

The following problems sets are compiled from B. A. Averill and P. Eldredge, *General Chemistry: Principles, Patterns, and Applications*. License: CC BY-NC-SA. Source: [Open Textbook Library](#).

Reading: Averill 11.2; 11.4-11.7; 12.5

1. Promotion and hybridization

Averill Chapter 9, Section 2, Numerical Problem 1

Draw an energy-level diagram showing promotion and hybridization to describe the bonding in CH_3^- . How does your diagram compare to that for methane? What is the molecular geometry?

2. Promotion and hybridization

Averill Chapter 9, Section 2, Numerical Problem 2

Draw an energy-level diagram showing promotion and hybridization to describe the bonding in CH_3^+ . How does your diagram compare with that for methane? What is the molecular geometry?

3. Hybridization

Averill Chapter 9, Section 2, Numerical Problem 7

What is the hybridization of the central atom in PF_6^- . Is this ion likely to exist? Why or why not? What would be the shape of the molecule?

4. Hybridization

Averill Chapter 9, Section 2, Numerical Problem 8

What is the hybridization of the central atom in SF_5^- ? Is this ion likely to exist? Why or why not? What would be the shape of the molecule?

5. IMFs and periodic trends

Averill Chapter 11, Section 2, Conceptual Problem 9

In group 17 of the periodic table, elemental fluorine and chlorine are gases, whereas bromine is a liquid and iodine is a solid. Why?

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6. Identifying IMFs

Averill Chapter 11, Section 2, Conceptual Problem 11

Identify the most important intermolecular interaction in each of the following.

- SO₂
- HF
- CO₂
- CCl₄
- CH₂Cl₂

7. Polarizability and periodic trends

Averill Chapter 11, Section 2, Conceptual Problem 14

Arrange Kr, Cl₂, H₂, N₂, Ne, and O₂ in order of increasing polarizability. Explain your reasoning.

8. Boiling point and periodic trends

Averill Chapter 11, Section 2, Conceptual Problem 20

Which compound in the following pairs will have the higher boiling point? Explain your reasoning.

- NH₃ or PH₃
- ethylene glycol (HCOH₂CH₂OH) or ethanol (CH₃CH₂OH)
- 2,2-dimethylpropanol [CH₃C(CH₃)₂CH₂OH] or n-butanol (CH₃CH₂CH₂CH₂OH)

9. H-bonds and periodic trends

Averill Chapter 11, Section 2, Conceptual Problem 24

- Explain why the hydrogen bonds in liquid HF are stronger than the corresponding intermolecular H ··· I interactions in liquid HI.
- In which substance are the individual hydrogen bonds stronger: HF or H₂O? Explain your reasoning.
- For what substance will hydrogen bonding have the greater effect on the boiling point: HF or H₂O? Explain your reasoning.

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10. Using Clausius-Clapeyron to find enthalpy

Averill Chapter 11, Section 4, Numerical Problem 2

The following table gives vapor pressure of water at various temperatures. Plot the data and use your graph to estimate the vapor pressure of water at 25°C and at 75°C. What is the vapor pressure of water at 110°C? Use these data to determine the value of ΔH_{vap} for water.

T(°C)	0	10	30	50	60	80	100
P (mmHg)	4.6	9.2	31.8	92.6	150	355	760

11. Processes in a phase change

Averill Chapter 11, Section 5, Conceptual Problem 4

Three distinct processes occur when an ice cube at -10°C is used to cool a glass of water at 20°C. What are they? Which causes the greatest temperature change in the water?

12. Phase boundaries in phase diagrams

Averill Chapter 11, Section 6, Conceptual Problem 2

If the slope of the line corresponding to the solid/liquid boundary in the phase diagram of water were positive rather than negative, what would be the effect on aquatic life during periods of subzero temperatures? Explain your answer.

13. Constructing a phase diagram

Averill Chapter 11, Section 6, Numerical Problem 2

Argon is an inert gas used in welding. It has normal boiling and freezing points of 87.3 K and 83.8 K, respectively. The triple point of argon is 83.8 K at 0.68 atm. Use these data to construct a phase diagram for argon and label all the regions of your diagram.

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