Problem Set 2

Instructions:

1. Answer all questions below. Show your work for full credit.
2. All problems are due by the end of the day on 5 Sept 2014.
3. You may collaborate, but everyone must turn in their own work.
4. Use of the problem template is suggested, but not obligatory.

1. A football kicker can give the ball an initial speed of $25\,\text{m/s}$. What are the **(a)** least and **(b)** greatest elevation angles at which he can kick the ball to score a field goal from a point $50\,\text{m}$ in front of goalposts whose horizontal bar is $3.44\,\text{m}$ above the ground?

2. A boy whirls a stone in a horizontal circle of radius $1.0\,\text{m}$ and at height $1.5\,\text{m}$ above level ground. The string breaks, and the stone flies off horizontally and strikes the ground dafter traveling a horizontal distance of $12\,\text{m}$. What is the magnitude of the centripetal acceleration of the stone during the circular motion?

3. While two forces act on it, a particle is to move at a constant velocity $\vec{v} = (3\,\text{m/s})\hat{\imath} - (4\,\text{m/s})\hat{\jmath}$. One of the forces is $\vec{F}_1 = (2\,\text{N})\hat{\imath} - (6\,\text{N})\hat{\jmath}$. What is the other force?

4. An elevator cab is pulled upward by a cable. The cab and its single occupant have a combined mass of $2000\,\text{kg}$. When that occupant drops a coin, its acceleration relative to the cab is $8.00\,\text{m/s}^2$ downward. What is the tension in the cable?

5. (a) What is the magnitude of the centripetal acceleration of an object on the Earth's equator due to the rotation of Earth? **(b)** What would Earth's rotation period have to be for objects on the equator to have a centripetal acceleration of magnitude $9.8\,\text{m/s}^2$?

6. Vrtoglavica Cave, near the border between Slovenia and Italy, holds the record for having the deepest single vertical drop of any cave on Earth at $603\,\text{m}$ (nearly $2000\,\text{ft}$). **(a)** If you dropped a rock at the top of the cave, how long would it take to reach the bottom, ignoring air resistance? **(b)** What would its speed be once it reached the bottom? **(c)** What is its speed when it is halfway to the bottom?