# Physics 161
# Lecture 15 Summ
# First Law of Thermodynamics

October 24, 2017

# Lecture 15: learning objectives

You will be able to define and calculate the work done on or by a gas.

You will be able to state and apply the first law of thermodynamics.

You will be able to identify and define the four most common thermal processes.

# Thermodynamic work

Work done on a gas:
The work done on a gas at constant pressure is the (negative of the) product of the pressure and the change in volume.

$$W = -P\Delta V$$

Note that the change in volume for compression is negative, so for compression the work done on the gas is a positive number. In this case the work done by the gas is negative.

If the gas expands, the work done on the gas is negative . The work done by the gas is positive.

# First law of thermodynamics

First law:
The change in thermal (internal) energy (U) of the system is equal to the heat (Q) added to the system plus the work (W) done on the system.

$$\Delta U = U_f - U_i = Q + W$$

Q is positive when heat is transferred into the system.

Q is negative when heat is transferred out of the system.

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# Thermal processes

There are four common types of thermal process.

**Isobaric:**
Pressure is constant throughout the process.

**Isovolumetric:**
Volume is constant throughout the process.

**Adiabatic:**
No heat is transferred to or from the system (Q=0) during the process.

**Isothermal:**
Temperature is constant throughout the process.

# Thermal processes

There are four common types of thermal process.

**Table 12.2** The First Law and Thermodynamic Processes (Ideal Gases)

| Process | $\Delta U$ | $Q$ | $W$ |
|---|---|---|---|
| Isobaric | $nC_v \Delta T$ | $nC_p \Delta T$ | $-P \Delta V$ |
| Adiabatic | $nC_v \Delta T$ | $0$ | $\Delta U$ |
| Isovolumetric | $nC_v \Delta T$ | $\Delta U$ | $0$ |
| Isothermal | $0$ | $-W$ | $-nRT \ln \left( \frac{V_f}{V_i} \right)$ |
| General | $nC_v \Delta T$ | $\Delta U - W$ | ($PV$ Area) |