



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

2 April 2024

This marking guideline consists of 9 pages.

QUESTION 1

- 1.1 1.1.1 A
 1.1.2 C
 1.1.3 D
 1.1.4 D
 1.1.5 C

(5 × 1) (5)

- 1.2 1.2.1 Given:
 $u = 0 \text{ m/s}$
 $a = 3 \text{ m/s}^2$
 $t = 30 \text{ s}$

$$s = ut + \frac{1}{2}at^2$$

$$s = 0 + \frac{1}{2} \times 3 \times 30^2 \checkmark$$

$$s = 1\,350 \text{ m} \checkmark$$

(2)

- 1.2.2 From G to H
 Given:
 $t = 120 \text{ s}$
 $a = 0 \text{ m/s}^2$

From F to G

$$v = u + at$$

$$v = 0 + 3 \times 30$$

$$v = 90 \text{ m/s} \checkmark$$

From G to H

$$s = vt$$

$$s = 90 \times 120$$

$$s = 10\,800 \text{ m} \checkmark$$

$$s = 10,8 \text{ km}$$

(2)

- 1.2.3 From H to J
 Given:
 $v = 0 \text{ m/s}$
 $s = 250 \text{ m/s}$
 $u = 90 \text{ m/s}$

$$v^2 = u^2 + 2as$$

$$a = \frac{0^2 - 90^2}{2 \times 250} \checkmark$$

$$a = -16,2 \text{ m/s}^2 \checkmark$$

$$v = u + at$$

$$t = \frac{0 - 90}{-16,2}$$

$$t = 5,556 \text{ s} \checkmark$$

$$t_T = 30 + 120 + 5,556$$

$$t_T = 155,556 \text{ s} \checkmark$$

- 1.3 Given:
 $N = 50 \text{ rpm}$
 $r = 0,15 \text{ m}$
 $t = 10 \text{ s}$

$$\theta = \frac{\pi N D t}{60}$$

$$\theta = \frac{\pi \times 50 \times 2 \times 0,15 \times 10}{60} \checkmark$$

$$\theta = 7,854 \text{ rads} \checkmark$$

(2)
[15]

QUESTION 2

- 2.1
- A concentrated load acts at a single point of a beam. ✓
 - A uniformly distributed load is spread evenly over a certain length of a beam. ✓

(2)

- 2.2 2.2.1 Taking moments about B

$$\Sigma \cup Moments = \Sigma \cup Moments$$

$$(5 \times 0,5) + (10 \times 1) + (15 \times 4) + (5 \times 6) + (9 \times 7,5) + (6 \times 10) =$$

$$(10 \times 1) + (F \times 9) \checkmark$$

$$\therefore F = 24,444 \text{ kN} \checkmark$$

Taking moments about F

$$\Sigma \cup Moments = \Sigma \cup Moments$$

$$(6 \times 1) + (B \times 9) = (10 \times 10) + (5 \times 8,5) + (10 \times 8) + (15 \times 5) +$$

$$(5 \times 3) + (9 \times 1,5) \checkmark$$

$$\therefore B = 35,556 \text{ kN} \checkmark$$

Checking the answers: $\Sigma \uparrow F = \Sigma \downarrow F$

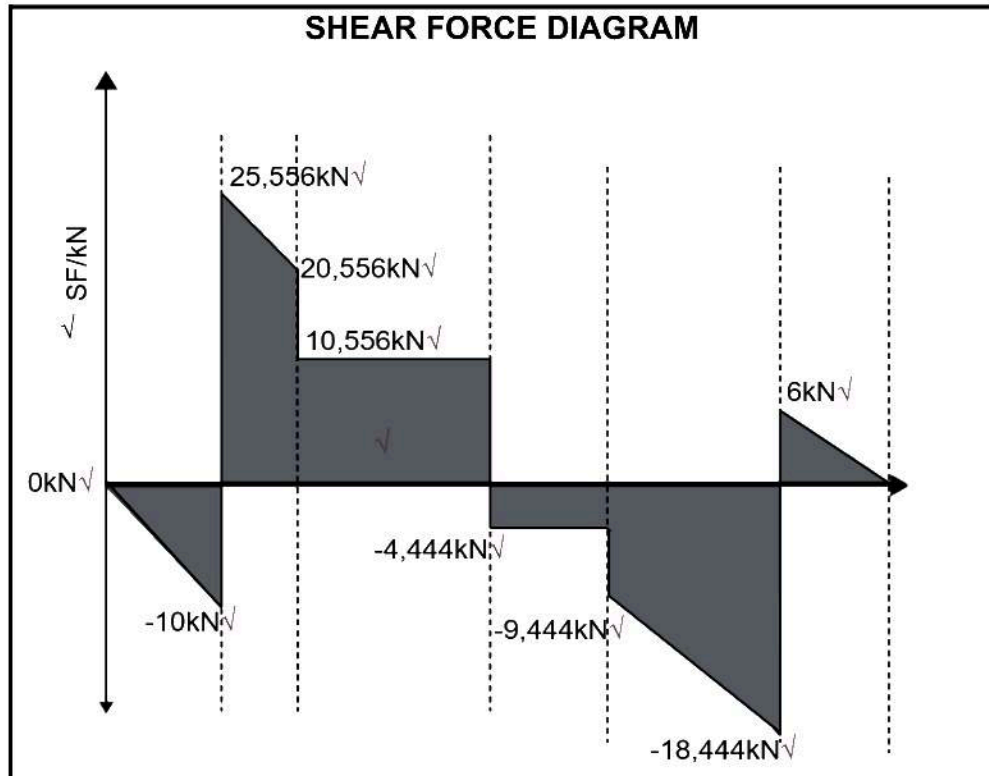
$$10 + 5 + 10 + 15 + 5 + 9 + 6 = 24,444 + 35,556$$

$$60 \text{ kN} = 60 \text{ kN} \checkmark$$

$\therefore$ Balanced and correct

(5)

2.2.2



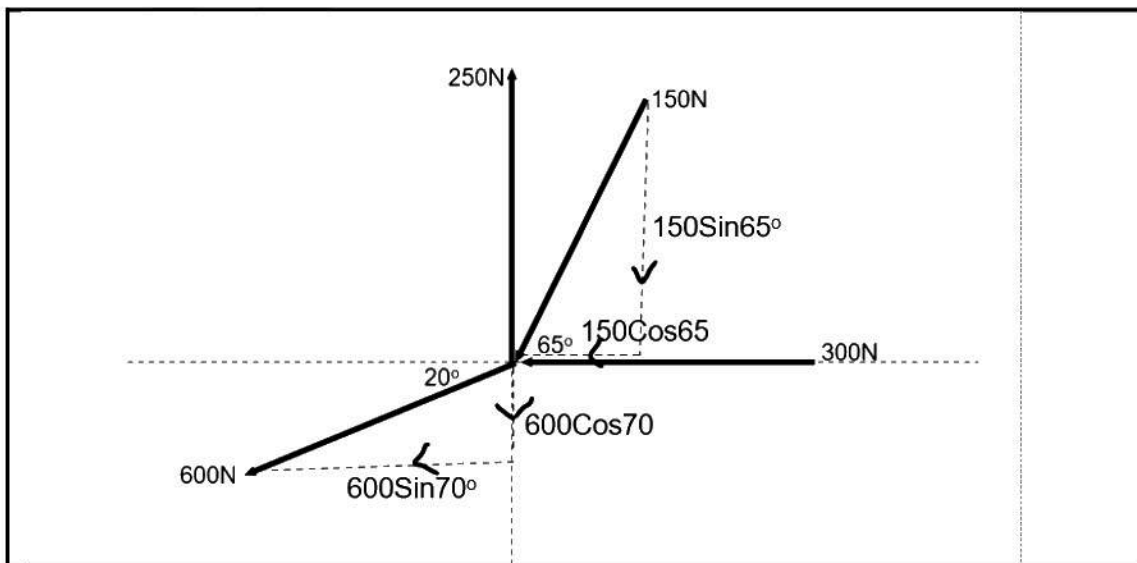
(5)
[12]

QUESTION 3

- 3.1
- If two forces acting at a point are represented in magnitude and direction by two sides of a parallelogram meeting at that point, ✓
 - their resultant is represented by the diagonal drawn from that point. ✓

(2)

3.2



$$\sum V_{COMP} = -300 - 150\sin 65 - 600\sin 70 = -927,208 \text{ N} \checkmark$$

$$\sum H_{COMP} = 250 - 150\cos 65 - 600\cos 70 - 300 = 91,158 \text{ N} \checkmark$$

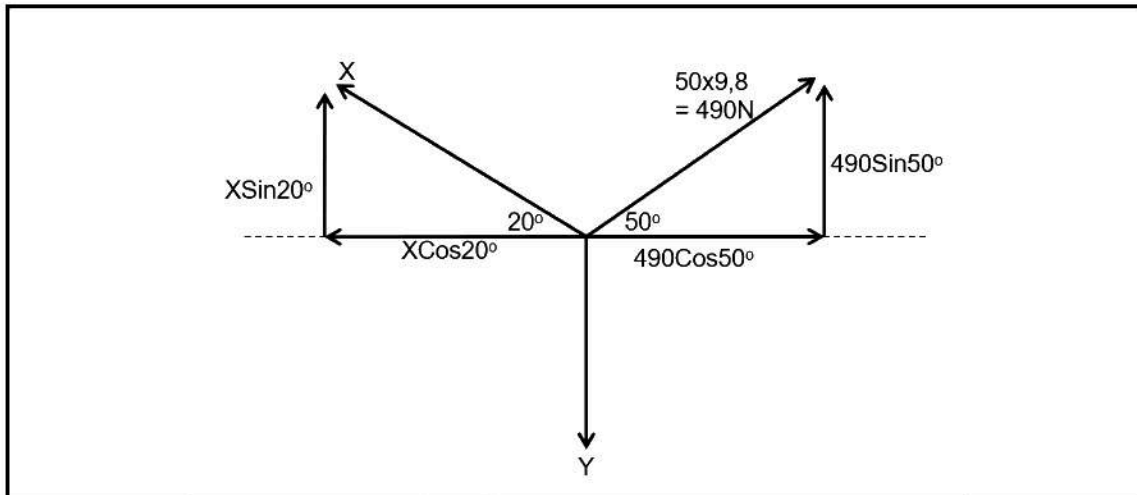
$$\begin{aligned}\therefore F_R &= \sqrt{927,208^2 + 91,158^2} \\ &= 931,678 \text{ N } \checkmark\end{aligned}$$

$$\begin{aligned}\tan \theta &= \frac{91,508}{927,208} \\ \therefore \theta &= 5,6^\circ \checkmark\end{aligned}$$

$$\therefore F_R = 931,678 \text{ N } \text{ W } 5,6^\circ \text{ N } \checkmark$$

(5)

3.3



$$\begin{aligned}\sum H_C &= 0 \\ X \cos 20^\circ &= 490 \cos 50^\circ \checkmark \\ X &= 335,18 \text{ N } \checkmark \\ \therefore x &= 34,202 \text{ kg } \checkmark\end{aligned}$$

$$\begin{aligned}\sum V_C &= 0 \\ X \sin 20^\circ + 490 \sin 50^\circ &= Y \checkmark \\ Y &= 335,18 \sin 20^\circ + 490 \sin 50^\circ \\ &= 490 \text{ N} \\ \therefore y &= 50 \text{ kg } \checkmark\end{aligned}$$

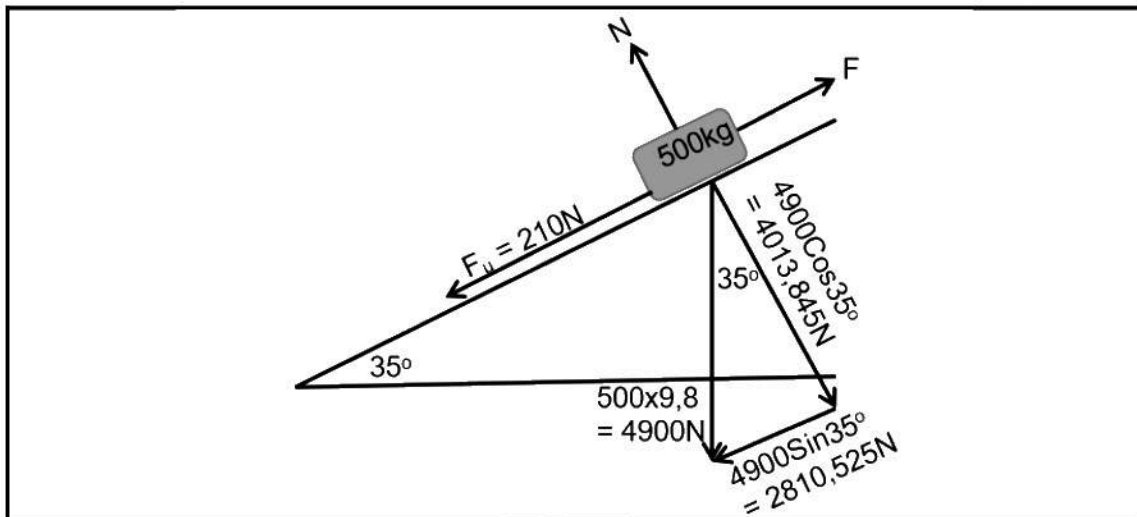
(5)
[12]

QUESTION 4

- 4.1
- Brings movement to a standstill
 - Transmits movements by means of belts
 - Removes material
 - Prevents slip between two contact surfaces

(4)

4.2



4.2.1 $4\,900 \sin 35^\circ = 2\,810,525\,N$

4.2.2 $4\,900 \cos 35^\circ = 4\,013,845\,N$

4.2.3 $F = 210 + 2\,810,525\checkmark$
 $= 3\,020,525\,N\checkmark$

4.2.4 $F_\mu = \mu N$
 $210 = \mu \times 4\,013,845\checkmark$
 $\therefore \mu = 0,052\checkmark$

(4 × 2)

(8)

[12]

QUESTION 5

- 5.1 It is the quantity of energy required to raise the temperature of 1 kg✓ of a substance by 1 °C. ✓

(2)

- 5.2
- Change in temperature ✓
 - Specific heat capacity ✓
 - Mass of the substance ✓

(3)

5.3 Heat gained = Heat lost

$$(mc\Delta t)_{\text{Water}} = (mc\Delta t)_{\text{Aluminium}}$$

$$30 \times 4\,187 \times (t_f - 25) = 0,9 \times 6 \times 900 \times (200 - t_f) \checkmark\checkmark$$

$$\therefore t_f = 31,517\,^\circ\text{C} \checkmark$$

- 5.4 5.4.1 $27 + 75 = 102\text{ }^{\circ}\text{C}$
 $102 + 273 = 375\text{ K} \checkmark$ (1)
- 5.4.2 $A_f = A_o + \Delta A$
 $= (0,35 \times 0,45) + (2 \times 0,35 \times 0,45 \times 54 \times 10^{-6} \times 75) \checkmark\checkmark$
 $= 0,159\text{ m}^2 \checkmark$ OR $158,776 \times 10^{-3}\text{ m}^2$ (3)
- 5.5 5.5.1 $179,9\text{ }^{\circ}\text{C} \checkmark$ (1)
- 5.5.2 $h_g = 2\,777 \times 2 \checkmark = 5\,554\text{ kJ} \checkmark$ (2)
- [15]**

QUESTION 6

- 6.1 Pascal's law states that a pressure change at any point in a confined fluid is transmitted equally in all directions throughout the fluid. (1)
- 6.2 6.2.1 $P = \rho gh$
 $= 1\,000 \times 9,8 \times 20 \checkmark$
 $= 196\,000\text{ Pa} = 196\text{ kPa} \checkmark$ (2)
- 6.2.2 $WD = P \times V$
 $= 196\,000 \times \frac{\pi \times 0,15^2 \times 0,25}{4} \checkmark\checkmark$
 $= 865,901\text{ J} \checkmark$ (3)
- 6.2.3 $V = \frac{\pi d^2}{4} \times l \times \text{No. of strokes}$
 $= \frac{\pi 0,15^2}{4} \times 0,25 \times 15 \checkmark$
 $= 66,268 \times 10^{-3}\text{ m}^3 \checkmark$
 $= 66,268\text{ l} \checkmark$ (3)
- 6.3 6.3.1 $\frac{f}{d^2} = \frac{F}{D^2}$
 $F = \frac{480 \times 0,9^2}{0,35^2} \checkmark\checkmark$
 $= 3\,173,878\text{ N} \checkmark$
- 6.3.2 $\frac{\pi d^2}{4} \times H \times \text{No. of strokes} = \frac{\pi D^2}{4} \times h$
 $d^2 \times H = D^2 \times h$
 $\therefore H = \frac{0,35^2 \times 0,15}{0,9^2} \checkmark\checkmark$
 $= 21,709 \times 10^{-3}\text{ m} \checkmark$
- (2 × 3) **(6)**

QUESTION 7

7.1 It is the potential difference across the terminal of the battery (or cell). (1)

7.2 7.2.1 $V_6 = 3 \times 6 = 18 \text{ V} = V_{2+8} \checkmark$

$$\begin{aligned}\therefore I_2 &= \frac{18}{10} \checkmark \\ &= 1,8 \text{ A} \checkmark\end{aligned}\quad (3)$$

7.2.2 $I_T = 3 + 1,8 = 4,8 \text{ A} \checkmark$ (1)

7.2.3 $V_R = 18 - 12 = 6 \text{ V} \checkmark$

$$\begin{aligned}\therefore R &= \frac{6}{4,8} \\ &= 1,25 \Omega \checkmark\end{aligned}\quad (2)$$

7.2.4 $P_R = V_R \times I_T$

$$\begin{aligned}&= 6 \times 4,8 \checkmark \\ &= 28,8 \text{ W} \checkmark\end{aligned}\quad (2)$$

7.3 Given:
 $V = 220 \text{ V}$
 $I = 25 \text{ A}$

7.3.1 $t = 3 \text{ hrs } 40 \text{ min} = 3,667 \text{ hrs}$

$$\begin{aligned}\text{Energy} &= VIt \\ &= 220 \times 25 \times 3,667 \times 3\,600 \checkmark \\ &= 72,607 \text{ MJ} \checkmark\end{aligned}\quad (2)$$

7.3.2 Cost = R1,65 per kWh

$$\begin{aligned}1 \text{ kWh} &= 3,6 \text{ MJ} \\ \therefore 72,607 \text{ MJ} &= 20,169 \text{ kWh} \checkmark\end{aligned}$$

$$\begin{aligned}\therefore \text{Total cost} &= R1,65 \times 20,169 \checkmark \\ &= R33,28 \checkmark\end{aligned}$$

(3)
[14]

QUESTION 8

- 8.1 It is a substance that contains the same type of atoms or a substance that cannot be broken down into simpler substances by chemical means. (1)
- 8.2.1 • NaCl (1)
- 8.2.2 • H₂O (1)
- 8.3 An element is a pure substance which contains only atoms of the same proton (2)
[5]

TOTAL: 100