Worksheet 4

January 26, 2022

Weekly homework assignments are posted approximately one week prior to the due date. Collaborations are encouraged and students must report all collaborators in writing on each assignment. All external sources (websites, books) must be properly cited. Additional problems are listed at the end of each assignment. This week's assignment is due *Tuesday, Feb 1st at 10:00am.*

Hess's Law

1. (4 pts) Calculate the reaction enthalpy for the formation of anhydrous aluminum bromide,

$$2\ \mathrm{Al(s)} + 3\ \mathrm{Br_2(l)} \rightarrow 2\ \mathrm{AlBr_3(s)},$$

from the following data:

$$2\ \mathrm{Al(s)} + 6\ \mathrm{HBr(aq)} \rightarrow 2\ \mathrm{AlBr_3(aq)} + 3\ \mathrm{H_2(g)}\ \Delta H^\circ = -1061\mathrm{kJ}$$
$$\mathrm{HBr(g)} \rightarrow \mathrm{HBr(aq)}\ \Delta H^\circ = -81.15\mathrm{kJ}$$
$$\mathrm{H_2(g)} + \mathrm{Br_2(l)} \rightarrow 2\ \mathrm{HBr(g)}\ \Delta H^\circ = -72.80\mathrm{kJ}$$
$$\mathrm{AlBr_3} \rightarrow \mathrm{AlBr_3(aq)}\ \Delta H^\circ = -368\mathrm{kJ}$$

Entropy

2. (2 pts) Calculate the change in entropy when the volume of 2.00 mol Ar(g) is increased from 5.00 L to 10.00 L while the temperature increases from 100. K to 300. K. Assume ideal behavior. Molar heat capacity at constant volume of Ar(g) is 12.47 J/(K mol). Report to 3 significant figures.

3. (4 pts) Consider the decomposition of NO_2 into nitric oxide and oxygen,

$$2\ NO_2(g) \rightarrow 2\ NO(g) + O_2(g).$$

Given the enthalpy of formation. Report all results to 4 significant figures.

Table 1: Standard enthalpy of formation (ΔH_f°) in kJ/mol

Molecule	ΔH_f°
$NO_2(g)$	33.18
$NO(g)$	90.29

(a) Calculate the enthalpy of reaction (ΔH_r) for the decomposition of $NO_2(g)$.

(b) The entropy of reaction (ΔS_r) is 146.4 J/(mol K), determine at what temperature is the reaction spontaneous.

Optional Additional Problems: Ch. 9 - odd problems 71 - 75, 93, 95; Ch. 18 - odd problems 27 - 41