

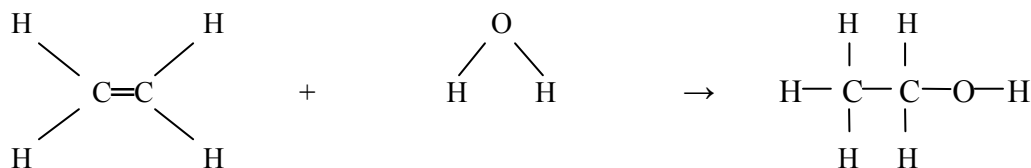
Exam IV – Chapters 8, 9

1. (10 pts) A 3.50 L container is filled with CO₂ gas at 45°C and 0.998 atm springs a leak. When the container is resealed, the pressure is 599 torr and the temperature is 13°C. How many moles of gas were lost?

0.017 mol Solve $PV=nRT$ for n_1 and $PV=nRT$ for n_2 . Then subtract the two n values.

2. (10 pts) One method for making ethanol, C₂H₅OH, involves the gas-phase hydration of ethylene, C₂H₄:

Estimate ΔH for this reaction from the given average bond dissociation energies, E_{BD} .



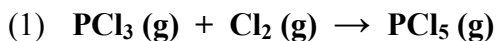
$\Delta H = E_{BD} \text{ reactants} - E_{BD} \text{ products} = -35 \text{ kJ/mol}$

Bond	E_{BD} kJ/mol
C=C	615
C-H	410
C-C	350
C-O	350
O-H	460
H-H	436

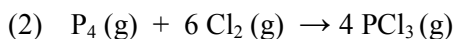
3. (10 pts) A 5.000 L steel bottle contains 50.22 g of noble gas at 125.0°C and 2.500 atm. What is the noble gas in the bottle?

solve $PV=nRT$ for n . Molar Mass = g/mol. $50.22 \text{ g} / \text{mol}$ from solving $PV=nRT = 131.29 \text{ g/mol} = \text{Xe}$

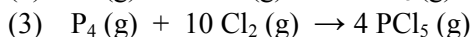
4. (8 pts) Phosphorous pentachloride is used in the industrial preparation of organic phosphorous compounds.



Use the equations (2) and (3) to calculate ΔH_{rxn} for equation (1).



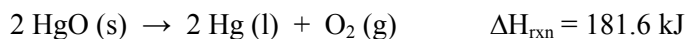
$\Delta H = -1280 \text{ kJ}$ (opposite sign)



$\Delta H = -1774 \text{ kJ}$

$\Delta H = -494 \text{ kJ} / 4 = -123 \text{ kJ}$

5. (10 pts) A mercury mirror forms inside a test tube by the thermal decomposition of mercury (II) oxide:

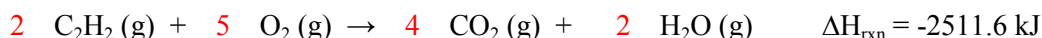


(a) Is the reaction exothermic or **endothermic**?

(b) How much heat is needed to decompose 555 g of HgO?

$$555 \text{ g (1 mol HgO / 216.59 g)}(181.6 \text{ kJ / 2 mol HgO)} = 233 \text{ kJ}$$

6. (8 pts) For the reaction

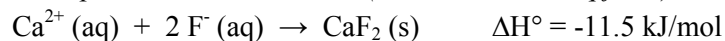


If the ΔH_f° value for $\text{CO}_2 = -393.5 \text{ kJ/mol}$ and ΔH_f° value for $\text{H}_2\text{O (g)} = -241.8 \text{ kJ/mol}$, what is the ΔH_f° value for $\text{C}_2\text{H}_2 \text{(g)}$?

$$\Delta H^\circ = \text{products} - \text{reactants}$$

$$\Delta H_f^\circ \text{ C}_2\text{H}_2 \text{(g)} = 227 \text{ kJ}$$

7. (10 pts) When 50.0 mL of 0.400 M $\text{Ca(NO}_3)_2$ is added to 50.0 mL of 0.800 M NaF, CaF_2 precipitates, as shown in the net ionic equation below. The initial temperature of both solutions is 25.00°C . Assuming that the reaction goes to completion, and that the resulting solution has a mass of 100.0 g and a specific heat of $4.18 \text{ J/(g}^\circ\text{C)}$, calculate the final temperature of the solution. (*Hint: Determine q first!*)



Work backwards. $\Delta H^\circ \times n = -11.5 \text{ kJ} \times 0.0200 \text{ mol}$

$$q = ms\Delta T \quad 230 \text{ J} = 100.0 \text{ g} \times 4.18 \text{ J/(g}^\circ\text{C)} \times \Delta T$$

$$\Delta T = T_{\text{final}} - T_{\text{initial}} = 25.55^\circ\text{C or } 26^\circ\text{C}$$

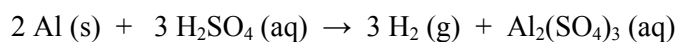
8. (8 pts) List the following gases in order of increasing speed at 400K: CO_2 , N_2O_4 , SF_6 , UF_6 .

slow UF₆, SF₆, N₂O₄, CO₂ fast

9. (8 pts) A closed container holds argon, O_2 and H_2 gases. The total pressure in the container is measured to be 787 torr. The container has 0.650 moles of Ar, 0.853 moles of O_2 and 0.294 moles of H_2 . Calculate the mole fraction and the partial pressure of argon gas in the container.

$$P_{\text{Ar}} = P_{\text{total}}X_{\text{Ar}} = 787 \text{ torr (0.650/1.797)} = 285 \text{ torr}$$

10. (10 pts) In the laboratory, hydrogen gas is produced by the following reaction:



How many liters of H_2 gas, collected over water at an atmosphere of 753 torr and a temperature of 21.0°C , can be made from 3.682 g of Al and excess H_2SO_4 ? The partial pressure of water vapor is 18.65 torr at 21.0°C .

$$3.682 \text{ g Al} \left(\frac{1 \text{ mol}}{26.98 \text{ g}} \right) \left(\frac{3 \text{ mol H}_2}{2 \text{ mol Al}} \right) = 0.2047 \text{ mol}$$

$$\text{Note: } P_{\text{H}_2} = P_{\text{total}} - P_{\text{H}_2\text{O}} = 0.966 \text{ atm} \quad V = (nRT)/P = 5.11 \text{ L}$$

11. (8 pts) A balloon containing argon gas, carbon dioxide gas, nitrogen gas, and dinitrogen oxide gas has a pinhole leak in it. Which gas will diffuse first from the leak?

$$\text{N}_2 = 28.02 \text{ g/mol}$$

Extra Credit: (15 pts total)

- a) (3 pts) Write a balanced equation for the reaction of potassium metal with water.
- b) (4 pts) Using the following data, calculate the ΔH° for the above reaction:
- ΔH°_f value for $\text{H}_2\text{O (l)} = -285.8 \text{ kJ/mol}$
 - ΔH°_f value for $\text{H}_2\text{O (g)} = -241.8 \text{ kJ/mol}$
 - ΔH°_f value for $\text{KOH (s)} = -424.8 \text{ kJ/mol}$
 - ΔH°_f value for $\text{KOH (aq)} = -482.4 \text{ kJ/mol}$
- c) (4 pts) If a 7.55 g piece of potassium metal was dropped into 400.0 g of water at 25°C , what is the final temperature of the water if all the heat released is used to warm the water and the specific heat of the solution is the same as water.
- d) (4 pts) What is the molarity of the potassium hydroxide solution prepared in part (c), and how many milliliters of 0.554 M H_2SO_4 are required to neutralize it?