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 \( \frac{1}{2}mv_i^2 + W_{frict} + mgy_i = \frac{1}{2}mv_f^2 + mgy_f + \frac{1}{2}ky_f^2 \) and solve taking \( v_f = 0, y_i = 3, y_f = 0, W_{frict} = -(17,000)(3) \).

• 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 \( m \rightarrow \frac{1}{2}MR^2 \) and \( k \rightarrow mgR \), and \( x \rightarrow \theta \). 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.