higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

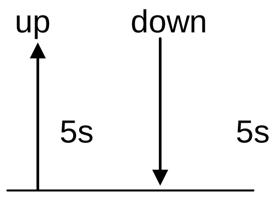
ENGINEERING SCIENCE N4

2 APRIL 2015

This marking guideline consists of 10 pages.

QUESTION 1

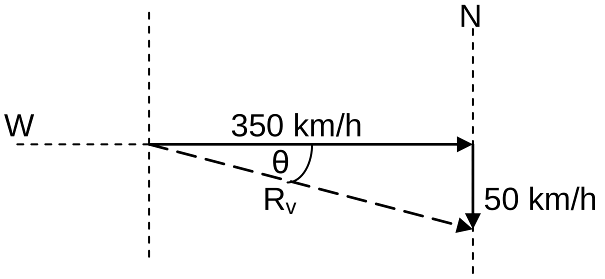
1.1



1.1.1 $v = u + gt$
$0 = u + (-9,8)(5)$ √
$u = 49$ m/s √ (2)

1.1.2 $s = ut + ½gt^2$ or $v^2 = u^2 + 2gs$
$s = (49)(5) + ½(-9,8)(5^2)$ √√ $(0^2) = (49^2) + 2(-9,8)s$
$s = 245 – 122,5$ $19,6s = 2401$
$s = 122,5$ m √ $s = 122,5$ m (3)

1.2



$R_v = \sqrt{350^2 + 50^2}$ √

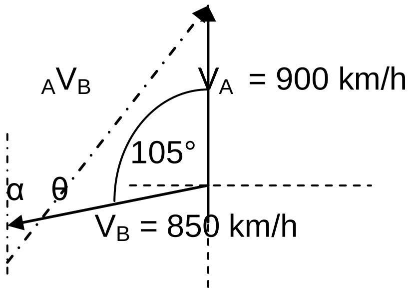
$R_v = 353,553$ km/h √

$\theta = \tan^{-1}(\frac{50}{350})$ √

$\theta = 8,138°$

$R_v = 353,553$ km/h E 8,138°S √ (4)

1.3



$_AV_B = \sqrt{900^2 + 850^2 - 2(900)(850)\cos 105°}$ √

= 1388,702 km/h √

$\frac{\sin\theta}{900} = \frac{\sin 105°}{1388.702}$ √

$\theta = 38{,}756°$

α = 90 - 38,756 – 15

α = 36,244° √

$_AV_B$ = 1388,702 km/h N 36,244° E√ (5)

[14]

QUESTION 2

2.1 Angular acceleration is the rate of change of angular velocity.√ (1)

2.2 $w_o = 2\pi n$ $\quad$ $w_f = 2\pi n$

$= 2\pi(\frac{800}{60})$ $\quad$ $= 2\pi(\frac{300}{60})$

= 83,776 rad/s $\quad$ = 31,416 rad/s

2.2.1 $\theta = 2\pi n$

$\theta = 2\pi(30)$√

$\theta = 188{,}496\ rad$√ (2)

2.2.2 $\alpha = \frac{w_f^2 - w_o^2}{2\theta}$

$\therefore \alpha = \frac{(31{,}416)^2 - (83{,}776)^2}{2(188{,}496)}$ √√

$\therefore \alpha = \frac{986{,}965 - 7018{,}418}{376{,}992}$

$\therefore \alpha = -15{,}999\ rad/s^2$ √ (3)

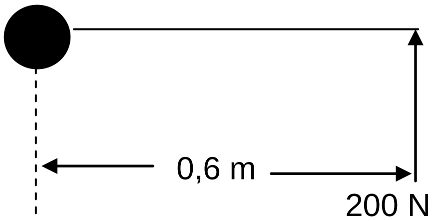
2.2.3 $\theta = \frac{w_f + w_o}{2} \times t$

$t = \frac{2\theta}{w_f + w_o}$

$t = \frac{2(188{,}496)}{31{,}416 + 86{,}776}$ √

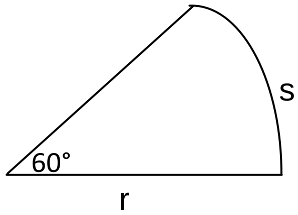
t = 3,19 s√ (2)

2.3 2.3.1



T = F x r
T = 200 x 0,6
T = 120 N.m√ (1)

2.3.2



$\theta = 2\pi n$

$\theta = \frac{2\pi 60}{360}$

$\theta = 1{,}047\ rad$ √

$s = r\theta$

s = (0,6)(1,047)
s = 0,628 m √

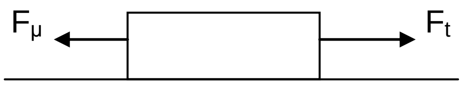
W = F x s
W = 200 x 0,628
W 125,6 J √ (3)

[12]

QUESTION 3

3.1 An object remains at rest or continues to move in a straight line with uniform velocity unless acted upon by an unbalanced force.√ (1)

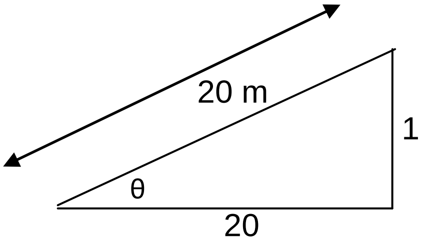
3.2 m = 150 Mg and F_μ = 6 N/Mg × 150 Mg
m = 150 × 10^6 g F_μ = 900 N
m = 150 000 kg



3.2.1 $F_a = F_t - F_\mu$ √
ma = $F_t - F_\mu$
(150 000)a = 33 000 – 900 √
a = 0,214 m/s^2 √ (3)

3.2.2 W = F_t x s
W = 33 000 x 2000 √
W = 66 x 10^6 J√
W = 66 MJ (2)

3.3 3.3.1



$\tan\theta = \frac{1}{20}$

$\theta = 2{,}862°$

h = 20sin θ
h = 20sin2,862°
h = 0,999 m

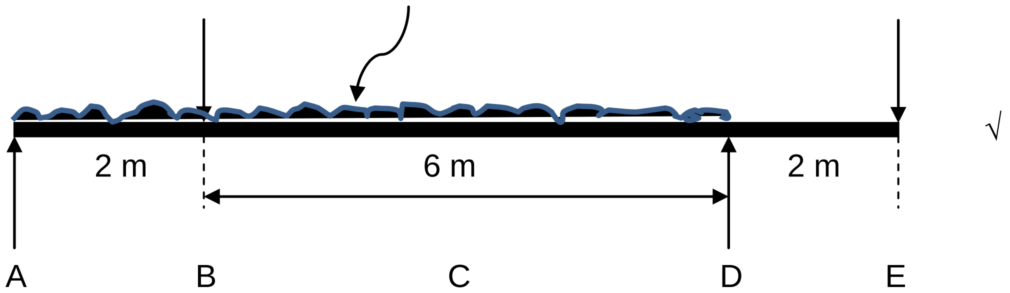
PE_{max} = mgh
PE_{max} = (6)(9,8)(0,999)√√
PE_{max} = 58,741 J √ (3)

3.3.2 $PE_{top} = KE_{bottom}$
KE_{bottom} = 58,741
$\frac{1}{2}mv^2$ = 58,741 √
$\frac{1}{2}(6)v^2$ = 58,741√
v^2 = 19,58
v = 4,425 m/s√ (3)

[12]

QUESTION 4

4.1 4.101



√

(1)

4.1.2 Taking moments about A
ΣACWM = ΣCWM
(D x 8) = (50 × 2) + (16 × 4) + (30 × 10)√√
8D = 100 + 64 + 300
D = 58 N

Taking moments about D
ΣACWM = ΣCWM
(50 x 6) + (16 x 4) = (30 x 2) + (A x 8) √√
300 + 64 = 60 + 8A
A = 38 N

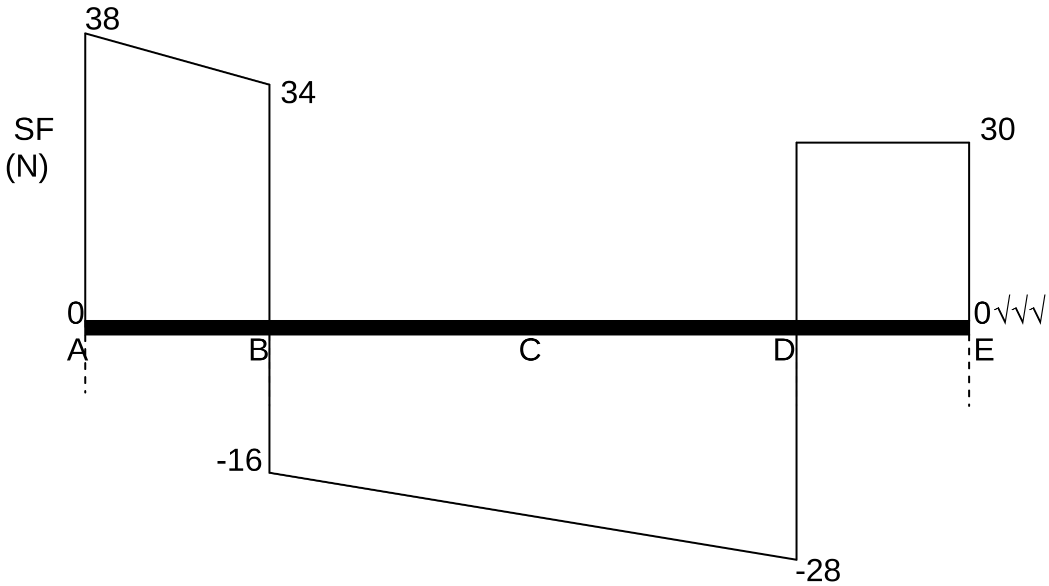
Check: ↑F = 58 + 38
= 96 N
↓F = 50 + 16 + 30
= 96 N
↑F = ↓F (4)

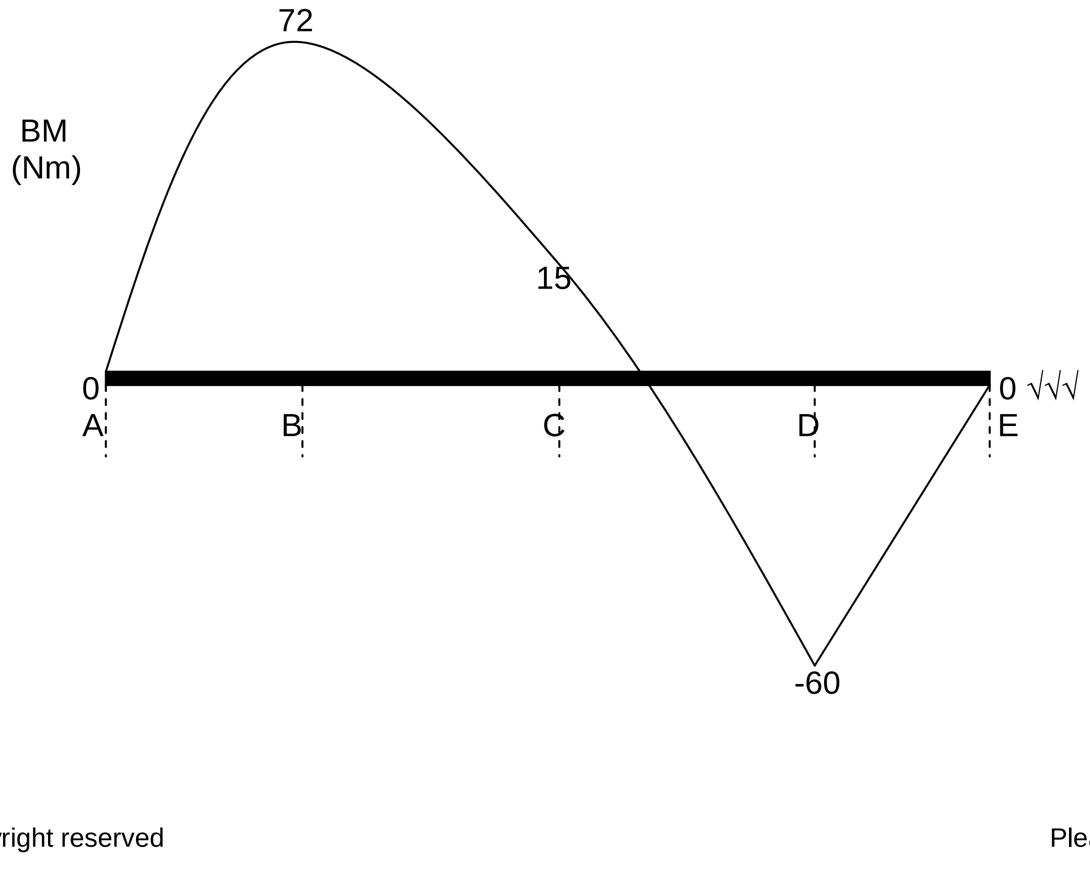
4.1.3 BM_A = 0 Nm
BM_B = (38 × 2) – (4 x 1) = 72 Nm√
BM_C = (38 × 5) – (4 × 4) – (50 × 3) – (6 × 1,5) = 15 Nm√
BM_D = -(30 × 2) = -60 Nm√

OR

BM_D = (38 × 8) – (50 × 6) – (16 × 4) = -60 Nm
BM_E = 0 Nm (3)

4.1.4





(6)

4.2 $A_1 = 150 \times 200$ $x_1 = 150/2$
$= 30\ 000$ $= 75$ √

$A_2 = 200 \times 350$ $x_2 = 150 + 200/2$
$= 70\ 000$ $= 250$ √

$A_3 = 200 \times 70$ $x_3 = 150 + 200 + 200/2$
$= 14\ 000$ $= 450$√

$$X_T = \frac{A_1x_1 + A_2x_2 + A_3x_3}{A_T}$$

$$= \frac{(30\ 000)(75) + (70\ 000)(250) + (14\ 000)(450)}{114\ 000}$$

= 228,509 units √ (4)

[18]

QUESTION 5

5.1 5.1.1 $A = \frac{\pi d^2}{4}$

$= \frac{\pi(0{,}075)^2}{4}$

$= 4{,}418 \times 10^{-3}\ m^2$√

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

$\therefore P = \frac{400}{4{,}418 \times 10^{-3}}$√

P = 90538,705 Pa √
P = 90,539 kPa (3)

5.1.2 $\frac{f}{d^2} = \frac{F}{D^2}$

$D^2 = \frac{F \times d^2}{f}$

$D^2 = \frac{(25000)(0{,}075^2)}{400}$ √

$D^2 = 0{,}351$
D = 0,593 m √
D = 593 mm (2)

5.2 5.2.1

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

$A = \frac{\pi(0{,}15^2)}{4}$

A = 17,671 × 10 $^{-3}$ m^2 √

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

$P = \frac{20000}{17{,}671 \times 10^{-3}}$ √

P = 1 131 797,861 Pa √

P = 1,132 MPa (3)

5.2.2

W = P x V

(3 000) = (1,132 x 10^6) x V√

V = 2,65 x 10^{-3} m^3√ (2)

5.2.3

V = A x sl

(2,65 x 10 $^{-3}$) = (17,671 x 10 $^{-3}$) x sl √

sl = 0,15 m √ (2)

5.3 5.3.1

$V_{pump} = \frac{100 \times 20}{60}$

V_{pump} = 33,333 litres √

$V_T = V_{pump} + V_{accumulator}$

250 = 33,333 + $V_{accumulator}$

$V_{accumulator}$ = 216,667 litres √

$V_{accumulator}$ = 0,217 m^3

5.3.2

$V = \frac{\pi D^2}{4} \times h$

$h = \frac{4V}{\pi D^2}$

$h = \frac{4 \times 0{,}217}{\pi \times 0{,}25^2}$ √

h = 4,421 m √

(2 × 2) (4)

[16]

QUESTION 6

6.1 For any material, within certain limits, Young's modulus of elasticity is a constant where the strain is proportional to the stress which produces it.√√ (2)

6.2 6.2.1

$$\sigma = \frac{F}{A}$$

$$\sigma = \frac{(350)(9{,}8)}{1{,}5 \times 10^{-4}} \surd$$

σ = 22 866 666,67 Pa√

σ = 22,867 MPa

6.2.2

$$\varepsilon = \frac{\Delta L}{L_o}$$

$$\varepsilon = \frac{7{,}5 \times 10^{-5}}{5} \surd$$

$\varepsilon = 1{,}5 \times 10^{-5}$ √

6.2.3

$$E = \frac{stress}{strain}$$

$$E = \frac{22{,}867 \times 10^{6}}{1{,}5 \times 10^{-5}} \surd$$

$E = 1{,}524 \times 10^{12}$ Pa

E = 1524,467 GPa √

(3 × 2) (6)

6.3

$$\sigma_t(w-d)t = N\frac{\pi d^2}{4}\tau \quad \text{. . . . (1)}$$

Now, the effective cross-sectional area for shear stress of the rivet in double shear = 2 × A, because we have two shear planes.

$$\therefore \tau = \frac{F}{A}$$

$$\therefore 2\tau = \frac{F}{A}$$

Hence, in equation (1), we multiply $\tau\ by\ 2$

$$\sigma_t(w-d)t = \frac{N\pi d^2}{4} \times 2\tau$$

$$\therefore 350 \times 10^6(0{,}075 - 0{,}02)0{,}012 = \frac{(1)(\pi)(0{,}02)^2}{4}2\tau \ \surd\surd\surd$$

$$\therefore 231\ 000 = 6{,}283 \times 10^{-4}\tau$$

$$\therefore \tau = 3{,}676 \times 10^{8} Pa \ \surd$$

$$\therefore \tau = 367{,}65 MPa$$

(4)

[12]

QUESTION 7

7.1 The volume of a given mass of gas is inversely proportional to the pressure on it, if the temperature remains constant.√√ (2)

7.2 $\Delta A = 2\alpha A_o \Delta t$

$\therefore \Delta A = (2 \times 20 \times 10^{-6})(0{,}3 \times 0{,}3)(90 - 20)$ √√

$\therefore \Delta A = 2{,}52 \times 10^{-4} m^2$ √ (3)

7.3 7.3.1

$V_o = \frac{\pi d^2}{4} \times l$

$\therefore V_o = \frac{\pi (0{,}05)^2}{4} \times 1$

$\therefore V_o = 1{,}963 \times 10^{-3} m^3$ √

$\% \ increase = \frac{\Delta V}{V_o} \times 100$

$\% \ increase = \frac{9{,}513 \times 10^{-6}}{1{,}963 \times 10^{-3}} \times 100$ √

% increase = 0,485 %√ (3)

7.3.2

$\Delta V = V_0 . \gamma . \Delta t$

$\therefore 9{,}513 \times 10^{-6} = 1{,}963 \times 10^{-3} . \gamma . 95$ √

γ = 51,012 x 10 $^{-6}$

α = 17,004 x 10 $^{-6}$ /K√ (2)

7.4 7.4.1

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$P_2 = \frac{P_1 V_1 T_2}{T_1 V_2}$

$P_2 = \frac{(1 \times 10^5)(22{,}5)(423)}{(293)(5)}$ √√

P_2 = 649 658,703 Pa √

P_2 = 649,659 kPa

7.4.2

$\frac{P_2}{T_2} = \frac{P_3}{T_3}$

$T_3 = \frac{P_3 T_2}{P_2}$

$T_3 = \frac{(3{,}5 \times 10^5)(423)}{(649{,}659 \times 10^3)}$ √√

T_3 = 227,889 K √

(2 × 3) (6)

[16]

TOTAL: 100