CONCEPT: THE FIRST LAW OF THERMODYNAMICS

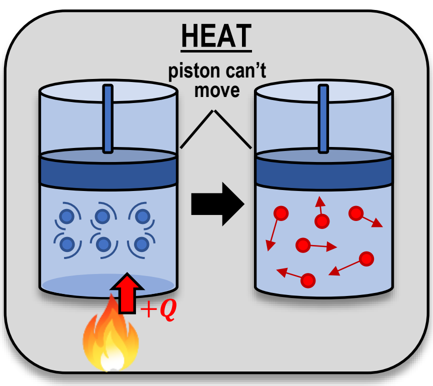
● **The First Law of Thermodynamics** is an equation relating Internal Energy, Heat, and Work.

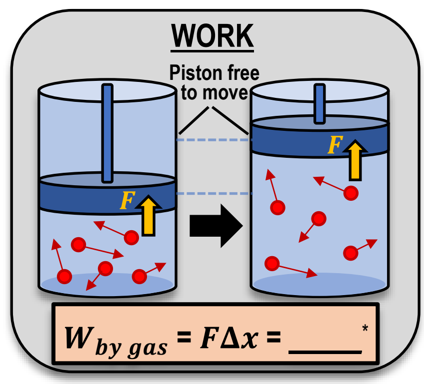
$\Delta E_{int,OF}$ = ____________

$\Delta E_{int,OF}$ = 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* (ΔV↑), **W_{BY} = [+ | –], E_{int} [increases | decreases]**
If gas is *compressed* (ΔV↓), **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 1m³ to 3m³. *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
$\boldsymbol{W_{BY}} = \boldsymbol{P\Delta V}$ (constant P)

CONCEPT: ALTERNATE EQUATION FOR THE FIRST LAW OF THERMODYNAMICS

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

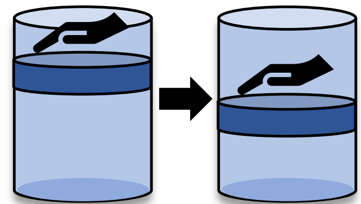
$\Delta E_{int,OF} = Q_{TO} - W_{BY}$, where W_{BY} = Work done **_BY_** the system/gas

$\Delta E_{int,OF} = Q_{TO}$, where W_{ON} = Work done ____ the system/gas

} _____ = _____

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 5m^3 to 3m^3.

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)
$R = 8.314 \frac{J}{mol \cdot K}$