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.

(a) CoO(*s*)
(b) 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) V_2O_5
b) Cl_2O_4
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*

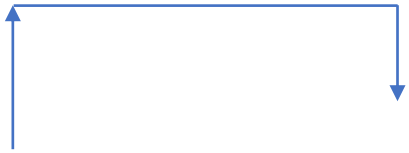
Learning Objective: Define what is meant by enthalpy of atom combination and the terms exothermic and endothermic in terms bond making or breaking processes

Assessment question: $\Delta H^\circ_{ac} = -2184.76$ kJ/mol for SO_4^{2-} (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.

$$I_2\,(g) + Cl_2\,(g) \rightarrow 2\,ICl\,(g)$$
$$I_2\,(g) + Br_2\,(g) \rightarrow 2\,IBr\,(g)$$

a) Which do you expect to have a stronger bond Cl_2 or Br_2? 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 N_2, 110 pm; HNNH, 125 pm; and H_2NNH_2, 146 pm. Which molecule would you select if you needed a source of N atoms using the least amount of energy. Explain.