Energy Transfer

Grades: 9-12

Topic: Energy Basics

Owner: ACTS

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Thermal Physics

Vocabulary

Kinetic Energy (KE): energy due to translational or rotational motion (velocity) of particles.

$$KE = (1/2)\text{mass}*\text{velocity}^2$$

(all energy measured in Joules)

Potential Energy (PE): stored energy due to position; several types; (ex) electric potential energy is stored in molecules based on the *electrical forces* which bond them.

Vocabulary

<u>Internal Energy</u> [also called thermal energy]: the sum of <u>all</u> the potential and kinetic energies from all the molecules in an object.

<u>Absolute Temperature</u>: a measurable quantity that is *linear & proportional* to the ***<u>average</u>*** <u>translational</u> KE of all the molecules in an ideal gas. Measured in Kelvin (K). Absolute zero (0 K) corresponds to all molecules stopping.

$$\text{Average KE} = (3/2)kT^1$$ (k=ideal gas law constant)

Good approximation for liquids and solids as well!

Vocabulary

Heat: the amount of internal energy transferred from an object with a higher temperature to an object with a lower temperature, *due to their difference in temperature*.

Work: the amount of internal energy transferred *not due to a temperature difference.*

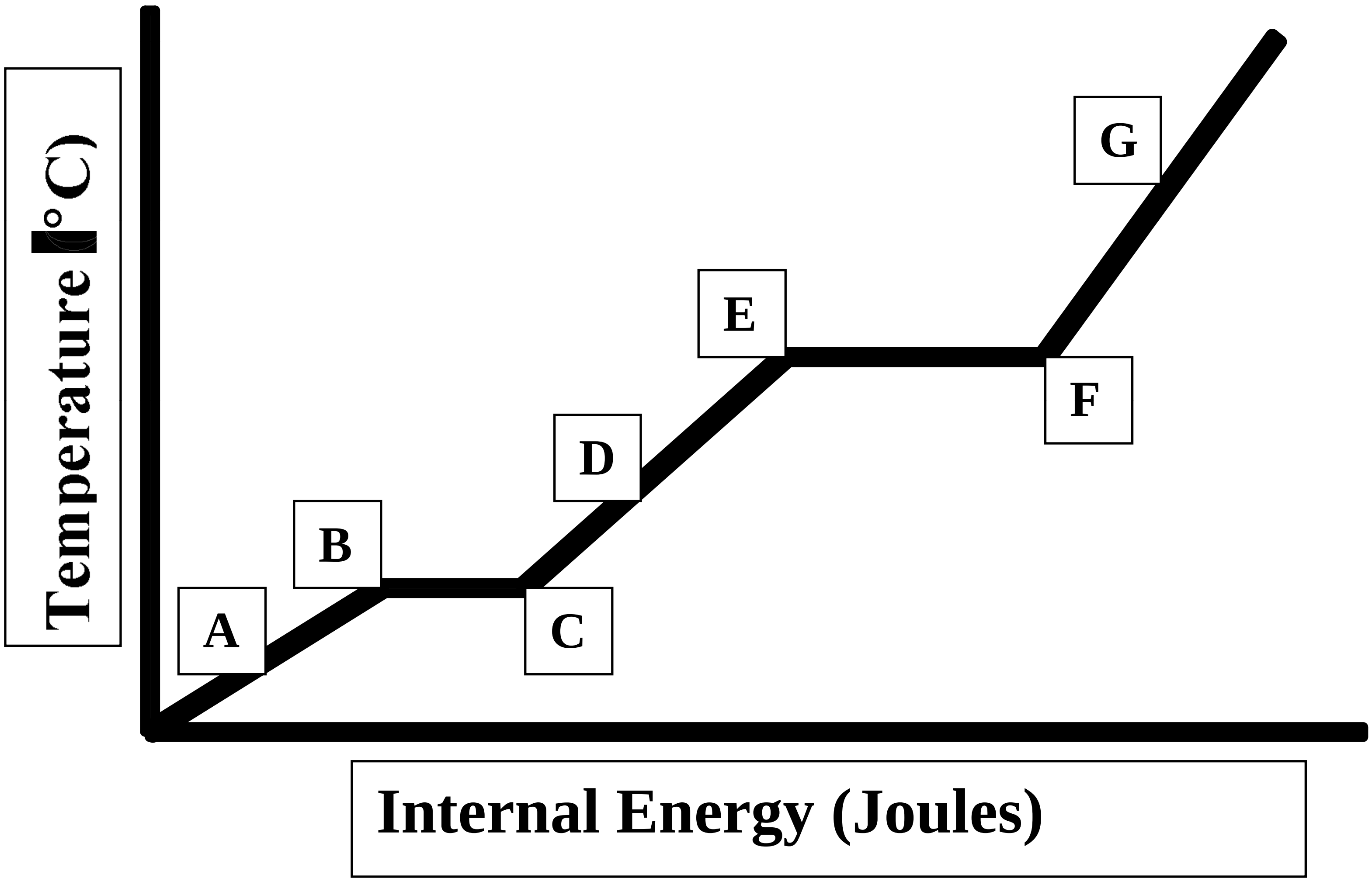
Vocabulary

Specific Heat Capacity (c): The heat absorbed(released) to raise(lower) a unit mass of the substance a unit temperature. A property of the substance due to its number of molecules of different masses.

Specific Latent Heat of Fusion (L): The heat absorbed(released) to change phase of a unit mass of a substance from solid to liquid (liquid to solid) at a *constant* temperature.

Specific Latent Heat of Vaporization (L): The heat absorbed(released) to change phase of a unit mass of a substance from liquid to gas(gas to liquid) at a *constant* temperature.

Create a basic concept map which explains the heating graph. A more detailed concept map will be created later.

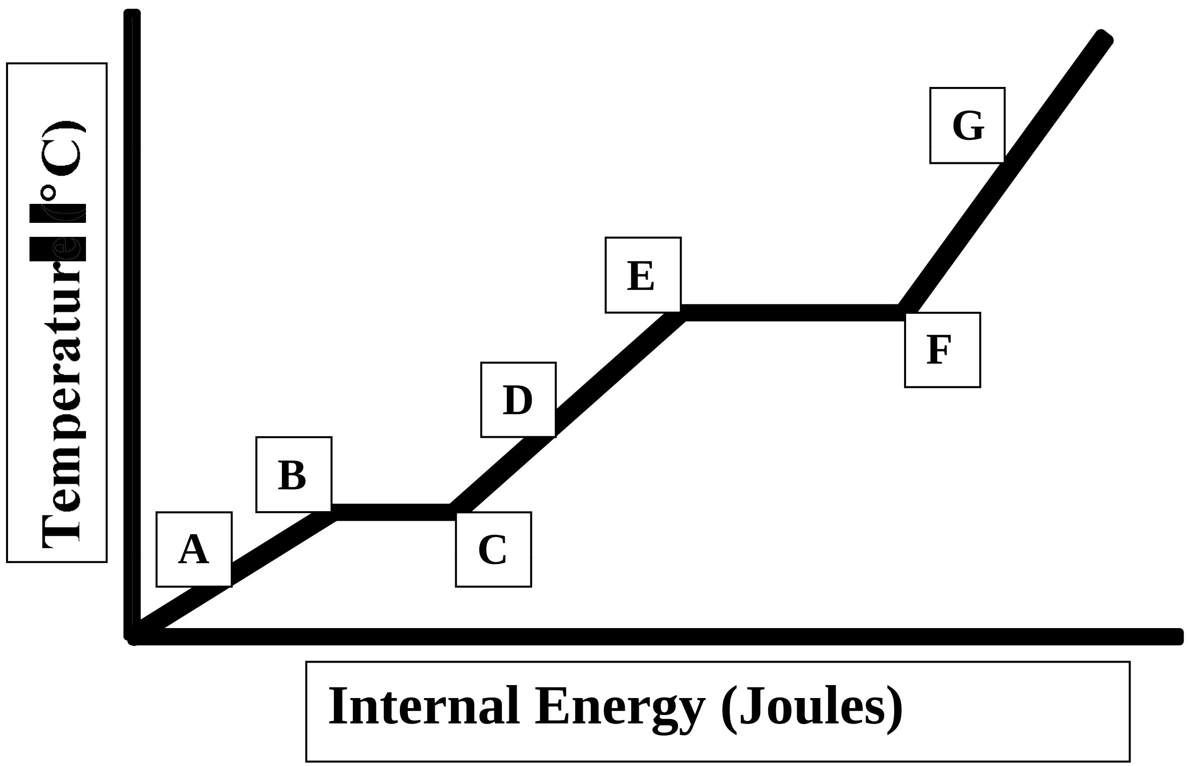


First Law of Thermodynamics: $\Delta U = Q + W$ for a closed system

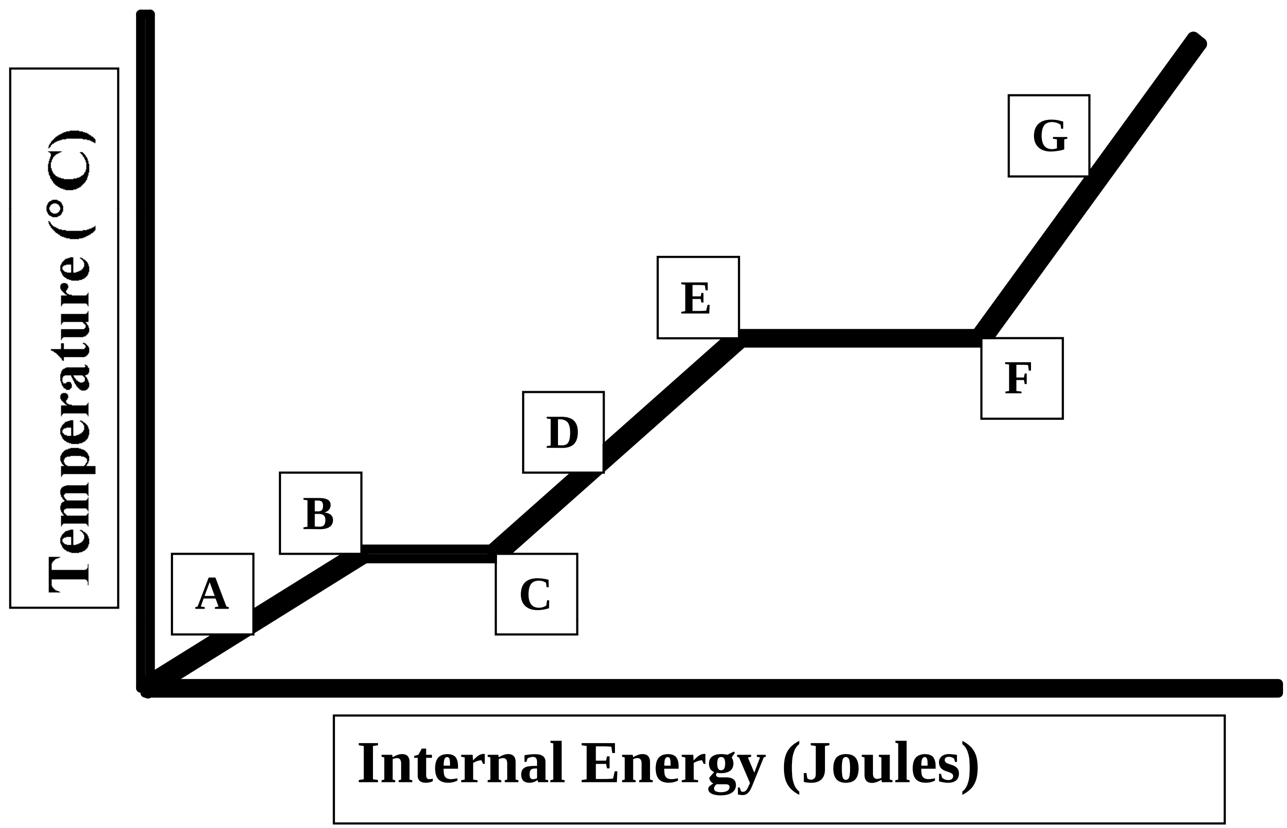
[+Q = heat input and +W = work input.]

Moving left to right, heat will be input to the system.
Moving right to left, heat will be output of the system.

For simplicity, no work will be input or output from the system. However, work can still be done *inside the system* as with phase changes.



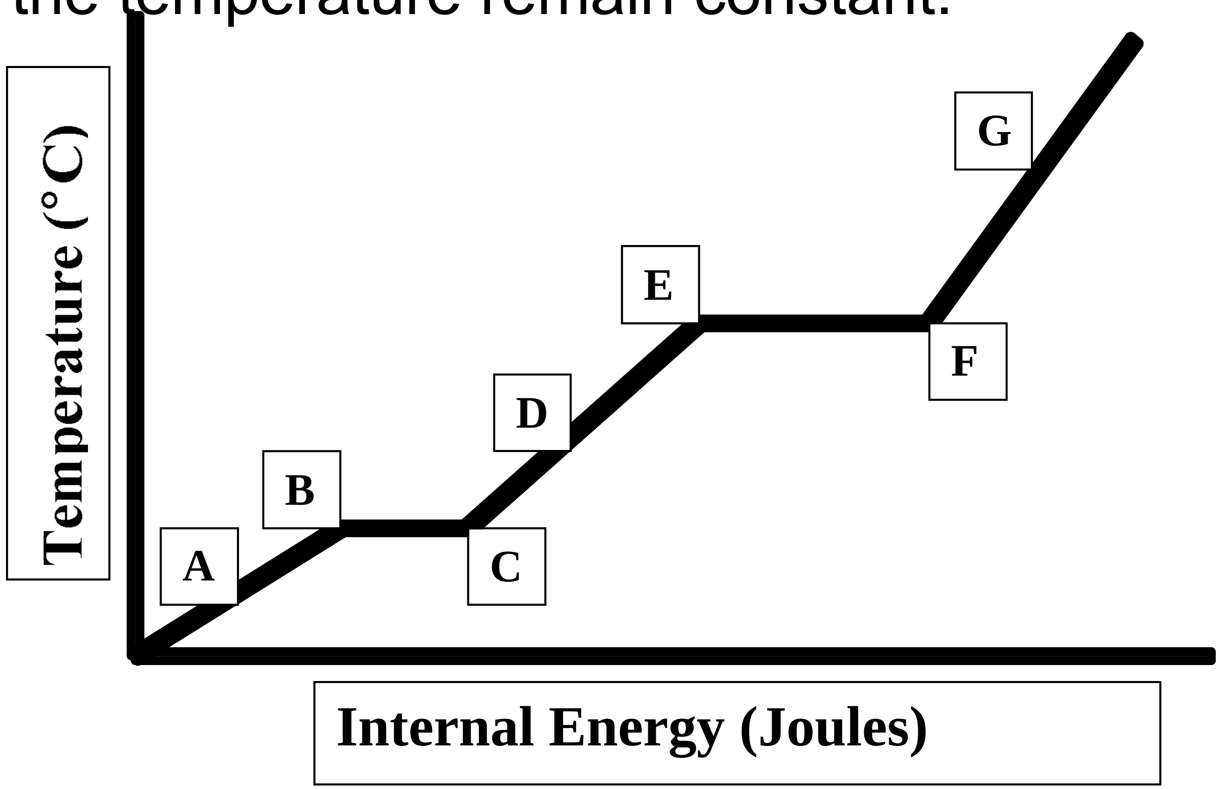
The heat input in the *solid* phase, *section A*, increases internal energy by increasing the KE of the molecules, which increases temperature. The PE stays constant.



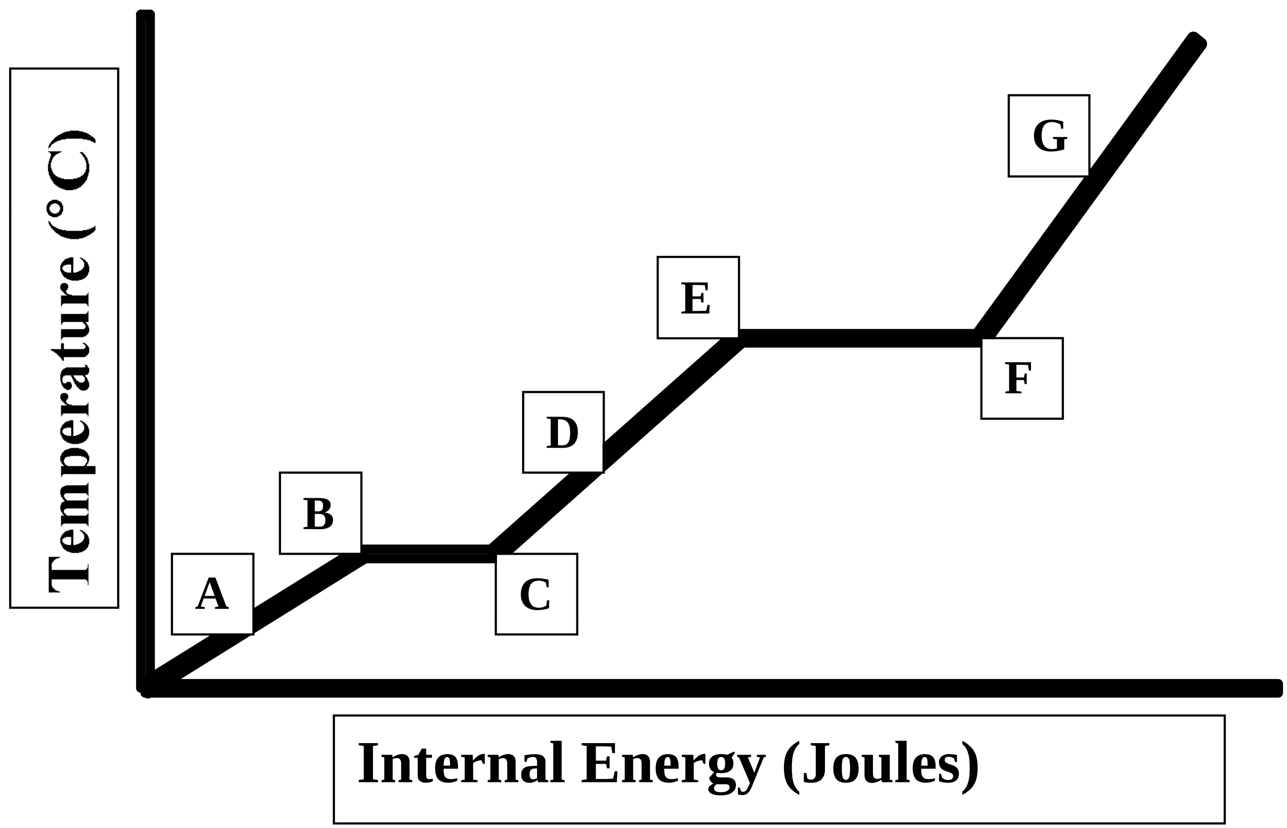
The heat input in the *melting* phase, *section B-C*, also increases internal energy.

Specifically, the heat input does work against the attractive conservative electric force until the molecules break loose and flow slowly over each other. The work is stored in the molecules as increased PE.

The KE and the temperature remain constant.



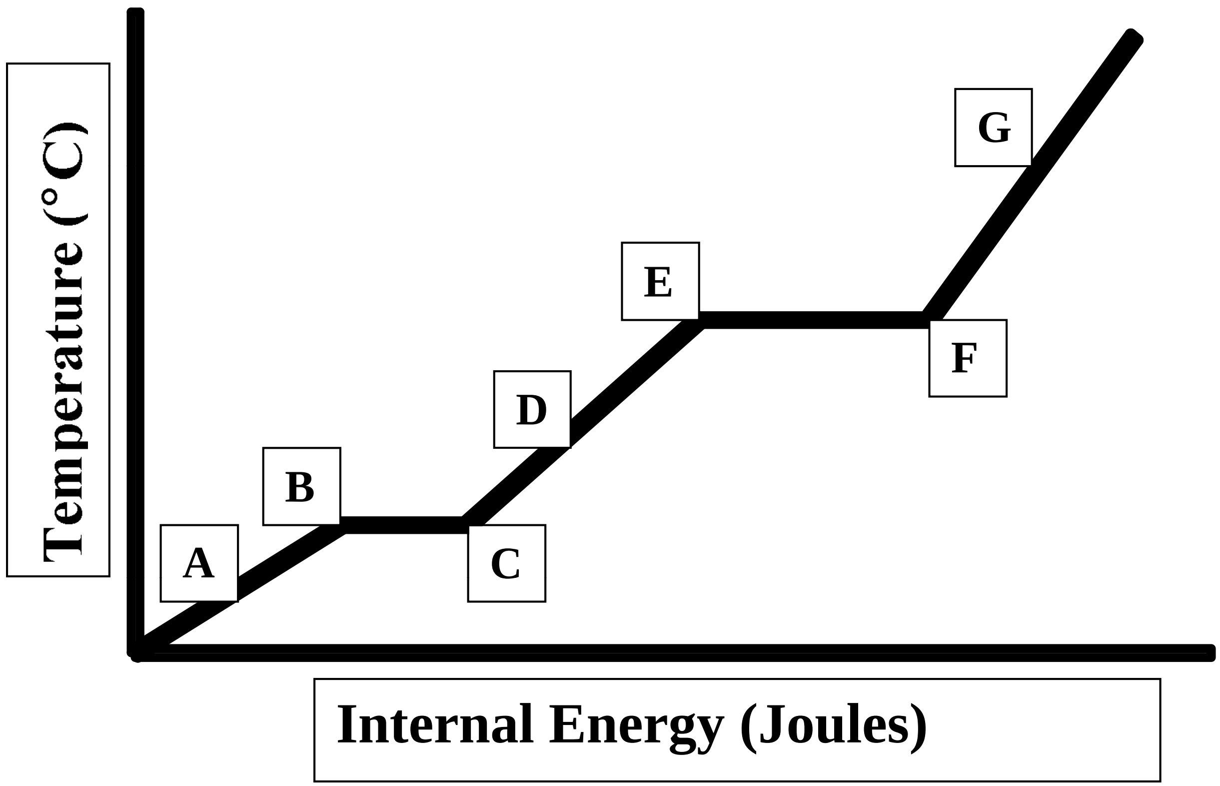
The heat input in the *liquid* phase, *section D*, increases internal energy by increasing the KE of the molecules, which increases temperature. The PE stays constant.



The heat input in the *vaporizing* phase, *section E-F*, also increases internal energy.

Specifically, the heat input does work against the attractive conservative electric force until the molecules move quickly and randomly. The work is stored in the molecules as increased PE.

The KE and the temperature remain constant.



The heat input in the *gas* phase, *section G*, increases internal energy by increasing the KE of the molecules, which increases temperature. The PE stays constant.

In the *ideal gas law*, the PE is ignored since it is assumed to be much smaller than the KE due to the high speed of the particles.