Efficiency formula

Efficiency is a measure of how much work or energy is conserved in a process.

In many processes, work or energy is lost, for example as a waste (تبذير) heat or vibration.

A perfect process would have an efficiency of 100%.

$$\text{Effeciency} = \frac{\text{energy output}}{\text{energy input}} \times 100\%$$

$$\eta = \frac{W_{out}}{W_{in}} \times 100\% ,$$

W_{out} – the work or energy produced by process, unit (Joule).

W_{in} – the work or energy put in to process, unit (Joule).

$$\text{Efficiency} = \frac{\text{Useful (مفيد) output Energy}}{\text{Total input Eenergy}}$$

$$= \frac{\text{Useful power output}}{\text{Total power input}}$$

The work "الشغل"

The work done by a constant force "$\vec{F}$" on a particle that moves a displacement "$\vec{d}$" in straight line in the direction of force, is given by the scalar product

$$W = \vec{F}\cdot\vec{d} = Fd\cos\theta \quad , \theta\text{-angle between } \vec{F} \,\&\, \vec{d}$$

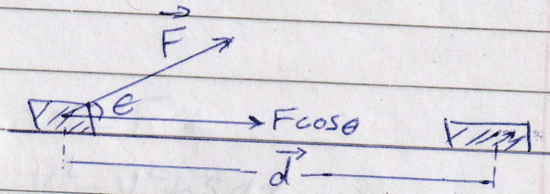
IF the force and displacement in the same direction

$$W = Fd \quad , (\theta = 0)$$

الشغل في الفيزياء هو كمية الطاقة اللازمة لتحريك جسم بقوة F ولمسافة x

ويحسب الشغل الميكانيكي المؤثر على جسم عن طريق حاصل الضرب القياسي للقوة المؤثرة والمسافة التي تحركها الجسم كالآتي

$$W = \vec{F}\cdot\vec{d} = Fd\cos\theta$$



وعند دفع الجسم بقوة موازية لاتجاه الإزاحة فإن $W = Fd$

والشغل كمية عددية ليس لها خاصية الاتجاه. يقاس الشغل بوحدات: J أو erg.

$J = kg\text{-}m^2\text{-}s^{-2}$

$erg = gm\text{-}cm^2\text{-}s^{-2} \quad , \quad 1J = 10^7 erg$

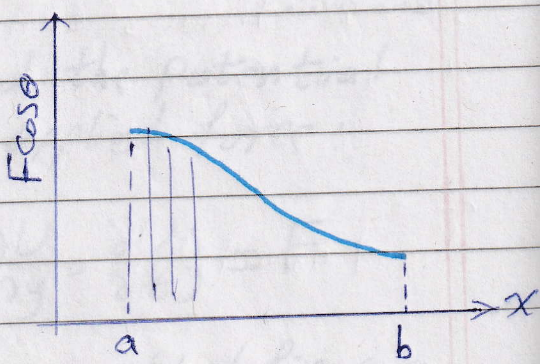
work done by a variable force

IF the force is changing or the body is moving along curve path. IF the force given by $F(x)$ (a function of x) then the work done by the force along the x-axis from a to b is

$$W = \int_a^b \vec{F}(x)\cdot d\vec{x}$$

في حال تغيرت القوة المؤثرة مع الزمن أو انحرف مسار الجسم عن
الخط المستقيم فإن الشغل

$$W = \int_a^b \vec{F} \cdot d\vec{x} = \int_a^b F\cos\theta\, dx$$



Work and Energy

The work closely related to the energy.

The work-energy principle state that:
An increase in the kinetic energy of a rigid body is caused by an equil amount of positive work done on the body by the resultant force acting on that body.

$$W = \Delta K.E.$$

provement:

$W = Fd \;,\; d = x \Rightarrow W = Fx$

according Newtons law $V^2 = V_0^2 + 2ax \rightarrow$

$ax = \frac{1}{2}(V^2 - V_0^2) \;,\; F = ma \rightarrow a = \frac{F}{m}$

$\frac{F}{m}x = \frac{1}{2}(V^2 - V_0^2)$

$Fx = \frac{1}{2}m(V^2 - V_0^2) \;,\; K.E. = \frac{1}{2}mV^2$

$\therefore W = \frac{1}{2}mV^2 - \frac{1}{2}mV_0^2 = \Delta K.E$

$W = \frac{1}{2}mV^2 \;,\; \text{if } V_0 = 0$

$w = Fd$, $\nabla w = \frac{\partial w}{\partial x} + \frac{\partial w}{\partial y} + \frac{\partial w}{\partial z}$

$\nabla w = F$

الطاقة الكامنة

The function $U(x)$ is called **the potential energy** associated with applied force:

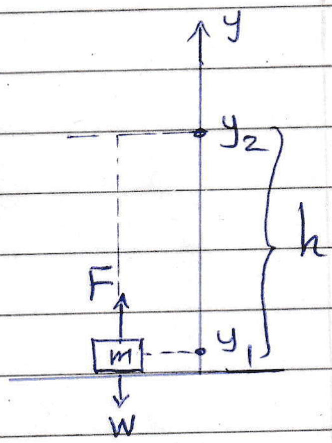
$$\nabla w = -\nabla U = -\left(\frac{\partial U}{\partial x}, \frac{\partial U}{\partial y}, \frac{\partial U}{\partial z}\right) = F$$

Because the potential energy U defines a force F at every point x in space, the set of forces is called a **force filed**.

work by gravity

The work done on the object by its weight is

$$w = Fd = mg(y_2 - y_1)$$
$$= mgh$$



work by spring

يؤثر

consider a spring that exerts a horizontal force

$$F = (-kx, 0, 0)$$

$$W = \int \vec{F} \cdot \vec{dx} = \int_0^x -kx\,dx = -k\int_0^x x\,dx = -\frac{1}{2}kx^2$$

work by gas

$W = \int \vec{F} \cdot \vec{dl}$, ضغط الغاز

pressure $P = \frac{F}{A}$

Volume $V = Al$

$dV = A\,dl \rightarrow dl = \frac{dV}{A}$

$= \int PA \cdot \frac{dV}{A}$

$= \int_a^b P\,dV$