

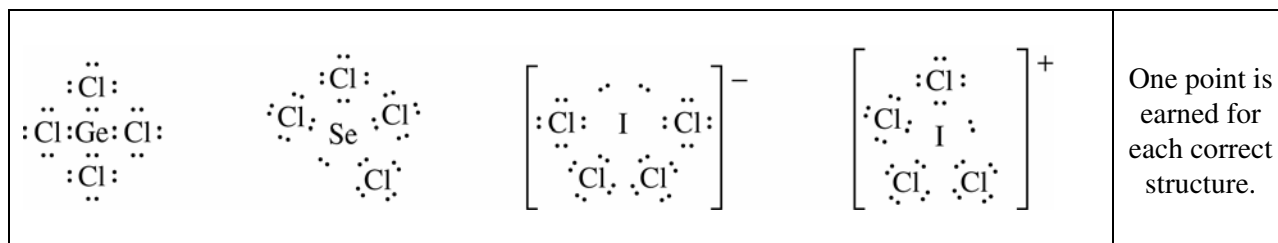
AP[®] CHEMISTRY
2006 SCORING GUIDELINES (Form B)

Question 6



6. The species represented above all have the same number of chlorine atoms attached to the central atom.

(a) Draw the Lewis structure (electron-dot diagram) of each of the four species. Show all valence electrons in your structures.



(b) On the basis of the Lewis structures drawn in part (a), answer the following questions about the particular species indicated.

(i) What is the Cl – Ge – Cl bond angle in GeCl_4 ?

109.5°	One point is earned for the correct angle.
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(ii) Is SeCl_4 polar? Explain.

<p>Yes. The SeCl_4 molecule is polar because the lone pair of nonbonding electrons in the valence shell of the selenium atom interacts with the bonding pairs of electrons, causing a spatial asymmetry of the dipole moments of the polar Se-Cl bonds. The result is a SeCl_4 molecule with a net dipole moment.</p>	<p>One point is earned for the correct answer.</p>
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(iii) What is the hybridization of the I atom in ICl_4^- ?

d^2sp^3 or sp^3d^2	One point is earned for the correct hybridization.
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(iv) What is the geometric shape formed by the atoms in ICl_4^+ ?

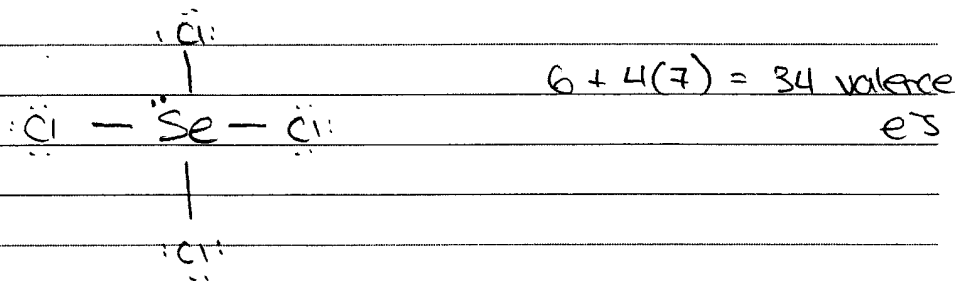
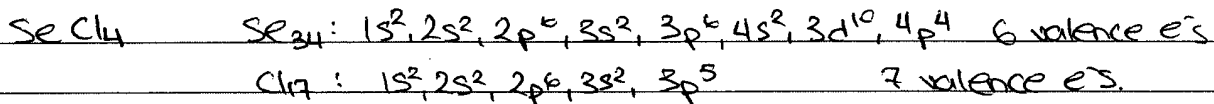
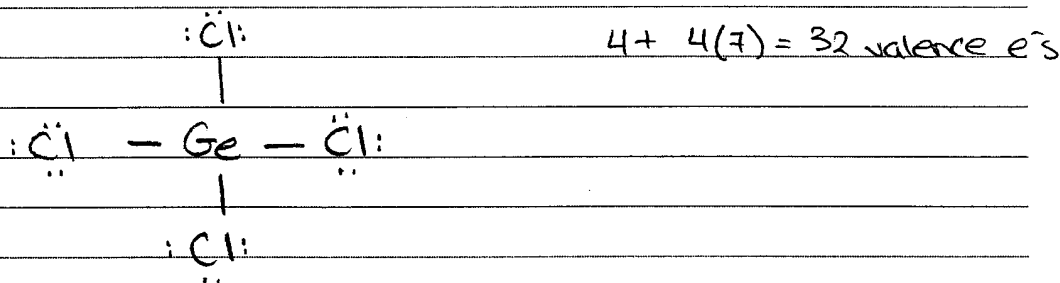
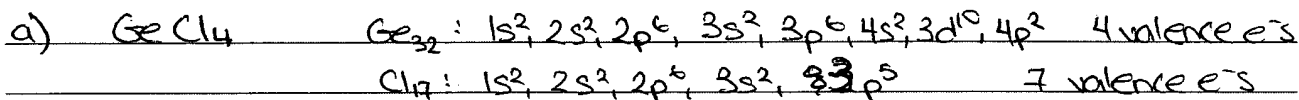
See-saw (or distorted tetrahedral or disphenoidal)	One point is earned for the correct shape.
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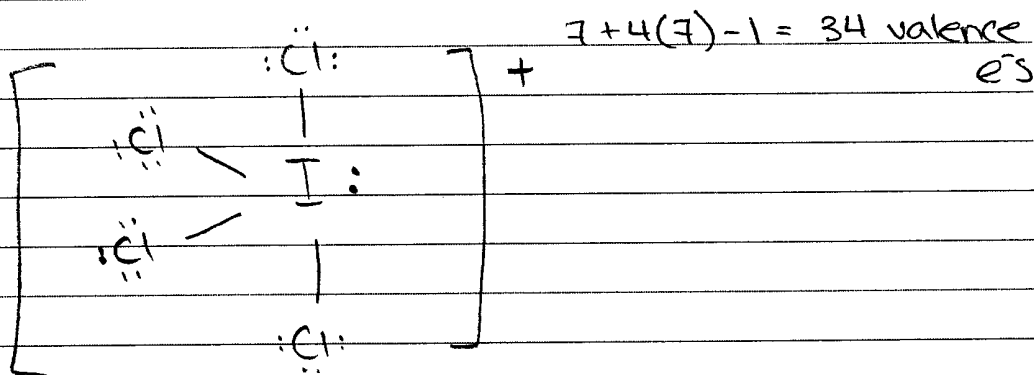
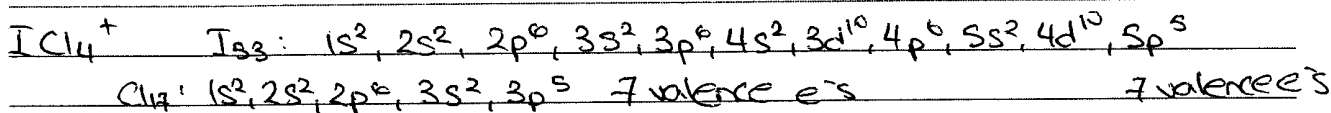
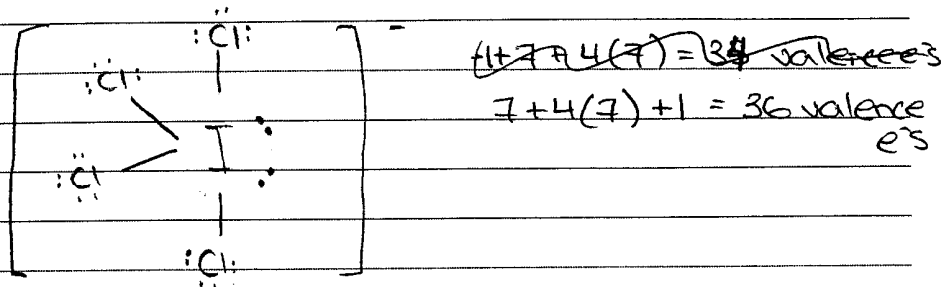
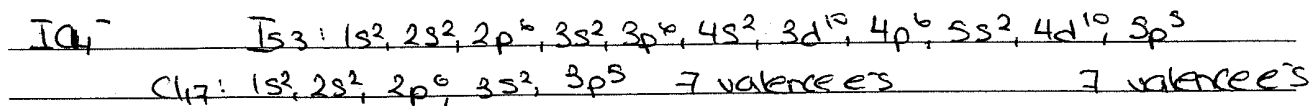
6. The species represented above all have the same number of chlorine atoms attached to the central atom.

- (a) Draw the Lewis structure (electron-dot diagram) of each of the four species. Show all valence electrons in your structures.
- (b) On the basis of the Lewis structures drawn in part (a), answer the following questions about the particular species indicated.
- (i) What is the Cl - Ge - Cl bond angle in GeCl₄ ?
 - (ii) Is SeCl₄ polar? Explain.
 - (iii) What is the hybridization of the I atom in ICl₄⁻ ?
 - (iv) What is the geometric shape formed by the atoms in ICl₄⁺ ?



GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 6.



- b) i) 109.5° is the Cl-Ge-Cl bond angle.
 ii) ~~Yes~~ ^{No} because ~~there is one lone pair~~ the polar directions cancel out. ~~of~~ The net polar moment = 0.
 iii) the hybridization of I is ICl_4^- is d^2sp^3
 iv) the geometric shape of ICl_4^+ is see saw.

GO ON TO THE NEXT PAGE.



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(a) Draw the Lewis structure (electron-dot diagram) of each of the four species. Show all valence electrons in your structures.

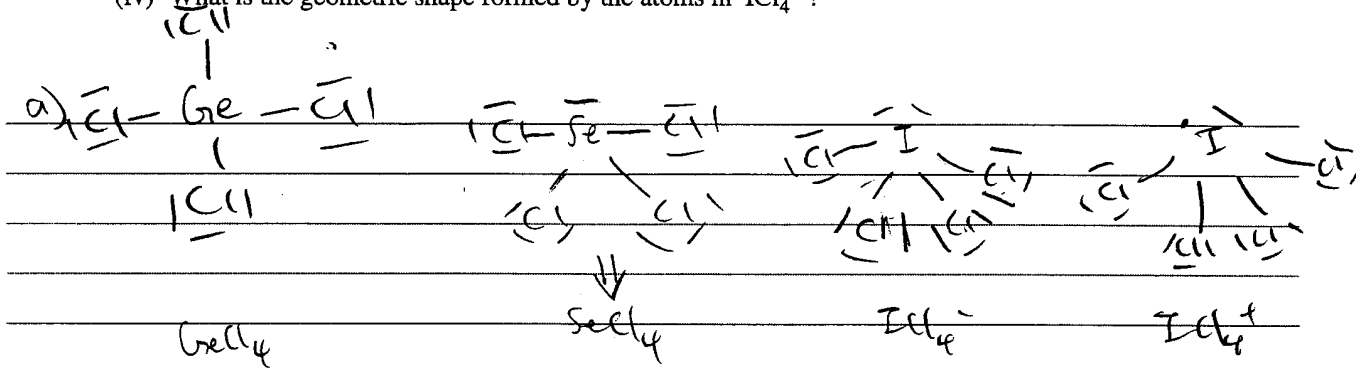
(b) On the basis of the Lewis structures drawn in part (a), answer the following questions about the particular species indicated.

(i) What is the Cl-Ge-Cl bond angle in GeCl_4 ?

(ii) Is SeCl_4 polar? Explain.

(iii) What is the hybridization of the I atom in ICl_4^- ?

(iv) What is the geometric shape formed by the atoms in ICl_4^+ ?



b) (i) 120°

(ii) Yes, because there is a nonbonded pair of e^- , pushing the chlorines away, causing an overall net polar direction.

(iii) $sp^3 d^2$

(iv) trigonal bipyramidal

GO ON TO THE NEXT PAGE.



6. The species represented above all have the same number of chlorine atoms attached to the central atom.

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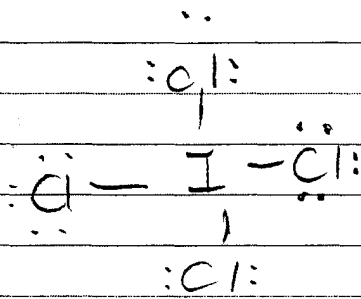
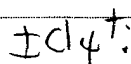
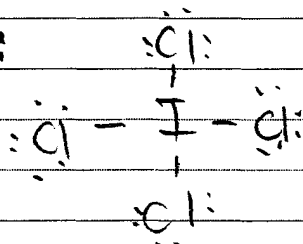
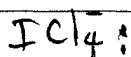
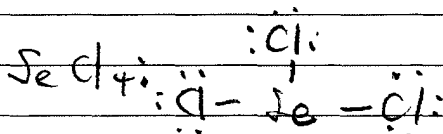
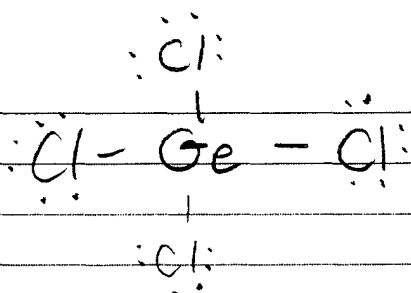
(i) What is the Cl-Ge-Cl bond angle in GeCl₄?

(ii) Is SeCl₄ polar? Explain.

(iii) What is the hybridization of the I atom in ICl₄⁻?

(iv) What is the geometric shape formed by the atoms in ICl₄⁺?

a)



GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 6.

b) (i) 0°

(ii) SeCl4 is not polar, because its Lewis structure is symmetrical.

(iii)

(iv) Tetrahedral

GO ON TO THE NEXT PAGE.

AP[®] CHEMISTRY
2006 SCORING COMMENTARY (Form B)

Question 6

Sample: 6A
Score: 7

This response earned 7 out of 8 possible points: 4 points for part (a), 1 point for part (b)(i), 1 point for part (b)(iii), and 1 point for part (b)(iv). The point was not earned in part (b)(ii) because the response indicates incorrectly that SeCl_4 has no net polar moment.

Sample: 6B
Score: 5

Part (a) earned only 3 out of 4 possible points because the Lewis structure drawn for ICl_4^+ has an extra electron. The point was not earned in part (b)(i) because a bond angle of 120° is incorrect, and the point was not earned in part (b)(iv) because the geometry given is incorrect.

Sample: 6C
Score: 3

Only 1 point was earned in part (a) because the lone pairs of electrons are left out of the Lewis structures drawn for SeCl_4 , ICl_4^- , and ICl_4^+ . The point was not earned in part (b)(i) because a bond angle of 0° is incorrect. The point was earned in part (b)(ii) because the answer is consistent with the incorrect Lewis structure drawn in part (a). Part (b)(iii) is not attempted. The point was earned in part (b)(iv) because the answer is consistent with the incorrect Lewis structure drawn in part (a).