higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N4

3 APRIL 2019

This marking guideline consists of 13 pages.

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DATE: 6 APRIL 2019

CONSESSION

1. Reduce marks for QUESTIONS 2.4 and 6.2 by 8 marks
2. The total 100 to be reduced by 8 marks to 92 for all candidates
3. Mark all candidates out of a total of 92 marks.
4. Convert the mark achieved out of 92 per candidate to percentage
5. Record the percentage achieved on the mark sheet

✓= 1 mark
√ = ½ mark

QUESTION 1

1.1 1.1.1 When pressure is exerted in an enclosed system it will be transmitted with the same intensity throughout in all directions.

1.1.2
- When you use the same force to push a truck and a car, the car will have more acceleration than the truck, because the car has less mass. OR
- It is easier to push an empty shopping cart than a full one, because the full shopping cart has more mass than the empty one, therefore more force is required to push the full shopping cart. OR
- Pushing a car with twice much force produce twice as much acceleration. OR.
- A vehicle of more weight will loose petrol when comparing with that of lesser weight both travelling at the same speed and same distance

(2 × 2) (4)

1.2 1.2.1 Deformation of a material due to internal stress (2)

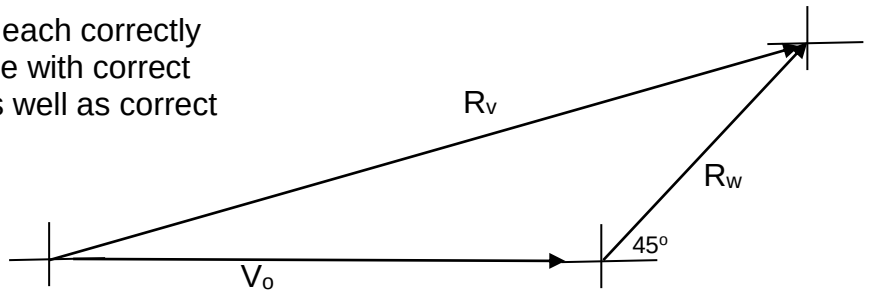
1.2.2 Sum of all forces to the left or right of a section on a beam. (1)

1.3
- Air or gas accumulator
- Spring accumulator
- Mass accumulator

(Any 2 × 1) (2)

1.4 Triangular velocity vector diagram.

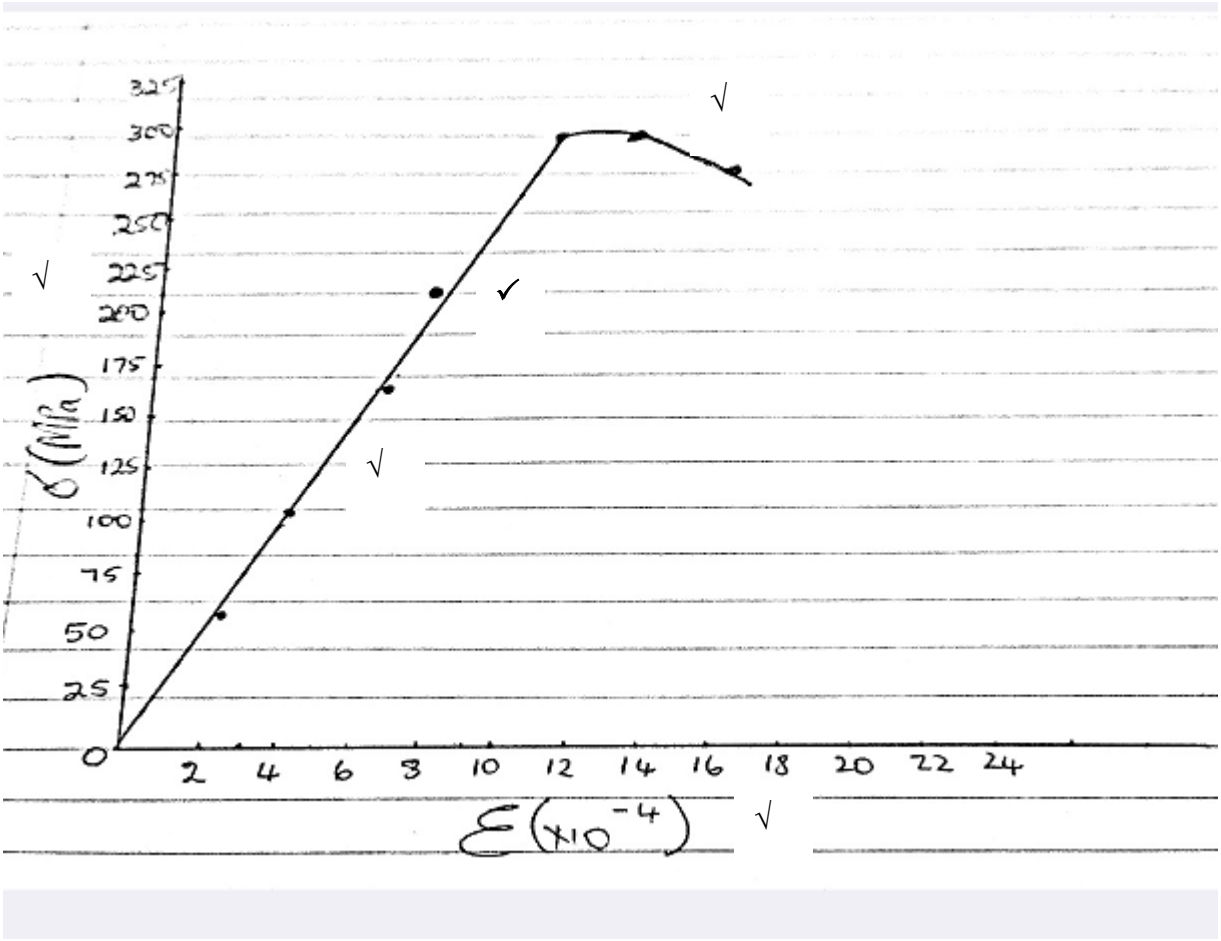
½ mark for each correctly labelled side with correct direction as well as correct angle



(2)

1.4

Stress-strain



(3)

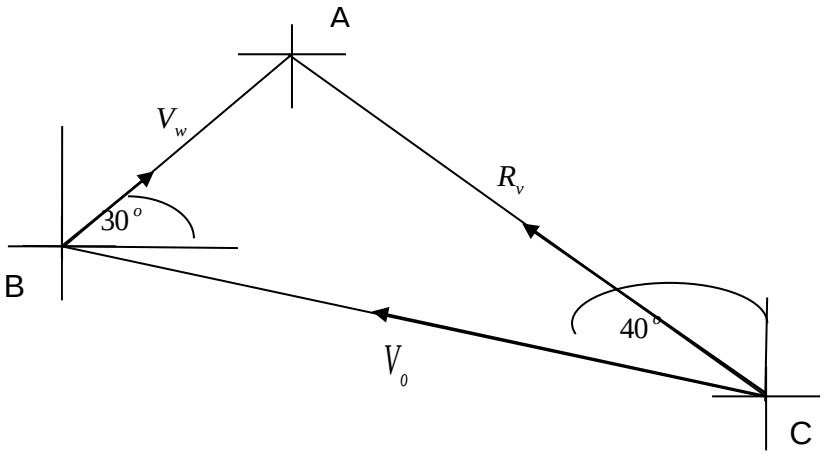
[14]

QUESTION 2

2.1 $V_o = 360\ km \rightleftarrows/\rightleftarrows h\ \ N40^oW$

$V_w = 120\ km \rightleftarrows/\rightleftarrows h\ \ W30^oS$

$R_v = ...$



$B = (30° + 50°)$

$= 80°$

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

$b = \sqrt{360^2 + 120^2 - 2(360)(120)Cos80}$ ✓

$= 359{,}161\ km \rightleftarrows/\rightleftarrows h$

$\frac{SinC}{C} = \frac{SinB}{b}$

$C = sin^{-1}(\frac{120,Sin80}{359{,}161})$ ✓

$= 19{,}210°$ ✓

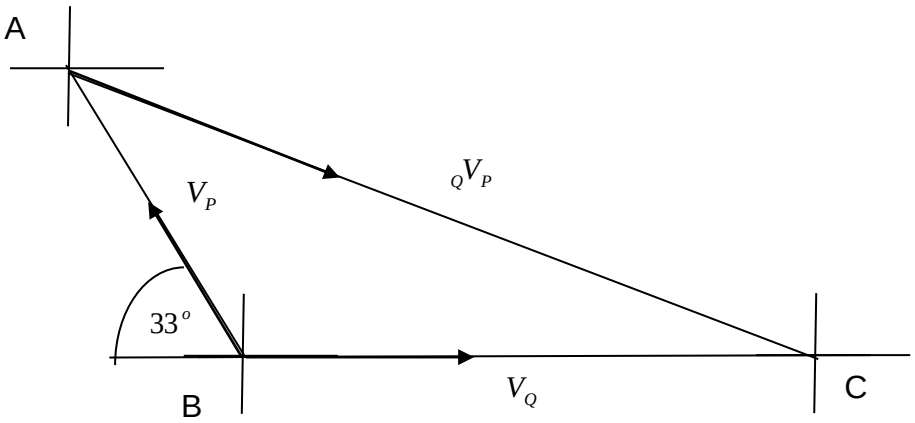
$\theta = 40° - 19{,}210°$

$= 20{,}79^0$

✓ ✓

$R_v = 359{,}161\ km \rightleftarrows\rightleftarrows/h\ N20{,}79°W$ OR W69,21ºN (5)

2.2 $V_P = 270\ km \rightleftarrows/\rightleftarrows h\ W33°N$
$V_Q = 220\ km \rightleftarrows\rightleftarrows /\rightleftarrows h$ E
${}_QV_P = ...$



$B = (57^o + 90^0)$
$= 147^0$

$b = \sqrt{a^2 + c^2 - 2acCosB}$
$b = \sqrt{220^2 + 270^2 - 2(220)(270)Cos147}$ ✓
$= 470{,}036\ km \rightleftarrows/\rightleftarrows h$
$\frac{SinA}{a} = \frac{SinB}{b}$
$a = sin^{-1}(\frac{220.Sin147}{470{,}03})$
$= 14.769^0$ ✓
✓ ✓
${}_QV_p = 470{,}036\ km \rightleftarrows/\rightleftarrows h \quad E18.231°S$ (4)

2.3 **DO NOT MARK**

[9]

QUESTION 3

3.1 3.1.1 B
3.1.2 C
(2 × 2) (4)

3.2 3.2.1 B (2)
3.2.2 C (2)
3.2.3 A (1)
[9]

QUESTION 4

$\theta = 28°$
$m = 1\ 200\ kg$
$S_{slope} = 15\ m$
$S_{horizontal} = 15\ m$

4.1 $E_{p(top)}$

$E_{p(top)} = mgh$
$= (1\ 200\ kg).(9{,}8m/\rightleftarrows s^2).15\ m.Sin28$ ✓
$= 82814{,}784\ J$ ✓

(2)

4.2 $E_{k(top)}$, 8m

$E_{p(7m)} = m.g.8m.Sin\theta$
$= 1\ 200\ kg(9{,}8\ m/\rightleftarrows s^2).7m.Sin28$
$= 38646{,}899\ J$ ✓

$E_{p(lost)} = E_{p(top)} - E_{p(8m)}$
$= 82814{,}784j - 38646{,}899\ J$
$= 44167{,}885J$✓

$\therefore\ E_{k(8m)} = E_{p(lost)}$
$= 44167{,}885J$✓

$$v = \sqrt{\frac{2(44167{,}885)}{1200}}$$

$= 8{,}58\ m/\rightleftarrows s$ ✓

(4)

4.3 a , v = o , 20 m

$E_{k(bot)} = 82814{,}784\ J$

$$v = \sqrt{\frac{2(82814{,}7840}{1200}}$$ ✓

$= 11.748\ m \rightleftarrows/\rightleftarrows s$ ✓

$v^2 = u^2 + 2a.S$

$$a = \frac{v^2 - u^2}{2.S}$$

$$= \frac{0^2 - (11.748\ m \rightleftarrows/\rightleftarrows s)^2}{2(20\ m)}$$

$= -3{,}450\ m \rightleftarrows/\rightleftarrows s^2$✓

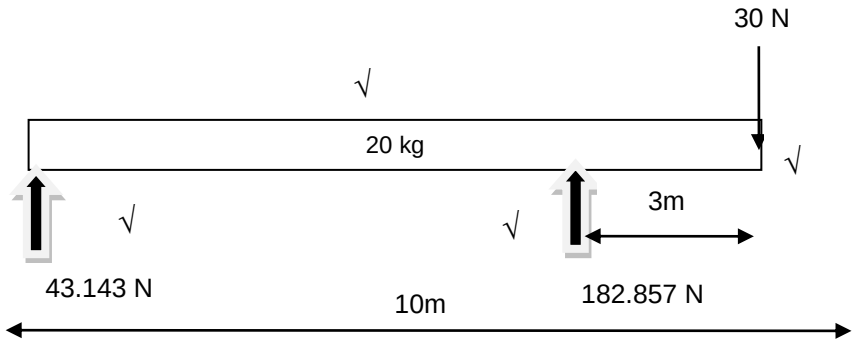
(3)

4.4 $E_{k(20m)} \Rightarrow \frac{1}{2}.1\ 200\ kg(0) = 0$✓ (1)

[10]

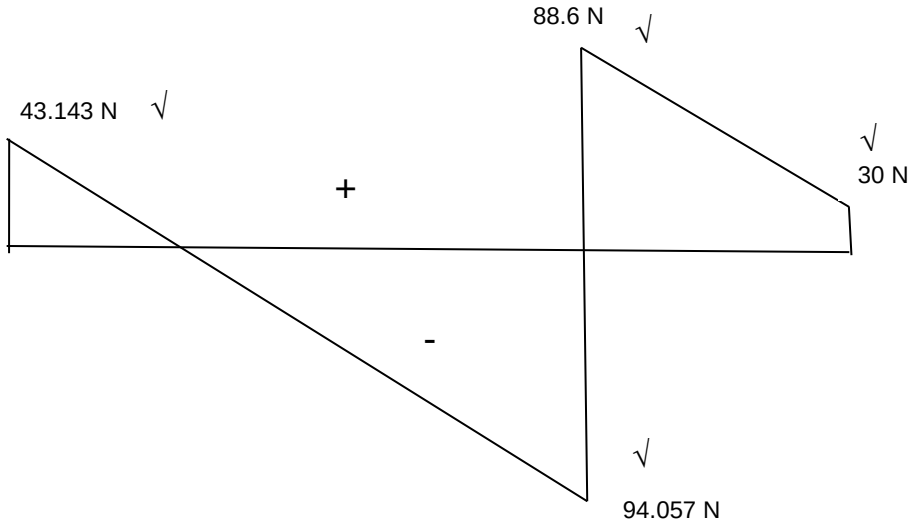
QUESTION 5

5.1 5.1.1



(2)

5.1.2



(2)

5.1.3 $\sum F_D = 0$

$\sum F_D \Rightarrow 43.143\,N - 19.6N/m = 0$

$x = \dfrac{-43.143\,N}{-19.6N/m}$

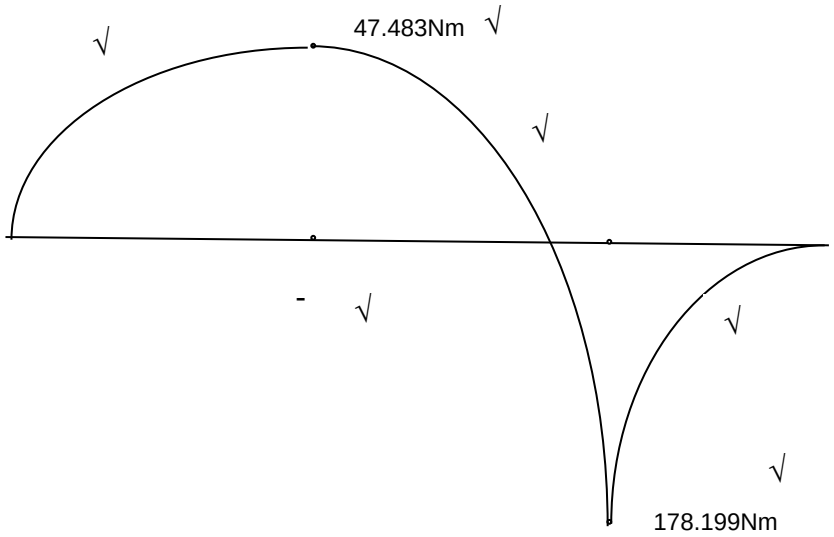
$= 2.201m$ ✓

$BM_E \Rightarrow 43{,}143\ N(2{,}201\ m) - 19.6\ N/m(2{,}201\ m)\frac{2.201}{2} = 47{,}483\ Nm$ ✓

$BM_D \Rightarrow 43{,}143\ N(7m) - 19{,}6\ N \rightleftarrows /m(7\ m)\frac{7}{2} = -178{,}199\ Nm$ ✓

(3)

5.1.4



(3)

5.2

Shape (m^3)	Volume	G	VG
	$= \frac{\pi d^2}{4} S_l$ $= \frac{\pi (100)^2}{4}.(80)$ $= 628318{,}857\sqrt{}$	$= \frac{h}{2}$ $= \frac{80}{2}$ $= 40\ \sqrt{}$	$= (628318{,}857)40$ $= 25132754{,}28\sqrt{}$
	$= \frac{\pi d^2}{4} S_l$ $= \frac{\pi (60)^2}{4}.(100)$ $= 282743{,}339\ \sqrt{}$	$= h_1 + \frac{h}{2}$ $= 80 + \frac{100}{2}$ $= 130\ \sqrt{}$	$= (282743.339),130$ $= 36756634\ ,07\ \sqrt{}$
	$\sum V = 628318{,}857 + 282743{,}339$ $= 911062{,}196\sqrt{}$		$\sum VG = 2513275{,}28 + 36756634{,}07$ $= 61889375{,}28\sqrt{}$
	$= \frac{\sum VG}{\sum V} = \frac{61889375}{911062{,}196}\sqrt{}$ $= 67{,}931\ mm\ \sqrt{}$		

(5)
[15]

QUESTION 6:

6.1 $f_{eff} = 310\ N$
$S_l = 120\ mm$
$d = \frac{1}{3}D$

$MA = 20$

6.1.1 W_R , $\eta = 93\%$

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

$f_p = \frac{f_h MA.\eta}{100}$
$= \frac{310\ N.(20).(93)}{100}$ ✓
$= 5766\ N$ ✓
$W_R = \frac{D^2.f_p}{d^2}$
$= \frac{(D)^2.(5766\ N)}{(\frac{1}{3}D)^2}$ ✓✓

$= 51894\ N$ ✓ (5)

6.1.2 n , $S_L = 480\ mm$ $\eta = 93\%$

$V_a = \frac{\pi.D^2}{4}.S_L$

$= \frac{\pi(0.36m)^2}{4}.(0{,}41\ m)$
$= 0.041732916\ m^3$ ✓
$V_S = V_a \frac{100}{\eta}$
$= 0.041732916\ m^3 \frac{100}{93}$
$= 0.044874104\ m^3$ ✓
$\therefore \frac{\pi.d^2.S_l.n}{4} = 0{,}044874104\ m^3$
$\therefore n = \frac{4(0{,}0448741042\ m^3}{\pi(0{,}12)^2(0{,}12)m^3}$

$\therefore n = \frac{0.029119692\ m^3}{0.001140398\ m^3}$
$= 33{,}065$ ✓

(3)

6.2 DO NOT MARK

6.3 $d = 210\ mm$
$sl = 480mm$
$N = 444r/min$
$Slip = 11{,}5\%$
$Vs = \frac{\pi d^2}{4} sl.n.c.\frac{N}{60}$
$Vs = \frac{\pi(0{,}21)^2}{4}(0{,}48).3.\frac{444}{60}$
$Vs = 0{,}369081844m^3$ ✓
$V_a = V_s.\frac{\eta}{100}$
$V_a = 0{,}369081844.\frac{88{,}5}{100}$ ✓

$= 0.326637432\,m^3/s$
$= 326{,}637\,l/s$ ✓

(3)
[11]

QUESTION 7

7.1 $S = 40\,mm$ $d_f = 30\,mm$
$l_o = 800\,mm$ $l_o = 520\,mm$
$E = 116\,GPa$
$\delta_{round} = 380\,MPa$

7.1.1 $\delta_{square} = \frac{F}{a}$
$F = \delta.a$
$= 380 \times 10^6\,Pa(\frac{\pi d^2}{4})$
$= 380 \times 10^6 Pa(\frac{\pi(0{,}3\ m)^2}{4})$ ✓
$= 268606{,}1719\ N$ ✓
Square

$\delta_{square} = \frac{268606{,}1719\ N}{(0{,}04\ m)^2}$

$= 167878750\ Pa$ ✓ (3)

7.1.2

$$\Delta l_{round} = \frac{F..l}{A.E}$$
$$= \frac{268606\ N.(0{,}52\ m)}{\frac{\pi(0{,}03\ m)^2}{4}.116\ \times\ 10^9}$$
$$= 1{,}70345\ \times\ 10^{-3} m \quad ✓$$

$$\Delta l_{square} = \frac{F..l}{A.E}$$
$$= \frac{268606\ N.(0{,}8\ m)}{(0{,}04\ m)^2)116 \times 10^9}$$
$$= 1.1578\ \times\ 10^{-3} m \quad ✓$$

$$\Delta l_{tot} = \Delta l_{square} + \Delta l_{round}$$
$$= 1{,}70345 \times 10^{-3} mm + 1{,}15778 \times 10^{-3} mm$$

$$= 2{,}862 \times 10^{-3} m \quad ✓ \qquad (3)$$

7.2 $d = 35\ mm$
$l_o = 650\ mm$
$F = 80\ kN$
$\Delta l = 0{,}311\ m$

7.2.1

$$\delta = \frac{F}{a}$$
$$= \frac{80\ 000\ N}{\frac{\pi(0{,}085\ m)^2}{4}} ✓$$
$$= 83150337{,}62\ Pa$$
$$= 83{,}150\ MPa \quad ✓$$

7.2.2

$$\varepsilon = \frac{\Delta l}{l}$$
$$= \frac{0.311\,mm}{650\,mm} \quad ✓$$
$$= 4.78461 \times 10^{-4} ✓$$

(2 × 2) (4)
[10]

QUESTION 8

8.1 $l = 3\ m$
$t = 25\ °C$
$\Delta t = 380\ K$
$l_2 = 3{,}024\ m$

8.1.1 Δl

$$\Delta l = l_o.\alpha.\Delta t$$

$$\alpha = \frac{\Delta l}{l_o.\Delta t}$$

$$= \frac{0{,}024\ m}{3m.(380\ ^oC)} \checkmark$$

$$= 21{,}05 \times 10^{-6}/^oC \checkmark$$ (2)

8.1.2 Aluminum

Or any metal close to $21{,}05 \times 10^{-6}/^oC$ (1)

8.2 $m_1 = 12\ kg$

$P_1 = 170\ kPa$ $P_2 = 310\ kPa$

$t_1 = 21\ ^oC$ $t_2 = 38\ ^oC$

$R = 287\ J \rightleftarrows / \rightleftarrows kgK$

$T_1 \Rightarrow 21\ ^oC + 273 = 294\ K$

$T_2 \Rightarrow 38\ ^oC + 273 = 308\ K$

$$P_1V_1 = m_1RT_1$$

$$V_1 \Rightarrow \frac{m_1.R_1.T_1}{P_1} = \frac{12\ kg \times (287\ J \rightleftarrows / \rightleftarrows kgK).(294\ K)}{(170 \times 10^3)} \surd$$

$$= 5{,}956\ m^3 \checkmark$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 \Rightarrow \frac{T_2P_1V_1}{T_1P_2} = \frac{170 \times 10^3\,(5{,}956\ m^3)308\ K}{294K.(310 \times 10^3\ Pa)} \surd$$

$$= 3{,}423\ m^3 \checkmark$$

Volume added= $V_1 - V_2$

$$= 5{,}956\ m^3 - 3{,}423\ m^3$$

$$= 2{,}535\ m^3 \checkmark$$

$$m_{added} \Rightarrow \frac{P_2.V_2}{R.T_2} = \frac{(310 \times 10^3 Pa).(2{,}535\ m^3)}{(287\ J \rightleftarrows / \rightleftarrows kgK).(308\ K)} \checkmark$$

$$= 8{,}890\ kg \checkmark$$

(6)

8.3 $V_1 = 0.208\ m^3$ $V_2 = ...$

$t_1 = 30\ ^oC$ $t_2 = 6\ ^oC$

$P = 185\ kPa$

8.3.1 V_2

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

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

$$= \frac{1850\ kPa.(275K).(0{,}208\ m^3)}{293\ K.(0{,}208\ m^3)} \checkmark$$

$$= 1736\ kPa \quad \checkmark$$

(2)

8.3.2 V_2

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

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

$$= \frac{1850\ kPa.(275K).(0{,}208\ m^3)}{293\ K.(0{,}089\ m^3)} \checkmark$$

$$= 4057{,}983 kPa \quad \checkmark$$

(3)
[14]

TOTAL: 92