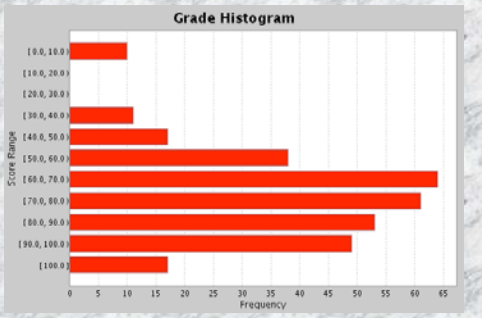
Announcements 13 Apr 09

- **Homework #9**
  - **Online Homework (momentum Chapter 9) due tomorrow by 8 am**
- **Supplemental Instruction session canceled today, rescheduled for Tuesday at**
  - ***8:45 - 10:00 pm in Du Bois 10th floor***
- **Office hours today**
  - ***3:30 - 5:00 pm as always***
- **Exam 2**
  - ***All points now included***
  - ***Average = 70.9***
  - ***Median = 74.0***



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Chapter 10
Energy and Work

Topics:

- Energy, what is it? What are the different forms of energy and how can energy be transformed or transferred?
- Work
- Kinetic, potential and thermal energy
- Law of conservation of energy
- Application to elastic collisions

Sample question:

Using just a fast run-up and flexible pole, how can a pole vaulter reach an astonishing 6 m (20 ft) off the ground?

2

Different forms of energy

- What forms of energy do you know of?
- What do we mean by conservation of energy?

DEMO: energy toys, colliding masses

3

Work and energy

- Energy is the capacity to do work

There are many phenomena in nature that we associate with energy, and these phenomena may have little in common other than a connection to energy

1. light
2. heat
3. raising an object up
4. motion
5. electricity
6. radioactivity

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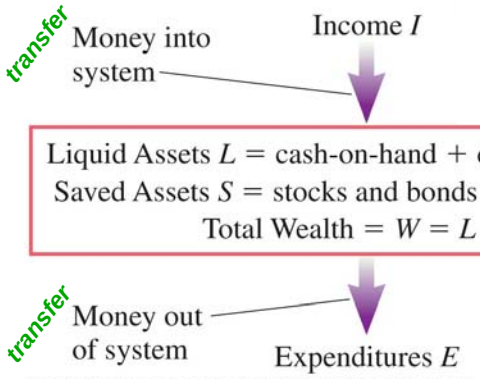
Energy as a natural money



- Relationship between monetary transfers and wealth is $\Delta Wealth = I - E$
  i.e. wealth is constant (*conserved*) if system is isolated
- Wealth is constant (*conserved*) if money is transformed from one form (e.g. cash) into another (e.g. stocks) inside syst

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Forms of energy

Kinetic energy K

Energy of motion

Gravitational potential energy U_g

Stored energy associated with an object's height

Elastic or spring potential energy U_s

Stored energy associated with stretching of object

Thermal energy E_{th}

Sum of molecular kinetic and potential energies

Chemical energy E_{chem}

Energy stored in molecular bonds (due to electric force)

Nuclear energy $E_{nuclear}$

Energy stored in nuclear bonds (nuclear force)

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Energy transformation

$E_{chem} \rightarrow U_g$

$K \rightarrow E_{th}$

$E_{chem} \rightarrow E_{th}$

$U_s \rightarrow K \rightarrow U_g$

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Energy transfer: Work & Heat

Work: mechanical transfer of energy to a body by application of a force

Heat: non-mechanical transfer of energy (due to a temperature difference btw environment and system)

Energy is transferred from the environment to the system

$W \rightarrow E_{th}$

$W \rightarrow K$

$W \rightarrow U_s$

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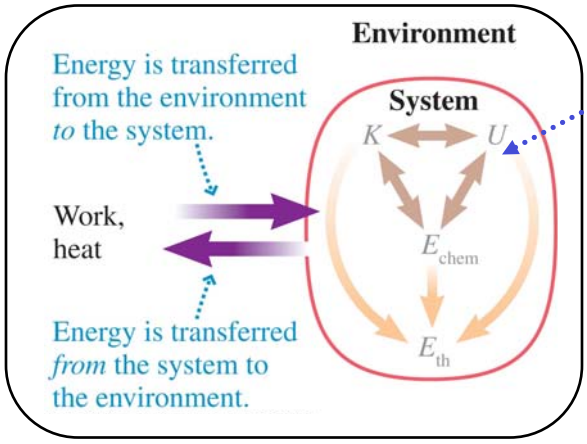
Energy model

- A system is characterized by a total energy E
- This total energy may consist of many different forms of energy

$$E = K + U_g + U_s + E_{th} + E_{chem} + \ldots$$



Energy transformation question 1

PRS

A child is on a playground swing, motionless at the highest point of her arc. As she swings back down to the lowest point of her motion, what energy transformation is taking place?

A. $K \rightarrow U_g$
B. $U_g \rightarrow E_{th}$
C. $U_s \rightarrow U_g$
D. $U_g \rightarrow K$
E. $K \rightarrow E_{th}$

Answer: D

Energy transformation question 2

PRS

A skier is cruising down a slope at a *constant* speed. What energy transformation is taking place?

A. $K \rightarrow U_g$

B. $U_g \rightarrow E_{th}$

C. $U_s \rightarrow U_g$

D. $U_g \rightarrow K$

E. $K \rightarrow E_{th}$

Answer: B

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Energy conservation

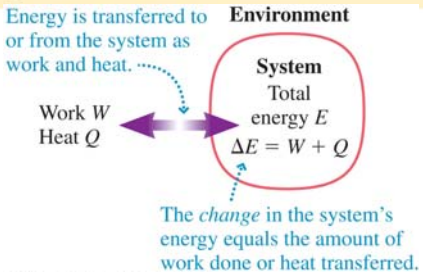
Law of conservation of energy for an isolated system The total energy of an isolated system remains constant:

The energies in the system are constantly transforming from one kind to another . . . . . but their *sum* is a constant: it doesn't change.

$$K + U_g + U_s + E_{th} + E_{chem} + \ldots = E = \text{constant} \qquad (10.2)$$

Law of conservation of energy including energy transfers The change in the total energy of a nonisolated system is equal to the energy transferred into or out of the system as work W or heat Q:

$$\Delta K + \Delta U_g + \Delta U_s + \Delta E_{th} + \Delta E_{chem} + \cdots = W + Q \qquad (10.4)$$



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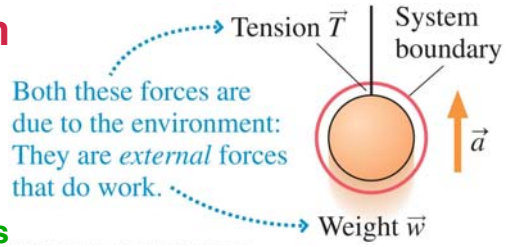
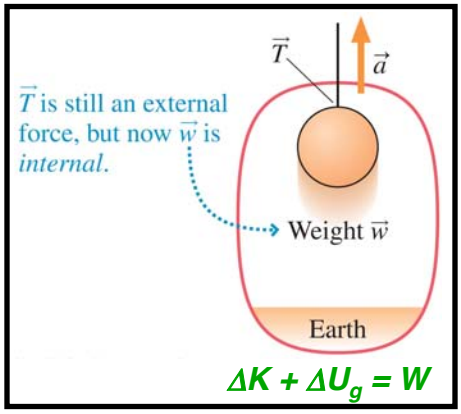
Choosing the system

Only forces due to agents outside the system do work (i.e. transfer energy)

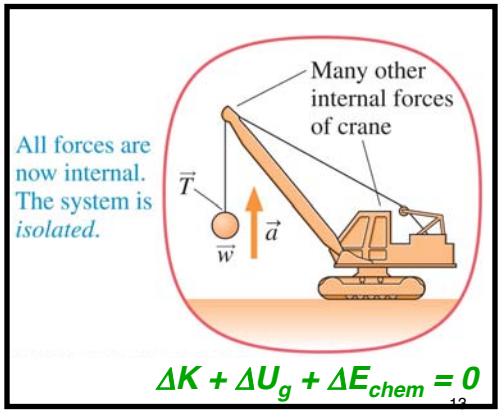
➔ Energy equation changes



$\Delta K = W$



$\Delta K + \Delta U_g = W$



$\Delta K + \Delta U_g + \Delta E_{chem} = 0$