

PHYSICS 101: Fundamentals of Physics I – Final Exam Prep Sheet

Exam Date: June 10, 2008, 1-3pm

First and foremost, I want to make it clear that this exam will be **cumulative**. Anything we've discussed in class is fair game. As with both of the other exams, students with last names from A-M will take their test in CAT 61, and those with last names N-Z will take their test in Curtis 340. You will have 2 hours to complete the exam, so you should be sure to be on time.

It is expected that you will bring a calculator for the exam. You may not borrow a calculator from your neighbor during the exam.

A formula sheet, identical to the one attached, will be included with the exam. While the formulas will be given, the meanings of the letters in the formulas will not. In your preparation, you should make sure that you understand all terms used in the formula sheet. Finally, the exam will be comprehensive. It is also strongly recommended that you review the homeworks in preparation for the exam, and that you understand all of the mistakes that you've made previously.

Chapters covered:

Serway: Chapters 1-8,10

This exam will be cumulative. You should take a look at the topics for the first exam, because I reserve the right to ask about those. In addition to the topics covered on the first and second exam (for which you should review the corresponding review sheets):

- Center of Mass. You should be able to compute the center of mass, and center of mass velocity for a set of particles. You should also be aware that the momentum for isolated systems is conserved, and know how to apply this to real systems.
- Momentum. You should be able to compute the momentum of an individual particle, and compute the momentum of a collection of particles.
- Collisions. You should know the difference between elastic and inelastic collisions, and know which quantities are conserved. Hint: Momentum is **always** conserved, and Kinetic Energy is conserved in elastic collision.
- Basic Rotation. You should be able to use the kinematic equations of motion for a rigidly rotating body. You should also be able to compute elementary moments of inertia, the energy of a rotating body, and the torque on a rigid rotator.

Formula Sheet

Physical Constants

$$G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$$

$$g = 9.8 \text{ m/s}^2 \simeq 10 \text{ m/s}^2$$

$$c = 3 \times 10^8 \text{ m/s}$$

Some useful math relations

$$\frac{dC}{dt} = 0$$

$$\frac{d(t^n)}{dt} = nt^{n-1}$$

$$\frac{d(\cos(at))}{dt} = -a \sin(at)$$

$$\frac{d(\sin(at))}{dt} = a \cos(at)$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{Quadratic Formula}$$

Projectile Relations

$$\Delta \vec{r} = \vec{r}_f - \vec{r}_i$$

$$\vec{r} = x\hat{i} + y\hat{j}$$

$$\vec{v} = \frac{d\vec{r}}{dt}$$

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$\vec{r}(t) = \vec{r}_i + \vec{v}_i t + \frac{1}{2} \vec{a} t^2$$

$$\vec{v}(t) = \vec{v}_i + \vec{a} t$$

$$v_f^2 - v_i^2 = 2a_x \Delta x$$

Circular Motion

$$a_c = \frac{v^2}{r}$$

$$a_t = \frac{dv}{dt} \quad \text{tangential acceleration}$$

Newton's Laws

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

$$\sum \vec{F} = 0 \quad \text{equilibrium}$$

Some specific forces

$$\begin{aligned}F_{g,y} &= -mg \\F_s &= -kx \\F_{G,r} &= -\frac{GMm}{r^2} \\F_r &= \mu F_N \\R &= \frac{1}{2}D\rho A v^2 \text{ (air resistance)} \\V_t &= \sqrt{\frac{2mg}{DA\rho}}\end{aligned}$$

Solution of a spring

$$\begin{aligned}x(t) &= x_0 \cos \omega t \\ \omega &= \sqrt{k/m}\end{aligned}$$

Energy

$$\begin{aligned}K &= \frac{1}{2}mv^2 \\W &= \vec{F} \cdot \Delta \vec{r} \\W &= \Delta K \\E_{mech} &= K + U \\-\frac{dU}{dx} &= F_x \\E &= K + U + E_{th} \\P &= \frac{dW}{dt} \\&= \vec{F} \cdot \vec{v}\end{aligned}$$

Potential Energies

$$\begin{aligned}U_g &= mgy \\U_s &= \frac{1}{2}kx^2 \\U_G &= -\frac{GMm}{r}\end{aligned}$$

Center of Mass

$$\begin{aligned}\vec{r}_{com} &= \frac{\sum_i m_i \vec{r}_i}{M} \\\vec{v}_{com} &= \frac{d\vec{r}_{com}}{dt} \\&= \frac{\sum_i m_i \vec{v}_i}{M} \\M\vec{v}_{com} &= \vec{P} = \sum_i \vec{p}_i\end{aligned}$$

Momentum

$$\begin{aligned}\vec{p} &= m\vec{v} \\ \frac{d\vec{p}}{dt} &= \vec{F}_{ext}\end{aligned}$$

Elastic Collisions in 1-d

$$\begin{aligned}p_{1f} &= p_{1i} \left(\frac{m_1 - m_2}{m_1 + m_2} \right) \\ p_{2f} &= p_{1i} \left(\frac{2m_2}{m_1 + m_2} \right) \quad v_{1f} = v_{1i} \left(\frac{m_1 - m_2}{m_1 + m_2} \right) \\ v_{2f} &= v_{1i} \left(\frac{2m_1}{m_1 + m_2} \right)\end{aligned}$$

Rotational Kinematics

$$\begin{aligned}\omega &= \frac{d\theta}{dt} \\ \alpha &= \frac{d\omega}{dt} \\ \theta(t) &= \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2 \\ \omega(t) &= \omega_0 + \alpha t\end{aligned}$$

Energy of Rotation

$$\begin{aligned}I &= \sum_i m_i r_i^2 \\ K_{rot} &= \frac{1}{2} I \omega^2 \\ I_{circle} &= MR^2 \\ I_{disk} &= \frac{MR^2}{2} \\ \tau &= r F_{\perp} \\ &= \frac{dL}{dt} \\ L &= I\omega\end{aligned}$$