First Law of Thermodynamics

Heat Capacity

Heat capacity (C) of a body is the amount of thermal energy (Q) required to raise the temperature of the whole body by one kelvin (or one degree celcius). $C = \frac{Q}{\Delta T}$

Specific Heat Capacity

Specific heat capacity (c) of a substance is the amount of thermal energy (Q) required to raise the temperature of unit mass of the substance by one kelvin (or one degree celcius). $c = \frac{Q}{m\Delta T}$

Latent Heat

Latent heat is the amount of heat absorbed or released by the whole body of the substance during a change in its physical phase that occurs at constant temperature.

Specific Latent Heat

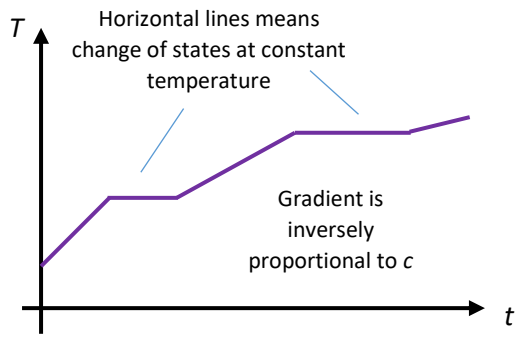
Specific latent heat of a substance is the amount of heat absorbed or released by unit mass of the substance during a change in its physical phase that occurs at constant temperature. $L = \frac{Q}{m}$

- *Vaporization*: when it changes physical phase from liquid to vapour at constant temperature. Equivalently, it is the amount of heat released by unit mass of the substance when it changes physical phase from vapour to liquid at constant temperature.
- *Fusion*: when it changes physical phase from solid to liquid at constant temperature. Equivalently, it is the amount of heat released by unit mass of the substance when it changes physical phase from liquid to solid at constant temperature.
- *Sublimation*: when it changes physical phase from solid to vapour at constant temperature. Equivalently, it is the amount of heat released by unit mass of the substance when it changes physical phase from vapour to solid at constant temperature

Kinetic Theory of Gas to Melting and Boiling

- What does melt at *constant temperature* mean?
    - Mean kinetic energy of molecules is proportional to temperature. Constant temperature mean no change in mean kinetic energy of molecules
    - Hence, the energy supplied during melting must be solely used to increase the potential energy due to intermolecular forces among molecules
- Why, in general, specific latent heat of vaporization is larger than specific latent heat of fusion?
    - Increasing in potential energy among molecules would mean increasing in average separation distance among molecules, thus increasing in volume.
    - However, the increase in volume from liquid to solid is higher than that from solid to liquid.
    - Significant work against atmospheric pressure must be done to change from liquid to solid.

Temperature against Time Curves (An example)

c	Note:
	• Assume constant power ○ The longer the horizontal line, the more the energy input to the body • Can read off ○ Melting point ○ Boiling point

Internal Energy

The internal energy of a system is the sum of the random kinetic and potential energies of the individual atoms or molecules of the system.

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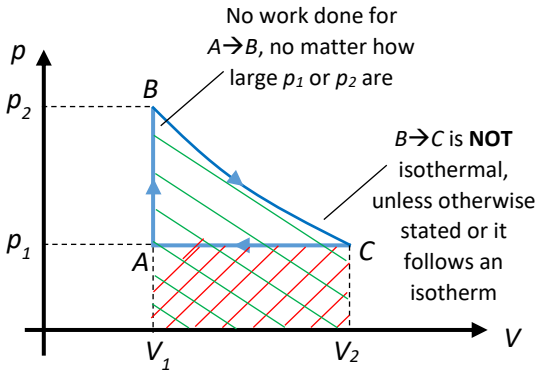
It states that the ***increase*** **in internal energy ΔU** of a **closed system** is **equal to** the **sum of the heat *supplied to*** **the system Q and the external work done *on*** **the system W**.

$$\Delta U = Q + W$$

The sign conventions for the various quantities are:

	Positive	**Negative**
ΔU	**Increase** in Internal Energy	**Decrease** in Internal Energy
Q	Heat **absorbed by** system	Heat **given out** from system
W	Work done **on** system →Compression	Work done **by** system →Expansion

***p-V* Diagram (An Example)**	**Notes**
	• Direction of arrows indicate process directions, here *A*→*B*→*C*→*A* • *A*→*B*, isochoric/isovolumetric process; *W* = 0 • *C*→*A*, isobaric process; $W = -p\Delta V$, i.e. $W = -p_1(V_1 - V_2)$ • *W* is obtained from area under *p-V* diagram. ○ $W_{C\to A}$ represented by red area (positive, 'cos compression) ○ $W_{B\to C}$ represented by green area (Negative) • $\Delta U_{A\to B\to C\to A} = 0$. (Cyclic process)