Part 1 Door

1. Did the force required to open the door depend on the distance from the hinge? How is this related to the concept of torque?

   Yes, the farther from the hinge, the longer the lever arm ℓ, the less force *F* required to open the door.

2. For which situation was the most force required? For which situation was the least force required? Why?

   The most force is required when pushing close to the hinge and the least is required when pushing near the edge of the door, farthest from the hinge, where the lever arm ℓ is greatest.

Part 2 Turntable

3. Explain why the linear velocities for the dots are different, but the angular velocities are the same.

   The linear velocity is determined by dividing the *total linear distance* traveled by a dot by the *total time t*. The linear distance for one rotation is the circumference of the circle made by the dot, or $c = 2\pi r$, where *r* is the dot's distance from the center of the turntable.

   The total distance for the first dot is $c_1 = 10(2\pi r_1) = 20\pi r_1$ and the total distance for the second dot is $c_2 = 10(2\pi r_2) = 20\pi r_2$. Since $r_1 \neq r_2$, this means that $c_1 \neq c_2$. The *linear velocities* are $v_1 = \frac{c_1}{t}$ and $v_2 = \frac{c_2}{t}$, and $v_1 \neq v_2$.

   The *total angular distance* traveled by the dots during time *t* is the same; they each make the same number of revolutions on the turntable.

Part 3 Bicycle Wheel

4. Describe the differences among the relative forces required to turn the bicycle wheel during the following situations:

   stool not rotating and wheel rotating clockwise or counterclockwise with its axis (handle) vertical:

   stool rotating clockwise and wheel rotating clockwise with its axis vertical:

   stool rotating clockwise and wheel rotating counterclockwise with its axis vertical:

stool rotating clockwise and wheel rotating clockwise with its axis horizontal:

stool rotating clockwise and wheel rotating counterclockwise with its axis horizontal:

Describe what you experienced.