



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

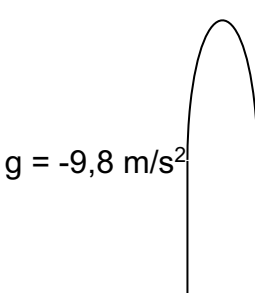
ENGINEERING SCIENCE N3

30 MARCH 2016

This marking guideline consists of 11 pages.

NOTE: ALTERNATE CORRECT ANSWERS MUST BE CONSIDERED.

QUESTION 1: MOVEMENT

- 1.1 1.1.1 $V^2 = u^2 + 2as$
 $a = \frac{v^2 - u^2}{2s}$
 $a = \frac{(0)^2 - (20)^2}{2(50)}$ ✓ Correct substitution
 $= -4 \text{ m/s}^2$ ✓ Negative answer only (2)
- 1.1.2 $v = u + at$
 $t = \frac{v - u}{a}$
 $t = \frac{(0) - (20)}{-4}$ ✓ Substitution
 $= 5 \text{ s}$ ✓ Correct answer (2)
- 1.2 1.2.1  $g = -9,8 \text{ m/s}^2$
 $v = u + gt$
 $u = v - gt$
 $= (0) - (-9,8)(3)$ ✓ u value
 $= 29,4 \text{ m/s}$
 $s = \frac{v^2 - u^2}{gt}$
 $= \frac{(0)^2 - (29,4)^2}{-9,8(2)}$ ✓ Substitution
 $= 44,1 \text{ m}$ ✓ Correct answer
u = ? (3)
- 1.2.2 $s = 44,1 \times 2$
 $= 88,2 \text{ m}$ ✓ Correct answer (1)
- 1.2.3 $u = v = 29,4 \text{ m/s}$ ✓ Correct answer (1)

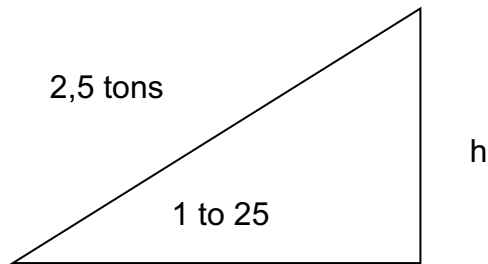
1.3

$$v = 55 \text{ km/h} \quad \frac{55 \times 1\,000}{3\,600} = 15,278 \text{ m/s}$$

$$t = 3 \text{ min} \times 60 = 180 \text{ s}$$

$$u = 0 \text{ m/s}$$

$$m = 2,5 \times 1\,000 = 2\,500 \text{ kg}$$



1.3.1

$$a = \frac{v - u}{t}$$

$$= \frac{15,277 - 0}{180}$$

$$= 0,085 \text{ m/s}$$

(✓) substitution

(✓) Correct answer (2)

1.3.2

$$E_K = \frac{1}{2}mv^2$$

$$= \frac{1}{2}(2\,500)(15,277)^2$$

$$= 291\,733,411 \text{ J}$$

(✓) substitution

(✓) Correct answer (2)

1.3.3

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

$$= (0)(180) + \frac{1}{2}(0,085)(180)^2$$

$$= 1377 \text{ m}$$

(✓) s value

$$E_p = mgh$$

$$= 2500(9,8)(1377/25)$$

$$= 1349460 \text{ J}$$

(✓) Substitution

(✓) Correct answer

(3)
[16]

QUESTION 2: MOMENTS

- 2.1 A force is that influence which changes or tends to change the state of rest of a body.(✓) If the body is already moving, a force is that influence which brings the body to rest or changes the direction of the body.(✓) (2)

- 2.2 2.21 Taking moments about L:

$$\Sigma \text{ Anti-clockwise Moments} = \Sigma \text{ Clockwise Moments}$$

$$(R \times 14) = (200 \times 5) + (90 \times 15) + (100 \times 10)(\checkmark)$$

$$E = 239,286 \text{ N}(\checkmark) \quad (2)$$

Taking moment about R:

$$\Sigma \text{ Anti-clockwise moments} = \Sigma \text{ Clockwise Moments}$$

$$(100 \times 4) + (200 \times 9) = (L \times 14) + (90 \times 1)(\checkmark)$$

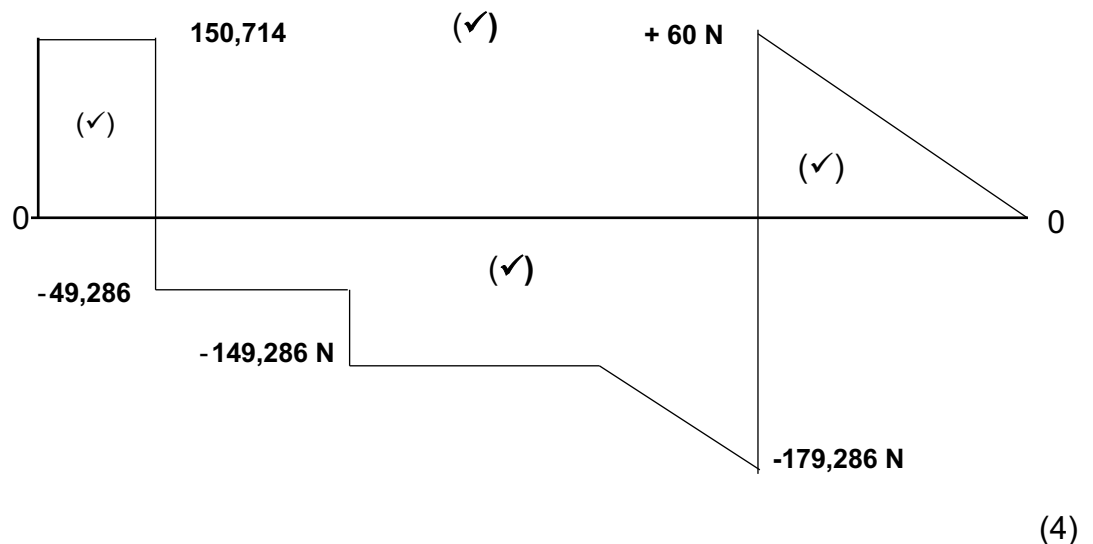
$$L = 150,714 \text{ N} \quad (\checkmark) \quad (2)$$

Test:

$$\text{Upward forces} = \text{Downward forces}$$

$$239,286 + 150,714 \text{ kN} = 390 \text{ kN} \quad (\checkmark) \quad (1)$$

2.2.2



- 2.3 $\cos \theta \times F \times 5 \text{ m} = 1,2 \times 120 + 200 \times 3,1 \text{ m}$

$$\cos 30^\circ \times F \times 5 = 144 + 620 \quad (\checkmark)$$

$$F = \frac{764}{\cos 30^\circ \times 5}$$

$$F = 176,443 \text{ N} \quad (\checkmark)$$

(2)

[13]

QUESTION 3: FORCES

3.1 The equilibrant of a system of forces in the same plane(✓) is that single force which will balance the system of forces.(✓) (2)

3.2 $HC = -150 + 216.506 + 141.421 = 207.927 \text{ N } \checkmark$
 $VC = 300 + 125 - 141.42 = 283.579 \text{ N } \checkmark$

$$R = \sqrt{(207.927)^2 + (283.579)^2}$$

$$= \sqrt{123650.686}$$

$$= 351.64 \text{ N } \checkmark$$

$$\tan \theta = \frac{283.579}{207.927}$$

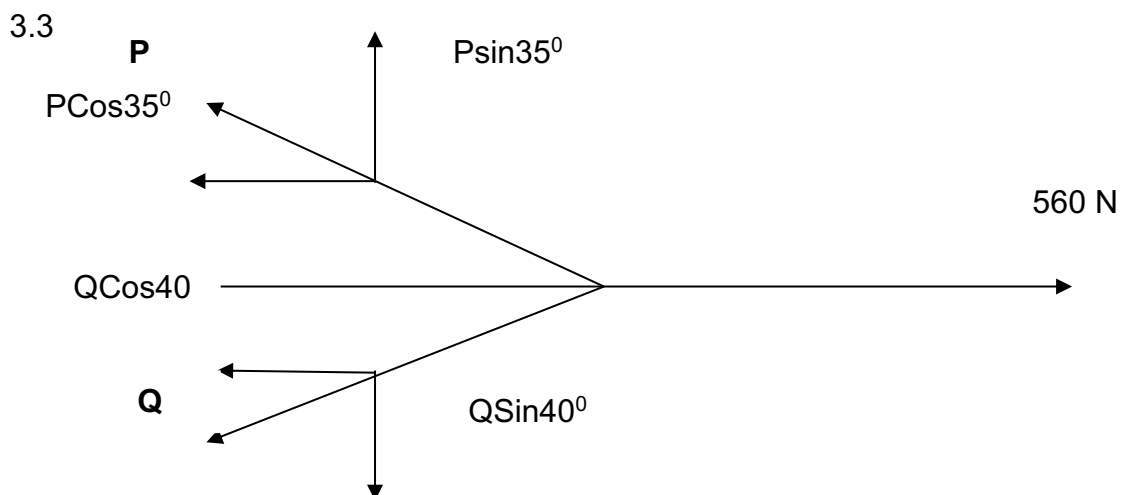
$$= 1.36$$

$$\theta = \tan^{-1} 1.36$$

$$= 53.67^\circ$$

$$= E 53.67^\circ \text{ N } \checkmark$$

(4)



$$V_C = \sum \downarrow F = \sum \uparrow F$$

$$P \sin 35 = Q \sin 40$$

(✓) Substitution

$$P = \frac{Q \sin 40}{\sin 35}$$

$$P = 1,1207 Q \dots\dots\dots (1)$$

(✓) Equation (1)

$$\sum H \quad P \cos 35 + Q \sin 40 = 560$$

$$(1,1207Q) \cos 35 + Q \sin 40 = 560 \quad (\checkmark) \text{ Substitution}$$

$$0,918Q + 0,766Q = 560$$

$$Q = \frac{560}{1,684}$$

$$Q = 332,537 \text{ N}$$

(✓) Value of Q

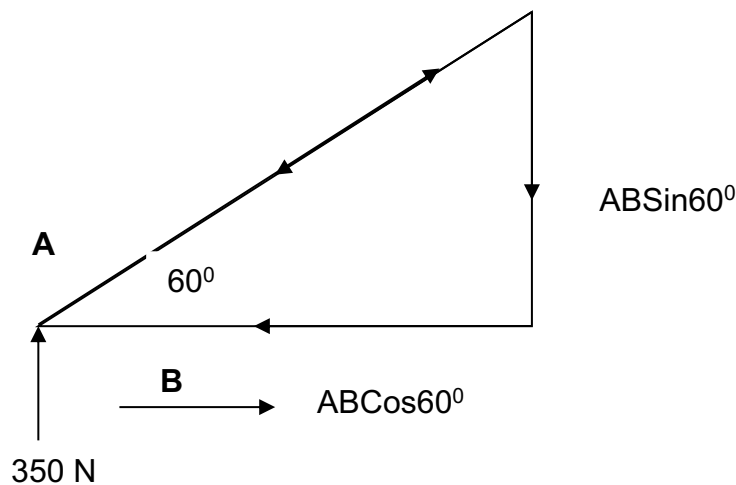
$$P = \frac{295,82 \sin 40}{\sin 35}$$

$$= 372,663 \text{ N}$$

(✓) Value of P

(5)

3.4



$$\sum \downarrow F = \sum \uparrow F$$

$$AB \sin 60^\circ = 350$$

(✓) Equation

$$AB = \frac{350}{\sin 60^\circ}$$

$$= 404,145 \text{ kN}$$

(✓) AB Value

$$\sum \leftarrow F = \sum \rightarrow F$$

$$AB \cos 60^\circ = BC$$

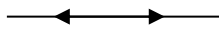
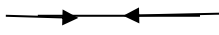
$$404,145 \cos 60^\circ = BC$$

$$BC = 202,225 \text{ kN}$$

(✓) BC Value

Member	Magnitude	Nature
AB	404,145	Strut
BC	202,07	Tie

(✓) Nature

Strut Tie (4)
[15]**QUESTION 4: FRICTION**

- 4.1 Static friction opposes the initial movement. The force required to just move a body is called the static friction force.(✓)

Kinetic friction opposes the force causing the movement after the body is in motion.(✓)

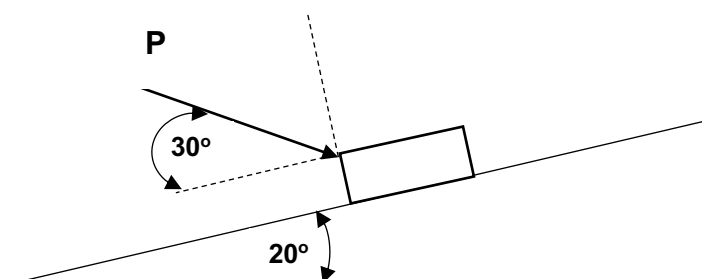
(2)

- 4.2
- Braking pads of vehicles, trains, lifts and aircraft
 - Clutch engagement to transmit torque or power
 - Drilling, cutting, turning made possible by friction between cutting surface and material.(✓)

(Any 2 × 1)

(2)

4.3

**FIGURE 6**

$$4.3.1 \quad F_{\text{applied}} = F\mu + W \times \sin\alpha$$

$$P \times \cos\theta = \mu(W \times \cos\alpha + P \times \sin\theta) + W \times \sin\alpha \quad (\checkmark)$$

$$P \times \cos(30^\circ) = 0,4(2\,500 \times \cos 20^\circ + P \times \sin 30^\circ) + 2\,500 \times \sin 20^\circ$$

$$P \times 0,866 = 0,4(2500 \times 0,9397 - P \times 0,5) + 855,05 \quad (\checkmark)$$

$$P \times 0,866 = 939,7 - 0,2 \times P + 855,05 \quad (\checkmark)$$

$$P \times 0,866 - 0,2 \times P = 939,7 + 8379,494 \quad (\checkmark)$$

$$0,666 \times P = 1794,75 \quad (\checkmark)$$

$$P = 2694,82 \text{ N} \quad (\checkmark) \quad (6)$$

$$4.3.2 \quad \tan = \mu$$

$$\mu = \tan^{-1} 0,4$$

$$= 21,8^\circ \quad \checkmark$$

(1)

[11]

QUESTION 5: HEAT

5.1 Energy cannot be created or destroyed(✓) therefore heat gained is equal to heat lost by an object.(✓) (2)

$$5.2 \quad m = 45 \times 0,75 = 33,75$$

$$t_1 = 180^\circ \text{C}$$

$$shc_{(\text{STEEL})} = 500 \text{ J/kg } ^\circ \text{C}$$

$$m_{\text{oil}} = 1\,500 \text{ J/kg } ^\circ \text{C}$$

$$t_2 = 20^\circ \text{C}$$

Heat lost by steel = Heat gained by oil

$$m \times shc \times (T_2 - T_1) = m \times shc \times (T_3 - T_2) \quad (\checkmark)$$

$$45 \times 0,75 \text{ kg} \times 500 \text{ J/kg} \cdot ^\circ \text{C} \times (180 - T_2) = 5 \text{ kg} \times 1\,500 \text{ J/kg} \cdot ^\circ \text{C} \times (T_2 - 20)$$

$$16\,875 \times (180 - T_2) = 7\,500 \times (T_2 - 20) \quad (\checkmark)$$

$$3\,037\,500 - 16\,875 \times T_2 = 7\,500 \times T_2 - 150\,000$$

$$7\,500 T_2 + 16\,875 T_2 = 3\,037\,500 + 150\,000 \quad (\checkmark)$$

$$24\,375 T_2 = 3\,187\,500$$

$$T_2 = 130,769^\circ \text{C} \quad (\checkmark) \quad (4)$$

$$5.3 \quad l = 19 \text{ m}$$

$$t_1 = 18^\circ \text{C}$$

$$t_2 = 100^\circ \text{C}$$

$$\alpha = 25 \times 10^{-6} / ^\circ \text{C}$$

$$5.3.1 \quad \Delta t = 100 - 18 \quad (\checkmark) \\ = 82 \text{ } ^\circ\text{C} \quad (1)$$

$$5.3.2 \quad \Delta l = l_0 \times \alpha \times \Delta t \\ \Delta l = 19 \times 25 \times 10^{-6} \times 82 \quad (\checkmark) \\ \Delta l = 0,03895 \text{ m or } 38,95 \text{ mm} \quad (\checkmark) \quad (2)$$

$$5.3.3 \quad L_F = \Delta l + l_0 \\ L_F = 0,03895 + 19 \quad (\checkmark) \\ L_F = 19,03895 \text{ m} \quad (\checkmark) \quad (2)$$

$$5.4 \quad 5.4.1 \quad h_f = \text{liquid enthalpy} \\ 5.4.2 \quad h_{fg} = \text{enthalpy of evaporation} \\ 5.4.3 \quad h_g = \text{enthalpy of dry steam} \\ 5.4.4 \quad h_{su} = \text{enthalpy of superheated steam} \quad (4 \times 1) \quad (4) \\ [15]$$

QUESTION 6: HYDRAULICS

$$6.1 \quad 6.1.1 \quad \text{Hydraulics refers to the pressure}(\checkmark) \text{ and work done of fluids.}(\checkmark) \quad (2) \\ 6.1.2 \quad \text{Hydrostatics refers to fluids that are at rest.} \quad (1) \\ 6.1.3 \quad \text{Fluidity is a fluid or a gas which has no form}(\checkmark) \text{ but takes up the} \\ \text{form of a vessel in which it is captured.}(\checkmark) \quad (2) \\ 6.2 \quad 6.2.1 \quad \text{Volume} = 1,4 \times 10^{-3} \text{ m}^3 \\ F = 2,4 \text{ kN} \\ A = \pi(0,06)^2 \text{ or } A = \frac{\pi d^2}{4} \quad (\checkmark) \text{ Area} \\ P_r = \frac{F}{A} \quad (\checkmark) \text{ Substitution} \\ = \frac{2\,400}{0,0113} \\ = 212,2 \text{ kPa} \quad (\checkmark) \text{ Answer} \quad (3)$$

$$\begin{aligned}
 6.2.2 \quad \text{Stroke length} &= \frac{\text{Volume}}{\text{Area}} \\
 &= \frac{1,4 \times 10^{-3} \text{ m}^3}{0,0113 \text{ m}^2} \quad (\checkmark) \text{ Substitution} \\
 &= 0,1238 \text{ m or } 123,8 \text{ mm} \quad (\checkmark) \text{ Answer} \quad (2)
 \end{aligned}$$

$$\begin{aligned}
 6.2.3 \quad WD &= P \times v \\
 &= 212 \ 200 \times 1,4 \times 10^{-3} \\
 &= 297 \text{ J/stroke} \quad (2) \\
 &\quad [12]
 \end{aligned}$$

QUESTION 7: ELECTRICITY

7.1 Power factor ($\cos \alpha$) is the ratio of actual power or watts to volt amps. ($\checkmark$)
The smaller the phase angle the higher the efficiency and vice versa. ($\checkmark$) (2)

$$\begin{aligned}
 7.2 \quad 7.2.1 \quad R_p &= \frac{R_1 + R_2 + R_3}{R_1 R_2 + R_1 R_3 + R_2 R_3} \\
 &= \frac{8 \times 5 \times 5}{8 \times 5 + 8 \times 5 + 5 \times 5} \quad (\checkmark) \text{ Substitution} \\
 &= \frac{200}{105} \quad (\checkmark) R_p = 1,905 \Omega \\
 &= 1.905 \Omega \quad (\checkmark) R_T = 9.505 \Omega \\
 R_t &= 1.905 + 0.6 + 0.5 + 4.5 + 2 \\
 &= 9.505 \Omega \quad (3)
 \end{aligned}$$

$$\begin{aligned}
 7.2.2 \quad \text{Emf} &= 4 \times 4 = 16 \text{ V} \\
 R_t &= 4 \times 0.5 = 0.6 \Omega \\
 I &= \frac{E}{R + r} \\
 &= \frac{16}{9.505 + 0.6} \quad (\checkmark) \text{ Substitution} \\
 &= 1.583 \text{ A} \quad (\checkmark) \text{ Current} \\
 V &= IR \quad (\checkmark) \text{ Volt drop} \\
 &= 1.583 \times 2 \\
 &= 3.166 \text{ V} \quad (3)
 \end{aligned}$$

7.3	7.3.1	$\frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{I_S}{I_P}$ $V_S = \frac{N_S V_P}{N_P}$ $= \frac{50 \times 220}{600} \text{ OR } \frac{1 \times 220}{12}$ $= 18,33 \text{ V}$	(✓) Substitution (✓) Solution	(2)
	7.3.2	$I_P = \frac{N_S \times I_S}{N_P} \text{ OR } \frac{V_S \times I_S}{V_P}$ $= \frac{50 \times 20}{600} \text{ OR } \frac{18,33 \times 20}{220}$ $= 1,667 \text{ A}$	(✓) Substitution (✓) Solution	(2) [12]

QUESTION 8: CHEMISTRY

8.1	• By painting the metal • By applying oil or grease • By electroplating with zinc or tin • By galvanising • By using plastic film	(Any 2 × 1)	(2)
8.2	8.2.1 Limestone (Marble) = CaCO_3		
	8.2.2 Caustic soda = NaOH	(2 × 1)	(2)
8.3	Carbon		(1)
8.4	• Low melting point • Soft • Good adhesion to other metals	(Any 1 × 1)	(1) [6]
TOTAL:			100