THERMODYNAMICS

SPECIFIC HEAT CAPACITY

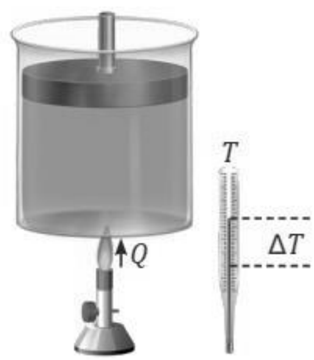
HEAT CAPACITY

Heat capacity is the measure of how much heat you need to make a certain amount of something get 1 degree Celsius hotter.

Now, imagine a closed container filled with gas, and we're heating it up with something outside, like in the picture. In a certain time, the gas gets a certain amount of heat, which we call Q, and its temperature goes up by ΔT. In this case, we calculate the heat capacity C like this:

$C = \frac{Q}{\Delta T} = \frac{dQ}{dT}$

The unit of heat capacity is JK-1.



Specific heat capacity

Heat capacity is how much heat it takes to make one unit of a substance (like one gram or one kilogram) get 1°C warmer. We often use this for solids and liquids, and we call it s.

$s = \frac{C}{m} = \frac{Q}{m\Delta T}$

Or

$s = \frac{1}{m}\frac{dQ}{dT}$

Molar heat capacity

The molar heat capacity is the heat needed to make one mole of a substance get 1 degree Celsius warmer.

Molar heat capacity, $C_n = \frac{C}{n} = \frac{Q}{n\Delta T} = \frac{1}{n}\frac{dQ}{dT}$

Or

$\Delta Q = nC_n \Delta T$

From the first Law of thermodynamics,

$\Delta Q = \Delta U + \Delta W$

Due to W, the change in heat (ΔQ) and the molar heat capacity (C_n) are path dependent.

Specific heat capacity at constant volume (C_V)

The specific heat at constant volume is the heat needed to make one mole of gas, which weighs one gram, get 1° C hotter without letting it change in volume.

Specific heat capacity at constant pressure (C_P)

The specific heat at constant pressure is the heat needed to make one mole of gas, which weight 1 gram, get 1° C hotter while keeping the pressure constant.

In an experiment, students had six gas samples with different amounts, as listed in the table. They were told to note the values for heat capacity at constant volume (C_v) when the temperature increased by 1° C.

Gases	Q (for 1° C rise)	C_p
1 mol O_2	Q_1	x
2 mol O_2	Q_2	x
6 mol O_2	Q_3	x
1 mol N_2	Q_4	x
1 mol H_2	Q_5	x
1 mol He	Q_6	y

In the experiment, they discovered that the C_v values were the same for five of the samples (O_2, N_2, H_2), but not for helium (He). They concluded that C_v doesn't change based on how many moles of gas there are or the atomic number of the gas.

Gases	Q (for 1° C rise)	C_p
1 mol O_2	Q_7	a
2 mol O_2	Q_8	a
6 mol O_2	Q_9	a
1 mol N_2	Q_{10}	a
1 mol H_2	Q_{11}	a
1 mol He	Q_{12}	b

They saw the same results when they did the experiment under constant pressure. This showed that there's something important about gases called "atomicity."

The heat capacity at constant pressure (CP) and the heat capacity at constant volume (CV) are built-in qualities of a gas and depend on this atomicity.