Circular Motion and Gravitation

Ch 7

Circular Motion

7.1

Objectives

- **Solve** problems involving centripetal acceleration.
- **Solve** problems involving centripetal force.
- **Explain** how the apparent existence of an outward force in circular motion can be explained as inertia resisting the centripetal force.

Circular Motion

- Any object that revolves around a single axis is in circular motion
- The axis of rotation is the line that "rotates" around the axis
  - Question:
    - The Axis of rotation for a car tire is….

Tangential Speed

- The **tangential speed** (v_t) of an object in circular motion is the object's speed along an imaginary line drawn tangent to the circular path.
- Tangential speed depends on the **distance** from the object to the center of the circular path.
- When the tangential speed is constant, the motion is described as **uniform circular motion.**

Centripetal Acceleration

- Even at a constant speed, an object following circular motion is accelerating!
- **Centripetal acceleration** is….

Centripetal Accel.

$$Centripetal\ Accel. = \frac{(tang. speed)^2}{radius\ of\ circ. path}$$

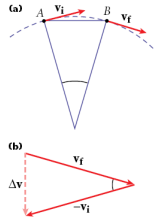
$$a_c = \frac{{v_t}^2}{r}$$

A girl is swinging on a tire swing. If the she has an centripetal acceleration of 3 m/s² and the rope is 2.1 meters long, what is the girls tangential speed?

$a_c = \frac{{v_t}^2}{r}$

Centripetal Acceleration

- **(a)** As the particle moves from *A* to *B*, the direction of the particle's velocity vector changes.
- **(b)** For short time intervals, **Δv** is directed toward the center of the circle.
- Centripetal acceleration is always directed toward the center of a circle.



A car is moving around a circular track with a centripetal acceleration of 15 m/s². If the car has a tangential speed of 31 m/s, what is the distance between the car and the center of the track?

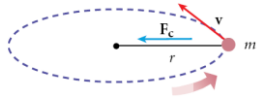
$a_c = \frac{{v_t}^2}{r}$

Tang. Acceleration

- You have seen that centripetal acceleration results from a change in direction.
- In circular motion, an acceleration due to a change in speed is called tangential acceleration.
- Think of a car driving in a circle…
  - Because the car is moving in a circle, the car has a centripetal component of acceleration.
  - If the car's speed changes, the car also has a tangential component of acceleration.

Centripetal Force

- Example: Swinging a ball around in a horizontal circular path with a constant speed
  - Constants: Mass and r (distance ball is from center)



Centripetal Force

– The force exerted by the string has horizontal and vertical components. The vertical component is equal and opposite to the gravitational force. The horizontal component is the net force

– This net force, which is directed toward the center of the circle, is a **centripetal force.**

Centripetal Force

- Centripetal force is the net force on an object moving in a uniform circular motion
- This force can come from…
  - Friction – cars tires
  - Gravity – orbiting planet or moon

Centripetal Force

- Equation

$$Centripetal\ Force = \frac{mass\ *(tang.speed)^2}{radius\ of\ circ.path}$$

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

A girl is swinging on a tire swing. If the she has a tangential speed of 2.5 m/s and the rope is 2.1 meters long, what is the girls mass if there is a centripetal force of 88 N?

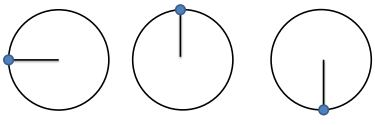
$F_c = \frac{mv_t{}^2}{r}$

A 905 kg car travels around a circular track is a circumference of 3.25 km. If there is a 2140 N centripetal force, what is the tangential speed of the car?

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

Centripetal Force

- What if the string breaks … (rotating clockwise)
  - Vertical movement



  - How about Horizontal movement

Centripetal Force Misinterpreted

- What direction is the force acting on a car that is turning clockwise?

- How about the person in the car?