Physics 200
Midterm Study Guide

Part 1: General Outline of Topics/Concepts

- Scalar vs. Vector quantities
    - What is the difference?
    - List a few of each
    - Be able to distinguish between them.
- Acceleration
    - What it means
    - Formula
- Difference between average and instantaneous (e.g. velocity, acceleration...)
- Free-fall (the state of being influenced only by the gravity of a nearby planet)
    - Object launched upward on Earth
        - Velocities at different points in its flight
        - Acceleration at different points in its flight
- Kinematics graphing
    - Create and interpret graphs of position, velocity, and acceleration versus time.
    - Use any type of kinematics graph (e.g. velocity vs time) to generate another (e.g. acceleration vs time)
    - Relate different types of kinematics graphs using the concept of slope (e.g. "the slope of an object's position graph at some point in time equals the velocity of the object at that time.")
- 2-D Kinematics
    - Vector addition
        - Difference between component and resultant vectors
        - Head-to-tail addition
            - How component vectors connect to one another
            - How component vectors connect to the resultant vector
        - Trig functions
        - How to compute the addition of vectors in 2 dimensions
            - Orthogonal vectors
                - Add component vectors in x dimension to get x component of the resultant
                - Add component vectors in y dimension to get the y component of the resultant
                - Add the x and y components (head-to-tail) of the resultant to get the resultant vector
                    - Determine magnitude using trig or Pythagorean theorem
                    - Determine direction (in degrees relative to some direction) using an inverse trig function
            - Non-Orthogonal Vectors
                - Same as orthogonal vectors, except that the first step is to resolve all of the vectors into their x and y component vectors. This will require trig functions.
        - In a "river problem," focusing on velocities the resultant vector will be the velocity of the object relative to the Earth.
    - Projectile motion
        - Independence of motion in 2 dimensions – motion in the y dimension can be analyzed separately from motion in the x dimension. The two motions do not affect one another.
        - When a projectile is launched at some angle above horizontal, and it flies in a parabolic trajectory…
            - What governs its y dimension motion?
            - What governs its x dimension velocity?

- Newton's Laws -- Know and be able to apply
  - 1st Law – There is no acceleration unless there is a net force
    - When velocity is constant, net force = 0;
  - 2nd Law – F_{net} = ma
    - Why do objects free-fall at the same rate, regardless of mass?
  - 3rd Laws – For every force, there is always an equal and opposite reaction force
    - Forces are the same, but accelerations may be different
    - Identify action/reaction pairs (e.g. Earth pulls falling apple down; falling apple pulls Earth up)
  - Understand the difference between weight and mass
- Forces
  - Difference between individual forces and net forces
  - Understand that the "net force" depends on how you choose the system upon which that net force is acting (e.g. when you jump, if you are the system, the net force acting on you is the force of the Earth pushing you up; if the system is you and the Earth, then there is no net force, because your force against the Earth cancels out its force against you)
  - Solve problems by writing two expressions for net force acting on a system and setting them equal to one another. The two expressions are F_{net} =
    - ma
    - vector sum of all individual forces
  - Forces acting on objects that are moving up or down at any velocity or acceleration
    - Find the normal force exerted by the floor of an elevator (or a scale) on a person standing in the elevator (that is moving up or down or sitting still)
    - Find the tension in a rope that is suspending an object
  - Terminal velocity
    - What it means
    - Relationship between net force of a falling object and its terminal velocity
      - How do weight and drag compare when…
        - A falling object is speeding up
        - A falling object is slowing down
        - An object is falling at terminal velocity
      - What determines the weight and drag of falling objects?
  - Friction
    - Understand the nature of friction (opposes motion, with a force less than or equal to some opposing force; can't exist in the absence of an opposing force)
    - Know how to calculate
    - Non-conservative force – removes energy from a system

- Forces in 2-D
  - Remember that each dimension can be analyzed independently – One exception is that a sliding object's weight or normal force, which act in the y dimension, can affect the force of friction, which acts horizontally on the object.
  - As with other force problems, write two expressions for net force and set them equal (i.e. $m_{system}a$ = sum of individual forces), but do this separately for both the x dimension and y dimension forces.

- Uniform Circular motion
  - When an object is traveling in a circle at uniform speed,
    - what is the direction of the object's acceleration?
    - what is the object's acceleration?
    - What is the net force acting on the object (direction and magnitude)?
    - Be able to identify the the force(s) that are providing or contributing to the net force
- Gravitation
  - Newton's law of gravitation – know what all of the variables mean; understand what happens when each variable is manipulated
  - Know the factors that determine the value of g on or near a planet.
  - Know how g and G are different, and how they are related
- Kepler's Laws -- Know and apply
  - 1st – All orbits are elliptical, with the orbited body at one focus of the ellipse
  - 2nd – Law of equal areas
  - 3rd – Law of periods
- Orbiting bodies
  - Uniform circular orbits –
    - speed is constant
    - Know what factors determine speed
  - Elliptical orbits –
    - speed is not constant
    - understand how speed varies in an orbit -
- Energy
  - PE vs KE
  - Be able to correctly apply the law of conservation of energy
  - Non-conservative forces (e.g. forces that add to or subtract from a system's energy; friction, external pushes and pulls…)
    - Know how NC forces affect the energy conservation formula
  - Know and apply the Work-Energy Theorem
  - Know what work and power are, and be able to calculate them
- Springs
  - Spring force
  - Spring PE

Part 2: Problems

- Use the correct units for everything
- Know and apply kinematics formulas in one dimension to find speed, velocity, elapsed time, displacement, distance, and/or acceleration.
- Add component vectors to get a resultant. Describe the magnitude and direction (in degrees relative to some direction) of the resultant.
    - Orthogonal vectors
    - Non-orthogonal vectors
- Resolve a non-orthogonal vector (described in terms of its magnitude and direction [in degrees relative to some direction]) into its x and y components.
- Solve problems relating to projectiles with symmetric trajectories launched at some angle above horizontal. A variety of variables could be solved for in this situation.
- Solve problems relating to projectiles launched horizontally from a height.
- Solve problems relating to objects that are moving vertically (up or down) at any acceleration, either suspended by a rope or standing on a surface (probably a bathroom scale).
- Solve problems relating to systems of blocks, ropes, and pulleys, with or without surface friction, and with or without inclined surfaces. Find accelerations, tensions, or values of μ.
- Solve problems with motionless objects suspended by non-vertical ropes.
- Solve problems involving uniform circular motion in horizontal and vertical circles.
- Solve problems with satellites orbiting in circles at constant speed.
- Solve problems using Newton's Law of Gravitation
- Solve problems using Kepler's 3rd Law
- Solve problems relating to kinetic energy and potential energy (gravitational and/or spring), with or without friction. Variables that you solve for may include: KE, PE (spring or grav), velocity…
- Solve problems using the law of conservation of energy
- Solve problems using $PE_i + KE_i + W_{nc} = PE_F + KE_F$
- Use either of the preceding formulas to solve problems relating to "roller coaster" type objects traveling up and/or down inclines and encountering forces.