To Download Resources:

Helping Students Show What They Know

AACT AP Chemistry Review Webinar 2020

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About Us

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- 10 Year AP TDC Member
- Reader, TL, QL, EL
- Author
- Pre-AP DC

Michael
- 22 year AP Teacher
- AP Reader since 2011
- Item Writer for the AP Exam since 2014
- ChemEdX Lead Contributor
Why are we here?

- March 4 -> May 7: Two Months Out!
- Curriculum Mostly Done?
How do we feel?
What do we want to prevent?

Student Response

"I think you should be more explicit here in step two."
Conceptual Understanding
1. Verbal descriptions--macro
2. Chemical explanations--micro
3. Calculations with units
4. Justification of choices
5. Formulation of hypotheses
1. Verbal *descriptions*

Have students *describe in words* what they observe during chemical processes:

a. identify the *measurables*.

b. learn the *correct vocabulary*.

c. design a meaningful *experiment*.
1. Verbal descriptions

d. memorization is necessary to learn vocabulary and some basic chemical facts. It is not an end in itself, but it can be a useful tool to categorize and access conceptual knowledge.
2. Chemical explanations

Have students believe is during chem:

a. in terms
b. using "part" when possible
3. **Calculations** with units

d. *algorithmic calculations* are okay only if they are accompanied by *conceptual understanding*
General Advice

- Remind students to read each problem carefully and to answer the question posed in the prompt.

- Require students to show all work in calculations, and to report answers with units to the correct precision (significant figures).
Goals for Students

- Become “Chemically Conversant”
  - Approach a problem from multiple perspectives (Atom and Mol. Str., Thermo, Kinetics, and Equil.)
  - DO NOT PIGEONHOLE!
- Can they convince others of their answer conceptually? <-- WRITING + DISC.
- Math can give a false sense of understanding.......
The process this year

- Dec 2019 - AACT Questionnaire to AP Community
- ID areas group feels comfortable with
- Units 1-7 “fair game”
- Write Questions and Distribute
- Create Rubrics and “Pre Read”
- Webinar
1. Answer the following questions about compounds containing silver (Ag).

\[ 2 \text{AgNO}_3(aq) + \text{Na}_2\text{SO}_4(aq) \rightarrow \text{Ag}_2\text{SO}_4(s) + 2 \text{NaNO}_3(aq) \quad \Delta H^\circ = -17.8 \text{ kJ/mol}_{\text{rxn}} \]

A student is assigned the task of experimenting with precipitation reactions of the silver cation. The student performs the reaction represented by the equation above by combining 100. mL of 1.00 M AgNO\textsubscript{3}(aq) with 50.0 mL of 1.50 M Na\textsubscript{2}SO\textsubscript{4}(aq) in an insulated cup calorimeter. Assume that the reaction proceeds to completion with 100% yield.

(a) Write the net ionic equation for the reaction above.

(b) Determine the mass of Ag\textsubscript{2}SO\textsubscript{4}(s) produced in this experiment.

(c) Determine the magnitude of the energy change in the form of heat that occurred when the two solutions were mixed.
When performing the experiment, the student initially added the 100. mL of 1.00 \( M \) AgNO\(_3\)(aq) to the insulated cup calorimeter and recorded the initial temperature as shown in the diagram above. The student then added 50.0 mL of 1.50 \( M \) Na\(_2\)SO\(_4\)(aq), which had the same initial temperature as the AgNO\(_3\)(aq).

(d) Based on your calculations in part (c) and the precision of the thermometer shown above, what value would the student record as the final temperature of the reaction mixture? Justify your answer with calculations. Assume that the calorimeter is perfectly insulated and the specific heat of the reaction mixture is 4.18 \( J/(g\cdot ^\circ C) \). Also assume that the volumes are additive and that the density of the final solution is 1.10 g/mL.
Upon doing more research, the student discovers additional information about Ag₂SO₄(s) and another compound containing silver, AgCl(s).

<table>
<thead>
<tr>
<th>Substance</th>
<th>Ag₂SO₄(s)</th>
<th>AgCl(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molar Solubility (mol/L)</td>
<td>?</td>
<td>1.4 × 10⁻⁵</td>
</tr>
<tr>
<td>$K_{sp}$</td>
<td>1.1 × 10⁻⁵</td>
<td>?</td>
</tr>
<tr>
<td>Lattice Energy (kJ/mol)</td>
<td>1800</td>
<td>?</td>
</tr>
</tbody>
</table>

(e) Explain how the data in the table supports the observation that a precipitate formed when solutions of AgNO₃(aq) and Na₂SO₄(aq) were mixed.

(f) Using the data in the table, calculate the value of $K_{sp}$ for AgCl.
(g) Shown above is a particulate representation of 300. mL of a saturated solution of AgCl. Based on this diagram, create a particulate representation of the AgCl solution when half of the solid AgCl is removed from 300. mL of the saturated solution.

(h) The lattice energy of Ag₂SO₄(s) is 1800 kJ/mol. Would you predict the lattice energy of AgCl(s) to be greater than, less than, or equal to 1800 kJ/mol? Justify your answer.
(a) Write the net ionic equation for the reaction above.

\[ 2\text{Ag}^+ (aq) + \text{SO}_4^{2-} (aq) \rightarrow \text{Ag}_2\text{SO}_4 (s) \quad 3\text{pts} \]

1 point is earned for the correct net ionic equation.

(b) Determine the mass of Ag$_2$SO$_4$ produced in this experiment.

**What is LR?**

\[ 0.1\text{L} \text{AgNO}_3 \left( \frac{1\text{mole}}{2\text{mL}} \right) \left( \frac{2\text{mL}}{1\text{mL}} \right) = 0.2000 \text{mole AgNO}_3 \]

I have 0.0750 mL Na$_2$SO$_4$ so

\[ 0.1\text{L} \text{AgNO}_3 \left( \frac{1\text{mole}}{31.89 \text{mL}} \right) \left( \frac{31.89 \text{mL}}{1\text{mL}} \right) = 15.69 \text{mole Ag}_2\text{SO}_4 \]

4pts clear determination of LR

3pts mass Ag$_2$SO$_4$

1 point is earned for the correct number of moles of Ag$_2$SO$_4$. This value may be implicit.

1 point is earned for the correct mass of Ag$_2$SO$_4$ consistent with the number of moles of Ag$_2$SO$_4$.

(c) Determine the magnitude of the energy change in the form of heat that occurred when the two solutions were mixed.

\[ 15.69 \text{mole Ag}_2\text{SO}_4 \left( \frac{1\text{mole}}{31.89} \right) \left( \frac{17.8\text{kJ}}{1\text{mole}} \right) = -289\text{kJ} \quad 3\text{pts} \]

3pts for calculation

1 point is earned for the correct calculation of the amount of heat produced that is consistent with the moles of Ag$_2$SO$_4$ calculated in part (b).
(d) Based on your calculations in part (c) and the precision of the thermometer shown above, what value would the student record as the final temperature of the reaction mixture? Justify your answer with calculations. Assume that the calorimeter is perfectly insulated and the specific heat of the reaction mixture is 4.18 J/(g°C). Also assume that the volumes are additive and that the density of the final solution is 1.10 g/mL.

\[ \text{Volume of soln} = 150 \text{ mL} \left(\frac{1.10 \text{ g}}{2.3 \text{ mL}}\right) = 165.26 \text{ mL} \]

\[ 891 = (165.26 \times 4.18) \Delta T \]

\[ \Delta T = 1.29 \text{°C} \]

Thermometer reads to nearest 1°C, so to 52°F.

\[ 20.0 + 1.29 = 21.0 \text{°C} \]

For correct precision.

1 point is earned for the correct calculation of \( \Delta T \) that is consistent with the value of heat obtained in part (c).

1 point is earned for the correct final temperature of the reaction mixture, rounded to the nearest 1°C, that is consistent with the value of \( \Delta T \).
<table>
<thead>
<tr>
<th>Substance</th>
<th>( \text{Ag}_2\text{SO}_4(s) )</th>
<th>( \text{AgCl}(s) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molar Solubility</td>
<td>?</td>
<td>( 1.4 \times 10^{-5} )</td>
</tr>
<tr>
<td>( \text{mol/L} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( K_{sp} )</td>
<td>( 1.1 \times 10^{-5} )</td>
<td>?</td>
</tr>
<tr>
<td>Lattice Energy</td>
<td>1800</td>
<td>?</td>
</tr>
<tr>
<td>( \text{kJ/mol} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(e) Explain how the data in the table supports the observation that a precipitate formed when solutions of \( \text{AgNO}_3(aq) \) and \( \text{Na}_2\text{SO}_4(aq) \) were mixed.

The \( K_{sp} \) for \( \text{Ag}_2\text{SO}_4 \) \(<1\). This implies the salt is, at best, slightly soluble.

(f) Using the data in the table, calculate the value of \( K_{sp} \) for \( \text{AgCl} \).

\[
K_{sp} = \left[ \text{Ag}^+ \right] \left[ \text{Cl}^- \right] = 1.4 \times 10^{-5} \times 1.4 \times 10^{-5} = 2 \times 10^{-15}
\]

1 point is earned for a correct explanation.

\[
K_{sp} \leq [2.0 \times 10^{-10}] \text{ or } 2.0 \times 10^{-10}
\]

1 point is earned for a correct calculation of \( K_{sp} \).
(g) Shown above is a particulate representation of 300. mL of a saturated solution of AgCl. Based on this diagram, create a particulate representation of the AgCl solution when half of the solid AgCl is removed from 300. mL of the saturated solution.

1 point is earned for a correct drawing.

(h) The lattice energy of Ag\textsubscript{2}SO\textsubscript{4}(s) is 1800 kJ/mol. Would you predict the lattice energy of AgCl(s) to be greater than, less than, or equal to 1800 kJ/mol? Justify your answer.

Lattice Energy depends on the charge of the cation and anion as well as the distance between them. As Ag\textsuperscript{+} has +1 and Cl\textsuperscript{-} has -1 charge, compared to the +1,-2 of Ag\textsubscript{2}SO\textsubscript{4}, I would predict that AgCl has a lower LE.

1 point is earned for the correct answer with an appropriate justification.

Total: 29 pts!
1a) LOOKS GOOD

(a) Write the net ionic equation for the reaction above.

\[ 2Ag^+ + 2NO_3^- + 2Na^+ + SO_4^{2-} \rightarrow Ag_2SO_4 + 2Na^+ + 2NO_3^- \]

\[ 2Ag_{(aq)}^+ + SO_4^{2-}_{(aq)} \rightarrow Ag_2SO_4_{(s)} \]

(b) Determine the mass of Ag$_2$SO$_4$ produced in this reaction.

\[ 2Ag_{(aq)}^+ + SO_4^{2-}_{(aq)} \rightarrow Ag_2SO_4_{(s)} \]
\[
Ag^+(aq) + SO_{4}^{2-}(aq) \rightarrow Ag_2SO_4(s)
\]

\[
Ag^+ + SO_{4}^{2-} \rightarrow Ag_2SO_4
\]

\[
Ag^+ + SO_{4}^{2-} \rightarrow Ag_2SO_4(s)^0
\]

\[
Ag^+ + NO_3^{-} + Na^+ + SO_{4}^{2-} \rightarrow Ag_2SO_4 + Na^+ + NO_3^{-}
\]
WRONG/MISSING CHARGES ON IONS

\[ 2 \text{Ag}^{+} + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 (s) \]

\[ 2 \text{Ag}^{2+} + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 \]

\[ 2 \text{AgNO}_3 + \text{Na}_2\text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 + 2 \text{NaNO}_3 \]

- \[ 2 \text{Ag} + 2\text{HNO}_3 + 2\text{Na}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{Na}^+ + 2\text{HNO}_3 \]
- \[ 2 \text{Ag} + \text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 \]

b) Determine the mass of \( \text{Ag}_2\text{SO}_4 (s) \) produced in this reaction.
WRONG/MISSING CHARGES ON IONS

2Ag(aq) + NO_3(aq) + Na_2(aq) + SO_4(aq) → Ag_2(s) + SO_4(s) + 2Na(aq)

2Ag(aq) + SO_4(aq) → Ag_2SO_4(s)

(a) Write the net ionic equation for the reaction above.

2Ag^+ + 2NO_3^- + 2Na^+ + SO_4^2- → 2Ag^+ + SO_4^2- + 2Na^+ + 2NO_3^-
DIDN’T CROSS OF THE SPECTATOR IONS

(a) Write the net ionic equation for the reaction above.

\[
2\text{AgNO}_3(aq) + \text{Na}_2\text{SO}_4(aq) \rightarrow \text{Ag}_2\text{SO}_4(s) + 2\text{NaNO}_3(aq)
\]

\[
\text{Ag}^+ + \text{NO}_3^- + \text{Na}_2\text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 + \text{Na}^+ + \text{NO}_3^-
\]

\[
2\text{Ag}^+ + \text{Na}_2\text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{Na}^+
\]

\[
2\text{Ag}^{\text{aq}} + 2\text{NO}_3^{\text{aq}} + 2\text{Na}^{\text{aq}} + \text{SO}_4^{2-\text{aq}} \rightarrow \text{Ag}_2\text{SO}_4(s) + 2\text{Na}^{\text{aq}} + 2\text{NO}_3^{\text{aq}}
\]
MINOR ISSUES

\[ \text{Ag}_2^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 \]
MAJOR ISSUES

(a) Write the net ionic equation for the reaction above.

\[ 2\text{AgNO}_3 + \text{Na}_2\text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{NaNO}_3 \]

\[ 2\text{Ag}^+ + 2\text{NO}_3^- + 2\text{Na}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{Na}^+ + 2\text{NO}_3^- \]

\[ \text{NO}_3^- + \text{Na}^+ \rightarrow \text{2NaNO}_3 \]

(b) Write the net ionic equation for the reaction above.

\[ \text{SO}_4^{2-} + 2\text{NO}_3^- + 2\text{Ag}^+ + 2\text{Na}^+ \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{NaNO}_3 \]

(c) Write the net ionic equation for the reaction above.

\[ \text{Ag}^{+2} \text{(aq)} + \text{NO}_3^{-2} \text{(aq)} + \text{Na}^{+} \text{(aq)} + \text{SO}_4^{2-} \text{(aq)} \rightarrow \text{Na}^{+} \text{(aq)} + \text{NO}_3^{-} \text{(aq)} \]

(d) Write the net ionic equation for the reaction above.

\[ \text{2Ag}^+ + \text{Na}_2^- \rightarrow \text{Ag}_2 + 2\text{Na}^- \]
MAJOR ISSUES

$2\text{AgNO}_3\text{(aq)} + \text{Na}_2\text{SO}_4\text{(aq)} \rightarrow 2\text{NaNO}_3\text{(aq)} + 2\text{Ag}\text{SO}_4\text{(s)} + 17.8\text{kJ}$

$2\text{Ag}^{+2} + 2\text{NO}_3^{-2} + 2\text{Na}^{+2} + 2\text{SO}_4^{-2} \rightarrow 2\text{Ag}^{+2} + 2\text{SO}_4^{-2} + 2\text{Na}^{+2} + 2\text{NO}_3^{-2}$

$2\text{Ag} + \text{NO}_3^{-} + \text{Na}_2 + \text{SO}_4 \rightarrow \text{Ag}_2 + \text{SO}_4 + 2\text{Na} + \text{NO}_3$

$2\text{Ag} + 2\text{NO}_3^{-} + \text{Na}_2 + \text{SO}_4 \rightarrow \text{Ag}_2 + 2\text{SO}_4 + 2\text{Na} + 2\text{NO}_3$

$2\text{Ag} + \text{Na}_2 \rightarrow \text{Ag}_2 + 2\text{Na}$
MAJOR ISSUES

\[ 2Ag + 2NO_3 + Na_2 + SO_4 \rightarrow Ag_2 + SO_4 + 2Na + 2NO_3 \]

\[ 2Ag + NO_3 + Na_2 + SO_4 \rightarrow Ag_2 + SO_4 + 2Na + NO_3 \]

(a) Write the net ionic equation for the reaction above.

\[ Ag + NO_3 + Na_2 + SO_4 \rightarrow Ag_2 + SO_4 + No + NO_3 \]

\[ \text{Ag}^{\text{aq}} + \text{Na}_2^{\text{aq}} \rightarrow \text{Ag}_2^{\text{aq}} + 2\text{Na}^{\text{aq}} \]

\[ 2Ag + \text{Na}_2 \rightarrow Ag_2 + 2\text{Na} \]
(b) Determine the mass of AgSO₄(s) produced in this experiment.

\[
\begin{align*}
\text{mol AgNO}_3 \times 1.00 \text{ M} (0.100 \text{ L}) &= 0.100 \text{ mol AgNO}_3 \\
\text{mol Na}_2\text{SO}_4 \times 1.50 \text{ M} (0.0500 \text{ L}) &= 0.0750 \text{ mol Na}_2\text{SO}_4 \\
0.100 \text{ mol AgNO}_3 &\quad 1 \text{ mol Ag}_2\text{SO}_4 & 311.8 \text{ g Ag}_2\text{SO}_4 \\
2 \text{ mol AgNO}_3 &\quad 1 \text{ mol Ag}_2\text{SO}_4 & \text{AgNO}_3 \text{ limits the rxn}
\end{align*}
\]

\[
\begin{align*}
0.0750 \text{ mol Na}_2\text{SO}_4 &\quad 1 \text{ mol Ag}_2\text{SO}_4 & 311.8 \text{ g Ag}_2\text{SO}_4 \\
1 \text{ mol Na}_2\text{SO}_4 &\quad 1 \text{ mol Ag}_2\text{SO}_4 \\
\end{align*}
\]

(1 L) = 0.1 mol AgNO₃

0.5 (1.5 M) = 0.75 mol Na₂SO₄

0.1 mol AgNO₃ = 0.75 mol Ag₂SO₄ limiting

0.75 mol Na₂SO₄ = 1.0 mol Ag₂SO₄

\[
\begin{align*}
\text{mol Ag}_2\text{SO}_4 \times 0.5 \text{ mol AgSO}_4 &= 0.5 \text{ mol AgSO}_4 \\
311.8 \text{ g AgSO}_4 &\quad 1 \text{ mol Ag}_2\text{SO}_4 \\
\end{align*}
\]

\[
\begin{align*}
\text{mol Ag}_2\text{SO}_4 \times 0.0750 \text{ mol AgSO}_4 &= 0.075 \text{ mol AgSO}_4 \\
311.8 \text{ g AgSO}_4 &\quad 1 \text{ mol Ag}_2\text{SO}_4 \\
\end{align*}
\]

\[
\begin{align*}
\text{mol AgSO}_4 \times 15.6 \text{ g AgSO}_4 &= 15.6 \text{ g AgSO}_4 \\
1 \text{ mol AgSO}_4 &\quad 1 \text{ mol Ag}_2\text{SO}_4 \\
\end{align*}
\]

\[
\begin{align*}
\text{mol AgSO}_4 \times 23.4 \text{ g AgSO}_4 &= 23.4 \text{ g AgSO}_4 \\
1 \text{ mol AgSO}_4 &\quad 1 \text{ mol Ag}_2\text{SO}_4 \\
\end{align*}
\]

\[
\begin{align*}
\text{mol AgSO}_4 \times 15.59 \text{ g AgSO}_4 &= 15.59 \text{ g AgSO}_4 \\
1 \text{ mol AgSO}_4 &\quad 1 \text{ mol Ag}_2\text{SO}_4 \\
\end{align*}
\]
$$\text{AgNO}_3: \quad 0.100 \text{ moles} \times \frac{1 \text{ mol} \text{ Ag}_2\text{SO}_4}{2 \text{ mole AgNO}_3} \times \frac{311.8 \text{ g}}{1 \text{ mol Ag}_2\text{SO}_4} = 15.59 \text{ g} \rightarrow 15.6 \text{ g Ag}_2\text{SO}_4$$

$$\text{Na}_2\text{SO}_4: \quad 0.0750 \text{ moles} \times \frac{1 \text{ mol} \text{ Ag}_2\text{SO}_4}{1 \text{ mol Na}_2\text{SO}_4} \times \frac{311.8 \text{ g}}{1 \text{ mol Ag}_2\text{SO}_4} = 23.385 \rightarrow 23.4 \text{ g}$$

$$V \cdot M = \frac{n}{\beta}$$

$$\text{(100 mL = (0.1 L) (1.00 M)} = 0.1 \text{ mol AgNO}_3$$

$$\text{So mL = (0.05 L) (1.50 M)} = 0.075 \text{ mol Na}_2\text{SO}_4$$

$$A_5 = 107.8 \cdot 2 = 215.6 \text{ g}$$

$$S = 32.0 \times 32.0 = 1024 \rightarrow = 311.8$$

$$0 = 6.00 \cdot 4 = 24$$

(c) Determine the magnitude of the energy change in the form of heat for the compound reaction.
GOT THE 1\textsuperscript{ST} PT., BUT MISSED THE 2\textsuperscript{ND} PT.

(b) Determine the mass of Ag\textsubscript{2}SO\textsubscript{4}(s) produced in this experiment.

\[ (1.5\text{M})(0.05\text{L}) = \frac{0.075\text{mol Ag}_2\text{SO}_4}{1\text{mol Ag}_2\text{SO}_4} \times \frac{1\text{mol SO}_4^2-}{1\text{mol Ag}_2\text{SO}_4} = 0.075\text{mol Ag}_2\text{SO}_4 \]

\[ \frac{0.05\text{mol Ag}_2\text{SO}_4}{1\text{mol Ag}_2\text{SO}_4} \times 375.8\text{g Ag}_2\text{SO}_4 = 18.79\text{g Ag}_2\text{SO}_4 \]

\[ \text{AgNO}_3 (1.00)(0.1) = 0.1\text{mol} \]
\[ \text{Na}_2\text{SO}_4 (1.50)(0.05) = 0.075\text{mol} \]
\[ 0.1\text{mol AgNO}_3 \times \frac{1\text{mol Ag}_2\text{SO}_4}{2\text{mol AgNO}_3} = 0.05\text{mol} \]
\[ 0.075\text{mol Na}_2\text{SO}_4 \times \frac{1\text{mol Ag}_2\text{SO}_4}{2\text{mol Na}_2\text{SO}_4} = 0.075\text{mol} \]
\[ (0.05\text{mol Ag})(22.39\times 2) = 223.9\text{g Ag} + 32.07 + (15.00 \times 4) \]
\[ (0.05)(142.09) = 7.1\text{g Ag}_2\text{SO}_4 \]
MISSED THE 1\textsuperscript{ST} PT., BUT GOT THE 2\textsuperscript{ND} PT.

1.5 \times 0.05 = 0.075 \text{ mol} \quad \frac{311.8 \text{ g Ag}_2\text{SO}_4}{1 \text{ mol Ag}_2\text{SO}_4} = \frac{23.39 \text{ g}}{\text{Ag}_2\text{SO}_4} \]  

(b) Determine the mass of AgSO\textsubscript{4}(s) produced in this experiment.

\[
\frac{50 \text{ mL}}{1000 \text{ mL}} = 0.05 \text{ L} \quad \text{mol} = (M)(L) = (1.50 \text{ M})(0.05 \text{ L})
\]

\[
0.0750 \text{ mol Na}_2\text{SO}_4 \quad 1 \text{ mol Ag}_2\text{SO}_4 \quad 311.8 \text{ g Ag}_2\text{SO}_4 \quad \frac{23.4 \text{ g}}{\text{Ag}_2\text{SO}_4}
\]

\[
\left[\text{Ag}^+\right]^2 = 0.50 \mu \text{M} \quad [\text{SO}_4] = 0.50 \mu \text{M} \quad \frac{50 \text{ mL}}{100 \text{ mL}}
\]

\[
0.50 \mu \text{M} + 0.50 \mu \text{M} (0.150 \text{ L}) = 0.150 \text{ mol Ag}_2\text{SO}_4
\]

\[
0.150 \text{ mol} \times \frac{311.8 \text{ g}}{1 \text{ mol}} = 46.47 \text{ g} \text{ Ag}_2\text{SO}_4
\]
STUDENT USED A B-C-A TABLE. IT WORKED.
THEY ALSO GOT THE 2ND PT.

(b) Determine the mass of Ag₂SO₄(s) produced in this experiment.

\[2\text{AgNO}_3 + \text{Na}_2\text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{NaNO}_3\]

\[
\begin{array}{c|c|c|c}

B & 0.1\text{mol} & 0.75\text{mol} & 0 \\
C & -x & 0.05 & +x \\
A & 0 & 0.025\text{mol} & +2x \\
\end{array}
\]

\[311.74 \times 0.05 = 15.587\text{g Ag}_2\text{SO}_4\]

\[2\text{Ag SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 \]

\[
\begin{array}{c|c|c|c}

B & 0.1 & 0.75 \\
C & -x & 0.05 \\
A & 0 & 0.05\text{mol} \\
\end{array}
\]

\[15.6\text{g Ag}_2\text{SO}_4\]

\[
\begin{array}{c|c|c|c}

0.05\text{mol} & 311.8\text{g} \\
1\text{mol} & 2\text{Ag}_2\text{SO}_4 \\
\end{array}
\]
STUDENT USED A 1-C-E TABLE. IT DIDN’T WORK. THEY DID GET THE 2\textsuperscript{ND} PT.

(b) Determine the mass of Ag\textsubscript{2}SO\textsubscript{4}(s) produced in this experiment.

$$2\text{Ag} + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4$$

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>.05</td>
<td>.075</td>
</tr>
<tr>
<td>C</td>
<td>- .05</td>
<td>- .025</td>
</tr>
<tr>
<td>E</td>
<td>(\emptyset)</td>
<td>.05</td>
</tr>
</tbody>
</table>

\[
\frac{\text{mol}}{0.1} = 1
\]

\[
\frac{\text{mol}}{-1.5}
\]

\[
0.05 = \text{mol} \times \frac{217.59 \text{ g}}{1 \text{ mol}} = 7.8 \text{ g} \quad \text{Ag}_2\text{SO}_4
\]

\[
0.075 \times 80.4 = 6.03 \text{ g AgNO}_3
\]
I DON'T SEE ENOUGH WORK TO SHOW WHY AgNO₃ IS THE LIMITING REACTANT

(b) Determine the mass of Ag₂SO₄(s) produced in this experiment.

\[
\begin{align*}
\text{AgSO}_4 & = 311.80 \text{ g/mol} \\
0.1574 + 0.0626 + 0.0400 & = 0.2600 \\
\text{1 mol Ag}^+ & \times \frac{1 \text{ mol Ag}_2\text{SO}_4}{2 \text{ mol Ag}^+} \times \frac{311.80 \text{ g}}{1 \text{ mol Ag}_2\text{SO}_4} = 15.6 \text{ g Ag}_2\text{SO}_4
\end{align*}
\]
(c) Determine the magnitude of the energy change in the form of heat that occurred when the two solutions were mixed.

\[
q = -
\]

\[
q = 0.0500 \text{ mol}_\text{rxn} \cdot (-17.8 \text{ kJ/mol}_\text{rxn})
\]

\[
q = -0.890 \text{ kJ} = -890. \text{ J}
\]

\[
\frac{0.100 \text{ mol AgNO}_3}{2 \text{ mol AgNO}_3} \cdot \frac{1 \text{ mol}_\text{rxn}}{2 \text{ mol AgNO}_3} = 0.0500 \text{ mol}_\text{rxn}
\]

\[
-17.8 \text{ kJ/mol}_\text{rxn} \times 0.0500 \text{ mol}_\text{rxn} = -0.89 \text{ kJ}
\]

0.89 kJ were released.

\[
(-17.8 \text{ kJ/mol}_\text{rxn}) \cdot 0.0500 \text{ mol Ag}_2\text{SO}_4 = -0.890 \text{ kJ in this reaction}
\]
NUMBER OF MOLES = 0.1

$1 \text{ mol } \text{AgNO}_3 \times \frac{-17.8 \text{ kJ}}{\text{ mol}} = -17.8 \text{ kJ}$

NUMBER OF MOLES = 1.15

(c) Determine the magnitude of the energy change in the form of heat that occurred when the two solutions were mixed.

$-17.8 \text{ kJ/mol} \times 1.15 \text{ mol} = -20.47 \text{ kJ}$
The magnitude of the energy change was negative.

\[-17.8 \text{ kJ/mol} \times \frac{1000 \text{ J}}{1 \text{ kJ}} = \frac{-17800}{-17.8} \text{ kJ/mol}\]

The energy of the reactants was greater than the energy of the products and the energy changed by at least \(-17.8 \text{ kJ/mol}\).
(c) Determine the magnitude of the energy change in the form of heat that occurred when the two solutions were mixed.

\[ \Delta H = -17.8 \text{ kJ/mol} \]

The change was exothermic, \(-17.8 \text{ kJ/mol}\)
Initial Temperature: 20. °C

Volume = 100. mL + 50.0 mL = 150. mL

\[ Q = mc \Delta T \rightarrow \Delta T = \frac{Q}{mc} \]

\[ \Delta T = \frac{890. J}{150 \text{ mL}} \left( \frac{1.10 \text{ g}}{\text{mL}} \right) \left( 4.18 \text{ J/g}^\circ \text{C} \right) = 1.29 \circ \text{C} \]

20. °C + 1.29 °C = 21 °C

Final temperature: 21 °C

\[ \Delta H = 890 \text{ J} \]

\[ 890 \text{ J} = (115 \text{ g})(4.18 \text{ J/g}^\circ \text{C})(\Delta T) \]

\[ \Delta T = 1.29 \circ \text{C} \]

20. °C + 1.29 °C = 21.29 °C

21 °C
CONFUSION OF UNITS (kJ vs. J)

\[ q = mc \Delta T \]

\[ m: \ 150 \text{mL} \ (1.10 \text{g/mL}) = 165 \text{g solution} \]

\[ -0.89 = 165 \text{g} \ (4.183/(g{\cdot}^\circ \text{C})) \ (T_f - 20) \]

\[ T_f = 199.98 \]

The student would still record a temperature of 20\(^\circ\text{C}\).
CORRECT MAGNITUDE FOR $\Delta T$

FINAL $T =$ CORRECT PRECISION, BUT WRONG DIRECTION

solution is 1.10 g/mL.

\[ q = mc\Delta T \]

\[ 890 = 165 \cdot 4.18 \Delta T \]

$\Delta T = -1.23 \, ^\circ C$

\[ q = \frac{150 \, \text{mL} \cdot 1.10 \, \text{g} = 165 \, \text{g}}{1 \, \text{mL}} \]

\[ -0.890 \, \text{kJ} \cdot 1000 \, \text{J} = -890 \, \text{J} \]

Final temp = 19 $^\circ C$

FINAL $T =$ WRONG PRECISION

\[ q = mc\Delta T \]

\[ 890 = 165 \cdot 4.18 \Delta T \]

$\Delta T = 1.29 \, ^\circ C$

Final temp: 21.3 $^\circ C$
NUMBER OF MOLES = 0.175

\[
\frac{17.8 \text{ kJ}}{1 \text{ mol}} \times 0.175 \text{ mol} = 3.12 \text{ kJ}
\]

ERROR CARRIED FORWARD FOR \( \Delta T \)

FINAL \( T \) HAS CORRECT PRECISION

(3) Also assume that the volumes are additive and that the density of the final solution is 1.10 g/mL.

\[ q = mc\Delta T \]

\[ 3120 = 165 (4.18)(x - 20) \]

\[ 4.523 = x - 20 + 20 \]

\[ x = 25 \]

\[ T_f = 25^\circ C \]
NUMBER OF MOLES = 0.1

1 mol AgNO₃ x \(-17.8 \text{kJ} \) mol\(^{-1}\) \(-1.78 \text{kJ}\)

ERROR CARRIED FORWARD FOR \(\Delta T\)
FINAL \(T\) = WRONG PRECISION

\[
0 = \frac{c}{V} \times 110 = \frac{q}{150} \quad q = mc \Delta T
\]

\(x = 165\)

\(-1.78 \text{kJ} = -1780 \text{J}\)

\[
1780 \text{J} = (165 \text{g})(4.185 \text{J/g} \cdot ^\circ C)(x - 20^\circ C)
\]

\(22.6^\circ C = x\)
DOES THIS ANSWER SEEM REASONABLE TO YOU?

Initial temp 20°

\[-1.835 \text{kJ} = \frac{1.109}{20} \times 10.004185 \times (x - 20)\]

= \boxed{-270°C}

\[q = mc\Delta T\]
\[-17.8 = 0.000165 (9.18) (\Delta T - 20)\]
\[-17.8 = 0.00016897 (\Delta T - 20)\]
\[-2580.83 = \Delta T - 20\]
\[-2580.83 = \Delta T\]

50 mL

120 mL
(e) Explain how the data in the table supports the observation that a precipitate formed when solutions of AgNO₃(aq) and Na₂SO₄(aq) were mixed.

The data in the table supports that a precipitate formed when solutions of AgNO₃ and Na₂SO₄ were mixed because Ag₂SO₄(s) has a Ksp that is less than 1.

When AgNO₃(aq) and Na₂SO₄(aq) are mixed, Ag₂SO₄(s) is made. The Ksp value for Ag₂SO₄(s) shown in the data value, 1.1 x 10⁻⁵, is a small number which means the molar solubility of Ag₂SO₄(s) is small and precipitate will form.

The data in the table supports the observation that a precipitate formed when solutions of AgNO₃(aq) and Na₂SO₄(aq) were mixed is the Ksp of AgSO₄ is very low. Since the Ksp is low it signifies that it has low solubility.
SIMPLY BECAUSE IT HAS A $K_{sp}$ VALUE, IT MUST NOT BE VERY SOLUBLE IN WATER

The precipitate formed 5/6 of the $K_{sp}$ of $\text{Ag}_2\text{SO}_4$ exists so $\text{Ag}_2\text{SO}_4(s) \rightarrow \text{Ag}^{+1} \text{aq} + \text{SO}_4^{2-} \text{aq}$.

Which means that $\text{Ag}^{+1} + \text{SO}_4^{2-}$ are aqueous and $\text{Ag}_2\text{SO}_4$ is a solid which means a precipitate is formed.

YOU HAVE TO USE THE DATA IN THE TABLE. THE FACT THAT $\text{Ag}_2\text{SO}_4$ IS A SOLID IS NOT ENOUGH OF A JUSTIFICATION

Because $\text{Ag}_2\text{SO}_4$ is solid therefore a precipitate and it was produced.
THE STUDENT STATES THAT $Q > K_{sp}$ BUT USES THE WRONG VALUE OF $Q$

(e) Explain how the data in the table supports the observation that a precipitate formed when solutions of $\text{AgNO}_3(aq)$ and $\text{Na}_2\text{SO}_4(aq)$ were mixed.

Precipitate forms when $Q_{sp}$, instantaneous solubility product, is higher than $K_{sp}$.

$$Q_{sp} = [\text{Ag}^+]^2 \cdot [\text{SO}_4^{2-}] = [\text{AgNO}_3]^2 \cdot [\text{Na}_2\text{SO}_4]$$

$$= (1.00 \text{ M})^2 \cdot (1.50 \text{ M}) = 1.50.$$  

$Q_{sp} \gg K_{sp}$, precipitate forms, according to Le Chatelier's principle.

(f) Using the data in the table, calculate the value of $K_{sp}$ for $\text{AgCl}$.

DIDN'T READ THE QUESTION CAREFULLY

(e) Explain how the data in the table supports the observation that a precipitate formed when solutions of $\text{AgNO}_3(aq)$ and $\text{Na}_2\text{SO}_4(aq)$ were mixed.

According to the table, $\text{AgCl}$ only had a molar solubility of $1.4 \times 10^{-5}$, so it is unlikely to be soluble.
The lattice energy is high, which means that it formed an ionic precipitate. The Ksp value also shows the solubility of Ag₂SO₄ and it is not the most soluble.
R: $\text{AgCl} \rightleftharpoons \text{Ag}^+ + \text{Cl}^-$

$K_{sp} = [\text{Ag}^+][\text{Cl}^-]

K_{sp} = (x)(x)

K_{sp} = (1.4 \times 10^{-5})^2

K_{sp} = 2.0 \times 10^{-10}$

$K_{sp} = [\text{Ag}^+][\text{Cl}^-] = (1.4 \times 10^{-5})^2 = 2.0 \times 10^{-10}$

$x = 1.4 \times 10^{-5}$

$x^2 = (1.4 \times 10^{-5})^2

K_{sp} = 1.96 \times 10^{-10}$
GOOD SET-UP, BUT CALCULATION ERROR

(f) Using the data in the table, calculate the value of $K_{sp}$ for AgCl.

$AgCl(s) \rightleftharpoons Ag^+ + Cl^-$

$K_{sp} = [Ag^+][Cl^-]$

$K_{sp} = (1.4 \times 10^{-5})(1.4 \times 10^{-5})$

$K_{sp} = 1.96 \times 10^{-10}$

SET UP A $K_{sp}$ EXPRESSION
THAT INCLUDED $[Ag^+]$, $[Cl^-]$, and $[AgCl]$

$AgCl = Ag^+ + Cl^-$

$K_{sp} = \frac{(1.4 \times 10^{-5})(1.4 \times 10^{-5})}{1.4 \times 10^{-5}}$

$K_{sp} = 1.4 \times 10^{-5}$
DID THE SQUARE ROOT OF THE MOLAR SOLUBILITY INSTEAD OF SQUARING THIS VALUE

\[ K_{sp} = [Ag^+] [Cl^-] \]
\[ K_{sp} = [1.4 \times 10^{-5}]^2 \]
\[ K_{sp} = 0.0037 \]

MOLAR SOLUBILITY IS NOT THE SAME AS THE Ksp

\[ K_{sp} = [AgCl] \]
\[ [AgCl] = \text{molar solubility} \]
\[ = K_{sp \ AgCl} = 1.4 \times 10^{-5} \]
CONFUSED BETWEEN AgCl AND Ag$_2$SO$_4$

\[ \text{K}_{sp} = (5)(2s)^2 \]
\[ \text{K}_{sp} = 4s^3 \]
\[ \text{K}_{sp} = (9)(1.4 \times 10^{-5})^3 \]
\[ \text{K}_{sp_{AgCl}} = 1.1 \times 10^{-10} \]
THE MOST COMMON MISTAKE WAS TO REDUCE THE NUMBER OF PARTICLES BY HALF
WE ALSO SAW STUDENT DRAWINGS LIKE THESE
Less than. Lattice energy is the amount of energy needed to overcome an ionic bond, and the stronger the charges, the stronger the bond.

Cl is only a charge of -1, while sulfate ion is -2. Therefore, Ag₂SO₄ is held together more strongly than AgCl, causing AgCl to have a lattice energy lower than that of Ag₂SO₄.

(h) The lattice energy of Ag₂SO₄(s) is 1800 kJ/mol. Would you predict the lattice energy of AgCl(s) to be greater than, less than, or equal to 1800 kJ/mol? Justify your answer.

The lattice energy would be less than 1800 kJ/mol. The charges of the ions in Ag₂SO₄ is greater than the charges in AgCl.
AgCl has greater lattice energy because chloride is more electronegative than sulfate.

I predict that the lattice energy of AgCl to be greater than 1800 kJ/mol. Cl is more electronegative than SO₄, which means it bonds more strongly to Ag. This makes the lattice energy higher because more energy is required to break the bond.

Justification based on molar mass

(h) The lattice energy of Ag₂SO₄(s) is 1800 kJ/mol. Would you predict the lattice energy of AgCl(s) to be greater than, less than, or equal to 1800 kJ/mol? Justify your answer.

Lattice energy of AgCl(s) would be less than that of Ag₂SO₄ because the mass of AgCl is less than that of Ag₂SO₄.
ASSUMPTION THAT A SMALLER $K_{sp}$ VALUE (OR LOWER SOLUBILITY) MEANS THAT AgCl SHOULD HAVE A GREATER LATTICE ENERGY

I would predict the lattice energy of AgCl (s) to be greater than 1860 KJ/mol because the molar solubility of AgCl (s) is less than Ag₂SO₄ (s). Therefore, it will require more lattice energy to break the ionic bonds in order for the AgCl (s) to dissolve.

I would predict the lattice energy of AgCl to be greater than the lattice energy of Ag₂SO₄. That is because Ag₂SO₄ has a larger $K_{sp}$, meaning it has a weaker lattice structure allowing it to be more easily dissolved.
Q1 - Take Home Lessons

(a) read question carefully
   practice writing NIEs

(b) molarity $\neq$ moles
   molar mass should be easy
   practice solving limiting reactant problems
Q1 - Take Home Lessons
(c) heat \( (q) \neq \Delta H \)
connect \( q \) to the limiting reactant
exothermic vs. endothermic
system vs. surroundings
(d) write units in the middle of calculations; consider precision, and “does my final answer make sense?”
(e-f) \( K_{sp} \neq \) molar solubility
read question carefully

(g) amount of ionic solid in a saturated solution has no effect on the concentration of the ions

(h) Coulomb's law (charge & distance)

three processes involved in solubility (supersaturation, nucleation, growth)
### Q2

<table>
<thead>
<tr>
<th>Substance</th>
<th>Lewis Electron-Dot Structure</th>
<th>Boiling Point (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{C}_2\text{H}_4\text{FCl}$</td>
<td><img src="attachment" alt="Lewis Structure" /></td>
<td>326</td>
</tr>
<tr>
<td>$\text{C}_2\text{Cl}_3\text{F}$</td>
<td><img src="attachment" alt="Lewis Structure" /></td>
<td>344</td>
</tr>
</tbody>
</table>

Answer the following questions related to the structures and properties of $\text{C}_2\text{H}_4\text{FCl}$ and $\text{C}_2\text{Cl}_3\text{F}$, as shown in the table above.

(a) In the table above, complete the Lewis electron dot structure for $\text{C}_2\text{Cl}_3\text{F}$. Be sure to include all shared pairs and unshared pairs of electrons in the diagram.

(b) Identify the approximate value of the C–C–Cl bond angle in the $\text{C}_2\text{H}_4\text{FCl}$ molecule.

(c) Which bond, C–Cl or C–F, would be longer in the $\text{C}_2\text{H}_4\text{FCl}$ molecule? Justify your answer in terms of atomic structure.

(d) A chemistry student examined the data in the table above and claimed that the reason why $\text{C}_2\text{Cl}_3\text{F}$ has a higher boiling point than $\text{C}_2\text{H}_4\text{FCl}$ is because the bonds in $\text{C}_2\text{Cl}_3\text{F}$ are stronger than the bonds in $\text{C}_2\text{H}_4\text{FCl}$. Do you agree with the student’s claim? Justify your answer.
(b) Identify the approximate value of the C–C–Cl bond angle in the C₂H₄FCl molecule.

Any value between 104° and 110°

1 point is earned for an acceptable bond angle.

(c) Which bond, C–Cl or C–F, would be longer in the C₂H₄FCl molecule? Justify your answer in terms of atomic structure.

I predict that the C–Cl bond would be longer. Cl has valence electrons in higher energy levels and thus these electrons are further from the nucleus than those of F. Because the Cl atom

1 point is earned for the correct answer with the appropriate justification.

(d) A chemistry student examined the data in the table above and claimed that the reason why C₂Cl₃F has a higher boiling point than C₂H₄FCl is because the bonds in C₂Cl₃F are stronger than the bonds in C₂H₄FCl. Do you agree with the student’s claim? Justify your answer.

I disagree. Boiling point is the temperature at which a substance changes from liquid to gas. Hence, in order to boil, intermolecular forces must be overcome. The bonds in a molecule have nothing to do with the IMFs, as you do not break bonds to heat

1 point is earned for the correct answer with the appropriate justification.
Part b)

Any value between 104° and 110°

- 180°
- 109.5°
- 105°
- 90°
- 136°
- 120°

The bond angle at C-C-Cl is approximately 90.4°.

(b) Identify the approximate value of the C–C–Cl bond angle in the C₂H₄FCl molecule.

C–C–Cl = 120°
Part c)

C-Cl would be longer because Cl has an extra energy level, increasing the distance between it and the C.

(c) Which bond, C-Cl or C-F, would be longer in the C₂H₄FCl molecule? Justify your answer in terms of atomic structure.

C-Cl would be the longer bond. Cl has a larger atomic radius than F, because it has one more shell of electrons.

C-Cl because Cl has a larger atomic radius than F since Cl is one period lower.

C-Cl would be longer since Cl has an extra row of electrons making its radius greater and therefore further away from C.
Misc not there

C-Cl. Chlorine has more valence electrons than fluorine. This means it has a larger atomic radius and therefore a longer bond length with C than F has with C.

The C-Cl bond would be longer because chlorine has a larger radius compared to fluorine.

c-Cl would have the longer bond since its atomic radius is slightly smaller than C-F's atomic radius.
Electronegativity

The bond C-Cl would be longer in the C$_2$H$_4$FCl molecule because it has a lower electronegativity than F. Cl has one more valence shell than F, so its nucleus is less attracted to valence electrons, including valence electrons of other atoms. This makes the bond C-Cl longer.
of atomic structure.

C-Cl, because Cl has an extra energy level than that of F.

The outer electrons have less coulombic attraction to the nucleus than F, and is therefore less electronegative. Less electronegativity causes the bond to be longer for C-Cl than C-F.

The C-Cl bond would be longer than the C-F bond. Since F is more electronegative, it will attract C closer to it than Cl.

The C-Cl bond would be longer because F is more electronegative than Cl. Therefore, F will have a stronger attraction of electrons, and its bond would be shorter.
Part D

Disagree. The reason why C₂Cl₃F has a higher boiling point than C₂H₄FCl is because C₂Cl₃F experiences stronger intermolecular attractive forces. This can be explained by the fact that C₂Cl₃F has a larger electron cloud, is more polarizable, and experiences stronger London dispersion forces than C₂H₄FCl.

(d) A chemistry student examined the data in the table above and claimed that the reason why C₂Cl₃F has a higher boiling point than C₂H₄FCl is because the bonds in C₂Cl₃F are stronger than the bonds in C₂H₄FCl. Do you agree with the student’s claim? Justify your answer.

I disagree with student’s claim. Both molecules have London dispersion forces, but C₂Cl₃F is more polarizable than C₂H₄FCl because of larger electron clouds. Thus, its intermolecular forces, not bonds within the molecule, require more energy to overcome and make the boiling point higher for C₂Cl₃F.

Not necessarily. C₂Cl₃F has a greater boiling point because its IMF is greater, which in turns stems from the fact that it contains bigger, more polarizable atoms than C₂H₄FCl (Cl>H).
No since boiling point is a physical change and doesn't affect intramolecular bonds.

C₃H₇FCl. Do you agree with the student's claim? Justify your answer.

I agree with the student that the bonds are stronger, but this student is talking about the bonds within the molecule, whereas boiling point is determined by bonds between the molecules. Since both the C₃H₇FCl molecule and the C₂H₆F molecule are non-polar, they both have London dispersion molecules, so the one with the stronger London dispersion forces (induced dipole-induced dipole) will have the higher boiling point since the bonds will be harder to break, and the C₃H₇FCl molecule has less electrons and is smaller than the C₂H₆F, so the C₃H₇FCl will be easier to induce a dipole, therefore, the interactions between the molecules will be stronger, and will have a higher boiling point. Therefore I do not agree with the student that the boiling point is higher because of the interactions within the molecule, it is interactions between molecules.
Yes I agree w/ the student's claim because the stronger the bonds are in a compound, the more energy is needed to break apart the particles. In this case, the stronger the bonds are in a compound, the more heat energy is required to break apart the particles.

Yes bc C₂Cl₃F has a double bond and C₂H₄FCl has all single bonds. Double bonds are stronger bc they have a lower potential energy and thus require more energy to break compared to single bonds.

I agree because C₂Cl₃F has one set of double bonds, whereas C₂H₄FCl has none, so since single bonds are weaker than double bonds, C₂H₄FCl has weaker bonds overall.
I agree with this claim because the molecules in C₂Cl₃F have the ability to have dipole-dipole forces which are stronger than the predominantly LDF's from the nonpolar hydrocarbons in C₂H₄FCl. Therefore, because the IMF's are stronger in C₂Cl₃F, it has a higher boiling point as more energy is required to overcome the forces.

The boiling point of C₂H₄FCl is because the bonds in C₂H₄FCl are stronger than the bonds in C₂Cl₃F. Do you agree with the student's claim? Justify your answer.
Q2 - Take Home Lessons

- The Art of Lewis Structures
- "simple" questions are still valuable
- Misconceptions in bonding
- IMF, IMF, IMF
- Close Reading!!
Thank You!

Special Thanks to all who helped by submitting responses

pricep@trinityvalleyschool.org
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LOOKS GOOD

Write the equation for the reaction above:

\[ 2\text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4(s) \]

\[ 2\text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 \]

\[ 2\text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 \]
LOOKS GOOD

$2\text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4$
NOT BALANCED

$$\text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4(s)$$
WRONG/MISSING CHARGES ON IONS

\[ 2 \, Ag^+(aq) + 2 \, SO_4^{2-} (aq) \rightarrow Ag_2SO_4(s) \]

\[ 2 \, Ag^+ + 2 \, SO_4^{2-} \rightarrow Ag_2SO_4 \]

\[ 2Ag + (NO_3) + Na_2SO_4 \rightarrow Ag_2SO_4 + 2NaNO_3 \]

\[ 2Ag^{+} + SO_4^{2-} (aq) \rightarrow Ag_2SO_4 (s) \]

\[ 2Ag + 2NO_3^{-} (aq) + Ag_2SO_4 + 2NO_3^{-} (aq) \rightarrow Ag_2SO_4 (s) \]

\[ 2Ag (aq) + 2SO_4^{2-} (aq) \rightarrow Ag_2SO_4 (s) \]
WRONG/MISSING CHARGES ON IONS

\[ \text{N.I.: } 2 \text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 (s) \]

\[ 2\text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 \]

(a) Write the net ionic equation for the reaction above.

\[ 2\text{Ag} + \text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 \]
WRONG/MISSING CHARGES ON IONS

\[ 2\text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4^{(s)} \]

\[ 2\text{Ag}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4^{(s)} \]

\[ 2\text{Ag}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{Ag}_2\text{SO}_4^{2-}(\text{s}) \]
MAJOR ISSUES

\[ 2\text{AgNO}_3(aq) + \text{SO}_4^{2-}(aq) \rightarrow \text{Ag}_2\text{SO}_4(s) + 2\text{NO}_3(aq) \]

\[ 2\text{AgNO}_3 + \text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{NO}_3 \]

\[ 2\text{Ag}^+(aq) + \text{Na}_2^-(aq) \rightarrow \text{Ag}_2(s) + 2\text{Na}^-(aq) \]

\[ 2\text{Ag}(aq) + \text{SO}_4(aq) \rightarrow \text{Ag}_2(s) + \text{SO}_4(aq) \]

\[ 2\text{Ag} + \text{Na}_2 \rightarrow \text{Ag}_2 + 2\text{Na}^+ \]
MAJOR ISSUES

\[ \text{Ag}^+ (aq) + \text{NO}_3^- (aq) + \text{Na}^+ (aq) + \text{SO}_4^{2-} (aq) \rightarrow \text{Ag}_2 (s) + \text{SO}_4^{2-} (s) + \text{Na}^+ (aq) + \text{NO}_3^- (aq) \]

\[ 2\text{Na}^{+} (aq) + \text{SO}_4^{2-} (aq) \rightarrow \text{Ag}_2 \text{SO}_4 (s) \]

\[ 2\text{Ag}^+ + 2 \text{NO}_3^- \rightarrow \text{Ag}_2 \text{SO}_4 (s) \]

\[ 2\text{Ag} (s) + \text{SO}_4^{2-} (aq) \rightarrow \text{Ag}_2 (s) + \text{SO}_4^{2-} (s) \]

\[ 2\text{AgNO}_3 \rightarrow 2\text{Ag}^+ + \text{NO}_3^- \]
DIDN’T CROSS OF THE SPECTATOR IONS

\[
2 \text{Ag}^+ + 2\text{NO}_3^- + 2\text{Na}^+ + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{Na}^+ + 2\text{NO}_3^-
\]

\[
2\text{Ag}^+ + 2\text{NO}_3^- + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4(s) + 2\text{NO}_3^-
\]

\[
2\text{AgNO}_3 + \text{SO}_4^{2-} \rightarrow \text{Ag}_2\text{SO}_4 + 2\text{NO}_3^-
\]

(a) Write the net ionic equation for the reaction above.

\[
2\text{AgNO}_3 + \text{Na}_2\text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4(s) + 2\text{NaNO}_3 + 17.8 \text{kJ/mol}_{\text{rxn}}
\]