Department of Air Conditioning and Refrigeration Engineering Technology

Class: 2nd

Subject: Thermodynamics

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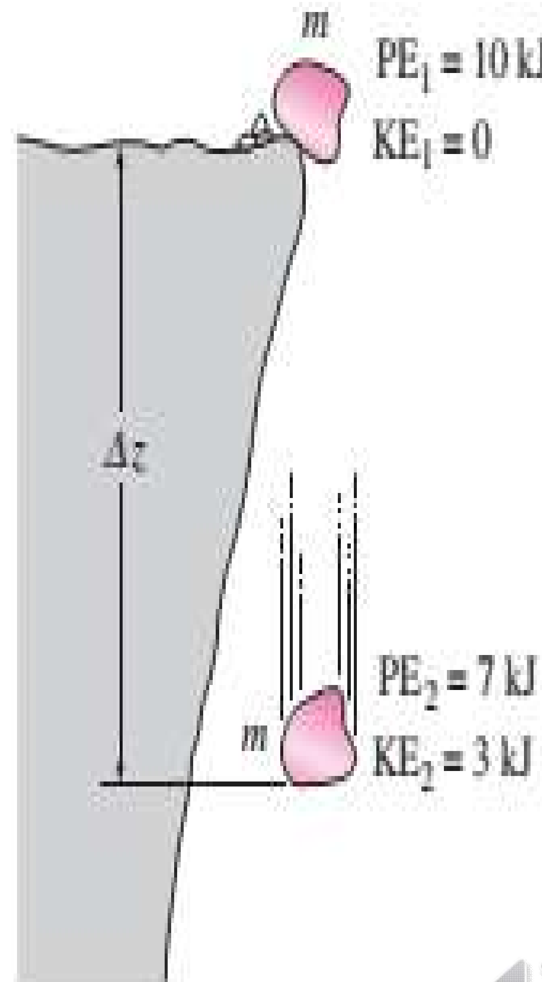
First Law of Thermodynamics (conservation of energy)

Energy can be neither created nor destroyed during a process; it can only change forms.

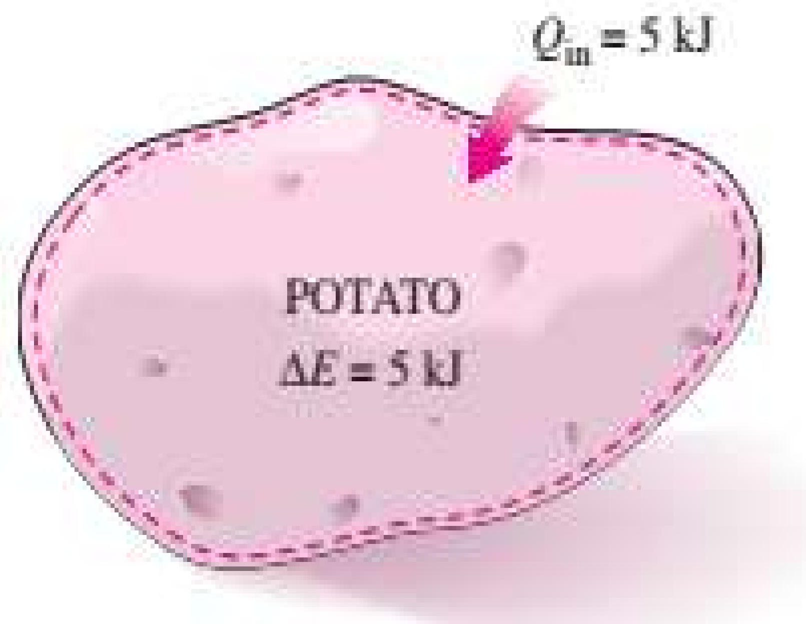
- الطاقة لا تفنـى ولا تستحدث فمتى ما اختفى شكل من أشكال الطاقة ظهر بشكل آخر. بوساطته نحسب كميـات الـشغل والحرارة المنتقلة عبر حدود النظام عندما تحدث تغيرات معينة في الحالة،

مثلاً الشغل الناتج من تمدد بخار في توربين، الشغل اللازم لضغط هواء في ضاغط.

- لقد اهمل القانون الاول نسبة التحول والاتجاه، إذ اوضح انه يمكن تحويل الـشغل كليـاً الى حرارة بالاحتكاك ولكن لايمكن تحويل الحرارة الى شغل.



In the absence of any work interactions, the energy change of a system is equal to the net heat transfer.



The increase in the energy of a potato in an oven is equal to the amount of heat transferred to it.

First Law of Thermodynamics Non Flow Energy Equation (Close System)

-Non-flow energy equation (N.F.E.E)

$Q - W = \Delta U + \Delta KE + \Delta PE \ldots \ldots (1)$

Where

$\Delta U = m.cv.\Delta T = m.(U2 - U1)$

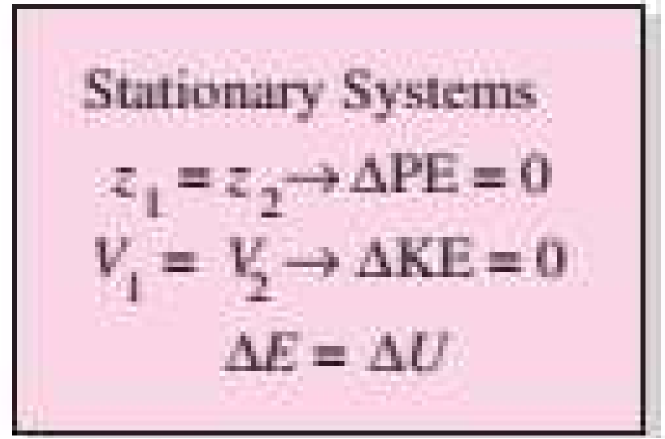
$\Delta K.E = \frac{1}{2} m.\Delta c^2 = \frac{1}{2} m.(c_2^2 - c_1^2)$

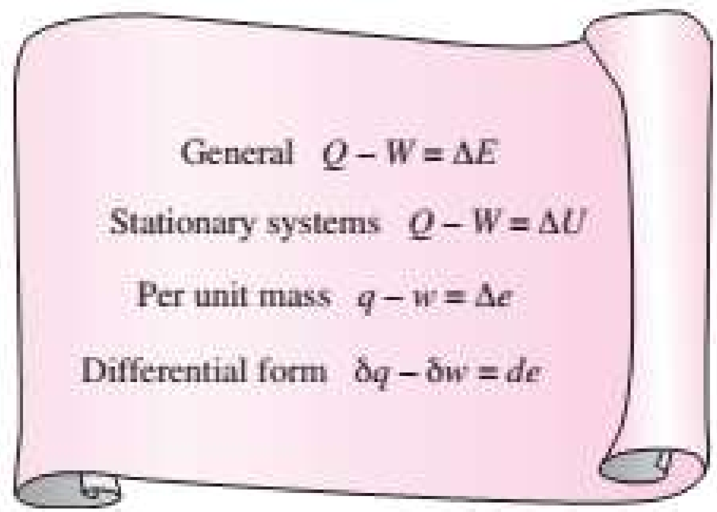
$\Delta P.E = m.g.\Delta z = m.g.(z_2^2 - z_1^2)$.

$\Delta E = \Delta U + \Delta KE + \Delta PE$

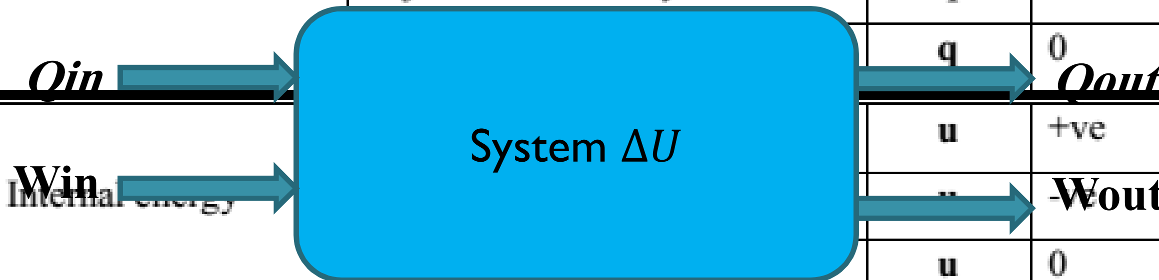
$\mathbf{Q - W = U2 - U1 \ldots \ldots (2)}$

$\mathbf{q - w = u2 - u1 \ldots \ldots}$ **(3) per (kg)**





Heat	Received by the system	**q**	+ve
	Rejected from the system	**q**	-ve
		q	0
Internal energy		**u**	+ve
		u	-ve
		u	0
Work	Done by the system	**w**	+ve
	Done on the system	**w**	-ve
	No work done	**w**	o



$\sum dQ = \sum dW$ $q = w + \Delta u$ $dq = du + dw$	***For both reversible and irreversible process***
$dq = du + \int pdv$ $q = \Delta u + \int pdv$ $w = \int pdv$	***For reversible process only***

- The following table contains the governing equations, displacement work equation and heat interaction equation for different non-flow thermodynamic processes:

Process	**Governing equations**	**Work** $W=\int_1^2 PdV$	**Heat interaction**
Constant volume (Isochoric)	$V = Constant$ $\frac{T_1}{T_2}=\frac{P_1}{P_2}$	$W=0$	$Q=mC_v(T_2-T_1)$
Constant pressure (Isobaric)	$P = Constant$ $\frac{T_1}{T_2}=\frac{V_1}{V_2}$	$W=P(V_2-V_1)$	$Q=mC_p(T_2-T_1)$
Constant temperature (Isothermal)	$T = Constant$ $P_1V_1=P_2V_2$ $\frac{V_2}{V_1}=\frac{P_1}{P_2}$	$W=P_1V_1\ln\left(\frac{V_2}{V_1}\right)$ $W=mRT\ln\left(\frac{V_2}{V_1}\right)$	$Q=P_1V_1\ln\left(\frac{V_2}{V_1}\right)$ $Q=mRT\ln\left(\frac{V_2}{V_1}\right)$
Adiabatic	$\left(\frac{P_2}{P_1}\right)=\left(\frac{V_1}{V_2}\right)^{\gamma}$ $\left(\frac{T_2}{T_1}\right)=\left(\frac{V_1}{V_2}\right)^{\gamma-1}$ $\left(\frac{T_2}{T_1}\right)=\left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$	$W=\frac{P_1V_1-P_2V_2}{\gamma-1}$ $W=\frac{mR(T_1-T_2)}{\gamma-1}$	$Q=0$
Polytropic	$\left(\frac{P_2}{P_1}\right)=\left(\frac{V_1}{V_2}\right)^{n}$ $\left(\frac{T_2}{T_1}\right)=\left(\frac{V_1}{V_2}\right)^{n-1}$ $\left(\frac{T_2}{T_1}\right)=\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}$	$W=\frac{P_1V_1-P_2V_2}{n-1}$ $W=\frac{mR(T_1-T_2)}{n-1}$	$Q=\left(\frac{\gamma-n}{\gamma-1}\right)W$