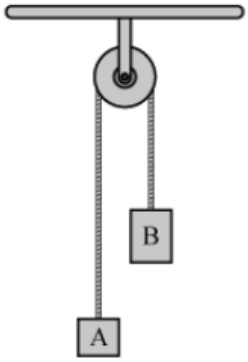
Wednesday Workshop Problems for Solution Posting - Week 9

A. based on Pre-Calculus Problem Set 7, Sec 6.5 #4 & #5: Let's pretend that the temperature over a day can be modeled as a sinusoidal function. Suppose you know the temperature varies between 32 and 68 degrees during the day and the average daily temperature first occurs at 8 AM. Hints: Use the given information to figure out the period and amplitude. Assume the average daily temperature is halfway between the maximum and minimum temperature, calculate the average daily temperature, and explain why it is equal to the midline. Use the facts that this is a sinusoidal function along with the time for the first occurrence of the average daily temperature to determine the horizontal shift.

a) Draw a graph of temperature vs. time. Use the given information/your graph to write down an equation that represents this sinusoidal model. Briefly explain why you would need to use your calculator in radians mode to calculate using this equation.
b) To the nearest tenth of a degree, what is the temperature at 10 am?
c) How many hours after midnight, to two decimal places, does it first reach 41 degrees? The second time?

B. based on Physics Problem Set 7 #8: A pulley and string arrangement is used to connect two objects A and B as shown in the diagram. Here, m_A = 2.95 kg and m_B = 7.70 kg. The string connecting the two objects is of negligible mass and the pulley is frictionless. The objects start from rest and move with constant acceleration. **Determine the magnitude of the acceleration of each block and the magnitude of the tension in the connecting string by doing the following**:



- Draw separate and clear free-body force diagrams for each object, representing each object with a dot and giving each force a clear and useful label and making it clear that there are only two forces acting on each object;
- Noting that the tension in the rope pulls and has the same magnitude so that the tension force acting on each object points up with the same value and so should have the same label on the free-body force diagram;
- Using Newton's Second Law and the free-body force diagram to write down an equation for each object, making sure that the signs on each force and acceleration in each equation clearly indicates the direction of the force and/or acceleration, noting that since one object is accelerating up, the other object must be accelerating down;
- Doing algebra on the 2 equations you obtain from Newton's Second Law (one equation for each object), showing/explaining clearly all the algebra moves you make to answer the questions.

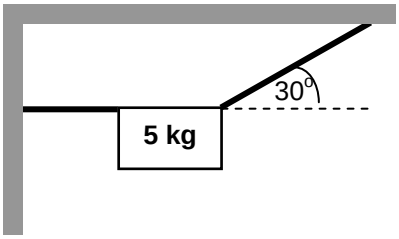
C. based on Quiz 7 #2: At t = 0 minutes, you are at the very top of a ferris wheel.The function $h(t)$ gives your height (in meters) above the ground t minutes after you were at the top: $h(t) = 15\cos\left(\frac{2\pi}{5}t\right) + 18$

a) Draw a graph of height vs. time.
b) Determine each of the following quantities and briefly explain your reasoning:

- The diameter of the ferris wheel
- The time for one full revolution
- Your minimum and maximum height above the ground.

c) Briefly explain why your calculator needs to be in radian mode to do calculations with $h(t)$. Evaluate $h(2.5)$. What does this quantity mean? Make sense of this answer given your answers to b).
d) When is the first time after $t = 0$ that you are at a height of 15 meters? The second time? Make sense of these answers given your graph in part a).

D. based on Quiz 7 #3: A 5 kg block is held by two ropes as shown.
a) Determine the magnitude of the tension in the horizontal rope by doing the following:



- Carefully draw a clear free-body force diagram for the block using a ruler and protractor, representing the block with a dot and giving each force a clear and useful label and making it clear that there are only three forces acting on the block;
- Using Newton's Second Law and your free-body force diagram to write down an equation for the force components in each direction making sure that the signs on each force and acceleration component in each equation clearly indicates the direction of the force and/or acceleration, and explaining why the acceleration is zero in this case;
- Doing algebra on the 2 equations you obtain from Newton's Second Law (one equation for each direction), showing/explaining clearly all the algebra moves you make to answer the question.

b) Without doing any calculations, and just using your free body diagram and protractor and ruler as needed, rank the magnitude of the forces acting on the block in order from smallest to largest. Take advantage of (and explain that you used) the fact that in equilibrium, the sum of the force vectors acting on an object adds up to zero.