

PHYSICS 101: Fundamentals of Physics I – Exam 2 Prep Sheet

Exam Date: May 22, 2009 8:00am

On May, we'll have our second exam. As with the first exam, students with last names from A-M will take their test in Nesbitt 111, and those with last names N-Z will take their test in Nesbitt 125. You will have 50 minutes to complete the exam, so you should be sure to be on time. The format will be mostly similar to the homeworks and the first exam, with calculations based on the equations discussed in class, and similar in structure and difficulty to previous years' exams. I will **not** reuse problems from previous years. Some questions will involve interpretation as well.

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:

Young and Freedman: Chapters 1-8 (but not elastic collisions)

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, since the 1st exam, there have been a number of topics which are clearly stressed more than others, including:

- Different forms of friction. While the first exam only covered contact friction, this exam can include contact friction, viscosity, or air resistance. And yes, I'll only use the form of air resistance that you've seen in your book.
- Free-body diagrams/equilibrium. I know these showed up in the last exam, but only as a simple exercise. You should be able to relate the forces of a complex system: a block on a plane, a mass suspended by multiple ropes, etc. You should also be able to use the principles of equilibria ($\sum F_y = 0$, for example) to compute all of the forces in a system.
- Energy. You should know how to compute the kinetic energy of a particle and compute the work done on a body. You should know how to relate the two using the work-kinetic energy theorem. In addition, you should be able to use the relationship between energy and power. You should understand conservation of mechanical energy, and under what circumstances it can be applied. You should also be prepared to compute problems which have any of the following three forms of potential energy: particles near the surface of the earth, masses on a spring, and gravitationally interacting bodies.
- Conservative/Nonconservative and Isolated/Non-Isolated systems. You should be prepared to distinguish between systems in which mechanical energy is and is not conserved.
- Energy Diagrams. You should be able to draw energy diagrams, and be able to compute equilibria points, escape velocity, and kinetic energy as a function of position by using conservation of energy.
- Gravity. You should understand gravity in general (as opposed to near the surface of the earth), and be prepared to compute the forces between bodies, potential energies, circular orbital speeds, and escape speeds.

- Center of Mass and Momentum. You should know how to compute and apply center of mass. Further, you should be able to compute the momentum of a system, and relate it to velocity and impulse.

Formula Sheet

Physical Constants

$$\begin{aligned}G &= 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2 \\g &= 9.8 \text{ m/s}^2 \simeq 10 \text{ m/s}^2 \\c &= 3 \times 10^8 \text{ m/s}\end{aligned}$$

Some useful math relations

$$\begin{aligned}\frac{dC}{dt} &= 0 \\ \frac{d(t^n)}{dt} &= nt^{n-1} \\ \frac{d(\cos(at))}{dt} &= -a \sin(at) \\ \frac{d(\sin(at))}{dt} &= a \cos(at) \\ x &= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{Quadratic Formula}\end{aligned}$$

Projectile Relations

$$\begin{aligned}\Delta \vec{r} &= \vec{r}_f - \vec{r}_i \\ \vec{r} &= x\hat{i} + y\hat{j} \\ \vec{v} &= \frac{d\vec{r}}{dt} \\ \vec{a} &= \frac{d\vec{v}}{dt} \\ \vec{r}(t) &= \vec{r}_i + \vec{v}_i t + \frac{1}{2} \vec{a} t^2 \\ \vec{v}(t) &= \vec{v}_i + \vec{a} t \\ v_f^2 - v_i^2 &= 2\vec{a} \cdot \Delta \vec{r}\end{aligned}$$

Circular Motion

$$\begin{aligned}a_c &= \frac{v^2}{r} \\ a_t &= \frac{dv}{dt} \quad \text{tangential acceleration}\end{aligned}$$

Newton's Laws

$$\begin{aligned}\vec{F} &= m\vec{a} \\ \sum \vec{F} &= 0 \quad \text{equilibrium}\end{aligned}$$

Some specific forces

$$\begin{aligned}F_{g,y} &= -mg \\F_s &= -kx \\F_{G,r} &= -\frac{GMm}{r^2} \\F_f &= \mu F_N \\f &= -Cv^2 \text{ (air resistance)} \\f &= -kv \text{ (viscosity)} \\v_{esc} &= \sqrt{\frac{2GM}{r}} \\v_c &= \sqrt{\frac{GM}{r}}\end{aligned}$$

Energy

$$\begin{aligned}K &= \frac{1}{2}mv^2 \\W &= \vec{F} \cdot \Delta\vec{r} = F\Delta r \cos(\theta) \\W &= \Delta K \\E_{mech} &= K + U \\E &= K + U + E_{th} \\W + Q &= \Delta E \\P &= \frac{dW}{dt} \\&= \vec{F} \cdot \vec{v}\end{aligned}$$

Potential Energies

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

Momentum and Center of Mass

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

$$\vec{J} = \vec{F} \Delta t$$

$$\vec{F} = \frac{d\vec{p}}{dt}$$

Rocket Science

$$v = v_e \ln(M_i/M_f)$$