PHYSICS 103: Lecture 9

Agenda for Today:

- Circular Motion
- Gravity

Read Sections 5.1, 5.2, 5.4

HW (due next Tuesday)

CH5:
Q2, Q3, Q4, Q9, Q10, Q12, Q13, Q20
E1, E3, E5, E8, E13, E15, CP2, CP5

CENTRIPETAL ACCELERATION

- Is the velocity of this object changing?
- Is this object accelerating?
- Is there a net force acting on it?
CENTRIPETAL FORCE

• Force always points toward center of circle

CENTRIPETAL ACCELERATION/FORCE

• Acceleration/force always points toward center
• Acceleration/Force is larger at larger velocities
• Acceleration/Force gets larger as radius decreases

\[ a = \frac{v^2}{r} \]

IMPORTANT POINT: CENTRIPETAL FORCE IS NOT A NEW KIND OF FORCE. IT IS ANY FORCE OR COMBINATION OF FORCES THAT TOGETHER MAKE SOMETHING MOVE ALONG A CURVE

For anything moving in a circle with constant speed
Example problem: Mass on a string

Demo: Accelerometer attached to a string

\[ a = \frac{2\pi^2}{t^2} \]

If we set it to make a sound when \( a = 3g \) and if we make \( t \), the time it takes to make one revolution, equal to 1 second, what must the radius, \( r \) be to hear the sound?

CENTRIPETAL FORCE: EXAMPLE

• What is the net force on the chalk?
• What is the tension in the string?
• Does this depend on whether it is a vertical or horizontal circle?

The Ferris Wheel

• Why do you feel light at the top?
• Why do you feel heavy at the bottom?
CENTRIPETAL FORCE: EXAMPLE

**Fighter Planes**

What is the centripetal force felt by a 100 kg fighter pilot traveling 100 m/s in a loop of radius 100 m?

\[ F = \frac{m \cdot v^2}{r} \]

\[ F = \frac{(100 \text{ kg})(100 \text{ m/s})^2}{100 \text{ m}} = 10,000 \text{ N} \]

\[ W = mg = (100 \text{ kg})(10 \text{ m/s}^2) = 1,000 \text{ N} \]

Maximum humans can take is \( \sim 9 \text{ g} \)

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**FORCE OF GRAVITY**

- Attractive force between all massive objects
- Increases with increasing masses
- Increases as the two objects get closer by \( r^{-2} \)

\[ F = \frac{G \cdot m_1 \cdot m_2}{r^2} \]

\[ G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2 \]
Gravitational Force Between People

- Calculate the gravitational force between you and your neighbor. Assume your masses are 100 kg and the distance between you is 50 cm. Compare this to the gravitational force between you and the Earth.

\[ F = G \frac{m_1 \cdot m_2}{r^2} \]

Main Points from Today’s Lecture

- Centripetal Acceleration/Force
  You should understand that anything moving in a circle is accelerating and has a net force on it towards the center of the circle which is equal to \( \frac{mv^2}{r} \) if it is moving with a constant speed.

- Gravity
  You should understand that gravity is a force that exists between all objects and that it is proportional to the masses of the objects and inversely proportional to the distance squared.

HW

CH5:
Q2, Q3, Q4, Q9, Q10, Q12, Q13, Q20
E1, E3, E5, E8, E13, E15, CP2, CP5