Honors Physics Equation Sheet

1. Vectors and Trigonometry

- **Pythagorean Theorem:** $c^2 = a^2 + b^2$
- **Vector Components:**
  - $V_x = V\cos(\theta)$
  - $V_y = V\sin(\theta)$
- **Resultant Angle:**
  - $\theta = \tan^{-1}(V_x V_y)$

2. Kinematics (Motion in 1D & 2D)

- $v_f = v_i + at$
- $\Delta x = \frac{1}{2}(v_i + v_f)t$
- $\Delta x = v_i t + \frac{1}{2}at^2$
- $v_f^2 = v_i^2 + 2a\Delta x$

3. Dynamics (Forces & Newton's Laws)

- **Newton's Second Law:** $\sum F = ma$
- **Weight (Force of Gravity):** $F_g = mg$
- **Force of Friction:** $F_f = \mu N$

4. Circular Motion and Gravity

- **Centripetal Acceleration:** $a_c = \frac{v^2}{r}$
- **Centripetal Force:** $F_c = \frac{mv^2}{r}$
- **Universal Law of Gravitation:** $F_G = G\frac{m_1 m_2}{r^2}$

  - $G = 6.67 \times 10^{-11} \ \text{N} \cdot \text{m}^2/\text{kg}^2$

5. Work, Energy, and Power

- **Work:** $W = Fd\cos(\theta)$
- **Kinetic Energy:** $KE = \frac{1}{2}mv^2$
- **Gravitational Potential Energy:** $PE_g = mgh$

- **Conservation of Energy:** $E_i = E_f$

  - $KE_i + PE_i = KE_f + PE_f$
- **Power:** $P = \frac{W}{t} = Fv$

6. Momentum and Collisions

- **Momentum:** $p = mv$
- **Impulse-Momentum Theorem:** $J = F\Delta t = \Delta p$
- **Conservation of Momentum:** $\sum p_{initial} = \sum p_{final}$

7. Rotational Motion

- **Torque:** $\tau = rF\sin(\theta)$
- **Newton's Second Law (Rotational):** $\sum \tau = I\alpha$
- **Rotational Kinematics:**
  - $\omega_f = \omega_i + \alpha t$
  - $\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2$
  - $\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$
- **Rotational Kinetic Energy:** $KE_R = \frac{1}{2}I\omega^2$

8. Simple Harmonic Motion

- **Hooke's Law (Spring Force):** $F_s = -kx$
- **Period of a Spring:** $T = 2\pi\sqrt{\frac{m}{k}}$
- **Period of a Pendulum:** $T = 2\pi\sqrt{\frac{L}{g}}$