Private tutoring : Contact me to find tutors

My office hours: Right after class on Mon/Thr

Common Exam, Friday, April 13, 2007

8:30 - 9:45 A.M. at KUPF 205

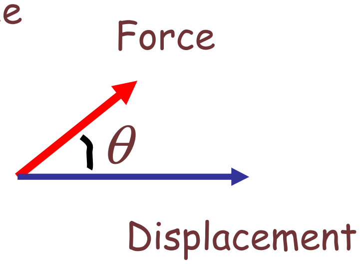
Chaps. 6, 7, 8

Last class, we learned….

Kinetic energy $K = \frac{1}{2}mv^2$ (MKS unit: J)

Work done by a constant force

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

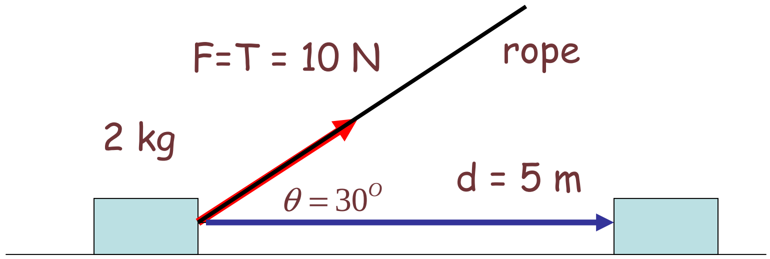


Multiple forces

$$W_{total} = W_1 + W_2 + W_3 + \ldots$$

Work and Kinetic energy relation: $W_{total} = K_f - K_i$

Example (Somewhat related to HW#9-Prob.1)



Frictionless surface

a. Find the forces on the box.

b. Find the work by each force.

c. Find the total work

d. If initial velocity is zero, what is the final velocity?

Spring force

Spring force:

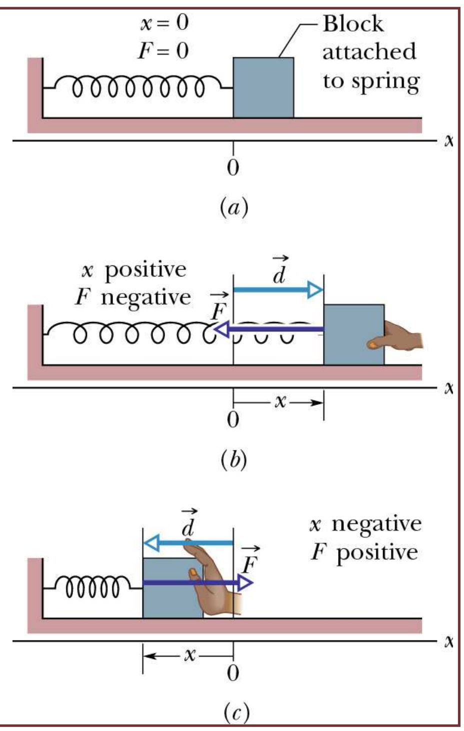
restoring force

variable force

Hooke's law:

$$F_{spring}(x) = -kx$$

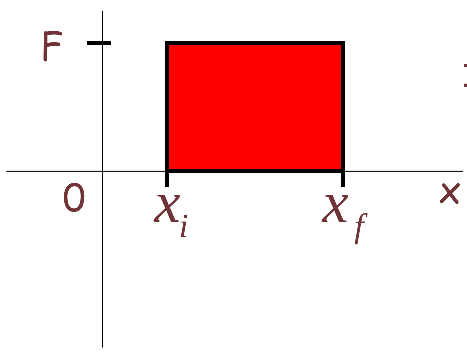
(k: spring constant)



Work done by a constant force (ex: gravity force)

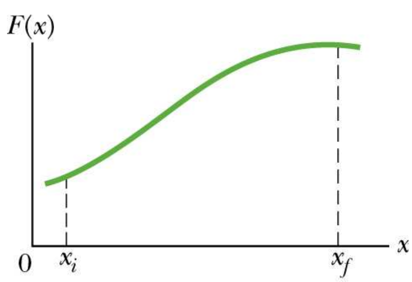
$W = Fd\cos\theta$: work done by a "*constant*" force

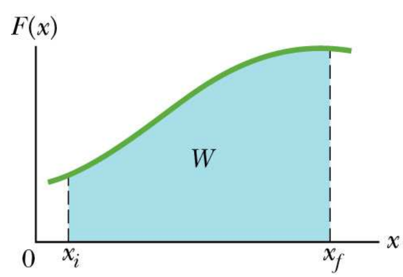
For 1D: $W = F\Delta x = F(x_f - x_i)$



$\pm$ (Area in F vs. x graph) = (Work)

Work done by a variable force (ex: spring force)





$\pm$ (Area in F vs. x graph) = (Work)

(Integration) = $\pm$ (Area) → $W = \int_{x_i}^{x_f} F(x)\,dx$

Math note: Integration

$$\int_{x_i}^{x_f} \left(f(x) + g(x) \right) dx = \int_{x_i}^{x_f} f(x)dx + \int_{x_i}^{x_f} g(x)dx$$

$$\int_{x_i}^{x_f} (\text{constant}) \times f(x)dx = (\text{constant}) \times \int_{x_i}^{x_f} f(x)dx$$

$$\int_{x_i}^{x_f} (\text{constant})\, dx = (\text{constant}) \times (x_f - x_i)$$

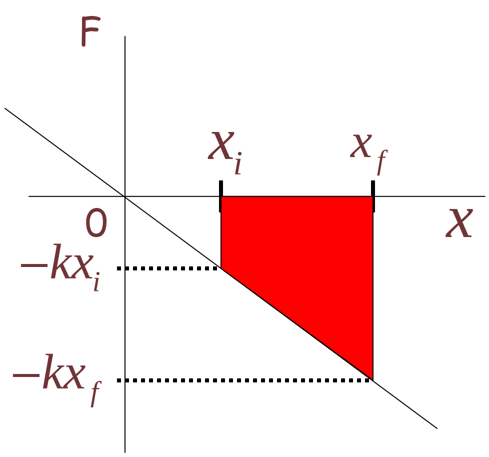
$$\int_{x_i}^{x_f} x\, dx = \frac{1}{2}x_f^2 - \frac{1}{2}x_i^2$$

Exercise: $\int_{x_i}^{x_f} \left(-kx \right) dx = ?$

Ans: $\frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$

Work done by a spring force

$W_{spring} = \int_{x_i}^{x_f} F_{spring}(x)dx$, where $F_{spring}(x) = -kx$



$\pm$ (Area) = (Work)

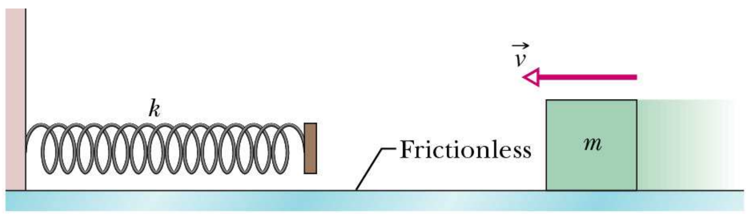
$$W_{spring} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$$

(True for any x_i and x_f)

Note: $W_{total} = K_f - K_i$ is true with spring force.

Sample Problem 7-8

A block of mass $m = 0.40\ kg$ slides across a horizontal frictionless counter with a speed of $v = 0.50\ m/s$. It runs into and compresses a spring of spring constant $k = 750\ N/m$. When the block is momentarily stopped by the spring, by what distance ***d*** is the spring compressed?



Power

Work doesn't depend on the time interval

Work to climb a flight of stairs~3000 J — 10 s / 1 min / 1 hour

Power is work done per unit time

Average Power $P_{avg} = \frac{W}{\Delta t}$

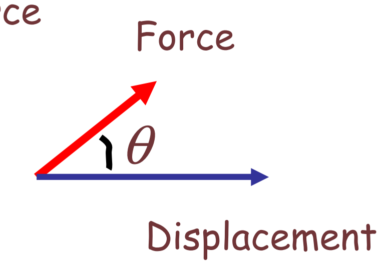
Instantaneous Power P = dW/dt = F dx/dt = Fv (in 1D)

Units $\frac{\text{Work}}{\text{time}}$ $\frac{1\ J}{1\ s}$ = 1 Watt 1 hp = 746 W

In 2D & 3D, Power: $P = \vec{F} \cdot \vec{v} = Fv\cos\theta$

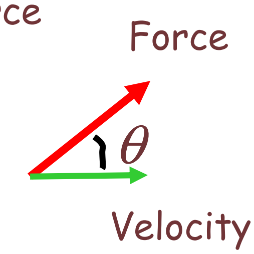
Work done by a constant force

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

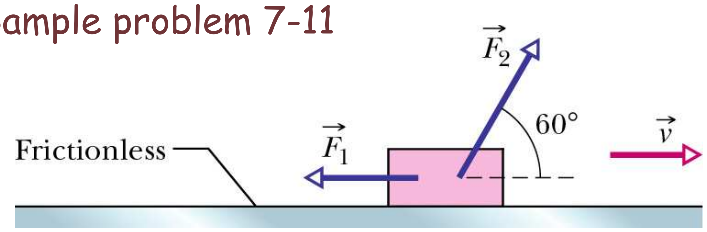


Power done by a constant force

$$P = Fv\cos\theta \equiv \vec{F}\bullet\vec{v}$$



Sample problem 7-11



Two constant forces $\boldsymbol{F_1}$ and $\boldsymbol{F_2}$ acting on a box as the box slides rightward across a frictionless floor. Force $\boldsymbol{F_1}$ is horizontal, with magnitude *2.0 N*, force $\boldsymbol{F_2}$ is angled upward by *60°* to the floor and has a magnitude of *4.0 N*. The speed *v* of the box at a certain instant is *3.0 m/s*.

a) What is the power due to each force acting on the box? Is the net power changing at that instant?

b) If the magnitude $\boldsymbol{F_2}$ is, instead, *6.0 N*, what is now the net power, and is it changing?

Suggested further reading

Work done by gravitational force:

Sample Problem 7-5

Sample Problem 7-6

Example of work-kinetic energy relation

$$W_{total} = W_1 + W_2 + W_3 + \ldots = K_f - K_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

A spring force and work

$$F_{spring}(x) = -kx$$

$$W_{spring} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$$

Power

Work done per unit time, $P = \frac{dW}{dt}$

$$P = Fv\cos\theta \equiv \vec{F} \bullet \vec{v}$$