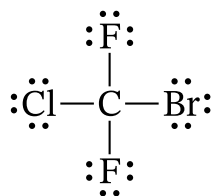


Question 5

The following information applies to parts A and B.

5. The Lewis diagram of CBrClF_2 is shown.

**Part A**

Which of the bonds in CBrClF_2 (C–Br, C–Cl, or C–F) is the most polar? **Justify** your answer.

Part B

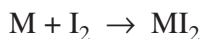
In a molecule of CBrClF_2 , the F–C–F bond angle is 106.8° and the Br–C–Cl bond angle is 112.3° . **Explain** the difference in bond angles using principles of atomic structure and VSEPR theory.

Part C

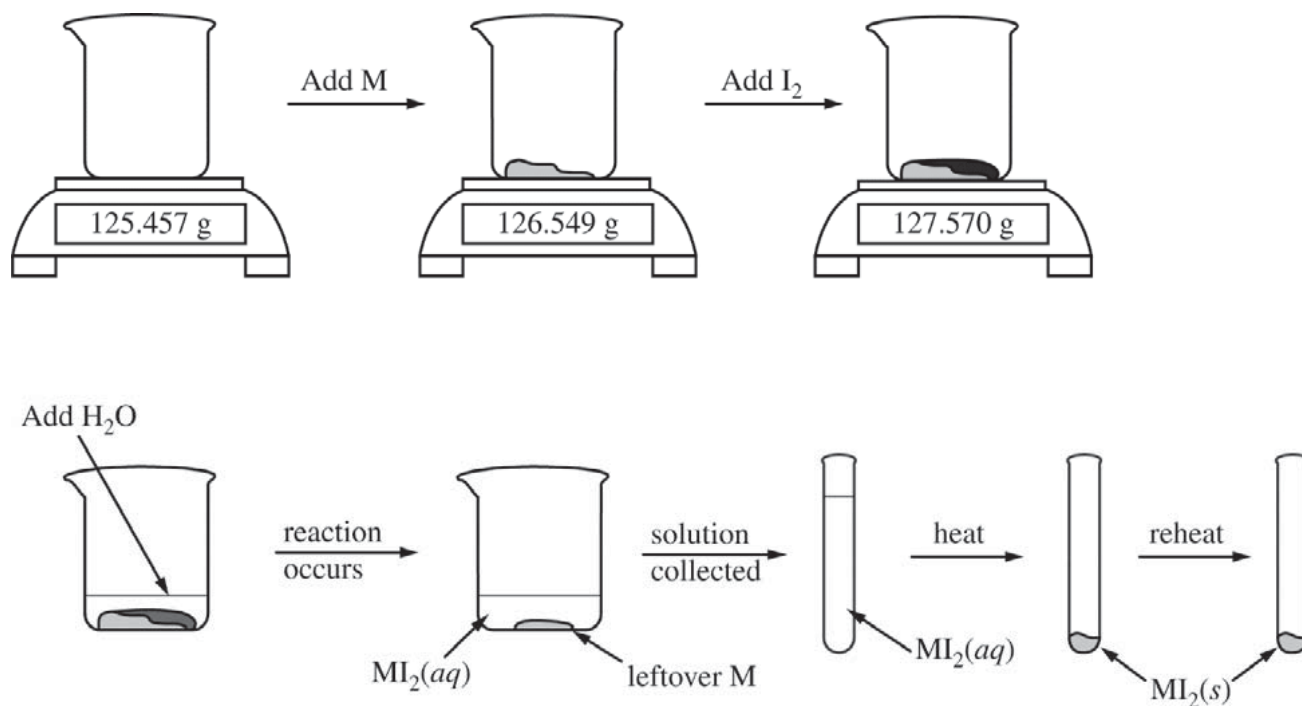
Lewis diagrams and boiling points for CBr_4 and CBrClF_2 are given in the following table.

Formula	CBr_4	CBrClF_2
Lewis diagram	$\begin{array}{c} \text{:}\ddot{\text{Br}}\text{:} \\ \\ \text{:}\ddot{\text{Br}}\text{—}\text{C}\text{—}\ddot{\text{Br}}\text{:} \\ \\ \text{:}\ddot{\text{Br}}\text{:} \end{array}$	$\begin{array}{c} \text{:}\ddot{\text{F}}\text{:} \\ \\ \text{:}\ddot{\text{Cl}}\text{—}\text{C}\text{—}\ddot{\text{Br}}\text{:} \\ \\ \text{:}\ddot{\text{F}}\text{:} \end{array}$
Boiling point	463 K	269 K

- Clearly **identify** all the intermolecular forces in pure $\text{CBr}_4(l)$ and in pure $\text{CBrClF}_2(l)$.
 $\text{CBr}_4(l)$:
 $\text{CBrClF}_2(l)$:
- In terms of the relative strengths of all the intermolecular forces, **explain** why pure $\text{CBr}_4(l)$ has a higher boiling point than pure $\text{CBrClF}_2(l)$ does.



3. To determine the molar mass of an unknown metal, M, a student reacts iodine with an excess of the metal to form the water-soluble compound MI_2 , as represented by the equation above. The reaction proceeds until all of the I_2 is consumed. The $\text{MI}_2(aq)$ solution is quantitatively collected and heated to remove the water, and the product is dried and weighed to constant mass. The experimental steps are represented below, followed by a data table.



Data for Unknown Metal Lab	
Mass of beaker	125.457 g
Mass of beaker + metal M	126.549 g
Mass of beaker + metal M + I ₂	127.570 g
Mass of MI ₂ , first weighing	1.284 g
Mass of MI ₂ , second weighing	1.284 g

- (a) Given that the metal M is in excess, calculate the number of moles of I_2 that reacted.
- (b) Calculate the molar mass of the unknown metal M.

The student hypothesizes that the compound formed in the synthesis reaction is ionic.

- (c) Propose an experimental test the student could perform that could be used to support the hypothesis. Explain how the results of the test would support the hypothesis if the substance was ionic.

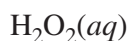
The student hypothesizes that Br_2 will react with metal M more vigorously than I_2 did because Br_2 is a liquid at room temperature.

- (d) Explain why I_2 is a solid at room temperature whereas Br_2 is a liquid. Your explanation should clearly reference the types and relative strengths of the intermolecular forces present in each substance.

While cleaning up after the experiment, the student wishes to dispose of the unused solid I_2 in a responsible manner. The student decides to convert the solid I_2 to $\text{I}^-(aq)$ anion. The student has access to three solutions, $\text{H}_2\text{O}_2(aq)$, $\text{Na}_2\text{S}_2\text{O}_3(aq)$, and $\text{Na}_2\text{S}_4\text{O}_6(aq)$, and the standard reduction table shown below.

Half reaction	E° (V)
$\text{S}_4\text{O}_6^{2-}(aq) + 2 e^- \rightarrow 2 \text{S}_2\text{O}_3^{2-}(aq)$	0.08
$\text{I}_2(s) + 2 e^- \rightarrow 2 \text{I}^-(aq)$	0.54
$\text{O}_2(g) + 2 \text{H}^+(aq) + 2 e^- \rightarrow \text{H}_2\text{O}_2(aq)$	0.68

- (e) Which solution should the student add to $\text{I}_2(s)$ to reduce it to $\text{I}^-(aq)$? Circle your answer below. Justify your answer, including a calculation of E° for the overall reaction.



- (f) Write the balanced net-ionic equation for the reaction between I_2 and the solution you selected in part (e).

Compound	Melting Point ($^\circ\text{C}$)
LiI	449
KI	686
LiF	845
NaF	993

6. A student learns that ionic compounds have significant covalent character when a cation has a polarizing effect on a large anion. As a result, the student hypothesizes that salts composed of small cations and large anions should have relatively low melting points.

- (a) Select two compounds from the table and explain how the data support the student's hypothesis.
- (b) Identify a compound from the table that can be dissolved in water to produce a basic solution. Write the net ionic equation for the reaction that occurs to cause the solution to be basic.