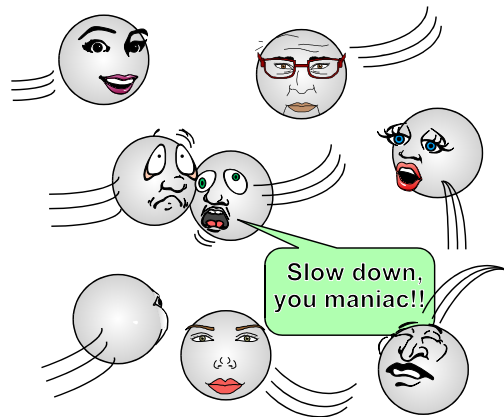


Phase Changes

Heating a substance in a given phase generally causes the temperature to increase. This causes the particles to move faster and collide harder. Harder, faster collisions cause particles to rebound harder moving them further apart. Larger distances between particles weakens the forces of attraction between them. When the forces of attraction are weak enough, the distance between the particles increases markedly and the phase changes. As a result, a solid melts and a liquid evaporates. The reverse happens when a substance cools. As the particles slow down and the collisions weaken, the particles move closer together increasing the forces of attraction between the particles. As a result, a gas condenses and a liquid freezes. At normal atmospheric pressures, some substances change directly from a solid to a gas. This change is called sublimation. This is what occurs when ice cubes shrink in the freezer, or when a wash dries on a clothesline on a cold winter day. Some substances, such as dry ice [CO₂(s)], never pass through a liquid phase at standard pressure [101.3 kPa]. A gas can also change directly to a solid. This is called deposition.



Answer the questions below based on your reading and on your knowledge of chemistry.

- In the space below are the labels **solid**, **liquid**, and **gas**. Draw arrows between them to represent phase changes. Label each arrow with the name of the phase change it represents. Two examples are done for you. Also, draw an arrow labeled **temperature** to show the direction in which temperature is increasing.



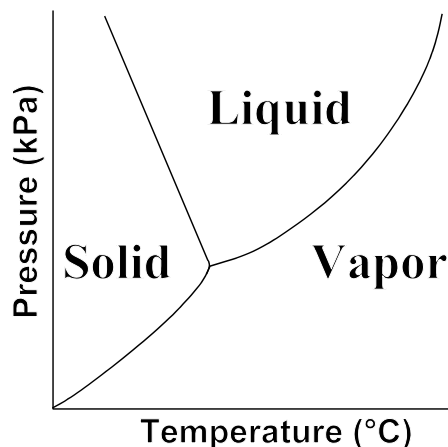
- Under what conditions does a solid melt? Why? _____

- Under what conditions does a gas condense? Why? _____

4. Why do substances change phase as the temperature changes? Refer to the distance between particles and the force of attraction between them in your answer. _____

5. To the right is a graph showing the relationship between temperature, pressure, and phase for a substance. Answer the questions below based on the graph.

- a. Draw a dotted line going across the graph at a pressure where sublimation could occur. Label it "a."
- b. Draw a solid line going across the graph at a pressure where melting and vaporization could occur. Label it "b."
- c. Under normal conditions, carbon dioxide gas turns directly into a solid as it is cooled. What could be done to make carbon dioxide form a liquid? _



6. Under normal conditions, butane is a gas. In butane lighters, the gas is put under pressure and it forms a liquid. Explain why a gas liquefies under pressure even without cooling it. _____

7. What would happen to a liquid at a constant temperature as the pressure is reduced? Why? _____

8. What happens to the forces of attractions between particles as the temperature changes? Why? _____
