha &= \frac{U^2 - V^2}{25} \\ &= \frac{20^2 - 10^2}{2 \times 100} \checkmark \\ &= 0,75\text{ m/s}^2 \checkmark \end{aligned}$$

$$\begin{aligned} F_a &= ma \\ &= 500 \times 10^3 \times 0,75 \\ &= 375\text{ kN} \checkmark \end{aligned}$$

$$\begin{aligned} F_b &= F_g + F_a - F_r \checkmark \\ &= 49,05 + 375 - 20 \checkmark \\ &= 404,05\text{ kN} \checkmark \end{aligned}$$

(9)

6.2
$$\begin{aligned} \omega_D &= F_b \times s \\ &= 404,05 \times 10^3 \times 200 \checkmark \\ &= 80,81\text{ MJ} \checkmark \end{aligned}$$

(2)

[11]

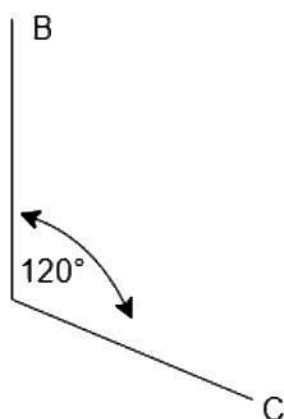
QUESTION 7

7.1

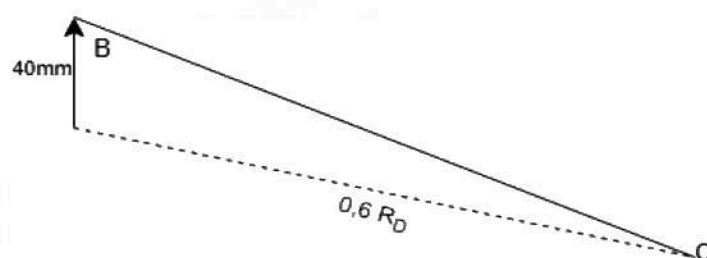
PLANE	Mass (kg)	Radius (mm)	Force polygon (mr)	Length (m)	Couple polygon mrl (kg.m ²)
A	-	-	R_a	0	0
B	2	0,05	0,1	0,2	0,02
C	2,5	0,06	0,15	0,4	0,06
D	-	-	R_d	0,6	$0,6 R_d$

✓✓✓✓

Choose A as reference.



Space diagram ✓



Vector diagram

Scale 20mm:0,01 kgm²

✓✓✓

$$0,6 R_D = 111 \text{ mm}$$

$$0,6 R_D = 0,0555$$

$$R_D = 0,093 \text{ ✓✓}$$

(10)

7.2

For dynamic load on bearing = $R_D \times \omega^2$

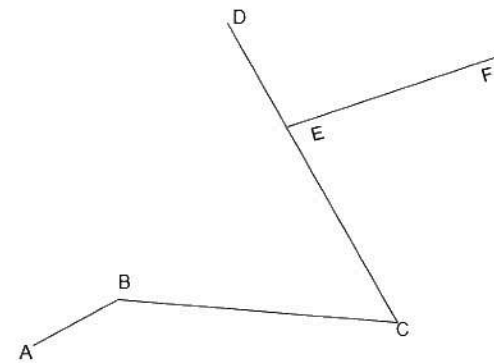
$$= 0,0925 \times \left(\frac{2\pi (2,10)}{60} \right)^2 \text{ ✓}$$

$$= 44,73 \text{ N ✓}$$

(2)

QUESTION 8

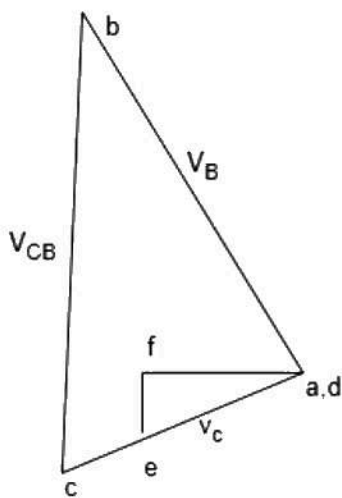
8.1



Space diagram ✓✓✓✓

(4)

8.2



Velocity diagram

✓✓✓✓

(4)

8.3

$$\begin{aligned} v &= \omega r \\ &= \frac{2\pi(150)}{60} \times 0,15 \checkmark \\ V_{ab} &= 2,356 \text{ m/s} \checkmark \end{aligned}$$

(2)

8.4

$$\begin{aligned} \frac{V_{ce}}{V_{cd}} &= \frac{CE}{CD} \\ &= \frac{V_{ce}}{1,5} = \frac{0,3}{0,45} \checkmark \\ V_{ce} &= 1 \text{ m/s} \checkmark \end{aligned}$$

(2)

8.5

$$V_{fd} = 0,9 \text{ m/s} \checkmark \checkmark$$

(2)

8.6

$$\begin{aligned} \omega_{de} &= \frac{dc}{DC} \\ &= \frac{1,55}{0,45} \checkmark \\ &= 3,44 \text{ rad/s} \checkmark \end{aligned}$$

(2)

[16]

TOTAL: