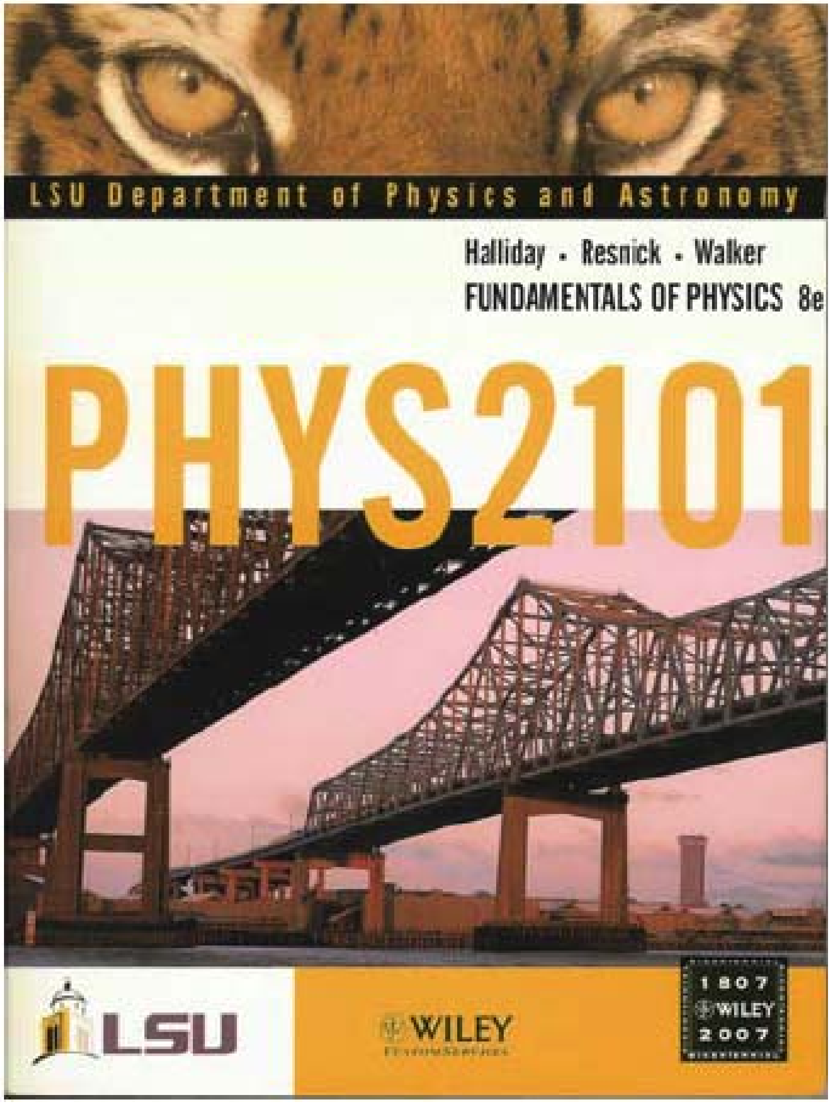


Physics 2101
Section 3
Mar. 1st: Ch. 7-9 review
Ch. 10

Announcements:

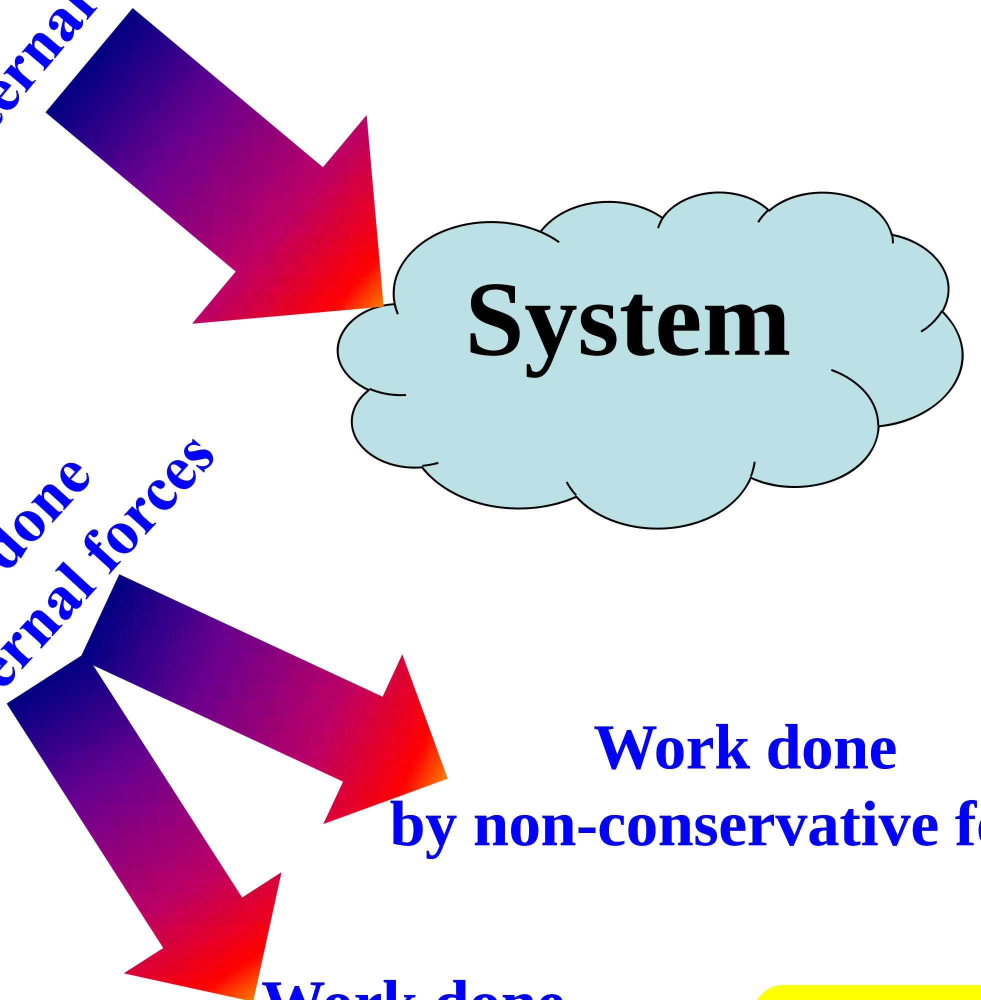
- Test#2 (Ch. 7-9) will be at 6 PM, March 3 (6) Lockett)

- Study session Monday evening at 6:00PM at Nicholson 130

Class Website:
http://www.phys.lsu.edu/classes/spring2010/phys2101-3/
Or go directly to my website

Work and Energy

Work done
by external forces



Work-energy theorem

$$W_{net} = \Delta K$$

$$W_{net} = \int \vec{F}_{net} \cdot d\vec{s}$$

$$K = \frac{1}{2} m v^2$$

Work done
by external forces

Work done
by non-conservative forces

Work done
by conservative forces

$$W_{conser.} = -\Delta U$$

Mechanical energy

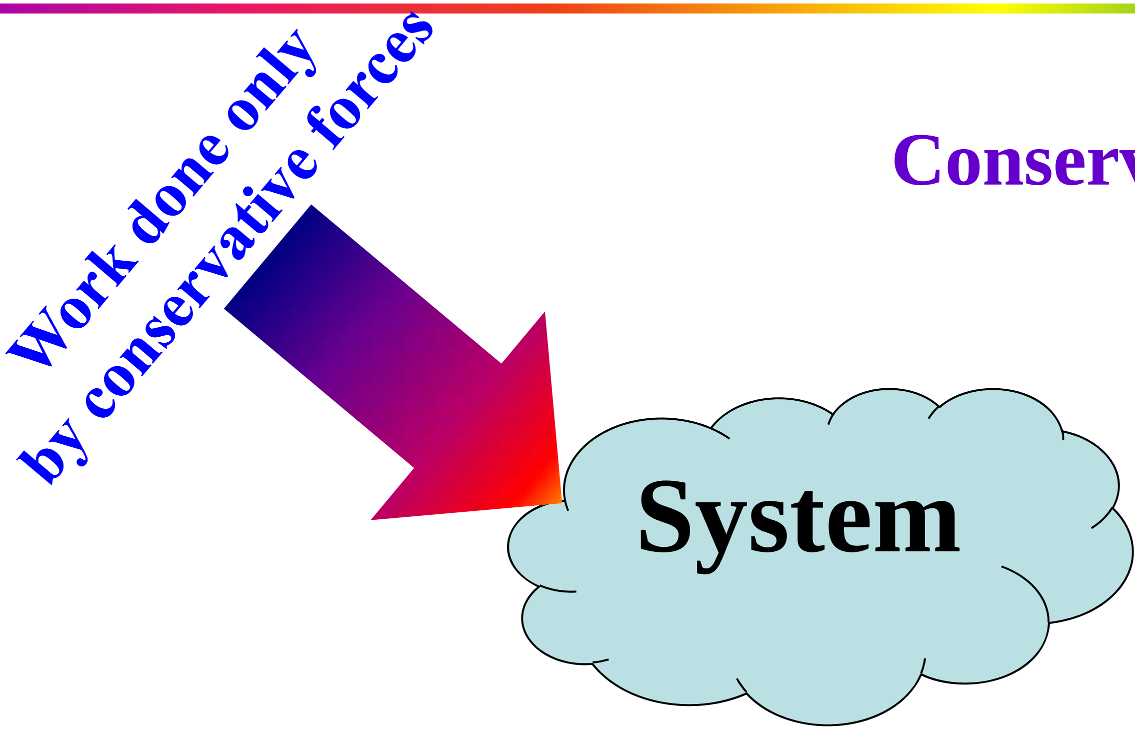
$$E \equiv K + U$$

$$\Delta E = \Delta K + \Delta U$$

Potential energy

$$U_{grav.}(y) = mgy; \qquad U_{elas.}(x) = \frac{1}{2} k x^2$$

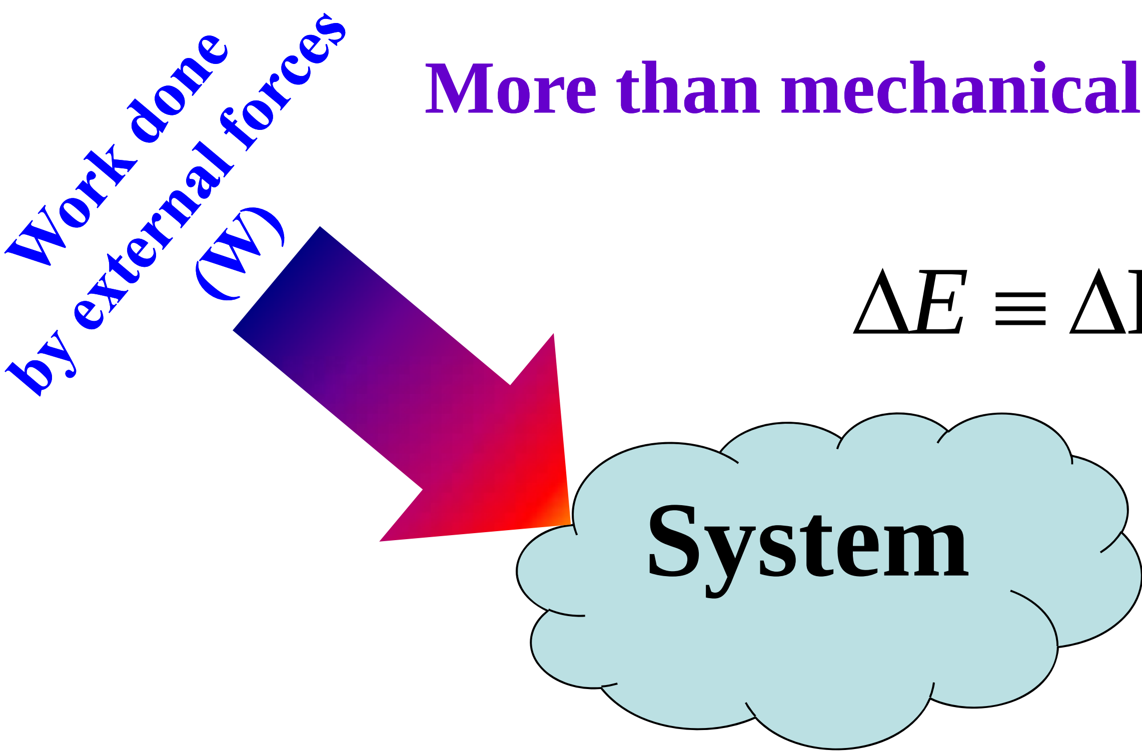
Work and Energy



Conservation of mechanical theorem

$$E_{mec} = K + U = \text{Const.}$$

$$\Delta \text{E}_{\text{mec}} = 0$$

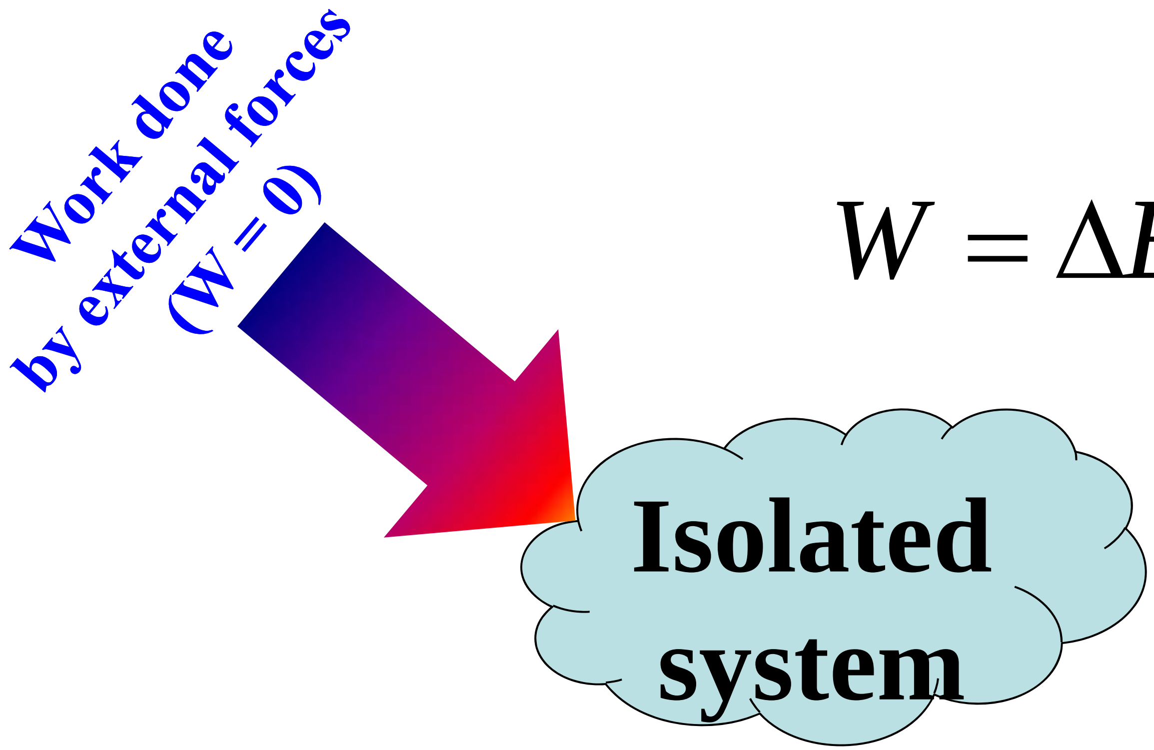


More than mechanical energy

$$\Delta E \equiv \Delta \text{E}_{\text{mec}} + \Delta \text{E}_{\text{themal}} + \Delta \text{E}_{\text{internal}}$$

$$W = \Delta E$$

Work and Energy



$$W = \Delta E = 0$$

Conservation of total energy:

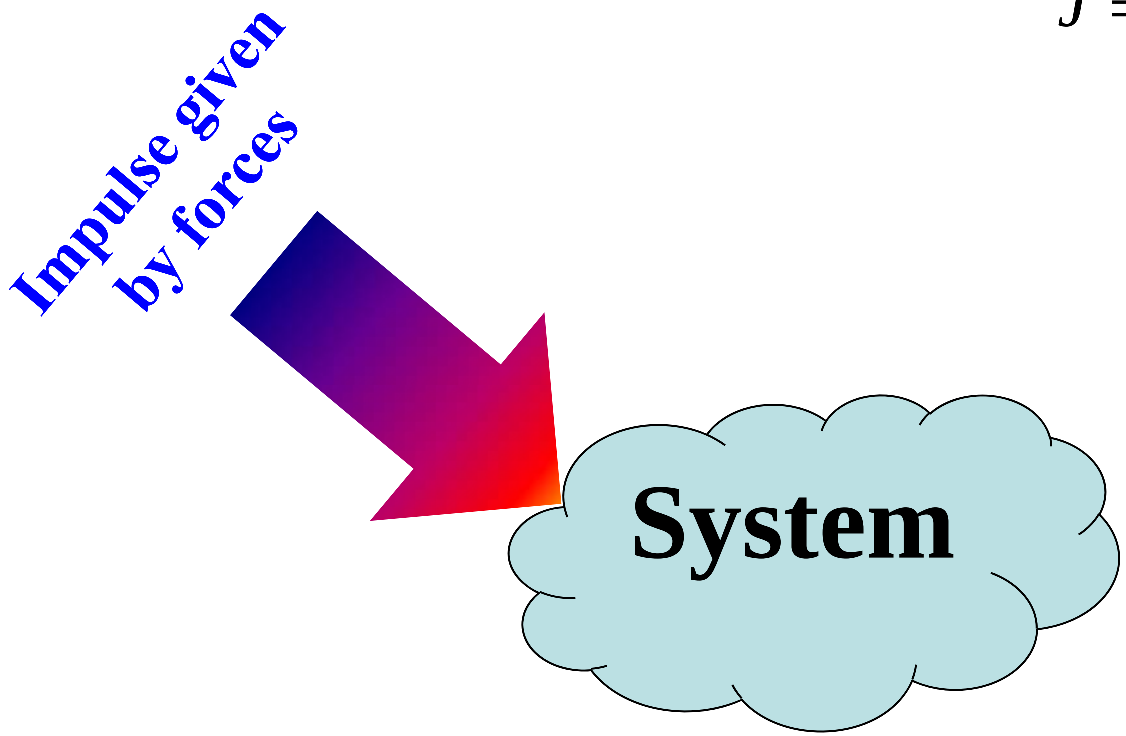
The total energy of an isolated system cannot change

Impulse and Momentum

$$\vec{J} = \Delta\vec{P} = \vec{P}_f - \vec{P}_i$$

$$\vec{P} = m\vec{v} \quad (\vec{P} = \sum m_n \vec{v}_n)$$

$$\vec{J} = \int_{t_i}^{t_f} \vec{F} dt$$



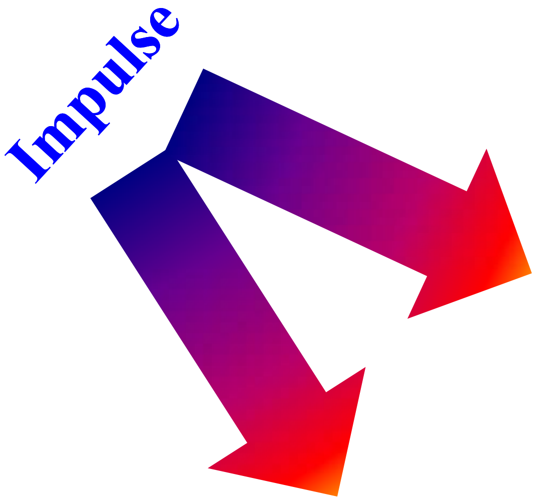
Any external impulse increases the momentum of a system

Nothing but Newton 2nd-law

$$\vec{F} = m\vec{a} = \frac{d\vec{P}}{dt}$$

$$\vec{J} = \int_{t_i}^{t_f} \vec{F} dt = \vec{P}_f - \vec{P}_i$$

Impulse and Momentum



Impulse from external forces $\sum \vec{J}_{ext.}$

Impulse from internal forces $\sum \vec{J}_{internal} = 0$ (collision forces)

No net external force $\sum \vec{F}_{ext.} = 0$

Isolated System

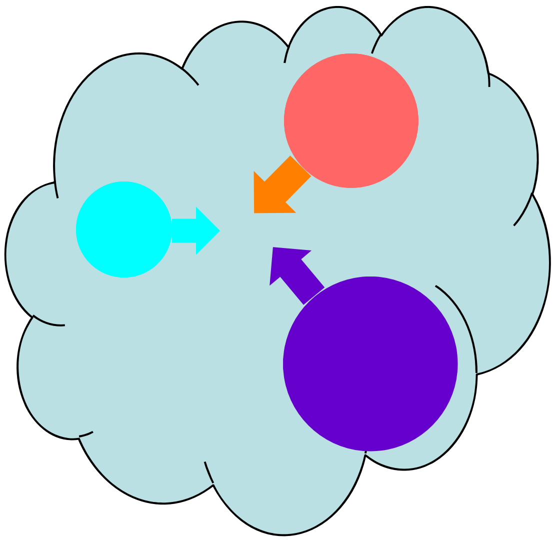
Conservation of total Momentum:

The total momentum of an isolated system cannot change

$$\sum \Delta\vec{P} = \sum_n \Delta m_n \vec{v}_n = 0$$

Impulse and Momentum

$$\sum \vec{F}_{ext.} = 0$$



Application to collision:

$$\sum \Delta \vec{P} = \sum_n \Delta m_n \vec{v}_n = 0$$

Elastic collision:

$$\begin{cases} \sum \Delta \vec{P} = \sum_n \Delta m_n \vec{v}_n = 0 \\ \sum \Delta K = \sum_n \Delta(\frac{1}{2} m_n v_n^2) = 0 \end{cases}$$

The total momentum and total kinetic energy cannot change

Friction Force Problems

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

Non-conservative Forces: Friction

Mechanical energy:

Conservative System $E_{mech} = K + U$

Friction takes Energy out of the system—treat it like thermal energy

$\Delta E_{mech} \neq 0$ Lose Mechanical energy

In general the work done by an external force is

$$W = \Delta E = \Delta E_{mech} + \Delta E_{Thermal}$$

If there is no work done by an external force

$$\Delta E_{mech} + \Delta E_{Thermal} = 0$$

$$E_{mech}(final) = E_{mech}(initial) - E_{th}(final) + E_{th}(initial)$$

$$K_f + U_f = K_i + U_i - \boxed{F_f \bullet displacement} \Leftarrow \Delta E_{Thermal}$$

A new way to look at Friction

Question #8: A block of mass m slides down the inclined plane starting with zero velocity. Region D has friction and it comes to rest after moving a distance D.

Mechanical Energy is not Conserved.

$$E_{mec}(final) = E_{mec}(initial) - \Delta E_{th}$$

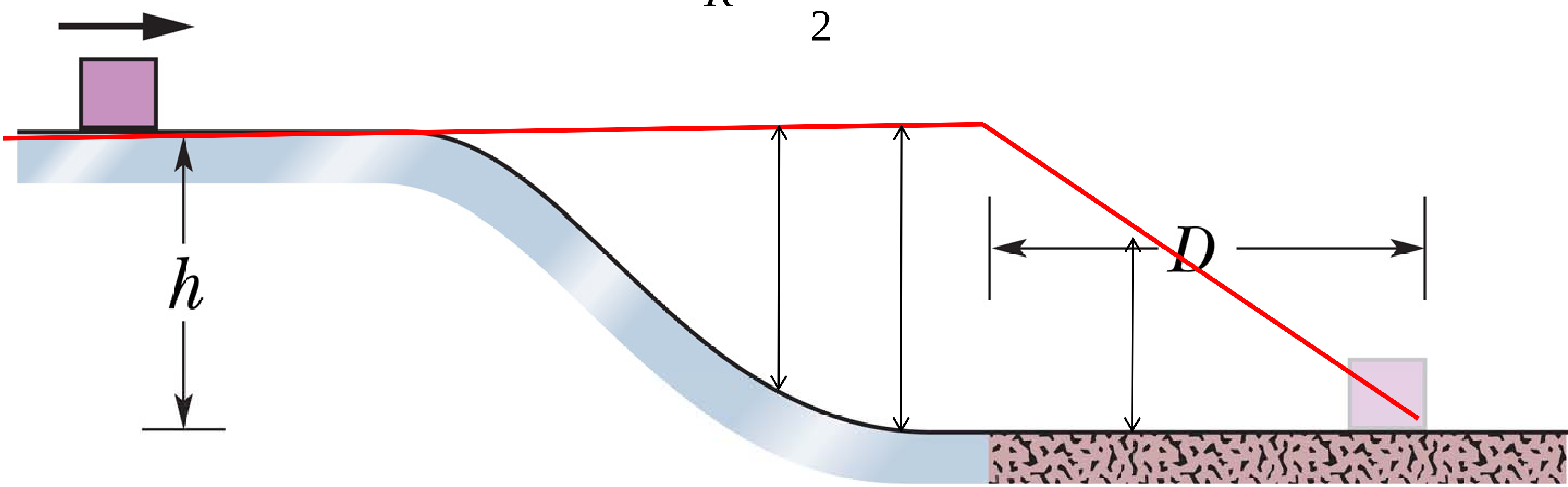
$$E_{mec}(final) = E_{mec}(initial) - F_f x$$

We can draw this.

$$E_{mec}(final) = E_{mec}(initial) - \Delta E_{th}$$

$$E_{mec}(final) = E_{mec}(initial) - F_f x$$

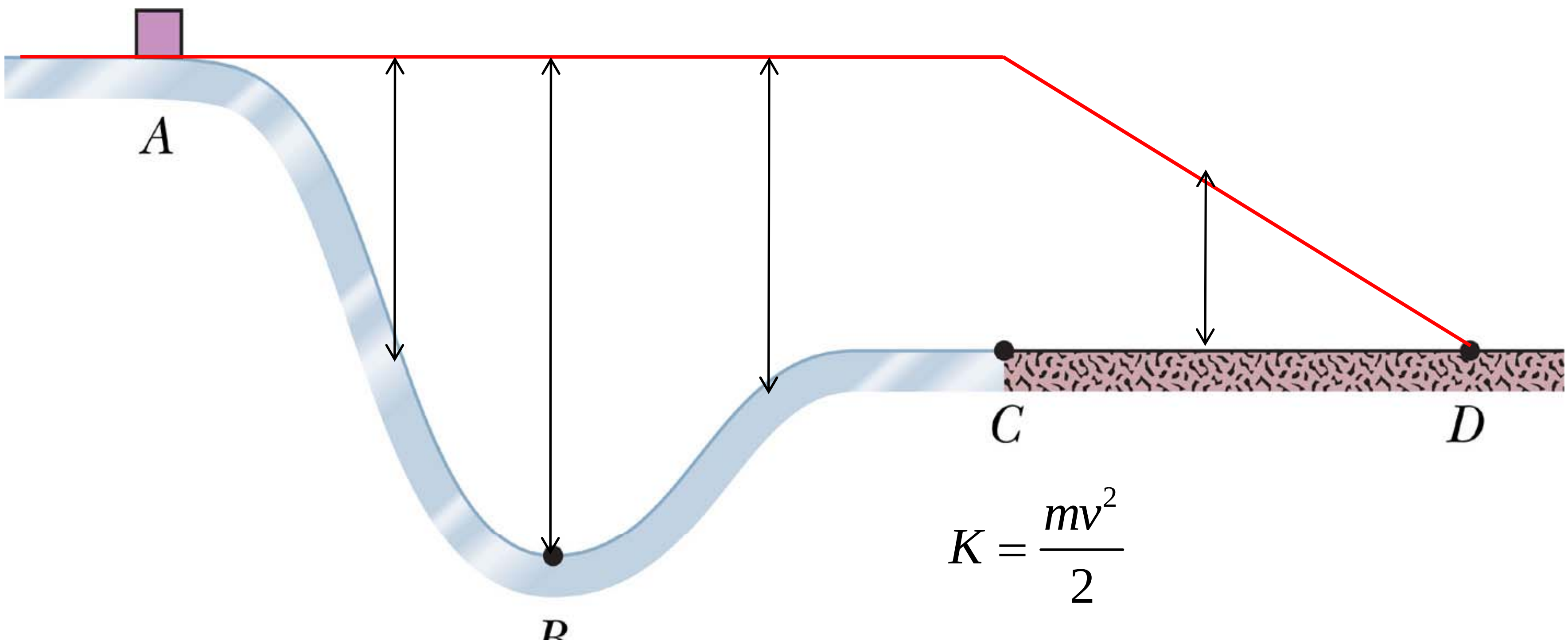
$$K = \frac{mv^2}{2}$$



A new way to look at Friction

Question #9: Find K and E_{mec} as the block moves along.

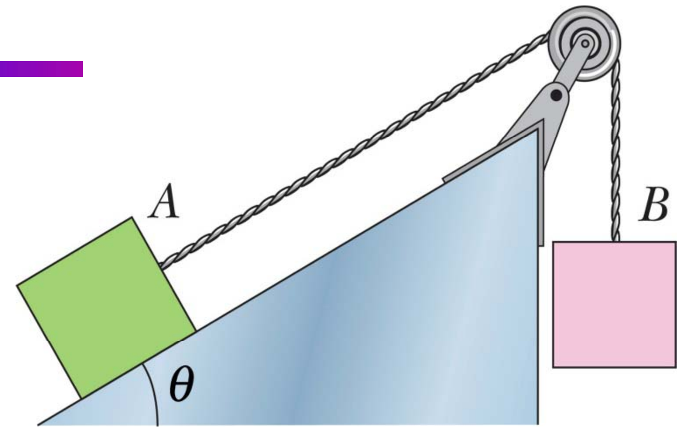
E_{mech}-$F_f$distance



$$K = \frac{mv^2}{2}$$

Problem: No Friction

The pulley is massless and the incline is frictionless. If the blocks are released from rest with the connecting cord taut, block B accelerated downward. What is their total kinetic energy when block B has fallen a distance L?



From conservation of Mechanical Energy, the change in total potential energy is equal AND opposite (i.e. negative) to the change in the total kinetic energy.

Initially the blocks are stationary, so that $KE_i=0$

We define the potential energy to be zero initially.

→ This means $E_{mech} = 0$

When Block B has fallen L m, Block A has risen [(L)sinθ]

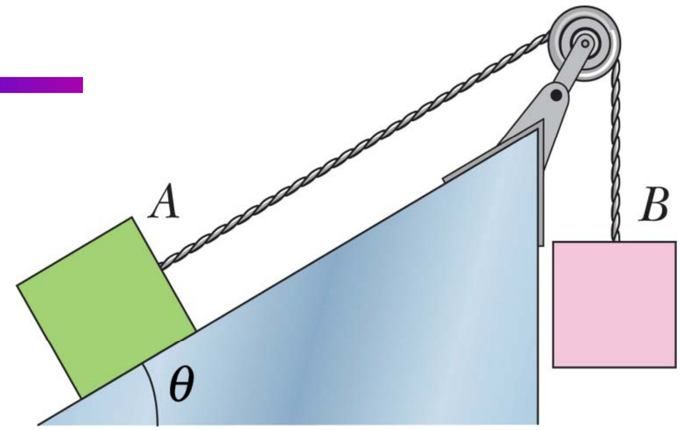
Thus, the final total kinetic energy is:

$$E_{mec} = K_f + U_f = K_i + U_i = 0 + 0$$

$$K_f + U_f = \frac{(m_A + m_B)v^2}{2} - m_B gL + m_A Lg\sin\theta = 0$$

$$K_f = \frac{(m_A + m_B)v^2}{2} = m_B gL - m_A Lg\sin\theta$$

Problem: Friction



The pulley is massless and the incline has a kinetic coefficient of friction μ_k. If the blocks are released from rest with the connecting cord taut, block B accelerated downward. What is their total kinetic energy when block B has fallen a distance L?

Not a conservative force so Mechanical Energy is not conserved.

Initially the blocks are stationary, so that K_i=0

We define the potential energy to be zero initially. → This means $E_{mech} = 0$

When Block B has fallen L m, Block A has risen [(L)sinθ]: $U_f = -m_B gL + m_A gL\sin\theta$

The Energy removed (thermal) is the work done by friction = $m_A gL\cos\theta$

$$K_f + U_f = K_i + U_i - \Delta E_{th} = -\Delta E_{th}$$

$$K_f + U_f = \frac{(m_A + m_B)v^2}{2} - m_B gL + m_A Lg\sin\theta = -m_A gL\mu_k\cos\theta$$

$$K_f = \frac{(m_A + m_B)v^2}{2} = m_B gL - m_A Lg(\sin\theta + \mu_k\cos\theta)$$

$$v == \sqrt{\frac{2Lg(m_B - m_A(\sin\theta + \mu_k\cos\theta))}{(m_A + m_B)}}$$

A 10 kg block is released from point A in the figure . The track is frictionless except for the portion between points B and C, which has a length of 6 m. The block travels down the track, hits a spring of force constant 250 N/m, and compresses the spring 0.3 m from its equilibrium position before coming to rest momentarily. Determine the coefficient of Kinetic friction between the block and the rough surface between B and C.

Lets draw the picture again!

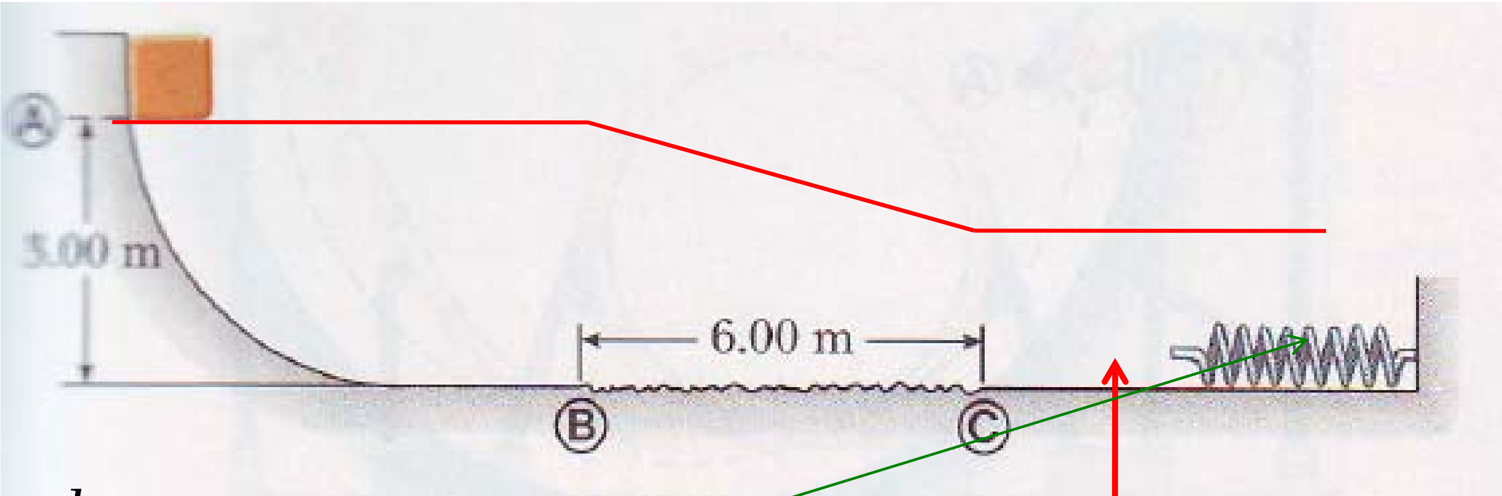


FIGURE P7.51

$$E_{mec}(initial) = mgh$$

$$\text{Energy lost} = F_f d = mg\mu_k d$$

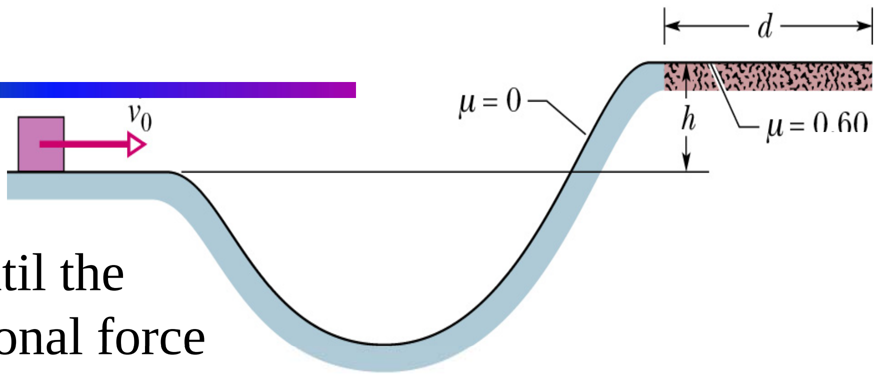
After the block passes the friction surface

$$E_{mech} = K + U = \frac{mv^2}{2} = mgh - mg\mu_k d$$

So when it compresses the spring v=0

$$\frac{kx^2}{2} = mgh - mg\mu_k d$$

Problem: Friction



A block slides along a track from one level to a higher level, by moving through an intermediate valley. The track is frictionless until the block reaches the higher level. There is a frictional force that stops the block in the distance **d**. The block's initial speed is $\mathbf{v_0}$; the height difference is **h**; the coefficient of kinetic friction is μ_k. <u>What is **d**?</u>

What do we know? Along the part of the track which is frictionless, conservation of Mechanical Energy holds. However, at the top the friction transfers energy out of the system (ΔE_{therm}). Since the system is "isolated" the change in the total energy is zero.

$$0 = W_{ext,net} = \left[\Delta K + \Delta U_{net}\right] + \Delta E_{therm}$$

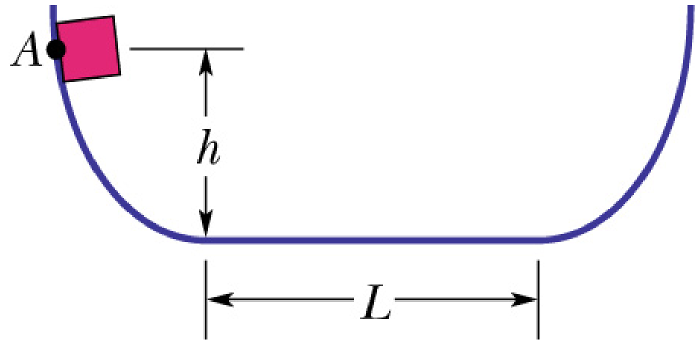
$$0 = \left[\left(0 - \tfrac{1}{2} m v_0^2\right) + \left(mgh - 0\right)\right] + \left(\mu_k (mg)\right) d$$

Solving for d

$$d = \frac{1}{\mu_k mg}\left(\tfrac{1}{2} m v_0^2 - mgh\right)$$

$$= \frac{v_0^2}{2\mu_k g} - \frac{h}{\mu_k}$$

Problem 8-63 A particle can slide along a track as shown. The curved portions of the track are frictionless, but the flat part has a coefficient of kinetic friction of $\mu_k = 0.20$. The particle is released from rest at point A, which is a height h=L/2 above the flat part of the track.



Where does the particle finally stop?

Initial mechanical energy

$$E_{mec} = U_{grav} = mgh = \frac{1}{2}mgL$$

Energy lost to friction every time going through the flat part

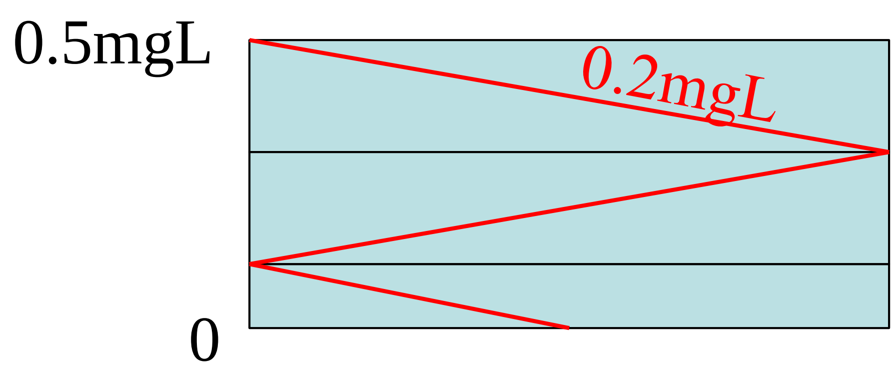
$$W_{fric} = -\mu_k mg \cdot L$$

Assume the particle moves n trips (not run-trip)

$$\Delta E = W = n \cdot W_{fric}$$

$$-\frac{1}{2}mgL = n \cdot -\mu_k mg \cdot L$$

$$n = \frac{1}{2\mu_k} = 2.5$$



Stop at the middle of the flat part!