Galileo Galilei (1564-1642)

I. Show Burke video

II. Introduce
   A. Contemporary of Kepler
   B. Father of Experimental Science
   C. Looked at motion and gravity
   D. Invented the pendulum clock
   E. First to use telescope in astronomy
   F. Invented thermometer
   G. This blew the lid of Aristotle and Ptolemy
   H. Landed Galileo in hot water

III. Motion
   A. Dropped and rolled balls to study motion
      1. No clock existed
      2. Used Pulse
      3. Proposed a pendulum based clock.
         a. The time a pendulum takes to swing back and forth
            depends only on the length of the pendulum arm
         b. Not the weight
         c. Christian Huygens invented it in 1656
         d. John Harrison figured out how to build a pendulum
            clock that would not change period with temperature.
      4. End up using ancient water clock
   B. Found that falling, sliding or rolling objects increase their
      velocities at a constant rate.
      1. The rate depended on the slope of the incline
      2. Friction was a problem
         a. We live in a high friction, low inertia universe.
         b. Hence Aristotle's view that all objects are at rest unless
            acted upon by a force appears correct.
      3. If you use heavy objects and work to minimize friction
         a. falling objects accelerate toward the center of the Earth
            at a constant rate
b. Galileo wrote in Dialogue on Two Great World Systems: “In the accelerated motion, the augmentation of velocity being continual, you cannot divide the values of velocity which continually increase into any determinate number because changing every moment, they are evermore infinite. Therefore, we shall be better able to exemplify our intention by describing a triangle...”
Note: geometric arguments.
c. Also, he makes no assumptions about velocities being able to take on any values.
d. Ultimately establishes that $v = at$ where $a = 9.8m/s^2$
and $x = at^2/2$, where $v$ is a changing velocity, and $t$ is the time the object is falling (starting at $v = 0$).
e. Draw $v$ vs $t$ and show that the area under the curve is $1/2at^2$
C. Galileo described inertia - objects maintain their velocities unless acted on by a force.
D. This directly counters Aristotel!

IV. Telescope
A. Hans Lippershey, Dutch spectacle maker, develops a telescope for looking at distant objects in 1608.
B. Galileo develops his own in 1609
   1. In Science, crucial to be the first to adapt new technology!
   2. 3X magnification
   3. Slide of refracting telescope
   4. Proved it did not distort!
C. Looks at the heavens and sees much new material:
   1. Many more stars
      a. Milky way filled with countless stars
      b. Nebula - smudges of light - such as the Praesepe cluster in Cancer resolve into stars.
   2. 4 moons around Jupiter (slide)
      a. Revolve over days or weeks
      b. So much for Earth at the center of every system
   3. Venus has full phases.
      a. Slide
      b. Ptolemy says impossible - should never have more than 1/2 phase
c. show figure.  
4. Mountains on the moon - figure  
5. Sun Spots  
a. Revolve with a spinning sun every 23 days  
b. Come and go on a monthly basis  

V. Published in “The Sidereal Messenger”  
A. in 1610  
B. only 1 year after developing the telescope  
C. In Latin  

VI. Church Trouble  
A. In 1616, Copernicus’s book was banned as an “odious hypothesis”  
B. Galileo was friends with pope Urban 8 and received permission to discuss his and Copernicus’s ideal in Italian - argued that Italians should not become a backward, ignorant people.  
C. published Dialogue on Two Great World Systems in 1632  
1. Dialogue between 3 characters  
a. Salviatia - brilliant Copernican scientist (Galileo)  
b. Sagred - intelligent but naive questioner  
c. Simlicio - Aristotelian philosopher  
2. Sagred always ends up agreeing with Salviatia and Simlicio ends up looking like a fool.  
D. Hauled up in front of an inquisition court in 1633  
1. Giovani Bruno had been an intellectual who declared the the Universe was infinite and the stars were other suns. He was burned at the stake in 1600.  
2. Galileo was put under house arrest for life  
3. Books banned  
4. Books unbanned in 1835 - 200 years later  
5. Exonerated in 1992 - Pope John Paul wrote  
   In the 17th century theologians failed to distinguish between belief in the Bible and interpretation of it. Galileo contended that the Scriptures cannot err but are often misunderstood. This insight made the scientist a wiser theologian than his Vatican accusers.  

Descartes (1596-1650)  
I. Generation younger than Galileo
II. Philosopher
A. Doubt:
   1. Begins with self doubt
   2. Cannot doubt “doubt”
   3. I doubt therefore I am
   4. Builds a complex and flawed philosophy
B. Mathematician:
   1. Cartesian coordinate system
   2. Illustrate
C. Physicist/Astronomer
   1. Matter is infinitely Divisible because “nature abhors a vacuum”
      a. Matter does not have to have any particular characteristic, color taste, spell
      b. Matter has only size, shape, and position
      c. Space has only size, shape, and position
      d. Hence, Matter and space are the same.
   2. Planets move in a circle for the same reason water in a funnel swirls as it goes down a drain.
      a. Pressure from the Ether force everything into vortices
      b. show figure