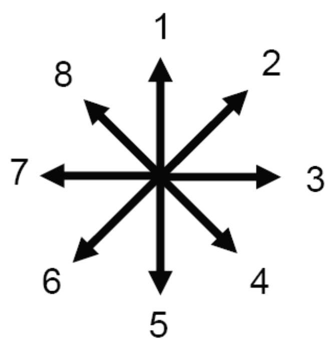
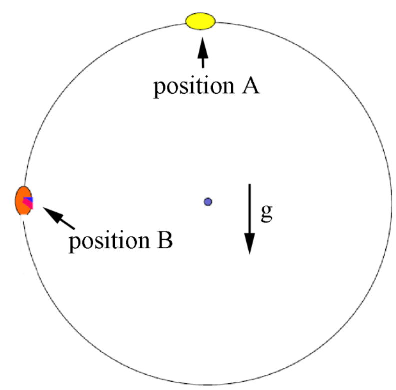
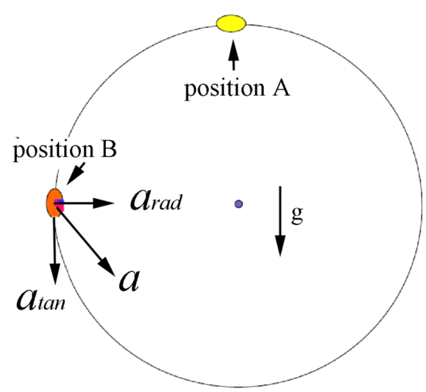
Circular Motion
Concept Questions

Question 1 A bead is given a small push at the top of a hoop (position A) and is constrained to slide around a frictionless circular wire (in a vertical plane). Circle the arrow that best describes the direction of the acceleration when the bead is at the position B.





Solution (4): The bead is speeding up at position B therefore it has a tangential component of the acceleration (pointing downward) and it is traveling in a circular trajectory so it has a radial component of the acceleration pointing towards the center of the circle. Direction 4 best describes the sum of these two components.



Question 2 A car is rounding a circular turn of radius $200\ \text{m}$ at constant speed. The magnitude of its centripetal acceleration is $2\ \text{m}\cdot\text{s}^{-2}$. What is the speed of the car?

1. 400 m/s
2. 20 m/s
3. 100 m/s
4. 10 m/s
5. None of the above.

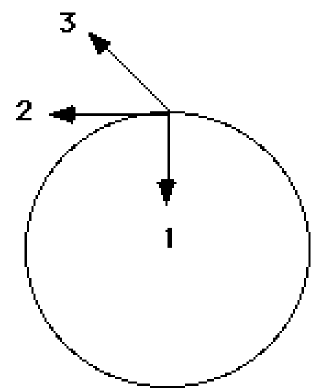
Answer 2. The magnitude of the centripetal acceleration for a car undergoing circular motion is given by $a = v^2 / R$. Therefore the speed of the car is
$v = \sqrt{aR} = \sqrt{(2\ \text{m}\cdot\text{s}^{-2})(200\ \text{m})} = 20\ \text{m}\cdot\text{s}^{-1}$

Question 3 You are a passenger in a racecar approaching a turn after a straight-away. As the car turns left on the circular arc at constant speed, you are pressed against the car door. Which of the following is true during the turn (assume the car doesn't slip on the roadway)?

1. A force pushes you away from the door.
2. A force pushes you against the door.
3. There is no force pushing you against the door.
4. The frictional force between you and the seat pushes you against the door.
5. There is no force acting on you.
6. You cannot analyze this situation in terms of the forces on you since you are accelerating.
7. Two of the above.
8. None of the above.

Answer 7. The force acting on you pushing you away from the door in this example is the normal component of the contact force between you and the door and pushing toward the center of the circle. Although you may feel a tendency to move outward (continue in your linear motion), there is no force pushing you outward.

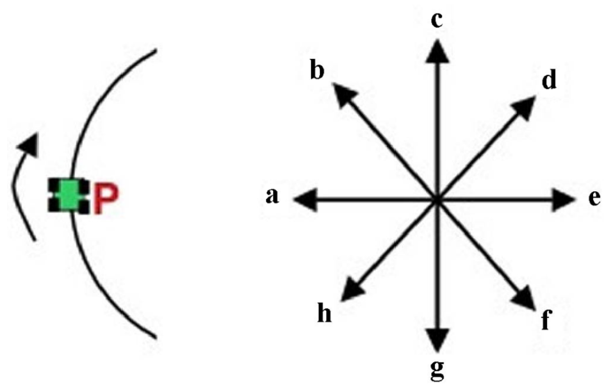
Question 4: As the object speeds up along the circular path in a counterclockwise direction, shown below, its acceleration points:



1. toward the center of the circular path.
2. in a direction tangential to the circular path.
3. outward.
4. none of the above.

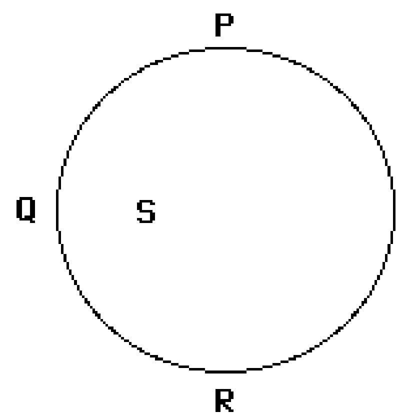
Answer 4. The object always has a component of the acceleration pointing inward. When it is speeding up, it has a component of the tangential acceleration in the direction of motion (counterclockwise). The vector sum of these two components points somewhere between the arrow 1 and 2.

Question 5 A golf cart moves around a circular path on a level surface with decreasing speed. Which arrow is closest to the direction of the car's acceleration while passing the point P?



Answer f. Since the object is slowing down, the vector describing its acceleration vector has both a tangential and radial component vectors. The radial component vector points inward and the tangential component vector points opposite the direction of its velocity, so the arrow f in the figure best describes the vector sum.

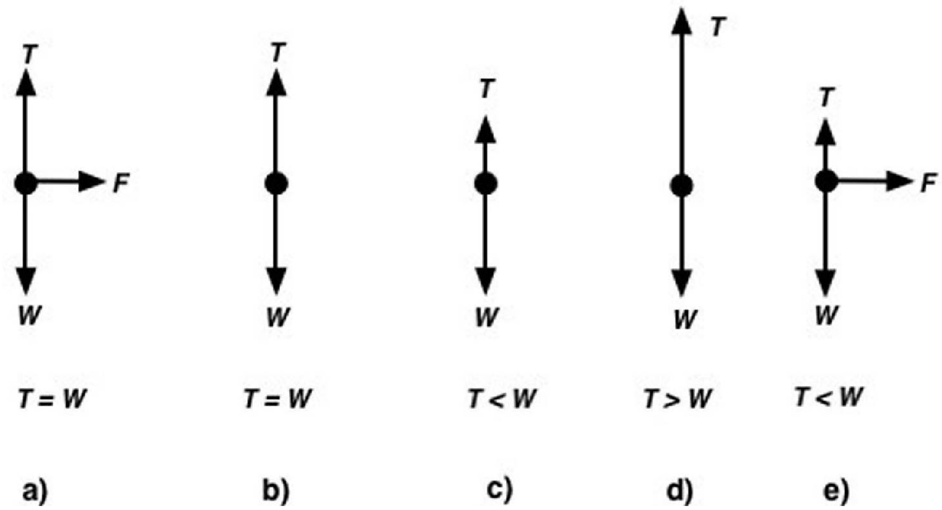
Question 6 An object moves counter-clockwise along the circular path shown below. As it moves along the path its acceleration vector continuously points toward point *S*. The object



1. speeds up at P, Q, and R.
2. slows down at P, Q, and R.
3. speeds up at P and slows down at R.
4. slows down at P and speeds up at R.
5. speeds up at Q.
6. slows down at Q.
7. No object can execute such a motion.

Answer 3. At the point P the acceleration has a positive tangential component so it is speeding up. At the point S the acceleration has a zero tangential component so it is moving at a constant speed. At the Point R the acceleration has a negative tangential component so it is slowing down.

Question 7 A pendulum bob swings down and is moving fast at the lowest point in its swing, T is the tension in the string, and W is the gravitational force exerted on the pendulum bob. Which free-body diagram below best represents the forces exerted on the pendulum bob at the lowest point? The lengths of the arrows represent the relative magnitudes of the forces.



Answer d. The bob is undergoing circular motion. It is accelerating towards the center. Newton's Second Law gives $T - W = mr\omega^2$ hence $T = W + mr\omega^2$ so $T > W$.