PHYS 117 MT2 Formula Sheet
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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

$$v_i = v_o + at$$
$$\Delta x = v_o t + \tfrac{1}{2}at^2$$
$$v_f^2 = v_o^2 + 2a\Delta x$$
$$\Delta x = \tfrac{1}{2}t\,(v_o + v_i)$$

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

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

DRAW VECTOR DIAGRAMS

2 Newton's Laws of Motion

$$
\begin{aligned}
\vec{F} &= m\vec{a} \\
F_g &= mg = weight \\
F_g &= \frac{GMm}{r^2} \\
g &= \frac{GM}{r^2} = \frac{F_g}{m} \\
F_N &= mg \quad \text{(horizontal surface)} \\
F_N &= mg\cos\theta \quad \text{(angled surface)} \\
F_{f_s} &= \mu_s F_N \\
F_{f_k} &= \mu_k F_N \\
\mu_k &< \mu_s \quad \text{(always)} \\
F_c &= ma_c = \frac{mv^2}{r} = mr\omega^2 \\
F_{drag} &= \tfrac{1}{2}C\rho A v^2 \\
\tan\theta &= \frac{v^2}{rg} \quad \text{(banked curve)} \\
F_c &= mg\tan\theta = F_{Nx} \quad \text{(banked curve)}
\end{aligned}
$$

FREE-BODY DIAGRAMS ONLY INCLUDE EXTERNAL FORCES