# AP® CHEMISTRY
# 2007 SCORING GUIDELINES (Form B)

## Question 2

Answer the following problems about gases.

(a) The average atomic mass of naturally occurring neon is 20.18 amu. There are two common isotopes of naturally occurring neon as indicated in the table below.

| Isotope | Mass (amu) |
|---|---|
| Ne-20 | 19.99 |
| Ne-22 | 21.99 |

(i) Using the information above, calculate the percent abundance of each isotope.

| | |
|---|---|
| Let $x$ represent the natural abundance of Ne-20.<br>$19.99x + 21.99(1-x) = 20.18$<br>$19.99x + 21.99 - 21.99x = 20.18$<br>$19.99x - 21.99x = 20.18 - 21.99$<br>$-2x = -1.81$<br>$x = 0.905$<br>$\Rightarrow$ percent abundances are: Ne-20 = 90.5%<br>Ne-22 = 9.5% | One point is earned for the correct answer. |

(ii) Calculate the number of Ne-22 atoms in a 12.55 g sample of naturally occurring neon.

| | |
|---|---|
| $12.55 \text{ g Ne} \times \frac{1 \text{ mol Ne}}{20.18 \text{ g Ne}} \times \frac{0.095 \text{ mol Ne-22}}{1 \text{ mol Ne}} \times \frac{6.022 \times 10^{23} \text{ Ne-22 atoms}}{1 \text{ mol Ne-22}}$<br>$= 3.6 \times 10^{22}$ Ne-22 atoms | One point is earned for the correct molar mass.<br>One point is earned for the correct fraction of Ne-22 in Ne.<br>One point is earned for the number of atoms. |

## Question 2 (continued)

(b) A major line in the emission spectrum of neon corresponds to a frequency of $4.34 \times 10^{-14}\ s^{-1}$. Calculate the wavelength, in nanometers, of light that corresponds to this line.

| | |
|---|---|
| $c = \lambda\nu \quad \Rightarrow \quad \lambda = \frac{c}{\nu}$<br>$\lambda = \frac{3.0\times10^{8}\ m\,s^{-1}}{4.34\times10^{14}\ s^{-1}} \times \frac{1\ nm}{10^{-9}\ m} = 690\ nm$ | One point is earned for the correct setup.<br>One point is earned for the answer. |

(c) In the upper atmosphere, ozone molecules decompose as they absorb ultraviolet (UV) radiation, as shown by the equation below. Ozone serves to block harmful ultraviolet radiation that comes from the Sun.

$$O_3(g) \xrightarrow{UV} O_2(g) + O(g)$$

A molecule of $O_3(g)$ absorbs a photon with a frequency of $1.00 \times 10^{15}\ s^{-1}$.

(i) How much energy, in joules, does the $O_3(g)$ molecule absorb per photon?

| | |
|---|---|
| $E = h\nu$<br>$= 6.63 \times 10^{-34}\ J\ s \times 1.00 \times 10^{15}\ s^{-1}$<br>$= 6.63\times10^{-19}\ J$ per photon | One point is earned for the correct answer. |

(ii) The minimum energy needed to break an oxygen-oxygen bond in ozone is 387 kJ $mol^{-1}$. Does a photon with a frequency of $1.00 \times 10^{15}\ s^{-1}$ have enough energy to break this bond? Support your answer with a calculation.

| | |
|---|---|
| $\frac{6.63\times10^{-19}\ J}{1\ photon} \times \frac{6.022\times10^{23}\ photons}{1\ mol} \times \frac{1\ kJ}{10^{3}\ J} = 399\ kJ\ mol^{-1}$<br>399 kJ $mol^{-1}$ > 387 kJ $mol^{-1}$, therefore the bond can be broken. | One point is earned for calculating the energy.<br>One point is earned for the comparison of bond energies. |

# AP® CHEMISTRY
# 2006 SCORING GUIDELINES

## 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.

| | |
|---|---|
| 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?

| | |
|---|---|
| +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, $CO_3^{2-}$.

| | |
|---|---|
| $Q_2CO_3$ | 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. |