Physics 4A Lecture Final Review

1. ***MOTION IN 1-D***
   a) Understand the terms and concepts required to describe the motion of a particle moving in one dimension.
   b) Know how to use and derive the kinematic equations to describe the motion of an object moving with constant acceleration
   c) Know how to use the graphs of x vs. t, v vs. t , and a vs. t to find the position, velocity, and acceleration of a particle moving with constant or non-constant acceleration.
   d) Know how to find the position, velocity and acceleration graphically.
   e) Know how to calculate the displacement and velocity using the area interpretation.
   f) Know how to apply the kinematic equations to object in free-fall motion.
   g) Understand and know how to define the following terms:
      - Position
      - Displacement
      - Average velocity
      - Instantaneous velocity
      - Average speed
      - Average acceleration
      - Instantaneous acceleration
      - Free-fall Motion
      - Acceleration of gravity

2. ***VECTORS***
   a) What is a vector quantity?
   b) What is a scalar quantity?
   c) Why are vectors important?
   d) Know how to add vectors graphically (geometrically) and using component method.
   e) What are unit vectors? What are they used for?
   f) Know how to calculate displacement, velocity (average), and acceleration (average) vectors.
   g) How do you draw the velocity vector given the path of the particle?
   h) Vector properties (equality of vectors, commutative law, associative law, vector subtraction, negative of a vector, scalar multiplication)
   i) Scalar component of a vector.
   j) Vector components of a vector.
   k) Magnitude and direction of a vector.
   l) Know how to sketch vectors graphically.
   m) Know how to apply the kinematic equations in component form.

3. ***MOTION IN 2-D***
   a) Motion in 2D can be analyzed by treating the x and y motion separately. The two motions are independent, each with constant acceleration.
   b) Kinematic equations can be used to describe motion in 2-D since it's motion with constant acceleration.
   c) Calculate the maximum height of a projectile.
   d) Calculate the range of a projectile.
   e) What is the maximum range of a projectile?
   f) What is the path(trajectory) of a projectile moving in 2-D?
   g) What are the acceleration components?

h) know how to describe motion in different reference frames.
i) What is an inertial reference frames? Why are they important?
j) Know how to use the relative motion equations in component and vector form.
k) Relative motion in 3D.
l) Know how to use the relative motion equations using the proper subscript notation.
m) What is uniform circular motion (UCM)?
n) What is the magnitude and direction of the acceleration of a particle moving in UCM?
o) What equations can you use to calculate radial (centripetal) acceleration?
p) Why does a particle moving un UCM have acceleration?
q) What is the circumference of a circle?
r) Know how to describe the motion of a particle in a circular path but not in UCM.

4. ***NEWTON'S LAWS OF MOTION (VERY IMPORTANT!!!!!!)***

a) How many Newton's Laws are there? (really?)
b) Make sure you're able to write down Newton's laws of motion and be able to explain conceptually and practically each one of them.
c) Know how to apply Newton's Laws of Motion to describe the motion of a system in equilibrium or moving with constant acceleration. See " STEPS IN USING NEWTON'S LAWS OF MOTION" on notes on homepage.
d) ALWAYS define your system when applying Newton's Laws.
e) Define a convenient SYSTEM and use a convenient coordinate system to apply Newton's Laws.
f) ALWAYS draw a FREE-BODY diagram when applying Newton's Laws making sure to include ALL external forces acting on system !!!!!
g) Newton's Laws fail when applied to particles moving near the speed of light and when applied to the subatomic scale.
h) What is an inertial reference frame?
i) What are the 4 fundamental forces of nature?
j) Give examples of different types of forces.
k) Know how to apply Newton's Laws to a system moving in Uniform Circular Motion.
l) Kinetic and static frictional forces.
m) Coefficients of friction.
n) What is the maximum value of static frictional force? How can you calculate it?
o) Is there a maximum value of kinetic frictional force?
p) Understand and know how to define the following terms:

- Equilibrium
- Conditions for equilibrium
- Net (resultant) force
- External forces
- Internal forces
- System
- Free-Body Diagram
- Mass
- Inertia
- Weight
- Apparent weight
- Action-reaction force
- Non-inertial reference frames

5. ***WORK***

a) Know the definition of the scalar (dot) product.
b) Know how to compute the scalar product.
c) Definition of work $W = \vec{F} \bullet \vec{s}$
d) Work is a scalar quantity NOT a vector quantity.
e) What is the physical interpretation of work?
f) Know how to compute the work done by a constant and non-constanr force.
g) Know how to compute work graphically using the graph of F vs. x.
h) How do you compute the net work on a system?
i) What does negative work mean?
j) What is the work done by the spring force?
k) Know what kinetic energy is and how to compute it.
l) Understand the meaning and how to use the Work-KE Theorem.
m) What are the steps we outlined in class to apply the W-KE Theorem?
n) What is the limitation on the W-KE Theorem?
o) Why is the W-KE Theorem important?
p) Can you apply the W-KE Theorem if friction is involved? Explain!
q) Work is measure of transferring energy into/out of a system due to a force doing work on system.
r) What is power? What does power measure? Explain.
s) What equations can you use to computer power?
t) What do we mean by net power delivered to an object (system)?
u) What is the spring force equation?
v) What is the physical meaning of the spring constant?
w) What is the physical meaning of the negative sign in the spring force equation?
x) What is the work done by the spring force for a giving displacement?
y) How do you calculate the work done by gravity along a curved path?
z) What is the Work-Energy equation when friction is involved? How do you apply it?

6. ***POTENTIAL ENERGY AND CONSERVATION OF ENERGY***

a) Conceptually understand and be able to explain potential energy (PE) and conservative forces.
b) What is the relation between PE and conservative forces?
c) Why are conservative forces important?
d) What are the two definitions of conservative forces we discussed in lecture?
e) What is the gravitational PE function? How do you compute it?
f) What is the elastic PE function? How do you compute it?
g) Why are only changes in PE important?
h) Know how to prove if a force is conservative.
i) Is friction a conservative force?
j) What is an isolated system?
k) What is the mechanical energy of a system?
l) When is the mechanical energy of a system conserved?
m) What are steps we outlined in class to apply COME?
n) What are the conservative forces we discussed in the class?
o) Is mechanical energy conserved if there is friction? Explain
p) How do you apply COE if there is friction involved?
q) What is the difference between COME and COE?
r) If $\sum \vec{F}_{ext} \neq 0$, how do you apply energy considerations to solve a problem?
s) Know how to solve problems using Newton's Laws, W-KE theorem, and COME.

7. ***MOMENTUM***
   a) What is the definition of momentum.
   b) Why is momentum important?
   c) Momentum is a vector quantity.
   d) What is N2L in terms of momentum?
   e) A rapid change in momentum requires a large net force and a gradual change in momentum requires a small net force.
   f) When is the momentum of a system conserved?
   g) When is the momentum of a system conserved even is there are external forces?
   h) Know how to describe the motion of a system using the center of mass.
   i) Know how to find the center of mass of a discrete system of particles and extended 3D body.
   j) When is the velocity of center of mass conserved?
   k) When is the position of the center of mass conserved?
   l) What is impulse?
   m) Why is impulse important?
   n) What is the geometric interpretation of impulse?
   o) What is the SI unit of impulse?
   p) What is the Impulse-Momentum Relation?
   q) How does the Impulse-Momentum Relation lead to conservation of momentum?
   r) What are the steps we outlined in class to apply COM?
   q) What is an elastic, inelastic, and perfectly inelastic collision?
   r) How does a rocket move in space?

8. ROTATIONAL MOTION
   a) What is the physical interpretation of angular displacement, angular speed, and angular acceleration of a rotating body about a fixed axis of rotation.
   b) Know how to apply the rotational equations of motion for constant α to describe the rotational motion of a body.
   c) How did we obtain the rotational equations of motion in the lecture?
   d) What is a rigid body?
   e) What are the SI units of the rotational quantities?
   f) Of the 3 rotational quantities $\Delta\theta, \omega, \alpha$, which are vectors?
   g) How do you determine the direction of $\boldsymbol{\omega}, \boldsymbol{\alpha}$?
   h) How do you relate linear and angular quantities?
   i) How do you calculate the tangential and radial acceleration of a rotating particle?
   j) What is torque?
   k) What does torque depend on?
   l) What are the 3 method of computing torque?
   m) What is lever arm?
   n) What is the physical interpretation of moment of inertia?
   o) How do you compute moment of inertia for a discrete system of particles and for an extended 3D body?
   p) How do you calculate rotational KE for a system?
   q) Understand how to use N2L for rotational motion $\sum \tau_{ext} = I\alpha$.
   s) Know how to use $\sum \vec{\tau}_{ext} = I\vec{\alpha}$, $\sum \vec{F}_{ext} = m\vec{a}$ and conservation of energy to describe the motion of a sysem.
   t) What is the parallel-axis theorem?
   u) Know how to describe rolling motion without slipping.

9. ***ANGULAR MOMENTUM***

a) Know how to calculate the cross-product between two vectors.
b) Know how to calculate the torque vector.
c) What is the definition of angular momentum?
d) How do calculate the magnitude and direction of angular momentum?
e) What is the angular momentum of a particle moving in a straight line? Why does it have an angular momentum since its moving in a straight line?
f) What is the angular momentum of a system rotating about a fixed axis?
g) Know how to apply N2L for rotational motion in terms of angular momentum

$$\sum \vec{\tau}_{ext} = \frac{d\vec{L}_{sys}}{dt}.$$

h) When is the angular momentum of a system conserved?
i) If $\sum \vec{\tau}_{ext}$ for a system, can you still apply conservation of angular momentum?
j) Know how to apply conservation of angular momentum to a system to analyze the motion of a system.

10. ***NEWTON' S LAW OF GRAVITY***

a) What is Newton's law of gravity?
b) When dis Newton publish the law of gravity?
c) What is the equation for the weight of an object using the law of gravity?
d) What is the revised equation for 'g'?
e) What is the revised equation for gravitational PE?
f) How do you calculate the work done by gravity?
g) How do apply COME using the law of gravity?
h) What is the total energy of a satellite?
i) Is the total energy of a satellite negative, positive, or zero? Explain.
j) What is the binding energy?
k) What is the escape speed? How do you calculate it?
l) Know how to derive the orbital speed of a satellite.
m) Know how to derive Kepler's 3rd Law.