

CONCEPT: THE FIRST LAW OF THERMODYNAMICS

- The First Law of Thermodynamics is an equation relating Internal Energy, Heat, and Work.

$$\Delta E_{int, OF} = \underline{\hspace{2cm}}$$

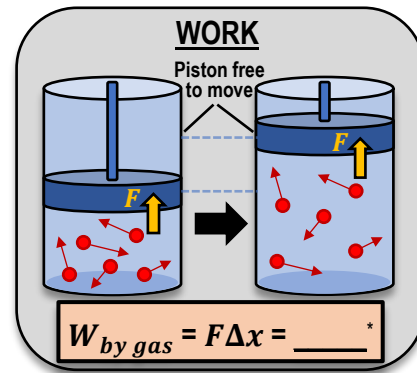
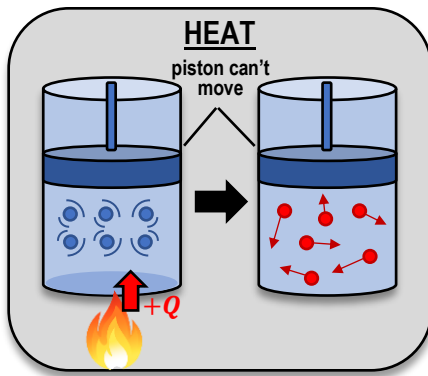
$\Delta E_{int, OF}$ = Change in Internal Energy OF the system/gas

Q_{TO} = Heat added TO / removed FROM the system/gas

W_{BY} = Work done BY the system/gas

EXAMPLE: What is the change in internal energy of a gas if the work done on the environment by the gas is 200J, and you add 500 J of heat to the gas?

- Internal Energy can be changed in two ways: through _____ and/or _____.



* only if pressure is constant

If heat is added, Q is [+ | -], E_{int} [increases | decreases]

If heat is removed, Q is [+ | -], E_{int} [increases | decreases]

If gas expands ($\Delta V \uparrow$), W_{BY} = [+ | -], E_{int} [increases | decreases]

If gas is compressed ($\Delta V \downarrow$), W_{BY} = [+ | -], E_{int} [increases | decreases]

EXAMPLE: You put gas inside a sealed container with a moveable piston, then remove 240 J of heat from it. The pressure in the container is 100 Pa. Calculate ΔE_{int} if the gas expands from a volume of 1m^3 to 3m^3 . Assume *pressure is constant*.

PROBLEM: A gas in a cylinder held at a constant pressure 1.80×10^5 Pa expands from a volume of 1.2 m^3 to 1.6 m^3 . The internal energy of the gas decreases from 4.40×10^5 J to 3×10^5 J. How much heat was transferred to the gas?

- A) -6.8×10^4 J
- B) 2.12×10^5 J
- C) 4.72×10^5 J
- D) 2.28×10^5 J

THERMO EQs

$$W_{BY} = P\Delta V \text{ (constant P)}$$

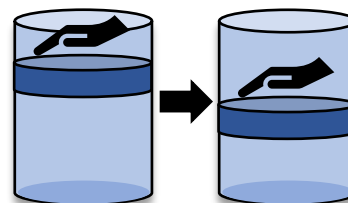
CONCEPT: ALTERNATE EQUATION FOR THE FIRST LAW OF THERMODYNAMICS

- You may see the 1st Law of Thermo EQ written a different way.

$$\left. \begin{array}{l} \Delta E_{int,OF} = Q_{TO} - W_{BY} \\ \Delta E_{int,OF} = Q_{TO} \end{array} \right\} \begin{array}{l} \text{, where } W_{BY} = \text{Work done } \underline{BY} \text{ the system/gas} \\ \text{, where } W_{ON} = \text{Work done } \underline{\hspace{1cm}} \text{ the system/gas} \end{array} \quad \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$$

EXAMPLE: You fill a container with gas and add 300J of heat. The gas has constant pressure of 100 Pa. You put your hand on a moveable piston attached to the container and push inward, compressing the gas from 5m³ to 3m³.

- a) Calculate the work done by the gas on your hand.



$$W_{BY} = P \Delta V_{gas}$$

- b) Calculate the work done on the gas from your hand.

- c) Calculate the change in Internal Energy of the gas using both “forms” of the 1st Law of Thermo equation.

PROBLEM: The internal energy of a system decreases by 500 J, and 230 J of work is done *on* the system. How much heat was added to this system?

- A) 730 J
- B) 270 J
- C) -270 J
- D) -730 J

THERMO EQs
$W_{BY} = P\Delta V$ (constant P)

PROBLEM: The internal energy of a monoatomic ideal gas is given as $E = \frac{3}{2}nRT$, where n is the # of moles and T is the temperature. If you add 1300 J of heat to 1.5 moles of a monoatomic gas, and its temperature increases from 270 to 320K, how much work was done by the gas?

THERMO EQs & CONSTANTS
$W_{BY} = P\Delta V$ (constant P)
$R = 8.314 \frac{J}{mol \cdot K}$