AP Physics 1: Rotational Dynamics

1. Three masses are joined together by a rigid, massless rod as shown below. Assume this is a ‘bird’s eye’ view of the object on a frictionless table.

M

2M

3M

L L F

Express the answers to the following questions in terms of L, M and F.

a. Determine the rotational inertia about an axis through the left end.

b. Determine the rotational inertia about an axis through the centre.

c. Determine the rotational inertia about an axis through the right end.

d. Determine the angular acceleration of the object if the axis of rotation is at the left end, perpendicular to the page.

e. Determine the angular acceleration of the object if the axis of rotation is at the centre, perpendicular to the page.

f. Determine the angular acceleration of the object if the axis of rotation is at the right end, perpendicular to the page.

2. Three masses are joined together by a rigid, massless rod as shown below. Assume this is a ‘bird’s eye’ view of the object on a frictionless table.

0.50L

2F

3M

2M

M

θ

2F L 1.5L F

Express the answers to the following questions in terms of L, M, F and θ.

a. Determine the rotational inertia about an axis through the left end.

b. Determine the rotational inertia about an axis through the centre.

c. Determine the rotational inertia about an axis through the right end.

d. Determine the angular acceleration of the object if the axis of rotation is at the left end, perpendicular to the page.

e. Determine the angular acceleration of the object if the axis of rotation is at the centre, perpendicular to the page.

f. Determine the angular acceleration of the object if the axis of rotation is at the right end, perpendicular to the page.

g. Determine the angular acceleration of the object if the axis of rotation is at the centre of mass, perpendicular to the page.

3. The object shown below has a fixed, rigid, frictionless axis through its centre, perpendicular to the plane of the page. The moment of inertia is 50.0kgm2. The forces on the object all act tangentially and F1=100.0N, F2=200.0N and F3=250.0N. The three radii are R1=60.0cm, R2=42.0cm and R3=28.0cm. Find the angular acceleration of the object.

F1 F3

R1

R2

R3

F2

4. A rope is wrapped around a solid cylindrical drum. The drum has a fixed frictionless axel through its center. The drum has a mass of 125kg and a radius of 50.0cm. The other end of the rope is tied to a 10.0kg mass. If the mass is released at rest, assuming the rope does not slip on the drum, find:

a. the angular acceleration of the drum.

b. the linear acceleration of the mass.

c. the tension in the rope.

d. Find the angular speed of a point on the outer edge of the drum after

the block falls 1.0m.

M

5. Two blocks are connected by string over a pulley as shown below. The pulley is NOT massless and frictionless.

M1

mp

M1=2.0kg

M2

M2=1.0kg

mp=500.0g

rp=12.0cm

Find the acceleration of the blocks and the tension on either side of the pulley.

6. A bicycle wheel rolls down an incline angled at 18o. The coefficient of friction between the wheel and the incline is 0.60. Assume the wheel rolls without slipping.

a. Find the acceleration of the wheel.

b. At what angle will static friction reach its maximum and slipping will begin?

7. A uniform rod has a mass of 4.0kg and a length of 2.00m. The rod is held horizontally, with one end fixed to a wall by a frictionless hinge. The rotational inertia is ML2.

a. Find the rotational acceleration when the rod is released.

b. Find the tangential acceleration of the end of the rod when released.