



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

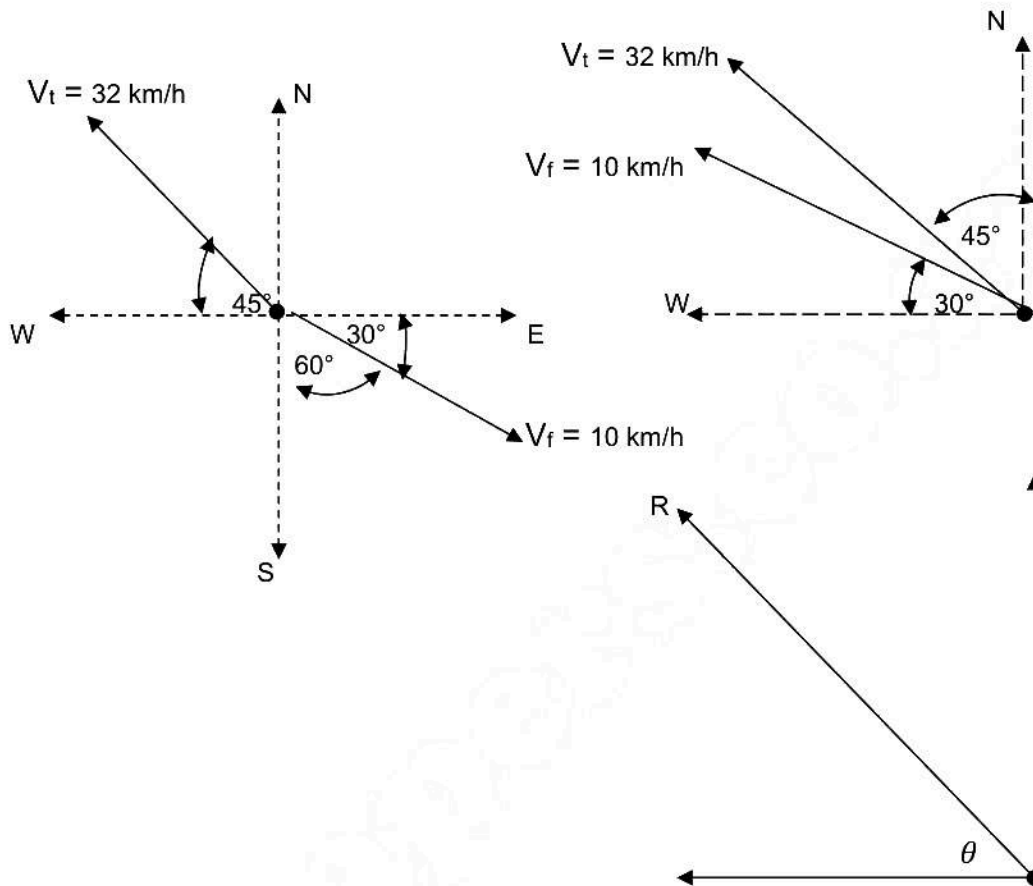
INGENIEURSWETENSKAP N4

1 April 2026

Hierdie nasienriglyn bestaan uit 13 bladsye.

VRAAG 1

1.1



$$\begin{aligned}\sum Hc &= 32\cos 135^\circ + 10\cos 150^\circ \\ &= 31,288 \text{ km/h wes}\checkmark\end{aligned}$$

$$\begin{aligned}\sum Vc &= 32\sin 135^\circ + 10\sin 150^\circ \\ &= 27,627 \text{ km/h noord}\checkmark\end{aligned}$$

$$\begin{aligned}R^2 &= \sum Hc^2 + \sum Vc^2 \\ &= \sqrt{31,288^2 + 27,627^2} \\ &= 41,74 \text{ km/h}\checkmark\end{aligned}$$

$$\begin{aligned}\theta &= \tan^{-1}\left(\frac{Vc}{Hc}\right) \\ &= \tan^{-1}\left(\frac{27,627}{31,288}\right) \\ &= 41,44^\circ\checkmark\end{aligned}$$

Snelheid van torpedo in verhouding tot vragskip = 41,74 km/h, W $41,44^\circ$ N✓

OF

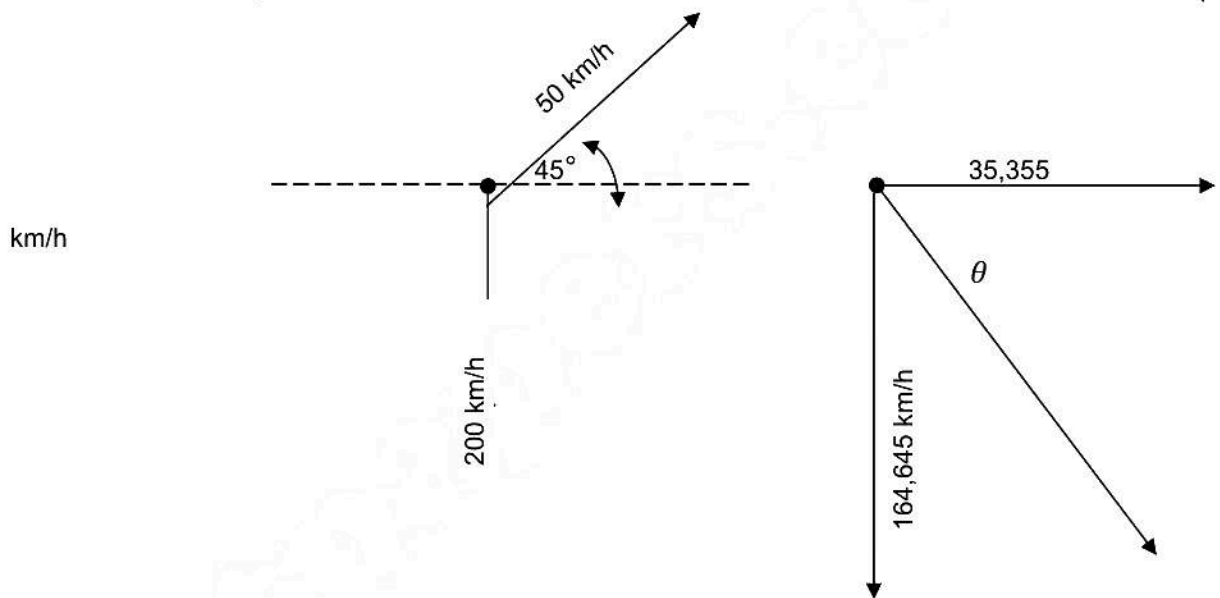
$$\begin{aligned}
 c^2 &= a^2 + b^2 - 2ab\cos\theta \\
 &= 32^2 + 10^2 - 2(32)(10) \times \cos(165)^\circ \checkmark \\
 c &= \sqrt{1\,678,256} \\
 c &= 41,74 \text{ km/h} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \sin C &= \frac{32 \sin 165^\circ}{41,74} \\
 &= \frac{8,282}{41,74} \\
 C &= \sin^{-1}\left(\frac{8,282}{41,74}\right) \\
 &= 11,445^\circ \checkmark \\
 &= 60 - 11,445^\circ = 48,555^\circ \checkmark
 \end{aligned}$$

Snelheid van torpedo in verhouding tot vragskip = 41,74 km/h, W 41,44° N ✓
N 48,555° W

(5)

1.2



$$\begin{aligned}
 \sum Hc &= 50 \cos 45^\circ \\
 &= 35,355 \text{ km/h oos} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \sum Vc &= 50 \sin 45^\circ - 200 \\
 &= 164,645 \text{ km/h suid} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 R^2 &= \sum Hc^2 + \sum Vc^2 \\
 &= \sqrt{35,355^2 + 164,645^2} \\
 &= 168,398 \text{ km/h} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \theta &= \tan^{-1}\left(\frac{Vc}{Hc}\right) \\
 &= \tan^{-1}\left(\frac{164,645}{35,355}\right) \\
 &= 77,88^\circ \checkmark
 \end{aligned}$$

Resultante snelheid = 168,398 km/h, O 77,88° S ✓

OF

$$V_r^2 = V_w^2 + V_a^2 - 2V_w \times V_a \times \cos 45^\circ$$

$$V_r = \sqrt{50^2 + 200^2 - (2 \times 50 \times 200 \cos 45^\circ)} \checkmark$$

$$V_r = 168,398 \text{ m/s} \checkmark$$

$$\frac{V_r}{\sin 75^\circ} = \frac{V_w}{\sin \alpha}$$

$$\alpha = \frac{50 \times \sin 45^\circ}{168,398} \checkmark$$

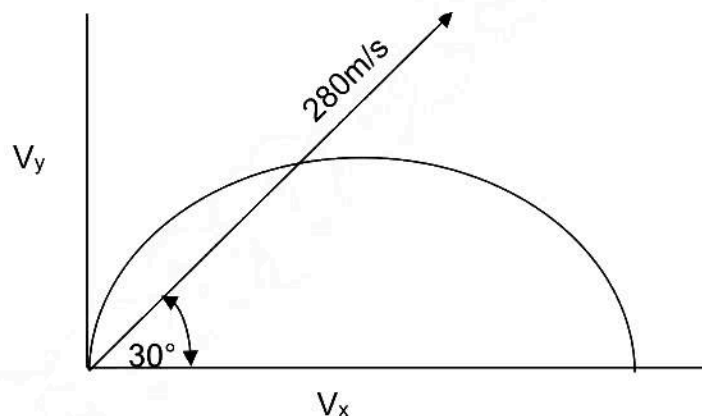
$$= 12,1195^\circ$$

$$\alpha = 90 - 12,1195 = 77,88^\circ \checkmark$$

Resultante snelheid = 168,398 km/h, O 77,88° S ✓ (5)

1.3 1.3.1 $V_x = 280 \cos 30^\circ = 242,487 \text{ m/s}$

$$V_y = 280 \sin 30^\circ = 140 \text{ m/s}$$



$$v = u - gt$$

$$0 = 140 - 9,8t$$

$$t = \frac{140}{9,8}$$

$$t = 14,286 \text{ sek} \checkmark \quad (1)$$

1.3.2 $s = ut + \frac{1}{2}gt^2$

$$= 140(14,286) + \frac{1}{2}(-9,8)(14,286)^2 \checkmark$$

$$= 999,999 \approx 1\,000 \text{ m} \checkmark \quad (2)$$

1.3.3 $t = 2 \times 14,286 = 28,572 \text{ sek}$

$$S = vt$$

$$= 242,487 \times 28,572 \checkmark$$

$$= 6\,928,339 \text{ m}$$

$$= 6,928 \text{ km} \checkmark \quad (2)$$

[15]

VRAAG 2

- 2.1 2.1.1 $\omega = \frac{2\pi n}{60}$
 $= 2 \times \pi \times \frac{105}{60} \checkmark$
 $\omega = 10,996 \text{ rad/s} \checkmark$
- 2.1.2 $v = \omega r$
 $= 10,996 \times 0,375 \checkmark$
 $v = 4,124 \text{ m/s} \checkmark$
- 2.1.3 $s = vt$
 $= 4,124 \times 15 \times 60 \checkmark$
 $s = 3\,711,6 \text{ m} \checkmark$

(3 × 2) (6)
- 2.2 2.2.1 $T = F \times R$
 $= 500 \times 0,45 \checkmark$
 $= 225 \text{ N.m} \checkmark$

(2)
- 2.2.2 $\theta = \frac{60 \times \pi}{180} \checkmark$
 $\theta = 0,785 \text{ rad} \checkmark$

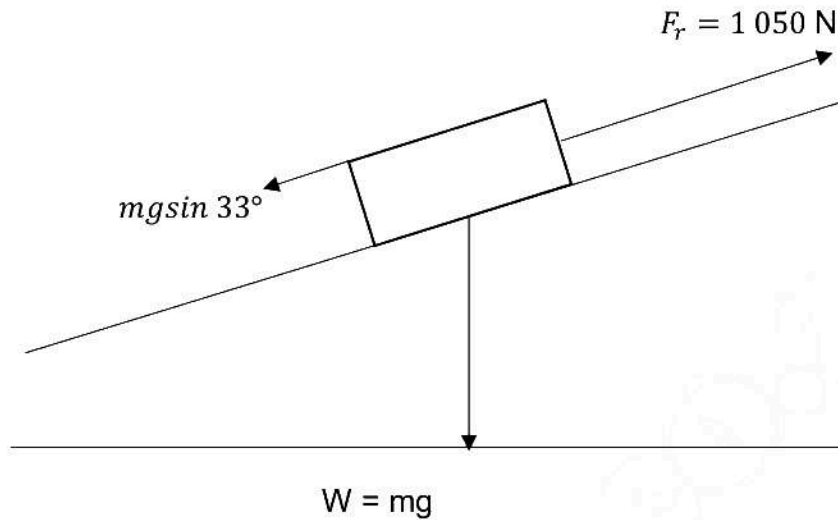
 $W = T\theta$
 $= 225 \times 0,785 \checkmark$
 $W = 176,625 \text{ J} \checkmark$

(4)
[12]

VRAAG 3

- 3.1 Dit is die energie wat 'n liggaam het as gevolg van die relatiewe posisie daarvan in verhouding tot 'n verwysingsvlak en swaartekrag. (2)

3.2 $m = 600 \text{ kg}$, $u = 0 \text{ m/s}$, $F_r = 1\,050 \text{ N}$, $s = 65 \text{ m}$



$$F = ma$$

$$mg \sin 33^\circ - 1\,050 = 600 \times a$$

$$600 \times 9,8 \sin 33^\circ - 1\,050 = 600 \times a \checkmark$$

$$2\,152,478 = 600 \times a$$

$$a = 3,588 \text{ m/s}^2 \checkmark$$

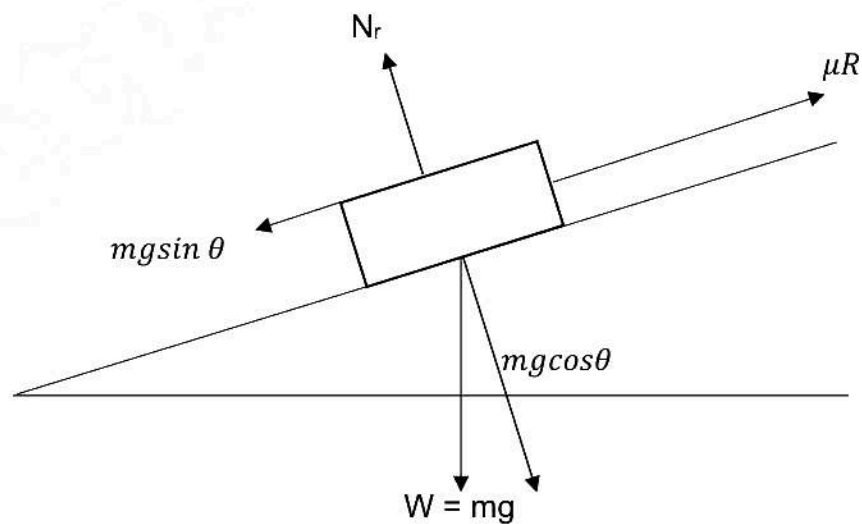
$$v^2 = u^2 + 2as$$

$$v = \sqrt{u^2 + 2as}$$

$$v = 21,597 \text{ m/s} \checkmark$$

(3)

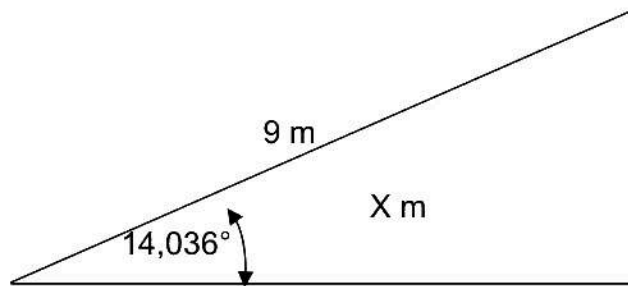
3.3



$$\tan \theta = \mu$$

$$\tan \theta = 0,25$$

$$\theta = 14,036^\circ \checkmark$$



$$\frac{x}{9} = \tan 14,036^\circ \checkmark$$

$$x = 9 \times \tan 14,036^\circ$$

$$x = 2,25 \text{ m} \checkmark$$

(3)

3.4 3.4.1 $m = 48 \text{ kg}, h = 17 \text{ m}$

$$E_p = mgh$$

$$= 48 \times 9,8 \times 17 \checkmark$$

$$E_p = 7\,996,8 \text{ J} \checkmark$$

$$E_p = 7,997 \text{ kJ}$$

(2)

3.4.2 Wins in $E_k = \text{verlies in } E_p$

$$E_k = 7\,996,8 \text{ J} \checkmark$$

(1)

3.4.3 $\frac{1}{2} m v^2 = 7\,996,8 \checkmark$

$$\frac{1}{2} \times 48 \times v^2 = 7\,996,8 \checkmark$$

$$v = \sqrt{333,2}$$

$$v = 18,254 \text{ m/s} \checkmark$$

(3)

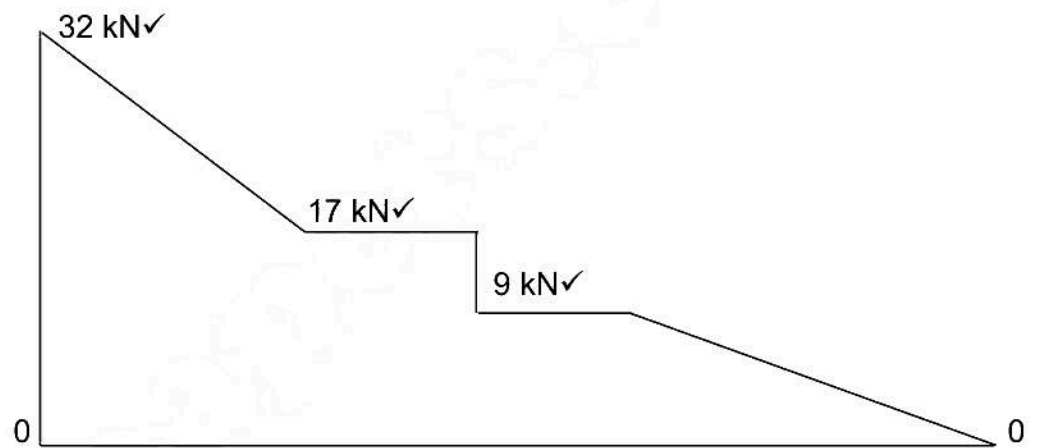
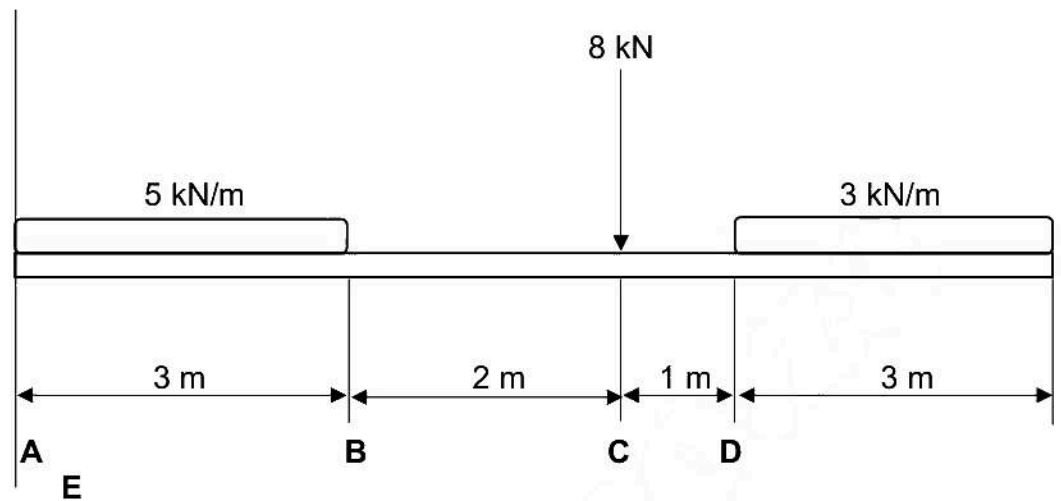
[14]

VRAAG 4

4.1 Die som van kloksgewyse momente om enige punt is gelyk aan die som van antikloksgewyse momente om dieselfde punt.

(2)

4.2 4.2.1



$$R_A = (5 \times 3) + 8 + (3 \times 3) = 32 \text{ kN} \quad (3)$$

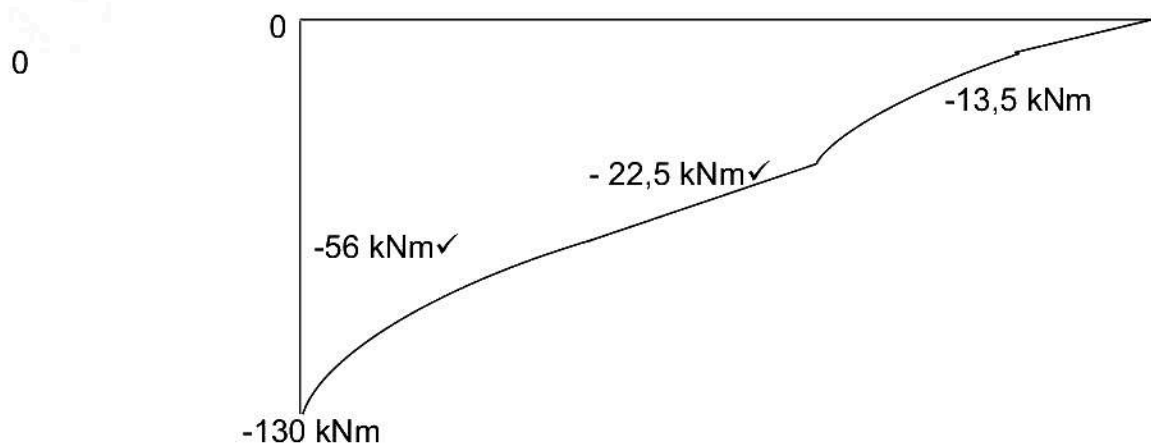
4.2.2

$$BM_A = - (3 \times 3 \times 7,5) - (8 \times 5) - (5 \times 3 \times 1,5) = -130 \text{ kNm}✓$$

$$BM_B = - (3 \times 3 \times 4,5) - (8 \times 2) = -56,5 \text{ kNm}✓$$

$$BM_C = - (3 \times 3 \times 2,5) = -22,5 \text{ kNm}✓$$

$$BM_D = - (3 \times 3 \times 1,5) = -13,5 \text{ kNm}✓$$



$$4.3 \quad A_1 = 200 \times 220 \\ = 44\,000 \\ \bar{X}_1 = \frac{200}{2} = 100 \text{ mm} \checkmark$$

$$A_2 = 250 \times 400 \\ = 100\,000 \text{ mm}^2$$

$$\bar{X}_2 = 200 + \frac{250}{2} \\ = 325 \text{ mm} \checkmark$$

$$A_3 = 300 \times 90 \\ = 27\,000 \text{ mm}^2$$

$$\bar{X}_3 = 200 + 250 + \frac{300}{2} \\ = 600 \text{ mm} \checkmark$$

$$\bar{X}_T = \frac{A_1 \bar{X}_1 + A_2 \bar{X}_2 + A_3 \bar{X}_3}{A_T} \\ = \frac{44\,000 \times 100 + 100\,000 \times 325 + 27\,000 \times 600}{171\,000} \\ = 310,526 \text{ mm} \checkmark$$

(4)
[15]

VRAAG 5

$$5.1 \quad MA = \frac{F}{E} \\ F = MA \times E \\ = 15 \times 300 \\ F = 4\,500 \text{ N} \checkmark$$

Aangesien die druk dieselfde is in albei silinders:

$$\frac{F}{d^2} = \frac{W}{D^2} \\ \frac{F}{0,1 D^2} = \frac{W}{D^2} \\ W = \frac{D^2 \times F}{0,1 D^2} \\ W = F \times 10 \times \eta \\ = 4\,500 \times 10 \times 0,91 \checkmark \\ W = 40\,950 \text{ N} \\ W = 40,95 \text{ kN} \checkmark$$

(3)

$$\begin{aligned}
 5.2 \quad 5.2.1 \quad Q_t &= \frac{ALSEN}{60} \quad \text{OF} \quad V = \frac{\pi d^2}{4} \times L \times N \times \% \text{ glip} \\
 &= \frac{\pi \times d^2 \times L \times N}{4 \times 60} \quad 0,0651 = \frac{\pi \times 0,6^2}{4} \times 0,3 \times \frac{50}{60} \times \% \text{ glip} \checkmark \\
 &= \frac{\pi \times 0,6^2 \times 0,3 \times 50 \times 10^3}{4 \times 60} \checkmark \quad \% \text{ glip} = 0,921\% \checkmark \\
 Q_t &= 70,686 \text{ l/s} \checkmark \quad \text{Werklike \% glip} = 100 - 92,1 \checkmark \\
 &= 7,9\% \checkmark \\
 \% \text{ glip} &= \frac{(Q_t - Q_a) \times 100}{Q_t} \\
 &= \frac{(70,686 - 65,1) \times 100}{70,686} \checkmark \\
 \% \text{ glip} &= 7,903\% \checkmark \quad (4)
 \end{aligned}$$

$$\begin{aligned}
 5.2.2 \quad P &= \rho g Q_t h \\
 &= 9,8 \times 70,686 \times 15 \checkmark \\
 P &= 10\,390,842 \text{ W} \\
 P &= 10,391 \text{ kW} \checkmark \quad (2)
 \end{aligned}$$

$$\begin{aligned}
 5.3 \quad V &= \frac{\pi d^2 h}{4} \\
 &= \frac{\pi \times 0,9^2 \times 101}{4} \checkmark \\
 V &= 64,253 \text{ m}^3 \checkmark \\
 m &= \rho V \\
 &= 1\,000 \times 64,253 \checkmark \\
 m &= 64\,253 \text{ kg} \\
 m &= 64,253 \text{ t} \checkmark \\
 E_p &= mgh \\
 &= 64\,253 \times 9,8 \times 101 \checkmark \\
 E_p &= 63\,597\,619,4 \text{ J} \\
 E_p &= 63,598 \text{ MJ} \checkmark \quad (6) \\
 & \quad [15]
 \end{aligned}$$

VRAAG 6

$$\begin{aligned}
 6.1 \quad 6.1.1 \quad &\text{Vir skuiwing van klinknael:} \\
 &A = 12 \times 22 \\
 &= 264 \text{ mm}^2 \checkmark \\
 \sigma &= \frac{F}{A} \\
 &= \frac{25\,000}{264 \times 10^{-6}} \\
 \sigma &= 94,697 \text{ MPa} \checkmark \quad (2)
 \end{aligned}$$

6.1.2

$$E = \frac{\sigma}{\varepsilon}$$

$$\varepsilon = \frac{\sigma}{E}$$

$$= \frac{94,697 \times 10^6}{195 \times 10^9}$$

$$\varepsilon = 0,486 \times 10^{-3} \checkmark$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\Delta L = L_0 \times \varepsilon$$

$$= 1,8 \times 0,486 \times 10^{-3}$$

$$\Delta L = 0,000874 \text{ m} \checkmark$$

$$L_f = L_0 + \Delta L$$

$$= 1,8 + 0,000486$$

$$L_f = 1,800 \text{ m} \checkmark$$

(3)

6.2

6.2.1

$$A_1 = \frac{\pi(D^2 - d^2)}{4}$$

$$= \frac{\pi(50^2 - 25^2)}{4}$$

$$A_1 = 1\,472,622 \text{ mm}^2$$

$$\sigma_{maks} = \frac{F}{A_1}$$

$$= \frac{55}{1\,472,622 \times 10^{-6}} \checkmark$$

$$\sigma_{maks} = 37,348 \text{ MPa} \checkmark$$

(2)

6.2.2

$$A_2 = \frac{\pi D^2}{4}$$

$$= \frac{\pi \times 50^2}{4}$$

$$A_2 = 1\,963,495 \text{ mm}^2$$

$$\sigma_{min} = \frac{F}{A_2}$$

$$= \frac{55}{1\,963,495 \times 10^{-6}} \checkmark$$

$$\sigma_{min} = 28,011 \text{ MPa} \checkmark$$

(2)

6.2.3 By deel 1:

$$E = \frac{\sigma_{maks}}{\epsilon_1}$$

$$\epsilon_1 = \frac{\sigma_{maks}}{E}$$

$$= \frac{37,348}{200 \times 10^3} \checkmark$$

$$\epsilon_1 = 0,18674 \times 10^{-3} \checkmark$$

By deel 2:

$$E = \frac{\sigma_{min}}{\epsilon_2}$$

$$\epsilon_2 = \frac{\sigma_{min}}{E}$$

$$= \frac{28,011}{200 \times 10^3} \checkmark$$

$$\epsilon_2 = 0,140055 \times 10^{-3} \checkmark$$

$$\epsilon_T = \epsilon_1 + \epsilon_2$$

$$= 0,18674 \times 10^{-3} + 0,140055 \times 10^{-3}$$

$$\epsilon_T = 0,326795 \times 10^{-3} \checkmark$$

(5)
[14]

VRAAG 7

7.1 'n Isotermiese proses is 'n termodinamiese proses waarin die temperatuur van die stelsel deurlopend konstant bly. (2)

7.2 7.2.1 $V_0 = 55 \times 45 \times 35 \checkmark$
 $V_0 = 86\,625 \text{ mm}^3 \checkmark$

$$\Delta V = \gamma V_0 \Delta T$$

$$= 3 \times 9 \times 10^{-6} \times 86\,625 \times (88 - 25) \checkmark$$

$$\Delta V = 147,349 \text{ mm}^3 \checkmark \quad (4)$$

7.2.2 $V = V_0 + \Delta V$
 $= 86\,625 + 147,349 \checkmark$
 $V = 86\,772,349 \text{ mm}^3 \checkmark \quad (2)$

7.3 $T_1 = 270 \text{ K}, T_2 = 340 \text{ K}, V_2 = V_1 + 0,29$

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

$$\frac{V_1}{270} = \frac{V_1 + 0,29}{340} \checkmark$$

$$340V_1 = 270V_1 + 78,3 \checkmark$$

$$70V_1 = 78,3$$

$$V_1 = 1,119 \text{ m}^3 \checkmark$$

7.4 7.4.1 B tot C is die isochoriese proses. (1)

7.4.2

$$W = \frac{1}{2}(30)(100) + (30)(100)✓✓$$
$$W = 1\,500 + 3\,000✓$$
$$W = 4\,500 \text{ kJ}$$
$$W = 4,5 \text{ MJ}✓$$

(3)
[15]

TOTAAL: 100