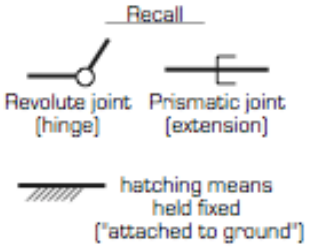
Assignment

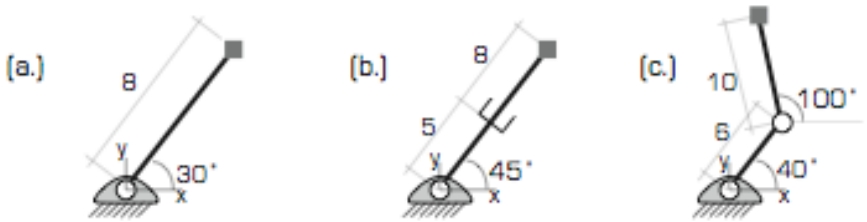
Kinematics Worksheet

Introduction to Robotics
Instructors: Michael Wolf & Jeremy Ma

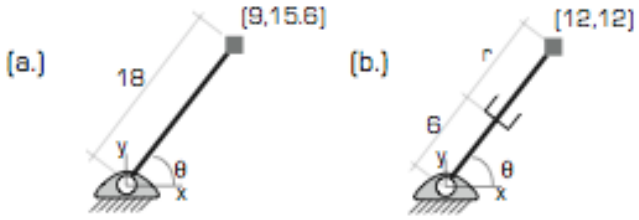
SHOW YOUR WORK.



1. **Forward Kinematics**: Find the position of the endpoint for each of the following robot arms in the given configurations. The position should be given in the "x" and "y" coordinates – e.g. (x, y) = (4.1, 2.8) or x=4.1 and y=2.8.
   Hint: the x and y coordinates can be considered the sides of a triangle, or in the case of (c), draw two triangles. You'll need the "sin" and "cos" buttons on a calculator. If you need a reminder, look at the first section on Wikipedia's "Trigonometry" article or other web page.



2. **Reverse Kinematics**: Find the joint angles required for the robot arm to place its endpoint at the specified location. Meaning, find the angle θ in degrees and for (b) how far the length **r** needs to extend.
   Hint: You'll need the "$\sin^{-1}$" and "$\cos^{-1}$" buttons on a calculator. These do the reverse of "sin" and "cos" — they give you the angle when you have the other part.



3. Reverse Kinematics for next week's challenge: Find a way to determine the joint angles of *your robot* from class to make its endpoint reach the following locations. You may use any means you prefer, but you must write up how you solved the problem, including any relevant drawings or computer applications you may have used. If you can't find the locations now, describe a method how you would approach this in class.
   (a) (x, y) = (0, 30)
   (b) (x, y) = (10, -14)

4. Extra Credit: Work out the general solution to #3 with math, so you can "plug in" any (x,y) coordinates and calculate the corresponding joint angles. Also OK: choose location (b) and find the joint angles using trigonometry.