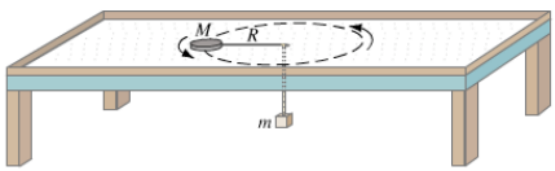
Name: ______________________________

You may answer the questions in the space provided here, or if you prefer, on your own notebook paper.

1. **Modified version of Chapter 5: 80**

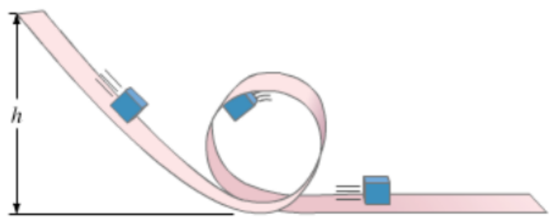
A small object of mass M moves in a circular path of radius R on a frictionless horizontal table. Iti s attached to a string that passes through a small frictionless hole in the center of the table. A second object with mass m is attached to the other end of the string. Show that the speed of the object on the table is

$$v = \sqrt{\frac{mgR}{M}}$$



2. **Chapter 7: 47**

A 1500 kg roller coaster car starts from rest at a height h=23.0 m above the bottom of a 15.0 m diameter loop. If friction is negligible, determine the downward force (normal force) of the rails on the car when the upside down car is at the very top of the loop. **Also**, what minimum height h would allow the car to stay on the loop at the very top? In other words, how small can h be until the car doesn't make it around the loop as it did in class? *Hint: The crucial point is when the net force holding the car up goes to zero.*



3. **Chapter 9: 78**

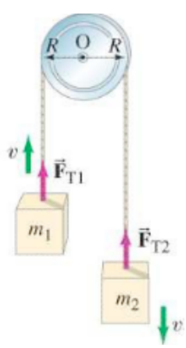
Two objects of mass $m_1 = 500$ g and $m_2 = 510$ g are connected by an ideal string of negligible mass that passes over a pulley with frictionless bearings but has mass 50.0 g and radius 4.00 cm. Treat the pulley as a disk. *Hint: Because there are two forces acting on a non-ideal pulley, unlike our problem with a block on the table, in this case the tension is not the same on either side of the pulley.*

(a) Find the acceleration of the objects.

(b) What is the tension in the string between the 500 g block and the pulley?

(c) What is the tension in the string between the 510 g block and the pulley?

(d) Previously we said that the tension in a string is uniform. That was a bit over-simplistic. Now that we are dealing with realistic pulleys, we have to account for the fact that the pulley has mass and that the point of contact between the pulley and rope is one of static friction just like the point of contact between a wheel and the road is static friction as discussed in class. Examples 9-12 and 9-13 will help you with this problem. In a sentence or two, explain why we can no longer assume that the tension in a rope is uniform throughout when we are talking about non-idealistic pulleys.



4. **Chapter 10:52**

   Two disks of identical mass but different radii r and $2r$ are spinning on frictionless bearings at the same angular speed ω_0, but in opposite directions. They are slowly brought together and frictional force between the surfaces brings them to a common angular velocity. What is the magnitude of that final angular velocity in terms of ω_0? What is the change in rotational kinetic energy of the system? Explain.