higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

21 November 2024

This marking guideline consists of 10 pages.

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QUESTION 1: MOTION, ENERGY AND POWER

1.1.1 T1/T2 = 5/2

T2 = 700 X 2/5 ✓

= 280 N ✓ (2)

1.1.3 P = Te x v

= 420 x 20 ✓

= 8400 N ✓

= 8.4 KW ✓ (3)

1.2 Given:

m = 1200 kg
u = 0 m/s
v = 72 km/h = 20 m/s
t = 180 s

1.2.1 $v = u + at$
$20 = 0 + 180a$ ✓
$\therefore a = 0{,}111 m/s^2$ ✓ (2)

1.2.2 $KE = \frac{1}{2}mv^2$
$= \frac{1}{2} \times 1200 \times 20^2$ ✓
$= 240\ kJ$ ✓ (2)

1.2.3 $s = ut + \frac{1}{2}at^2$
$= 0 + \frac{1}{2} \times 0{,}111 \times 180^2$ ✓
$= 1798{,}2m$ ✓

OR

$v^2 = u^2 + 2as$
$20^2 = 0^2 + 2 \times 0{,}111 \times s$
$\therefore s = 1801{,}802m$

$\theta = \tan^{-1}(\frac{1}{3})$
$= 18{,}435°$ ✓

$h = s \sin\theta$
$= 1798{,}2 \sin 18{,}435°$ ✓
$= 568{,}642m$ ✓

$h = 1801{,}802 \sin 18{,}435$
$= 569{,}781m$

$PE = mgh$
$= 1200 \times 9{,}8 \times 568{,}642$ ✓
$= 6{,}687MJ$ ✓

$\therefore PE = 1200 \times 9{,}8\ x\ 569{,}781$
$= 6{,}701MJ$ (7)

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QUESTION 2: MOMENTS

2.1
- Concentrated load/point load
- Uniformly distributed load (2)

2.2 2.2.1 Taking moments about A

$\Sigma \circlearrowright Moments = \Sigma \circlearrowleft Moments$

$(7 \times 2) + (5 \times 9{,}8 \times 12 \times 6) + (25 \times 10) = C \times 8$ ✓

$\therefore C = 474N$ ✓

Taking moments about C

$\Sigma \circlearrowright Moments = \Sigma \circlearrowleft Moments$

$(5 \times 9{,}8 \times 4 \times 2) + (A \times 8) + (25 \times 2) = (5 \times 9{,}8 \times 8 \times 4) + (7 \times 6)$ ✓

$\therefore A = 146N$ ✓

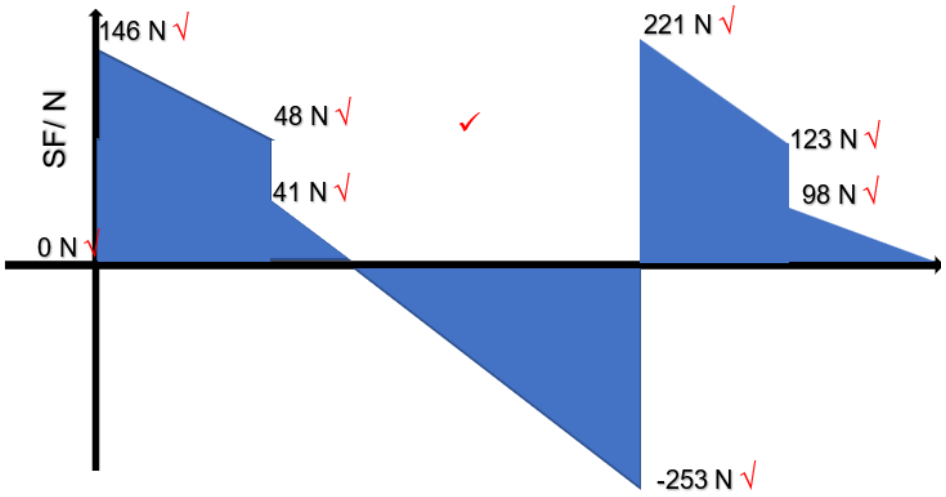
Checking the answers: $\Sigma \uparrow F = \Sigma \downarrow F$

$474 + 146 = 7 + 25 + (5 \times 9{,}8 \times 12)$

$620kN = 620kN$ ✓

$\therefore$ Balanced and correct (5)

2.2.2 The shear force diagram



(5)
[12]

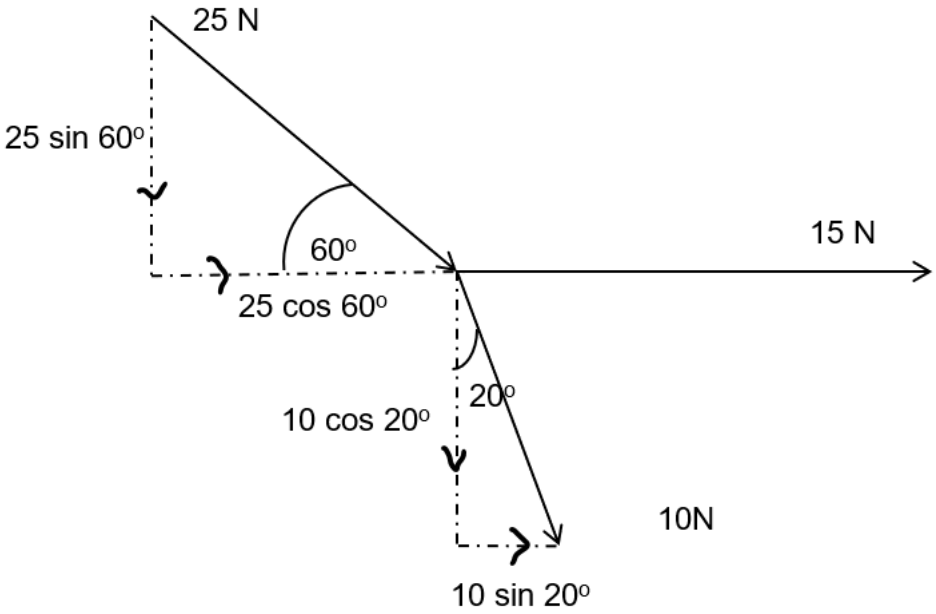
QUESTION 3: FORCES

3.1 Equilibrium of forces is when the size and direction of forces acting on an object are exactly balanced.✓✓

OR

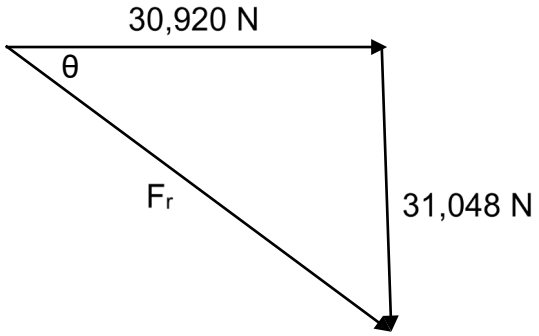
If a body remains at rest when a number of forces act upon it. (2)

3.2



$\sum V_{COMP} = -25\sin 60° - 10\cos 20° = -31{,}048N$ ✓✓

$\sum H_{COMP} = 10\sin 20° + 25\cos 60° + 15 = 30{,}920\ N$ ✓✓



$\therefore F_R = \sqrt{31{,}048^2 + 30{,}92^2}$
$= 43{,}818\ N$ ✓

$\tan\theta = \dfrac{31{,}048}{30{,}920}$
$\therefore \theta = 45{,}1°$ ✓

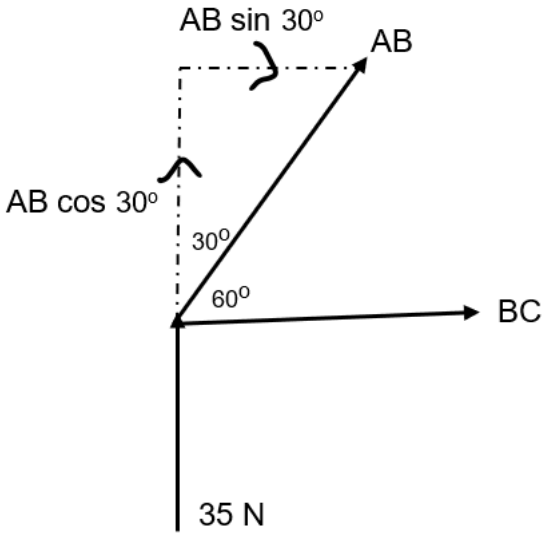
$\therefore F_R = 43{,}818\ N \quad E\ 45{,}1°S \quad OR\ S\ 44{,}9°\ E$ ✓ (7)

3.3 Taking moments about R

$\Sigma \circlearrowright Moments = \Sigma \circlearrowleft Moments$

$(L \times 6) = (20 \times 1{,}5) + (40 \times 4{,}5)$ ✓

$\therefore L = 35N$ ✓



$\sum V_{COMP} = 0$

$35 + AB \cos 30° = 0$

$\therefore AB = -40{,}415\ N$ ✓

$\sum H_{COMP} = 0$

$AB \sin 30° + BC = 0$

$\therefore BC = 20{,}208N$ ✓

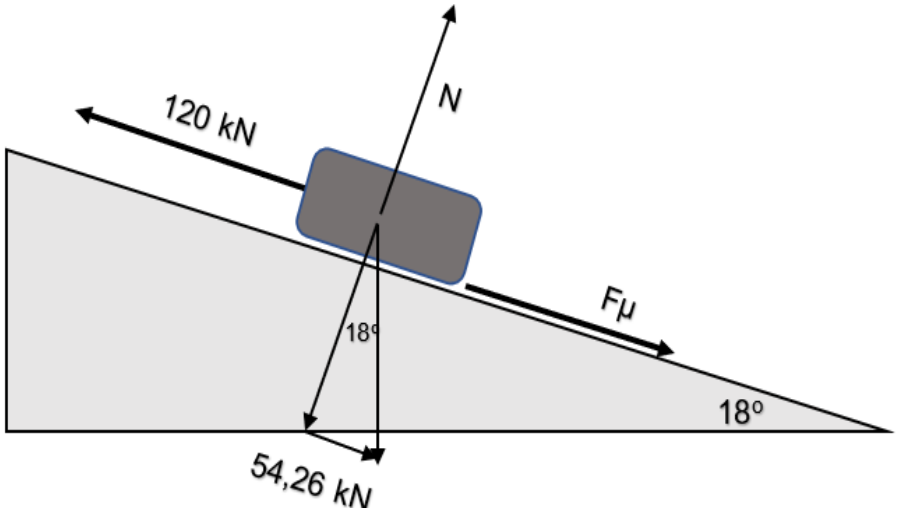
$\therefore AB = 40{,}415\ N\ Strut$ ✓$and\ BC = 20{,}208N\ Tie$ ✓ (6)

[15]

QUESTION 4: FRICTION

4.1
- Braking of an object OR brings movement to a standstill.
- Transmits movement by means of belts.
- Prevent slip between two contact surfaces.
- Any other relevant answer (3 × 1) (3)

4.2



4.2.1 $Parallel\ Weight\ Conponent$
$= W \sin 18°$
$= 54{,}26\ kN$✓
$\therefore W = 175{,}589kN$✓

4.2.2 $Perpendicular\ Weight\ Conponent$
$= W \cos 18°$
$= 175{,}589 \cos 18°$✓
$= 166{,}995\ kN$✓

4.2.3 $F_\mu = 120 - 54{,}26$✓
$= 65{,}74kN$✓

4.2.4 $\mu = \frac{F_\mu}{N}$
$= \frac{65{,}74}{166{,}995}$ ✓
$= 0{,}393$ ✓

(4 × 2) (8)
[11]

QUESTION 5: HEAT

5.1
- Steam layout must be erected where water and coal are available.
- Water is lost due to evaporation.
- The initial cost of the installation is very expensive.
- As a result of the combustion the atmosphere is contaminated. (4)

5.2 Given:

m_{fuel} = 4,28 kg
t = 55 mins
v_{water} = 200 ℓ
$\Delta\theta$ = 120° – 28°
Q_{water} = 60% Q_{fuel}

5.2.1 $Q = mc\Delta\theta$
$= 200 \times 4187 \times (120 - 28)$✓
$= 77{,}041MJ$✓ (2)

5.2.2 $Q_{WATER} = 60\% \times Q_{FUEL}$
$\therefore Q_{FUEL} = \frac{77{,}041}{60\%}$ ✓
$= 128{,}402MJ$✓ (2)

5.2.3 $HV = \frac{Q}{m}$
$= \frac{128{,}402}{4{,}28}$✓
$= 30MJ/kg$✓ (2)

5.2.4 Coal (1)

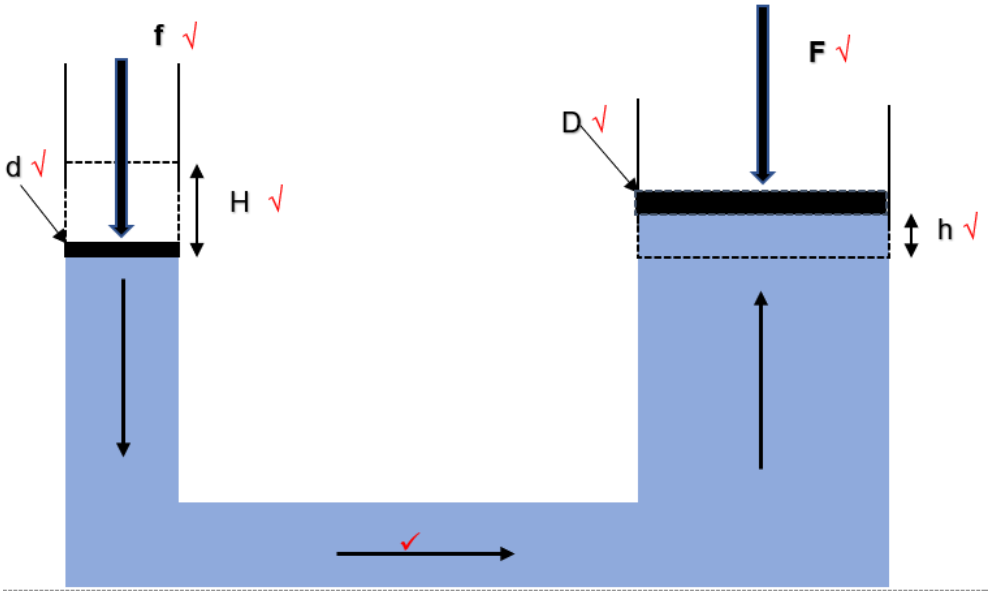
5.3 Given:

P = 1,2 Mpa
t = 400 °C

The steam is superheated✓
h_{sup} = 3261 kJ/kg✓ (2)
[13]

QUESTION 6: HYDRAULICS

6.1



(4)

6.2 Given:

P = 30 kPa√
h = 3,327

6.2.1 P = ρgh
30 x 1000✓ = ρ × 9,8 × 3,327✓
∴ ρ = 920 kg/m^3 ✓ (3)

6.3 Given:

D = 0,15 m
V = 2,5 × 10^{-3}m^3
F = 3,65 kN

6.3.1 $P = \frac{F}{A}$

$A = \frac{\pi D^2}{4}$

$= \frac{\pi \times 0{,}15^2}{4}$

$= 0{,}0177\ m^2$✓

$\therefore\ P = \frac{3{,}65 \times 10^3}{0{,}0176}$✓

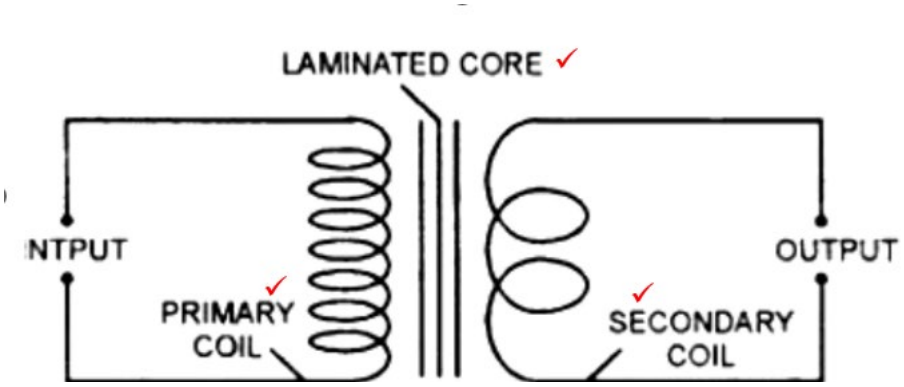
$= 0{,}206\ KPa$✓ (3)

6.3.2 $V = A \times h$
$2{,}5 \times 10^{-3} = 0{,}0177 \times h$✓
$\therefore h = 0{,}142\ m$
$= 14{,}2\ cm$✓ (2)

6.3.3 $WD = P \times V$
$= 0{,}206 \times 10^{3} \times 2{,}5 \times 10^{-3}$ ✓
$= 0.515\ J$ ✓ (2)
[14]

QUESTION 7: ELECTRICITY

7.1 A step-down transformer



(3)

7.2 Alternating current, current keeps switching directions periodically, forward, and backward while in the direct current it flows in a single direction steadily.✓✓ (2)

7.3 Given:

V_p = 210V
I_p = 11A
I_s = 55A
N_p = 600 turns

$$\frac{V_P}{V_S} = \frac{N_P}{N_S} = \frac{I_S}{I_P}$$

7.3.1 $\frac{V_P}{V_S} = \frac{I_S}{I_P}$

$\frac{210}{V_S} = \frac{55}{11}$ ✓

$\therefore V_S = 42V$ ✓

7.3.2 $\frac{N_P}{N_S} = \frac{I_S}{I_P}$

$\frac{600}{N_S} = \frac{55}{11}$ ✓

$\therefore N_S = 120 turns$ ✓

7.3.3 $\frac{N_P}{N_S} = \frac{600}{120}$ ✓

$= 5:1$ ✓

7.3.4 $P = VI$

$= 210 \times 11$ ✓ OR $= 42 \times 55$

$= 2310W$ ✓ $= 2310W$

(4 × 2) (8)
[13]

QUESTION 8: CHEMISTRY

8.1 • An atom is the smallest part of an element which can exist independently✓ (1)

8.2 • An element is a pure substance✓ which contains atoms of the same proton number.✓ (2)

8.3 • Painting the metal
• Applying oil or grease
• Electroplating (3)
[6]

TOTAL: 100

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