

# **PHYSICS 1**

**FINAL REVIEW**

# CHAPTER 3

Work:  $W = (F \cos \theta) \Delta x = \vec{F} \cdot \vec{\Delta x}$  (J)

*Power:  $P = \frac{W}{\Delta t} = F \cdot v$  (J/s or W)*

# ENERGY: $E = K + U_g + U_{el}$

- Kinetic energy:  $K = \frac{1}{2}mv^2 (J)$
- Potential energy:  $U_g = mgh (J)$ 
  - With h is the distance from potential origin to obj position.
- Elastic energy:  $U_{el} = \frac{1}{2}kx^2 (J)$ 
  - k is force constant or spring constant (N/m)
  - x is spring deformation (m)
  - Equilibrium position:  $x = 0$

## KINETIC ENERGY THEOREM:

$$W_{net} = \Delta K = K_f - K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv^2$$

Potential Energy:

$$W_{\text{gravity}} = -\Delta U_g = U_{gi} - U_{gf}$$

Work done by spring:

$$W = -\Delta U_{el} = \frac{1}{2}kx_1^2 - \frac{1}{2}kx_2^2$$

# CONSERVATIVE VS NONCONSERVATIVE

- Conservative force: gravity, elastic
- Nonconservative force: friction, resistance,...

Note: Work of resistive forces are always negative

Conservation of energy theorem: (Định luật bảo toàn cơ năng)  
(use for conservative system)

$$E_i = E_f$$

$$\Rightarrow K_i + U_{gi} + U_{eli} = K_f + U_{gf} + U_{elf}$$

Energy with nonconservative force

$$W_{nc} = \Delta E = (K_f + U_f) - (K_i + U_i)$$

# CHAPTER 4

Linear momentum: (động lượng)

$$\vec{p} = m\vec{v}$$

Impulse:

$$I = \Delta\vec{p} = \int d\vec{p} = \int_{t_i}^{t_f} \vec{F} \Delta t$$

Conservation of linear momentum:

$$\vec{p}_i = \vec{p}_f$$

# TWO TYPES OF COLLISIONS:

Inelastic collision: Kinetic energy is not conserved

$$E_{lost} = \Delta K$$

Elastic collision: both momentum and kinetic energy are conserved

$$K_i = K_f$$

# CHAPTER 5

Notation	Linear Translational	Angular Rotational
Basic quantities	$x$ (m) $v$ (m/s) $a$ (m/s <sup>2</sup> )	$\theta$ (rad) $\omega$ (rad/s) $\alpha$ (rad/s <sup>2</sup> )
Basic formula	$a$ const $v = v_0 + at$ $x = x_0 + v_0 t + \frac{1}{2}at^2$ $v^2 - v_0^2 = 2a\Delta x$	$\alpha$ const $\omega = \omega_0 + \alpha t$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$ $\omega^2 - \omega_0^2 = 2\alpha\Delta\theta$
Inertia	mass: $m$ (kg)	Moment of inertia } Rotational inertia } ❖ $I = \sum mR^2$ (kg×m <sup>2</sup> ) ❖ $I = \dots$



Notation	Linear Translational	Angular Rotational
Speeding up Slowing down	$\mathbf{a} \cdot \mathbf{v}$ $\vec{\mathbf{a}} \cdot \vec{\mathbf{v}}$	$\boldsymbol{\alpha} \cdot \boldsymbol{\omega}$ $\vec{\boldsymbol{\alpha}} \cdot \vec{\boldsymbol{\omega}}$
Force vs Torque	Newton's 2 <sup>nd</sup> law: $\vec{\mathbf{F}} = m\vec{\mathbf{a}}$ (N)	$\vec{\boldsymbol{\tau}} = \vec{\mathbf{r}} \times \vec{\mathbf{F}}$ or $\tau = Fd$ (d: moment/lever arm) Newton's 2 <sup>nd</sup> law: $\vec{\boldsymbol{\tau}} = I \times \vec{\boldsymbol{\alpha}}$ (N·m)
Convention of (+) direction	y up x to the right	Counterclockwise

Notation	Linear Translational	Angular Rotational
<b>Energy</b> $E = K + U$	$K = \frac{1}{2}mv^2 \text{ (J)(eV)}$ $U_g = mgh \text{ (y up, 0 at ...)}$ $U_{el} = \frac{1}{2}kx^2 \text{ (J)(eV)}$	$K = \frac{1}{2}I\omega^2 \text{ (J)(eV)}$
<b>Work</b>	$W = \vec{F} \cdot \Delta \vec{x} \text{ or } \int_{x_i}^{x_f} \vec{F}(x) \cdot d\vec{x}$ <p>(J)(eV)</p>	$W = \vec{\tau} \cdot \Delta \vec{\theta} \text{ or } \int_{\theta_i}^{\theta_f} \vec{\tau}(\theta) \cdot d\vec{\theta}$ <p>(J)(eV)</p>
<b>Power</b>	$P = \frac{W}{\Delta t} = \vec{F} \cdot \vec{v}$ <p>(J/s)(W)</p>	$P = \frac{W}{\Delta t} = \vec{\tau} \cdot \vec{\omega}$ <p>(J/s)(W)</p>
<b>Momentum</b>	$\vec{p} = m\vec{v} \text{ (kg} \cdot \text{m/s)}$	$\vec{L} = \vec{r} \times \vec{p}$ $\vec{L} = I\vec{\omega} \text{ (kg} \cdot \text{m}^2/\text{s)}$

Notation	Linear Translational	Angular Rotational
Impulse	$\vec{I} = \Delta \vec{p} = \vec{F} \Delta t = \int_{t_i}^{t_f} \vec{F}(t) dt$ $\diamond \vec{F}_{net} = \frac{\Delta \vec{p}}{\Delta t} \text{ or } \frac{d\vec{p}}{dt}$	$\vec{I} = \Delta \vec{L} = \vec{\tau} \Delta t = \int_{t_i}^{t_f} \vec{\tau}(t) dt$ $\diamond \vec{\tau}_{net} = \frac{\Delta \vec{L}}{\Delta t} \text{ or } \frac{d\vec{L}}{dt}$
Momentum conservation	$\color{blue}{+} \vec{F}_{net} = \vec{0} \Rightarrow \Delta \vec{p} = \vec{0}$ $\Rightarrow \sum \vec{p}_i = \sum \vec{p}_f$ $\Rightarrow \sum m_i v_i = \sum m_f v_f$	$\color{blue}{+} \vec{\tau}_{net} = \vec{0} \Rightarrow \Delta \vec{L} = \vec{0}$ $\Rightarrow \sum \vec{L}_i = \sum \vec{L}_f$ $\Rightarrow \sum I_i \omega_i = \sum I_f \omega_f$

## Pure rotation relationship:

$$s=R\theta$$

$$v=R\omega$$

$$a_T=R\alpha$$

$$v^2$$

$$a_R = \frac{v^2}{R}$$

$$a = \sqrt{a_T^2 + a_R^2}$$

## Rolling motion relationship:

$$s_{cm} = R\theta$$

$$v_{cm} = R\omega$$

$$a_{cm} = R\alpha$$

Total kinetic energy (translation + rotation)

$$K = \frac{1}{2} I_{cm} \omega^2 + \frac{1}{2} M v_{cm}^2$$