



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANOTECHNICS N4

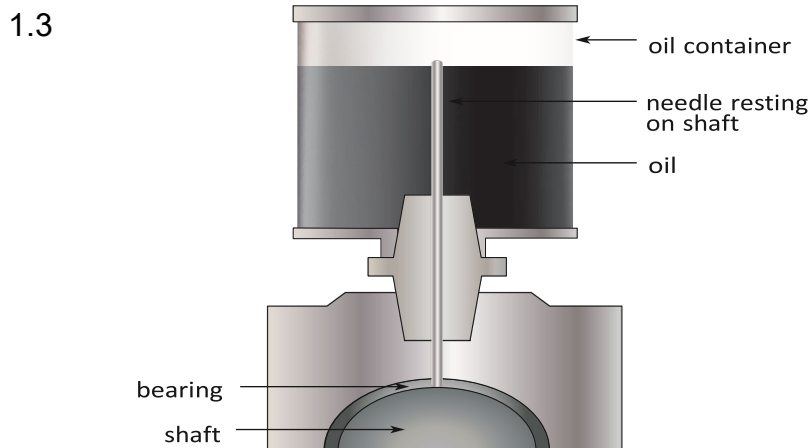
23 November 2023

This marking guideline consists of 10 pages.

QUESTION 1

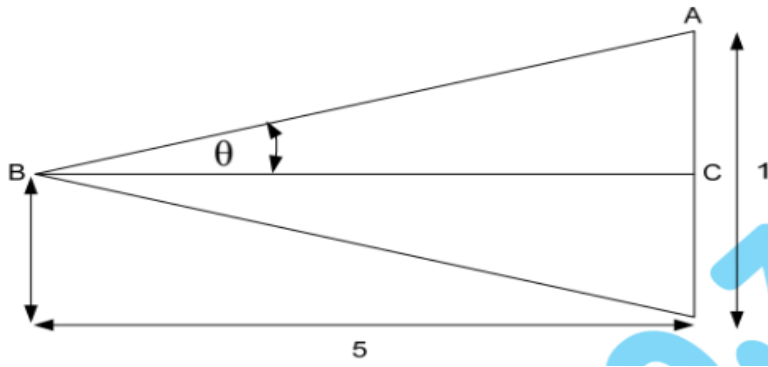
- 1.1
- There is moderate demand for the product.
 - Production is broken down into a number of different operations.
 - A limited number of items are produced at a time.
 - The volume of production is lower than in mass production.
 - There is a degree of standardisation, because each item in batch production is identical.
- (5)

- 1.2
- Reduces overspraying
 - Less solvent is needed
 - Overhead spray painting is possible
 - Air pockets are eliminated, allowing uniform coverage on uneven surfaces
 - Paint container holds a large quantity of paint
- (5)



(2 marks for correct sketch and 3 marks for any 3 correct labels) (5)
[15]

QUESTION 2



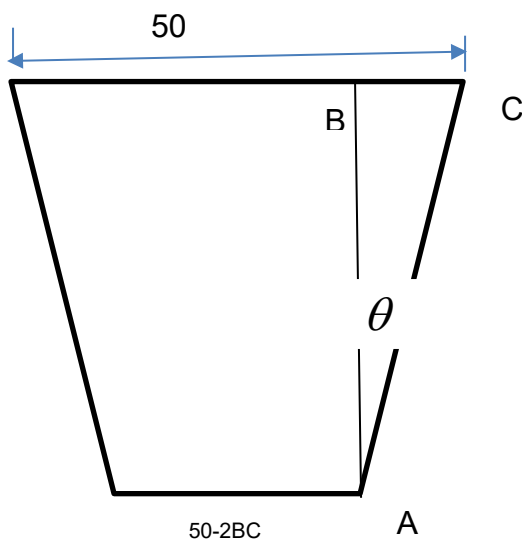
$$\tan \theta = \frac{AC}{BC}$$

$$= \frac{0.5}{5} \checkmark$$

$$\theta = \tan^{-1}(0.1)$$

$$\text{Included angle} = 2(5.711^\circ)$$

$$= 11^\circ 25' \checkmark$$



In triangle ABC:

$$AB = 80$$

$$\tan \theta = \frac{BC}{AB}$$

$$BC = AB \tan \theta$$

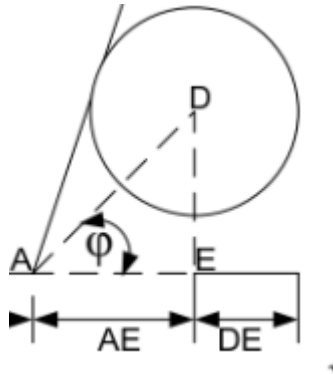
$$= 80 \tan \theta$$

$$= 80 \tan 5.711^\circ \checkmark$$

$$= 8mm \checkmark$$

- Small diameter = $50 - 2BC$ ✓
 $= 50 - 2(8)$
 $= 34\text{mm}$ ✓

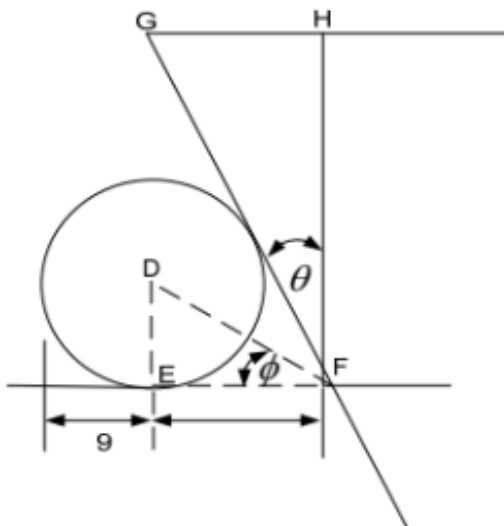
$$X = 34 + 2AE + r$$



In triangle ADE:

$$\theta = \frac{(90 - 5.711)}{2} \checkmark$$

$$\theta = 42,145^\circ \checkmark$$



$$EF = AE = \frac{9}{\tan 42.15} = 9.944 \checkmark$$

$$X = 34 + (2 \times 9.944) + (2 \times 9) \checkmark$$
$$= 71.888 \text{ mm} \checkmark$$

$$HF = 80 - 55$$
$$= 25 \text{ mm} \checkmark$$

$$\tan \theta = \frac{GH}{HF}$$

$$GH = HF \tan \theta$$
$$= 2.5 \tan 5.711$$
$$= 2.5 \text{ mm} \checkmark$$

$$Y = (50 - 2GH) + 2 \times 9 \times 9.944 \checkmark$$

$$= (50 - 2 \times 2.5) + 2 \times 9 \times 9.944$$
$$= 82.89 \text{ mm} \checkmark$$

[15]

QUESTION 3

3.1

Condition	Gear A	Gear B	Gear C	Gear D	Arm E
<i>Fix arm E and rotate gear A by +1 rev</i>	$+1 \checkmark$	$\frac{+60}{+20} \times \frac{+24}{-16} = -4,5 \checkmark$	$\frac{+60}{+20} = 3 \checkmark$	$\frac{+60}{+20} = 3 \checkmark$	0
<i>Multiply by x and add y</i>	$x + y$	$-4,5x + y \checkmark$	$3x + y$	$3x + y$	$+y \checkmark$
$N_E = 0$ $N_B = 120$	$N_A = ?$	$N_B = 120$			$0 \checkmark$
$N_B = +120$ $N_A = 0$	$N_A = 0 \checkmark$	$N_B = 120$			$N_E = ?$

NB: Half mark for each mark ($\checkmark$) allocated in the table

$$-4,5x + y = 120 \dots\dots\dots 1 \checkmark$$

$$y = 0 \dots\dots\dots 2 \checkmark$$

Subtract equation 1 from equation 2

$$-4,5x = 120$$

$$x = -\frac{120}{4,5} \checkmark$$

$$x = -26,66$$

$$\text{And } y = 0$$

$$\text{But } N_A = x + y \checkmark$$

$$N_A = -26,66 + y$$

$$N_A = -26,66 + 0$$

$$= -26,66r / m \checkmark$$

(8)

3.2

$$x + y = 0 \dots\dots\dots 1 \checkmark$$

$$-4,5x + y = 120 \dots\dots\dots 2 \checkmark$$

Subtract equation 1 from equation 2

$$5,5x = -120 \dots\dots\dots 2 \checkmark$$

$$x = \frac{-120}{5,5}$$

$$x = -21,82 \checkmark$$

$$y = +21,82 \checkmark$$

$$N_E = y \checkmark$$

$$N_E = +21,82r / m \checkmark$$

(7)
[15]

QUESTION 4

4.1

$$v = \frac{\pi d N}{60}$$

$$v = \frac{\pi \times 0,4 \times 300}{60}$$

$$v = 6.283 \text{ m/s} \checkmark$$

$$\frac{T_1}{T_2} = e^{\left(\frac{0.2 \times \pi}{\sin 20^\circ}\right)}$$

$$T_1 = 6.278 T_2$$

$$\sigma = \frac{T_1}{A}$$

$$T_1 = 7 \times 10^6 \times 300 \times 10^{-6}$$

$$= 2100 \text{ N} \checkmark$$

Substitute 2 in 1

$$\frac{2100}{T_2} = 6.278$$

$$T_2 = 334.5 \text{ N} \checkmark$$

$$P = (T_1 - T_2)v$$

$$= (2100 - 334.5)6.283$$

$$= 11093 \text{ W} \checkmark$$

$$\text{Power for three belts} = 3(11093)$$

$$P = 33.28 \text{ kW} \checkmark$$

[5]

QUESTION 5

5.1

$$Q = C_d \times A \times \sqrt{\frac{2gh}{(m^2 - 1)}}$$

$$A = \frac{\pi D^2}{4}$$

$$= \frac{\pi 0.08^2}{4}$$

$$= 5.026 \times 10^{-3} m^2 \checkmark$$

And

$$m^2 = \frac{D^4}{d^4} \checkmark$$

$$m^2 = \frac{0.08^4}{0.03^4}$$

$$m^2 = 50.57 \checkmark$$

Also

$$h = 12.6(h_1)$$

$$h = 12.6(0.025)$$

$$h = 0.315m \checkmark$$

$$Q = 0.95 \times 0.00503 \times \sqrt{\frac{2g(0.315)}{(50.57 - 1)}} \checkmark$$

$$= 0.00167 m^3 / s \checkmark$$

$$= 0.00167 \times 3600 \times 1000$$

$$= 6012 l / h \checkmark$$

(7)

5.2

$$Q_a = \frac{54000}{1000 \times 60 \times 60} = 0.015 m^3 / s \checkmark$$

$$Q_t = A_t \times v_t$$

$$= \frac{\pi d^2}{4} \times \sqrt{2gh} \checkmark$$

$$= \frac{\pi 0.06^2}{4} \times \sqrt{2g4}$$

$$= 0.025 m^3 / s \checkmark$$

$$C_d = \frac{Q_a}{Q_t} \checkmark$$

$$= \frac{0.015}{0.025}$$

$$= 0.6 \checkmark$$

(5)

5.3

$$Q_1 = Q_2 \checkmark$$

$$v_1 \times A_1 = v_2 \times A_2 \checkmark$$

$$v_2 = \frac{v_1 \times A_1}{A_2}$$

$$v_2 = \frac{20 \times 0.2^2}{0.4^2} \checkmark$$

$$v_2 = 5 \text{ m/s} \checkmark$$

Find P_2

$$\frac{P_1}{\rho \times 9.81} + \frac{v_1^2}{2g} + h_1 = \frac{P_2}{\rho \times 9.81} + \frac{v_2^2}{2g} + h_2$$

$$\frac{16000}{1000 \times 9.81} + \frac{20^2}{2(9.81)} + 0 = \frac{P_2}{1000 \times 9.81} + \frac{5^2}{2(9.81)} + 0 \checkmark$$

$$1.631 + 20.387 = 0.000102 P_2 + 1.274 \checkmark$$

$$22.018 - 1.274 = 0.000102 P_2 \checkmark$$

$$20.744 = 0.000102 P_2$$

$$P_2 = 203.373 \text{ kPa} \checkmark$$

(8)
[20]**QUESTION 6**

6.1

- Linear fluctuating load
- Fluctuating stepped load
- Sinusoidal fluctuating load
- Continuously fluctuating load

(4)

6.2

$$P = (T_1 - T_2) v$$

$$140000 = (15T_2 - T_2) \frac{1500}{60} \checkmark$$

$$(15T_2 - T_2) = \frac{140000}{25} \checkmark$$

$$T_2 = 400 \text{ N} \checkmark$$

And

$$T_1 = 15(400) \checkmark$$

$$T_1 = 6000 \text{ N} \checkmark$$

Therefore:

$$\begin{aligned} \text{Total tensile force on each bearing} &= \frac{6000 + 400}{2} \checkmark \\ &= 3200 \text{ N} \checkmark \end{aligned}$$

(7)

6.3

$$L_{10h} = \left(\frac{1 \times 10^6}{60 \times n} \right) \times \left(\frac{C_r}{P_r} \right) \checkmark$$

$p = 3$ for ball bearings ✓

$$L_{10h} = \left(\frac{1 \times 10^6}{60 \times 1200} \right) \times \left(\frac{48,2 \times 10^3}{4500} \right)^3 \checkmark$$

$$L_{10h} = 17068 \text{ hours } \checkmark$$

(4)
[15]

QUESTION 7

7.1

7.1.1

$$v = \frac{\pi D n}{60} \checkmark$$

$$v = \frac{\pi 0.08(400)}{60} \checkmark$$

$$v = 1.676 \text{ m/s } \checkmark$$

(3)

7.1.2

$$F_u = \mu \times F$$

$$F_u = 0.04 \times 30000 \checkmark$$

$$F_u = 1200 \text{ N } \checkmark$$

(2)

7.1.3

$$P_u = F_u \times v$$

$$P_u = 1200 \times 1.676 \checkmark$$

$$P_u = 2011.2 \text{ W } \checkmark$$

(2)

7.2

7.2.1

$$P = F \times v$$

And

$$v = \frac{0.15}{6} \checkmark$$

$$v = 0.025 \text{ m/s } \checkmark$$

$$P = 850 \times 0.025 \checkmark$$

$$P = 21.25 \text{ W } \checkmark$$

(4)

7.2.2

$$P = F \times v$$

And

$$v = \frac{\pi D n}{60} \checkmark$$

$$v = 3.927 \text{ m/s } \checkmark$$

$$P = 750 \times 3.927 \checkmark$$

$$P = 2945.25 \text{ W } \checkmark$$

(4)

[15]

TOTAL: 100