Physics 161
Lecture 9, Summary
Uniform Circular Motion

October 3, 2017

Lecture 9: learning objectives

This lecture

You will be able to define radian measure, angular position/displacement, angular speed, and angular acceleration.

You will be able to apply rotational kinematics to objects undergoing uniform angular acceleration.

You will be able to apply the concept of centripetal acceleration and Newton's second law to objects in uniform circular motion.

Radians and angles

Radian:
There are π radians in 180°. Or, 1 radian = (180/π)°.

$$\theta = \frac{s}{r}$$

Angular displacement:
The difference in final and initial angles, in radians.

$$\Delta\theta = \theta_f - \theta_i$$

Angular velocity

Average angular velocity (between two times):
The difference in final and initial angles, in radians, divided by the difference in final and initial times.

$$\overline{\omega} = \frac{\theta_f - \theta_i}{t_f - t_i} = \frac{\Delta\theta}{\Delta t}$$

Instantaneous angular velocity (at a single time):
The average angular velocity in the limit that the time interval vanishes.

$$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t}$$

Angular acceleration

Average angular acceleration (between two times): The difference in final and initial angular velocities, divided by the difference in final and initial times.

$$\overline{\alpha} = \frac{\omega_f - \omega_i}{t_f - t_i} = \frac{\Delta\omega}{\Delta t}$$

Instantaneous angular acceleration (at a single time): The average angular acceleration in the limit that the time interval vanishes.

$$\alpha = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t}$$

Linear-angular relations

Tangential speed:
The product of the distance from the axis of rotation multiplied by the angular speed.

$$v_t = r\omega$$

Tangential acceleration:
The product of the distance from the axis of rotation multiplied by the angular acceleration.

$$a_t = r\alpha$$

Centripetal force

Centripetal acceleration:
The acceleration of an object in uniform circular motion, directed towards the centre of rotation.

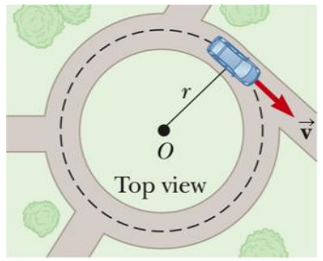
$$a_c = \frac{v^2}{r} \qquad a_c = r\omega^2$$

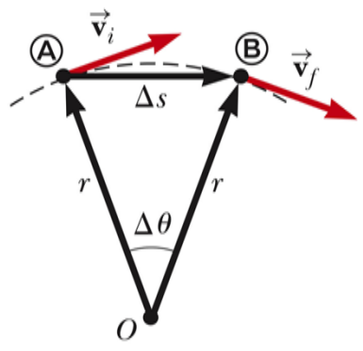
Centripetal force:
The force acting on an object in uniform circular motion, directed towards the centre of rotation.

$$F_c = ma_c = m\frac{v^2}{r} = mr\omega^2$$

Centripetal Acceleration

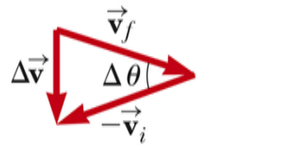
Centripetal acceleration:
The acceleration of an object in uniform circular motion, directed towards the centre of rotation.





The magnitude of this acceleration is:

$$a_c = \frac{v^2}{r} \qquad a_c = r\omega^2$$



14