Student Worksheet

Centripetal Force

The key to understanding uniform circular motion is identifying the forces responsible for the centripetal acceleration, and remembering that the centripetal acceleration is always directed toward the centre of the circle around which the object moves. Your experiences with circular motion and the apparent force that acts on you when moving in this way can be misleading when trying to interpret the dynamics of these situations. For example, when turning a corner while riding in a car as a passenger, you may feel a force acting outward from the centre of the circle, pressing you against the door. This situation is often explained in terms of a "centrifugal" force, but what is actually happening in this situation?

For a car moving with uniform circular motion, its instantaneous velocity is directed along a tangent to the circle. This is the direction the car's inertia would take the car if there were no other forces acting on it. However, to maintain uniform circular motion, some force or combination of forces act on the car to keep it moving toward the centre of the circle. The sensation you feel as a passenger in the car is actually the car door pushing against you, keeping you accelerating toward the centre of the circle.

Since the centripetal acceleration is directed toward the centre of the circle, the net force is also directed toward the centre of the circle.

Practice Questions

For each of the following *italicized* objects moving with uniform circular motion (a) draw the FBD of the object, and (b) state the force or combination of forces that act on the object to provide the centripetal acceleration.

1. The Sun holds *Earth* in orbit by gravitational attraction.

2. A *car* travels around a curved but horizontal road surface.

3. A *ball* is tied to the end of a string and whirled around on a frictionless horizontal surface.

(continued)

4. A *passenger* is on an amusement park ride where she stands on a platform with her back against a wall as the whole ride revolves in a horizontal plane.

5. A *rubber stopper* is tied to the end of a string, and whirled around in a circle describing a vertical plane. Draw the FBD of the rubber stopper at the top and at the bottom of the circle.

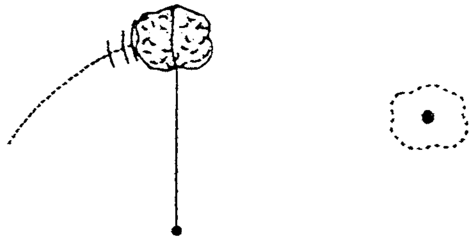
6. A *car* is travelling at a constant speed around a banked curve in the road. Show the components of the forces as appropriate.

7. The *pilot* of a jet flies the plane in a vertical circle. Draw the FBD of the pilot at the top of the circle and at the bottom of the circle.

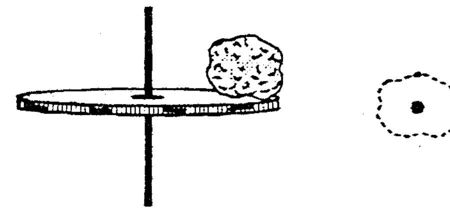
8. A *passenger* on a roller coaster moves through a vertical loop. Draw the FBD of the passenger at the bottom of the circle when the passenger is upright and at the top of the circle when the passenger is upside down.

9. A *rock* in a sling is whirled around in a circle that describes a horizontal plane. The plane of the circle is below the end of the sling the person is holding. Show the appropriate components of the forces in the FBD.

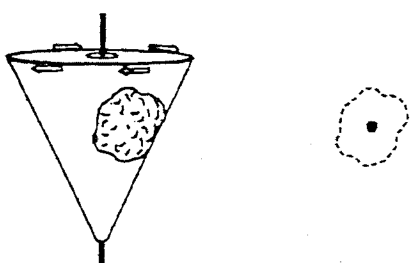
25. Swinging on a rope, at the top of a vertical circle.



26. Riding on a horizontal disk that is rotating at constant speed about its vertical axis. Friction prevents rock from sliding. Rock is moving straight out of the paper.



27. Resting against the frictionless inside wall of a cone rotating about its vertical axis at constant speed. Not accelerating vertically. Moving straight out of the paper.



28. Stuck by friction against the inside wall of a drum rotating about its vertical axis at constant speed. Rock is moving straight out of the paper.