**Question 8**

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.

| | |
|---|---|
| $8s^1$ | One point is earned for the electron configuration. |

(b) Would Q be a metal or a nonmetal? Explain in terms of electron configuration.

| | |
|---|---|
| It would be a metal (**OR** an alkali metal). The valence electron would be held only loosely. | One point is earned for the correct answer and explanation, which must include reference to the valence electron. |

(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.

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|---|---|
| It would have the largest atomic radius in its group because its valence electron is in a higher principal shell. | One point is earned for the correct answer and explanation; the size must refer to number of electron shells. |

(d) What would be the most likely charge of the Q ion in stable ionic compounds?

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|---|---|
| + 1 | One point is earned for the correct charge. (Must be consistent with configuration in part (a).) |

(e) Write a balanced equation that would represent the reaction of Q with water.

| | |
|---|---|
| $2\ Q(s) + 2\ H_2O(l) \rightarrow 2\ Q^+(aq) + 2\ OH^-(aq) + H_2(g)$ | One point is earned for $H_2$ as a product.<br>One point is earned for balancing the equation. |

(f) Assume that Q reacts to form a carbonate compound.

(i) Write the formula for the compound formed between Q and the carbonate ion, $CO_3^{2-}$.

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|---|---|
| $Q_2CO_3$ | One point is earned for the formula consistent with the charge given in part (d). |

(ii) Predict whether or not the compound would be soluble in water. Explain your reasoning.

| | |
|---|---|
| It would be soluble in water because all alkali metal carbonates are soluble. | One point is earned for the answer consistent with the identification of Q. |

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(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.

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(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, $CO_3^{2-}$.

(ii) Predict whether or not the compound would be soluble in water. Explain your reasoning.

a) $8s^1$

b) Q is a metal because Group 1 elements are alkaline metals. Q has one lone electron and will exhibit metallic bonding (metal cations and a sea of delocalized electrons) because that gives the element a much more stable electron configuration (a full octet).

c) Q has the largest radius because it is in period 8 (with $n=8$). As n shell level increases, there are more levels of electrons to shield the outer electrons. Thus the size of the atom will be large.

d) Q will have a 1+ charge.

e) $2Q_{(s)} + 2H_2O_{(l)} \rightarrow 2Q^+_{(aq)} + 2OH^-_{(aq)} + H_{2(g)}$

f) i) $Q_2CO_3$

ii) The compound will be soluble. All group 1 metals tend to be soluble. Their tendency to lose an electron makes ionization easy. As an ionic compond, the ionic attractions will be weaker than, for example, $Na_2CO_3$, because Q is a larger atom. With ionic compounds, larger atoms, ad increased distance from nuclei, mean weaker ion-ion interaction. In solution the $Q^+$ ad $CO_3^{2-}$ will more easily break off due to ion-dipole interactions between water and the separate ions.

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, $CO_3^{2-}$.

(ii) Predict whether or not the compound would be soluble in water. Explain your reasoning.

(a) $8s^1$

(b) It would be a metal because it would have a strong tendency to lose its valence electron

(c) It would have the largest because atomic radii go up as you move down each column and Q would be at the very bottom of its group.

(d) $Q^+$

(e) $H_2O + Q \rightarrow Q^+ + OH^- + H_2$

(f) i) $Q_2CO_3$

ii) It would be soluble in water because every other alkali metal is soluble with a carbonate in an ionic compound, and Q is in group 1.

GO ON TO THE NEXT PAGE.

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8. Suppose that a stable element with atomic number 119, symbol Q, has been discovered.

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(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, $CO_3^{2-}$.

(ii) Predict whether or not the compound would be soluble in water. Explain your reasoning.

a) $8s^1$ $[Rn]\,8s^1$

b) Q would be a metal because

c) largest because Q would have the most energy levels which would add extra volume to the atom. As you go down a group the atomic radius increases.

d) It would be a plus one.

e) $Q + H_2O \rightarrow QHO$

GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 8.

f) (i) $Q_7 CO_3 \rightarrow Q CO_3$

(iii) it would not be soluble because most oxates are not soluble in water.

# AP® CHEMISTRY
# 2006 SCORING COMMENTARY

## Question 8

### Overview

The intent of this question was to test students on their ability to make predictions about the chemistry of a hypothetical element with atomic number 119. Students were asked to write the ground-state electron configuration of the valence shell; predict and explain in terms of electron configuration whether Q would be a metal or a nonmetal; state and explain in terms of electronic structure whether Q would have the largest or smallest atomic radius in its group; give the most likely charge of the Q ion; write a balanced equation for the reaction of Q with water; write the formula for the compound formed between Q and the carbonate ion; and predict and explain whether the compound would be soluble in water.

**Sample: 8A**
**Score: 8**

This response earned all 8 points: 1 point for part (a), 1 point for part (b), 1 point for part (c), 1 point for part (d), 2 points for part (e), 1 point for part (f)(i), and 1 point for part (f)(ii). The point was earned in part (b) despite the reference to "alkaline" metals because the response correctly indicated group 1. Further, the student gives an excellent description of metallic bonding. The point was earned in part (f)(ii) despite the reference to the solubility of group 1 "metals" because the excellent description of weak ion-ion interactions makes it clear that the student is describing the solubility of the compound.

**Sample: 8B**
**Score: 6**

The point was not earned in part (c) because the student gives a correct conclusion but bases the answer on periodic trends rather than electronic structure. Only 1 point was earned in part (e) because the equation is not balanced.

**Sample: 8C**
**Score: 3**

The point was not earned in part (b) because there is no explanation. In part (e) the points were not earned because $H_2$ is not given as a product and the equation is not balanced. The point was not earned in part (f)(i) because the formula given is not consistent with the ionic charge specified in part (d). The point was not earned in part (f)(ii) because the explanation is not consistent with the behavior of an alkali metal carbonate.