Physics Exploration Homework Supplement P110-9.pdf

Moment of Inertia and Angular Momentum

Go to the Physics Exploration Center. Enter through the resource room 311/312 Thaw Hall. BEFORE STARTING the exploration assignment, answer the following questions.

(a) What happens to the angular speed of a spinning figure skater when she draws in her extended arms? Explain your reasoning. Is there any external torque acting on the skater when she brings her extended arms closer to her body?

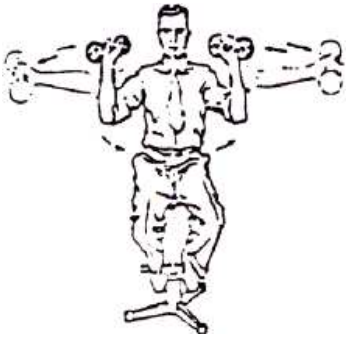
(b) A spinning star is collapsing under its own gravitational force. Should the angular speed of the star change? How? Explain your reasoning.

(c) A swimmer dives from a high diving board into a pool. If she wants to be able to spin in the air several times before landing in the pool, should she keep her body extended or curl it up in a ball? Explain your reasoning.

(d) A beetle bug is spinning at the edge of a horizontal plate spinning at constant angular speed. If the bug crawls closer to the center of the plate, should the angular speed change? How? Explain your reasoning. Is there any external torque acting on the bug-plate system when the bug crawls closer to the center?

(e) Do you notice an underlying similarity between all the four examples above? Which law of physics provides the explanation for all of them?

Now perform the following explorations.



(f) Sit down on the rotating stool with the barbells in your hands. Predict how your angular speed

should change, if at all, if your friend gave you an initial spin and you alternately brought the barbells closer or farther from your body while spinning. Explain the reasoning. Now put the barbells close to your body, your feet on the stool, and ask your friend to rotate you. Once you are rotating, put your arms as far away from your body as possible. What happens to your angular speed? Put back the arms close to your body. What happens to your angular speed then? Does your prediction match your observation? Repeat this process a few times. Write down a reason for this change in angular speed.

(g) Sit down on the rotating stool with the two ends of the bicycle wheel in your two hands. Keep your feet on the stool. Predict how your angular speed should change, if at all, if your friend gave the wheel an initial spin and then you flipped it upside down. Explain the reasoning. Now ask a friend to give an initial spin to the wheel while you sit stationary on the stool. Flip the wheel upside down and note what happens to your speed. Flip the wheel back to its original direction and note the change in your speed again. Write down a reason for these changes.

(c) You are given a device called "governor" which is used to govern the speed of ships. Predict what should happen to the angular speed of a spinning governor if the two balls where brought closer together without applying any torque to it? Explain your reasoning. Now spin the governor and press the handle of the governor down in order to bring the two balls closer together. What happens to the angular speed? How can you convince your friend that although you applied a "force" on the handle, you did not apply any "torque" to the governor (Hint: What is the lever arm for the vertical force you applied along the axis of rotation to bring the balls closer)?