Physics 2130 Exam 1 Outline

Vectors

- Adding vectors graphically (building chains)
- Subtracting vectors
- Change in vector: $\Delta\vec{v} = \vec{v}_f - \vec{v}_i$ is the vector to add to $\vec{v}_i$ to get $\vec{v}_f$.
- Component form of vectors
  - $\hat{x}$, $\hat{y}$, $\hat{z}$
  - Magnitude: $|\vec{v}| = \sqrt{v_x^2 + v_y^2 + v_z^2}$
  - Using trigonometry to write components: which gets the cosine?
  - Adding vectors by components

Basic Kinematics

- Displacement
- velocity $\vec{v} = \dfrac{d\vec{r}}{dt}$
- speed $v = |\vec{v}|$
- Acceleration $\vec{a} = \dfrac{d\vec{v}}{dt}$
- $\vec{v}$ and $\vec{a}$ in same-ish direction? Speeding up. Opposite-ish directions? Slowing down
- Reading position, velocity, and acceleration graphs

Free Fall

- Objects are in free fall when they feel no force other than gravity
- They accelerate downwards with $\vec{a} = g\downarrow = 9.8\text{m/s}^2\downarrow$
- Turning point: $v = 0$ when object changes direction, but $a \neq 0$

Constant Acceleration Problems

- Basic procedure
  - Draw a picture.
  - Define coordinate axes (which direction is +xˆ or +yˆ)
  - Identify "initial" and "final" moments of the motion
  - Make a table of variables: fill in what you know, determine what you need, and find the Don't-Know-Don't-Care variable
  - Choose equation without that DKDC variable
  - Solve for what you need
  - Check your answer for sign and magnitude
- The equations mentioned below only work if the acceleration is constant over the entire interval.
- "Drop" means "release without any initial velocity"
- Calculate velocities *right after* they leave the hand/gun/etc and *right before* they hit the ground.

One-Dimensional Motion with Constant Acceleration

- Five variables: Δx, v_i, v_f, a, and Δt

Equations

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

$$v_f = v_i + a\Delta t$$

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

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

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

$$W = mg$$

$$K = \mu_K N$$

$$S \leq \mu_S N$$

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

$$\frac{F}{A} = Y\frac{\Delta L}{L}$$

$$\frac{F}{A} = B\frac{\Delta V}{V}$$

$$\frac{F}{A} = G\frac{\Delta x}{L}$$

- The first four are vectors; their sign (positive or negative) depends on the direction you call "positive"
- You need three of these, and then you can solve for the other two

Two-Dimensional Motion with Constant Acceleration

- Different axes (x and y) have their own equations and variables (but share Δt)
- Motion along different axes are independent of each other
- Know how to solve problems in two dimensions (projectile motion)

Free-Body/Force Diagrams

- Draw objects of interest separately from environment
- Label all forces acting on each object
- Identify noncontact forces: every surface has normal force and maybe frictional force
- Five types of forces: N,T,W,S,K
- Know how to do box-on-an-incline problems
- **Normal force** is an adjustable push, always perpendicular to contact surface
- **Tension** is an adjustable pull, points along the rope
- **Friction** is parallel to the contact surface between two objects
- **Kinetic Friction** is for when objects are sliding against each other. It is a nonadjusting force.
- **Static Friction** is an adjusting force when objects are *not* sliding against each other
- Coefficients of friction μ_S and μ_K are unitless numbers. Usually $\mu_K \leq \mu_S$
- Static friction breaks when $\vec{S} > \mu_S N$ where N is the normal force from the same contact surface as S

Uniform Circular Motion

- When objects go around a corner, acceleration points towards center of the turn
- Uniform circular motion is at constant speed
- The velocity is tangent to the circle
- The acceleration is centripetal (towards the center)
- $a = v^2/r$
- "Centripetal" is a direction not a type of force; almost any type of force can be centripetal

Newton's Laws

- Newton's First Law: Objects move at constant velocity unless the forces are unbalanced
- Newton's Second Law: If forces are unbalanced, then $\vec{a} = \vec{F}/m$
- Newton's Third Law: If A pushes on B, B pushes on A. These are *force twins* or a *force pair*.
  - are the same type of force
  - have the same magnitude
  - point in opposite directions
  - act on different objects

Elasticity

- Springs and spring constant
- Elastic limit
- Tensile, compression, and shear stress
- Young's, Bulk, and Shear modulus