Chapter 5.1,2 : Energy & Work

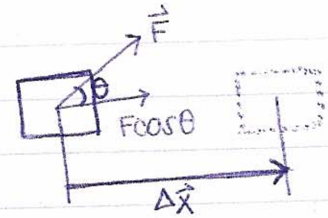
- Mechanical Energy
  - Kinetic (motion)
  - Potential (position)
- Chemical Energy
- Electromagnetic Energy
- Nuclear Energy

} Energy can be transformed to another form, but can't be destroyed

very closely related to energy: **Work**

$W \equiv (F\cos\theta)\Delta x$

- F ← magnitude of net force
- θ ← angle between $\vec{F}$ and $\Delta\vec{x}$
- Δx ← magnitude of displacement



No info on: time, object's velocity / acceleration

Scalar quantity

Units

- SI: Newton (N) · meter (m) = Joule (J)
- US: ft · lb

$J = kg\cdot m^2/s^2$

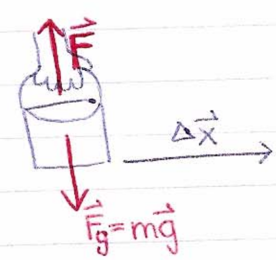
mv^2

($KE = \frac{1}{2}mv^2$)

$\frac{J}{1sec}$ = watt

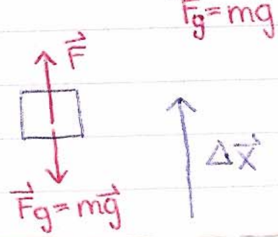
W = 0 when F, Δx are perpendicular

- Carrying a bucket of water
- Displacement horizontal, force vertical
- cos(90°) = 0, no work done!



Can be > or < 0 (pos. or neg.)

- Lifting > 0, Lowering < 0
  - Force upward, Δx downward



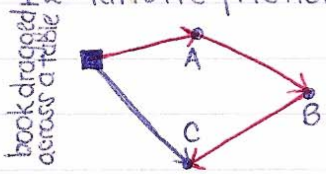
Two Kinds of Forces

Conservative: if work done on the object moving between 2 points is independent of the path the object takes b/w the points

- Depends only on x_i, x_f
- Any conservative force can have potential energy function associated
- IE: gravity, (ideal) spring force, electromagnetic forces

Nonconservative: work depends on path taken

- IE: kinetic friction, air drag



Blue path = shorter

Work required? blue < red

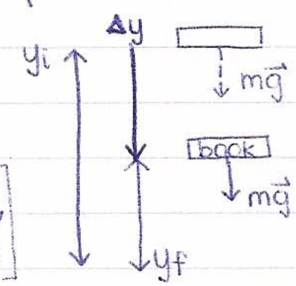
Friction depends on path

Work and Potential Energy

Conservative force ⇒ PE function

Evaluating the dif. of the function at any 2 pts in an object's path gives the negative of the work done by the force b/w those pts.

IE: gravity



$PE = mgy$

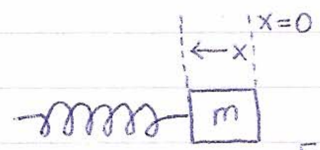
$W_{on\,book} = PE_i - PE_f = mgy_i - mgy_f = mg(y_i - y_f)$

Work Energy Thm: $W_{nc} = (KE_f - KE_i) + (PE_f - PE_i)$ $= 0$, W_c

$v = \sqrt{2g\Delta y}$

Conservation of Energy: $KE_i + PE_i = KE_f + PE_f$

Spring Force



Hooke's Law: $F = -kx$

- restoring force, opp. dir. of x
- spring constant, dependent on: how spring was formed, material, thickness of wire, etc.

F varies w/ x: work is the area under the curve

Linear spring is simple: $A = \frac{1}{2}bh \rightarrow W = \frac{1}{2} x_{max} F_{max} = \frac{1}{2}kx^2$

PE in a Spring: $PE_s = \frac{1}{2}kx^2$

- Elastic PE related to work reqd to compress spring from equil. position
- Work = PE; $KE_{i,f} = 0$

Spring + Gravity: $W_{nc} = (KE_f - KE_i) + (PE_{gf} - PE_{gi}) + (PE_{sf} - PE_{si})$

(gravitational PE; elastic PE assoc. w/ spring)

PE: total PE of energy of system

Conservation of Energy: $(KE + PE_g + PE_s)_i = (KE + PE_g + PE_s)_f$