2.9 Newton's Laws of Motion

PRE-LECTURE READING 2.9

- *Astronomy Today,* 8th Edition (Chaisson & McMillan)
- *Astronomy Today,* 7th Edition (Chaisson & McMillan)
- *Astronomy Today,* 6th Edition (Chaisson & McMillan)

VIDEO LECTURE

- Newton's Laws of Motion[1] (20:18)

SUPPLEMENTARY NOTES

Isaac Newton (1642-1727)

- See Isaac Newton[2].
- Wrote *Philosophie Naturalis Principia Mathematica* [3] (*The Mathematical Principals of Natural Philosophy*), also known as *Principia* (1687)
- Introduced *physical law*, the idea that all natural phenomena, no matter how complex or diverse, can be explained by a few, underlying, simple laws of nature
    - Physical law should be contrasted with *empirical law*, which is the practice of determining mathematically accurate and useful, but physically vacuous, descriptions of individual phenomena (e.g., Kepler's Laws).
    - For example, Newton was able to explain not only Kepler's Laws, but practically every macroscopic motion on and off of Earth, with Newton's Laws. However, Kepler's Laws only describe, and do not even explain, the motions of planets around stars, moons around planets, etc.
- Introduced *universal law*, the idea that these laws of nature apply everywhere in the universe, not just here on Earth
- Invented calculus (as did Gottfried Leibniz[4], independently)

Newton's First Law (NI)

- See Newton's First Law[5].

[1] http://youtu.be/3HtwKhPcibc
[2] http://en.wikipedia.org/wiki/Isaac_Newton
[3] http://en.wikipedia.org/wiki/Philosophi%C3%A6_Naturalis_Principia_Mathematica
[4] http://en.wikipedia.org/wiki/Gottfried_Leibniz
[5] http://en.wikipedia.org/wiki/Newton's_laws_of_motion

Every body continues in a state of rest or in a state of uniform motion in a straight line unless it is compelled to change that state by a force acting on it.

- Previously, it was thought that the natural state of an object was to return to rest. Newton's insight was that objects only do this because of forces (e.g., friction) acting on them.

Newton's Second Law (NII)

When a force, F, acts on a body of mass, m, it produces in it an acceleration, a, equal to the force divided by the mass. Thus $a = \frac{F}{m}$ or $F = ma$.

- A force is a push or a pull.
- A force acting on an object results in an acceleration (or deceleration) of that object.
- An acceleration (or deceleration) is a change in velocity.

Newton's Third Law (NIII)

To every action there is an equal and opposite reaction.

- Action and reaction mean force.
- You cannot create a force in one direction without simultaneously creating an equal force in the opposite direction.

ASSIGNMENT 2

- Do Question 9.