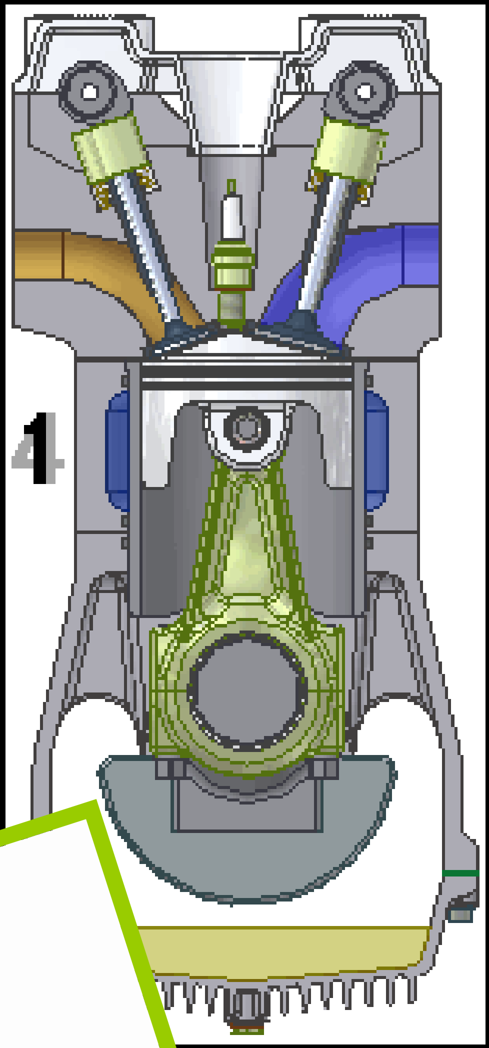
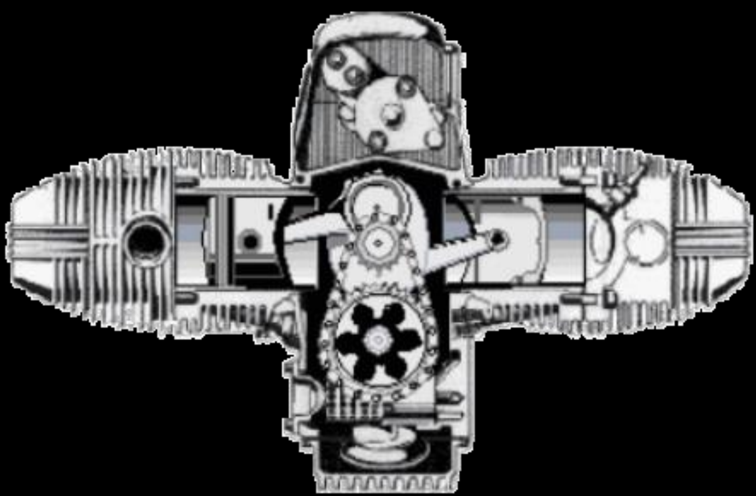
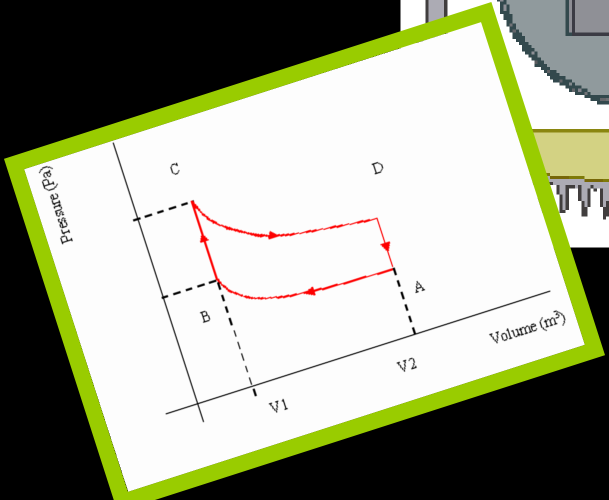
Thermodynamics







Thermodynamics

- **Heat**
- **Internal Energy**
- **Work**
- **Heat Reservoir / Heat Sink**

Thermodynamics

Thermodynamics

- Zeroth Law
- First Law
- Second Law

Very Important Terms

Thermodynamics

- **Adiabatic**
- **Isobaric**
- **Isochoric (Isovolumetric)**
- **Isothermic**

Very Important Terms

Thermodynamics

- **Carnot Theorem**
- **Thermal Efficiency**
- **Carnot Efficiency**

Very Important
Terms

Thermodynamics

- **Entropy**
- **Reversible**
- **Irreversible**

Very Important Terms

Thermodynamics

- Thermodynamics - study of properties and movement of thermal energy (Q).

  Q is measured in Joules like all other forms of energy

Thermodynamics

- Laws of Thermodynamics - each are associated with a variable.

Zeroth law	Temperature, T
First law	Internal energy, U
Second law	Entropy, S

Entropy: A thermodynamic quantity representing the unavailability of a system's thermal energy for conversion into mechanical work, often interpreted as the degree of disorder or randomness in the system.

Thermodynamics

- Adiabatic

A thermodynamic process that occurs without gain or loss of heat and without a change in entropy

Look for gases that are insulated from the environment

From Greek *a* “not“, *dia* “through”, and *batos* “passable”

Thermodynamics

- Isobaric

  A thermodynamic process that occurs while the pressure remains constant

  From Greek *isos* "equal“ and *baros* "weight"

Thermodynamics

- Isochoric (Isolvolumetric)

  A thermodynamic process that occurs while the volume remains constant

  Look for gases that are contained in a closed or fixed container

  From Greek *isos* "equal“ and *choro* "place"

Thermodynamics

- Isothermal

  A thermodynamic process that occurs while the temperature remains constant

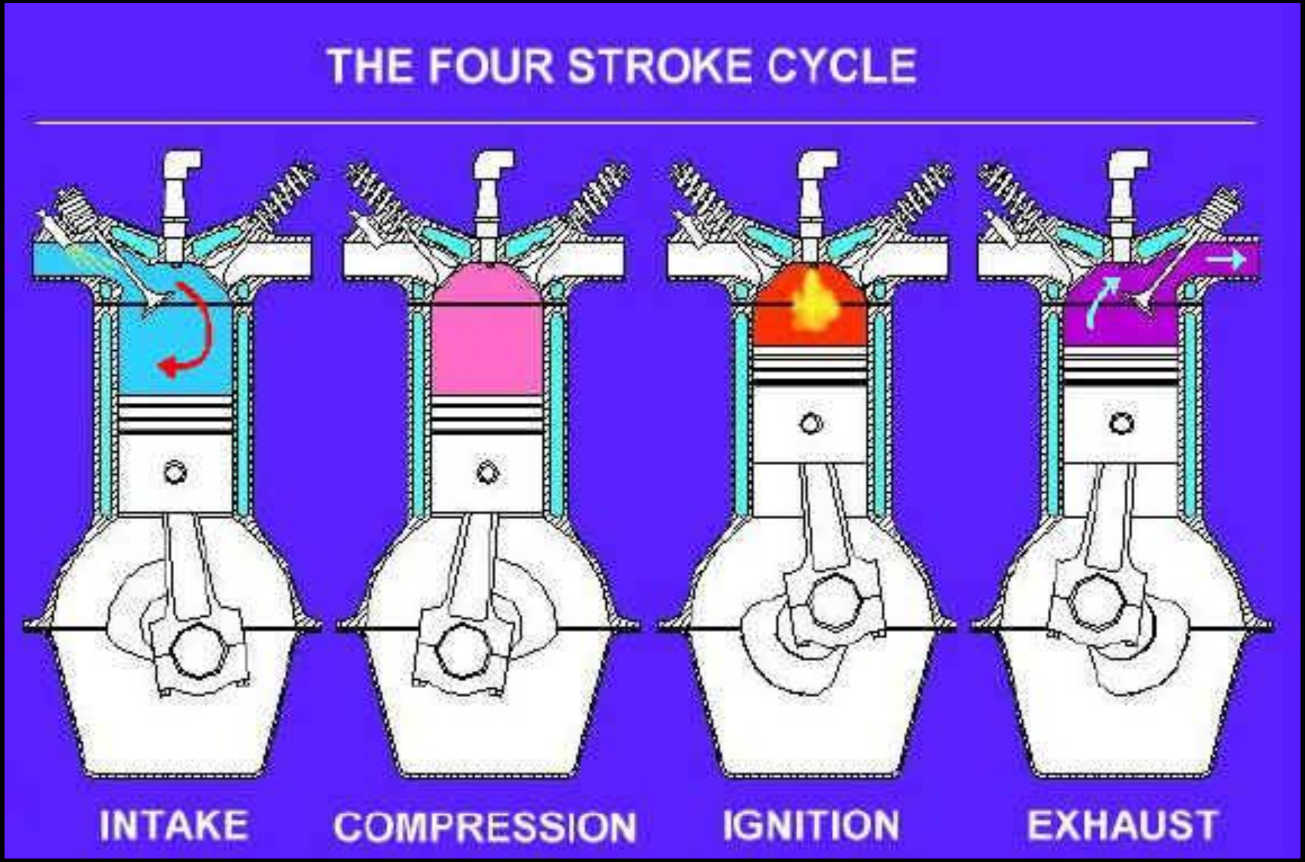
  Usually a relatively slow process to allow the gas to maintain its temperature

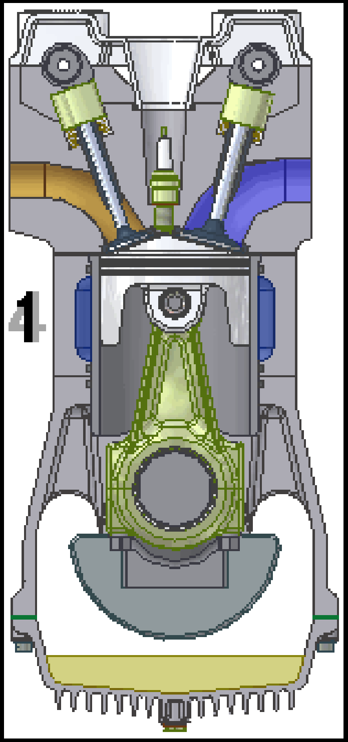
  From Greek *isos* "equal"

  and *therme* "heat"

Thermodynamics

- Combustion Engine





Thermodynamics

- **What is work?**

  Work is the work done <u>by</u> a gas

  Therefore…

  Positive work is the compression of a gas

  Negative work is expansion of a gas

- **What is work?**

  Work is the work done <u>on</u> a gas

Thermodynamics

$W = P\Delta V$

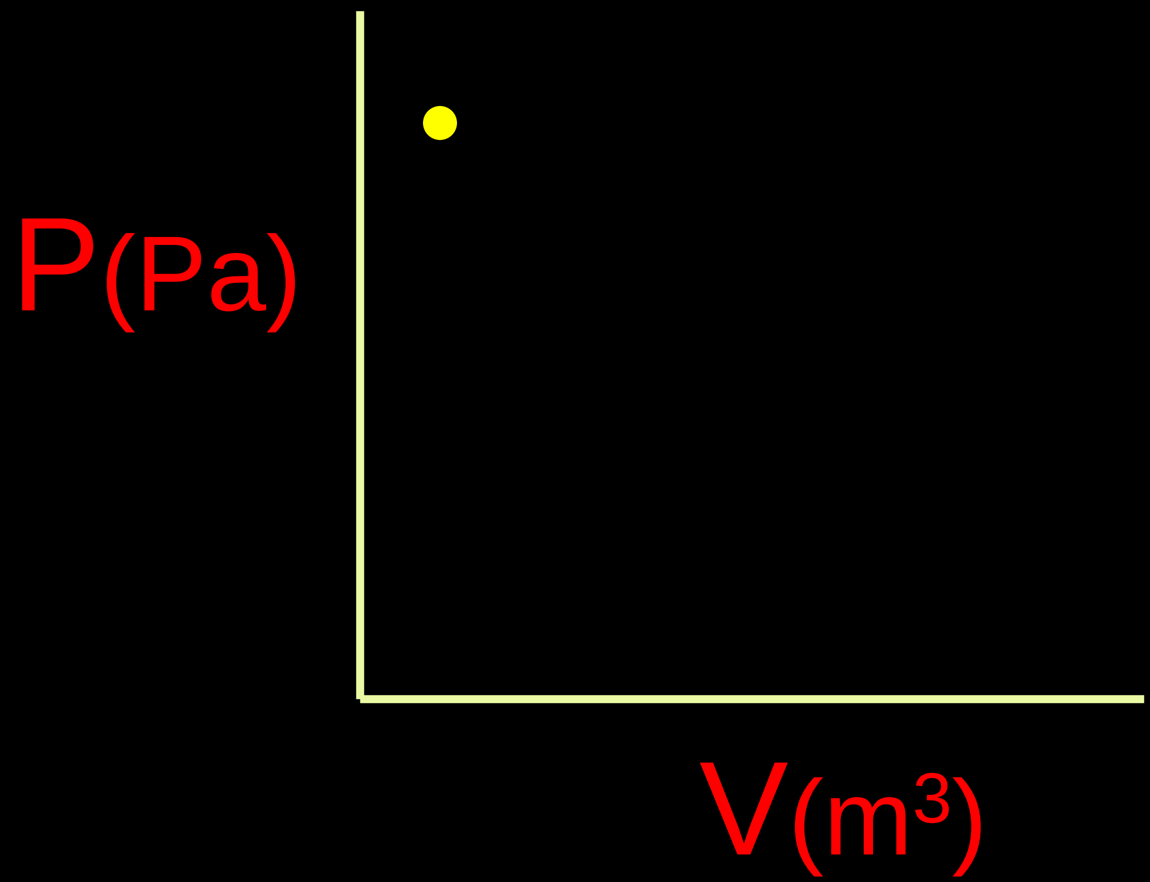
In order for work to be accomplished by the gas, it must expand or contract (change volume)

A change in pressure, only, will not result in any work being accomplished

- In most examples a piston or object atop the gas must be moved for work to be accomplished
- Since we are considering the work done by the gas, as the piston moves, the gas loses energy
- Expansion is negative work; contraction is positive work

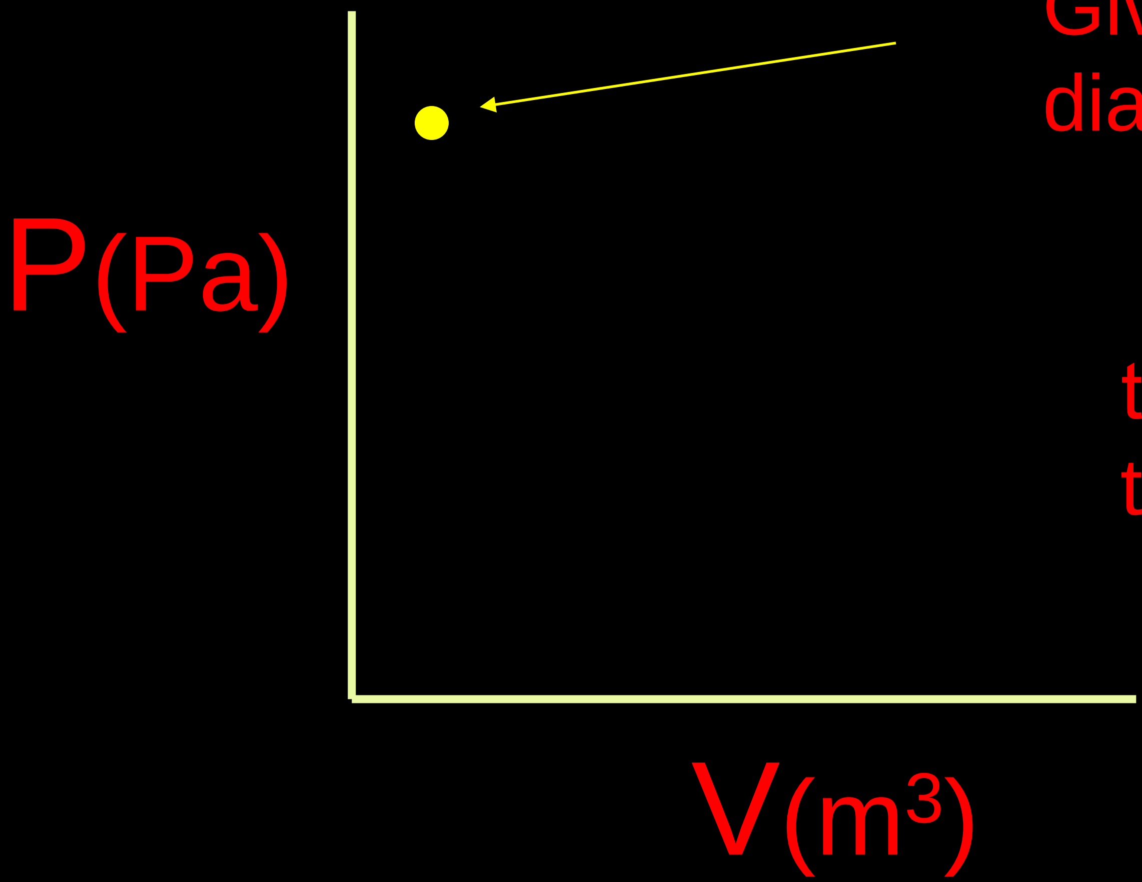
Thermodynamics

PV Diagram basics



Thermodynamics

PV Diagram basics



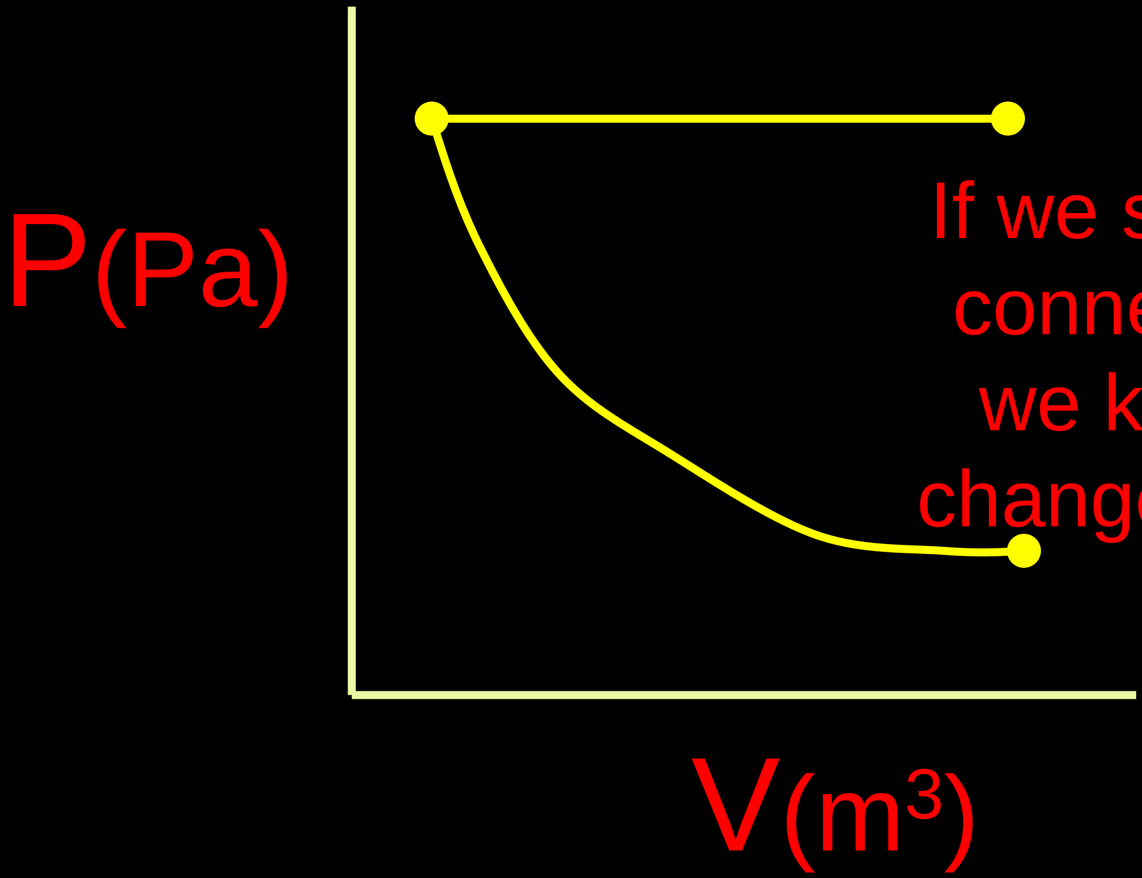
Given a point on the diagram we can use

$$PV = nRT$$

to find the gas's temperature (K)

Thermodynamics

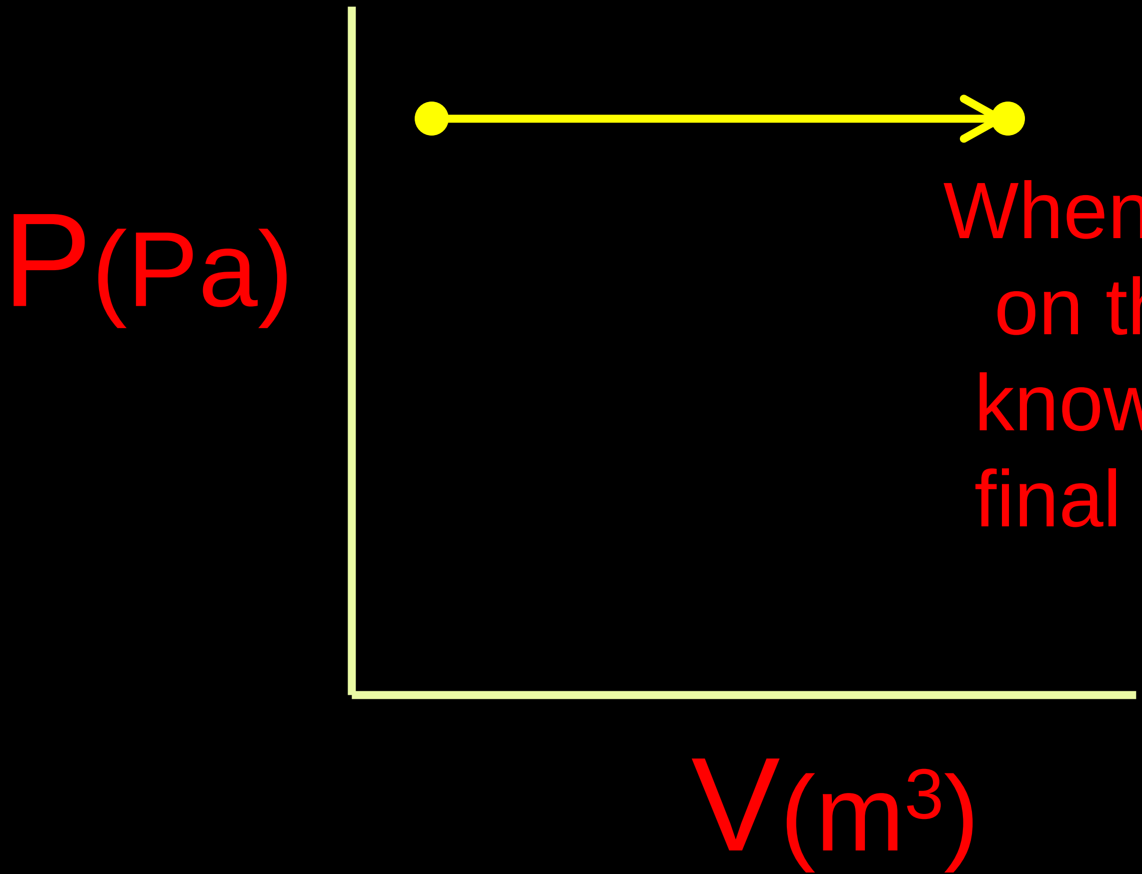
PV Diagram basics



If we see a line or curve connecting points then we know the gas has changed its properties in some way

Thermodynamics

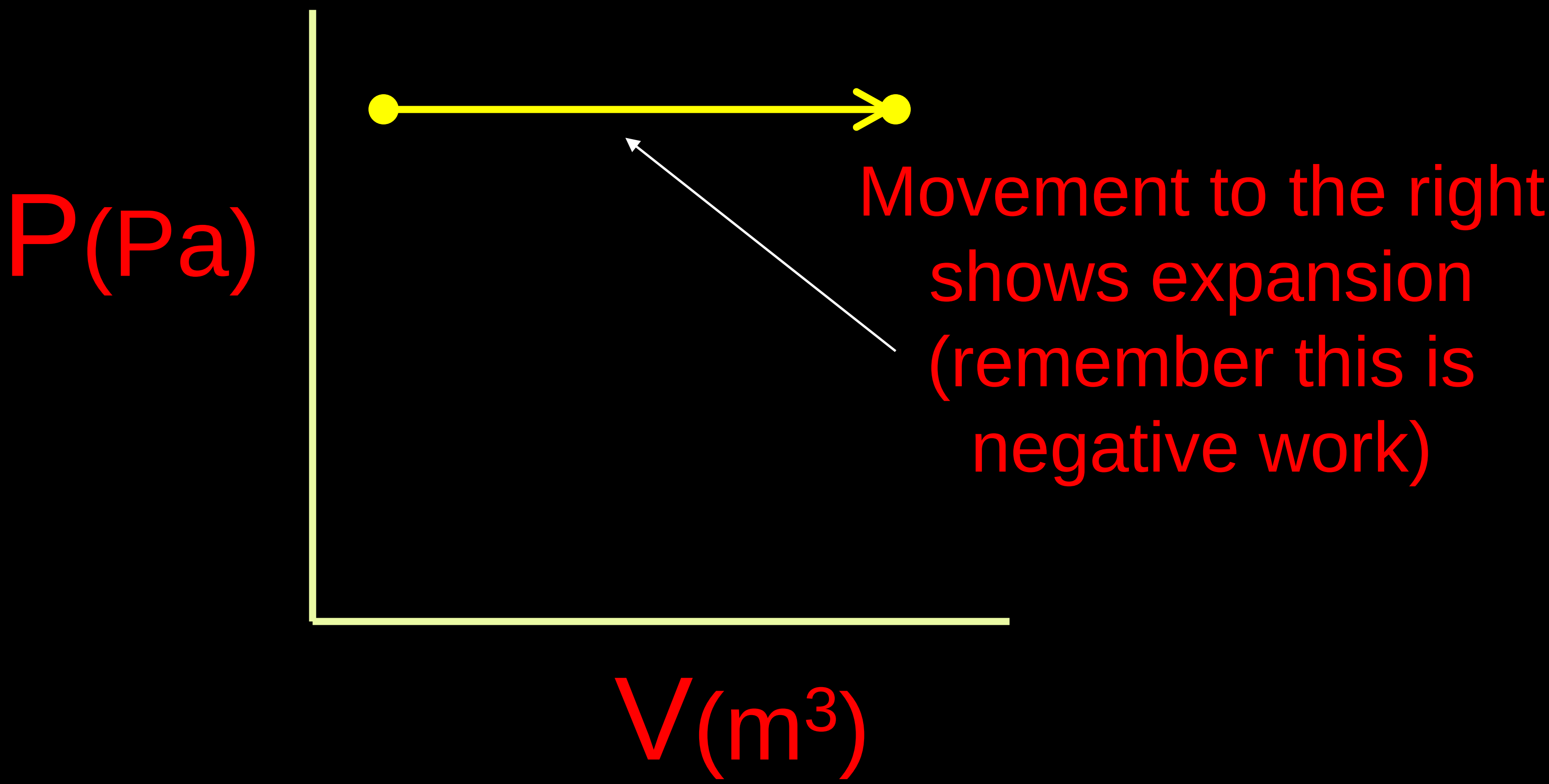
PV Diagram basics



When we see an arrow on that line, then we know the original and final states of the gas

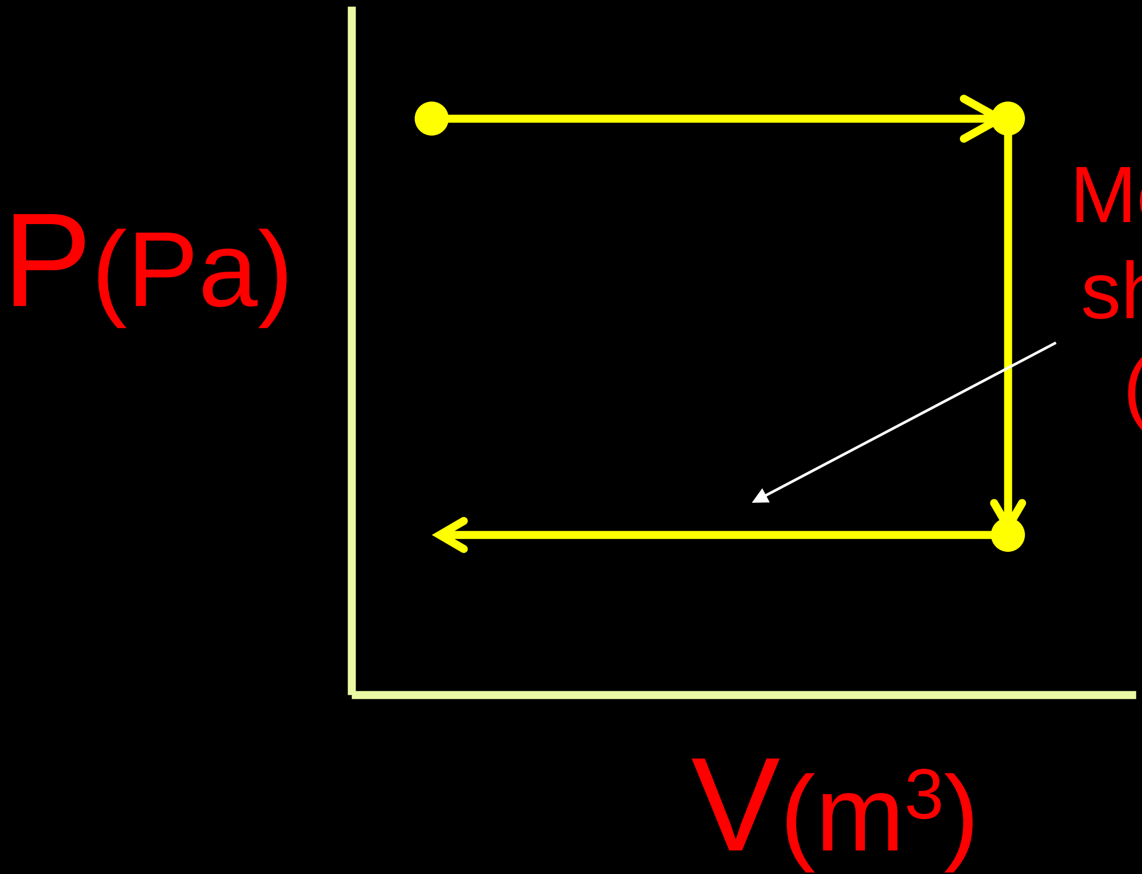
Thermodynamics

PV Diagram basics



Thermodynamics

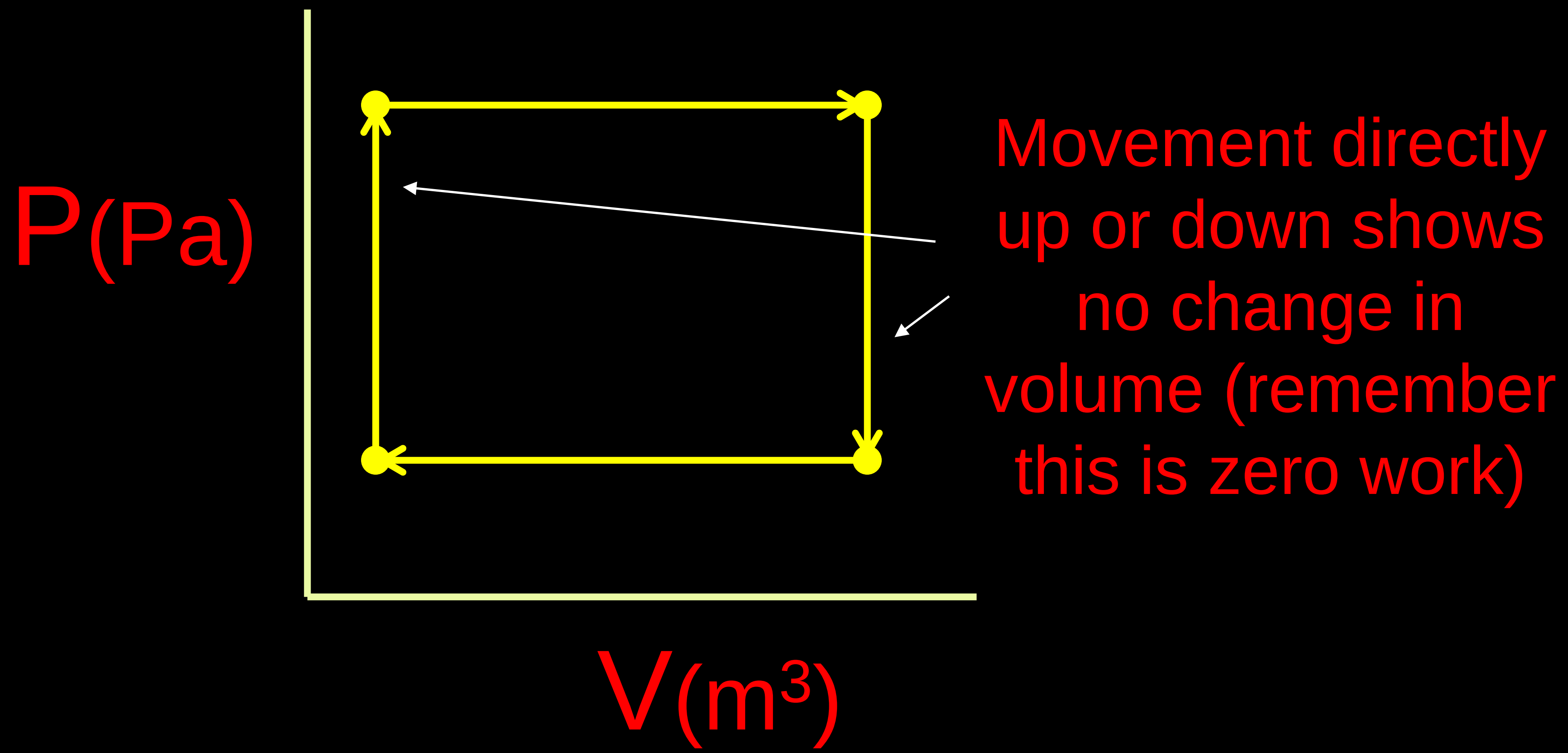
PV Diagram basics



Movement to the left shows compression (remember this is positive work)

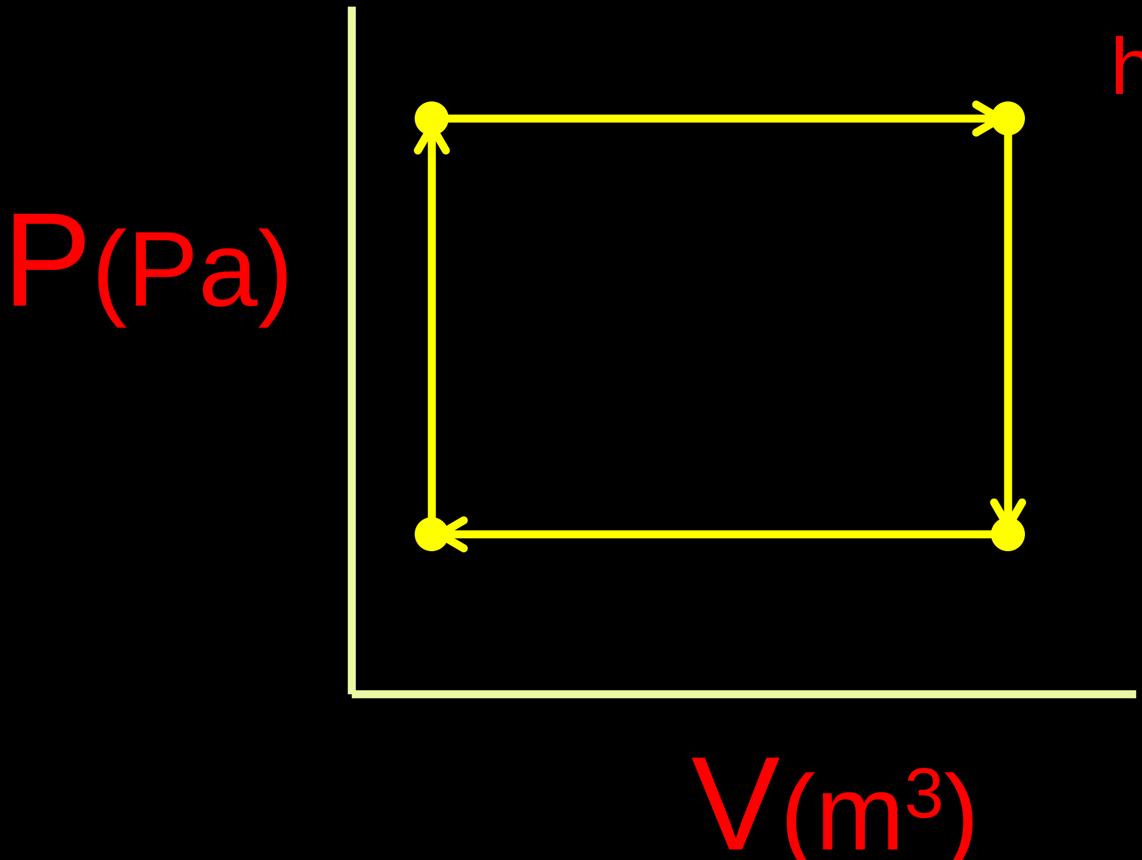
Thermodynamics

PV Diagram basics



Thermodynamics

PV Diagram basics



When the path closes then we have one complete cycle

The gas has returned to its original pressure, temperature, and volume