Ch.6:

Work and energy are **scalars**!

(but CAN be positive or negative)

\[ W = F_x \cdot x \]

\[ W = \Delta E \]

Work done on an object = change in energy of the object

Total work = work on an object + work to overcome friction + ….other work

(or \( \Delta E \) of the obj) (or thermal energy)

**Work can be positive or negative** (since \( W = \Delta E \))

Energy of a system is conserved **IF there is no net external force** acting on the system

\[ \begin{align*} 
& \text{If there is no friction} \quad \text{initial TME} = \text{final TME} \\
& \text{If friction is present} \quad \text{initial TME} = \text{final TME} + \text{Work to overcome friction} 
\end{align*} \]

\[ KE = \frac{1}{2}mv^2 \]

\[ PE = mgh \]

\[ EPE = (\text{avg Force}) \cdot x = \frac{1}{2}kx^2 \]

**Springs:**

\[ F = kx \quad \text{where “k” is the “spring constant”} \]

\[ \Delta F = k\Delta x \quad \text{(Hooke’s Law)} \]

**F vs. x graphs**

\[ \text{Slope} = k \]

\[ \text{Area} = \text{work} = \text{change in EPE} \]

\[ \text{(Area can be positive or negative)} \]

\[ P = \frac{W}{t} = \frac{\Delta E}{t} \]

\[ \Delta E = P \cdot t \quad \text{(joules or kWh)} \]

\[ P = F \cdot v \quad \text{(where F and v point in the same direction)} \]

**Inclined planes:**

\[ F_x = mgsin\theta \]

\[ F_y = mgcos\theta \]

**Force of friction** = \( \mu F_N \)

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Ch.7

Impulse, p, Δp, v, Δv, F are vectors!

\[ p = mv \]

Impulse = \( F \cdot t = \Delta p \)

\[ \Delta p = m \Delta v \]

only if mass is constant

Total momentum of a system is conserved IF there is no net external force acting on the system

\[ \sum p_o = \sum p_f \]

Collisions:
- Collision forces are equal and opposite
- Impulse and \( \Delta p \) are equal and opposite
- Perfectly elastic: KE is conserved (\( p \) is conserved)
- Inelastic: KE will not be conserved (\( p \) is conserved)
- In between: KE will not be conserved (\( p \) is conserved)

 Explosions:
- \( p \) is conserved and KE increases

1-D collisions:
\[ m_1v_1 + m_2v_2 + \ldots = m_1v_1' + m_2v_2' + \ldots \]

[for inelastic collisions this simplifies to: \( m_1v_1 + m_2v_2 + \ldots = (\text{total mass})v \)]

When two equal masses have a perfectly elastic collision, they trade velocities!

2-D collisions
- momentum is conserved for both the x components and the y components
- the total initial momentum vector is the same as the total final momentum vector
  (same magnitude, same angle, same x & y components)

For the AP exam in May:

F vs. t graphs
- \( Area = impulse = \Delta p \)
- (area can be positive or negative)

p vs. t graphs
- \( slope = \text{Force} \)