Chemistry 150

Sample Exam 1 (Chapters 7 – 9)

Closed book; open notes, lab notebook, calculator, exercises; no collaboration. The exam is one hour long, and is worth 60 points.

1. A few years ago, the Russian army used a gaseous anasthetic called etorphine ($C_{25}H_{33}NO_4$; molar mass = 411.54) to neutralize a Chechen-led takeover of a Moscow theater, with lethal consequences. The **partial pressure** of etorphine at 25.°C is 3.26×10^{-12} torr. Assuming that the theater was at that temperature and had 760. torr of total pressure and a volume of 1.00×10^{9} L, and assuming etorphine is an ideal gas, how many molecules of etorphine caused such a terrible situation?

2. You react 0.102 g of magnesium strip with 25.666 g of 0.500 M hydrochloric acid. The density of the HCl solution is 1.020 g/mL. You quickly turn a beaker full of water upside down above the reacting magnesium. Given that the solution temperature was 22.4°C and the pressure was 765.0 torr, what is the **volume** of hydrogen gas that you expect to collect?

3. In a volcanic eruption, many gases are emitted from the vent. These gases are generally denser than air, and it has been found that the denser the gas is, the more toxic the gas is. The people living in Pompeii, for instance, probably died from inhaling these toxic gases leaking in through holes in the walls and roofs of their houses. Assume that the gases are all at the same temperature and exhibit ideal behavior. Use Graham's law of effusion

$$\frac{rate\ of\ effusion\ of\ gas\ 1}{rate\ of\ effusion\ of\ gas\ 2} = \sqrt{\frac{molar\ mass_2}{molar\ mass_1}}$$ to determine whether the **densest**

gases (and therefore most toxic) gases arrive **first** or **last** when a volcano erupts. For full credit, show how you used the equation. You do not need any numbers in your reasoning, though you may make some up if you wish.

4. Here is the summary of the class data for Lab 5, for the combustion of magnesium:

$\Delta H_{combustion}$ (experimental) = – 589 ± 41 kJ/mol (this is a 2-sigma range)

$\Delta H_{combustion}$ (theoretical) = – 602 kJ/mol

a. What is the **percent error** of the class mean off of the theoretical value?

b. Did the class as a whole suffer a **systematic** or a **random** error? Explain your choice.

c. Suppose, in your individual reaction, you had grayish residue left over in the magnesium reaction with hydrochloric acid, but no residue left over in the magnesium oxide reaction with hydrochloric acid. Would your $\Delta H_{combusiton}$ of magnesium have been **higher** than, **lower** than, or the same as the theoretical value of –602 kJ/mol? Assume you had no other errors. **Explain** your reasoning!

5. The reaction which creates nitrous acid is:

$HCl\ (g) + NaNO_2\ (s) \rightarrow HNO_2\ (l) + NaCl\ (s)$

Using the following thermochemical equations, calculate $\Delta H°_{rxn}$ for the above reaction. You may use some or all of these equations.

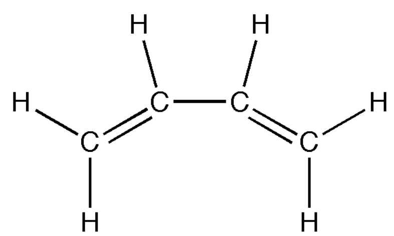
$2\ NaCl\ (s) + H_2O\ (l) \rightarrow Na_2O\ (s) + 2\ HCl\ (g)$ $\Delta H° = +\ 507.31$ kJ

$NO\ (g) + NO_2\ (g) + Na_2O\ (s) \rightarrow 2\ NaNO_2\ (s)$ $\Delta H° = -\ 427.14$ kJ

$NO\ (g) + NO_2\ (g) \rightarrow N_2O\ (g) + O_2\ (g)$ $\Delta H° = -\ 42.68$ kJ

$2\ HNO_2\ (l) \rightarrow N_2O\ (g) + O_2\ (g) + H_2O\ (l)$ $\Delta H° = +\ 34.35$ kJ

6. What is the **hybridization** at each carbon in 1,3-butadiene? The condensed structural formula is given below.



7. a. Given the **MO energy diagram** below, fill in the orbitals with electrons to show the *ground state* of the NO^- ion.

(imagine a diagram similar to the text's Figure 7.20 b (p. 283) here.

b. What is the **bond order** of NO^-?