

1 Kinematics

1.1 Scalar Product

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$$

1.2 Cross Product

$$\vec{A} \times \vec{B} = -\vec{B} \times \vec{A} = AB \sin \theta$$

$$\vec{A} \times \vec{B} = (A_y B_z - A_z B_y) \hat{i} + (A_z B_x - A_x B_z) \hat{j} + (A_x B_y - A_y B_x) \hat{k}$$

Use right hand rule (point fingers along the first vector, curl hand in towards next vector).

1.3 1D/2D Kinematics

$$v_i = v_o + at$$

$$\Delta x = v_o t + \frac{1}{2} at^2$$

$$v_f^2 = v_o^2 + 2a\Delta x$$

$$\Delta x = \frac{1}{2} t (v_o + v_i)$$

1.3.1 Projectile Motion

$$t = \frac{2v_o \sin \theta}{-g}$$

$$\Delta x = \frac{v_o^2 \sin(2\theta)}{-g} = \frac{2v_o^2 \sin \theta \cos \theta}{-g}$$

1.4 Relative Motion

$$v_{pw} = v_{pg} + v_{gw}$$

2 Newton's Laws of Motion

$$\vec{F} = m\vec{a}$$

$$F_g = mg = \text{weight}$$

$$F_g = \frac{GMm}{r^2}$$

$$g = \frac{GM}{r^2} = \frac{F_g}{m}$$

$$F_N = mg \quad (\text{horizontal surface})$$

$$F_N = mg \cos \theta \quad (\text{angled surface})$$

$$F_{fs} = \mu_s F_N$$

$$F_{fk} = \mu_k F_N$$

$$\mu_k < \mu_s \quad (\text{always})$$

$$F_c = ma_c = \frac{mv^2}{r} = mr\omega^2$$

$$F_{drag} = \frac{1}{2} C \rho A v^2$$

$$\tan \theta = \frac{v^2}{rg} \quad (\text{banked curve})$$

$$F_c = mg \tan \theta = F_{Nx} \quad (\text{banked curve})$$

**FREE-BODY DIAGRAMS ONLY INCLUDE
EXTERNAL FORCES**

3 Work Power Energy

3.1 Energy

$$E_k = \frac{1}{2} mv^2 = \frac{p^2}{2m}$$

$$E_{pg} = mgh = \frac{-GMm}{r}$$

$$E_{ps} = \frac{1}{2} k (\Delta x)^2$$

3.2 Work

$$\Delta \sum E = \Delta E_k + \Delta E_p = W$$

$$= Fd \cos \theta \quad (\text{Force parallel to direction of motion})$$

3.3 Power

$$P = \frac{W}{t} = Fv$$

$$h_{min} = \frac{5r}{2} \quad (\text{rollercoaster loop})$$

DRAW VECTOR DIAGRAMS

4 Linear Momentum/Collisions

4.1 Momentum

4.2 Impulse

4.3 Centre of Mass

5 Rotational Motion

5.1 Rotational Kinematics

5.2 Rotational Work Power Energy

5.3 Inertia

6 Angular Momentum

6.1 Centre of Mass

A Terms/Definitions

B Constants

C Conversions

D Orders of Magnitude

E Trigonometry

F Calculus