higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

INGENIEURSWETENSKAP N4

4 APRIL 2018

Hierdie nasienriglyn bestaan uit 17 bladsye.

VRAAG 1: ALGEMEEN

1.1 1.1.1 Hoekverplasing: die hoek wat gedurende rotasie gevorm word en wat in straalhoeke gemeet word.

1.1.2 Elastisiteit: die eienskap wat 'n voorwerp in staat stel om sy oorspronklike vorm of grootte te herwin wanneer die krag wat spanning meebring verwyder word. (2 × 1) (2)

1.2
- Vloeistowwe het 'n defnitiewe vorm.
- Vloeistowwe neem die vorm van die houer aan.
- Water en hidrouliese vloeistowwe kan gebruik word om werk te verrig.
- Water en hidrouliese vloeistowwe kan herhaaldelik gebruik word.

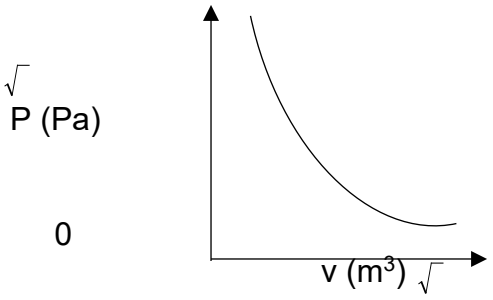
(Enige 2 × 1) (2)

1.3
- Massa-gelaaide akkumulator
- Veer-gelaaide akkumulator
- Lug- of gas-akkumulator (3)

1.4 Boyle se wet: As die temperatuur konstant bly, is die saamdrukking/kompressie in 'n gas omgekeerd eweredig aan die volume daarvan.✓

$P_1V_1 = P_2V_2$√ OF PV = K

Volumekompressie/volumesaamdrukking



(4)

1.5 1.5.1 Pascal se wet: In 'n geslote stelsel sal die druk wat toegepas word in alle rigtings dieselfde / ewe groot wees✓. (1)

1.5.2 Newton se tweede wet van beweging: Die tempo✓ van beweging is direk eweredig aan en in dieselfde rigting as die toegepaste krag✓. (2)

1.6 Die hidrouliese pers behou 95% van die vloeistof in die ram✓.

OF

5% vloeistof vloei uit die hidrouliese pers✓. (1)

1.7 $\bar{F} = m.a$ ✓ (1)

1.8 $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ ✓ (1)

[17]

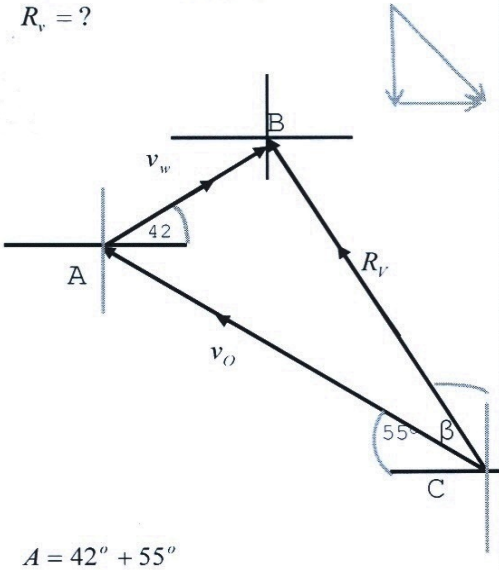
VRAAG 2: KINEMATIKA

2.1

$V_o = 330Km/h\ N35^0W$

$V_w = 90Km/h\ E42^0N$

$R_v = ?$



$A = 42^o + 55^o$

$= 97^o$ √

$a = \sqrt{b^2 + c^2 - 2bc\cos B}$

$a = \sqrt{90^2 + 330^2 - 2(90)(350)\cos 97^0}$

$a = 352,476Km/h$ √

$\frac{SinC}{c} = \frac{SinA}{a}$

$C = \sin^{-1}(\frac{cSinA}{a})$

$= \sin^{-1}(\frac{90Sin97}{352,476})$

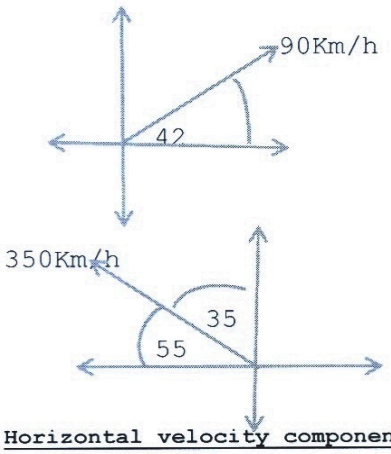
$= 14,681^0$ √

$\beta \Rightarrow 35^0 - 14,681^0 = 20,319^o$ √

√

$R_v = 352,476Km/h\ N20,319^0W$ (5)

ALTERNATIVE



Horizontal velocity components

- 90cos42= 66,883Km/h E
- 330cos55=189,280Km/h W

$\sum V_{Horizontal} = 66,883Km/h - 189Km/h$

$= -122,397Km/h$ √ **Or**

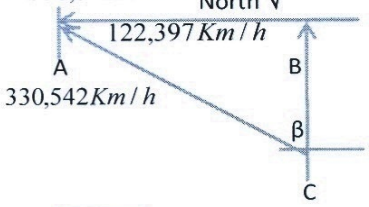
$= 122,397Km/h$ West√

Vertical velocity components

- 90sin42= 60,222Km/h N
- 330sin55=270,320Km/h N

$\sum V_{Horizontal} = 270,320Km/h + 60,222Km/h$

$= 330,542Km/h$ North √



$b = \sqrt{a^2 + c^2}$

$b = \sqrt{(330,542Km/h)^2 + (122,397Km/h)^2}$

$= 352,476Km/h$ √

$\tan\beta = (\frac{122,397Km/h}{330,542Km/h})$

$= 20,319^o$ √√ (5)

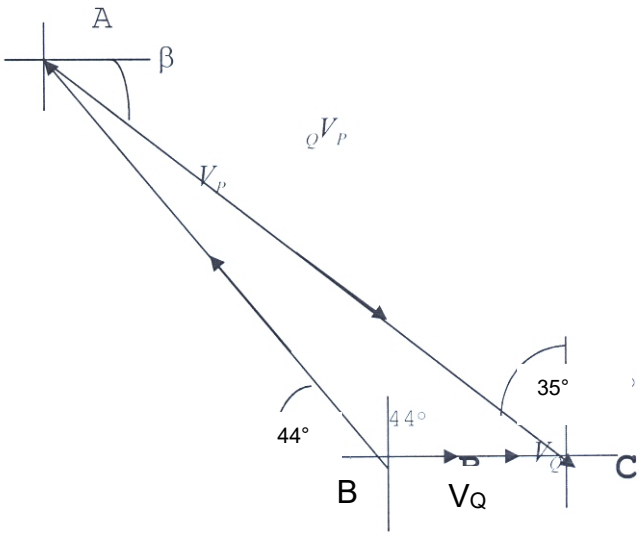
$R_v = 352,476Km/h\ N20,319^0W$

(5)

2.2 $V_o = 200\ km/h\ W44^o N$

$V_Q = 200\ km/h\ E$

${}_QV_P = ?$



$B = 46^o + 90^o$

$= 136^o \surd$

$b = \sqrt{a^2 + c^2 - 2ac\cos B}$

$b = \sqrt{200^2 + 200^2 - 2(200)(200)\cos 136^o}$

$b = 370{,}874\ km/h \surd$

$\frac{SinA}{a} = \frac{SinB}{b}$

$A = \sin^{-1}(\frac{aSinB}{b})$

$A = \sin^{-1}(\frac{200Sin136}{370{,}874})$

$= 22^0 \surd$

$\beta \Rightarrow 44 - 22^0 = 22^o \surd$

${}_QV_P = 370{,}874\ km/h\ E22^0 S$

(5)

2.3 $h_{\max} = \frac{2}{3}L$ √

$$\frac{u^2}{2g}\sin^2\theta = \frac{2}{3}\frac{u^2}{g}\sin 2\theta$$

$$\frac{1}{2}\sin^2\theta = \frac{2}{3}\sin 2\theta \text{ √}$$

$$\frac{\sin^2\theta}{\sin 2\theta} = \frac{2.2}{3}$$

$$\frac{\sin^2\theta}{\sin 2\theta} = \frac{4}{3}$$

$$\frac{\sin^2\theta}{2\sin\theta\cos\theta} = \frac{4}{3} \text{ ✓}$$

$$\frac{\sin\theta}{\cos\theta} = \frac{8}{3} \text{ √}$$

$$\tan\theta = \frac{8}{3}$$

$$\theta = \tan^{-1}(\frac{8}{3})$$

$\theta = 69{,}444^o$ √ (5)

[15]

VRAAG 3: HOEKBEWEGING

3.1 3.1.1 D (2)

3.1.2 D (2)

3.2 3.2.1 D (2)

3.2.2 C (2)

3.2.3 A (1)

[9]

VRAAG 4: DYNAMIKA

4.1 m = 1 ton
E_{k1} = 4,8 kJ
E_{k2} = 9,3 kJ
vlak = horisontaal
s = 200 m

4.1.1 Versnelling (horisontale pad)

$$u = \sqrt{\frac{2(4900\ J)}{1\,000\ kg}}$$

=3,130 m/s √

$$V = \sqrt{\frac{2(9\,300\ J)}{1\,000\ kg}}$$

=4,313m/s √

$$(v_2)^2 = (v_1)^2 + 2.a.S$$

$$a = \frac{(v)^2 - (u)^2}{2(200)}$$

$$= \frac{(4{,}313)^2 - (3{,}130)^2}{2(200)}$$

= 0,022 m/s²√ (2)

4.1.2 Ek, S = 140 m

Velocity after 140 m

$V^2 = U^2 + 2as$ ✓

$V = \sqrt{V^2 + 2as}$

$= \sqrt{(3{,}130)^2 + 2(0{,}022)140}$
= 3,994 m/s ✓

$$\therefore Ek = \frac{1}{2}.mv^2$$

$$= \frac{1}{2}.1\,000\,.\,(3{,}9946)^2$$

$$= 7\,978{,}415\ J$$

$$= 7{,}978\ kJ$$ ✓

(3)

4.2 m = 880 kg
u = 30 m/s
v = 0
s = 50 m
f_u = 295 N
vlak: horisontaal

4.2.1 Spoedvermindering

$$a = \frac{(v)^2 - (u)^2}{2.(S)}$$
$$= \frac{(0)^2 - (30)^2}{2.(50)} \checkmark$$

$=-9\ m/s^2 \checkmark$ (2)

4.2.2 Remkrag

$f_a = -(f_B + f_w) \checkmark$
$f_B = -f_a - f_w)$
$= -m.a - 295N \checkmark$
$\surd$
$= -880\ kg\ (-9\ m/s^2) - 295\ N$
$= 7920\ N - 295\ N\ \surd$
$= 7625\ N \checkmark$

(4)
[11]

VRAAG 5: STATIKA

5.1 5.1.1

$$spring = (20\ Kg)(98\ m/s^2)$$

$$f_{spring} = \frac{(20\ Kg)(98\ m/s^2)}{10\ m}$$

$$= 19{,}6\ N/m$$

$\Delta \cong A$

$$\sum F_{\perp}.S(ac) = \sum F_{\perp}.(c)$$

$$B(13\ m) = 196\ N(5\ m) + 300\ N(12\ m) + 150\ N(15\ m)$$

$$B \Rightarrow \frac{6830\ Nm}{13\ m} = 525{,}385\ N\ \surd$$

$\Delta \cong B$

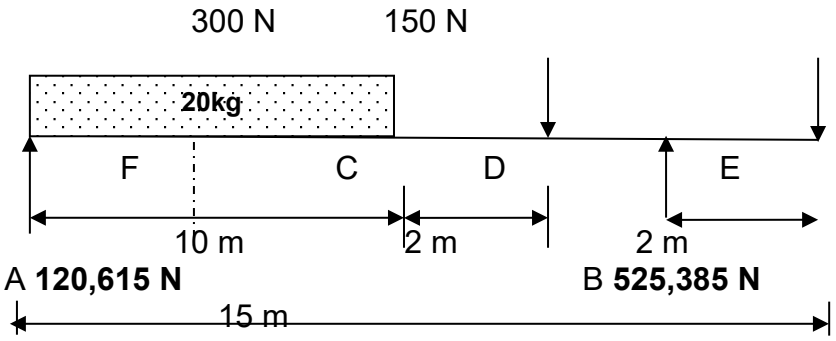
$$\sum F_{\perp}.S(ac) = \sum F_{\perp}.(c)$$

196 N (8 m) +300 N(1 m) = 150 N(2 m) + A(13 m)

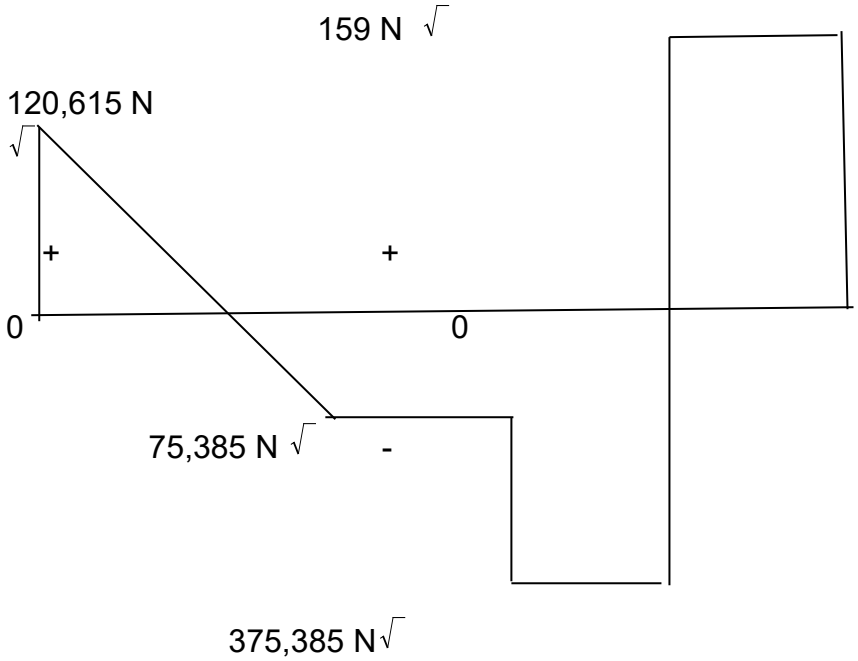
$$A \Rightarrow \frac{1568\ Nm}{13\ m} = 120{,}615\ N\ \surd$$

(2)

5.1.2



Calculate:



(2)

5.1.3 $BM_{A\rightarrow}$(120,615 N).(o m) = 0

$BM_{C\rightarrow}$(120,615 N).(10 m)-(196 N).(5 m) = 226,15 Nm ✓

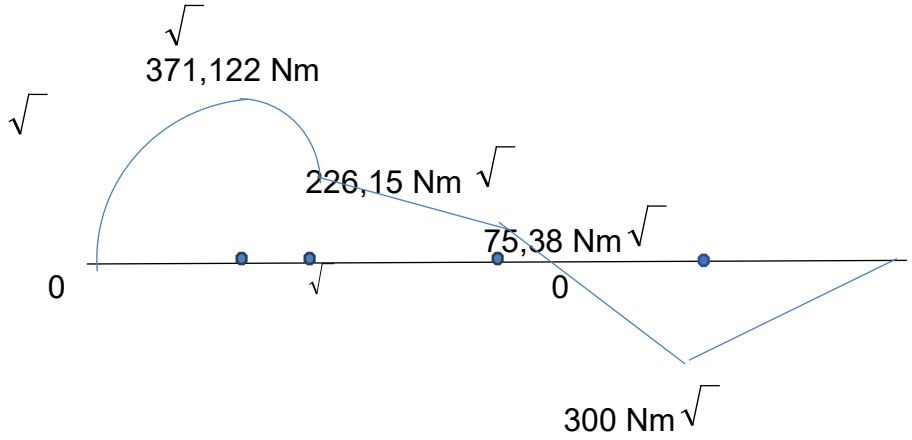
$BM_{D\rightarrow}$(120,615 N).(12 m)-(196 N).(7 m) = 75,38 Nm ✓
$BM_{B\rightarrow}$(120,615 N).(13 m)-(196 N).(8 m) – 300 N(1 m) =-300,005 Nm✓

$BM_{E\rightarrow}$(120,615 N).(15 m)-(196 N).(10 m)- (300 N).(3 m)-(130 N).(0 m) = 0

$$\sum f_s = 0$$
$$120{,}615\ N - (19{,}6\ N/m).x = 0$$
$$x = \frac{-120{,}615\ N}{-19{,}6\ N/m}$$
$$= 6{,}154\ m\ ✓$$

$BM_{F\rightarrow}$(120.615 N).(6.154 m) – (19,6 N).(6,154 m)(0,5)(2,333 m)
= 371,122 Nm ✓ (5)

5.1.4



(2)

5.2

Vorm	V (mm^3)	G (mm)	VG (mm^4)
Silinder A	$V_A = \frac{\pi D^2}{4} H$ $= \frac{\pi 50^2}{4} 20$ =39269,908√	$G = \frac{H}{2}$ $= \frac{20}{2}$ =10√	39269,908(10) =392699,08√
Silinder B	$V_B = \frac{\pi d^2}{4} h$ $= \frac{\pi 30^2}{4} 80$ =56548.668√	$G = H + \frac{h}{2}$ $= 20 + \frac{80}{2}$ =60√	56548.668(60) =3392920.066√
	$\sum v. = 39269.908 + 56548.668$ =95818,576√	$y = \frac{\sum v.G}{\sum V}$ =39.508 mm✓	$\sum v.G = 392699.08 + 3392920.066$ =3785619,146√

(4)
[15]

VRAAG 6: HiDROULIKA

6.1 D = 120 mm = 0,12 m D = 220 mm = 0,22 m

Sl = 380 mm
n = 80
m = 2,1 tons
$\eta = 94{,}6\%$

6.1.1 MA , f_h =311.4N

$\frac{W_R}{f_p} = \frac{D^2}{d^2}$ and $MA = \frac{f_p}{f_h} . \frac{100}{\eta}$

$W_R = 2{,}1 \times 10^3 kg\ (9{,}8\ m/s^2)$
$= 20580\ N$ ✓

$f_p = \frac{d^2 W_R}{D^2}$
$f_p = \frac{(0{,}12\ m)^2 20580 \cdots N}{(0.22\ m)^2}$ ✓
$= 6122.975 N$ ✓

(5)

$$MA = \frac{f_p}{f_h}.\frac{100}{\eta}$$
$$= \frac{6122{,}975\ N}{311{,}4\ N}.\frac{100}{94{,}6}\ \checkmark$$
$$= 20{,}785\ \checkmark$$

6.1.2 SL,

$$V_a = V_s.\frac{\eta.}{100}$$
$$= \frac{\pi.d^2.sl.n}{4}.\frac{\eta.}{100}$$
$$= \frac{\pi.(0{,}120\ m)^2.0380\ m.(80)}{4}.\frac{94{,}6}{100}\ \checkmark$$
$$= 0{,}496\ m^3\ \checkmark$$ (2)

6.2 C = 3
d = 280 mm
S_l= 390 mm
N = 333,33 r/min
Slip = 4,8%

V_a

$$Slip.\% = \frac{V_s - V_a}{V_s}.100$$
$$V_s = \frac{\pi.d^2 sl.n.C.}{4}.N.60$$
$$= \frac{\pi.(0.28\ m)^2.(0.39\ m).3.333.33.}{4.}.\frac{60}{h}$$
$$= 1440.8456\ m^3/h\ \checkmark$$
$$\therefore Slip.\% = \frac{V_s - V_a}{V_s}.100$$
$$4.8 = \frac{1440.8456\ m^3 - V_a}{1440.8456\ m^3}.100\ \checkmark$$
$$0.048(1440.8456\ m^3) = 1440.8456\ m^3 - V_a$$
$$V_a = 1.372\ kl/h\ \checkmark$$

Alternatief

$$\eta = 100 - Slip\%$$
$$= 95{,}2\%\ \surd$$
$$V_a = V_s.\frac{\eta}{100}$$
$$V_s = \frac{\pi.d^2 sl.n.C.}{4}.N.60$$

$$= \frac{\pi.(0.28m)^2.(0.39m).3.333.33.}{4.}.\frac{60}{h}$$
$$= 1440.8456\ m^3/h \checkmark$$

$$\therefore V_a = 1440.8456.(1000l).\frac{95.2}{100}\ \surd$$
$$V_a = 1.372\ kl/h \checkmark$$ (3)

6.3 D = 444 mm
= 0,444 m
P = 1200 000 Pa

6.3.1 Arbeid verrig

$$V = \frac{\pi.d^2}{4}h$$
$$= \frac{\pi(0{,}44\ m)^2}{4}18\ m\ \surd$$
$$= 11083{,}539\ m^3$$
$$W = P.V$$
$$= 1\,200\ Pa.(11083{,}539\ m^3)\ \surd$$
$$= 13300606.8J$$
$$= 13.301\ MJ \checkmark$$ (2)

6.3.2 P, t = 12 uur

$$P = \frac{W}{t}$$
$$= \frac{13300606\ J}{12(3600\ s)} \checkmark$$

$$= 307.884\ W \checkmark$$ (2)

[14]

VRAAG 7: SPANNING, VERVORMING EN YOUNG SE MODULUS VAN ELASTISITEIT

7.1 F = 300 kN
S = 120 mm
l = 0,95 m
E = 110 GPa

7.1.1 δ

$$\delta = \frac{F}{a}$$

$$= \frac{300000\ N}{(0{,}12\ m)^2} \checkmark$$

$$= 20833333.33Pa \checkmark$$

$$= 20{,}833\ MPa$$ (2)

7.1.2 Δl_{tot}

$$a = \frac{\pi}{4}(d^2)$$

$$\Delta l_{tot} = \frac{F.l}{A.E}$$

$$= \frac{300000N.(0{,}95\ m)}{(0{,}12\ m).(112\times10^9\ Pa)} \checkmark$$

$$= 1{,}799\times10^{-4}\ m \checkmark$$ (2)

7.2 d = 24,4 mm
E = 209 GPa
l_o = 31 m
m = 0,88 ton

Δl

$$F = m.g$$
$$= 880\ kg.(9{,}8\ m/s^2)$$
$$= 8624\ N$$
$$E = \frac{\delta}{\varepsilon}\ \varepsilon = \frac{\delta}{E}$$
$$\delta = \frac{F}{a}$$

$$= \frac{8624\ N}{\frac{\pi.(0.0244\ m)^2}{4}}\ ✓$$

$$= 18443324{,}77 Pa\ ✓$$

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

$$= \frac{18443324.77 N}{209\times10^9\ Pa}.\ ✓$$

$$= 8.824\times10^{-5}\ ✓$$
$$\varepsilon = \frac{\Delta l}{l}$$
$$\Delta l = \varepsilon.l$$
$$= 8{,}824\times10^{-5}.(31\ m)$$

$$= 0{,}274\times10^{-3}\ m\ ✓$$

(5)
[9]

VRAAG 8: HITTE

8.1

$V = 0{,}77\ m^3$
$\gamma = 17 \times 10^{-7} / K$
$\Delta T = 233K$
$\Delta V = V_o.\gamma.\Delta T$

$\Delta V = 0{,}77m^3.17 \times 10^{-3} / K.(233K)$

$= 0.00304997\ m^3$ ✓
$\Delta V = V_2 - V_o.$
$V_2 = \Delta V + V_o.$
$= 0{,}00304997\ m^3 + 0{,}77\ m^3$
$= 0{,}773\ m^3$ ✓

(3)

8.2 A

$V_A = 2\ m^3$
$t_A = 25^o C$
$P_A = 580kPa$
R=287J/kg.K

$m_B = 6\ kg$
$V_B = ?$
$t_A = 35^o C$
$P_B = 580kPa$

$t_{eqil} = 20\ ^oC$

8.2.1 $\sqrt{}$ $T_A = 298\ K$ $\sqrt{}$ $T_{equi} = 293\ K$ $\sqrt{}$ $T_B = 308\ K$ $\sqrt{}$

$V_B = ?$
$P_B V_B = m_B R T_B$
$V_B = \dfrac{m_B R T_B}{P_B}$
$= \dfrac{6\ kg(287\ J/kg.K).(308\ K)}{580000\ Pa}$ ✓
$= 0{,}914\ m^3$ ✓

(3)

8.2.2 $P_{equi} = ?$

$P_{equi}V_{equi} = m_{equi}RT_{equi}$

$V_{equi} = V_A + V_B$

$= 2\ m^3 + 0{,}914\ m^3$

$= 2{,}914\ m^3$ √

$P_AV_A = m_ART_A$

$m_A = \dfrac{P_AV_A}{RT_A}$

$= \dfrac{580000Pa(2\ m^3)}{(287\ J/kg.K).(298\ K)}$ ✓

$= 13{,}563\ kg$ √

$P_{equi} \Rightarrow \dfrac{m_{equi}RT_{equi}}{V_{equi}} = \dfrac{13{,}563(287).(293\ K)}{2{,}914}$ ✓

$P_{equi} = 391{,}395\ kPa$ ✓

(4)
[10]

TOTAAL: 100