Physics 2a, Nov 3, lecture 19

⋆Reading: finish chapter 7, start chapter 8.

• Example of falling elevator, 2000Kg, falling at $v_i = 25m/s$ when it hits spring. Constant friction force of 17,000N. Spring compresses at most $3m$. What is spring's k? Write $\frac{1}{2}mv_i^2 + W_{fricf} + mgy_i = \frac{1}{2}mv_f^2 + mgy_f + \frac{1}{2}ky_f^2$ and solve taking $v_f = 0$, $y_i = 3$, $y_f = 0$, $W_{fricf} = -(17,000)(3)$.

• Roller coaster, minimum velocity to go over hill? Forces?

• Aside on loop-the-loop and snowball problems. Balance forces, including the normal force, with total inward force giving ma_{rad}. Contact is lost where the normal force goes to zero.

• Energy diagrams and $U(x)$. You can think about $U(x)$ as just like a roller coaster track! Example of energy diagram for mass on spring again. Turning points. Other examples of energy diagrams, e.g. qualitative $U(r)$ for gravity motion, e.g. earth around sun, or moon around earth.

• Mass on spring again, $E = \frac{1}{2}m\dot{x}^2 + \frac{1}{2}kx^2$.

• Pendulum and energy conservation: $E = \frac{1}{2}mv^2 + mgh$, where $h = R(1 - \cos\theta)$ and $v = R\frac{d\theta}{dt}$. If we expand for small angles, $\cos\theta \approx 1 - \frac{1}{2}\theta^2 + \ldots$ (Taylor series), we get $E \approx \frac{1}{2}mR^2\dot{\theta}^2 + \frac{1}{2}mgR\theta^2$, similar equation for mass on spring with $m \to \frac{1}{2}mR^2$ and $k \to mgR$, and $x \to \theta$. More on this later.

• Ballistic pendulum example. Find v after the collision. Finding v before the collision will segue into our next topic, conservation of momentum.