Read 7.4-7.5

Due to David B. being gone and spring break, bonus points for Exam 2 not yet in D2L,

Available shortly

Exam 2 solutions on web page

H.W Due Friday

chapter 6

Conservation of Energy

gravity $U = mgh$

spring $U = \frac{1}{2}kx^2$

Kinetic Energy $\frac{1}{2}mv^2$

Conservative forces

Total mechanical energy conserved

$E_i = K_i + U_i = E_f = K_f + U_f$

If friction

(Last Lecture)

$W_{nc} = \Delta K + \Delta U$

Power

Power defined as the rate at which energy is transferred or transformed

Energy transfer into the system is done by external work

Power defined as rate that work is done

$$P = W/t$$

unit J/s = Watt (W)

1 horsepower = 550 ft-lbs = 746 W

Note $P = \frac{W}{t} = \frac{F d \cos\theta}{t} = F v \cos\theta$

ex) A deep sea chamber is raised 1700 m at a constant velocity in 5 minutes. If cable has a tension of 8900 N, how much power is required to lift chamber?

$\theta = 0$

$$P = \frac{W}{t} = \frac{Fd\cos\theta}{t}$$

$\cos 0° = 1$

$$P = \frac{8900\,N \cdot 1700\,m}{300\,s}$$

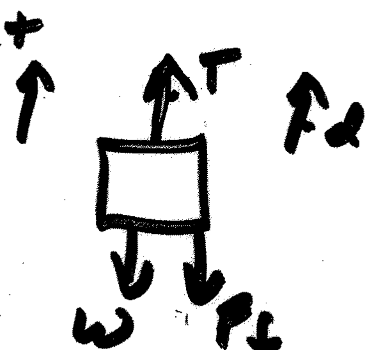
$$\underline{5.04 \times 10^4\,W}$$

$$5.04 \times 10^4\,W \left| \frac{1\,hp}{746\,W} \right|$$

$$\underline{= 67.6\,hp}$$

ex) A 1000 kg elevator carries a 800 kg load. A frictional force of 4000 N retards its motion. What minimum power must motor deliver to lift elevator at a constant rate of 3.0 m/s?

$$P = \frac{W}{t} = \frac{Fd\cos\theta}{t} = Fv\cos\theta$$



$$T - mg - F_f = 0$$

$$T = mg + F_f$$

$$T = (1800\,kg)(9.8\,m/s^2) + 4000\,N$$

$$T = 2.16 \times 10^4\,N$$

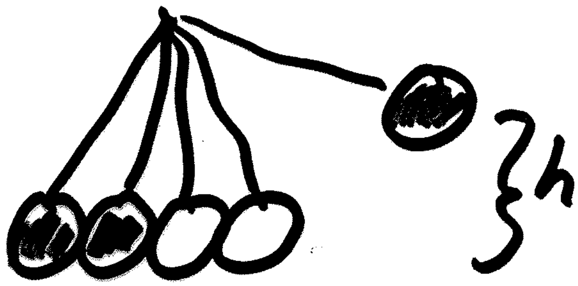
$$P = (2.16\times10^4\,N)(3\,m/s)\cos 0^\circ$$

$$\boxed{P = 6.48 \times 10^4\,W}$$

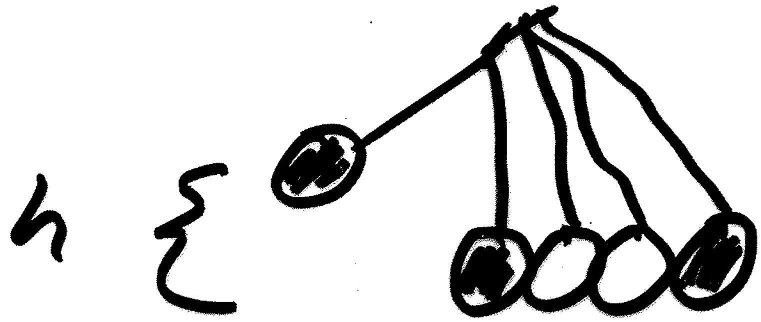
Interactive Question

A 50 kg woman runs up a flight of stairs in 5 s. Her net upward displacement is 5 m. What power did the woman exert while she was running?

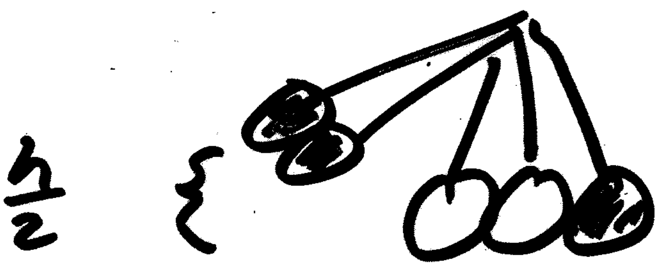
A) 250 W
B) 750 W
C) 0.5 kW
D) 1.0 kW
E) 5 kW



$E_i = mgh$



$E_f = mgh$



$$E_f = 2mg\frac{h}{2}$$
$$= mgh$$

Conservation of Energy allows 2 balls to rise $\frac{h}{2}$, but this does not happen.

Another conservation

<u>LAW</u>

Chapter 7

Conservation of linear momentum

momentum $\boxed{\vec{p} = m\vec{v}}$ Note momentum is a vector!

Newton's 2nd Law

$$\Sigma \vec{F} = m\vec{a} = m\frac{\Delta \vec{v}}{\Delta t} = \frac{m(\vec{v}_f - \vec{v}_i)}{\Delta t}$$

$$= \frac{\vec{p}_f - \vec{p}_i}{\Delta t} = \frac{\Delta \vec{p}}{\Delta t}$$

Rewrite Newton's 2nd Law

$$\boxed{\Sigma \underset{①}{\vec{F}} = \frac{\Delta \vec{p}}{\Delta t} \rightarrow \Delta \underset{②}{\vec{p}} = \Sigma \vec{F} \Delta t}$$

① Rate of change of momentum is proportional to the net force applied

(2) $\Delta\vec{p} = \Sigma\vec{F}\Delta t$

Net force acting over a period of time produces a <u>change</u> in momentum

If only 1 force $\Rightarrow$ $\vec{F}\Delta t = \Delta\vec{p}$

Define $\boxed{\vec{F}\Delta t \leftrightarrow \text{impulse}}$

Interactive Question

A rubber ball and a lump of putty have equal mass. They are thrown with equal speed against a wall. The ball bounces back with nearly the same speed with which it hit. The putty sticks to the wall. Which object experiences the greater momentum change?

A) The ball
B) The putty
C) Both experience the same momentum change
D) Cannot be determined from the information given

putty

m $\qquad$ $\vec{p}_i = m\vec{v}$

$\vec{v}$ $\qquad$ $\vec{+}$

$v_f = 0$

$p_f = 0$

$\Delta p = mv - 0 = \underline{mv}$

ball

$\vec{+}$

m

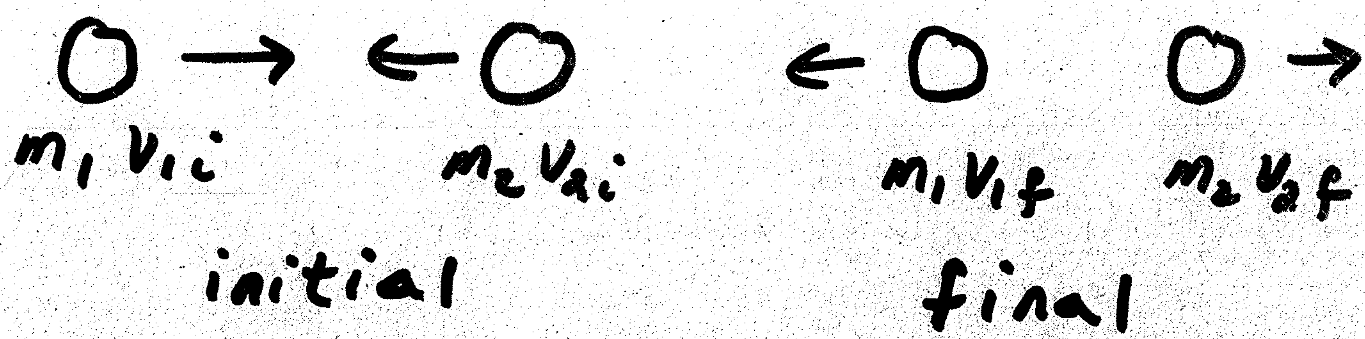
$p_i = \underline{mv}$ $\longrightarrow$ $\qquad$ $\underline{mv}$ $\longleftarrow$

$\vec{v}$

$\Delta p = \cancel{mv - mv} = 0$

$\Delta p = mv - (-mv) = \boxed{2mv}$

Look at 2 balls colliding



ball 1

$$\vec{F}_1 \Delta t = \Delta \vec{p}_1 = m_1 \vec{v}_{1f} - m_1 \vec{v}_{1i}$$

ball 2

$$\vec{F}_2 \Delta t = \Delta \vec{p}_2 = m_2 \vec{v}_{2f} - m_2 \vec{v}_{2i}$$

F_1 = Force of ball 2 on ball 1

F_2 = Force of ball 1 on ball 2

Newton's 3rd Law

$$F_1 = -F_2 \Rightarrow F_1 \Delta t = -F_2 \Delta t$$

This leads to 2 very important results.

$$F_1 \Delta t = -F_2 \Delta t \Rightarrow \boxed{\Delta p_1 = -\Delta p_2}$$

when 2 objects collide, the magnitude of the <u>change</u> in momentum for each object is the same

$$\Delta p_1 = -\Delta p_2$$

$$m_1 \vec{v}_{1f} - m_1 \vec{v}_{1i} = -(m_2 \vec{v}_{2f} - m_2 \vec{v}_{2i})$$

algebra

$$m_1 \vec{v}_{1i} + m_2 \vec{v}_{2i} = m_1 \vec{v}_{1f} + m_2 \vec{v}_{2f}$$

$$\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_{1f} + \vec{P}_{2f}$$

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in general

$$\sum \vec{P}_i = \sum \vec{P}_f$$

IF there are no external forces acting (isolated system)

$$\boxed{\text{momentum is conserved}}$$