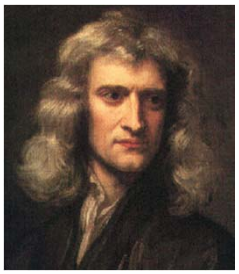
Kepler's Laws, Newton's Laws—19 Sept

- Announcement
  - 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
  - Application of Kepler's Laws
  - Newton: Same laws apply to a falling apple & moving planet.
  - Description of motion



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

Question #1 on Kepler's Laws

- K1: A planet's path is an ellipse with the sun at one focus.
- K2: A planet "sweeps" out the same area in an equal amount of time.
- K3: The planets' periods P and semi-major axes a are related by

  $P^2=a^3$

- A planet, which has an almost circular orbit, and a comet, which has a highly elliptical orbit, have the same periods. Draw their orbits on a single picture.

1. Grading: sun's position
2. Grading: lengths of major axes.

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1. Grading: sun's position
   A. Centered for comet
   B. Offset for comet
2. Grading: lengths of major axes.
   A. Same for both
   B. Different

Question #2 on Kepler's Laws

- A planet's path is an ellipse with the sun at one focus.
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Mar 20, 2004 06:49	186.4 days	
Sept 22, 2004 16:30		179.1days
Mar 20, 2005 12:33		

- Summer is long and winter is short: more precisely, the length of time from the spring equinox to the fall equinox is longer than that from the fall equinox to the spring equinox. Recall that the sun is north of the equator in summer, and its is on the equator on the equinoxes.
- Q: Draw the Earth's orbit so as to account for this.

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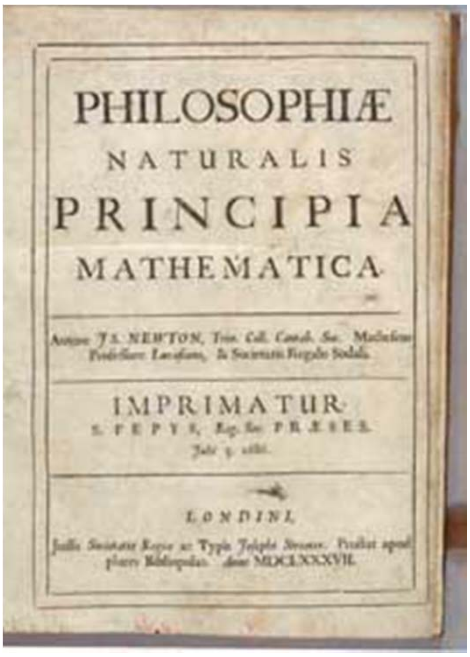
1. Grading. S1: Earth is closest to the sun sometime during Winter in MI. S2: My explanation did not include the orbital speed of Earth.
   A. TT
   B. TF
   C. FT
   D. FF

Newton's Laws of motion

- The discovery of the laws of motion, the first science.
  - *De Revolutionibus Orbium Coelestium*, Copernicus, 1543
  - *Astronomia Nova*, Kepler, 1609
  - *Philosophiae Naturalis Principia Mathematica*, Newton, 1687
- Copernicus
  - What moves. What is stationary.
- Kepler
  - Laws of planetary motion:
- Newton
  - Planets and apples move according to the same laws.
  - Using K's Laws, Newton derived the Law of Gravity. Key check of N's Laws.

Copernicus	1473–1543
Columbus sails	1492
Tycho Brahe	1546–1601
Shakespeare	1564–1616
Johannes Kepler	1571–1630
Jamestown	1607
King James Bible	1611
Harvard College	1636
Isaac Newton	1642–1727
George Washington	1732-1799

- Nature and Nature's laws lay hid in night./ God said, Let Newton be! and all was light. —Newton's epitaph by Alexander Pope


PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA
IMPRIMATUR
LONDINI

"Natural" Motion for Newton & Aristotle

- 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.

1. A book falls off the table and lands on the floor. For Newton, what is natural, needing no further explanation?
   a. The book is on the floor.
   b. The book is halfway to the floor.
   c. The book has fallen 1" from the table.