

# Forces and States

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Information: Some Molecules and Their States

$\text{F} \cdot \cdot \text{F}$ Fluorine Gas Molar mass = 38.0 g	$\text{Cl} \cdot \cdot \text{Cl}$ Chlorine Gas Molar mass = _____	$\text{Br} \cdot \cdot \text{Br}$ Bromine Liquid Molar mass = _____	$\text{I} \cdot \cdot \text{I}$ Iodine Solid Molar mass = _____
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## Critical Thinking Questions

1. What type of force exists between two  $\text{F}_2$  molecules—dispersion, dipolar, or hydrogen bonds?
2. What type of force exists between two  $\text{Cl}_2$  molecules—dispersion, dipolar, or hydrogen bonds?
3. Recall the trend in sizes as one proceeds down a column of the periodic table. Do atoms get larger or smaller? Rank the sizes of fluorine, chlorine, bromine, and iodine in order from smallest to largest.
4. The forces between chlorine molecules cause them to be a gas at room temperature. The forces between bromine molecules cause them to be liquid at room temperature.
  - a) Do chlorine or do bromine molecules have stronger forces of attraction between them?
  - b) True or False: If two different kinds of molecules have dispersion forces, then the dispersion forces are equal in strength.
5. Considering your answers to questions 2 and 3, complete the following:  
 The larger the molecules are, the \_\_\_\_\_ the intermolecular forces between them.
6. The states of the substances are given in the table above. Which type of substance has the strongest intermolecular forces: solids, liquids, or gases? Explain.

7. The molar mass of fluorine is given in the table above, but the molar masses for chlorine and others are not given. Use your periodic table to calculate the masses and place them in the blanks provided.
8. From what you can gather from the table, are lighter molecules more likely to be gases or solids?
9. Propane's formula is  $C_3H_8$  and octane's formula is  $C_8H_{18}$ . Propane is a gas at room temperature, but octane is a liquid.
- Which molecule has the strongest intermolecular forces: propane or octane?
  - Would you expect  $C_2H_6$  to be a solid, liquid or a gas at room temperature?
10. Consider two substances—one that has dipolar intermolecular forces and one that has London dispersion forces.
- Which has the strongest intermolecular forces?
  - Which is most likely to be a gas at room temperature?
11. What determines whether a substance will be a solid, liquid or a gas at room temperature?
12. Which of the following describes what happens to the molecules when water changes from a liquid to a gas?
- The molecules get closer together
  - The molecules become farther apart.
  - The molecules slow down.
  - The molecules break up into atoms.
13. It takes a lot of heat energy to boil a certain liquid. What can we say about the intermolecular forces in the liquid—are the forces strong or weak?
14. Water boils at a temperature of  $100^\circ\text{C}$ . Acetone boils at  $50.5^\circ\text{C}$ . Ethyl alcohol boils at  $79^\circ\text{C}$ . Acetaldehyde boils at  $20.8^\circ\text{C}$ . Rank the four substances in order from the strongest intermolecular forces to the weakest.

15. Which substance from question 14 is a gas at room temperature (25°C)?

### **Information: Freezing Points of Some Substances**

<b>Substance</b>	<b>Freezing Point (degrees Kelvin)</b>
Acetone	179
Ethyl Alcohol	158.6
Carbon dioxide	194.5
Hexane	178
Water	273

### **Critical Thinking Questions**

16. Two of the substances in the table have nearly the same strength of intermolecular forces. Name these two substances.
17. If a substance has a low freezing point, then you must cool it down a lot before the molecules will stick together enough to become a solid. Therefore, if a substance has a low freezing point would you say that the intermolecular forces are strong or weak?
18. Rank the substances in the table in order from strongest to weakest intermolecular forces.
19. True or False: A substance's freezing point and its melting point are at the same temperature.
20. Substance A is very polar. Substance B is nonpolar. Which substance would require the most energy to melt? Explain.
21. Water's melting and boiling point is very high. What does this fact tell you about water's intermolecular forces?