AP1

Question:

Which of the following statements concerning circular motion is correct?

I. An object's velocity is constantly changing as it moves in a circular path at constant speed.
II. Any object moving in a circular path at constant speed is accelerating.
III. Circular motion is not a natural state of motion.

- **a.** I only
- **b.** II only
- **c.** I and II
- **d.** II and III
- **e.** I, II and III

Answer:

e.

AP1

Question:

What is the direction of an object's acceleration as it moves in a circular path at constant speed?

a. Tangent to the path
b. Outward, away from the circle's center
c. Inward, toward the circle's center
d. Objects moving in circular paths are not accelerating
e. Can't answer unless the speed of the object is known

Answer:

c.

Question:

Which of the following statements concerning uniform circular motion is correct?

I. **An object moving in uniform circular motion follows a path governed by its inertia.**
II. **In order for an object to move in uniform circular motion it must have an acceleration which is tangent to the circular path of its motion.**
III. **The direction of an object moving in uniform circular motion is at every point tangent to the circular path of its motion.**

a. I only
b. II only
c. III only
d. II and III only
e. I, II and III

Answer:

c.

Question:

A ball attached to a string is whirled around in a horizontal circle having a radius **r**. If the radius of the circle is changed to **4r** and the same tension centripetal force $\mathbf{F_c}$ is applied by the string, the new speed of the ball is which of the following?

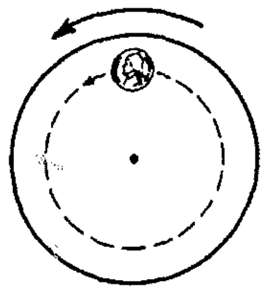
(A) One-quarter the original speed
(B) One-half the original speed
(C) The same as the original speed
(D) Twice the original speed
(E) Four times the original speed

Answer:

D

AP1

Question:



View from Above

The horizontal turntable shown above rotates in a circular path and as viewed from above. The coin on the turntable moves counterclockwise in the circle as shown. Below are possible directions of forces acting on the coin at the point shown.

(A) ← (B) → (C) ↙ (D) ↓ (E) ↑ I only

a. Which vector shows the force responsible for the coin's speed change if it is slowing down?
b. Which vector shows the force responsible for the coin's speed change if it is speeding up?
c. Which vector shows the net force responsible if the coin is speeding up?
d. Which vectors shows the force responsible for changing the coins direction?

Answer:

B, A, C, D

Question:

Which statement(s) concerning objects in circular motion and rotating frames is(are) correct?

I. **The centrifugal force is actually the reaction force applied by the source of the centripetal force.**

II. **The centrifugal force is one of the forces in the 3rd law force pair which acts on the rotating object.**

III. **The centripetal force is an "apparent" force felt by an observer in the rotating frame.**

IV. **The centrifugal force is not a real force, but rather an effect of the object's inertia.**

V. **The inertial frame is the frame of reference for an observer moving with the rotating object.**

VI. **The "reactive" force is a result of inertia and the "apparent" force is a result of rotation.**

Answer:

IV

Question:

A child whirls a ball at the end of a rope, in a uniform circular motion. Which of the following statements is **NOT** true?

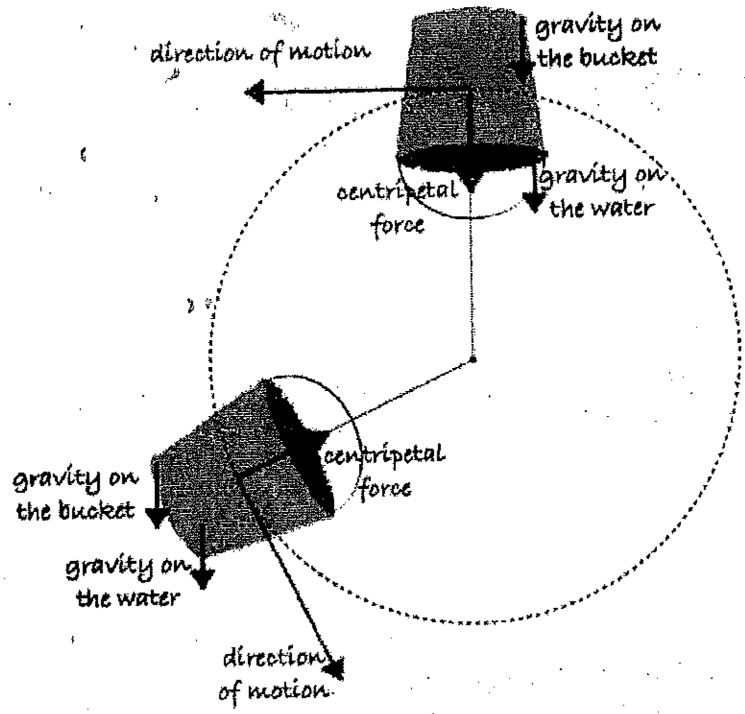
(A) The speed of the ball is constant
(B) The velocity of the ball is constant
(C) The radius is constant
(D) The magnitude of the ball's acceleration is constant
(E) The acceleration of the ball is directed radially inwards towards the center

Answer:

B. Any object moving in a curved path, like a circle, has a constant change in direction. Velocity is a vector comprising both magnitude and direction. By definition, since the ball's direction is constantly changing, the velocity must also be changing.

Question:

Consider the famous trick of a student swinging a bucket of water in a vertical circle. When the bucket gets to the top, the student doesn't get wet because the water does not drop out but instead stays neatly in the bucket, as shown in the diagram below.



Based on the principles of *circular motion*, why doesn't the student get wet?

- **a.** At the top of the circular path the *centrifugal* force pulls the water upward and away from the center.
- **b.** At the top of the circular path the *centripetal* force pulls the water upward and away from the center.
- **c.** At the top of the circular path the water's inertia tends to make it move upward and away from the circle's center where the student is standing.
- **d.** At the top of the circular path the water's inertia tends to make it move forward or tangent to path and away from the circle's center where the student is standing.
- **e.** None of the above

Answer:

d.

What's Going On?

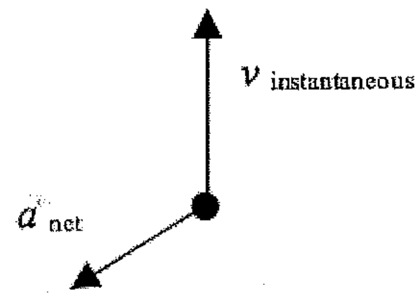
Even though the water is — for an instant — right over your head, it doesn't fall down on you the same way it would if you just turned a bucket full of water upside-down. When you simply turn a bucket upside-down, we know that the water falls out of the bucket because gravity is pulling it towards the earth, but the bucket doesn't fall because you are holding it above the earth - exerting a force opposite to gravity.

In our case, gravity is still pulling the water towards the earth, but it is also pulling the bucket towards the earth, so they're moving together. Above your head, the bucket and water are moving forward, and they'd like to keep going that way, but the string you are using to swing the bucket yanks the water and bucket back into the circular path, exerting what we call a centripetal force.

The water and the bucket are both being pulled by the force of gravity to move downwards but are redirected into a circular path by the centripetal force of the rope! Because of this, the water stays neatly in the bucket, just like the passengers stay in their seats on the roller coaster!

ACI

Question:

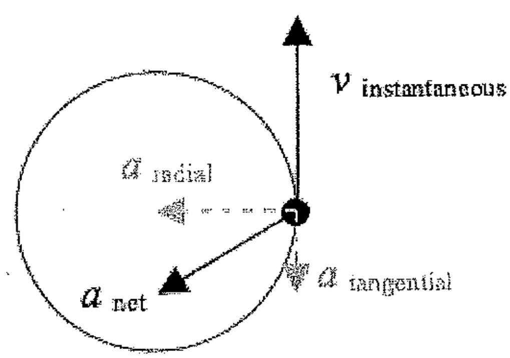


The instantaneous velocity and net acceleration for an object moving in a circular path are shown above. At this moment in time, the object is

a. speeding up in a clockwise circle
b. slowing down in a clockwise circle
c. speeding up in a counterclockwise circle
d. slowing down in a counterclockwise circle
e. traveling in a clockwise circle at constant speed

Answer:

The correct answer is *d*. The instantaneous velocity of the object is tangent to its circular path, and we know that there's a radial (centripetal) aspect of the net acceleration that points towards the center of the circular path. Thus, we can conclude that the object is traveling in a circular path that is located to its left, as shown here.



We can also see that the net acceleration must include a tangential component of acceleration that is in the opposite direction of the instantaneous velocity, implying that the object is slowing down as it travels along this circular path.

Question:

Which of the following statements concerning circular motion is correct?

- **I.** **The change of velocity ΔV of an object moving in a circle at constant speed is always directed toward the circle's center.**
- **II.** **An object moving in uniform circular motion is constantly being accelerated toward the circle's center.**
- **III.** **A centripetal force is necessary for circular motion and counteracts an object's inertial tendency to move away from the circular path along a tangent direction.**

- **a.** I only
- **b.** II only
- **c.** I and II
- **d.** II and III
- **e.** I, II and III

Answer:

e.

Question:

Which of the following statements concerning circular motion are true??

I. **A *centripetal* force is necessary for an object to move with circular motion.**
II. **A *centrifugal* force is necessary for an object to move with circular motion.**
III. **The circular motion of objects are described by Newton's 1st law.**

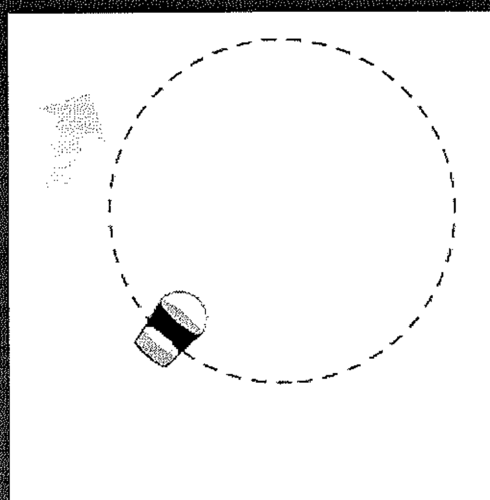
a. I only
b. II only
c. I and II
d. II and III
e. I, II and III

Answer:

a.

Short Response

14. Explain how it is possible for all the water to remain in a pail that is whirled in a vertical path, as shown below.



Answer: The water remains in the pail even when the pail is upside down because the water tends to move in a straight path due to inertia.

End of Slide

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Question:

Which of the following statements describing a rotating system is correct?

I. ***Centrifugal* force is not a real force and must be "invented" by an observer in a rotating system.**

II. ***Centrifugal* force is mistaken for the effects of inertia by an observer in a rotating system.**

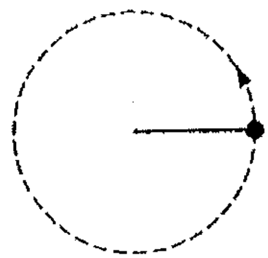
III. ***Centrifugal* means "center seeking" and its force always acts toward the center of the circular path in rotating systems.**

a. I only
b. II only
c. I and II
d. II and III
e. I, II and III

Answer:

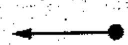
a.

Question:



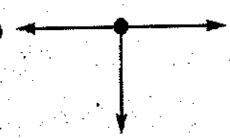
Side View

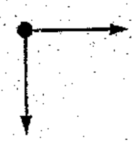
A stone attached to a string is swings in a vertical circle with constant speed with no air friction, as shown in the figure above. Which of the following vector diagrams correctly show the forces acting on the stone when it is at the position shown?

(A) 

(B) 

(C) 

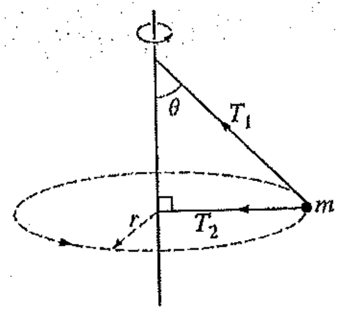
(D) 

(E) 

Answer:

C

Question:



A ball of mass m is attached to a vertical rod by two massless strings. The rod is rotated about its axis so that both strings are taut, with tensions T_1 and T_2, respectively. The strings and rod form the right triangle shown in the figure above. The ball rotates in a horizontal circle of radius r with speed v.

a.

What is the magnitude of the net force on the ball?

(A) mv^2/r
(B) mg
(C) T_2
(D) $T_2 + mv^2r$
(E) $T_1 + mg$

b.

What is the tension T_1 in the upper string?

(A) $mg\cos\theta$
(B) $mg\sin\theta$
(C) $mg\tan\theta$
(D) $mg/\cos\theta$
(E) $mg/\sin\theta$

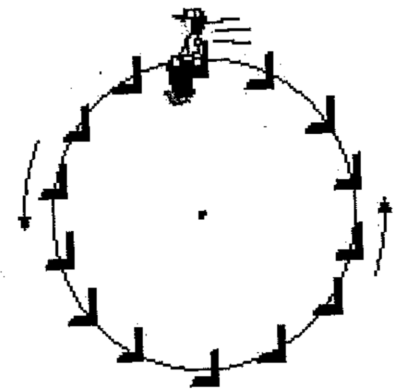
Answer:

a. A
b. D

Question:

A person riding a Ferris wheel is strapped into her seat by a seat belt. The wheel is spun so that the centripetal acceleration is g. Select the correct combination of forces that act on her when she is at the top. In the table Fg = force of gravity, down; Fb = seat belt force, down; and Fs = seat force, up.

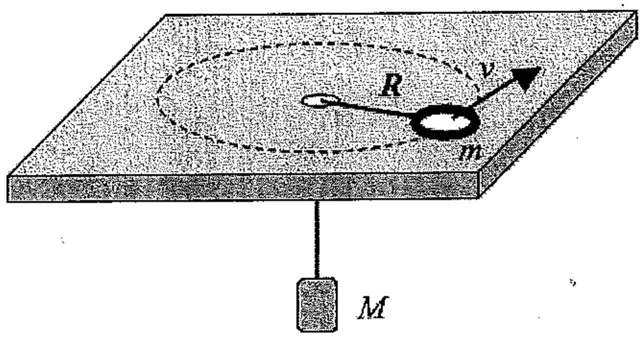
	F_g	F_b	F_s
A.	0	mg	0
B.	mg	0	0
C.	0	0	mg
D.	mg	mg	0
E.	mg	0	mg



Answer:

B. Gravity continues to act downward at the top. Both the applied force from the seat belt and the normal force from the seat are zero since the acceleration is equal to ***g***. The rider's weight provides all the necessary inward centripetal force at the top point.

Question:



A disk of mass *m* is placed on a frictionless table, and attached to a vertically-hanging mass *M* by a string that passes through a frictionless opening in the surface. The disk is given a speed *v* so that it travels in a circle with a constant radius R. What is the speed *v* of the disk's motion?

a. $\sqrt{\frac{RMg}{m}}$

b. $\sqrt{Rg}$

c. $\sqrt{\frac{Rmg}{M}}$

d. $\sqrt{\frac{R}{m}}$

e. none of these

Answer:
The correct answer is *a*. The force of gravity acting on the hanging mass *M* supplies a centripetal force that keeps the disk *m* moving in a circle with constant radius and velocity.

$$F_c = \frac{mv^2}{r}$$

$$F_g = \frac{mv^2}{r}$$

$$Mg = \frac{mv^2}{R}$$

$$v = \sqrt{\frac{RMg}{m}}$$

Question:

Which of the following statements concerning the non-uniform circular motion of an object is correct?

I. The net force acting on the ~~on the~~ object is the centripetal force.
II. The centripetal acceleration causes a change in the object's speed as moves along the circular path.
III. The object could either be speeding up or slowing down along the circular path.

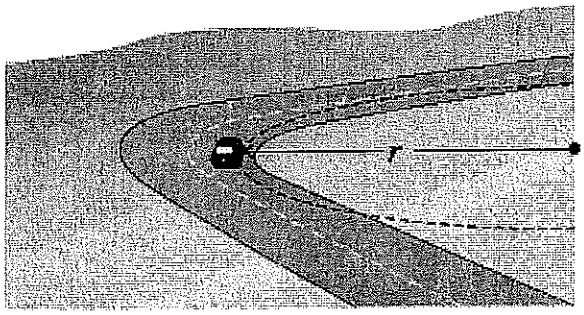
a. I only
b. II only
c. III only
d. I and III only
e. I, II and III

Answer:

c.

Question:

The driver of a 1000 kg car tries to turn through an unbanked circular curve of radius 100 m at a speed of 10 m/s. The actual frictional force between the tires and slippery road has a magnitude of 900 N. The car:



a. slides to the inside of the curve
b. is able to make the turn safely
c. slows down due to the frictional force
d. makes the turn only if it goes faster
e. slides off to the outside of the curve

Answer:

e. Applying $\mathbf{mv^2/r}$ determines that 1000 N of centripetal force is necessary to provide the inward pull to change the car's direction at this speed and radius. Since the frictional force can only provide 900 N, the car will slide off the curve to the outside.

Question:

Which statement concerning a vehicle's circular motion along banked and unbanked curves is correct?

- **I.** **The normal force on a banked curve provides the required centripetal force necessary to allow a vehicle follow a circular path when friction drops to zero.**
- **II.** **On an unbanked curve, friction is the only source providing the necessary centripetal force allowing a car to safely negotiate the circular path.**
- **III.** **The required banking angle for a zero friction force is determined by a car's mass and speed.**

a. **I only**
b. **II only**
c. **III only**
d. **I and III only**
e. **II and III only**

Answer:

a.