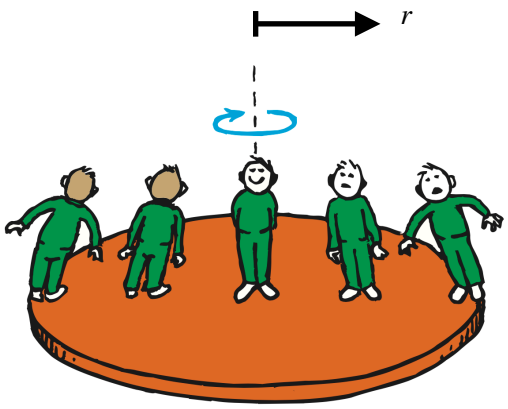
Ch. 8 HW Rotational Motion

Show **ALL WORK**. You may be randomly selected to solve one of the problems next class which will count towards 20% of your final grade.

1) **(5 pts)** A person stands on a rotating turntable of radius R at different distances r away from the axis of rotation.

hint: recall the relation between tangential and angular speed is given by $v \sim \omega r$, where $\sim$ is a symbol read as *"proportional to"*



(a) **(1 pts)** Calculate the tangential speed of the person at the *center*

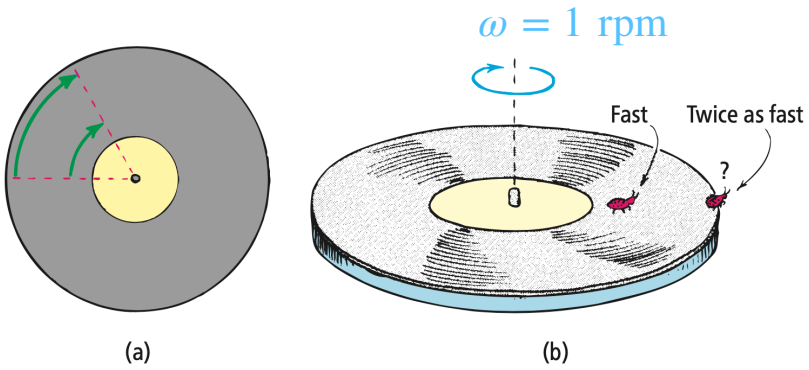
(b) **(2 pts)** As the person moves away from the center does their tangential speed increase or decrease ? Explain

(c) **(2 pts)** determine by how much the tangential speed of the person changes if:

(i) ω doubles (r kept constant)

(ii) r is reduced by half (ω kept constant)

2) **(5 pts)** A ladybug is located *somewhere* in a turntable of radius $R = 1$ m and spinning at a rate of 1 revolution *per* minute (rpm)

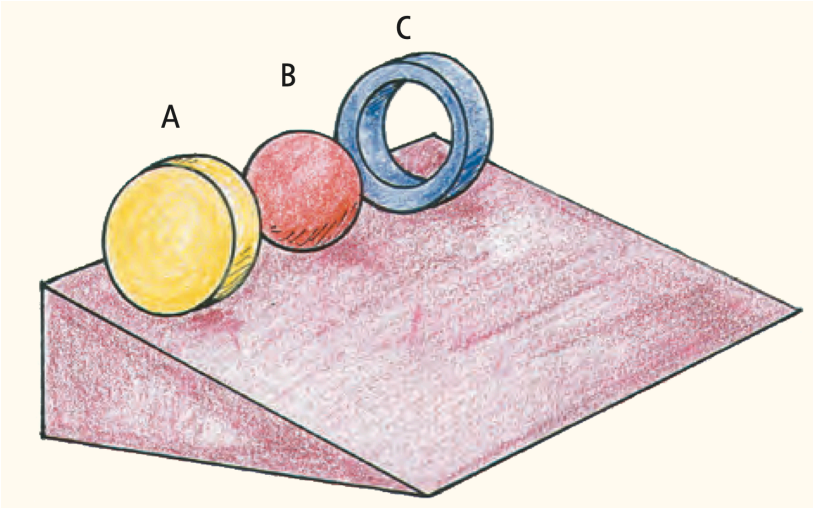


(a) **(1 pt)** Convert the angular speed of the turntable from revolutions / minute (rpm) to radians / sec. *hint:* 1 revolution (360 deg) $\equiv 2\pi$ radians.

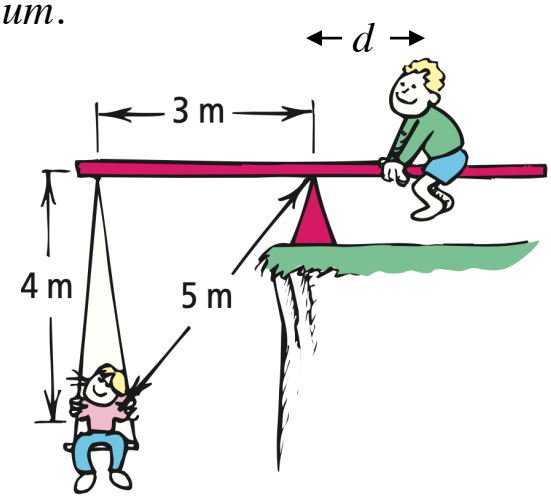
(b) **(2 pts)** If the turntable spins at a rate of 1 revolution *per* minute (rpm), calculate the *tangential speed* of the ladybug if she is located *halfway* from the center. *hint:* recall, the formula $v = R\omega$, requires ω to be in rad/sec (which you determined in part (a))

(c) **(2 pts)** Suppose now the ladybug walks towards the *edge* of the turntable. Calculate her *tangential speed* in this case

3) **(1 pt)** Beginning from a rest position, a solid disk A, a solid ball B, and a hoop C race down an inclined plane. ***The three objects have the same mass and radius.*** Rank them in reaching the bottom: winner, second place, and third place (*hint:* think about how the mass is distributed from the axis of rotation; perhaps note down the moment of inertia *I* for each, see table 8.1 of the Conceptual Physics 13th ed. textbook for the different moment of inertias)



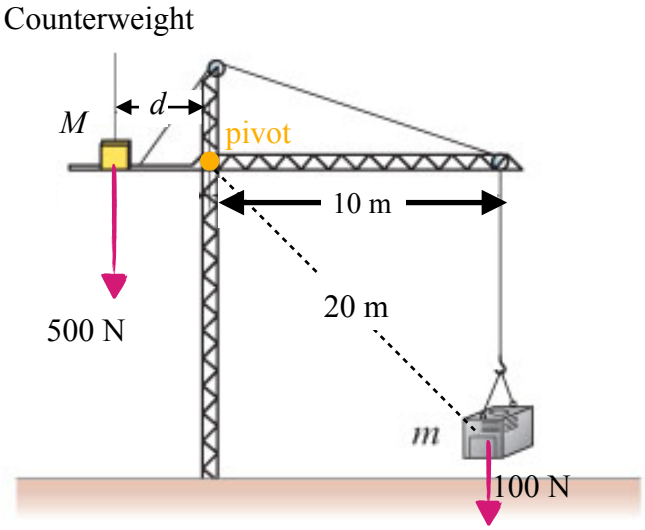
4) **(10 pts)** A girl of weight 250 N and her brother of weight 500 N sit in a seesaw at *equilibrium*.



(a) **(5 pts)** find the torque exerted by: (i) the girl (τ_1) and (ii) her brother (τ_2) (*hint:* remember, at equilibrium, the sum of all torques must balance out, so once you find the torque exerted by the girl, what must the torque exerted by her brother be such as to maintain equilibrium?)

(b) **(5 pts)** at what distance d from the axis of rotation must her brother be to maintain *equilibrium* (*hint:* the torque of the girl and her brother from part (a) must balance out)

5) **(20 pts)** A crane lifting an air-conditioning (AC) unit of 100 N must be balanced with a counterweight box of 500 N so that there is no net torque tending to tip it.

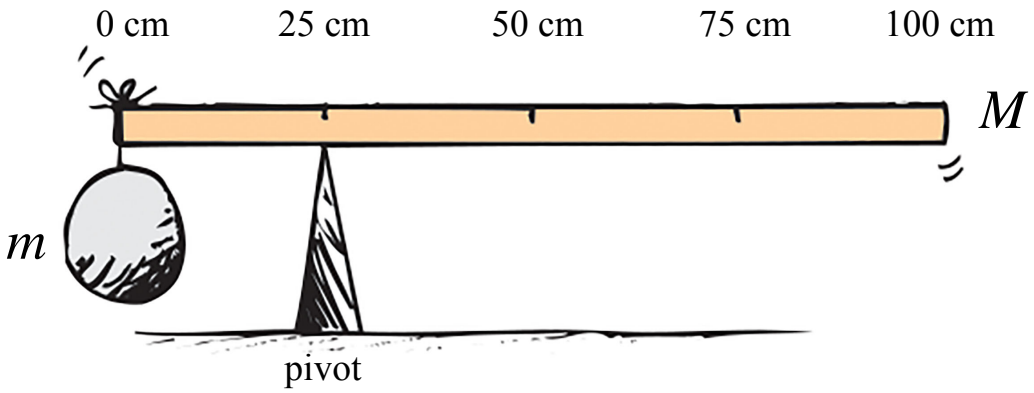


(a) **(5 pts)** calculate the torque on the counterweight box

(b) **(5 pts)** calculate the torque on the AC unit

(c) **(10 pts)** at what distance *d* from the pivot must the counterweight be to balance out the torque from the AC unit ?

6) **(20 pts)** A uniform meter-stick supported at the "25 cm" mark *balances* when a 1-kg rock is suspended at the 0-cm end.

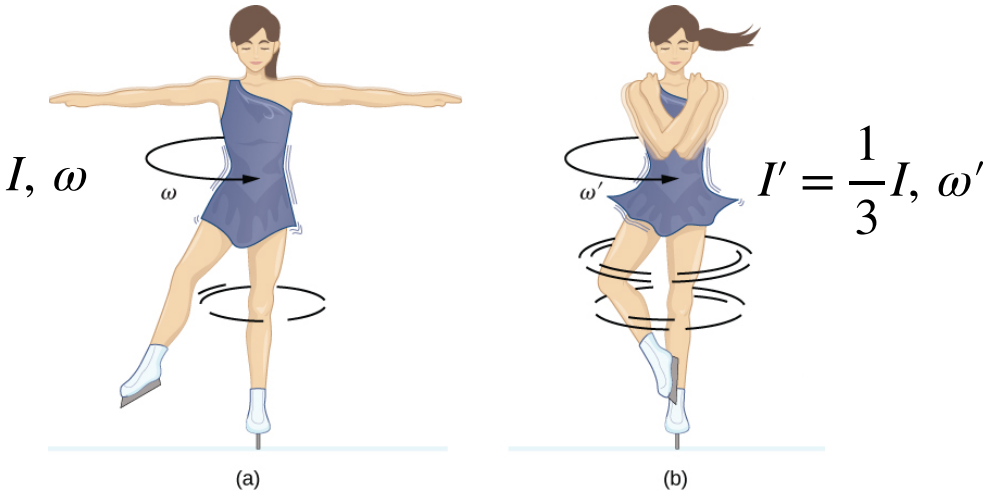


(a) **(5 pts)** calculate the *torque* exerted by the rock

(b) **(5 pts)** locate the center of mass (c.m.) of the meter-stick, mark it with an **X** and find a general expression for the torque τ exerted by the ruler at the c.m. in terms of M, g, and distance of the c.m. from the axis of rotation.

(c) **(10 pts)** calculate the mass M of the meter-stick required in order to maintain *equilibrium* with the rock. (*hint*: the *torques* found in parts (a) and (b) must *balance out*, then solve for M)

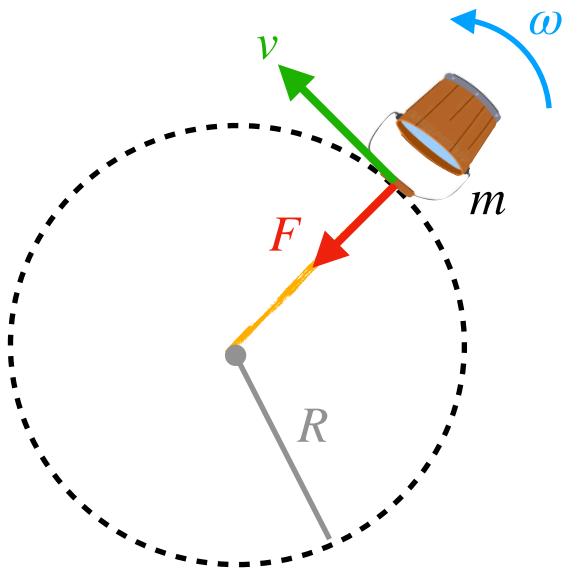
7) **(10 pts)** An ice skater with extended arms has a rotational inertia I and spins at an angular rate of ω (*hint*: think of angular momentum $L = I\omega$, is it conserved ? If so, does the angular momentum change or not ?)



(a) **(5 pts)** write a general expression for her final angular speed ω' in terms of her initial angular speed ω if she reduces her rotational inertia to one-third (I' = 1/3 I) of the initial value

(b) **(5 pts)** if she initially rotates at ω = 3 rotations / sec, what is her final angular speed ω' (*hint*: start from your result in part (a))

8) **(15 pts)** A 5-kg bucket filled with water is spun with an angular speed of ω = 1 revolution per second which traces out a circular path of radius R = 1 m.



(a) **(2 pts)** Calculate the angular speed in units of radians per second (rad/s) *hint:* 1 revolution (360 deg) ≡ 2π radians

(b) **(3 pts)** Calculate the tangential speed of the bucket

(c) **(10 pts)** Calculate the tension force exerted on the rope attached to the bucket as it is spun *hint:* note in this example the centripetal force is in fact the tension on the rope