Circular Motion Review KEY

1. Define or explain the following:
   a. Frequency
      The number of times that an object moves around a circle in a given period of time.
   b. Period
      The amount of time needed for an object to move once around a circular path.

   c. Hertz
      The standard unit of frequency. 1 cycle/second (or 1 revolution per second)

   d. Centripetal Force
      The centrally directed force that causes an object's tangential velocity to change direction as it moves around a circle.
   e. Centrifugal Force
      The imaginary outward force which you feel as you go around a turn in a car. This "force" is a consequence of you being accelerating and your brain interpreting your tendency to move in a straight line as a force.
2. Which of the following is NOT a property of Centripetal Force?
   a. It is unbalanced
   b. It always has a real source
   ~~c. It is directed outward from the center of the circle~~
   d. Its magnitude is proportional to mass
   e. Its magnitude is proportional to the square of speed
   f. Its magnitude is inversely proportional to the radius of the circle
   g. It is the amount of force <u>required</u> to turn a particular object in a particular circle

3. If an object is swung by a string in a vertical circle, explain two reasons why the string is most likely to break at the bottom of the circle.
   1. The string tension needs to overcome the weight of the object to provide the needed centripetal force.

   2. The object is moving the fastest at the bottom unless some force keeps the object at a constant speed as it moves around the circle.

4. What is meant by the "critical velocity" for a particular circle? What is the critical velocity for a circle of radius 8 meters?
   The critical velocity is the lowest speed that will allow a ball on a string to complete a vertical circle without falling out of the circular path. This means that the weight of the object provides all of the centripetal force. $v_{crit}=8.94\ m/s$

5. Draw a free-body diagram of a car driving over the top a circular "hump" in the road at the critical velocity for that "hump".
   Normal force goes to zero. So, the car has only a weight force acting down.

6. What provides the centripetal force for a car rounding a level curve? If the maximum coefficient of friction, μ, for a car on a level road is 0.9, what is the tightest curve the car can navigate at highway speed (~30 m/s)?

   Friction. r = 100 m

7. A 50 cm rope is used to twirl a 500 gram mass in a conical pendulum. If the period of the revolution is 1 second, what is the angle of the rope to the vertical? What is the tension in the rope?

   $59.6^{o}$, 9.87 N

8. Draw free-body diagrams of a person standing in the gondola of a constant-speed Ferris Wheel at the 12 o'clock, 3 o'clock and 6 o'clock positions. If the person feels as if she weighs 700 N at the bottom of the loop and 650 N at the 3 o'clock position, what would she feel her weight would be at the top of the wheel? What is her mass?

   12 o'clock Should have weight down, larger than normal force up
   3 o'clock Should have weight down, equal size normal force up, and friction force to the side
   6 o'clock Should have normal force up larger than weight down

   600 N, 65 kg

9. A25-cm-radius turntable spins at 45 rpm with a dime placed on the rim and NOT sliding off. What μ is required between the dime and the turntable? What is the linear speed of the dime?

   0.56