Chapter 5 and Experiment 12M

1. A coffee-cup calorimeter is being used to investigate the heat of reaction for

   \[ \text{HCl (aq)} + \text{NaOH (aq)} \rightarrow \text{H}_2\text{O (l)} + \text{NaCl (aq)} \]

50.0 mL of 1.00 M HCl are placed in the cup, and the initial temperature is 22.3°C. When 50.0 mL of 1.00 M NaOH are poured into the cup and mixed, the temperature of the contents is 29.0°C.

(a) Is this reaction endothermic or exothermic?

(b) Calculate the \( q_{\text{water}} \) for the contents, assuming \( C = 4.18 \text{ J/g °C} \) and density = 1.00 g/mL.

(c) What is \( q_{\text{reaction}} \) for the amounts used in the reaction?

(d) Calculate the heat of reaction PER MOLE (\( \Delta H^\circ \)).

(e) What would be the final temperature if 100.0 mL of 1.00 M NaOH are added instead of 50.0 mL?

(f) What quantity is measured in a coffee-cup calorimeter, \( \Delta U \) or \( \Delta H \)?
2. Explosives

We studied the reaction of the explosive TNAZ, which explodes as follows:

\[ \text{C}_3\text{H}_4\text{N}_4\text{O}_6 (s) \rightarrow \text{CO}_2 (g) + 2 \text{CO} (g) + 2 \text{H}_2\text{O} (g) + 2 \text{N}_2 (g) \]

(a) Is TNAZ a **HIGH EXPLOSIVE** or a **LOW EXPLOSIVE**?

(b) How many single _____ and double _____ bonds are there in TNAZ?

(c) What is the **molecular geometry** around N in the NO₂ groups? ___________

(d) What is the **hybridization** of the N atoms in the NO₂ groups? _____ the C atoms? _____

(e) What is the approximate **bond angle** for the O-N-O bonds? _____ the C-C-N bonds? _____

(f) What is the **formal charge** on the atoms in the NO₂ groups? N ____ O= ____ O- _____

(g) Calculate the **heat of reaction** for the explosion using heats of formation. \( \Delta H^\circ \text{TNAZ} = +177 \text{ kJ/mol} \)

(h) Calculate the **heat of reaction** for the explosion using bond dissociation enthalpies (p. 329), and N=O +607 kJ/mol.
3. Lines at $\lambda = 486.2 \text{ nm}$ and $\lambda = 656.3 \text{ nm}$ appear in the emission spectrum of a H atom.

   (a) Which line has the higher frequency?

   (b) Calculate the energy of one photon, and of one mole of photons, for the 656.3 nm radiation.

   (c) For a Bohr atom, which transition involves emission of the HIGHEST amount of energy?

       $n = 1 \to n = 4$  $n = 5 \to n = 4$  $n = 5 \to n = 1$

   (d) How do the energies of the H emission lines compare with those of radio waves, X-rays, microwaves, infrared?

4. What is the maximum number of electrons which can be accommodated in the

    $n = 1$ level?  $n = 2$ level?  $n = 3$ level?

5. Which of the following are NOT possible quantum number sets?

    3, 2, 1, 0  3, 2, 2, $\frac{1}{2}$  3, 1, -1, $\frac{1}{2}$  3, 0, 1, - $\frac{1}{2}$
Chapter 7

6. Write ground-state electron configurations for the following species: Are they dia- or paramagnetic?

(a) Al
(b) Be
(c) Mn$^{2+}$
(d) S$^2^-$

7. Which of the following species has the SMALLER radius?
   (a) Cl$^-$ or Br$^-$
   (b) Ne or Na$^+$
   (c) C or F
   (d) C or Sn

8. Which of the following species has the LARGER first ionization energy?
   (a) He or Kr
   (b) B or F
   (c) Si or O

9. For the following molecules, give
   (i) the Lewis structure
   (ii) the electron-pair arrangement
   (iii) the molecular geometry
   (iv) polar molecule? (yes or no) Draw individual bond vectors in the molecule!
   (v) hybridization of the central atom
   (vi) formal charges on all atoms

<table>
<thead>
<tr>
<th>Lewis structure</th>
<th>electron-pair arrangement</th>
<th>molecular geometry</th>
<th>polar (Y/N)</th>
<th>hybridization of central atom</th>
<th>formal charges</th>
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<tbody>
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<td>BF$_4^-$</td>
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<td>SOCl$_2$</td>
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<td>I$_3^-$</td>
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