Physics 207 Exam 1 Summary  
Hokin, Spring 2012

- Kinematics
  - position $\mathbf{r}(t)$
  - velocity $\mathbf{v}(t) = \frac{d\mathbf{r}}{dt}$
  - acceleration $\mathbf{a}(t) = \frac{d\mathbf{v}}{dt} = \frac{d^2\mathbf{r}}{dt^2}$
  - average velocity $\mathbf{v}_{avg} = \frac{\Delta \mathbf{r}}{\Delta t}$
  - If $a$ = constant then $\mathbf{v}_{avg} = \frac{\mathbf{v}(t_1) + \mathbf{v}(t_2)}{2}$

- 1-D motion with $a = \text{const}$:
  - $x(t) = x_0 + v_0 t + \frac{1}{2}at^2$
  - Free-fall $a = -g$
  - $x(t) = x_0 + v_0 t$
  - velocity-position: $v^2 = v_0^2 + 2a(x - x_0)$

- 2-D motion with $a = \text{const}$: $x, y$ motion independent
  - projectile motion $\mathbf{r}(t) = x = x_0 + v_{0x}t$
  - $y(x)$ is parabola $y = y_0 + v_{0y}x - \frac{1}{2}gt^2$
  - trajectory, range, peak $y$, etc.
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• Uniform Circular Motion

  uniform = constant ang speed \( \omega \)
  \[ \vec{v} = \text{constant (uniform)} \]
  \[ \vec{v} \perp \vec{r} \text{ (perpendicular)} \]
  \( \vec{r} = \text{constant (circular)} \)

  \[ \omega = \frac{d\theta}{dt} \text{ (rad/sec)} \]
  \( \omega = \frac{1}{r} \)
  \( r = \text{constant} \)

  period \( T = \frac{2\pi}{\omega} \text{ (sec)} \)

  Centripetal acceleration
  \[ \vec{a} = -\frac{\vec{v}^2}{r} \]
  \( \vec{a} = -\omega^2 \vec{r} \)

• Nonuniform Circular Motion

  \( r = \text{constant} \) \( \omega = \text{constant} \)

  \[ \vec{a} = r \vec{a}_t + \omega^2 \vec{r} \]

  tangential \hspace{1cm} \text{centripetal accel. accel.}

• Relative Motion - Galilean Transformation

  \[ \vec{v} = \vec{v} + \vec{V} \]
  \[ \vec{v} = \vec{v} + \vec{V} \]
Dynamics

Newton's 1st Law  \( \vec{p} = m \vec{v} = \text{constant if no force} \)
"inertia" inverted = mass for linear motion
\( \text{ (= moment of inertia for rotation) } \)
"body in motion stays in motion..."

Newton's 2nd Law  \( \vec{F} = \frac{d\vec{p}}{dt} \)
defines "force"
\( = ma \) if \( m = \text{constant} \)

\Rightarrow\) Free-body diagrams to get net force on object
  
  * isolate object of interest
  * identify all forces acting on object
    * contact force or gravity
  * \( \sum \vec{F} = ma \), solve

Newton's 3rd Law  interacting objects exert
  
  equal and opposite force
action/reaction
pairs  \( \Rightarrow \) Draw force pairs when working out interacting objects
Specific Forces

Gravity
\[ F_g = G \frac{m_1 m_2}{r^2} \quad G = 6.67 \times 10^{-11} \frac{\text{m}^3}{\text{kg}^2 \text{N}^2} \]

Sliding / Static Friction
\[ f_k = \mu_k F_N, \quad F_N = \text{normal force} \]

\[ f_s = \mu_s F_N \]

Fluid Drag
- Inertial Drag:
\[ F_d = -\frac{1}{2} \rho A C_D v^2 \]
  (moving mass of fluid out of way)
- Viscous Drag:
\[ F_d = -6\pi \eta \]
  (moving through "sticky" fluid)

Stokes:
\[ S = 6\pi \eta r, \quad \eta = \text{viscosity} \]

Pulleys
\[ T = \text{constant on both sides of pulley} \]

(Tension)

Frictionless, massless pulley

2D Dynamics - again, just 1D dynamics in each direction

Solve \[ \Sigma \text{forces} = \max \]

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EXAM TIPS

1. Be organized and clear

2. Be methodical - don't skip steps!
   (i.e. don't ask us to guess what you did.)

3. Manage your time. Move on if you're stuck.

4. If you can't solve a problem, tell us which concepts are involved.