Mechanics 2 Revision

Projectiles

- To solve problems we consider the horizontal and vertical components separately.
- $u_{vert} = U\sin\alpha$
  $u_{horz} = U\cos\alpha$
- Horizontal speed is unchanged throughout motion.

Particle Kinematics

- $\mathbf{r} = \int \mathbf{v}\,\mathrm{d}t = \iint \mathbf{a}\,\mathrm{d}t$
- $\mathbf{v} = \dot{\mathbf{r}} = \frac{\mathrm{d}\mathbf{r}}{\mathrm{d}t} = \int \mathbf{a}\,\mathrm{d}t$
- $\mathbf{a} = \dot{\mathbf{v}} = \ddot{\mathbf{r}} = \frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t} = \frac{\mathrm{d}^2\mathbf{r}}{\mathrm{d}t^2}$

Centre of Mass

- Centre of mass is the point at which the weight acts.
- Centre of mass will always lie on axis of symmetry.
- c.o.m. of a set of masses will be at $\frac{\sum m_i x_i}{\sum m_i}$ and likewise in the y axis.
- For a triangular lamina, c.o.m. lies $\frac{2}{3}$ distance from vertex to mid-point of opposite side.
- For an arc of angle 2α , c.o.m. lies $\frac{r\sin\alpha}{\alpha}$ from centre.
- For a sectorof angle 2α, c.o.m. lies $\frac{2r\sin\alpha}{3\alpha}$ from centre.
- In a suspended lamina hanging in equilibrium, the centre of mass will be vertically below the point of suspension.
- When on an inclined plane, the line of action of the weight must fall within the base of the object, else it will topple.

Work & Energy

- $Work = Force \times Distance$
- $Work = \Delta Energy$
- $K.E. = \frac{1}{2}mv^2$
- $P.E. = mgh$
- From conservation of energy, $KE + PE$ is constant.

Power

- Power is rate of change of energy.
- $Power = \frac{\Delta Energy}{time}$
- $Power = Force \times Speed$

Collisions

- $\mathbf{I} = \Delta\mathbf{p} = m\mathbf{v} - m\mathbf{u}$
- From conservation of momentum, $\Sigma\mathbf{p}_{before} = \Sigma\mathbf{p}_{after}$
- Newton's law of Restitution, $e = \frac{v_2 - v_1}{u_1 - u_2}$, where $0 \le e \le 1$
- For collision with a fixed surface, we see $v = eu$

Statics of Bodies

- A body is in equilibrium if the vector sum of the forces is zero, and the algebraic sum of the moments about any point is zero.
- $F \le \mu R$ but when in equilibrium
  $\mathrm{F} = \mu\mathrm{R}$