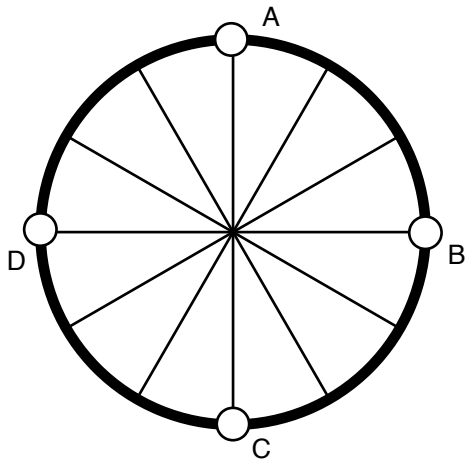
Vertical Circles

1. Imagine you (mass of 70 kg) are riding a Ferris Wheel with a radius of 15 meters. It takes 17 seconds to make one complete rotation.



Some warm up questions first:

   a. What is the frequency of your rotation in Hertz?

   b. What is your linear speed?

   c. What is your acceleration? (Give magnitude and direction.)

   d. What is the net force on you? (Give magnitude and sketch directions in the diagram.)

Now for some harder questions:

   e. When you are at your lowest position on the ride (C), there are two forces acting on you. What are they? Draw a force diagram.

   f. What is your weight? (Remember, for this problem, you have a mass of 70 kg.)

   g. You know the net force (from part d above), and you know the force of gravity on you (from part f) so what must be the normal force acting on you?

   h. What is the normal force acting on you when you are at the highest position on the Ferris Wheel (A). (First think about the two forces acting on your body, and then think about the net force on you.)

   i. Why are your answers to g and h different? Why does the normal force on you change?

   j. If you have ever ridden a Ferris Wheel, you feel a little heavier at the bottom and a little lighter at the top. Why?

2. Now you (mass 70 kg) are riding a fast Ferris Wheel (radius 11 meters). At the highest point, the normal force on you is only 300 N.

   a. What must be the net force on you?

   b. What is the normal force when you are at the lowest point?

   c. What is your linear speed?

   d. How many seconds will it take go around once?

Vertical Circles

3. A bag of books has a mass of 10 kg. A happy physics student is swinging the bag in a vertical circle of radius 0.90 meters. The student is swinging the bag with a speed of 10 m/s.
   a. What is the net force on the bag of books? In which direction does it point?

   b. How much force must the student provide when the bag is at the top of the circle?

   c. How much force must the student provide when the bag is at the bottom of the circle?

   d. Why would these numbers be different?

4. The same student with the same books from the previous problem is now getting tired.
   a. What is the *minimum* speed with which the student must swing the books in order for the books to stay in the bag at the top of the swing?

   b. What force must the student provide at the top of the swing?

   c. What force must the student provide at the bottom of the swing? (Assume a constant speed for the books.)

5. Still the same student and same books. If the *maximum* force that the student can provide is 250 N, what is the *maximum* speed that the student can swing the books at? (Be careful on this. Think about the force diagram on the books and where the student will need to pull with the most force.)

Answers: 1. a) 0.0588 Hz b) 5.54 m/s c) 2.05 m/s^2, to the center d) 143 N, to the center e) weight & normal f) 700 N g) 843 N h) 557 N
2. a) 400 N b) 1100 N c) 7.93 m/s d) 8.72 s
3. a) 1111 N, always to the center b) 1011 N c) 1211 N d) gravity is helping you at the top, but fighting you at the bottom 4. a) 3 m/s b) 0 N c) 200 N 5) 3.67 m/s