

phase change

the physical change of a substance from one state (solid, liquid, or gas) to another at constant temperature and pressure

latent heat

the energy per unit mass that is transferred during a phase change of a substance

When substances melt, freeze, boil, condense, or sublime (change from a solid to vapor or from vapor to a solid), the energy added or removed changes the internal energy of the substance without changing the substance's temperature. These changes in matter are called **phase changes**.

Latent heat is energy transferred during phase changes

To understand the behavior of a substance undergoing a phase change, you need to consider the changes in potential energy. Potential energy is present among a collection of particles in a solid or in a liquid in the form of attractive bonds. These bonds result from the charges within atoms and molecules. Potential energy is associated with the electric forces between these charges.

Phase changes result from a change in the potential energy between particles of a substance. When energy is added to or removed from a substance that is undergoing a phase change, the particles of the substance rearrange themselves to make up for their change of energy. This rearrangement occurs without a change in the average kinetic energy of the particles. The energy that is added or removed per unit mass is called **latent heat**, abbreviated as L . Note that according to this definition, the energy transferred as heat during a phase change simply equals the mass multiplied by the latent heat, as follows:

$$Q = mL$$

During melting, the energy that is added to a substance equals the difference between the total potential energies for particles in the solid and the liquid phases. This type of latent heat is called the *heat of fusion*. During vaporization, the energy that is added to a substance equals the difference in the potential energy of attraction between the liquid particles and between the gas particles. In this case, the latent heat is called the *heat of vaporization*. The heat of fusion and the heat of vaporization are abbreviated as L_f and L_v , respectively. **Table 6** lists latent heats for a few substances.

Table 6 Latent Heats of Fusion and Vaporization at Standard Pressure

Substance	Melting point (°C)	L_f (J/kg)	Boiling point (°C)	L_v (J/kg)
nitrogen	−209.97	2.55×10^4	−195.81	2.01×10^5
oxygen	−218.79	1.38×10^4	−182.97	2.13×10^5
ethyl alcohol	−114	1.04×10^5	78	8.54×10^5
water	0.00	3.33×10^5	100.00	2.26×10^6
lead	327.3	2.45×10^4	1745	8.70×10^5
aluminum	660.4	3.97×10^5	2467	1.14×10^7

extension

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