

# Entropy Questions

① Predict the feasibility of each of the following reactions at the stated temperature by calculating both  $\Delta S_{\text{surrounding}}$  and  $\Delta S_{\text{total}}$ .



$$\Delta S_{\text{sur}} = \frac{-49500}{350} = -141.4 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta S_{\text{total}} = -141.4 + -17.6 = -159 \text{ J K}^{-1} \text{ mol}^{-1}$$

(Remember  $49.5 \times 1000 \rightarrow \text{kJ mol}^{-1}$  into  $\text{J mol}^{-1}$ )

NOT  
FEASIBLE

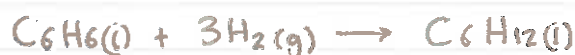


$$\Delta S_{\text{sur}} = \frac{-141000}{900} = -156.6 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta S_{\text{total}} = -156 + 230 = +73.3 \text{ J K}^{-1} \text{ mol}^{-1}$$

FEASIBLE

② Benzene can be hydrogenated to make cyclohexane:



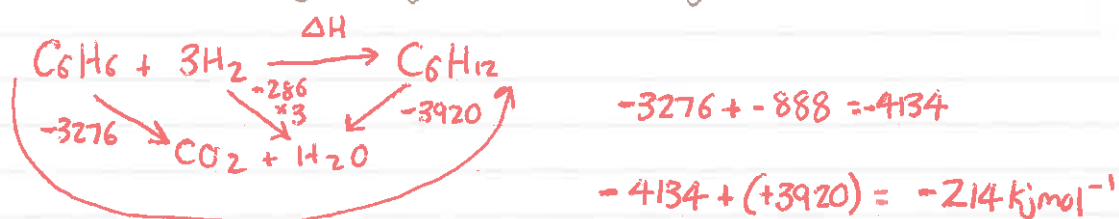
a) The enthalpy changes of combustion (in  $\text{kJ mol}^{-1}$ ) are:

$$\Delta H^\circ \text{C}_6\text{H}_6(\text{l}) = -3276$$

$$\text{H}_2(\text{g}) = -286$$

$$\text{C}_6\text{H}_{12}(\text{l}) = -3920$$

Calculate the enthalpy change for the hydrogenation of benzene.



b) Calculate  $\Delta S_{\text{surroundings}}$  if the reaction occurs at 330K.

$$\Delta S_{\text{sur}} = \frac{+214000}{330} = +648.48 \text{ J K}^{-1} \text{ mol}^{-1}$$

c) Calculate  $\Delta S_{\text{system}}$  from the standard entropy values (in  $\text{J K}^{-1} \text{ mol}^{-1}$ ):

$$S^\circ = \text{C}_6\text{H}_6(\text{l}) = 173$$

$$\text{C}_6\text{H}_{12}(\text{l}) = 204.4$$

$$\text{H}_2(\text{g}) = 130.6$$

$$\Delta S_{\text{system}} = 204.4 - (130.6 + 173) = 360.4 \text{ J K}^{-1} \text{ mol}^{-1}$$

d) Calculate  $\Delta S_{\text{total}}$  and comment on the feasibility of the reaction at 330K.

$$\Delta S_{\text{total}} = 648.48 + (-360.4)$$

$$\Delta S_{\text{total}} = +288.08 \text{ J K}^{-1} \text{ mol}^{-1}$$

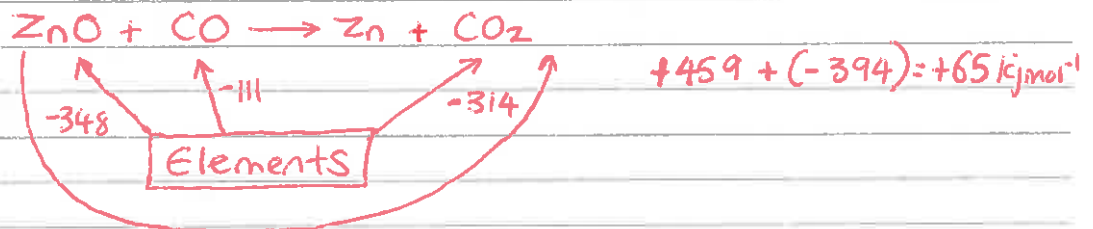
FEASIBLE

③ This is about the possible reduction of zinc oxide by carbon monoxide at 1000K.



$\Delta H_f^\circ$ (kJ mol <sup>-1</sup> )	$S^\circ$ J K <sup>-1</sup> mol <sup>-1</sup>
ZnO(s) -348	ZnO 43.6
CO(g) -111	CO(g) 197.6
Zn(s) 0	Zn(s) 41.6
CO <sub>2</sub> (g) -394	CO <sub>2</sub> (g) 213.6

a) Calculate the enthalpy change for the reaction.



b) Calculate  $\Delta S_{\text{system}}$ .

$$\Delta S_{\text{system}} = 255.2 - 241.2 = 14 \text{ J K}^{-1} \text{ mol}^{-1}$$

c) Calculate  $\Delta S_{\text{surroundings}}$  at 1000K.

$$\Delta S_{\text{surroundings}} = \frac{-65000}{1000} = -65 \text{ J K}^{-1} \text{ mol}^{-1}$$

d) Calculate  $\Delta S_{\text{total}}$  and comment on the feasibility of the reaction at 1000K.

$$\Delta S_{\text{total}} = -65 + 14 = -51 \text{ J K}^{-1} \text{ mol}^{-1}$$

NOT FEASIBLE @ 1000K

