

**2006 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS**

8. Suppose that a stable element with atomic number 119, symbol Q, has been discovered.
- (a) Write the ground-state electron configuration for Q, showing only the valence-shell electrons.
  - (b) Would Q be a metal or a nonmetal? Explain in terms of electron configuration.
  - (c) On the basis of periodic trends, would Q have the largest atomic radius in its group or would it have the smallest? Explain in terms of electronic structure.
  - (d) What would be the most likely charge of the Q ion in stable ionic compounds?
  - (e) Write a balanced equation that would represent the reaction of Q with water.
  - (f) Assume that Q reacts to form a carbonate compound.
    - (i) Write the formula for the compound formed between Q and the carbonate ion,  $\text{CO}_3^{2-}$ .
    - (ii) Predict whether or not the compound would be soluble in water. Explain your reasoning.

**STOP**

**END OF EXAM**

**2006 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS (Form B)**

Answer EITHER Question 7 OR Question 8 below. Only one of these two questions will be graded. If you start both questions, be sure to cross out the question you do not want graded. The Section II score weighting for the question you choose is 15 percent.

7. Account for each of the following observations in terms of atomic theory and/or quantum theory.
- (a) Atomic size decreases from Na to Cl in the periodic table.
  - (b) Boron commonly forms molecules of the type  $BX_3$ . These molecules have a trigonal planar structure.
  - (c) The first ionization energy of K is less than that of Na.
  - (d) Each element displays a unique gas-phase emission spectrum.
8. Use chemical and physical principles to account for each of the following.
- (a) An aluminum container filled with an aqueous solution of  $CuSO_4$  eventually developed a leak. Include a chemical equation with your answer.
  - (b) The inside of a metal container was cleaned with steam and immediately sealed. Later, the container imploded.
  - (c) Skin feels cooler after rubbing alcohol has been applied to it.
  - (d) The redness and itching of the skin caused by ant bites (injections of methanoic acid,  $HCO_2H$ ) can be relieved by applying a paste made from water and baking soda (solid sodium hydrogen carbonate). Include a chemical equation with your answer.

**STOP**

**END OF EXAM**

2007 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS (Form B)

	First Ionization Energy (kJ mol <sup>-1</sup> )	Second Ionization Energy (kJ mol <sup>-1</sup> )	Third Ionization Energy (kJ mol <sup>-1</sup> )
Element 1	1,251	2,300	3,820
Element 2	496	4,560	6,910
Element 3	738	1,450	7,730
Element 4	1,000	2,250	3,360

6. The table above shows the first three ionization energies for atoms of four elements from the third period of the periodic table. The elements are numbered randomly. Use the information in the table to answer the following questions.
- Which element is most metallic in character? Explain your reasoning.
  - Identify element 3. Explain your reasoning.
  - Write the complete electron configuration for an atom of element 3.
  - What is the expected oxidation state for the most common ion of element 2 ?
  - What is the chemical symbol for element 2 ?
  - A neutral atom of which of the four elements has the smallest radius?

STOP

END OF EXAM

2009 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS

6. Answer the following questions related to sulfur and one of its compounds.
- (a) Consider the two chemical species S and S<sup>2-</sup>.
- Write the electron configuration (e.g., 1s<sup>2</sup>2s<sup>2</sup> . . .) of each species.
  - Explain why the radius of the S<sup>2-</sup> ion is larger than the radius of the S atom.
  - Which of the two species would be attracted into a magnetic field? Explain.
- (b) The S<sup>2-</sup> ion is isoelectronic with the Ar atom. From which species, S<sup>2-</sup> or Ar, is it easier to remove an electron? Explain.
- (c) In the H<sub>2</sub>S molecule, the H–S–H bond angle is close to 90°. On the basis of this information, which atomic orbitals of the S atom are involved in bonding with the H atoms?
- (d) Two types of intermolecular forces present in liquid H<sub>2</sub>S are London (dispersion) forces and dipole-dipole forces.
- Compare the strength of the London (dispersion) forces in liquid H<sub>2</sub>S to the strength of the London (dispersion) forces in liquid H<sub>2</sub>O. Explain.
  - Compare the strength of the dipole-dipole forces in liquid H<sub>2</sub>S to the strength of the dipole-dipole forces in liquid H<sub>2</sub>O. Explain.

**STOP**

**END OF EXAM**