Lec #7: Mechanical Energy.

LAST TIME: A New Energy Pardigm

- Lessons of History
- Requirements for New Energy Pardigm

TODAY: Mechanical Energy. I.

- Forms of Energy; Conversion of Energy
- Laws of Motion; Forces
- Work, Power, and Energy
- Kinetic Energy, Potential Energy

NEXT: Thermal Energy. I. (read Chapter 4)

ENERGY FUNDAMENTALS

- Types of Energy
  - mechanical
  - thermal
  - chemical
  - nuclear
  - radiant (electromagnetic)
  - electrical
- How can we calculate how much energy is available but hidden?
- How can we tap into it?
- How do we maximize "efficiency"?

Total amount of energy is constant.

We cannot create or destroy energy, only **convert** it.

But sometimes conversions produce useful things...

Table 2.2 ENERGY CONVERSIONS

Conversion From:	To Chemical	To Electric	To Heat	To Light	To Mechanical
Chemical	Food Plants	Battery Fuel cell	Fire Food	Candle Phosphorescence	Rocket Animal muscle
Electrical	Electrolysis Electroplating	Transistor Transformer	Toaster Heat lamp Spark plug	Fluorescent lamp Light emitting diode	Electric motor Relay
Heat	Gasification Vaporization	Thermocouple	Heat pump Heat exchanger	Fire	Turbine Gas engine Steam engine
Light	Plant photosynthesis Camera film	Solar cell	Heat lamp Radiant solar	Laser	Photoelectric door opener
Mechanical	Heat cell (crystallization)	Generator Alternator	Friction brake	Flint Spark	Flywheel Pendulum Water wheel

Mechanical Energy: the energy associated with MOTION

Newton's Laws of Motion

- 1st Law of Motion: *any object will continue in its present state of motion (speed and direction) unless/until it is "acted upon" by a net outside "force"*
  - object at rest ---> stays at rest
  - object in motion ---> stays in motion at a constant speed and in a straight line
  - this seems to contradict every day experience, and maybe even "common sense"
  - our world is full of frictional forces, but they are not present in the "vacuum" of space

"INERTIA"

- 2nd Law of Motion: *to change an object's state of motion, a net "force" must be applied; amount of change is directly proportional to amount of force*

  Force = mass x acceleration
  - acceleration can be change in speed **or** direction
  - mass is a measure of inertia (resistance to change)
  - Ponder this for now: What is a "Force?"
  - this simple equation forms the basis of the Physics of motion; it led to the development of Calculus
- 3rd Law of Motion: *for every force applied to an object, there is an equal force in the opposite direction from that object*

Forces in Nature

- Gravity $F = G\, m_1 m_2 / r^2$
  - $g = G\, M_e / R_e^2 = 9.8\ m/s^2 = 32\ ft/s^2$
  - on Earth, $F = mg$
- Electrostatic $F = q_1 q_2 / r^2$
  - attractive or repulsive
- Magnetic (electromagnetic)
- Nuclear
- These are all "conservative".
  - depend only on position
  - mechanical energy is conserved (with proper accounting)