# AP Thermodynamics FR

1 (a) Entropy describes the number of positional probabilities of a system, the disorder of a system

(b) ① $Pb_{(s)}$ which has metallic bonding where the electrons are delocalized and free to move. Graphite is a more ordered covalent network solid

② $He_{(g)}$ at 0.05 atm because the volume would be larger and there would be more places for each atom to be

③ $CH_3CH_2OH$ is more complex and therefore there are more ways it can occupy its space

④ $Mg_{(s)}$ at 150°C has more kinetic energy so faster random motion. Each atom can move around to different places since each atom is moving faster

2 (a) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(\ell)}$

$C_2H_5OH_{(\ell)} + 3O_2 \rightarrow 2CO_2 + 3H_2O$

(b) Use Hess' law above ↑

$2C + 2O_2 \rightarrow 2CO_2$ $\quad \Delta H = 2(-393.5) = -787.0$

$2H_2 + O_2 \rightarrow 2H_2O$ $\quad \Delta H = 2(-285.8) = -571.6$

$2CO_2 + 3H_2O \rightarrow C_2H_5OH + 3O_2$ $\quad \Delta H = +1366.7\ kJ$

$2C + 2H_2 + H_2O \rightarrow C_2H_5OH$ $\quad$ [8.1 kJ]

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(c) $2C_{(s)} + 2H_{2(g)} + H_2O_{(l)} \rightarrow C_2H_5OH_{(l)}$

products − reactants

$(160.7) - [(2 \times 5.740) + (2 \times 130.6) + (69.91)]$

$(160.7) - (11.48) + (261.2) + (69.91)$

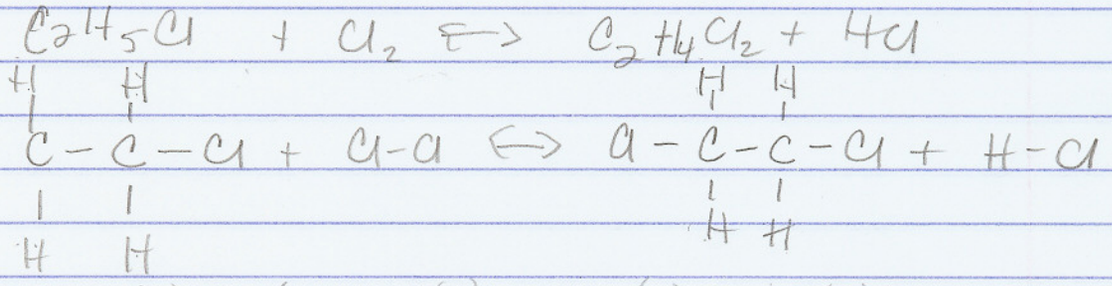
$160.7 - 342.59$

$\boxed{\Delta S = -181.89 \text{ KJ/mol}}$

3 Bond energies are the weirdos!!

(a)

$C_2H_5Cl + Cl_2 \rightleftarrows C_2H_4Cl_2 + HCl$



(1) C-C (5) C-H (1) C-Cl + (1) Cl-Cl − (1) C-C + (4) C-H + 2 C-Cl + (1) H-Cl

$[(347) + 5(414) + (377) + (243)] - [(347) + (4 \times 414) + (2 \times 377) + (431)]$

$3037 - 3188$

$\boxed{\Delta H = -151 \text{ KJ}}$

(b) $\Delta G = [(-80.3) + (-95.3)] - [(-60.5) + 0]$

$-175.6 - (-60.5) = -115.1 \text{ KJ} = \Delta G$

$\Delta G = \Delta H - \Delta ST$

$-115.1 = -151 - \Delta S(298)$

$35.9 = -\Delta S\, 298$

$\Delta S = \frac{-35.9}{298}$

$\boxed{\Delta S = .120 \text{ KJ/mol}}$

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(b) endothermic the process required or absorbed energy

(c) (i) $q = mc\Delta T$

$m$ = urea + water = 5.13g + 91.95g = 97.08g

$(97.08)(4.2\ J/g°C)(-3.2°)$

$= \boxed{1300\ J}$

(ii) molar enthalpy = $\frac{\Delta H \text{ or } q}{mol}$ $\frac{}{mol}$

# moles urea = $5.13\ g \times \frac{1\ mol\ urea}{60.0\ g} = .0855\ mol$

molar enthalpy = $\frac{1300\ J}{.0855\ mol} = \boxed{\frac{15\ kJ}{mol}}$