



## AP<sup>®</sup> Chemistry 1999 Scoring Guidelines

**The materials included in these files are intended for non-commercial use by AP teachers for course and exam preparation; permission for any other use must be sought from the Advanced Placement Program. Teachers may reproduce them, in whole or in part, in limited quantities, for face-to-face teaching purposes but may not mass distribute the materials, electronically or otherwise. These materials and any copies made of them may not be resold, and the copyright notices must be retained as they appear here. This permission does not apply to any third-party copyrights contained herein.**

These materials were produced by Educational Testing Service (ETS), which develops and administers the examinations of the Advanced Placement Program for the College Board. The College Board and Educational Testing Service (ETS) are dedicated to the principle of equal opportunity, and their programs, services, and employment policies are guided by that principle.

The College Board is a national nonprofit membership association dedicated to preparing, inspiring, and connecting students to college and opportunity. Founded in 1900, the association is composed of more than 3,900 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three million students and their parents, 22,000 high schools, and 3,500 colleges, through major programs and services in college admission, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT<sup>®</sup>, the PSAT/NMSQT<sup>™</sup>, the Advanced Placement Program<sup>®</sup> (AP<sup>®</sup>), and Pacesetter<sup>®</sup>. The College Board is committed to the principles of equity and excellence, and that commitment is embodied in all of its programs, services, activities, and concerns.

Copyright © 2001 by College Entrance Examination Board. All rights reserved. College Board, Advanced Placement Program, AP, and the acorn logo are registered trademarks of the College Entrance Examination Board.

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 1**

9 Points

One point deduction for mathematical error (maximum once per question)

One point deduction for error in significant figures\* (maximum once per question)

\*number of significant figures must be correct within +/- one digit.  
 (except for pH: +/- two digits)

(a)  $K = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]}$  **1 pt**

(b)  $[\text{OH}^-] = 5.60 \times 10^{-4} \Rightarrow \left\{ \begin{array}{l} \text{pOH} = 3.252 \\ [\text{H}^+] = 1.79 \times 10^{-11} \end{array} \right\} \Rightarrow \text{pH} = 10.748$  **1 pt**

(c)  $K_b = \frac{(5.60 \times 10^{-4})^2}{0.0180 - 5.60 \times 10^{-4}} = 1.74 \times 10^{-5} \text{ (or } 1.80 \times 10^{-5})$  **2 pts**

**Note:** 1<sup>st</sup> point for  $[\text{NH}_4^+] = [\text{OH}^-] = 5.60 \times 10^{-4}$ ; 2<sup>nd</sup> point for correct answer

(d)  $\% \text{ ionization} = \frac{5.60 \times 10^{-4}}{0.0180} \times 100\% = 3.11\% \text{ (or } 0.0311)$  **1 pt**



(i)  $\text{mol NH}_3 = 0.0180 \text{ M} \times 0.0200 \text{ L} = 3.60 \times 10^{-4} \text{ mol} = \text{mol H}^+ \text{ needed}$

$\text{vol HCl solution} = \frac{3.60 \times 10^{-4} \text{ mol}}{0.0120 \text{ M}} = 0.0300 \text{ L} = 30.0 \text{ mL}$  **1 pt**

(ii)  $\text{mol H}^+ \text{ added} = \text{mol } 0.0120 \text{ M} \times 0.0150 \text{ L} = 1.80 \times 10^{-4} \text{ mol H}^+ \text{ added}$   
 $= 1.80 \times 10^{-4} \text{ mol NH}_4^+ \text{ produced}$

$[\text{NH}_4^+] = \frac{1.80 \times 10^{-4} \text{ mol}}{0.0350 \text{ L}} = 0.00514 \text{ M} = [\text{NH}_3]$  **1 pt**

**Note:** Point earned for  $1.80 \times 10^{-4} \text{ mol}$ , or  $0.00514 \text{ M}$   $[\text{NH}_3]$  or  $[\text{NH}_4^+]$ ,  
 or statement “halfway to equivalence point”.

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 1 (cont.)**

$$K_b = 1.80 \times 10^{-5} = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = [\text{OH}^-] \Rightarrow \text{pOH} = 4.745 \Rightarrow \text{pH} = 9.255 \quad 1 \text{ pt}$$

( $= 1.74 \times 10^{-5}$ ) ( $= 4.759$ ) ( $= 9.241$ )

(iii) 10.0 mL past equivalence point

$$0.0100 \text{ L} \times 0.0120 \text{ M} = 1.20 \times 10^{-4} \text{ mol H}^+ \text{ in } 60.0 \text{ mL}$$

$$[\text{H}^+] = \frac{0.000120 \text{ mol}}{0.0600 \text{ L}} = 0.00200 \text{ M}$$

$$\text{pH} = -\log(2.00 \times 10^{-3}) = 2.700 \quad 1 \text{ pt}$$

---

One point deduction for mathematical error (maximum once per question)

One point deduction for error in significant figures\* (maximum once per question)

*\*number of significant figures must be correct within  $\pm$  one digit (except for pH:  $\pm$  two digits)*

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 2**

9 points

One point deduction for mathematical error (maximum once per question)

One point deduction for error in significant figures\* (maximum once per question)

\*number of significant figures must be correct within +/- one digit.

(a) (i)  $\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{17} \text{ nm/sec}}{495 \text{ nm}} \text{ (or, } = \frac{3.00 \times 10^8 \text{ m/sec}}{495 \times 10^{-9} \text{ m}}) = 6.06 \times 10^{14} \text{ sec}^{-1}$  **1 pt**

(ii)  $E = h\nu = (6.626 \times 10^{-34} \text{ J sec})(6.06 \times 10^{14} \text{ sec}^{-1}) = 4.02 \times 10^{-19} \text{ J}$  **1 pt**

(iii)  $(4.02 \times 10^{-19} \text{ J})(6.022 \times 10^{23} \text{ mol}^{-1})(0.00100 \text{ kJ/J}) = 242 \text{ kJ/mol}$  **1 pt**

**Note:** No units required if answers are numerically same as above. No penalty if answers are correct with different units and units are explicitly indicated (e.g., for part (ii),  $4.02 \times 10^{-22} \text{ kJ}$  is acceptable)

(b) (i) Energy is emitted. **1 pt**

The  $n = 6$  state is at a higher energy than the  $n = 2$  state. Going from a high energy state to a low energy state means that energy must be emitted. **1 pt**

**Note:** The key idea is that the energy of the  $n = 6$  state is higher (more excited) than the lower (less excited)  $n = 2$  state. The argument that " $e^-$  is farther away" at the  $n = 6$  level is not accepted.

(ii)  $E_2 = \frac{-2.178 \times 10^{-18} \text{ J}}{2^2} = -5.45 \times 10^{-19} \text{ J}, \quad E_6 = \frac{-2.178 \times 10^{-18} \text{ J}}{6^2} = -6.05 \times 10^{-20} \text{ J}$   
 $\Delta E = E_6 - E_2 = -6.05 \times 10^{-20} \text{ J} - (-5.45 \times 10^{-19} \text{ J}) = 4.84 \times 10^{-19} \text{ J}$

**OR,** **1 pt**

$$\Delta E = 2.178 \times 10^{-18} \left( \frac{1}{2^2} - \frac{1}{6^2} \right) \text{ J} = 2.178 \times 10^{-18} (0.2222) \text{ J} = 4.84 \times 10^{-19} \text{ J}$$

**Note:** Point earned for determining the energy of transition.  
Negative energies acceptable.

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 2 (cont.)**

$$E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E}$$

**OR,**

**1 pt**

$$\nu = \frac{E}{h} = \frac{4.84 \times 10^{-19} \text{ J}}{6.626 \times 10^{-34} \text{ J sec}} = 7.30 \times 10^{14} \text{ sec}^{-1}$$

**Note:** Point earned for writing or using  $E = \frac{hc}{\lambda}$ , or for calculating the frequency,  $\nu$

$$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^8 \text{ m sec}^{-1}}{7.30 \times 10^{14} \text{ sec}^{-1}} \times \frac{1 \text{ nm}}{10^{-9} \text{ m}} = 411 \text{ nm}$$

**OR,**

**1 pt**

$$\lambda = \frac{(6.626 \times 10^{-34} \text{ J sec})(3.00 \times 10^{17} \text{ nm sec}^{-1})}{4.84 \times 10^{-19} \text{ J}} = 411 \text{ nm}$$

Note: Point earned for correct wavelength;  $\lambda = 4.11 \times 10^{-7} \text{ m}$  accepted.  
Negative wavelength not accepted.

- (iii) The positive charge holding the electron is greater for  $\text{He}^+$ , which has a 2+ nucleus, than for H with its 1+ nucleus. The stronger attraction means that it requires more energy **1 pt** for the electron to move to higher energy levels. Therefore, transitions from high energy states to lower states will be more energetic for  $\text{He}^+$  than for H.

Note: Other arguments accepted, such as, “ $E$  is proportional to  $Z^2$ . Since  $Z = 2$  for  $\text{He}^+$  and  $Z = 1$  for H, all energy levels in  $\text{He}^+$  are raised (by a factor of 4).” Other accepted answers must refer to the increased charge on the  $\text{He}^+$  nucleus, and NOT the mass.

---

One point deduction for mathematical error (maximum once per question)

One point deduction for error in significant figures\* (maximum once per question)

*\*number of significant figures must be correct within  $\pm$  one digit*

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 3**

9 points:

One point deduction for mathematical error (maximum once per question)

One point deduction for error in significant figures\* (maximum once per question)

\*number of significant figures must be correct within +/- one digit.

- (a) Rate of  $\text{Br}_2(\text{g})$  loss occurs at  $\frac{1}{2}$  the rate of  $\text{NOBr}(\text{g})$  formation.

$$\text{Rate of } \text{Br}_2(\text{g}) \text{ loss} = \frac{3.24 \times 10^{-4} M}{2 \text{ sec}} = 1.62 \times 10^{-4} M \text{ sec}^{-1} \text{ (or mol L}^{-1} \text{ sec}^{-1}) \text{ } 1 \text{ pt}$$

**Note:** No penalty for missing units; ignore + or – signs

- (b) Comparing experiments 1 and 2,  $[\text{NO}]$  remains constant,  $[\text{Br}_2]$  doubles, and rate doubles; therefore,  $\text{rate} \propto [\text{Br}_2]^1 \Rightarrow$  reaction is first-order with respect to  $[\text{Br}_2]$ .

**1 pt**

$$\frac{6.38 \times 10^{-4}}{6.42 \times 10^{-4}} \cong 1 = \frac{k[\text{NO}]^x [\text{Br}_2]}{k[\text{NO}]^x [\text{Br}_2]} = \frac{k[0.0160]^x [0.0240]}{k[0.0320]^x [0.0060]} = \left(\frac{1}{2}\right)^x 4 = 1 \Rightarrow$$
$$\frac{1}{4} = \left(\frac{1}{2}\right)^x \Rightarrow x = 2 \Rightarrow \text{reaction is second-order with respect to } [\text{NO}]$$

**2 pts.**

**Note:** One point earned for a proper set-up, comparing experiments 2 and 3 (as is shown here)

or experiments 1 and 3. Second point earned for solving the ratios correctly and determining

that the exponent = 2. Also, credit can be earned for a non-mathematical approach (e.g., one point for describing the change in  $[\text{Br}_2]$  and subsequent effect on rate, another point for describing the change in  $[\text{NO}]$  and subsequent effect on rate).

- (c) (i)  $\text{Rate} = k[\text{NO}]^2[\text{Br}_2]$

**1 pt**

**Note:** Point earned for an expression that is not inconsistent with the answer in part

- (b)

(ii)  $k = \frac{\text{Rate}}{[\text{NO}]^2[\text{Br}_2]} = \frac{3.24 \times 10^{-4} M \text{ sec}^{-1}}{(0.0160)^2 (0.0120) M^3} = 105 M^{-2} \text{ sec}^{-1} \text{ (or } 105 \text{ L}^2 \text{ mol}^{-2} \text{ sec}^{-1})$

**2 pts.**

(Using rate of  $\text{Br}_2(\text{g})$  loss =  $1.62 \times 10^{-4} M \text{ sec}^{-1} \Rightarrow k = 52.7 M^{-2} \text{ sec}^{-1}$  is also correct.)

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 3 (cont.)**

**Note:** One point for solving for the value of the rate constant consistent with the

rate-law expression found in part (b) or stated in part (c); one point for the correct units consistent with the rate-law expression found in part (b) or stated in part

(c).

(d) No, it is not consistent with the given experimental observations.

**1 pt**

This mechanism gives a reaction that is first-order in [NO], and first-order in [Br<sub>2</sub>], as those are the two reactants in the rate-determining step. Kinetic data show the reaction is second-order in [NO] (and first-order in [Br<sub>2</sub>]), so this cannot be the mechanism.

**1 pt**

**Note:** One point earned for “No” [or for “Yes” if rate =  $k[\text{NO}][\text{Br}_2]$  in part (b)].

One point earned for justifying why this mechanism is inconsistent with the observed rate-law [or consistent with rate law stated earlier in response].

---

One point deduction for mathematical error (maximum once per question)

One point deduction for error in significant figures\* (maximum once per question)

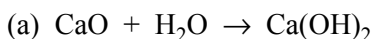
*\*number of significant figures must be correct within  $\pm$  one digit*

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

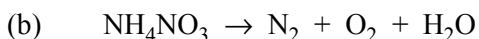
**Question 4**

15 points:

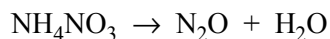
Students choose five of the eight reactions. Only the answers in the boxes are graded (unless clearly marked otherwise). Each correct answer earns 3 points, 1 point for reactants and 2 points for products. All products must be correct to earn both product points. Equations do not need to be balanced and phases need not be indicated. Any spectator ions on the reactant side nullify the 1 possible reactant point, but if they appear again on the product side, there is no product-point penalty. A fully molecular equation (when it should be ionic) earns a maximum of one point. Ion charges must be correct.



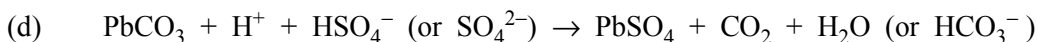
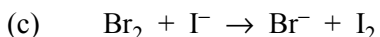
- *No penalty for the set of products  $\{ \text{Ca}^{2+}, \text{OH}^-, \text{and } \text{Ca(OH)}_2 \}$*



**OR**



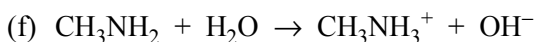
- *Two points earned for  $\text{NH}_4\text{NO}_2 \rightarrow \text{N}_2 + \text{H}_2\text{O}$*
- *No penalty for other oxides of nitrogen (e.g.,  $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{N}_2\text{O}_3$ ,  $\text{N}_2\text{O}_4$  – but not  $\text{N}_2\text{O}_5$ )*



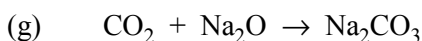
- *No reactant point earned for  $\text{H}_2\text{SO}_4$*
- *No product point earned for  $\text{H}_2\text{CO}_3$*



- *No penalty for the set of products  $\{ \text{FeO}, \text{Fe}, \text{and } \text{Al}_2\text{O}_3 \}$*



- *Two points earned for  $\text{MeNH}_2 + \text{H}_2\text{O} \rightarrow \text{MeNH}_3^+ + \text{OH}^-$*





**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 5**

8 Points

(a)  $PV = nRT$  **AND**  $n = \frac{m}{M}$ , **OR**  $\text{molar mass} = \frac{mRT}{PV}$ , **OR**  $M = \frac{DRT}{P}$  **1 pt**

- (b) temperature, atmospheric pressure, volume of the gas, and mass of gas (mass of pressurized container before and after releasing the gas) **3 pts**

**Note:** 1 point earned for any **two** of the above, 2 points earned for any **three** of them.  
 “The mass of the gas” is acceptable as a “measurement” for the 1<sup>st</sup> or 2<sup>nd</sup> point. Extraneous measurements (e.g., density, volume of liquid, etc.) are ignored. To earn 3<sup>rd</sup> point, “mass of pressurized container before and after releasing the gas”, or “change in mass of container” must be indicated.

- (c) to equalize internal pressure with room pressure (atmospheric pressure), or the pressure(s) will be the same. **1 pt**

(d)  $\% \text{ error} = \frac{(64 - 58) \text{ g}}{58 \text{ g}} \times 100\%$  (or  $\frac{6}{58} \times 100\%$ , or  $\frac{6}{58}$ ) **1 pt**

**Note:** No points earned for generic response (e.g.,  $\frac{|(\text{expt.} - \text{theor.})|}{\text{theor.}} \times 100$ ),

or for  $\frac{6}{64} \times 100\%$ . No penalty if “ $\times 100\%$ ” is absent or if value (10%) is not calculated.

- (e) Pressure will be larger, therefore number of moles will be larger **1 pt**

molar mass =  $\frac{\text{mass}}{\text{moles}}$ , therefore calculated molar mass will be smaller **1 pt**

**OR,**  $M = \frac{mRT}{PV}$  (or  $M = \frac{DRT}{P}$ ), and the denominator,  $PV$ , will be too large. **2 pts**

Therefore, the value of the molar mass ( $= \frac{mRT}{PV}$  or  $\frac{DRT}{P}$ ) will be too small.

**OR,** The pressure is larger, or the number of moles is larger, or since  $P_{\text{total}} = (P_{\text{unknown}} - P_{\text{water}})$  we know that  $P_{\text{total}} > P_{\text{unknown}}$ . **1 pt**

**Note:** If  $n = \frac{m}{M}$  is missing in part (a) but present in part (e), 1 point is earned for part (a).

8 points:

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 5 (cont.)**

- (a) (i)  $\Delta S^\circ$  is negative (–) **OR**  $\Delta S^\circ < 0$  **OR** entropy is decreasing. **1 pt**

3 moles of gaseous particles are converted to 2 moles of solid/liquid. **1 pt**

- One point earned for correct identification of (–) sign of  $\Delta S^\circ$
- One point earned for correct explanation (mention of phases is crucial for point)
- No point earned if incorrect  $\Delta S^\circ$  sign is obtained from the presumed value of  $\Delta G^\circ$

- (ii)  $\Delta H^\circ$  drives the reaction.

**1 pt**

The decrease in entropy ( $\Delta S^\circ < 0$ ) cannot drive the reaction, so the decrease in enthalpy ( $\Delta H^\circ < 0$ ) **MUST** drive the reaction.

**OR**

**1 pt**

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ ; for a spontaneous reaction  $\Delta G^\circ < 0$ , and a negative value of  $\Delta S^\circ$  causes a positive  $\Delta G^\circ$ .

- One point earned for identifying  $\Delta H^\circ$  as the principal driving force for the reaction
- One point earned for correct justification
- Justification point earned by mentioning the effects of changes in entropy and enthalpy on the spontaneity of the reaction **OR** by a mathematical argument using the Gibbs-Helmholtz equation and some implication about the comparison between the effects of  $\Delta S^\circ$  and  $\Delta H^\circ$

- (iii) Given that  $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$  and  $\Delta S^\circ < 0$ , an increase in temperature causes an increase in the value of  $\Delta G^\circ$  ( $\Delta G^\circ$  becomes less negative).

**1 pt**

- One point earned for the description of the effect of an increase in temperature on  $\Delta S^\circ$  and consequently on  $\Delta G^\circ$
- No point earned for an argument based on Le Châtelier's principle

- (b) (i) The reaction rate depends on the reaction kinetics, which is determined by the value of the activation energy,  $E_{\text{act}}$ . If the activation energy is large, a reaction that is thermodynamically spontaneous may proceed very slowly (if at all). **1 pt**

- One point earned for linking the rate of the reaction to the activation energy, which may be explained verbally or shown on a reaction profile diagram

- (ii) The catalyst has no effect on the value of  $\Delta G^\circ$ .

**1 pt**

The catalyst reduces the value of  $E_{\text{act}}$ , increasing the rate of reaction, but has no effect on the values of  $\Delta H^\circ$  and  $\Delta S^\circ$ , so it cannot affect the thermodynamics of the reaction.

**1 pt**

- One point earned for indicating no change in the value of  $\Delta G^\circ$
- One point earned for indicating (verbally, or with a reaction-profile diagram) that the catalyst affects the activation energy

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 7**

8 points:

a. **1 point**

$\text{C}_2\text{H}_5\text{OH}$  (Flask #3)

**1 point**

Ethanol, a nonelectrolyte, does not break up or dissociate in solution.

- One point earned for identifying  $\text{C}_2\text{H}_5\text{OH}$
- One point earned for the correct explanation.
- Explanation point earned for a description of a nonelectrolyte (e.g., something that does not break up or does not dissociate.)
- No point earned for describing  $\text{C}_2\text{H}_5\text{OH}$  as organic, or as the compound that contains the most hydrogens.

b. **1 point**

$\text{MgCl}_2$  (Flask #2)

**1 point**

The freezing-point depression is proportional to the concentration of solute particles. All solutes are at the same concentration, but the van't Hoff factor ( $i$ ) is largest for  $\text{MgCl}_2$ .

- One point earned for identifying  $\text{MgCl}_2$ .
- One point earned for the correct explanation.

c. **1 point**

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**  
**Question 7 (cont.)**

$\text{C}_2\text{H}_5\text{OH}$  (Flask #3)

**1 point**

The lowering of vapor pressure of water is directly proportional to the concentration of solute particles in solution.  $\text{C}_2\text{H}_5\text{OH}$  is the only nonelectrolyte, so it will have the fewest solute particles in solution.

- One point earned for identifying  $\text{C}_2\text{H}_5\text{OH}$ .
- One point earned for the correct explanation.

d. **1 point**

$\text{NaF}$  (Flask #1)

**1 point**

The  $\text{F}^-$  ion, generated upon dissolution of  $\text{NaF}$ , is a weak base. It is the only solution with  $\text{pH} > 7$ .

- One point earned for identifying  $\text{NaF}$ .
- One point earned for the correct explanation.

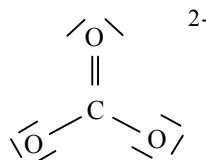
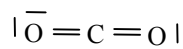
**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

**Question 8**

8 points

(a) (i)

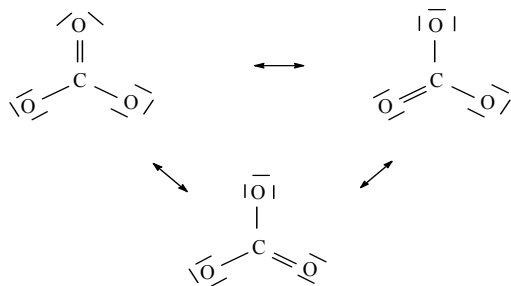
**2 pts**



- One point earned for each Lewis electron-dot structure
- Indication of lone pairs of electrons are required on each structure
- Resonance forms of  $\text{CO}_3^{2-}$  are not required

(ii) In  $\text{CO}_2$ , the C–O interactions are double bonds, **OR**, in  $\text{CO}_3^{2-}$  the C–O interactions are resonance forms (or figures below.)

**1 pt**



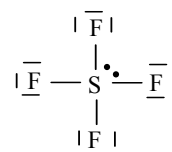
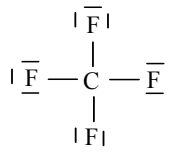
The carbon-oxygen bond length is greater in the resonance forms than in the double bonds.

**1 pt**

- 1<sup>st</sup> point earned for indicating double bonds are present in  $\text{CO}_2$  **OR** resonance occurs in  $\text{CO}_3^{2-}$
- 2<sup>nd</sup> point earned for **BOTH** of the above **AND** indicating the relative lengths of the bond types

(b) (i)

**2 pts**



- One point earned for each Lewis electron-dot structure
- Lone pairs of electrons are required on each structure

**AP<sup>®</sup> CHEMISTRY**  
**1999 SCORING GUIDELINES**

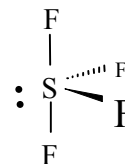
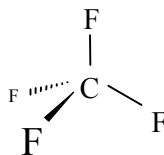
**Question 8 (cont.)**

- (ii)  $\text{CF}_4$  has a tetrahedral geometry, so the bond dipoles cancel, leading to a nonpolar molecule.

**1 pt**

With five pairs of electrons around the central S atom,  $\text{SF}_4$  exhibits a trigonal bipyramidal electronic geometry, with the lone pair of electrons. In this configuration, the bond dipoles do not cancel, and the molecule is polar.

**1 pt**



- One point earned for each molecule for proper geometry and explanation