The 1st Law of Thermo

- Two types of energy change of a system: work and heat
- Total energy change is the sum: first law

$$\Delta E_{\text{int}} = Q + W_{on}$$

Sometimes called “U” in thermo

- Note: work done by system has the opposite sign!

$$\Delta E_{\text{int}} = Q - W_{by}$$

Work by (on) Gases

$$W_{by} = \int_{V_1}^{V_2} p\, dV$$

$$W_{on} = -W_{by} = -\int p\, dV$$

- Special cases:
  - Constant pressure **(isobaric)**: $W_{on} = -p\Delta V$
  - Constant temperature **(isothermal)**: $W_{on} = -nRT \ln\left(\frac{V_2}{V_1}\right)$
  - On a graph, on PV diagram: see board

Molar Specific Heat (of Gases)

- Gases have simple relationships for specific heat: if volume fixed, only depends on shape of molecule and how many (or how many moles)

$$Q = n C_V \Delta T$$

Constant-volume molar specific heat (J/mol/K)

  - This is also the change in internal energy of *any* gas

$$\Delta E_{\text{int}} = n C_V \Delta T$$

  - This constant-volume specific heat is directly related to R:

$$C_V = 3/2\, R \quad \text{(monatomic)}$$
$$C_V = 5/2\, R \quad \text{(diatomic)}$$