

DEPARTMENT OF COMPUTING, MATHEMATICS AND PHYSICS

Section 12.3

B.H.

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Circular motio

Projectile motio

Section 12.3 Velocity and Acceleration

MATH211 Calculus III

Instructor: Ben Huang



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Learning objectives

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Projectile moti

Learning objectives: After studying this section, students will be able to

- find the **displacement**, **velocity** and **acceleration** of an object in motion with given conditions.
- use vector-valued functions to analyze circular motion and projectile motion.



Review of mechanics

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Mechanics

Circular motion

Projectile motio

	Differentiation	Integration
Displacement p (Position)	$\mathbf{p}'=\mathbf{v}$	
Velocity v	$\mathbf{v}'=\mathbf{a}$	$\int_{t_0}^{t_1} \mathbf{v}(t) \; \mathrm{d}t = \mathbf{p}(t_1) - \mathbf{p}(t_0)$
Acceleration a	$\mathbf{a}'=\mathbf{jerk}$	$\int_{t_0}^{t_1} \mathbf{a}(t) \; \mathrm{d}t = \mathbf{v}(t_1) - \mathbf{v}(t_0)$

Newton's second law: $\mathbf{F} = m\mathbf{a}$.



Circular motion

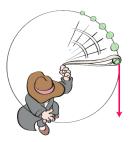
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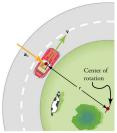
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Circular motion









Car around corner



Circular motion

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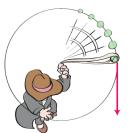
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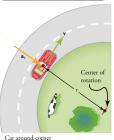
Circular motion

Projectile motion









Circular Motion with Constant Speed:

$$\mathbf{r}(t) = b\cos(\omega t)\mathbf{i} + b\sin(\omega t)\mathbf{j}$$



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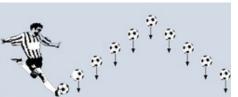
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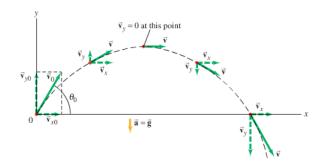


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Circular motion

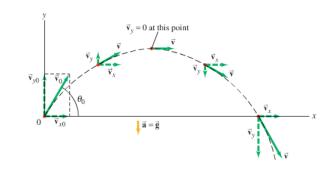


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$$\mathbf{a}(t) = \mathbf{g} = -g\mathbf{j}$$

$$\mathbf{v}(t) = \int_0^t \mathbf{a}(s) \, \mathrm{d}s + \mathbf{v}_0 = -gt\mathbf{j} + \mathbf{v}_0$$

$$\mathbf{r}(t) = \int_0^t \mathbf{v}(s) \, \mathrm{d}s + \mathbf{r}_0 = -\frac{1}{2}gt^2\mathbf{j} + \mathbf{v}_0t + \mathbf{r}_0$$