



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

**NATIONAL CERTIFICATE
APRIL EXAMINATION
ENGINEERING SCIENCE N2**

1 APRIL 2016

This marking guideline consists of 9 pages.

ALTERNATE CORRECT ANSWERS MUST BE CONSIDERED

QUESTION 1

1.1 1.1.1 $v = u + at$,
 $t = (v - u) / a = (90 - 0) / 10 = 9 \text{ s}$

1.1.2 $s = (v^2 - u^2) / (2a) = (90^2 - 0) / (2 \times 10) = 405 \text{ m}$

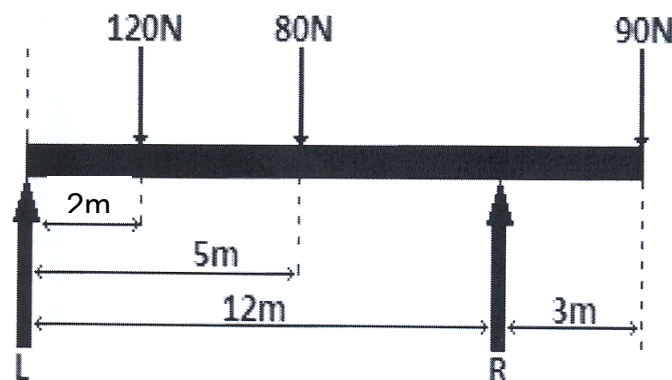
(2 x 2) (4)

1.2

QUANTITY	BASIC SI UNIT
Force	N
Pressure	Pa or N/m ² ✓
Acceleration	m/s ² ✓
Resistivity	Ωm✓
Energy	J✓
Distance	m✓
Specific heat capacity	J/kg °C✓
Coefficient of linear expansion	/°C✓

(7)
[11]**QUESTION 2**

2.1 2.1.1



Sketch of the beam ✓✓ (2)

$$2.1.2 \quad \sum M_L = 0 \quad R \times 12 = 120 \times 2 + 80 \times 5 + 90 \times 15 \checkmark$$

$$12R = 240 + 400 + 1350 \checkmark$$

$$R = 165,83 \text{ N} \checkmark$$

$$\sum M_R = 0 \quad 120 \times 10 + 80 \times 7 \checkmark = 90 \times 3 + 12L \checkmark$$

$$L = 124,17 \text{ N} \checkmark$$

(2 x 3) (6)

$$2.1.3 \quad \sum F_{uo} = \sum F_{down}$$

$$124,17 + 165,83 = 120 + 80 + 90$$

$$290 \text{ N} = 290 \text{ N}$$

(1)

$$2.2 \quad V_c = 250 \sin 40^\circ \quad \checkmark$$

$$= 160,7 \text{ N} \quad \checkmark$$

(2)

[11]**QUESTION 3**

$$3.1 \quad v = \sqrt{2xgxh} = \sqrt{2 \times 9,8 \times 50,5} = 31,46 \text{ m/s} \checkmark \checkmark$$

(2)

$$3.2 \quad m = (2486) / (9,8 \times 50,5) = 5,02 \text{ kg} \checkmark \checkmark$$

OR

$$m = 2486 / (0,5 \times 31,46^2) = 5,02 \text{ kg} \checkmark \checkmark$$

(2)

$$3.3 \quad \text{P.E.} = 2486 \text{ joules} \checkmark$$

(1)

$$3.4 \quad \text{Momentum} = m \times v = 5,02 \times 31,46 = 157,93 \text{ kg m/s} \checkmark \checkmark$$

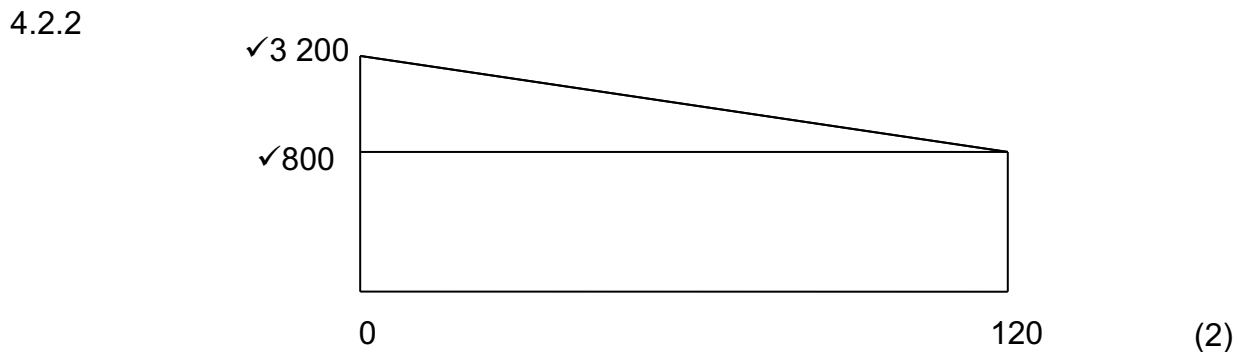
(2)

[7]

QUESTION 4

4.1 Power delivered at a rate of 1 joule per second. ✓ (1)

4.2 4.2.1 $W = w \times L$
 $= 20 \times 120$
 $= 2\,400 \text{ N}$ ✓ (1)



4.2.3 $W_{\text{total}} = W_{\text{triangle}} + W_{\text{rectangle}}$
 $= (0,5 \times 120 \times 2\,400) + (800 \times 120)$ ✓
 $= 240\,000 \text{ J}$ ✓
 $= 240 \text{ KJ}$ ✓ (3)

4.3 $T = F \times r$
 $= 3\,500 \times 0,28$ ✓
 $= 980 \text{ Nm}$ ✓

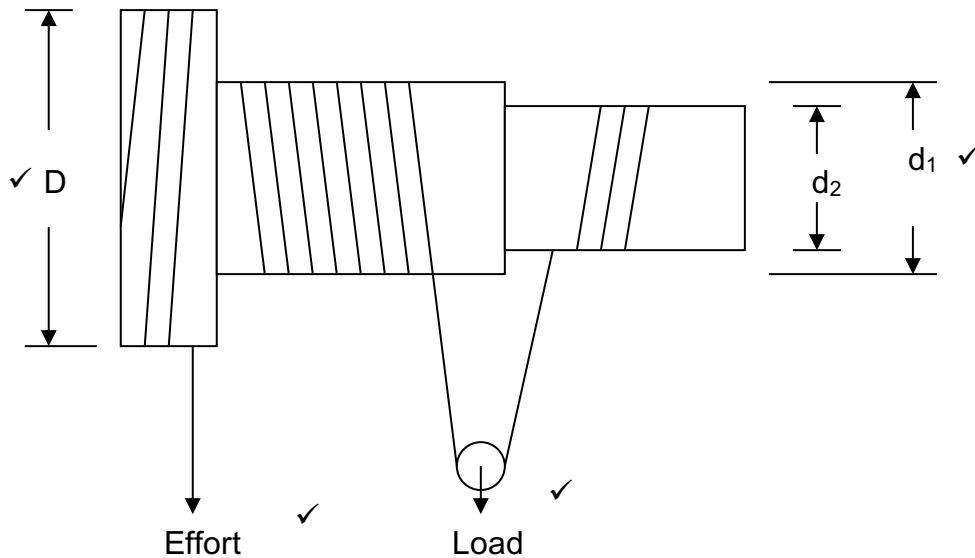
$r = D/2$
 $= 0,56/2$
 $= 0,28 \text{ m}$ ✓

(3)
[10]

QUESTION 5

5.1 Velocity ratio (also displacement ratio) is the ratio of the distance moved ✓ by the effort as opposed to the distance moved by the load. ✓ (2)

5.2



(4)

5.3 5.3.1
$$\begin{aligned} \text{Effort} &= \frac{\text{Load}}{MA} \\ &= \frac{1100}{16} \\ &= 68,75 \text{ N} \end{aligned}$$
 ✓ (1)

5.3.2
$$\begin{aligned} VR &= \frac{2D}{(d_1 - d_2)} \\ &= \frac{2 \times 520}{(340 - 290)} \\ &= 20,8 \end{aligned}$$
 ✓ ✓ (2)

5.3.3
$$\begin{aligned} \eta &= \frac{MA}{VR} \\ &= \frac{16}{20,8} \times 100 \\ &= 0,77 \times 100 \\ &= 76,92 \% \end{aligned}$$
 ✓ ✓ (2)

5.4 5.4.1 $T_A = \frac{T_B \times N_B}{T_B}$
 $= \frac{65 \times 750}{1950}$ ✓
 $= 25 \text{ Teeth}$ ✓ (2)

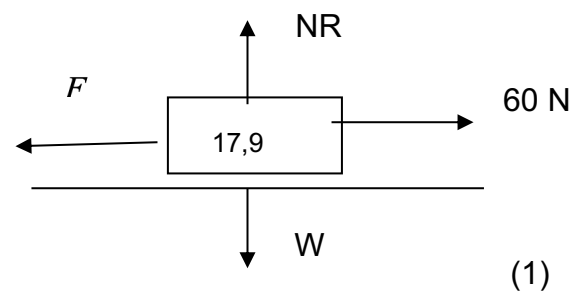
5.4.2 $N_D = \frac{T_C \times N_C}{T_D}$ NOTE $N_B = N_C$
 $= \frac{20 \times 750}{50}$ ✓
 $= 300 \text{ r/m}$ ✓ (2)

5.5 $P = \rho gh$
 $h = \frac{P}{\rho g}$
 $= \frac{83,52 \times 10^3}{1000 \times 9,8}$ ✓
 $= 8,52 \text{ m}$ ✓ (2)
[17]

QUESTION 6

- 6.1 • Applying lubricant ✓
 • Making the surfaces in contact as smooth as possible ✓ (2)

6.2 6.2.1 $\mu = \frac{F_\mu}{NR}$ $F_\mu = 60 \text{ N}$
 $= \frac{60}{175,42}$ and $NR = W = mg = 17,9 \times 9,8$
 $= 0,342$ $= 175,42 \text{ N}$ ✓



6.2.2 $\mu = \tan \theta$
 $\theta = \tan^{-1} \mu$
 $= \tan^{-1}(0,342)$ ✓
 $= 18,88^\circ$ (1)

$$\begin{aligned}
 6.3 \quad 6.3.1 \quad F_{\perp} &= w \cos \theta \\
 &= 20 \times 9,8 \times \cos 11 \\
 &= 192,4 \text{ N} \quad \checkmark
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 6.3.2 \quad F_{\parallel} &= w \sin \theta \\
 &= 20 \times 9,8 \times \sin 11 \\
 &= 37,4 \text{ N} \quad \checkmark
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 6.3.3 \quad \mu &= \frac{F_{\mu}}{NR} \\
 F_{\mu} &= \mu \times NR & N_R &= mg \cos \theta \checkmark \\
 &= 0,32 \times 20 \times 9,8 \times \cos 11 \\
 &= 61,568 \text{ N} \quad \checkmark
 \end{aligned} \tag{2}$$

$$\begin{aligned}
 6.3.4 \quad \Sigma F_{up} &= \Sigma F_{down} \\
 F_{\mu} &= F + W \sin \theta \\
 61,568 &= F + 37,4 \quad \checkmark \\
 F &= 24,168 \text{ N} \checkmark
 \end{aligned} \tag{2}$$

[10]**QUESTION 7**

7.1 Specific heat capacity: This is the heat energy needed to change the temperature of unit mass (1 kg) ✓ of a substance by unit temperature (1 °C). ✓ (2)

7.2 Boiler input: = 50/0,8 = 62,5 megawatt ✓
 Coal input = 62,5/30 = 2,08 kg/sec. ✓
 Coal input = 2,08 x 60 = 124,8 kg/min ✓ (3)

$$\begin{aligned}
 7.3 \quad \Delta L &= L \times \alpha \times \Delta t & \Delta t &= \frac{\Delta L}{L \times \alpha} = \frac{0,004}{6 \times 17 \times 10^{-6}} = 39,22 \text{ °C} \checkmark \checkmark \\
 t_{\text{warm}} &= 39,22 + 20 = 59,22 \text{ °C} \quad \checkmark
 \end{aligned} \tag{3}$$

7.4 Sensible heat is the heat added or removed from water ✓ which will cause a temperature change (water in the liquid form) ✓ (2)

$$\begin{aligned}
 7.5 \quad Q &= m \times C \times \Delta t & Q &= 50 \times 4187 \times (85 - 16) \checkmark \\
 Q &= 14,445 \text{ MJ} \quad \checkmark
 \end{aligned} \tag{2}$$

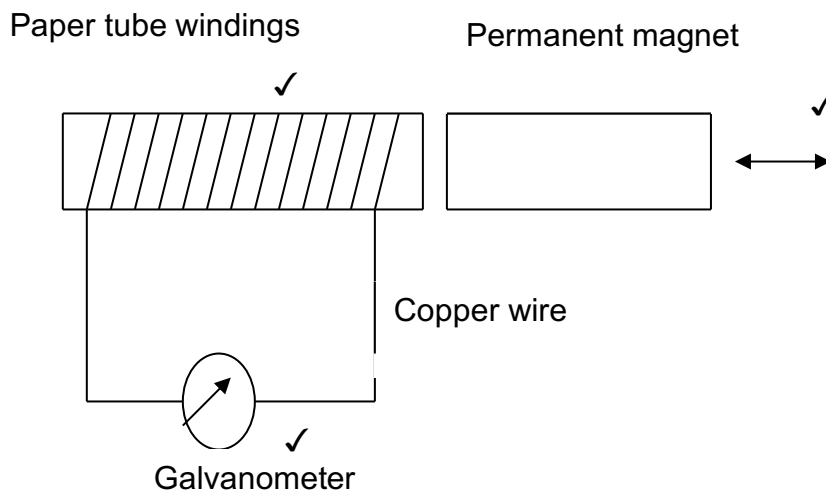
[12]

QUESTION 8

- 8.1 When an atom gains or loses one or more electrons it is said to be ionised with a negative or positive charge. It is referred to as an ion. ✓ (1)
- 8.2 When electrons ✓ are removed or lost ✓ (2)
- 8.3 Protons ✓ – positive ✓
Electrons ✓ – negative ✓
Neutrons ✓ – neutral ✓ (6)
- [9]**

QUESTION 9

- 9.1 9.1.1
- $$R_{AB} = \frac{R_A \times R_B}{R_A + R_B}$$
- $$= \frac{30 \times 6}{30 + 6} \quad \checkmark$$
- $$= 5 \, \Omega \quad \checkmark$$
- OR
- $$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$
- $$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{30} \quad \checkmark$$
- $$\frac{1}{R_p} = \frac{6}{30}$$
- $$R_p = 5 \, \Omega \quad \checkmark$$
- 1 substitution
1 correct answer
(minus ½ units) (2)
- 9.1.2
- $$R_{AC} = R_{AB} + R_{BC}$$
- $$= 5 + 10 \quad \checkmark$$
- $$= 15 \, \Omega \quad \checkmark$$
- 1 answer (mark with error 9.1.1) (2)
- 9.2 Minus 1 for incorrect diagram or diagram without labelling



(3)

9.3	• Number of turns in the coil • Speed of the relative motion • Strength of the magnet	(3 × 1)	(3)
9.4	• Generators • Transformers • Electrical motors	(Any 1 × 1)	(1)
9.5	$l = ?$ $a = 7,07 \times 10^{-3} \text{ m}^2$ $R = 2 \text{ } \Omega$ $t = 20^\circ \text{C}$ $\rho = 0,000 \text{ } 000 \text{ } 028 \text{ } \Omega \text{m} = 0,028 \times 10^{-6}$ $R = \frac{\rho \times l}{a}$ $l = \frac{R \times a}{\rho}$ $= \frac{2 \times 7,07 \times 10^{-3}}{0,028 \times 10^{-6}}$ $= 505000 \text{ m}$	 ✓ ✓	 1 substitution 1 correct answer (2) [13] TOTAL: 100