The Centripetal Force Requirement

Read from **Lesson 1** of the **Circular and Satellite Motion** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/circles/u6l1c.cfm

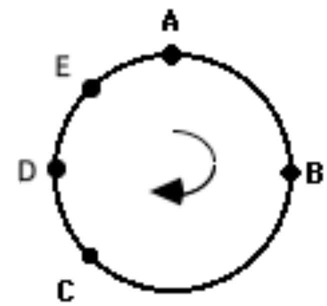
MOP Connection: Circular Motion and Gravitation: sublevels 2 and 4

Review Questions:

1. The net force acting upon an object is _________ as the direction of the object's acceleration.
   a. in the same direction b. in the opposite direction
   c. ... nonsense! There is no simple rule which relates the direction of the **a** and $\mathbf{F_{net}}$ vectors.

2. Consider the top view of the clockwise motion of an object shown at the right. Draw an arrow to indicate the direction of the ...
   a. acceleration vector at location A.
   b. velocity vector at location C.
   c. velocity vector at location D.

   Label your arrows with an **a** (for acceleration) and a **v** (for velocity).



Force Analysis of Circular Motion:

Every instance of the motion of an object in a circle or along a circular turn involves some force that is directed inward or *centripetally*. The centripetal force is an adjective to describe the net force; it is not actually a new force to be added to an already lengthy list - including friction, gravity, applied, tension, normal, spring, air resistance, etc. Rather, the **centripetal force requirement** is a principle that states that in order to have the motion of an object in a circle, there must be an inward net force to sustain the inward acceleration.

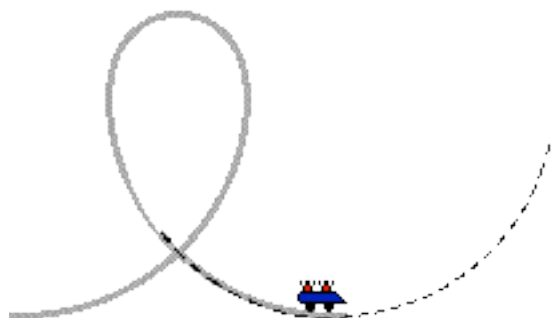
3. In each of the following instances, identify the type of the force that fulfills the centripetal force requirement. That is, identify the inward force acting upon the **bold-faced object**.

Description of a Circular-Type Motion	Centripetal Force
a. A **planet** is orbiting the sun.	
b. A **bucket** (filled with water) is held by a string and whirled in a horizontal circle.	
c. **Passengers** on the Cliff Hanger amusement park ride (a barrel ride) are rotated rapidly in a circle.	
d. The **moon** is orbiting the Earth.	
e. A **car** is making a turn along a level roadway.	
f. A **car** is making a turn along a banked exit ramp.	
g. In football, a **halfback** leans in and rounds the corner to head up field.	
h. A **roller coaster car** is at the top of a circular loop (on the *inside* of the track).	
i. A **roller coaster car** is at the bottom of a circular loop (on the *inside* of the track).	
j. **Clothes** move in a circle during the spin cycle in a washing machine.	

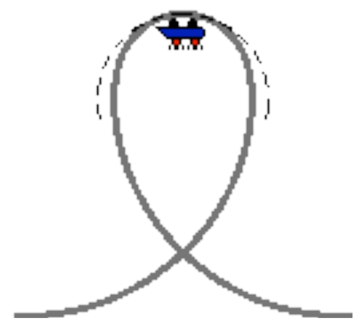
4. Consider the diagram in question #2 on the front side. Draw an arrow on the diagram to indicate the direction of the net force vector at both locations B and E. Label the vector with an **F** (for force).

5. Consider a roller coaster car passing through a clothoid loop. Two strategic positions on the loop are the top and the bottom of the loop. In the diagrams below, draw force vectors on the riders to depict the direction and the magnitude of the two forces acting upon the riders. The size of the force should be approximately equal to the size of the vector arrow. Label the two arrows according to type - F_{grav} and F_{norm}.

Loop Bottom



Loop Top



6. When the roller coaster car is at the bottom of the loop, the direction of the acceleration and the net force is directed ____________ (up, down). When the roller coaster car is at the top of the loop, the direction of the acceleration and the net force is directed ____________ (up, down).

7. In order for the conditions described in question #6 above to be true, how does the magnitude of the normal force compare to the magnitude of the gravity force at the two locations. Put a greater than (>) or a less than (<) symbol in the blanks below.

   Loop Bottom: F_{norm} _____ F_{grav} Loop Top: F_{norm} _____ F_{grav}

8. A person's sensation of weight is due to the presence of a normal force upon their body. Usually, this normal force is of the same magnitude as the force of gravity. So a 600 Newton person typically feels 600 N of normal force to provide a sensation of how much they weigh. When the normal force becomes greater than or less than the force of gravity, a person has a sensation of feeling heavy or feeling light. Where on the roller coaster loop would a person most likely feel heavy - top or bottom? _____________ Explain your answer.

9. **TRUE** or **FALSE**:

   The centripetal force is a distinctly separate force. It can be added to the list of forces (along with tension, friction, normal, etc.) that might act upon an object.

