

## Common Exam 3

April 11<sup>th</sup>, 2008, Friday

**Time: 8:30-9:45 am (Arrive by 8:15 am)**

**Room: KUPF 205**

**Bring your scientific calculators**

**B1. Ch.5 and B2. Ch.7-8**

Review session: During class on Thursday before exam

Old exams are posted on course web:

<http://web.njit.edu/~kenahn/08spring/phy105.htm>

## Last class we learned about...

### Spring force

Hooke's law:

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

x: displacement from relaxed position

k: spring constant (N/m)

### Spring Potential Energy

Spring (elastic) potential energy :

$$U_{spring}(x) = U_s = \frac{1}{2}kx^2$$

Mechanical energy :

$$E_{mech} \equiv K + U_g + U_s = \frac{1}{2}mv^2 + mgh + \frac{1}{2}kx^2$$

If  $W_{net} = W_g + W_s$

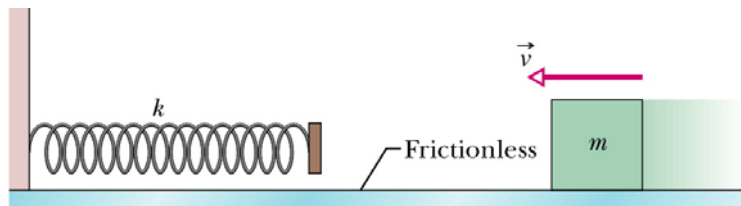
$$E_{mech,f} = E_{mech,i}$$

If  $W_{net} = W_g + W_s + W_{nc}$

$$E_{mech,f} - E_{mech,i} = \Delta E_{mech} = W_{nc}$$

### Example: Spring potential (Last class)

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



Today...

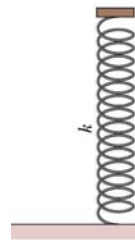
Example on spring and gravity potential

Power

More examples on "Work and Energy"

Example 1: Spring potential and Gravitational potential

A block of mass  $m = 0.40 \text{ kg}$  drops vertically and encounter the spring with a speed of  $v = 0.50 \text{ m/s}$ . It compresses a spring of spring constant  $k = 750 \text{ N/m}$ . 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  $P_{\text{avg}} = \frac{W}{\Delta t}$

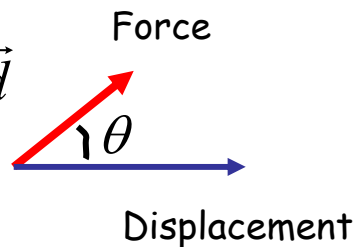
Instantaneous Power  $P = dW/dt = F dx/dt = Fv$  (in 1D)

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

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

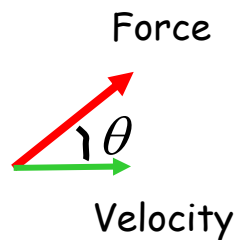
Work done by a force

$$W = |\vec{F}||\vec{d}|\cos\theta_{F,d} \equiv \vec{F} \cdot \vec{d}$$

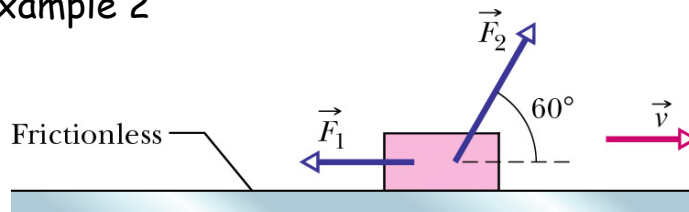


Power done by a force

$$P = |\vec{F}||\vec{v}|\cos\theta_{F,v} \equiv \vec{F} \cdot \vec{v}$$



### Example 2



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

- What is the power due to each force acting on the box?
- What are the powers by the normal force and by the gravity?
- What is the net power?

### Example 3

Killer whales are known to accelerate very fast. Calculate the average power a killer whale with mass  $8000\text{ kg}$  would need to generate to reach a speed of  $12.0\text{ m/s}$  from rest in  $6.0\text{ s}$ . Assume water resistance is negligible.



#### Example 4

What average power would a 1000 kg speedboat need to go from rest to 20 m/s in 5.0 s, assuming the water exerts a constant drag force of magnitude  $f_d = 500$  N and the acceleration is constant?

