CHAPTER X
ROTATION

PROBLEM SET

1) A rotating merry-go-round makes one complete revolution in 4.0 s (Fig. 10–45). (*a*) What is the linear speed of a child seated 1.2 m from the center? (*b*) What is her acceleration (give components)?

[Answer: a) 1.9 m/s, b) $3.0\ m/s^2$ towards to center(only radial component)]

2) A cooling fan is turned off when it is running at 850 rev/min. It turns 1350 revolutions before it comes to a stop. (*a*) What was the fan's angular acceleration, assumed constant? (*b*) How long did it take the fan to come to a complete stop?

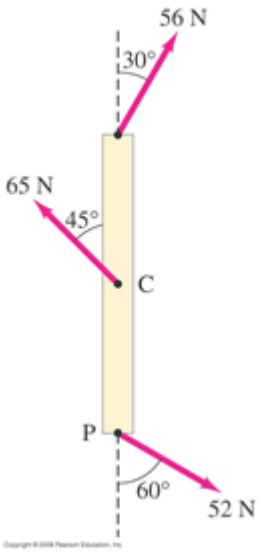
[Answer: a) $-0.47\ rad/s^2$, b) 190 s]

3) The angle through which a rotating wheel has turned in time t is given by $\theta = 8.5t - 15.0t^2 + 1.6t^4$, where θ is in radians and t in seconds. Determine an expression (*a*) for the instantaneous angular velocity ω and (*b*) for the instantaneous angular acceleration α (*c*) Evaluate ω and α at $t = 3.0$ s. (*d*) What is the average angular velocity, and (*e*) the average angular acceleration between $t = 2.0$ s and $t = 3.0$ s?

[Answer: a) $\omega = 8.5 - 30.0t + 6.4t^3$, b) $\alpha = -30.0 + 19.2t^2$ c)91 rad/s, 140 rad/s^2, d) 38 rad/s, e) 92 rad/s^2]

4) Determine the net torque on the 2.0-m-long uniform beam shown in Fig. 10–50. Calculate about (*a*) point C, the CM, and (*b*) point P at one end.

[Answer: a) 17 m · N, b) −10 m · N, negative sign indicates a clockwise torque]



5) *** Calculate the moment of inertia of the array of point objects shown in Fig. 10–53 about (*a*) the vertical axis, and (*b*) the horizontal axis. Assume $m = 2.2\,\text{kg}$, $M = 3.1\,\text{kg}$, and the objects are wired together by very light, rigid pieces of wire. The array is rectangular and is split through the middle by the horizontal axis. (*c*) About which axis would it be harder to accelerate this array?

[Answer: a) 6.6 kg · m^2, b) 0.66 kg · m^2, c) vertical axis]

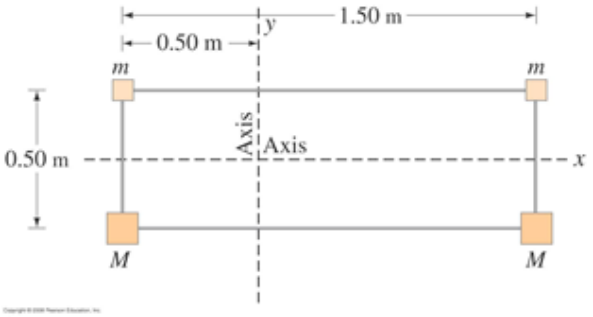
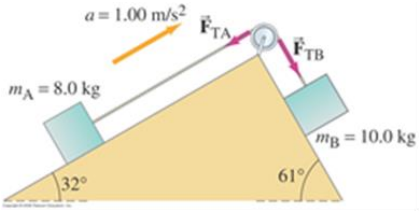
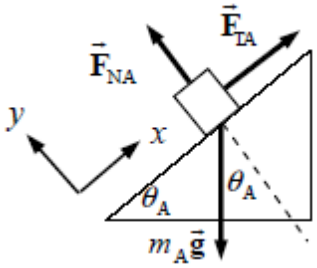


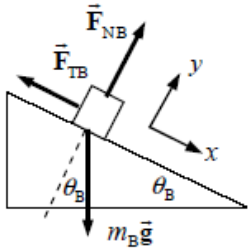
Fig. 10–53

6) *** Two blocks are connected by a light string passing over a pulley of radius 0.15 m and moment of inertia *I*. The blocks move (towards the right) with an acceleration of 1.00 m/s^2 along their frictionless inclines (see Fig. 10–54). (*a*) Draw free-body diagrams for each of the two blocks and the pulley. (*b*) Determine F_{TA} and F_{TB}, the tensions in the two parts of the string.

[Answer: a) figures below, b) $F_{TA} = 50$ N , $F_{TB} = 76$ N]

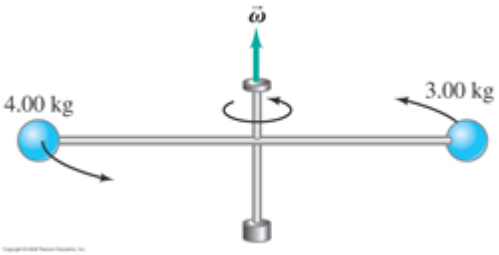






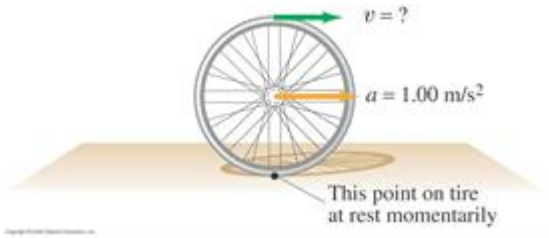
7) A 4.00-kg mass and a 3.00-kg mass are attached to opposite ends of a thin 42.0-cm-long horizontal rod (Fig. 10–60). The system is rotating at angular speed $\omega = 5.60\, rad/s$ about a vertical axle at the center of the rod. Determine (*a*) the kinetic energy *K* of the system, and (*b*) the net force on each mass. (*c*) Repeat parts (*a*) and (*b*) assuming that the axle passes through the CM of the system.

[Answer:a) K=4.84 J, b)$F_A = 26.3$ N, $F_B = 19.8$ N, c)K=4.74 J, $F_A = F_B = 22.6$ N]



8) A cyclist accelerates from rest at a rate of 1.00 m/s^2. How fast will a point at the top of the rim of the tire (diameter = 68 cm) be moving after 2.5 s? [*Hint*: At any moment, the lowest point on the tire is in contact with the ground and is at rest — see Fig. 10–63.]

[Answer: 5.0 m/s]



9) A 1.4-kg grindstone in the shape of a uniform cylinder of radius 0.20 m acquires a rotational rate of 1800 rev/s from rest over a 6.0-s interval at constant angular acceleration. Calculate the torque delivered by the motor.**[Answer: 53 m·N]**

10) *** A wheel of mass *M* has radius *R*. It is standing vertically on the floor, and we want to exert a horizontal force *F* at its axle so that it will climb a step against which it rests (Fig. 10–66). The step has height *h*, where $h < R$. What minimum force *F* is needed?

[Answer:

$$\frac{Mg\sqrt{2Rh - h^2}}{R - h}$$ **]**