



# higher education & training

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Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

## **MARKING GUIDELINE**

**NATIONAL CERTIFICATE**

**MECHANOTECHNICS N5**

**13 August 2025**

**This marking guideline consists of 10 pages.**

### QUESTION 1: EPICYCLIC GEAR DRIVE

| Condition                   | C         | B                                                    | A                                                                                                 | Arm L          |
|-----------------------------|-----------|------------------------------------------------------|---------------------------------------------------------------------------------------------------|----------------|
| Fix Arm L & rotate A +1 rev | +1        | $\frac{T_C}{T_B} = \frac{90}{80} = -1,125\checkmark$ | $\frac{T_C}{T_B} \times \frac{T_B}{T_A} = \frac{90}{80} \times \frac{80}{-70} = -1,286\checkmark$ | 0              |
| Multiply by X & Add Y       | $x + y$   | $-1,125x + y\checkmark$                              | $-1,286x + y\checkmark$                                                                           | $y$            |
| $N_L = 1$<br>$N_A = 0$      | $N_C = ?$ |                                                      | $0\checkmark$                                                                                     | $+1\checkmark$ |

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

$$1,286x + y = 0 \dots \dots \dots (2) \checkmark$$

Substitute eq1 into 2

$$1,286x + 1 = 0\checkmark$$

$$1,286x = -1$$

$$x = \frac{-1}{1,286}$$

$$x = \boxed{-0,777}\checkmark$$

$$N_C = x + y$$

$$N_C = -0,777 + 1$$

$$N_C = \boxed{0,223 \text{ revolutions}}\checkmark$$

[10]

### QUESTION 2: CONVEYOR BELT AND BELT DRIVES

$$2.1 \quad \theta_1 = \frac{180^\circ}{57,3} = 3,142 \text{ rad}\checkmark$$

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

$$\frac{23}{T_2} = e^{0,28(3,142)}\checkmark$$

$$T_2 = \frac{23}{2,41}\checkmark$$

$$T_2 = \boxed{9,544 \text{ kN}}\checkmark$$

(4)

$$2.2 \quad \theta_1 = \frac{230^\circ}{57,3} = 4,014 \text{ rad} \checkmark$$

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

$$\frac{9,544}{T_3} = e^{0,28(4,014)} \checkmark$$

$$T_2 = \frac{9,544}{3,077} \checkmark$$

$$T_2 = \boxed{3,102 \text{ kN}} \checkmark$$

(4)

$$2.3 \quad v = \frac{8 \times 10^3}{3\,600} \checkmark = 2,222 \text{ m/s} \checkmark$$

$$P_m = \frac{(T_1 - T_2)v}{\eta}$$

$$P_m = \frac{(23 - 3,102)2,222}{0,8} \checkmark$$

$$P_m = \boxed{55,27 \text{ kW}} \checkmark$$

(4)

$$2.4 \quad T_1 = w \times n \times ft$$

$$n = \frac{T_1}{w \times ft}$$

$$n = \frac{23 \times 10^3}{0,9 \times 5 \times 10^3} \checkmark$$

$$n = \boxed{5 \text{ plies}} \checkmark$$

(3)

- 2.5
- New design gives proper bending rigidity.
  - Long-life structure with good fatigue-resistance and elasticity.
  - There is no scattering, leakage and dropping of material.
  - It prevents deposit on belt from dropping.
  - Material is closed up in pipe and no foreign material comes in from outside.
  - A large angle of inclination can be used. For angles over 30, pipe conveyor belt with fins can be used.
  - Layout is easy and economical since transportation line is easily designed and layout cost is low.
  - Layout space is minimised.

(Any 5 × 1) ✓✓✓✓✓

(5)

[20]

### QUESTION 3: AERIAL ROPEWAYS AND ROPE HAULAGES

3.1

$$\text{Number of tubs per minute} = \frac{\text{ton per shift}}{60 \times \text{running hours} \times \text{ton/tub}}$$

$$\text{Number of tubs per minute} = \frac{700 \times 10^3}{60 \times 8 \times 710} \checkmark$$

$$\text{Number of tubs per minute} = \boxed{2,054 \text{ tubs/min}} \checkmark$$

$$\text{Tub pacing} = \frac{\text{Rope speed m/min}}{\text{Tubs per min}}$$

$$\text{Tub pacing} = \frac{75}{2,054} \checkmark$$

$$\text{Tub pacing} = \boxed{36,514 \text{ m}} \checkmark$$

$$\text{Average number of tubs each side} = \frac{965}{36,514} \checkmark$$

$$\text{Average number of tubs each side} = 26,428$$

$$\text{Average number of tubs each side} = \boxed{26 \text{ tubs}} \checkmark$$

$$\text{Pull against gravity} = \text{Out of balance load} \times \sin \theta$$

$$\text{Pull against gravity} = (\text{no. of tubs each side} \times \text{load} \times g) \times \sin 10^\circ$$

$$\text{Pull against gravity} = (26 \times 710 \times 9,81) \times \sin 10^\circ \checkmark$$

$$\text{Pull against gravity} = 31446,4 \text{ N}$$

$$\text{Pull against gravity} = \boxed{31,446 \text{ kN}} \checkmark$$

$$\text{Ton in haulage} = \text{Mass of tubs} + \text{Mass of load} + \text{Mass of rope}$$

$$\text{Ton in haulage} = (2 \times 26 \times 215) + (26 \times 710) + (2 \times 965 \times 2,5) \checkmark$$

$$\text{Ton in haulage} = (11180) + (18460) + (4825) \checkmark$$

$$\text{Ton in haulage} = 34465 \text{ kg}$$

$$\text{Ton in haulage} = \boxed{34,465 \text{ ton}} \checkmark$$

*Total rolling resistance = Ton in haulage × Track resistance*

*Total rolling resistance = 34,465 × 175✓*

*Total rolling resistance = 6031,375*

*Total rolling resistance = 6,031 kN✓*

*Total effective pull = Pull against gravity + Total rolling resistance*

*Total effective pull = 31,446 + 6,031✓*

*Total effective pull = 37,477 kN✓*

3.1 
$$\text{Motor power} = \frac{\text{Total effective pull} \times v}{\eta}$$

$$65,3 \times 10^3 = \frac{37,477 \times 10^3 \times \left(\frac{4,5 \times 10^3}{3600}\right)}{\eta} \checkmark$$

$$\eta = \frac{37,477 \times 10^3 \times (1,25)}{65,3 \times 10^3} \checkmark$$

$$\eta = 0,717$$

$$\eta = 72 \% \checkmark$$

(18)

- 3.2
- Endless rope haulages.✓
  - Main and tail rope haulages.✓

(2)

[20]

#### QUESTION 4: RAIL AND ROAD TRACTION

4.1 
$$F_R = F_\mu \times m \times g$$

$$F_R = 0,02 \times 280 \times 10^3 \times 9,81 \checkmark$$

$$F_R = 54936 \text{ N}$$

$$F_R = 54,936 kN \checkmark$$

(2)

4.2 
$$F_g = m \times g \times h$$

$$F_g = 280 \times 10^3 \times 9,81 \times \frac{1}{120} \checkmark$$

$$F_g = 22890 \text{ N}$$

$$F_g = 22,890 kN \checkmark$$

(2)

$$\begin{aligned}
 4.3 \quad F_a &= m \times a \\
 F_a &= 280 \times 10^3 \times 0,07 \checkmark \\
 F_a &= 19600 \text{ N} \\
 F_a &= \boxed{19,600 \text{ kN}} \checkmark \quad (2)
 \end{aligned}$$

$$\begin{aligned}
 4.4 \quad T_E &= F_R + F_g + F_a \\
 T_E &= 54,936 + 22,890 + 19,600 \checkmark \\
 T_E &= \boxed{97,426 \text{ kN}} \checkmark \\
 P_L &= T_E \times V \\
 P_L &= 97,426 \times 10^3 \times \frac{80 \times 10^3}{3600} \checkmark \\
 P_L &= 2165022,22 \text{ N} \\
 P_L &= \boxed{2165,02 \text{ kN}} \checkmark \quad (4) \\
 &\quad [10]
 \end{aligned}$$

### QUESTION 5: FLYWHEELS

$$\begin{aligned}
 \omega_2 &= \omega_1 + \alpha t \\
 \alpha &= \frac{\omega_2 - \omega_1}{t} \\
 \alpha &= \frac{1 - 2}{5} \checkmark \\
 \alpha &= \boxed{-0,2 \text{ m/s}^2} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 I &= mk^2 \\
 I &= (25 \times 10^3)(3)^2 \checkmark \\
 I &= \boxed{225\,000 \text{ kg} \cdot \text{m}^2} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 T &= I \times \alpha \\
 T &= 225\,000 \times 0,2 \\
 T &= 45\,000 \text{ Nm} \\
 T &= \boxed{45 \text{ kNm}} \checkmark
 \end{aligned}$$

[5]

### QUESTION 6: REDUCTION GEARBOX

- 6.1
- Spur gears.✓
  - Helical-toothed gears.✓
  - Double helical-toothed gears.✓
- (3)

- 6.2 1 200 turns of worm shaft will displace  $1\,200 \times 2 = 2400$  teeth. ✓

$$N_E = \frac{2400}{36} \checkmark$$

$$N_E = \boxed{66,67 \text{ r/min}} \checkmark$$

$$\frac{N_A}{N_D} = \frac{\text{No of teeth of driven gears}}{\text{No of teeth of driving gears}}$$

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

$$\frac{66,67}{N_D} = \frac{45 \times 74}{25 \times 22} \checkmark$$

$$N_D = \frac{66,67 \times 25 \times 22}{45 \times 74} \checkmark$$

$$N_D = \boxed{11,012 \text{ r/min}} \checkmark$$

(7)  
[10]

## QUESTION 7: ELEVATORS

7.1  $T_1 = m_1(g + a) + F_\mu$   
 $T_1 = 1230(9,81 + 1,4) + 410 \checkmark$   
 $T_1 = \boxed{14198,3 \text{ N.m}} \checkmark$

$T_2 = m_2(g - a) - F_\mu$   
 $T_2 = 440(9,81 + 1,4) - 390 \checkmark$   
 $T_2 = \boxed{3310,4 \text{ N.m}} \checkmark$

$T_{Load} = (T_1 - T_2)R$   
 $T_{Load} = (14198,3 - 3310,4)0,6$   
 $T_{Load} = \boxed{6532,74 \text{ Nm}} \checkmark$

$T_{Drum} = I\alpha$   
 $T_{Drum} = mk^2 \times \frac{a}{r} + T_\mu$   
 $T_{Drum} = 670(0,53)^2 \times \frac{1,4}{0,6} + 280 \checkmark$   
 $T_{Drum} = \boxed{719,14 \text{ Nm}} \checkmark$   
 $T_{total} = T_{Load} + T_{Drum}$

$T_{total} = 6532,74 + 719,14$   
 $T_{total} = \boxed{7251,88 \text{ Nm}}$

(8)

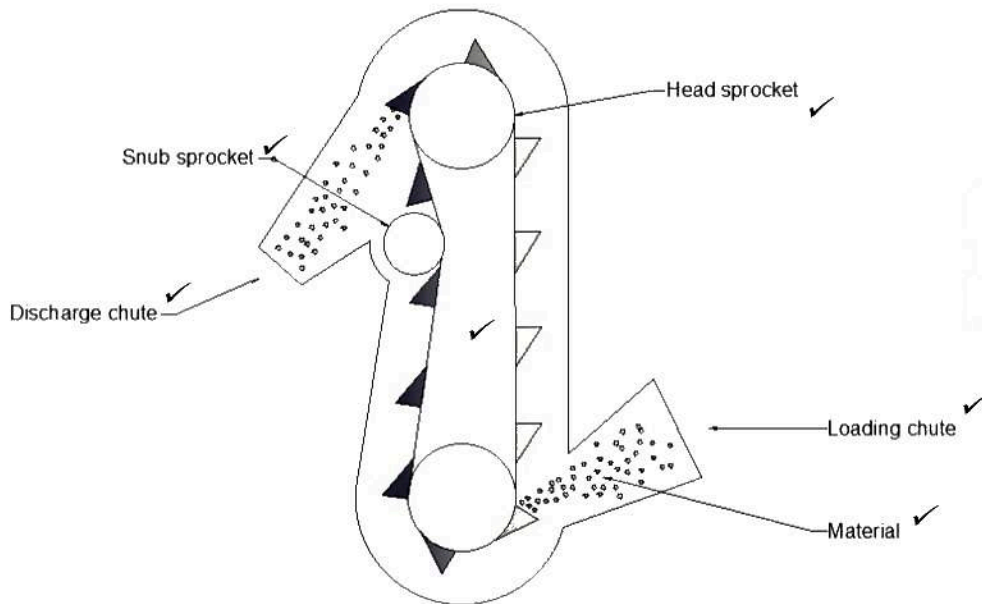
7.2  $P = T_{total} \times \omega$   
 $P = 7251,88 \times \left(\frac{3,5}{0,6}\right) \checkmark$   
 $P = \boxed{42,3 \text{ kW}} \checkmark$

(2)

[10]

## QUESTION 8: BUCKET ELEVATORS

8.1



4 marks for labelling  
1 mark for correct drawing (5)

8.2

8.2.1

$$m = \frac{380 \times 1000}{3600}$$

$$m = \boxed{105,56 \text{ kg/s}} \checkmark$$

$$\text{Volume delivered} = \frac{\text{mass of load}}{\text{density of load}}$$

$$\text{Volume delivered} = \frac{105,56}{800} \checkmark$$

$$\text{Volume delivered} = \boxed{0,132 \text{ m}^3/\text{s}} \checkmark$$

$$\text{Number of buckets/s} = \frac{\text{chain speed}}{\text{spacing of buckets}}$$

$$\text{Number of buckets/s} = \frac{0,8}{1} \checkmark$$

$$\text{Number of buckets/s} = \boxed{0,8 \text{ buckets/s}} \checkmark$$

$$\text{Volume of bucket} = \frac{\text{volume delivered/s}}{\text{number of buckets/s}}$$

$$\text{Volume of bucket} = \frac{0,132}{0,8} \checkmark$$

$$\text{Volume of bucket} = \boxed{0,165 \text{ m}^3} \checkmark$$

(7)

8.2.2  $P_g = mgh$   
 $P_g = 105,56 (9.81)(70) ✓$   
 $P_g = 72488,052 \text{ W}$   
 $P_g = \boxed{72,488 \text{ kW}} ✓$

$$P_m = \frac{P_g}{\eta}$$
$$P_m = \frac{72,488}{0,9}$$
$$P_m = \boxed{80,542 \text{ kW}} ✓$$

(3)  
[15]

**TOTAL: 100**