

Since matter cannot flow then $w=0$, therefore $\Delta u=q$ - closed system

Change in energy of a closed system is equal to the energy that passes its boundaries.

Expansion work

If work done on a system is (dw) and the energy supplied to it as heat as (dq) then:

$$du=dq+dw$$

This is work arising from change in volume ie -ve changes (compression) or +ve changes (expansion)

(a) General Expansion of work

Work required to move an object a distance (DZ) against an opposing force of magnitude F is - Fdz

$$dw=-Fdz$$

Expansion by dv against a pressure P_{ex} is

$$dw= -P_{ex}.dv$$

$$W=\int -P_{ex}.dv$$

To obtain total work done when volume changes from V_i to V_f we integrate this equation between initial and final volume

Force acting ($P_{ex}.A$) is equivalent to a weight raised as the system expands.

(b) Free expansion

This is expansion against 0 opposing force. It occurs when $P_{ex}=0$ and thus $dw=0$ hence free expansion $w=0$

There is no work done when a system expands freely . Expansion of this kind occurs when a system expands into a vacuum.

(c) expansion against constant pressure

This can be expressed as;

$$W= \int dv= -P_{ex}(V_f-V_i)$$

Therefore writing change in volume as;

$$\Delta V=V_f-V_i$$