**APPENDIX: EXAMPLE ASSESSMENTS ALIGNED TO LEARNING OBJECTIVES**

This appendix provides examples of student assessment questions that are organized according to Marzano’s taxonomy and the preliminary learning objectives for the course.

**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)   *Retrieval Level*

**Learning Objective:** Identify whether a compound is ionic or molecular based on the type of elements that make up their composition

**Assessment question:** Give an example of two elements that could form an ionic compound and two elements that would not.

2)    *Comprehension Level*

**Learning Objective:** Draw an appropriate microscopic representation depicting both the chemical composition and phase (solid, liquid, gas)

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

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

3)    *Analysis Level*

**Learning Objective:** Specify the name and symbolic notation representing an ionic or molecular binary compound using an appropriate microscopic or symbolic model

**Assessment question:** 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) *Knowledge Utilization Level*

**Learning Objective:** Decide what type of microscopic composition should be selected based on a desired observation or application of the material.

**Assessment question:** 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)   *Retrieval Level*

**Learning Objective:** Define what is meant by enthalpy of atom combination and the terms exothermic and endothermic in terms bond making or breaking processes

**Assessment question:** for (aq). Define what this quantity represents.

2)   *Comprehension Level*

**Learning Objective:** Draw a reaction energy diagram based on energies of atom combination data and describe how it relates overall energy of reaction

**Assessment question:** 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)   *Analysis Level*

**Learning Objective:** Analyze and compare individual molecular bond energies and overall reaction energies based on bond order, bond length or enthalpies atom combination

**Assessment question:** 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)   *Knowledge Utilization Level*

**Learning Objective:** Select the best compound for a reaction based on an assessment of the amount of energy absorbed or released.

**Assessment question:** 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.