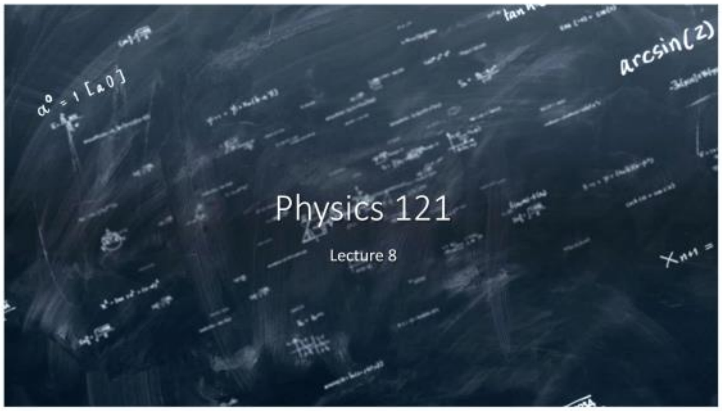
# Lecture 8 - 2.1

Thursday, February 2, 2023 9:33 AM




## Devotional Thought ( or Forumtional?)

Consumer model is "transactional," while the covenantal model is "transformational."

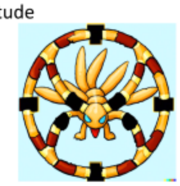
When do I feel God's please? Use your time at BYU to find out what truly satisfies.

Instead of analyzing the value of a relationship, accept the covenant and seek the mystery, meaning, and purpose

"In God's plan of happiness we are not so much looking for someone perfect but for a person with whom, throughout a lifetime, we can join efforts to create a loving, lasting and more perfect relationship. That is the goal.. All this won't just happen in an instant. Great marriages are built brick by brick, day after day, over a lifetime." – Elder Uchtdorf 2022

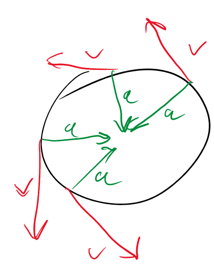
## Review

- Vectors can change direction while having same magnitude
  - Acceleration can change velocities while maintaining speed
- Circular motion results in centripetal acceleration
- Motions in rotating frames become pretty complicated



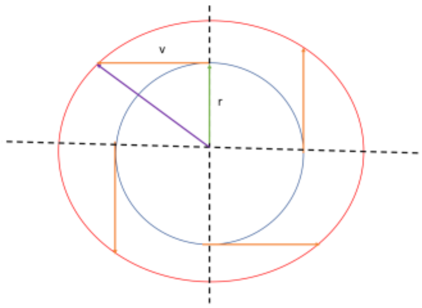
$$a_c = \frac{v^2}{r}$$

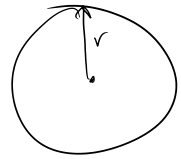
Center – Seeking
Centripetal




$$a_c = \frac{v^2}{r} = \frac{\Delta v}{t} \qquad v = \frac{d}{t}$$

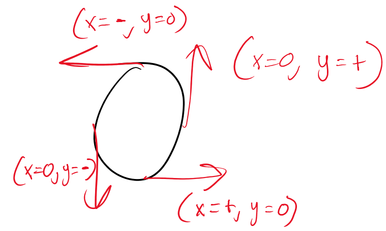
## Another go at my hand-waving derivation




$$d = 2r \cdot \pi$$

$$a_c = \frac{\cancel{\Delta v}\ 2v\pi}{\frac{2r\cdot\pi}{v}} = \boxed{\frac{v^2}{r} = a_c}$$




## We started off with one-dimensional motion

- Position $\vec{x}(t)$
- Velocity $\vec{v}(t) = \frac{\vec{x}(t)}{dt}$
- Acceleration $\vec{a}(t) = \frac{\vec{v}(t)}{dt} = \frac{d^2\vec{x}(t)}{dt^2}$

$\vec{x}(t)$ $\int \vec{v}(t)$

$\vec{v}(t)$ $\int \vec{a}(t)dt$

$\vec{a}(t)$

## Velocity (in one dimension)

- That thing out there moves in time
- When it moves, we can talk about a few different quantities

speed is just magnitude no direction

Average velocity
(positive or negative number)

$$\bar{v} = \frac{\text{displacement}}{\text{time}} = \frac{x_f - x_i}{t_f - t_i}$$

Average speed
(always positive)

$$\frac{\text{Total Distance}}{\text{Total Time}}$$

Velocity
(positive or negative number)

$$\vec{v}(t) = \frac{d\vec{x}(t)}{dt}$$

Speed
(always positive)

$$|\vec{v}(t)|$$

## Welcome Kinematic Equations!

$a(t) = \text{constant } a$

$v(t) = v_0 + at$

$x(t) = x_0 + v_0 t + \frac{1}{2}at^2$

$$v_f^2 - v_i^2 = 2a(x_f - x_i)$$

$\Delta v \quad = \quad \Delta x$

$\Delta v \quad = \quad a \Delta x$ ⟸ need a

$v_f^2 - v_i^2 \quad = 2a\Delta x$

need 2's

$v_f^2 - v_i^2 \quad = 2a(x_f - x_i)$

## Separation of axes

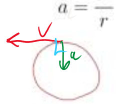
- Because the x and y axes are perpendicular to each other, we can think about the motion in x and y "separately"
- We can think about the path a ball takes through the air, for example, as two separate motions.


t to go up is same as
t to go down.

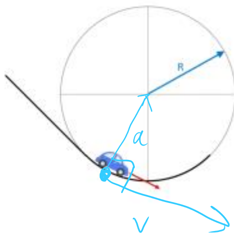
## Circular motion

- Motion in a circle
- For an object on a circular path at velocity v, the acceleration points to the middle of the circle and has a value of:

$$a = \frac{v^2}{r} \qquad \vec{a} \perp \vec{v} \qquad \vec{v} \perp \vec{r}$$

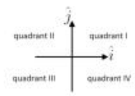


## Circular motion $a = \frac{v^2}{r}$ $\vec{a} \perp \vec{v}$ $\vec{v} \perp \vec{r}$

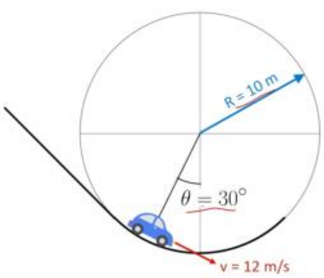



Q1: At the moment shown, in what direction does the acceleration vector point?

A. Towards quadrant I
B. Towards quadrant II
C. Towards quadrant III
D. Towards quadrant IV



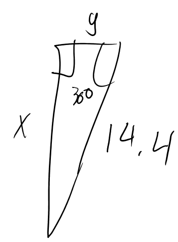

## Circular motion $a = \frac{v^2}{r}$ $\vec{a} \perp \vec{v}$ $\vec{v} \perp \vec{r}$




Q2: At the moment shown, what is the x-component of the acceleration?

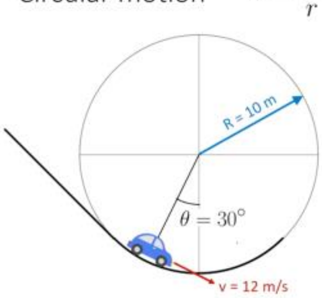
A. between 0 and 5 m/s² .
B. between 5 and 10 m/s² .
C. between 10 and 15 m/s² .
D. between 0 and -5 m/s² .
E. between 0 and -10 m/s² .

$$a = \frac{v^2}{r} = \frac{12^2}{10} = 14.4$$



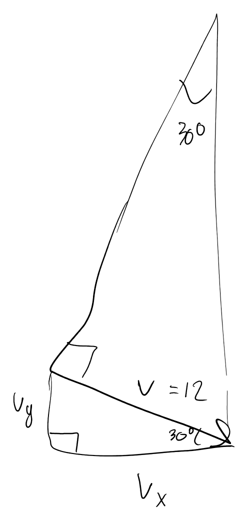

$= 14.4 \sin 30 = \boxed{7.2 \text{ m/s}^2}$

## Circular motion $a = \frac{v^2}{r}$ $\vec{a} \perp \vec{v}$ $\vec{v} \perp \vec{r}$




Q3: At the moment shown, what is the x-component of the velocity?

A. between 0 and 5 m/s .
B. between 5 and 10 m/s .
C. between 10 and 15 m/s .
D. between 0 and -5 m/s .
E. between 0 and -10 m/s .




$12 \cos 30 = \boxed{10.39 \text{ m/s}}$

$= \boxed{10.39\ m/s}$

## Exit Poll

- Please provide a letter grade for todays lecture:

A. A
B. B
C. C
D. D
E. Fail

## Midterm Review – 14 Questions; 14 Hints!

1. Constant velocity is caught up by constant acceleration
2. Draw position, velocity, accelerations
3. Evaluate functions, i.e. if X(t) is given, what is X(4)
4. Average velocity, displacement, speed, distance
5. Write out equations of motions, use points to find constants
6. Dimensional analysis (what units should be in exponents or trig functions?)
7. More displacement and velocity
8. Integrating accelerations
9. Tricky trigonometry? No! ; simple SOH CAH TOA
10. Vectors! in i and j
11. Redoing homework problems can be helpful, especially for 2D motion
12. Really, it can help!
13. Also true for circular motions!
14. Any easy end: Did the old Greek play Chess?