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.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Cl:Cl:Cl:Cl]</td>
<td>GeCl₄</td>
</tr>
<tr>
<td>[Cl:Se:Cl]</td>
<td>SeCl₄</td>
</tr>
<tr>
<td>[Cl:Cl:Cl:Cl]⁻</td>
<td>ICl₄⁻</td>
</tr>
<tr>
<td>[Cl:Cl:Cl:Cl]⁺</td>
<td>ICl₄⁺</td>
</tr>
</tbody>
</table>

One point is earned for each correct structure.

(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?

109.5°  
One point is earned for the correct angle.

(ii) Is SeCl₄ polar? Explain.

Yes. The SeCl₄ 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 SeCl₄ molecule with a net dipole moment.

One point is earned for the correct answer.

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

$d^2sp^3$ or $sp^3d^2$  
One point is earned for the correct hybridization.

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

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⁺ ?

\[
\begin{align*}
\text{GeCl}_4 & : \text{Ge} \quad 1s^2 \cdot 2s^2 \cdot 2p^6 \cdot 3s^2 \cdot 3p^6 \cdot 4s^2 \cdot 3d^{10} \cdot 4p^2 \quad 4 \text{ valence e}^- \\
\text{Cl} & : 1s^2 \cdot 2s^2 \cdot 2p^5 \cdot 3s^2 \cdot 3p^5 \quad 7 \text{ valence e}^- \\
\text{SeCl}_4 & : \text{Se} \quad 1s^2 \cdot 2s^2 \cdot 2p^6 \cdot 3s^2 \cdot 3p^6 \cdot 4s^2 \cdot 3d^{10} \cdot 4p^4 \quad 6 \text{ valence e}^- \\
\text{Cl} & : 1s^2 \cdot 2s^2 \cdot 2p^5 \cdot 3s^2 \cdot 3p^5 \quad 7 \text{ valence e}^- \\
\text{ICl}_4^- & : \text{I} \quad 6 + 4(7) = 34 \text{ valence e}^- \\
\text{Se} & \quad \text{Se} - \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\text{Se} & \quad \text{Se} - \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\end{align*}
\]
b) i) 109.5° is the Cl-Ge-Cl bond angle.
ii) Yes because there is one lone pair the polar directions cancel out. The net polar moment = 0.
iii) the hybridization of T is TCl₄ is d²sp³
iv) the geometric shape of TCl₄⁺ is see saw.
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⁺?

b) (i) 120°

(ii) Yes, because there is a net dipole, pushing the chlorines away, causing an overall net polar direction.

(iii) $sp^3d^2$

(iv) trigonal bipyramidal
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.
b) (i) 0°

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

(iii)

(iv) Tetrahedral
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 \( \text{SeCl}_4 \) 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 \( \text{ICl}_4^+ \) 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 \( \text{SeCl}_4 \), \( \text{ICl}_4^- \), and \( \text{ICl}_4^+ \). 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).