<u>Exam 1 Concepts</u>

Chapter 1:

- SI units
    - Time (s), distance/position (m), mass (kg)
    - Unit conversions
- Assume three significant figures
- Vectors have both magnitude and direction, requiring two numbers to describe them
    - Scalars only need one number to describe them, magnitude only
- Displacement: change in position of an object (final - initial)
- Vector addition:
    - Connect tail to head
    - Negative vector is flipped 180 degrees before adding, subtraction of vectors is treated as a negative vector
    - Multiplication by a scalar is to multiply the magnitude of the vector by that scalar
    - Component form (A_x, A_y) or polar form (r, θ)
- SOHCAHTOA and inverse tangent
    - Sin (θ)= opp/hyp
    - Cos (θ)= adj/hyp
    - Tan (θ)= opp/adj
- Quadratic formula: $x = [-b \pm \sqrt{(b^2 - 4ac)}] / 2a$
- Finding resultant vector:
    - Break each vector into x and y components using SOHCAHTOA

- Add components in each direction (+/- given by coordinate system)
    - $C = A + B = (A_x+B_x, A_y+B_y) = (C_x, C_y)$
- Used Pythagorean theorem with resultant x and y to find overall resultant
- Inverse tangent of resultant x and y components to find resultant angle
- Language such as “total displacement,” “distance from origin,” “how far to get back to the origin,” or simply “resultant vector” suggests that you need to find the resultant vector

Chapter 2:

- Mechanics: forces on an object and the resulting motion (cares about the cause of the motion)
- Kinematics: mathematically describing motion; one dimension; change in X as a function of time
- Average velocity= $\Delta X/\Delta t$ (m/s)
    - Path independent, focuses only on final and initial positions
- Average speed= total distance traveled/Δt
    - Path dependent
- Instantaneous velocity: limit of average velocity as t approaches 0
- Instantaneous speed: magnitude of velocity vector at any given time
- Average acceleration= $\Delta V/\Delta t$ (m/s^2)
    - Acceleration and velocity in same direction= speeding up
    - Acceleration and velocity in opposite directions= slowing down
- Acceleration of gravity: $g = 9.8\ m/s^2$

Equations of motion:

- Assumes constant acceleration (neither magnitude or direction are changing) and straight line motion (acceleration is parallel to velocity)

x(t): $x = x_0 + V_{0x}t + \frac{1}{2}\alpha_x t^2$

- if acceleration varies with time, to find later position, trajectory problems

Vx(t): $V_x = V_{0x} + \alpha_x t$

- to find velocity at any later time

Vx(x): $V_x^2 = V_{0x}^2 + 2\alpha_x (x - x_0)$

- when not provided with a time interval

Position at any time is proportional to $\frac{1}{2}\alpha_x t^2$

$X_a/X_b = \frac{1}{2}\alpha t_a^2 / \frac{1}{2} \alpha t_b^2 = (t_a/t_b)^2$

so $X_a/t_a^2 = X_b/t_b^2$

- relationship between time and position is quadratic
- ex. If "a" travels for twice as long as "b" and has twice as much time to accelerate, then is goes four times as far
    - $t_a = 2t_b$, $t_a/t_b = 2$, $X_a/X_b = (t_a/t_b)^2 = (2)^2 = 4$

Freefall: only force acting on the object in motion is the force of gravity

- $\alpha_\gamma = +/- g$ (direction given by coordinate system, g points downward of the motion)
- $V_\gamma = V_{0\gamma} - gt$
- $V_\gamma^2 = V_{0\gamma}^2 - 2g(y-y_0)$
- $y = y_0 + V_{0\gamma}t - \frac{1}{2} gt^2$

- change in direction at maximum height: velocity=0

Chapter 3:

- Acceleration = change in position/change in time. Since velocity has both magnitude and direction, acceleration can result from the motion changing speed or direction
    - always a non-zero in curved path motion because direction is always changing
    - always points to center of curve (tangent to the motion)
    - vector with x and y components

Projectile motion:

- Object moving with initial velocity and a path determined by trajectory
- Assumes flat earth (close enough to the surface that it appears to be flat)
- Treat x and y components of all variables independently
- $\alpha_x = 0$
    - No forces acting on the motion in the x and y direction that would speed it up or slow it down
    - Horizontal motion with constant V
    - Sub $\alpha_x = 0$ into kinematic equations in x direction
        - $V_x = V_{0x}$
        - $x = x_0 + V_{0x}t$ (only useful equation here for solving problems)
- $\alpha_y = +/- g$
    - $g = +/- 9.8\ m/s^2$

- If given a force of gravity in terms of g, (ex. 2g), multiply the value of g (9.8 m/s^2) by the scalar quantity (2)
- Vertical motion with constant α
- Sub $\alpha_y = -g$ (or multiple of it) into kinematic equations in y direction
    - $V_\gamma = V_{0\gamma} - gt$
    - $y = y_0 + V_{0\gamma}t - \frac{1}{2} gt^2$
- At highest point in trajectory, $V_\gamma = 0$, $V_x = V_{0x}$
- Origin @ $x_0 = y_0 = 0$ (choose point of origin that allows you to cancel out the most variables)
- Velocity vector is broken into its components using theta (if you don't know the angle, you can keep components as V_x and V_γ without using SOHCAHTOA)
- Total flight time is twice the amount of time it takes to reach highest point in trajectory (symmetry about h max)
- Two dimensions: expect to use two equations
- Two objects moving: expect to use two equations
- Velocity and range of motion are dependent on how long it is in the air!!

Don't forget:

- **DRAW IT OUT AND LABEL VARIABLES ON THE PICTURE**
- **SOLVE SYMBOLICALLY (don't plug in any numbers until the last step)**
- **LABEL ALL UNITS**

- **g IS A POSITIVE VALUE. IT GETS ITS NEGATIVE SIGN FROM ITS DIRECTION (if you solve symbolically and g loses its negative in the algebra, then plug in a positive 9.8 m/s²; it's not automatically negative)**