Speed and Velocity

Read from Lesson 1 of the Circular and Satellite Motion chapter at The Physics Classroom:
http://www.physicsclassroom.com/Class/circles/u6l1a.html

MOP Connection: Circular Motion and Gravitation: sublevel 1

Review:
1. A quantity that is fully described by magnitude alone is a _________ quantity. A quantity that is fully described by both magnitude and direction is a _________ quantity.
   a. scalar, vector  b. vector, scalar

2. Speed is a _________ quantity. Velocity is a _________ quantity.
   a. scalar, vector  b. vector, scalar  c. scalar, scalar  d. vector, vector

3. State the equation for calculating the average speed of an object.
   \[ \bar{v}_{avg} = \frac{\Delta d}{\Delta t} \]

Circular Motion:
4. An object which moves uniformly in a circle can have a constant _________ but a changing _________.
   a. speed, velocity  b. velocity, speed

5. The direction of a velocity vector is always _______. Circle all that apply.
   a. in the same direction as the net force that acts upon it
   b. in the opposite direction as the net force that acts upon it
   c. in the same direction as the object is moving
   d. in the opposite direction as the object is moving
   e. ... none of these!

6. True or False
   The direction of the velocity vector of an object at a given instant in time depends on whether the object is speeding up or slowing down.

7. For an object moving in uniform circular motion, the velocity vector is directed _______.
   a. radially inwards towards the center of the circle
   b. radially outwards away from the center of the circle
   c. in the direction of the tangent line drawn to the circle at the object's location

8. Use your average speed equation to determine the speed of ... (Given: Circumference \( = 2 \cdot \pi \cdot R \))
   a. ... a rider on a carousel ride that makes a complete revolution around the circle (diameter = 21.2-meter) in 17.3 seconds. PSYW
   \[ \bar{v} = \frac{\Delta d}{\Delta t} = \frac{2\pi R}{17.3 \text{ sec}} = 7.7 \text{ m/s} \]
   b. ... your clothes that are plastered to the wall of the washing machine during the spin cycle. The clothes make a complete revolution around a 61.9-cm diameter circle in 0.285 seconds. PSYW
   \[ \bar{v} = \frac{\Delta d}{\Delta t} = \frac{2\pi (0.619 \text{ m})}{0.285 \text{ sec}} = 6.8 \text{ m/s} \]

9. A roller coaster car is traveling over the crest of a hill and is at the location shown. A side view is shown at the right. Draw an arrow on the diagram to indicate the direction of the velocity vector.
Circular and Satellite Motion

7. Rex Things and Doris Locked are out on a date. Rex makes a rapid right-hand turn. Doris begins sliding across the vinyl seat (which Rex had waxed and polished beforehand) and collides with Rex. To break the awkwardness of the situation, Rex and Doris begin discussing the physics of the motion that was just experienced. Rex suggests that objects that move in a circle experience an outward force. Thus, as the turn was made, Doris experienced an outward force that pushed her towards Rex. Doris disagrees, arguing that objects that move in a circle experience an inward force. In this case, according to Doris, Rex traveled in a circle due to the force of his door pushing him inward. Doris did not travel in a circle since there was no force pushing her inward; she merely continued in a straight line until she collided with Rex. Who is correct? _______ Argue one of these two positions.

Doris is correct, Because... Physics!

8. Noah Formula guides a golf ball around the outside rim of the green at the Hole-In-One Futt-Putt Golf Course. When the ball leaves the rim, which path (1, 2, or 3) will the golf ball follow? (Note that this diagram depicts the bird's eye view.)

Explain why.

Newton's 1st Law: object will keep doing what it was doing unless a force changes it.

9. Suppose that you are a driver or passenger in a car and you travel over the top of a small hill in the road at a high speed. As you reach the crest of the hill, you feel your body still moving upward; your gluts might even be pulled off the car seat. It might even feel like there is an upward push on your body. This upward sensation is best explained by the _______.
   a. tendency of your body to follow its original upward path
   b. presence of an upward force on your body
   c. presence of a centripetal force on your body
   d. presence of a centrifugal force on your body

10. Darron Moore is on a barrel ride at an amusement park. He enters the barrel and stands on a platform next to the wall. The ride operator flips a switch and the barrel begins spinning at a high rate. Then the operator flips another switch and the platform drops out from under the feet of the riders. Darron is plastered to the wall of the barrel. This sticking to the wall phenomenon is explained by the fact that _______.
    a. the ride exerts an outward force on Darron that pushes him outward against the wall
    b. Darron has a natural tendency to move tangent to the circle but the wall pushes him inward
    c. air pressure is reduced by the barrel's motion that causes a suction action toward the wall
    d. the ride operator coats the wall with cotton candy that causes riders to stick to it

Always take time to reflect upon your own belief system that governs how you interpret the physical world. Be aware of your personal "mental model" which you use to explain why things happen. The idea of this physics course is not to acquire information through memorization but rather to analyze your own preconceived notions about the world and to dispel them for more intelligible beliefs. In this unit, you will be investigating a commonly held misconception about the world - that motion in a circle is caused by an outward (centrifugal) force. This misconception or wrong belief is not likely to be dispelled unless you devote some time to reflect on whether you believe it and whether it is intelligible. After considering more reasonable beliefs, you will be more likely to dispel the belief in a centrifugal force in favor of a belief in an inward or centripetal force.
Acceleration and Circular Motion

Read from Lesson 1 of the Circular and Satellite Motion chapter at The Physics Classroom:
http://www.physicsclassroom.com/Class/circles/u611b.html

MOP Connection: Circular Motion and Gravitation: sublevel 2

Review:
1. Accelerating objects are ______. Choose the one most inclusive answer.
   a. going fast   
   b. speeding up (only)  
   c. speeding up or slowing down  
   d. changing their velocity

2. Identify the three controls on an automobile that are responsible for causing the car to accelerate.
   Accelerator     Steering wheel     Break

Acceleration and Circular Motion:
3. A car that is moving in a circle at a constant speed of 30 mi/hr is ______.
   a. not accelerating since there is no change in velocity
   b. not accelerating despite the fact that there is a change in velocity
   c. accelerating since there is a change in velocity
   d. accelerating despite the fact there is no change in velocity.
   e. accelerating, but not for either reason mentioned above.

4. An object that is moving in a circle at a constant speed has a velocity vector that is directed ______ and an acceleration vector that is directed ______.
   a. tangent to the circle, tangent to the circle
   b. tangent to the circle, outwards
   c. tangent to the circle, inwards
   d. inwards, tangent to the circle
   e. outwards, tangent to the circle

5. An object moves in a clockwise direction along the circular path as shown in the diagram at the right. Three points along the path are labeled - A, B and C. For each location, draw a straight-line vector arrow in the direction of the velocity vector; label this vector as v. Then draw a straight-line vector arrow in the direction of the acceleration vector; label this vector as a.

6. An object that is moving in uniform circular motion will definitely have a large acceleration if it is ______.
   a. moving very fast
   b. moving along a sharp turn
   c. turning at a rapid rate
Justify your answer: All of the above.

Interesting Fact:
The moon orbits about the Earth with an average speed of just over 1000 m/s; yet its acceleration is less than 0.003 m/s². The moon is a fast-moving object with a low acceleration.

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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/u611e.html
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 \( \mathbf{a} \) 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 \( \mathbf{a} \) (for acceleration) and a \( \mathbf{v} \) (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.

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