Rotational Motion I -- Conceptual Questions

1.) A ball and a hoop of equal mass and radius start side by side and proceed to roll down an incline. Which reaches the bottom first? Explain.

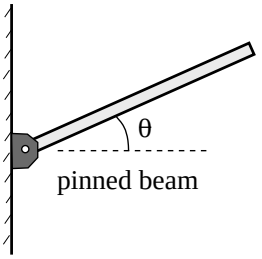
2.) If you drive a car with oversized tires, how will your speedometer be affected?

3.) Assume global warming is a reality. How will the earth's *moment of inertia* change as the Arctic ice caps melt?

4.) Artificial gravity in space can be produced by rotation. How so? Assume a rotating space station produces an artificial acceleration equal to g. If the rotational speed is halved, how will that acceleration change?

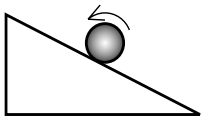
5.) Make up a conceptual graph-based question for a friend. Make it a real stinker, but give enough information so the solution *can* be had (no fair giving an impossible problem).

6.) A beam of length L is pinned at one end. It is allowed to freefall around the pin, angularly accelerating at a rate of $\alpha = k\cos\theta$, where k is a constant. If you know the angle at which it started its freefall, can you use rotational kinematics to determine the angular position of the beam after $t = .2$ *seconds*? Explain.



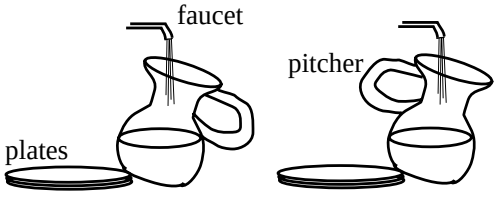
7.) The angular velocity of an object is found to be *-4 **j** radians per second.*

a.) What does the unit vector tell you?
b.) What does the negative sign tell you?
c.) What does the number tell you?
d.) How would questions *a* through *c* have changed if the *-4 **j*** had been an angular position vector?
e.) How would questions *a* through *c* have changed if the *-4 **j*** had been an angular acceleration vector?



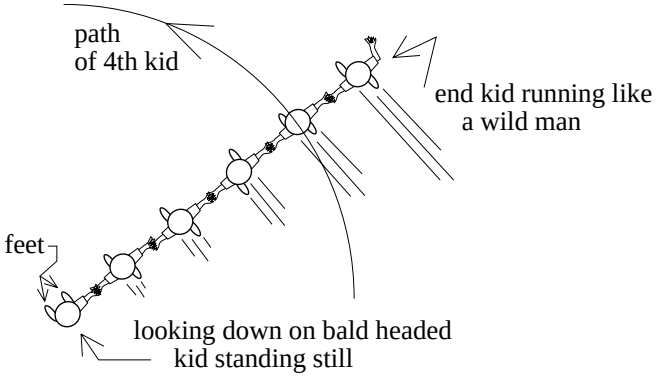
8.) A circular disk sits on an incline. When released, it freely rolls *up* hill. What must be true of the disk?

9.) Two people want to fill up their respective water pitchers. Both use a sink in which there are stacked plates. Neither is particularly fastidious, so each precariously perches his pitcher on the

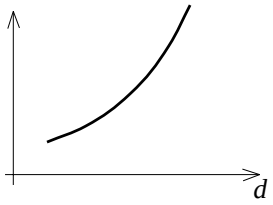


plates (notice I've made them guys?), then turns the faucet on. Which orientation is most likely to get the user into trouble? Will the trouble surface immediately or will it take time? Explain.

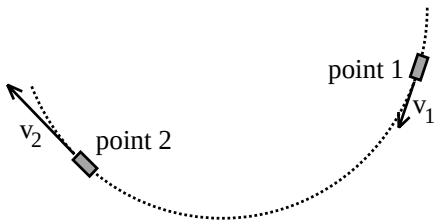
10.) A group of kids hold hands. The kid at one end stays fixed while all the rest try to keep the line straight as they run in a circle (when I was a kid, we called this game *crack the whip*). As you can see in the sketch, the farther a kid is from the stationary center, the faster that kid has to move to keep up. If the speed of the kid one spot out from the center is v, what is the speed of the kid four spots out from the center (see sketch)? You can assume that each kid is the same size and takes up the same amount of room on the line.



11.) A light, horizontal rod is pinned at one end. One of your stranger friends places a mass 10 centimeters from the pin and, while you are out of the room, takes a mysterious measurement. She then takes the same measurement when the mass is 20 centimeters, 30 centimeters, and 40 centimeters from the end. You get back into the room to find the graph shown to the right on the chalkboard. Your friend suggests that if you can determine what she has graphed, there might be something in it for you. What do you think she has graphed?



12.) A car rounds a corner. It goes into the curve with speed v_1 and exits the curve with greater speed v_2. Assume the magnitude of the velocity changes uniformly over the motion and the motion is circular and in the x-y plane (see sketch).



a.) On the sketch, draw the direction of acceleration of the car at the two points shown.

b.) Identify the car's angular acceleration at the two points.

c.) Why are angular parameters preferred over translational parameters when it comes to rotational motion?