Review for Exam 1: Chapters 1 – 5

Physics 1425, Section 1 (Dr. Yost)

Exam 1 will cover chapters 1 through 5. Chapter 6 will not be included on this exam, since we will just begin covering it on the class before the exam. You may use any calculator for the exam, but you may not bring notes. The only physics formulas you need to remember are those on this page. If any others are needed, they can be derived from these ones, or will be given. You should know basic algebraic, geometric, and trigonometric relations. Any derivatives or integrals needed will be given.

Chapter 1: Introduction, Measurement, Estimating

Concepts: definitions of units, significant figures, and powers of 10. The material here forms the background for the conventions in all of the other chapters, so there will be no questions specifically from this chapter, but no physics questions can be answered without some knowledge of it.

Chapter 2: Kinematics in One Dimension

Concepts: Average and instantaneous velocity and acceleration, falling objects, acceleration due to gravity, variable acceleration, graphical description of motion and velocity.

Equations:

Average velocity = displacement/time = $\Delta x/\Delta t$.

Average speed = total distance traveled (along path)/time.

Instantaneous velocity = dx/dt.

Average acceleration = change in velocity/time = $\Delta v/\Delta t$.

Instantaneous acceleration = dv/dt.

For constant acceleration:

$$\begin{aligned} v &= v_0 + at \\ x &= x_0 + v_0 t + at_2/2 \\ v^2 &- {v_0}^2 = 2a(x - x_0) \end{aligned} \tag{1}$$

The acceleration due to gravity at the Earth's surface is $g = 9.80\ \ \mathrm{m/s^2}$.

Chapter 3: Kinematics in Two Dimensions; Vectors

Concepts: Vectors, vector addition and subtraction, vector components, unit vectors, velocity and acceleration in two dimensions, projectile motion, uniform circular motion

Equations:

For a vector $\mathbf{V}$ with components V_x, V_y, and angle θ measured counterclockwise from the x axis,

$$V_x = V\cos\theta, V_y = V\sin\theta, \tag{2}$$

$$V = \sqrt{V_x^2 + V_y^2}, \tan\theta = \frac{V_y}{V_x}. \tag{3}$$

If inverting the tangent to find the angle θ, remember to be sure to check what quadrant the answer should be in. The normal inverse tangent assumes $V_x > 0$. Otherwise, you must add 180° to the angle θ.

All of the one-dimensional relations for constant acceleration still apply in two-dimensions, but they must be applied to the x and y directions independently.

In projectile motion, the x component is described by a constant velocity, and the y component is described by constant downward acceleration g, as for any falling body. The two components of motion are completely independent.

In uniform circular motion, there is an inward-pointing acceleration $a_c = v^2/R$ called the centripetal acceleration. The period of the motion is $T = 2\pi R/v$, and the frequency is $f = 1/T$. Frequency is measured in units of $\mathrm{s^{-1}}$.

Relative velocities add. If object 1 is moving with velocity $\mathbf{v}_{12}$ with respect to object 2, and object 2 is moving with velocity $\mathbf{v}_{23}$ with respect to object 3, then the velocity of object 1 with respect to object 3 is the vector sum $\mathbf{v}_{13} = \mathbf{v}_{12} + \mathbf{v}_{23}$.

Chapter 4: Newton's Laws of Motion

Concepts: Force, inertia, inertial frames, mass, Newton's Laws, weight, reaction force, weight, normal force, free-body diagrams, vector addition of forces, inclined planes

Equations:

Newton's second law: $\mathbf{F} = m\mathbf{a}$ (vector relation!)

Newton's third law: $\mathbf{F}_{12} = -\mathbf{F}_{21}$.

Weight: F(weight) $= mg$.

Statics: When there is no acceleration, the vector sum of all forces acting on an object must be zero.

Free Body Diagrams: To determine the motion of an object, isolate the object and draw a diagram showing all forces acting on that object. Do not show forces acting on any other object!

Inclined Planes: The motion is solved most easily in coordinates with one axis along the incline, and the other perpendicular to the incline. The normal force on the object balances the component of the weight in the perpendicular direction.

Chapter 5: Further Applications of Newton's Laws

Concepts: Friction, coefficient of static friction, coefficient of kinetic friction, inclined planes with friction, centripetal force, highway curves (friction and centripetal force combined), nonuniform circular motion, velocity-dependent forces, terminal velocity.

Equations:

Friction force $F_f = \mu_k F_N$, where μ_k is the coefficient of kinetic friction, and F_N is the normal force.

Centripetal force: For an object in circular motion, the inward centripetal acceleration must be due to the sum of all forces on the object.

For an object acted on by a resistive force which increases with velocity, the terminal velocity can be found by balancing the resistive force against the weight. When they are equal, the velocity becomes constant.