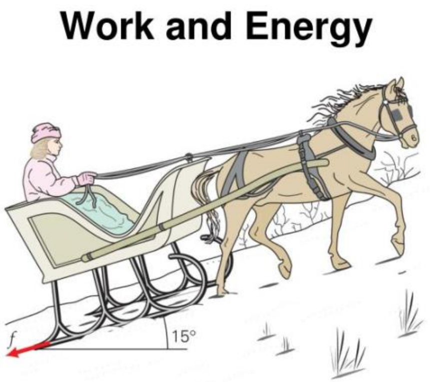
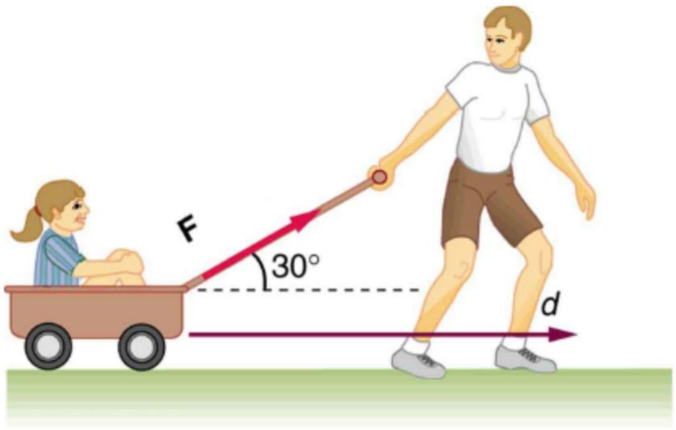
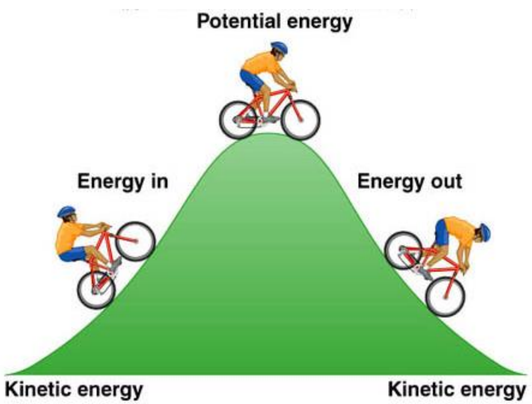
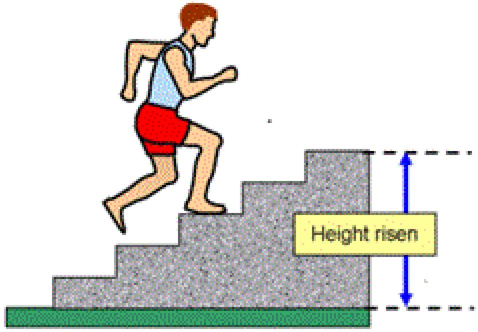




Work & Energy



Lecture First



Work and energy

1- Introduction

2- work done by constant force

3- Work done by varying force

4- work done by spring

5- work and kinetic energy

6- power

7-question with solution

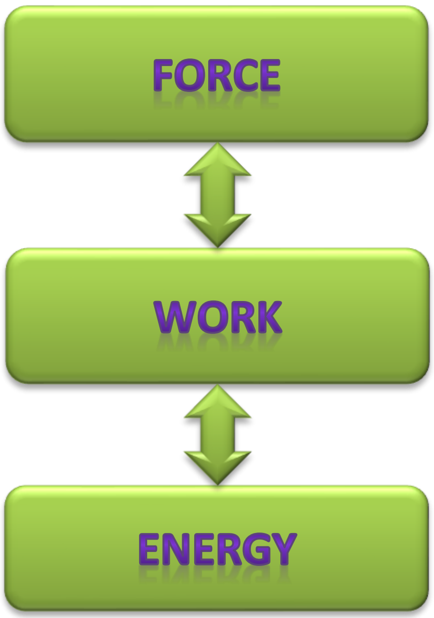
Introduction

- Energy
- Mechanical
- Nuclear
- Chemical
- Electromagnetic

ان مفهوم الشغل و الطاقة مهم جدا في علم الفيزياء حيث توجد الطاقة في الطبيعة في صور مختلفة مثل الطاقة الميكانيكية ، و الطاقة الكهرومغناطيسية ، و الطاقة الكيميائية ، و الطاقة الحرارية ، و الطاقة النووية . ان الطاقة بصورها المختلفة تتحول من شكل الى اخر ولكن في النهاية الطاقة الكلية ثابته. فمثلا الطاقة الكيميائية المختزنة في بطارية تتحول الى طاقة

كهربائية لتتحول بدورها الى طاقة حركية .

Work and Energy



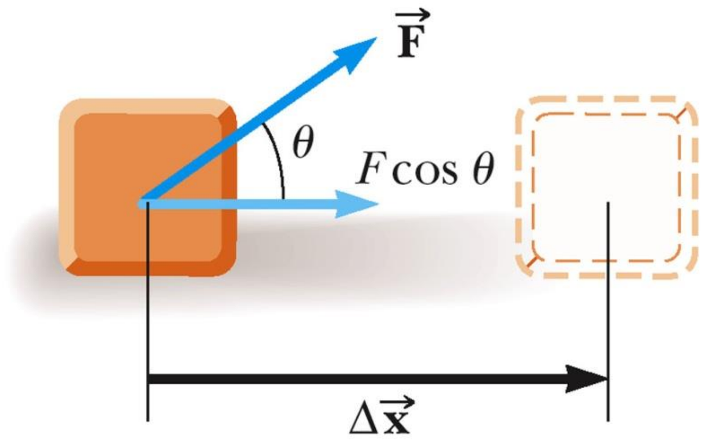
- و في هذا الجزء من المقرر سوف نركز على mechanical Energy و ذلك لأنه يعتمد على مفاهيم القوة التي وضعها نيوتن في القوانين الثلاثة ، ويجدر الذكر هنا أن الشغل والطاقة كميات قياسية وبالتالي فإن التعامل معها سيكون أسهل من استخدام قوانين نيوتن للحركة ، وذلك لأننا كنا نتعامل وبشكل مباشر مع القوة وهي كمية متجهة . وحيث أننا لم نجد أية صعوبة في تطبيق قوانين نيوتن وذلك الأن مقدار القوة المؤثرة على حركة الأجسام ثابت ، ولكن إذا ما أصبحت القوة متغيرة وبالتالي فإن العجلة ستكون متغيرة وهنا يكون التعامل مع مفهوم الشغل والطاقة اسهل بكثير في مثل هذه الحالات

- والشغل قد يكون ناتجة من قوة ثابتة constant forceأو من قوة متغيرة varying force . وسوف ندرس كلا النوعين في هذا الفصل

Work Done by a constant force

- The work(W) done by a constant force is defined as the distance moved multiplied by the component of the force in the direction of displacement:
- W≡ (F$\cos\theta$)Δx
- W=$\vec{F}.\Delta\vec{X}$ work is a scalar quantity

  - F is the magnitude of the force
  - Δ x is the magnitude of the displacement
  - θ is the angle between $\vec{F}$and $\Delta\vec{x}$
  - W≡ $F\Delta x$ when $\theta = 0$
  - SI Unit :Newton.meter=Joule
  - N.m=J



Example 1

Find the work done by a 45Nforce in pulling the luggage carrier at an angle $\theta = 50°$ for a distance d=75m.

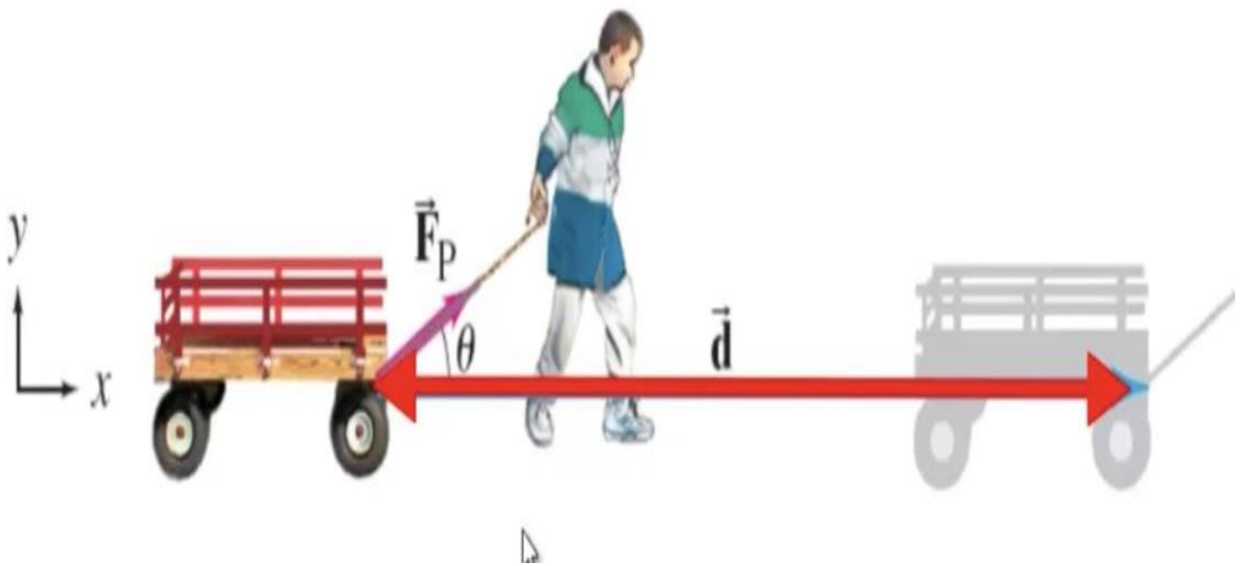
Solution:

W= (F cosθ)Δx

W= (F cos50°)d

W=45cos50°(75)

W=2170J



Work can be positive, Negative ,or zero

Work can be positive, Negative ,or zero . The sign of the work depends on the direction of the force relative to the displacement.

$W = \vec{F} . \Delta\vec{x}$ $\quad\quad\quad\quad$ $W \equiv (F\cos\theta)\Delta x$

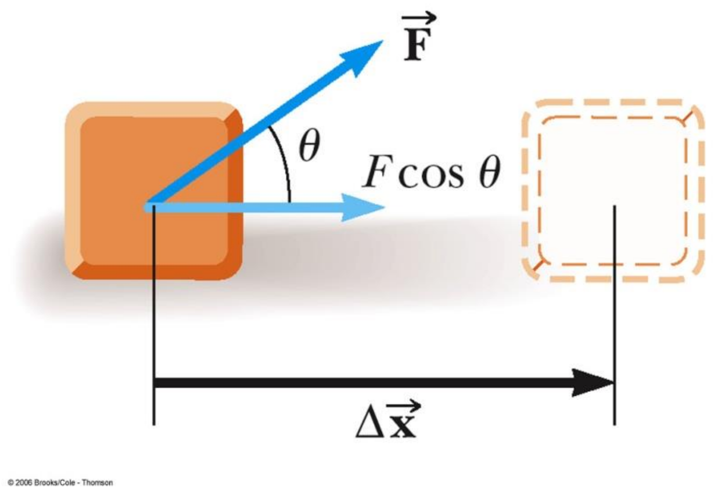
Work positive :W> 0 if $90 > \theta > 0$

Work negative :W< 0 if $180 > \theta > 90$

Work zero : W=0 if $\theta = 90°$

Work maximum if $\theta = 0°$

Work minimum if $\theta = 180°$



Example 2 : When work is zero

A man carries a bucket of water horizontally at constant velocity

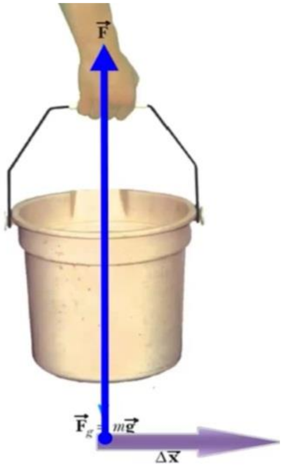
The force does no work on the bucket

Displacement is horizontal

Force is vertical

$$\cos 90° = 0$$

$$W = (F\cos\theta)\,\Delta x$$

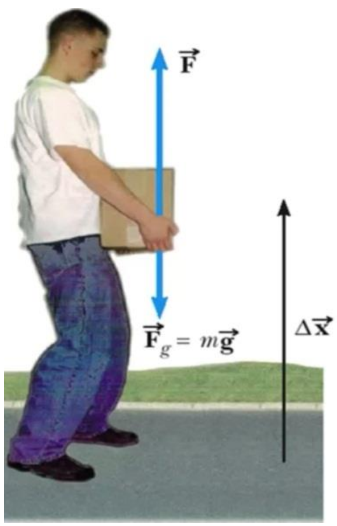


(b)

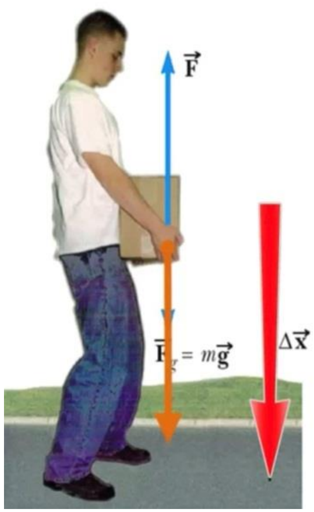
(a)

Example 3: work can be positive or negative

- Man does positive work lifting box.
- Man does negative work lowering box.
- Gravity does positive work when box lowers.
- Gravity does negative work when box is raised.
- (a)



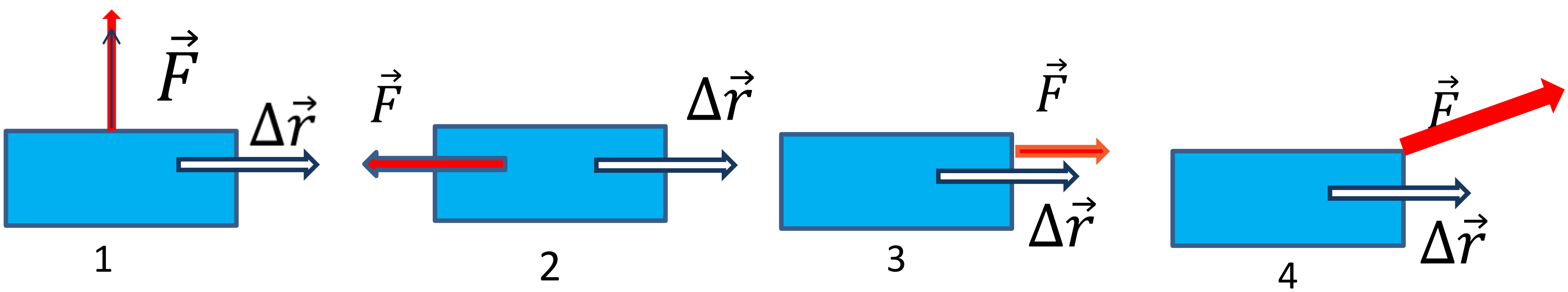
(a)



(b)

Work Done by a Constant Force

The work W done on a system by an agent exerting a constant force on the system is the product of the magnitude F of the force, the magnitude Δx of the displacement of the point of application of the force, and $\cos\theta$, where θ is the angle between the force and vectors



$W_1 = 0$

$W_2 = -F\Delta r$

$W_3 = F\Delta r$

$W_4 = F\Delta r\cos\theta$

Example 4

A particle moving in the x y plane undergoes a displacement given by $\Delta\vec{r}$= (2.0i + 3.0j) m as a constant force $\vec{F}$= (5.0i + 2.0j) N acts on the particle. Calculate the work done by F on the particle.

Solution

$W=\vec{F}.\Delta\vec{r}$ = [($5\hat{\imath} + 2\hat{\jmath}$) N] . [($2\,\hat{\imath} + 3\hat{\jmath}$) m]

= ($5\hat{\imath}\ .\ 2\hat{\imath}$ + $5\hat{\imath}\ .\ 3\hat{\jmath}$ + $2\hat{\jmath}\ .\ 2\,\hat{\imath}$ + $2\hat{\jmath}\ .\ 3\hat{\jmath}$) N . m

= [10 + 0 + 0 + 6] N . m =16 J

Example 5

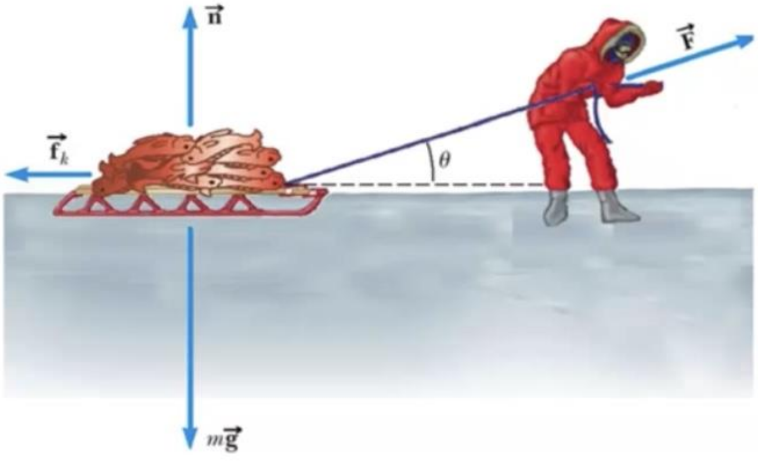
An Eskimo pulls a sled as shown. The total mass of the sled is 50.0 kg, and he exerts a force of 1.20×10^2 N on the sled by pulling on the rope. How much work does he do on the sled if $\theta = 30°$ and he pulls the sled 5.0 m ?

Solution

$W = (F \cos\theta)\, \Delta x$

$= (1.2 \times 10^2 \text{ N})\,(\cos 30°)\,(5.0 \text{ m})$

$= 5.2 \times 10^2$ J



Work Done by Multiple Forces

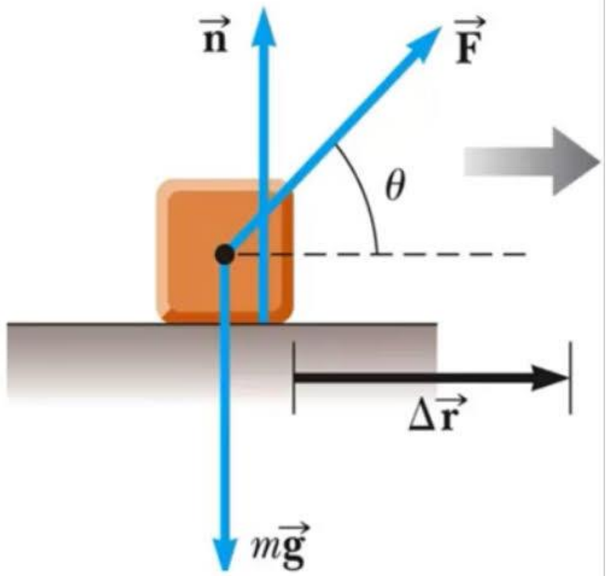
If more than one force acts on an object, then the total work is equal to the algebraic sum of the work done by the individual forces

$W_{net} = \sum W_{By\ individual\ forces}$

Remember work is a scalar ,

So this is the algebraic sum

$W_{net} = W_g + W_n + W_f = (F\cos\theta)\Delta x$



Example 6

In example 5 suppose μ_k =0.200, How much work done on the sled by friction, and the net work if θ = 30° and he pulls the sled 5.0 m .

Solution

$$W_{net} = W_F + W_{fric} + W_n + W_g$$

$$F_{net,y} = N - mg + F\sin\theta = 0$$

$$N = mg - F\sin\theta$$

$W_{fric} = (f_k \cos 180°)\Delta x = -f_k\Delta x = -\mu_k N\Delta x$

$= -\mu_k\ (mg - F\ sin\,\theta\ )\Delta x$

$= -(0.2)(50 * 9.8 - 1.2\times 10^2 * \sin 30°)(5)$

$= -4.3 \times 10^2 J$

$W_{net} = W_F + W_{fric} + W_n + W_g$

$5.2\times 10^2 - 4.3 \times 10^2 + 0 + 0$

=90N