Physics 111 Midterm (9:30am, 9 February 2009)
Prof. John Beacom – Winter 2009

Your Name: Rec. Instructor:

- You have the 48 minutes of class time for this midterm exam, and not more or less.
- The exam is in your recitation room at the usual time.
- Write your name and that of your recitation instructor on every sheet. After the first page, family name for each is enough.
- This exam is closed book, closed notes, and closed homework. No materials allowed.
- You may use a calculator, but you must clear the memory. No cell phones or PDAs may be used as calculators.
- We provide an equation sheet at the end. You cannot use your own. It’s ok to tear it off and keep it.
- All 8 multiple-choice problems are worth 5 points each, for a total of 40 points. You MUST put the correct letter in the space provided to obtain credit. If your writing is ambiguous, it will be marked as incorrect. No partial credit is given for multiple-choice problems.
- Each of the two show-work problems is worth 25 points in total, with each sub-part therein worth 5 points. On the show-work problems, you are REQUIRED to show your work to get credit. We will grade it with partial credit, so the more of what you know that you write down, the better.

- GENERAL ADVICE: Note the wording of the problems CAREFULLY, draw pictures, and check your work at the end. Also, don’t forget to breathe! You can do these problems.
Equations and Constants

- **Quadratic Equation:** The solutions of $ax^2 + bx + c = 0$ are $x = \left(-b \pm \sqrt{b^2 - 4ac}\right)/(2a)$.

- **Vectors:** For a vector $\vec{A}$, the components $A_x$ and $A_y$ can be positive or negative, but the magnitude $A = \sqrt{A_x^2 + A_y^2}$ is always positive.

- **Trigonometry:** For a right triangle, $\sin \theta = \text{opp}/\text{hyp}$, $\cos \theta = \text{adj}/\text{hyp}$, $\tan \theta = \text{opp}/\text{adj}$.

- **Average Velocity and Acceleration:**

  $$\vec{v}_{\text{avg}} = \frac{\vec{r} - \vec{r}_0}{t - t_0},$$
  $$\vec{a}_{\text{avg}} = \frac{\vec{v} - \vec{v}_0}{t - t_0}$$

  which can be separated into $x$- and $y$-components as needed.

- **Basic Kinematics:** For the motion in the $x$-direction, use

  $$v_x = v_{0x} + a_x t,$$
  $$x = \frac{1}{2}(v_{0x} + v_x)t,$$
  $$x = v_{0x}t + \frac{1}{2}a_x t^2,$$
  $$v_x^2 = v_{0x}^2 + 2a_xx.$$

  The displacement $\Delta x = x_{\text{final}} - x_{\text{initial}}$; the book uses the notation $x$ for $\Delta x$ when $x_0 = 0$. For motion in the $y$-direction, use the same equations, but with $y$-subscripts instead of $x$-subscripts.

- **Newton’s Second Law:** $\vec{F}_{\text{net}} = \sum \vec{F} = m\vec{a}$, which separates into components as

  $$\sum F_x = ma_x,$$
  $$\sum F_y = ma_y.$$

- **Friction:** For static friction, $f_s \leq f_s^{\text{maximum}} = \mu_s F_N$; for kinetic friction, $f_k = \mu_k F_N$.

- **Gravity:** $F_G = \frac{Gm_1m_2}{r^2}$, where $G = 6.67 \times 10^{-11}$ N m$^2$/kg$^2$. Also, $g = 9.80$ m/s$^2$.

- **Constants:**

  - radius of Earth: $R_E = 6.38 \times 10^6$ m
  - mass of Earth: $M_E = 5.98 \times 10^{24}$ kg