Phys141 – Fri 9/16

- **Today: Chapter 5.1-4**

Administrative:

- Midterm 1: Oct 5
  - Material up to Chapter 8
  - Mix of conceptual questions and quantitative questions
  - Only material covered in class or HW or lab
  - Similar to HW and quizzes and examples given in lecture

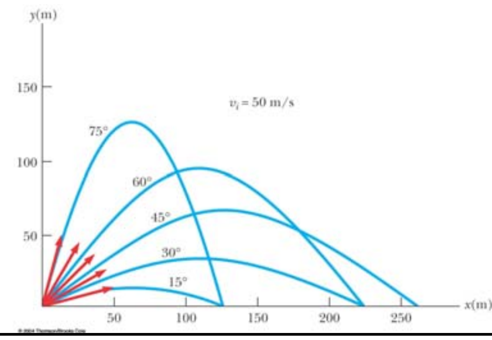
Significant figures: more digits than number of sig figures is o.k. for this class, unless I specifically ask you for significant figures

ToDo

- **Read: Chapter 5.5-8 online quiz, prepare lab2**

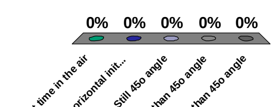
More About Projectiles

Active figure 4.11



How do we shoot a projectile the furthest distance on a downward inclined plane?

1. Longest time in the air
2. fastest horizontal initial speed
3. Still 45^o angle
4. Larger than 45^o angle
5. Smaller than 45^o angle



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Circular Motion – constant speed

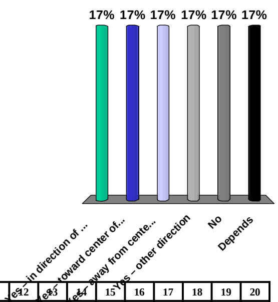
Length of trajectory for one revolution: $2\pi r$

period T: time required for one revolution: $\frac{2\pi r}{v}$

Velocity direction (demo circular motion)

Does an object rotating at constant speed experience acceleration?

1. Yes – in direction of motion
2. Yes – toward center of circle
3. Yes – away from center of circle
4. Yes – other direction
5. No
6. Depends



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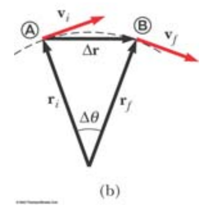
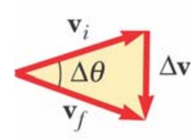
Changing Velocity in Uniform Circular Motion

- The change in the velocity vector is due to the change in direction

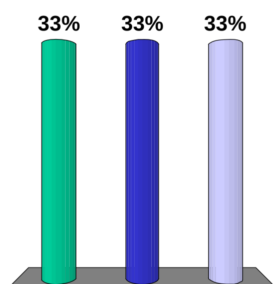


- The vector diagram shows $\Delta \mathbf{v} = \mathbf{v}_f - \mathbf{v}_i$



In the demo, into which bucket will the ball roll?

1. 1
2. 2
3. 3



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Centripetal Acceleration

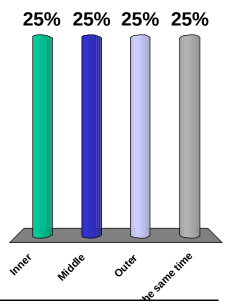
- On circular orbit of radius r, the magnitude of the centripetal acceleration vector is given by

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

- The direction of the centripetal acceleration vector is always changing, to stay directed toward the center of the circle of motion

Assume that the force is proportional to acceleration, which magnet will fall of the rotating disk first (demo)

1. Inner
2. Middle
3. Outer
4. All at the same time



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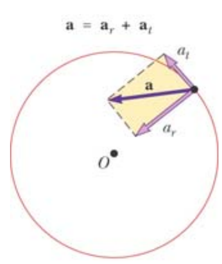
Tangential Acceleration

If the object does not move at constant speed, there is also *tangential acceleration*

Total Acceleration

- Change in object speed: *tangential acceleration*
- Change in direction of velocity vector: *radial acceleration*
- *Total acceleration:* Vector sum of radial and tangential acceleration



(b)

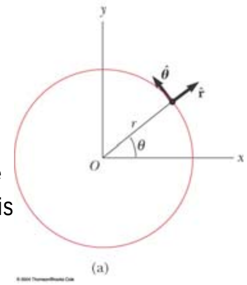
Total Acceleration, equations

- The tangential acceleration: $a_t = \frac{d|\mathbf{v}|}{dt}$
- The radial acceleration: $a_r = -a_C = -\frac{v^2}{r}$
- The total acceleration:
  - Magnitude $a = \sqrt{a_r^2 + a_t^2}$

Total Acceleration, In Terms of Unit Vectors

- Define the following unit vectors
  $\hat{\mathbf{r}}$ and $\hat{\theta}$
  - r lies along the radius vector
  - θ is tangent to the circle
- The total acceleration is

$$\mathbf{a} = \mathbf{a}_t + \mathbf{a}_r = \frac{d|\mathbf{v}|}{dt}\hat{\theta} - \frac{v^2}{r}\hat{\mathbf{r}}$$



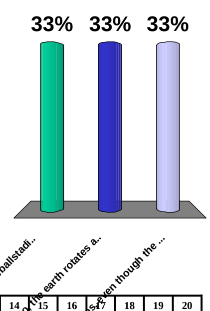
CHAPTER 5: Newton's First Law - *law of inertia*

- An object will resist attempts to change its velocity (objects have *inertia*)
- If an object does not interact with other objects, it has zero acceleration.

<u>Note:</u> To apply this law, use frame of reference that does not accelerate *(inertial reference frame)*

Do the lines in a baseballstadium provide an inertial reference frame?

1. Yes, the baseballstadium does not accelerate
2. No, the earth rotates and so the baseballstadium accelerates
3. Yes, even though the earth rotates we can always ignore such small accelerations due to the earth rotation



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Newton's Second Law

<u>In inertial frame:</u>

Force = Mass * acceleration *<u>or</u>* $acceleration = \frac{Force}{Mass}$

- Need force to accelerate
- Larger Mass, less acceleration for same force (acceleration inversely proportional to Mass)
- Law for an individual object
- More than one force can be applied to one object: Use vector sum of all forces as net force!

$\Sigma\mathbf{F} = m\,\mathbf{a}$

ΣF is vector sum over all forces F -> net force on object

Force

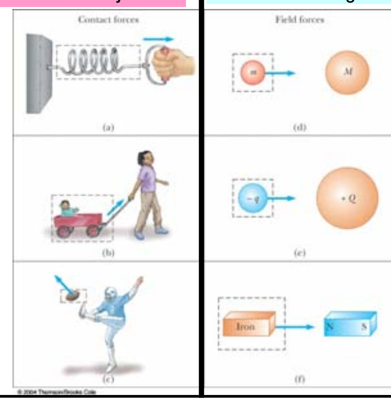
Units of Force?

dimensional analysis of Newton's 2nd law: F=ma $\quad kg\frac{m}{s^2}$

Derived units: Newton (N) $1N = 1\, kg\frac{m}{s^2}$

Contact forces involve physical contact between two objects

Field forces act through empty space – can act over long distance



Gravity

Electrical

Magnetic

Fundamental Forces

- Gravitational force
  - Between two objects
- Electromagnetic forces
  - Between two charges
- Nuclear force
  - Between subatomic particles
- Weak forces
  - Arise in certain radioactive decay processes

Other forces (including all contact forces) are result of fundamental forces

Examples:

Friction force: Caused by complicated sum of electromagnetic forces between many particles in the two surfaces that rub against each other.

Spring force: Result of electromagnetic forces between atoms in the spring

Force a wall exerts on a ball thrown against the wall: Result of electromagnetic forces between atoms in the ball and wall

More About Newton's Second Law

Like any vector equation (see e.g. 2D motion) Newton's Second Law can also be expressed in terms of components:

$\Sigma F_x = m\, a_x$

$\Sigma F_y = m\, a_y$

$\Sigma F_z = m\, a_z$

To Do

- **Chapter 5.5-5.8, and do online quiz**
- **Prepare Lab 2**
- **HW 3 due next week Fri**
- **First midterm Oct 5 (up to chapter 8)**
  - **Only material covered in class or HW or lab**
  - **Similar to HW and quizzes and examples given in lecture**
  - **Mix of conceptual questions and quantitative questions**