



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

13 August 2026

This marking guideline consists of 9 pages.

QUESTION 1: EPICYCLIC GEAR DRIVE

Condition	D	C	B	A	Arm
Fix Arm L & rotate A +1 rev	+1	$\frac{T_D}{-T_C} = \frac{45}{-35}$ $= -1,29 \checkmark$	$\frac{T_D}{-T_C} \times \frac{-T_C}{-T_B} = \frac{45}{-35} \times \frac{-35}{25}$ $= +1,8 \checkmark$	$\frac{T_D}{-T_A} = \frac{45}{15}$ $= -3 \checkmark$	0
Multiply by X & Add Y	$x + y$	$-1,29x + y \checkmark$	$1,8x + y \checkmark$	$-3x + y \checkmark$	y
$N_A = 0$ $N_{Arm} = 4$	$N_D = ?$	$N_C = ?$	$N_B = ?$	$0 \checkmark$	$4 \checkmark$

(4)

$$y = 4 \dots \dots \dots (1) \checkmark$$

$$-3x + y = 0 \dots \dots \dots (2) \checkmark$$

Substitute eqt1 into eqt2

$$-3x + 4 = 0$$

$$x = \frac{-4}{-3} \checkmark$$

$$x = 1,3 \checkmark$$

$$N_B = 1,8x + y$$

$$N_B = 1,8(1,3) + 4$$

$$N_B = \boxed{6,34 \text{ revs}} \checkmark$$

$$N_C = -1,29x + y$$

$$N_C = -1,29(1,3) + 4$$

$$N_C = \boxed{2,323 \text{ revs}} \checkmark$$

$$N_C = x + y$$

$$N_C = 1,3 + 4$$

$$N_C = \boxed{5,3 \text{ revs}} \checkmark$$

(6)

[10]

QUESTION 2: CONVEYOR BELTS AND BELT DRIVES

- 2.1
- Installation costs are lower
 - Installation much easier
 - Cheap maintenance
 - Does not require stronger bearings to support the head pulley shaft

(4)

2.2 2.2.1

Tensions

$$\theta_1 = \frac{235^\circ}{57,3} = 4,101 \checkmark$$

$$\frac{T_1}{T_2} = e^{\mu\theta_1}$$

$$\frac{30}{T_2} = e^{0,25(4,101)} \checkmark$$

$$\frac{30}{T_2} = \boxed{2,788} \checkmark$$

$$T_2 = \boxed{10,76 \text{ kN}} \checkmark$$

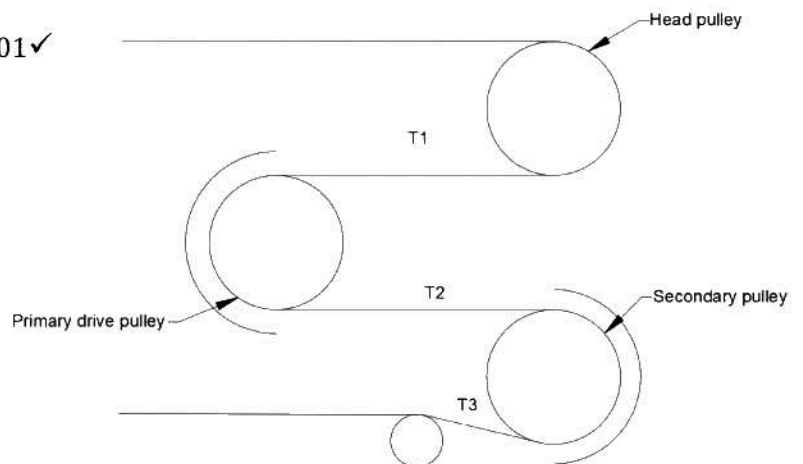
$$\theta_2 = \frac{195^\circ}{57,3} = 3,403 \text{ rad} \checkmark$$

$$\frac{T_2}{T_3} = e^{\mu\theta_2}$$

$$\frac{10,76}{T_3} = e^{0,25(3,403)} \checkmark$$

$$\frac{10,76}{T_3} = 2,341 \checkmark$$

$$T_3 = \boxed{4,597 \text{ kN}} \checkmark$$



(8)

2.2.2

$$P = (T_1 - T_3)v$$

$$P = (30\,000 - 4597) \left(\frac{7,2}{3,6} \right) \checkmark$$

$$P = 25403 \times 2 \checkmark$$

$$P = 50806 \text{ W}$$

$$P = \boxed{50,806 \text{ kW}} \checkmark$$

(3)

2.2.3

$$T_1 = ft \times w \times n$$

$$30 \times 10^3 = 75 \times 80 \times n \checkmark$$

$$n = \frac{30 \times 10^3}{75 \times 80} \checkmark$$

$$n = 5 \checkmark$$

(3)

2.2.4

$$P_i = \frac{P_o}{\eta}$$

$$P_i = \frac{50,806}{0,8} \checkmark$$

$$P_i = \boxed{63,51 \text{ kW}} \checkmark$$

(2)

QUESTION 3: BUCKET ELEVATORS

3.1

$$v = \sqrt{g \times \cos\theta \times r}$$

$$1,583 = \sqrt{9.81 \times \cos 25^\circ \times r} \checkmark$$

$$(1,583)^2 = 9.81 \times \cos 25^\circ \times r$$

$$r = \frac{(1,583)^2}{9.81 \times \cos 25^\circ} \checkmark$$

$$r = 0,282 \text{ m}$$

$$d = \boxed{564 \text{ mm}} \checkmark$$

$$v = \frac{95}{60} = 1,583 \text{ m/s}$$

(3)

3.2

$$L = 2\pi r + 2C$$

$$L = 2\pi(0,282) + 2(95) \checkmark$$

$$L = \boxed{192 \text{ m}} \checkmark$$

(2)

3.3

$$\text{No. of buckets/s} = \frac{\text{Chain speed}}{\text{spacing}}$$

$$\text{No. of buckets/s} = \frac{1,583}{0,8} \checkmark$$

$$\text{No. of buckets/s} = \boxed{1,98 = 2 \text{ bucket/s}} \checkmark$$

$$\text{Load in kg/s} = \frac{1300 \times 10^3}{8 \times 3600} \checkmark$$

$$\text{Load in kg/s} = \boxed{45,14 \text{ kg/s}} \checkmark$$

$$\text{Mass/bucket} = \frac{\text{Mass of load/s}}{\text{buckets/s}}$$

$$\text{Mass/bucket} = \frac{45,14}{2} \checkmark$$

$$\text{Mass/bucket} = \boxed{22,57 \text{ kg/bucket}} \checkmark$$

(6)

3.4

$$\text{Vertical height} = \frac{L}{2}$$

$$\text{Vertical height} = \frac{192}{2}$$

$$\text{Vertical height} = \boxed{96 \text{ m}} \checkmark$$

$$P_g = m \times g \times h$$

$$P_g = 45,57(9,81)(96) \checkmark$$

$$P_g = \boxed{42,92 \text{ kW}} \checkmark$$

$$\text{Motor power} = \frac{P_g}{\eta}$$

$$\text{Motor power} = \frac{42,92}{0,7} \checkmark$$

$$\text{Motor power} = \boxed{61,31 \text{ kW}} \checkmark$$

(4)
[15]

QUESTION 4: ELEVATORS

4.1

$$v = u + at$$

$$4 = 0 + (a \times 5) \checkmark$$

$$a = 0,8 \text{ m/s}^2 \checkmark$$

(2)

4.2

For acceleration

$$T_1 = m_1g + m_1a$$

$$T_1 = (1500)(9,81) + 1500(0,8) \checkmark$$

$$T_1 = \boxed{15915 \text{ N}} \checkmark$$

$$T_2 = m_2g - m_2a$$

$$T_2 = 550(9,81) - 550(0,8) \checkmark$$

$$T_2 = \boxed{4955,5 \text{ N}} \checkmark$$

(4)

$$\begin{aligned}
 4.3 \quad T_{load} &= (T_1 - T_2)r \\
 T_{load} &= (15915 - 4955,5) \times 0,5 \checkmark \\
 T_{load} &= \boxed{5479,75 \text{ Nm}} \checkmark \quad (2)
 \end{aligned}$$

$$\begin{aligned}
 4.4 \quad T_{rope} &= m \times a \times r \\
 T_{drum} &= 300 \times 0,8 \times 0,5 \checkmark \\
 T_{drum} &= 120 \text{ N.m} \checkmark \quad (2) \\
 & \quad \quad \quad [10]
 \end{aligned}$$

QUESTION 5: RAIL AND ROAD TRACTION

$$\begin{aligned}
 5.1 \quad v &= \sqrt{\frac{g \times b \times r}{2 \times h}} \\
 v &= \sqrt{\frac{9,81(1,25)(35)}{2(0,65)}} \checkmark \\
 v &= \sqrt{330,144} \checkmark \\
 v &= 18,17 \text{ m/s} \checkmark \\
 v &= \boxed{65,41 \text{ km/h}} \checkmark \quad (4)
 \end{aligned}$$

$$\begin{aligned}
 5.2 \quad \theta &= \tan^{-1}\left(\frac{v^2}{rg}\right) \\
 \theta &= \tan^{-1}\left(\frac{16,667^2}{120(9,81)}\right) \checkmark \\
 \theta &= \tan^{-1}(0,23606) \checkmark \\
 \theta &= \boxed{13,3^\circ} \checkmark \quad (3)
 \end{aligned}$$

$$\begin{aligned}
 5.3 \quad \text{Super elevation} &= \sin\theta \times \text{track width} \\
 &= \sin 13,3^\circ \times 1,25 \checkmark \\
 &= 0,2876 \text{ m} \checkmark \\
 &= 287,6 \text{ mm} \checkmark \quad (3) \\
 & \quad \quad \quad [10]
 \end{aligned}$$

QUESTION 6: FLYWHEELS

$$6.1 \quad \omega_2 = \frac{2\pi N_2}{60} = \frac{2\pi(120)}{60} = 12,566 \text{ rad } \checkmark$$

$$\omega_1 = \frac{2\pi N_1}{60} = \frac{2\pi(90)}{60} = 9,425 \text{ rad } \checkmark$$

$$\alpha = \frac{\omega_1 - \omega_2}{t}$$

$$\alpha = \frac{12,566 - 9,425}{30}$$

$$\alpha = \boxed{0,1047 \text{ rad/s}^2} \checkmark$$

(3)

$$6.2 \quad T = I \times \alpha$$

$$T = mk^2 \times \alpha$$

$$T = (812)(0,61)^2 \times 0,1047 \checkmark$$

$$T = \boxed{31,635 \text{ N.m}} \checkmark$$

(2)

[5]

QUESTION 7: ROPE HAULAGES AND ARIAL ROPEWAYS

$$7.1 \quad \frac{\text{Mass}}{\text{tub}} = \text{Full tub} - \text{Empty tub}$$

$$\text{Mass/tub} = 1300 - 400$$

$$\text{Mass/tub} = 900 \text{ kg } \checkmark$$

$$\text{Tubs/hr} = \frac{\text{mass per shift}}{\text{running hours} \times \text{mass/tub}}$$

$$\text{Tubs/hr} = \frac{850}{8 \times 0,9} \checkmark$$

$$\text{Tubs/hr} = \boxed{118,06 \text{ Tubs/hr}} \checkmark$$

$$\text{tub spacing} = \frac{\text{rope speed(m/hr)}}{\text{tubs/hr}}$$

$$\text{tub spacing} = \frac{2,8 \times 10^3}{118,06} \checkmark$$

$$\text{tub spacing} = \boxed{23,72 \text{ m}} \checkmark$$

$$\text{No. of tubs each side} = \frac{\text{Length of haulage}}{\text{tub spacing}}$$

$$\text{No. of tubs} = \frac{960}{23,72} \checkmark$$

$$\text{No. of tubs} = 22,47$$

$$\text{Say No. of tubs} = \boxed{22 \text{ on each side}} \checkmark$$

$$\begin{aligned}
 7.2 \quad \text{Mass of rope} &= 2 \times \text{Length of haulage} \times \text{mass of rope} \\
 &= 2 \times 960 \times 4 \\
 &= 7680 \text{ kg} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \text{Total mass of full tubs} &= \text{Mass of full tubs} \times \text{no. of tubs each side} \\
 &= 1300 \times 22 \\
 &= 28600 \text{ kg} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \text{Total mass of empty tubs} &= 2 \times \text{Mass of empty tubs} \times \text{no. of tubs each side} \\
 &= 2 \times 400 \times 22 \\
 &= 17600 \text{ kg} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 M_{\text{Total in haulage}} &= \text{Mass of rope} + M_T \text{ of full tubs} + M_T \text{ of empty tubs} \\
 &= 7680 + 28600 + 17600 \checkmark \\
 &= 53880 \text{ kg} \\
 &= \boxed{53,88 \text{ ton}} \checkmark \quad (5)
 \end{aligned}$$

$$\begin{aligned}
 7.3 \quad \text{Total rolling resistance} &= M_{\text{Total in haulage}} \times \text{track resistance} \\
 &= 53,88 \times 220 \\
 &= 11853,6 \text{ N} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \text{Out of balance load} &= \text{no. of tubs each side} \times \text{load} \times g \\
 &= 22 \times 900 \times 9.81 \\
 &= 194238 \text{ N} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \text{Pull against gravity} &= \text{out of balanced load} \times \sin \theta \\
 &= 194238 \times \sin 14^\circ \checkmark \\
 &= 46990,43 \text{ N} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \text{Total effective pull} &= \text{pull against gravity} + \text{total rolling resistance} \\
 &= 46990,43 + 11853,6 \checkmark \\
 &= \boxed{58844,03 \text{ N}} \checkmark
 \end{aligned}$$

$$\text{Motor power} = \frac{\text{total effective pull} \times \left(\frac{2,8}{3,6}\right)}{\eta}$$

$$\begin{aligned}
 \text{Motor power} &= \frac{58844,03 \times \left(\frac{2,8}{3,6}\right)}{0,8} \checkmark \\
 &= 57209,47 \text{ W} \\
 &= \boxed{57,21 \text{ kW}} \checkmark
 \end{aligned}$$

(8)
[20]

QUESTION 8: REDUCTION GEARBOX

8.1 1500 turns of worm shaft will displace $1500 \times 3 \checkmark = \boxed{4500 \text{ teeth}} \checkmark$

$$N_{\text{Worm wheel}} = \frac{T_{\text{displaced on worm}}}{T_{\text{Worm wheel}}}$$

$$N_{\text{Worm wheel}} = \frac{4500}{40} \checkmark$$

$$N_{\text{Worm wheel}} = \boxed{112,5 \text{ rpm}} \checkmark$$

(4)

8.2 $\therefore N_E = N_A = 112,5 \text{ rpm} \checkmark$

$$\frac{N_{\text{in}}}{N_{\text{out}}} = \frac{\text{product of driven gears}}{\text{product of driving gears}}$$

$$\frac{N_A}{N_D} = \frac{T_B \times T_D}{T_A \times T_C}$$

$$\frac{112,5}{N_D} = \frac{60 \times 70}{18 \times 20} \checkmark$$

$$N_D = \frac{18 \times 20 \times 112,5}{60 \times 70} \checkmark$$

$$N_D = \boxed{9,64 \text{ rpm}} \checkmark$$

(4)

8.3 $\text{Velocity ratio} = \frac{N_{\text{worm shaft}}}{N_D}$

$$\text{Velocity ratio} = \frac{1500}{9,64} \checkmark$$

$$\text{Velocity ratio} = \boxed{155,6}$$

$$\text{Velocity ratio} = \boxed{155,6 : 1} \checkmark$$

(2)

[10]

TOTAL: 100