higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

ENGINEERING SCIENCE N3

8 APRIL 2015

This marking guideline consists of 11 pages.

QUESTION 1: MOTION, POWER AND ENERGY

1.1 A machine is a mechanical device which enables work to take place✓ more effectively or more easily. ✓ (2)

1.2 1.2.1

$$h = 12\sin 10°$$
$$= 2{,}084\,m \quad ✓$$

1 m value of h

$$E_P = mgh$$
$$= 2\times 9{,}8\times 2{,}084 \quad ✓$$

1 m sub

$$= 40{,}846\ J \quad ✓$$

1 m solution (3)

1.2.2

$$E_P = E_K$$
$$= 40{,}842\ J \quad ✓$$

1 m solution (1)

1.2.3

$$E_K = \frac{1}{2}mv^2$$
$$v = \sqrt{\frac{2\times E_K}{m}}$$
$$= \sqrt{\frac{2\times 40{,}842}{2}} \quad ✓ \quad ✓$$
$$= 6{,}387\ m/s$$

1 m sub

1 m solution (2)

1.2.4

$$E_K = \frac{1}{2}mv^2$$
$$= \frac{1}{2}(2)(20)^2$$
$$= 400\ J \quad ✓$$

1 m EK

$$E_K = E_P = mgh$$
$$h = \frac{E_K}{mg}$$
$$= \frac{400}{2\times 9{,}8}$$
$$= 20{,}408\ m \quad ✓$$

1 m solution (2)

1.3 1.3.1

$$F_L = F_a + F_{RT}$$
$$F_L = 0 + [5\times \frac{120000\times 9{,}8}{1000}] \quad ✓$$

1 m converting

$$= 5880\ N \quad ✓$$

1 m solution (2)

1.3.2 $F_L = F_a + F_{RT}$

$F_a = 80000 - 5880$

$= 74{,}12\ kN$ ✓

1 m solution (1)

1.3.3 $F_a = ma$

$a = \frac{F_a}{m}$

$= \frac{74{,}120 \times 1000}{120\ 000}$ ✓

$= 0{,}618\ m/s^2$ ✓ ✓

1 m sub

1 m solution

-1/2 incorrect units (2) **[15]**

QUESTION 2: MOMENTS

2.1 Turning moment (torque) is applied force in Newtons,✓multiplied by the distance from the axis or fulcrum.✓ (2)

2.2 2.2.1

(E x 5) + (15 x 0.5) = (25 x 1) + (10 x 3) + (15 x 5,5)

5E + 7.5 = 25 + 30 + 82.5 ✓

E = 26 *kN* ✓ (2)

2 m for E

$(25 \times 4) + (10 \times 2) + (15 \times 5{,}5) = (B \times 5) + (15 \times 0{,}5)$

$100 + 20 + 82{,}5 = 5B + 7{,}5$ ✓

$B = 39\,kN$ ✓ (2)

2 m for B

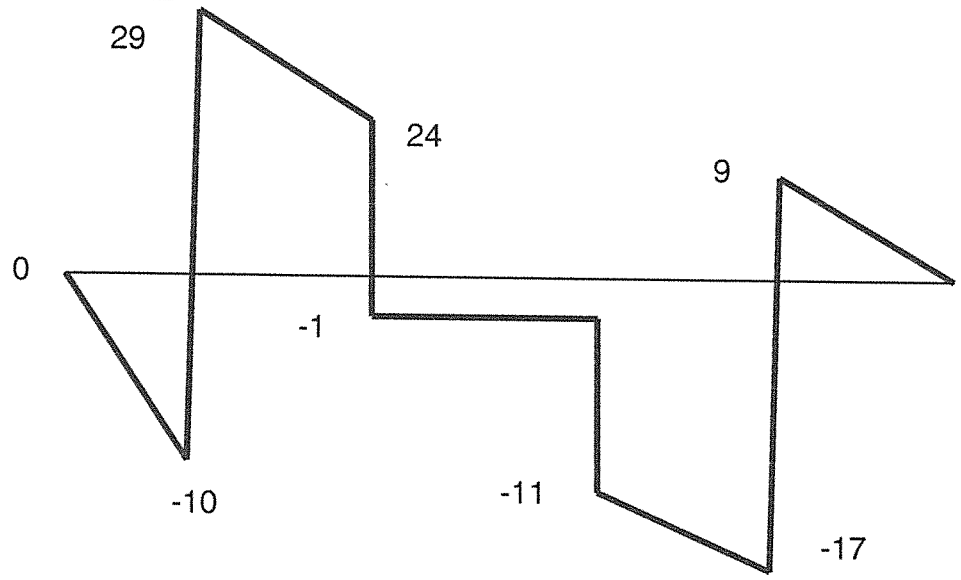
$F_{UP} = F_{DOWN}$

$26 + 39 = 15 + 25 + 10 + 15$

$65\ kN = 65kN$

1 m checking (1)

2.2.2



½ for 29
½ for -10
½ for 24
½ for -11
½ for -17
½ for 9

(3)

2.3 First, we must express the horizontal and vertical components in terms of the forces, F, and the given angle.✓
The second method is to resolve oblique force into components which can be used for calculating the moment of the force.✓ (2)

[12]

QUESTION 3: FORCES

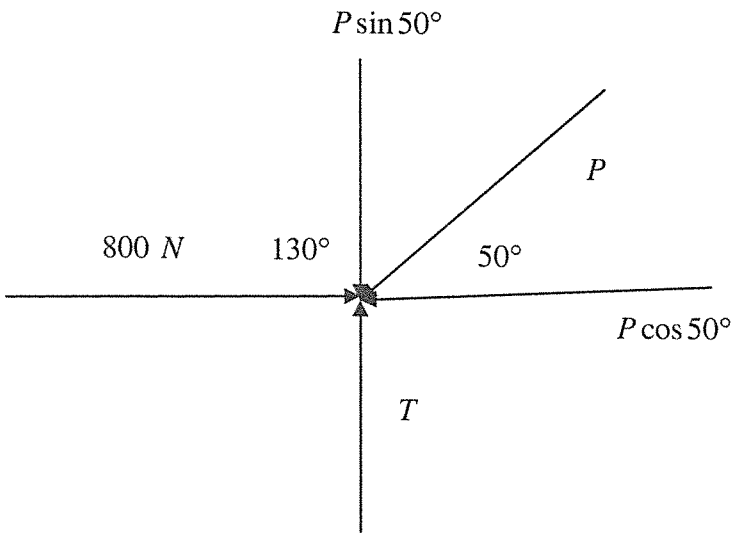
3.1 A scalar quantity is a quantity which possesses magnitude only. (1)

3.2 3.2.1 Directly (1)

3.2.2 Perpendicularly (1)

3.3 Tensile or pulling force✓
Compressive or pushing force✓ (2)

3.4



$$F_L = F_R$$

$$P\cos 50 = 800$$

$$p = \frac{8}{\cos 50} \checkmark$$

$$P = 1244{,}5 \checkmark$$

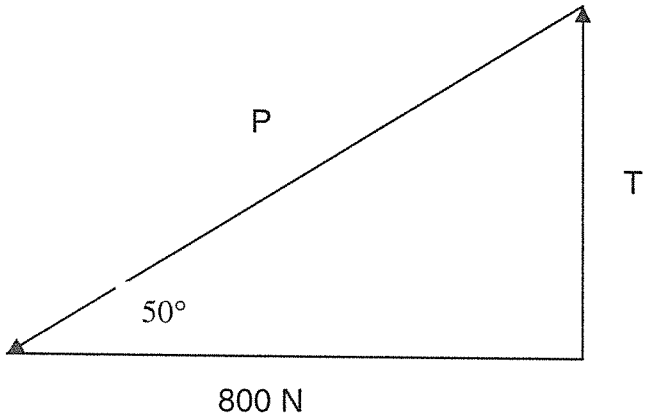
$$F_{UP} = F_{DOWN}$$

$$T = P\sin 50$$

$$T = 1244{,}579 \sin \checkmark$$

$$T = 953{,}40 \checkmark$$

OR



$$\tan\theta = \frac{T}{800}$$

$$T = 800 \tan 50$$

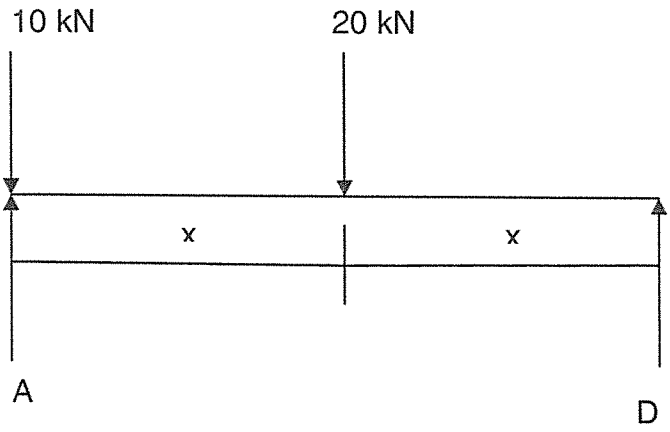
$$T = 953{,}403\,N$$

$$\cos\theta = \frac{800}{\cos 50}$$

$$= 1244{,}579\,N$$

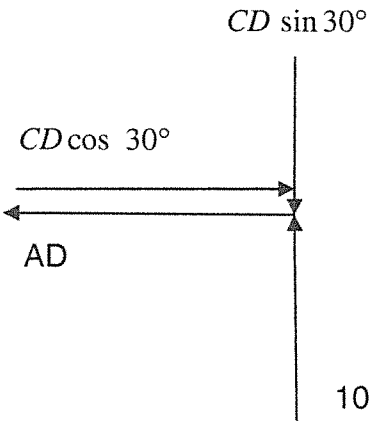
(4)

3.5



$20 \times x = D \times 2 \times x$ ✓

$D = 10\,kN$ ✓



$\sum F_{UP} = \sum F_{DOWN}$

$10 = CD \sin 30$ ✓

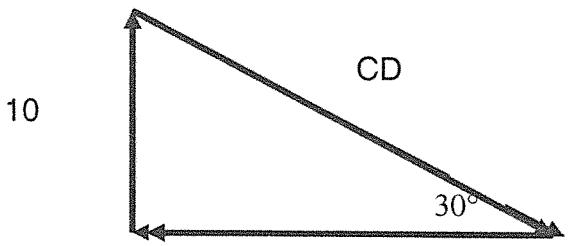
$CD = 20\,kN(strut / push)$ ✓

$\sum F_L = \sum F_R$

$AD = CD \cos 30$ ✓

$= 17{,}32\ kN(pull / tie)$ ✓

OR



$$AD = \frac{10}{\tan 30} \quad \text{AD}$$

$$= 17{,}32\ kN\ (Pull / tie)\ \checkmark$$

$$CD = \frac{10}{\sin 30}$$

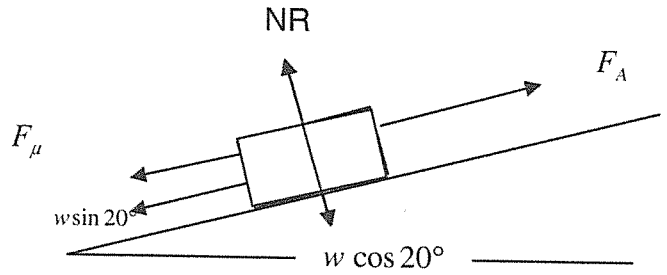
$$= 20\,kN\ (strut / push)$$

(6)
[15]

QUESTION 4: FRICTION

4.1
- Friction depends on the nature of the surfaces in contact.
- Friction is independent of the speed.
- Friction is independent of the size of the area in contact.
- Friction is proportional to the perpendicular force between the surfaces. (4)

4.2



4.2.1 The weight component parallel with the plane

= W Sin Θ

= 1 600 × 9,8 × Sin 20° ✓

= 5362,876 N ✓

4.2.2 The weight component perpendicular to the plane

= W Cos Θ

= 1 600 × 9,9 × cos 20✓

= 14 734,38 N✓

4.2.3 Force required to pull the block upward

Fup = Fμ = Fμ + Wsin Θ

= 75 + 5362,876

= 5587,876✓

= 55,87 kN✓

4.2.4 Power = F × V

= 5587,876 × 10^3 × 10 ✓

= 558787,6 W ✓

= 558,788 kW

(4 × 2) (8)

[12]

QUESTION 5: HEAT

5.1 Energy can neither be created nor destroyed,✓ but only converted from one form to another. ✓ (2)

5.2 30 steel parts x 200 g = 6 kg

M x c x Δt = m x c x Δt

W S

m x 4187 x (80 – 25) = 6 × 500 × (800 – 80)

m x 4187 x (80 – 25) = 232 5000

$$m = \frac{232\ 5000}{(4187 \times 55)}$$

M = 9,38 kg

1 kg = 1 litre

M = 9,38 litres (6)

5.3 ℓ 0 = 20 m

t_1 = 313 K

t_2 = 453 K

$\Delta l = l_0 \alpha \Delta t$

= 20 × 23 × 10^{-6} × (453 – 313) ✓

= 0,0644 m ✓

L_f = Lo + $\Delta \ell$

= 20 + 0, 0644

= 20,0644 m ✓ (3)

5.4 5.4.1 h_f

5.4.2 h_{fg}

5.4.3 h_g

5.4.4 h_{ss}

(4 × 1) (4)
[15]

QUESTION 6: HYDRAULICS

6.1 6.1.1 Pressure at a point in a liquid is the force exerted by the liquid due to its weight per unit area, acting downwards.✓

6.1.2 Total pressure on an area means the force or weight acting over the whole area.✓

(2 × 1) (2)

6.2 6.2.1

$P = 550\ 000$

$d = 150\ mm = 0,15\ m$

$L_s = 250\ mm = 0,25\ m$

$V = A \times L_s$

$= \frac{\pi (0,15)^2}{4} \times 0,25$ ✓ ✓

$= 4,418 \times 10 \ldots$

$OR\ \ 0,004418\ \ m^3$

6.2.2 $W = PV$

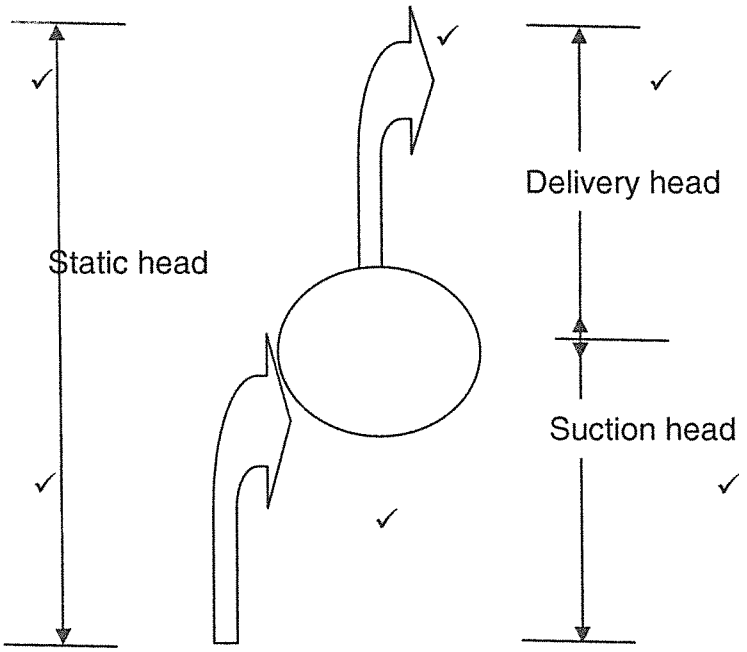
$= 550 \times 10^3 \times 4,418 \times 10^{-3}$ ✓

$= 2429,826\ J$ ✓

$= 2,429\ kJ$

(2 × 2) (4)

6.3



(6)
[12]

QUESTION 7: ELECTRICITY

7.1 7.1.1

$$r_T = \frac{0,4}{2} \quad \checkmark$$
$$= 0,2\ \Omega \quad \checkmark$$

7.1.2

$$I = \frac{E}{R + r}$$
$$= \frac{12}{6,15 + 0,2} \quad \checkmark$$
$$= 1,89\ A \quad \checkmark$$

(2 × 2) (4)

7.2 The potential difference (PD) of a cell is the voltage measured at the poles of a cell when current flows through it.✓

The electromotive force (emf) of a cell is the voltage measured at the poles of a cell when no current flows through it.✓ (2)

7.3 7.3.1

$V = 220\ V$

$P = 60\ W$

$I = 0{,}2727\ A$

$t = 1\ hour$

$Q = IVt$

$= 0{,}2727 \times 220 \times 3600$ ✓

$= 215\ 978{,}4\ J$ ✓

$OR\ \ 215{,}98\ kJ$

7.3.2 Time = 1 hour

$unit = kWh$

$= \frac{60 \times 1\ h}{1000}$

$= 0{,}06\ kWh \times 17{,}45$ ✓

$= 1{,}05$ ✓

(2 × 2) (4)

7.4 $Q = 200\,000\ J$

$t = 4\,\text{min}\,30\,\text{sec} = 4 \times 60 + 30 = 270\ \text{sec}$

$P = \frac{Q}{t}$

$= \frac{200\ 000}{270}$ ✓

$= 740{,}741\ W$ ✓ (3)

[13]

QUESTION 8: CHEMISTRY

8.1 Pure corrosion takes place when a bare surface✓comes into contact with an acidic on caustic liquid of gas.✓ A typical example is when battery acid gets onto bare metal parts in the engine compartment.✓ (3)

8.2 A typical example is an ordinary dry battery cell, of the kind used in torches and radios.✓ When current flows through the cell, the zinc oxidises and flows as zinc ions in solution through the electrolyte to combine with the manganese dioxide.✓ The zinc container becomes thinner and thinner as the metal decays from oxidation until it may open up in places and let some electrolyte leak out.✓ (3)

[6]

TOTAL: 100