**APPENDIX: EXAMPLE STUDENT LEARNING OBJECTIVES**

This appendix provides examples of student learning objectives that are organized according to Marzano’s taxonomy. These learning objectives are a preliminary set that will be extended and revised to match the Pitt General Chemistry curriculum.

**Marzano’s Learning Taxonomy:**

1) *Retrieval* (perform a procedure, produce information on demand, determine if information is accurate, inaccurate or unknown)

2) *Comprehension* (construct symbolic representation of information, identify basic structure of information)

3) *Analysis* (Specifying, Generalizing, Error Analysis, Classify, Matching)

4) *Knowledge Utilization* (Investigate, Experiment, Problem Solve, Decision Making)

**1.2 Compounds**

1)   Identify whether a compound is ionic or molecular based on the type of elements that make up their composition

Give an example of two elements that could form an ionic compound and two elements that would not.

2)    Draw an appropriate microscopic representation depicting both the chemical composition and phase (solid, liquid, gas)

Draw an appropriate molecular-level (microscopic) representation depicting each of the following.

1. CoO(*s*)
2. CO(*s*)

3)    Specify the name and symbolic notation representing an ionic or molecular binary compound using an appropriate microscopic or symbolic model

For each of the following identify either the correct name or the correct formula based on the information given:

a) V2O5

b) Cl2O4

c) calcium nitrate

4) Decide what type of microscopic composition should be selected based on a desired observation or application of the material.

You are given a set of three unique **binary** compounds each of which contains exactly a total of 4 atoms per unit. Within this set, you determine that exactly two of the three compounds contain chlorine, only one contains sodium, and only one is molecular. Propose a possible formula for each of the three different compounds comprising this set.

**2.2 Bond Energy**

1)   Define what is meant by enthalpy of atom combination and the terms exothermic and endothermic in terms bond making or breaking processes

for (aq). Define what this quantity represents.

2)   Draw a reaction energy diagram based on energies of atom combination data and describe how it relates overall energy of reaction

Below is an example energy diagram for a chemical reaction. What specific factors on a molecular level affect the quantities represented by the arrows in the diagram? Is the overall reaction endothermic or exothermic?

3)   Analyze and compare individual molecular bond energies and overall reaction energies based on bond order, bond length or enthalpies atom combination

Iodine reacts with the halogens to form a wide variety of compounds. Two reactions are shown below.

I2 (*g*) + Cl2 (*g*) → 2 ICl (*g*)

I2 (*g*) + Br2 (*g*) → 2 IBr (*g*)

a) Which do you expect to have a stronger bond Cl2 or Br2? Explain.

b) Explain why the overall change in enthalpy of reaction for both reactions is approximately the same magnitude.

4)   Select the best compound for a reaction based on an assessment of the amount of energy absorbed or released.

The N-N bond lengths in the following compounds are N2, 110 pm; HNNH, 125 pm; and H2NNH2, 146 pm. Which molecule would you select if you needed a source of N atoms using the least amount of energy. Explain.