Physics 105a-2008 Assignment 6

Due: Friday, 10-31-08, 4 pm
Reading: Chapters 10 and 11

To encourage you to start from the basic premises as much as possible, you may only use basic definitions (such as $v \equiv \frac{dx}{dt}$), mathematics (including such things as the circumference of a circle, area of a sphere, etc.), and the following equations as starting points for these problems:

**Constant acceleration:** $v = v_0 + at$ \quad $s = \Delta x = x - x_0 = v_0 t + \frac{1}{2} at^2$ \quad $v^2 = v_0^2 + 2as$ (and similar equations for $y$ and $z$.)

**Relative motion:** $v_{AC} = v_{AB} + v_{BC}$ \quad **Centripetal acceleration:** $a_c = \frac{v^2}{r}$

**Newton’s second law:** $F_{\text{net}} = \frac{dp}{dt}$. If mass is constant, $F_{\text{net}} = ma$

(Things such as Newton’s 3rd law and vector addition of forces are certainly also allowed as starting points – most people don’t ordinarily think of those as equations.)

**Spring force:** $F = -kx$ \quad **Weight:** $W = mg$ \quad **Friction:** $F_s \leq \mu_s N$ \quad $F_k = \mu_k N$

**Centripetal force:** $F_c = \frac{mv^2}{r}$

**Work:** $W = \int_{\text{Start}}^{\text{Finish}} F \cdot ds$ \quad If $F$ is constant and $s$ is a straight line, then $W = F \cdot s = F_s \cos \theta$

**Dot product:** $A \cdot B = AB \cos \theta$

**Conservation of energy:** $W_{\text{ext}} + Q_{\text{ext}} = \Delta K + \Delta U + \Delta U_{\text{int}}$

$W_{\text{int}} = \pm \Delta$? Choose sign and fill in the question mark from context)

**Potential energies:** near surface of Earth, $U_{\text{grav}} = mgy$ \quad $U_{\text{spring}} = \frac{1}{2} kx^2$

**Relations between force and potential energy:**

$\Delta U = -\int_{\text{Start}}^{\text{Finish}} F \cdot ds$ \quad $F = -\nabla U$ \quad $\nabla \equiv \hat{i} \frac{\partial}{\partial x} + \hat{j} \frac{\partial}{\partial y} + \hat{k} \frac{\partial}{\partial z}$ \quad In one dimension: $F = -\frac{dU}{dx}$

**Power:** $P \equiv \frac{dE}{dt}$ \quad $P = F \cdot v$

**Gravity:** $F = -\frac{GMm}{r^2} \hat{r}$ \quad $U = -\frac{GMm}{r}$ \quad $T^2 = \frac{4\pi^2 R^3}{GM}$ \quad “Equal areas in equal times”

**Center of mass:** $R = \sum \frac{m_i r_i}{M_{\text{tot}}}$ \quad $F_{\text{net ext}} = M_{\text{tot}} \frac{d^2 R}{dt^2}$

Assigned problems appear on the next page
Individual problems (For these, you may not consult any other human being, except for me.)
Q9.4
Q9.12
Q9.22

Group problems (For these, you are encouraged to work in small groups – no more than 5 students – but only after you have made a serious effort on each problem on your own.)

6A. The expressions $U = -\frac{GMm}{r}$ and $U = mgy$ both describe gravitational potential energy, but they look very different. Use a graph to explain how they are consistent with each other.

P6.74 (For an explanation of the banking of a plane, see the figure on the bottom right of p. 137. However, bear in mind that for this problem, the rudder produces an additional horizontal force that is not shown in the figure on p. 137.)

Q9.7
Q9.16
P9.40
P9.58
P10.14
P10.63