Correction

Thermodynamics **MCQ Avril 25th 2023**

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⟵ Please enter you student number, and write your name above.

NAME, First Name :

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Duration : 30 minutes - No document allowed and all calculators authorised - No wifi no 4/5G

Q1 A closed system has ten moles of an ideal gas of molar specific heat capacities $\overline{C}_{V_m} = 20.8\,\mathrm{J/(mol\ K)}$ and $\overline{C}_{P_m} = 29.1\,\mathrm{J/(mol\ K)}$. It is compressed in an adiabatic and reversible way from an initial pressure $P_i = 7\,\mathrm{bar}$ to a final $P_f = 49\,\mathrm{bar}$. Knowing that the initial system volume is $V_i = 20\,\mathrm{L}$, give and demonstrate the literal expression of the final temperature T_f as function of the given data.

Reminder : $R = 8.314\,\mathrm{J/(mol\ K)}$, $1\,\mathrm{bar} = 10^5\mathrm{Pa}$, $0\,°\mathrm{C} = 273\,\mathrm{K}$.

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Q2 Give the numerical value of the final temperature T_f in K.

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Q3 For open systems in adiabatic steady state flow processes, we have :

☐ $\Delta_s\dot{H} + \Delta_s\dot{E}_k^M + \Delta_s\dot{E}_p^M = \dot{Q} + \dot{W}_s$
☐ $\dot{Q} = 0$
☐ $\Delta_s\dot{H} + \Delta_s\dot{E}_k^M + \Delta_s\dot{E}_p^M = \dot{Q} + \dot{W}_{pf} + \dot{W}_s$
☐ $\Delta_s\dot{U} = \dot{Q} + \dot{W}_s$
☐ $\dot{W}_{pf} = 0$

Q4 An ideal gas (closed system of n moles in a volume V with specific molar heat capacities $\overline{C}_{V_m}$ and $\overline{C}_{P_m}$) undergoes an isochoric process from P_i, T_i to P_f, T_f. We have :

☐ $Q = n\overline{C}_{V_m}\Delta_t T$
☐ $\Delta_t H = n\overline{C}_{V_m}\Delta_t T$
☐ $\Delta_t U = Q + W_{pf} + W_s$
☐ $\Delta_t U = n\overline{C}_{V_m}\Delta_t T$
☐ $W_{pf} = -P\Delta V$

Q5 A closed system with 0.86 kg of only liquid water at $T_i = 100\,°\mathrm{C}$ and $P_i = 1.0\,\mathrm{atm}$ is first heated isobarically to entirely vaporise the water and then isochorically compressed to $P_f = 7.8\,\mathrm{atm}$. Give and demonstrate the literal expression of the heat exchanged during the entire process. Reminder : water latent heat : $L_{vap_w} = 2256\,\mathrm{kJ/kg}$
Water mass specific heat capacities : $\overline{C}_{\mathrm{water}} = 4.184\,\mathrm{kJ/kg\ K}$, $\overline{C}_{V_{\mathrm{steam}}} = 1.405\,\mathrm{kJ/kg\ K}$, $\overline{C}_{P_{\mathrm{steam}}} = 1.867\,\mathrm{kJ/kg\ K}$
Data : $M_w = 18\,\mathrm{g/mol}$, $R = 8.314\,\mathrm{J/(mol\ K)}$, $1\,\mathrm{atm} = 101\,325\,\mathrm{Pa}$, $0\,°\mathrm{C} = 273\,\mathrm{K}$,

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Q6 Give the numerical value of Q in MJ.

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Q7 A turbine of a hydroelectric powerplant receives a constant flow rate ($\dot{V}_w = 34\,\mathrm{m^3/min}$) of liquid water from a dam (altitude $h_{in} = 1083\,\mathrm{m}$, pressure $P_{in} = 4.5\,\mathrm{atm}$) and gives out the same flow rate to the downward valley (altitude $h_{out} = 513\,\mathrm{m}$, pressure $P_{out} = 1.0\,\mathrm{atm}$). Assuming an adiabatic reversible process, give and demonstrate the literal equation of the turbine shaft work $\dot{W}_s$ as function of the given data.
The liquid water density is $\rho_w = 10^3\ \mathrm{kg/m^3}$, $g = 9.81\,\mathrm{m/s^2}$ and $1\,\mathrm{atm} = 101\,325\,\mathrm{Pa}$.

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Q8 Give the numerical value of the shaft work $\dot{W}_s$ in MW.

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