

Newton's Laws—21 Sept



Isaac Newton (at 47) by Godfrey Kneller
Trustees of the Portsmouth Estate
www.huntington.org/LibraryDiv/Newton/Newtonexhibit.htm

- Announcement
 - For Friday, read pages from Galileo's *Starry Messenger*. Observations with first telescope.
 - First test: See 9/16
 - Astronomical Horizons Public Talk
 - Prof. Horace Smith
 - Exploding Stars in a Whirlpool and a Pinwheel
 - 7:30pm, Thursday, Sept 22, Abrams Planetarium
 - Newsletter & other talks:
http://www.pa.msu.edu/astro/after_dark/after_dark.pdf
- Outline
 - Do I know what natural motion is?
 - Description of motion. Acceleration.
 - $F=ma$
 - Law of gravity.


What is natural motion?

1. Natural motion is ____
 - A. Motion that requires no explanation.
 - B. Motion for which the path has a simple shape.
 - C. Motion at constant speed.
 - D. Motion in the same direction.

“Natural” motion according to Newton

- Natural motion is motion that needs no explanation: the object naturally moves that way.
 - Aristotle: For heavenly objects, natural motion is motion in a circle with the same speed. For base objects, natural motion is rest.
 - A book falls off the table and comes to rest on the floor. This needs no explanation because rest is the natural state.
 - Newton: Natural motion is moving at the same speed in the same direction.
 - Newton's First Law: In the absence of a force, an object moves at the same speed in the same direction.
2. Venus moves around the sun in a circle at the same speed. Does Newton consider this motion natural?
- a. Yes, Venus is a heavenly object.
 - b. Yes, the speed is the same.
 - c. No, the direction is not always the same.
 - d. No, Venus is not at rest.

Newton's Second Law

- Newton's First Law: In the absence of a force, an object moves at the same speed in the same direction.
- Velocity is the combination of speed and direction of motion
 - Specify speed and direction: I drive 10° north of east at 50mph. 
 - Draw an arrow. Length specifies speed. Direction of arrow indicates direction of velocity.









Change in velocity

- Q The velocity changed in
 - a. Case A only
 - b. Case B only
 - c. Neither cases A nor B
 - d. Both cases A and B
- Case A
 - Velocity at start
 - Velocity after 1 s
- Case B
 - Velocity at start
 - Velocity after 1 s
- Case C
 - Velocity at start
 - Velocity after 1 s
- Case D
 - Velocity at start
 - Velocity after 2 s

Acceleration

1. The velocity changed in
 - a. Case A only
 - b. Case B only
 - c. Neither cases A nor B
 - d. Both cases A and B
 - **Acceleration** is change in velocity divided by amount of time
 - Acceleration is arrow from the tip of the beginning velocity to the tip of the ending velocity divided by time
 2. Draw the acceleration for cases C & D. The length of the acceleration is greatest for which case? A, B, C, or D
- Case A
 - Velocity at start
 - Velocity after 1 s
 - Case B
 - Velocity at start
 - Velocity after 1 s
 - Case C
 - Velocity at start
 - Velocity after 1 s
 - Case D
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Newton's Second Law

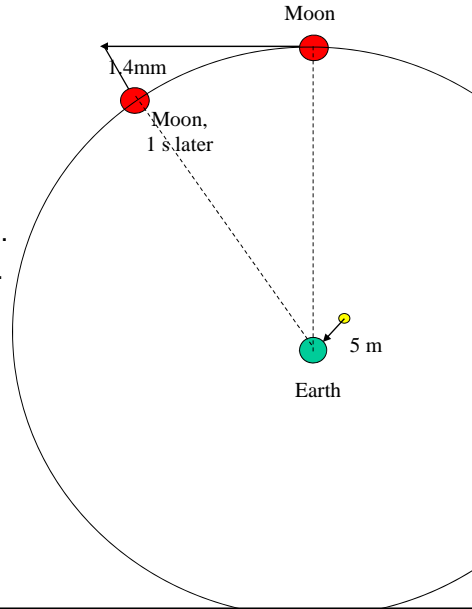
- Newton's Second Law tells how to find the motion if there is a force.
 - *Force = mass x acceleration*
 $F = m \times a$
 - Acceleration is change in velocity divided by amount of time.
- 3. My cat & I are riding in a car. We have seat belts on. I jam on the brakes. ___ is (are) the same for me & my cat.
 - a. Acceleration and force
 - b. Acceleration
 - c. Force
 - d. Neither
- Case A
 - Velocity at start 
 - Velocity after 1 s 
- Case B
 - Velocity at start 
 - Velocity after 1 s 
- Case C
 - Velocity at start 
 - Velocity after 1 s 
- Case D
 - Velocity at start 
 - Velocity after 2 s 

Newton discovers the law of gravity. His realization

- Newton was sitting under an apple tree and looking at the moon. An apple falls on his head. Newton suddenly realizes the moon and the apple fall for the same reason.
- 1. The moon stays up in the sky. What does Newton mean by "the moon falls?"
 - A. The moon is slowing getting closer to earth.
 - B. The moon is straying from its natural motion.
 - C. Newton is mistaken.

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Do all objects fall the same amount?

- Galileo found out experimentally.
 - Drop a lead ball and a wooden ball at the same instant.
 - Lead and wooden balls hit ground at the same time.
1. Is the acceleration greater for the heavier ball?
 - A. Y
 - B. N

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- Interpret using Newton's second law
 - Force of gravity = mass \times acceleration
- 2. Is the force of gravity is proportional to mass?
 - A. Y
 - B. N