Microscopic Properties of the Phases of Matter

PROPERTY	11.4 SOLIDS	11.5 LIQUIDS	11.6 GASES
1. SHAPE	Definite – strong cohesive forces	Indefinite-cohesive forces not strong enough to prevent random movement	Indefinite-cohesive forces weak
2. VOLUME	Definite-strong cohesive forces	Definite-strong cohesive forces	Indefinite-cohesive forces weak
3. Density	Particles closely packed	Particles closely packed	Particles widely separated
4. Compressibility	Particles closely packed	Particles closely packed	Particles widely separated
5. Thermal expansion (thermometers)	Increased KE causes slight increase in space between particles	Increased KE causes slight increase in space between particles	Particles widely separated and have high KE and move further apart when

Phase Changes Worksheet **Name** _____

Kinetic Theory of Matter:

- Molecules are always moving. This is known as the *kinetic* theory of matter.
- We measure this kinetic energy with a thermometer as *temperature*.
- The greater the material's internal energy, the higher the temperature of that material.
- *Heat* is the energy flow between objects of different temperature.
- Heat and temperature are NOT the same.
- *Brownian motion* describes how visible particles are seen moving due to invisible molecules bumping into them.

Phases of Matter:

Solid

matter that has definite volume and shape.
The molecules are packed together tightly and move slowly.

Liquid

matter that has definite volume but not shape.
Since the molecules of a liquid are loosely packed and move with greater speed, a liquid can flow and spread.

Gas

matter that has no definite volume or shape.
Molecules of a gas are so loosely arranged and move so rapidly that they will fill their container.

Phase Change Descriptions:

Melting

the change from solid to liquid.

Freezing

the change from liquid to solid.

Vaporization

the change from liquid to gas.

Evaporation

vaporization from the surface of a liquid.

Boiling

vaporization from within as well as from the surface of a liquid.

Condensation

the change from gas to liquid.

Sublimation

the change from solid to gas.

Deposition

the change from gas to solid.

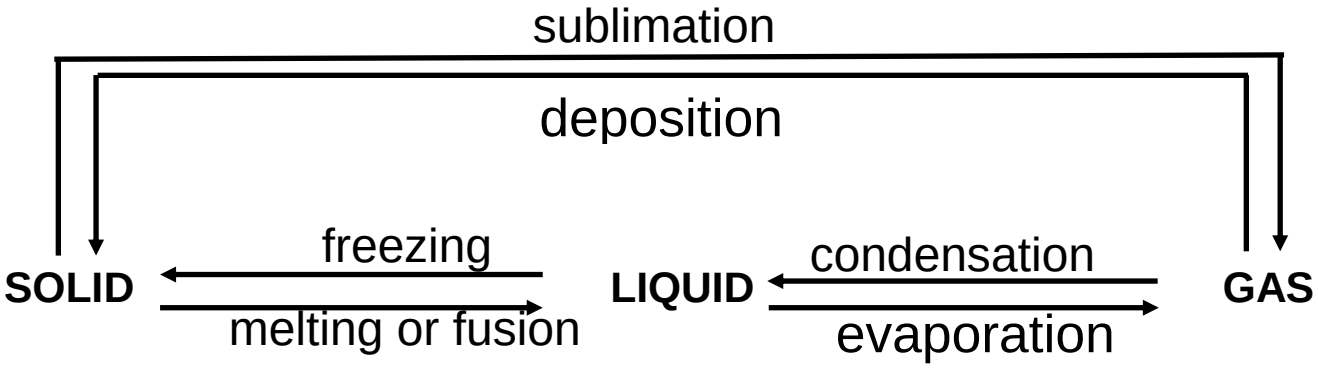
Endothermic

heat added or heat absorbed or heat into a substance.

Exothermic

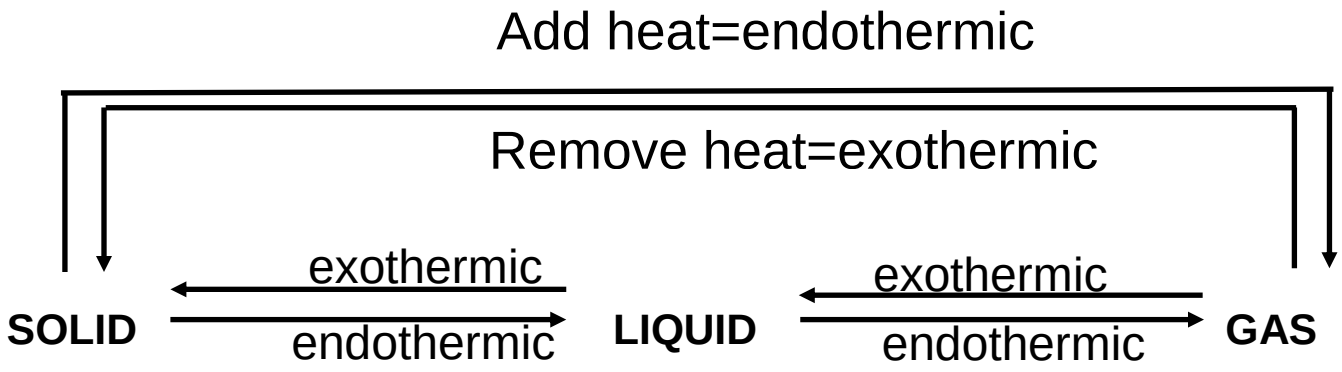
heat removed or heat lost or heat out of a substance.

CHANGES OF STATE



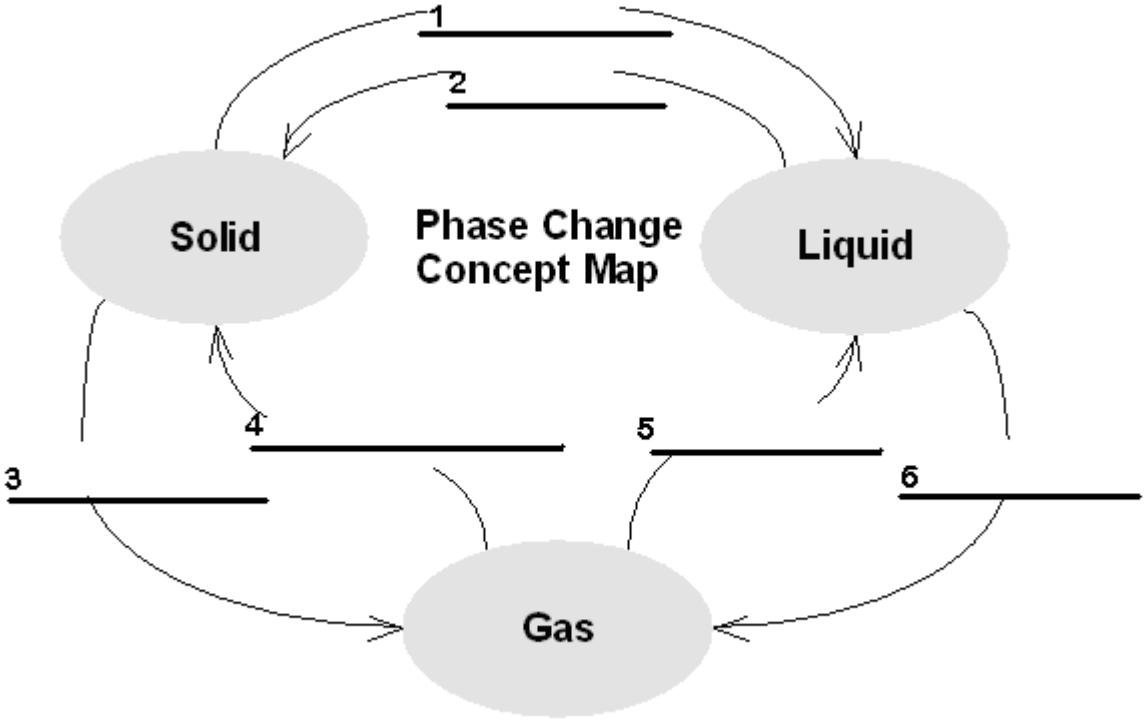
	CHANGES OF STATE		PHYSICAL PROPERTY
solid	freezing ⟵ ⟶ melting or	**liquid**	**melting point or freezing point**
liquid	condensation ⟵ ⟶ evaporation	**vapor**	**boiling point**
solid	deposition ⟵ ⟶ sublimation	**vapor**	**sublimation point**

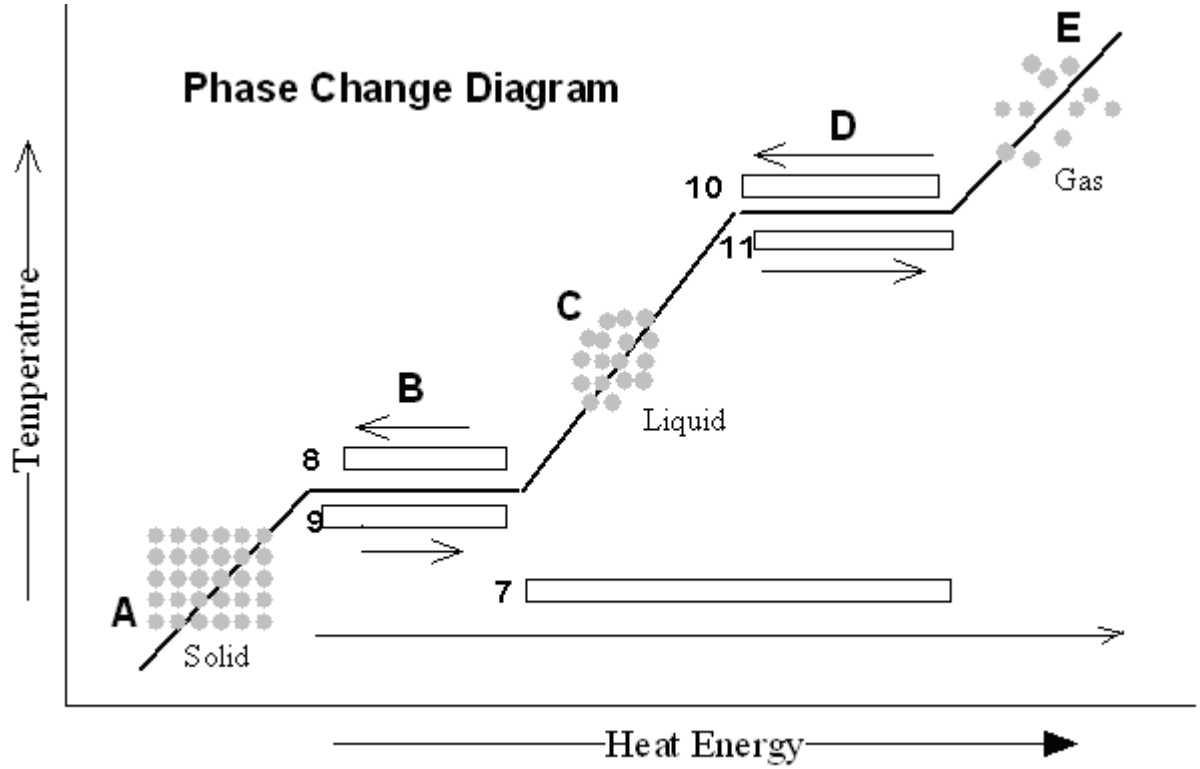
ENERGY CHANGES IN CHANGES OF STATE

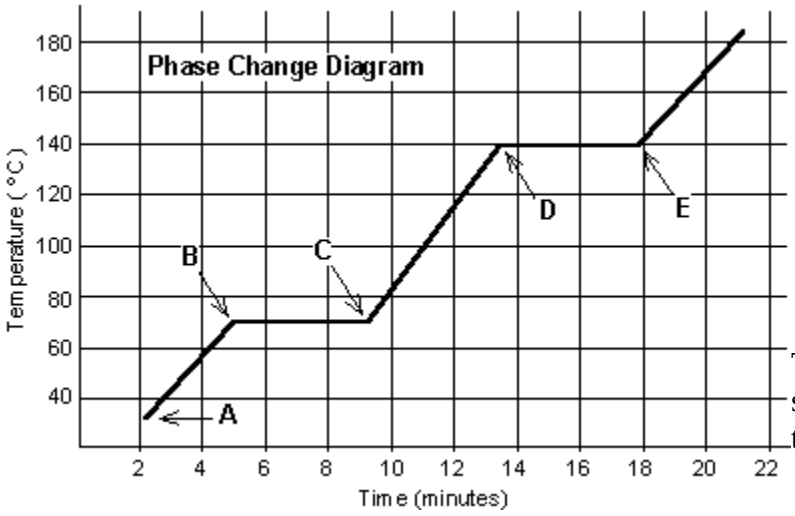


	CHANGES OF STATE		PHYSICAL PROPERTY
solid	exothermic ⟵ / ⟶ endothermic	**liquid**	**melting point** **freezing point**
liquid	exothermic ⟵ / ⟶ enodthermic	**vapor**	**boiling point**
solid	exothermic ⟵ / ⟶ endothermic	**vapor**	**sublimation point**

Fill in the phase changes in the blank provided.







Phase Change Worksheet

The graph was drawn from data collected as a substance was heated at a constant rate. Use the graph to answer the following questions.

At **point A**, the beginning of observations, the substance exists in a solid state. Material in this phase has _____ volume and _____ shape. With each passing minute, _____ is added to the substance. This causes the molecules of the substance to _____ more rapidly which we detect by a _____ rise in the substance. At **point B**, the temperature of the substance is _____°C. The solid begins to _____. At point C, the substance is completely _____ or in a _____ state. Material in this phase has _____ volume and _____ shape. The energy put to the substance between minutes 5 and 9 was used to convert the substance from a _____ to a _____. This heat energy is called the **latent heat of fusion**.

Between 9 and 13 minutes, the added energy increases the _____ of the substance. During the time from **point D to point E**, the liquid is _____. By **point E**, the substance is completely in the _____ phase. Material in this phase has _____ volume and _____ shape. The energy put to the substance between minutes 13 and 18 converted the substance from a _____ to a _____ state. This heat energy is called the **latent heat of vaporization**. Beyond **point E**, the substance is still in the _____ phase, but the molecules are moving _____ as indicated by the increasing temperature.

Which of these three substances was likely used in this phase change experiment?

Substance	Melting point	Boiling point
Bolognium	20 °C	100 °C
Unobtainium	40 °C	140 °C
Foosium	70 °C	140 °C

BONUS: For water, the value for the latent heat of vaporization is 6.8 times greater than the latent heat of fusion. Imagine we were adding heat at a constant rate to a block of ice in a beaker on a hot plate, and it took 4 minutes for the ice to melt completely. How long would it take, after the water started boiling, for the beaker to be completely empty (the liquid water totally converted to water vapor)?