Question: The lengths of the robot's links will obviously constrain the outer edge robot's workspace, since it would be impossible for it to reach further than the length of both links combined in any one direction. But can the lengths of a robot's links also limit the lower limit of its workspace? i.e. do certain link lengths prevent the robot from reaching all the way back to its base?

Yes, if the link lengths are not equal, the robot can not reach all the way back to its base.

Question: How is the 2.12 robot's workspace limited? Are there certain regions that it will have difficulty reaching? Can you think of any reasons why this might be the case?

Yes, there is a hole in the middle of the workspace where the effector cannot reach. This is due to the angle specifications for the two joints - since the second link is unable to extend in the opposite direction as the first link, there is a hole in the middle of the workspace. There is also a indent on the left side of the workspace due to the angle limitations on the first joint being from -113.7 to 113.7 degrees.

Question: Modify the code such that each joint is able to reach a range of angles form to . Experiment with the following cases: the robot links are of equal length, link 1 is longer than link 2, link 1 is shorter than link 2. How does this affect the reachable workspace?

Equal length: ellipse shape

L1>L2: ellipse shape with hole in middle

L2>L1: ellipse shape with hole in middle

Question 4 Notice that the function for ik_student calculates two possible pairs of joint coordinates. Why is that done? How does it select the best candidate? How would this change as the number of links increases/decreases? See what happens when we don't enforce the correct solution by changing the flag in ik_student(x,y,q0,L1,L2, true) from true to false.

To determine the most efficient join coordinate pair with respect to the most recent pair. It selects the best candidate by choosing the one with the smallest change in angle. As the number of links increase, the possible number of joint combination pairings would increase thus causing more fluctuation in convexity if the best candidates are not selected. If the flag is set to false, the joints fluctuate between convex and concave as the effector position moves in a circle.

Question 5 Would a real robot arm actually yield the commanded trajectory? Why/why not? Hint: Consider what might differ between a simulation and a real piece of hardware.

External factors like friction, viscous damping, and other disturbances
Resolution of weight point
Depends on speed, controller