Topic 6.

CHEMICAL THERMODYNAMICS

Theoretical QUESTIONS for preparation:

1. The First Law of Thermodynamics
- A. A system, surroundings, work, heat
- B. The first law of thermodynamics
- C. Internal energy
- D. Endothermic and exothermic processes

2. Enthalpy
- A. Reaction enthalpy
- B. Hess' law and standard enthalpy of formation

3. The second law of thermodynamics and entropy

4. Free-energy changes

TASKS

1. Calculate ΔH^0_{rxn} for the following reaction:
   $2\ C_3H_6(g) + 9\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(l)$
   If $\Delta H^0(C_3H_{6(g)})$= 20.9 kJ/mol, $\Delta H^0\ (CO_{2(g)})$= -393.2 kJ/mol, $\Delta H^0(H_2O_{(l)})$= -286 kJ/mol.

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LIVEWORKSHEETS

CALCULATIONS:

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ANSWER: _____

2. Calculate ΔH^0 for **$2Al(s) + Cr_2O_3(s) \rightarrow Al_2O_3(s) + 2Cr(s)$.**
   If $\Delta H^0(Cr_2O_{3(s)})$= -1128 kJ/mol; $\Delta H^0(Al_2O_{3(s)})$ =-1676 kJ/mol.

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3. Given the following entropy values ($Al_2O_3(s)$ is 51.00 J/K*mol; Al(s) is 28.32 J/K*mol; $H_2O(g)$ is 188.7 J/K*mol; $H_2(g)$ is 130.6 J/K*mol), determine ΔS for the reaction:
$Al_2O_3(s) + 3H_2(g) \rightarrow 2Al(s) + 3H_2O(g)$

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LIVEWORKSHEETS

4. Reaction at 25C: **$6C(graphite) + 3H_2(g) \rightarrow C_6H_6(l)$.**

Entropy contents (S) (J/mol*K):

C(graphite) = 5.74

$H_2(gas)$ = 130.68

$C_6H_6(l)$= 172.8

Calculate entropy change.

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LIVEWORKSHEETS

5. Calculate $\Delta G°$ for the reactions of complete glucose oxidation ($\mathbf{C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O}$) under standard conditions if $\Delta G°$ for each reaction are given:

$\Delta G°(C_6H_{12}O_6)$=-910 kJ/mol

$\Delta G°(O_2)$=0 kJ/mol

$\Delta G°(CO_2)$=-394 kJ/mol

$\Delta G°(H_2O)$=-237 kJ/mol

Will the process run spontaneously?

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LIVEWORKSHEETS

6. Reaction has a $\Delta H = +5600$ calories. The entropy change is -4.6 calories /Kelvin at 298 Kelvin. Is this reaction spontaneous?

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ANSWER: _____

7. Calculate the free energy change for the complete combustion of one mole of methane, $CH_4(g)$, the main component of natural gas: **$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l)$.** Use the table below. Is this reaction spontaneous?

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Substance	°H, kJ/mol	°S, J/K*mol
CH_4 (g)	-74.86	186.19
O_2 (g)	0	205.03
CO_2 (g)	-393.5	213.7
H_2O (l)	-285.84	69.96

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LIVEWORKSHEETS