Exo 1

$P = 40 N/cm^2$

. Etat initial

$V_i = 0{,}3 \, m^3$

$T_i = 20°C$

. Etat final

$T_f = 1500°C$

1) $\frac{PV}{T} = cte$

$$\frac{P_i V_i}{T_i} = \frac{P_f V_f}{T_f} \Leftrightarrow V_f = V_i \frac{T_f}{T_i} = 0{,}3 \frac{(1500+273{,}15)}{(273{,}15+20)}$$

$$\Leftrightarrow V_f = 0{,}3 \frac{1773{,}15 °K}{293{,}15 °K} \simeq 1{,}814 \, m^3$$

ou

$$V_f = 0{,}3 \frac{1773{,}15}{293{,}15} = 1{,}814 \Rightarrow \boxed{V_f = 1{,}82 \, m^3}$$

2) $dW = p\,dV$

$$W = p(V_2 - V_1) = 4 \cdot 10^5 (1{,}812 - 0{,}3) \simeq \boxed{604{,}00 \, KJ}$$

$$= 4 \cdot 10^5 (1{,}82 - 0{,}3)$$

$$= 4 \cdot 10^5 (1{,}82 - 0{,}3)$$

$$\boxed{W = 608{,}00 \, KJ}$$ fourni de l'energie

ou

$$W = 4 \cdot 10^5 (1{,}81491564 - 0{,}3) = \boxed{605{,}976 \, KJ}$$

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Exo 2

Etat 1

$T_i = 20°C$

$P_i = 15\, N/cm^2 = 15\, 10^4\, N/m^2$

$V_i = 0{,}8\, m^3$

Etat 2

$T_f = 20°C$

$V_f = 0{,}25\, m^3$

$$\frac{P_i V_i}{T_i} = \frac{P_f V_f}{T_f} \Longleftrightarrow P_f = \frac{P_i V_i}{V_f}$$

$$P_f = \frac{P_i V_i}{V_f} \Longrightarrow P_f = \frac{15 \cdot 10^4 \cdot 0{,}8}{0{,}25} = \boxed{48\, 10^4\, N/m^2}$$

$$\boxed{P_f = 48 \cdot 10^4\, N/m^2}$$

$P_f = 48\, N/cm^2$

$$\begin{cases} p \cdot v = RT \\ R = \dfrac{\bar{R}}{M} \\ m = M \cdot n \\ V = m v \\ x = \dfrac{\text{masse vap}}{\text{masse totale}} \end{cases}$$

$$\Leftrightarrow \quad pv = RT$$

$$PV = mRT$$

$$pv = \frac{\bar{R}}{M} \cdot T$$

$$pv = \frac{n}{m} \bar{R} \cdot T$$

$$\hookrightarrow \frac{1}{M} = \frac{n}{m}$$

$$m\, pv = n \bar{R} T$$

$$\boxed{PV = n \bar{R} T}$$

$$PV = nRMT$$

$$PV = \underbrace{nM}_{m} RT$$

$$Pmv = mRT$$

$$\boxed{Pv = RT}$$

$$pv = \frac{\bar{R}}{M} T$$

$$pv = n \frac{\bar{R}}{M} T$$

$$\boxed{PV = n \bar{R} T}$$

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Exo 3:

$$H = U + PV$$

$$h = u + pv$$

$$h = u + RT$$

$$dh = du + RdT$$

$$C_p \cancel{dT} = C_v \cancel{dT} + R \cancel{dT}$$

$$\boxed{C_p - C_v = R}$$

Exo 4:

$$\cancel{\delta Q}^{0} = \delta U + \delta W$$ Transformation adiabatique $\delta Q = 0$

$$\delta U = -\delta W$$

$$\delta W = p\,dV$$

$$du = C_v\,dT$$

$$dU = m\,C_v\,dT$$

$$\underbrace{m\,C_v\,dT}_{dU} = -\underbrace{P\,dV}_{\delta W} \iff dT = -\frac{P\,dV}{m\,C_v}$$

$$PV = n\bar{R}T.$$

$$d(PV) = d(n\bar{R}T)$$

$$V\,dP + P\,dV = n\bar{R}\,dT$$

$$\boxed{\frac{C_p}{C_v} = \gamma}$$

$$m = M \cdot n \Leftrightarrow M = \frac{m}{n} \Leftrightarrow \frac{1}{M} = \frac{n}{m}$$

$$R = \frac{\bar{R}}{M}$$

$$V dP + P dV = -\frac{n\bar{R}}{m} P \frac{dV}{C_v}$$

$$V dP + P dV = -\underbrace{\frac{\bar{R}}{M}}_{R} \frac{P dV}{C_v}$$

$$V dP + P dV = -R\, P \frac{dV}{C_v}$$

$$R = C_p - C_v$$

$$V dP + P dV = -(C_p - C_v) P \frac{dV}{C_v}$$

$$V dP + P dV = \frac{P dV\, C_v}{C_v} - \frac{C_p}{C_v} P dV$$

$$V dP + \cancel{P dV} = \cancel{P dV} - \gamma\, P dV \Leftrightarrow \frac{dP}{P} = -\gamma \frac{dV}{V}$$

$$\int \frac{dP}{P} = -\gamma \int \frac{dV}{V} \Leftrightarrow \ln P = -\ln V^{\gamma}$$

$$\Leftrightarrow \ln P + \ln V^{\gamma} = 0$$

$$\Leftrightarrow \ln (P \cdot V^{\gamma}) = 0$$

$$\Leftrightarrow \boxed{P V^{\gamma} = cte}$$ avec $\ln 1 = 0$

on bien $dU + dW = d\cancel{Q} = 0$

$$dU = -\underbrace{P dV}_{dW}$$

$$pv = RT$$

$$PV = n\bar{R}T$$

$$P = \frac{n\bar{R}T}{V}$$

$$\frac{n}{m}\bar{R} = \frac{\bar{R}}{M} = R$$

$$m C_v dT = -\underbrace{P}_{= \frac{n\bar{R}T}{V}} dV$$

$$C_v dT = -\frac{n}{m} \frac{\bar{R}T}{V} dV$$

$$C_v dT = -R T \frac{dV}{V}$$

$$\frac{C_v}{R} \frac{dT}{T} = -\frac{dV}{V} \Leftrightarrow \frac{C_v}{R} \int \frac{dT}{T} = -\int \frac{dV}{V}$$

$$\frac{C_v}{R}\ln\frac{T_2}{T_1}+\ln\frac{V_2}{V_1}=0$$

$$\ln\left[\left(\frac{T_2}{T_1}\right)^{\frac{C_v}{R}}\cdot\left(\frac{V_2}{V_1}\right)\right]=0 \iff \left(\frac{T_2}{T_1}\right)^{\frac{C_v}{R}}\frac{V_2}{V_1}=1$$

$$T_2^{C_v/R}\,V_2=T_1^{C_v/R}\,V_1 \qquad PV=RT$$

$$T_2\,V_2^{R/C_v}=T_1\,V_1^{R/C_v}$$

$$P_2\,V_2^{1+R/C_v}=P_1\,V_1^{1+R/C_v}$$

$$1+R/C_v=\gamma=\frac{C_p}{C_v}$$

$$\boxed{P_2\,V_2^{\gamma}=P_1\,V_1^{\gamma}=cte}$$

$$\gamma=1+\frac{R}{C_v}=\frac{C_v+R}{C_v}$$

$$R=C_p-C_v$$

$$\gamma=\frac{\cancel{C_v}+C_p-\cancel{C_v}}{C_v}$$

$$\boxed{\gamma=\frac{C_p}{C_v}}$$

$$\frac{C_p}{C_v}=\gamma$$

$$\underbrace{VdP+PdV}_{\delta''}=-n\frac{\bar{R}\,PdV}{m\,C_v}$$

$$m=Mn \Leftrightarrow M=\frac{m}{n} \Rightarrow \frac{1}{M}=\frac{n}{m}$$

$$R=\frac{\bar{R}}{M}$$

$$\underbrace{VdP+PdV}_{\delta''}=-\underbrace{\frac{\bar{R}}{M}}_{=R}\frac{PdV}{C_v}$$

$$\underbrace{VdP+PdV}_{\delta''}=-R\,\frac{PdV}{C_v}$$

on a $R=C_p-C_v$ (Exo3)

$$\underbrace{VdP+PdV}_{\delta''}=-\frac{(C_P-C_v)}{C_v}\,PdV$$

$$VdP+PdV=-\left(\frac{C_P}{C_v}-1\right)PdV$$

$$VdP+\cancel{PdV}+\frac{C_P}{C_v}PdV-\cancel{PdV}=0$$

$$VdP+\underbrace{\frac{C_P}{C_v}}_{\gamma}PdV=0 \Leftrightarrow VdP+\gamma\,PdV=0 \quad (*)$$

$$(*)/P.V \Leftrightarrow \frac{dP}{P}+\gamma\frac{dV}{V}=0 \Leftrightarrow \int\frac{dP}{P}+\gamma\int\frac{dV}{V}=0$$

$$\Leftrightarrow \ln P+\ln V^{\gamma}=cte$$

$$\Leftrightarrow \ln P.V^{\gamma}=cte$$

$$\boxed{PV^{\gamma}=cte}$$

$\ln 1=0$

e^0

c) $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Longleftrightarrow P_1 = \frac{P_2 V_2}{T_2} \cdot \frac{T_1}{V_1}$ | $V_1 = \frac{P_2 V_2}{T_2} \frac{T_1}{P_1}$

on a

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

$$P_1 \left(\frac{P_2 \cancel{V_2}}{T_2} \frac{T_1}{P_1} \right)^{\gamma} = P_2 \cancel{V_2^{\gamma}}$$

$$\frac{\cancel{P_2} V_2}{T_2} \frac{T_1}{V_1} V_1^{\gamma} = \cancel{P_2} V_2^{\gamma}$$

$$\frac{P_1}{P_1^{\gamma}} \cancel{V_2^{\gamma}} T_1^{\gamma} = \frac{P_2}{P_2^{\gamma}} T_2^{\gamma} \cdot \cancel{V_2^{\gamma}}$$

$$\boxed{T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}}$$

$$\boxed{P_1^{1-\gamma} T_1^{\gamma} = P_2^{1-\gamma} T_2^{\gamma}}$$

2) $dW = dU$ et $dU = m C_v dT$ $u = C_v dT$

$W = C_v dT$

$W = C_v (T_2 - T_1)$

$Cp - Cv = R$ (1)

(1)$/C_v \Longleftrightarrow \frac{Cp}{Cv} - 1 = \frac{R}{Cv}$ —— (2)

$\Longleftrightarrow \gamma - 1 = \frac{R}{Cv} \Longleftrightarrow Cv = \frac{R}{\gamma - 1}$

(3) dans (2)

$W = Cv (T_2 - T_1)$

$W = \frac{R}{\gamma-1} (T_2 - T_1)$

$$\begin{cases} PV = mRT \\ Pv = RT \\ PV = nRT \end{cases}$$

$T_2 = \frac{P_2 v_2}{R}$

$T_1 = \frac{P_1 v_1}{R}$

$\frac{V}{m} = v$

$W = \frac{R}{\gamma-1} \left(\frac{P_2 v_2}{R} - \frac{P_1 v_1}{R} \right) \Rightarrow \boxed{W = \frac{1}{\gamma-1} (P_2 v_2 - P_1 v_1)}$

$\boxed{\bar{W} = \frac{1}{\gamma-1} (P_2 V_2 - P_1 V_1)}$