Fundamental Forces

Unit: Quantum and Particle Physics

MA Curriculum Frameworks (2016): N/A

AP® Physics 2 Learning Objectives: 3.G.3.1

Mastery Objective(s): (Students will be able to…)

- Name, describe, and give relative magnitudes of the four fundamental forces of nature.

Success Criteria:

- Descriptions & explanations are accurate and account for observed behavior.

Language Objectives:

- Explain why the gravitational force is more relevant than the electromagnetic force in astrophysics.

Tier 2 Vocabulary: model, quantum

Notes:

All forces in nature ultimately come from one of the following four forces:

strong force (or "strong nuclear force" or "strong interaction"): an attractive force between quarks. The strong force holds the nuclei of atoms together. The energy comes from converting mass to energy.
Effective range: about the size of the nucleus of an average-size atom.

weak force (or "weak nuclear force" or "weak interaction"): the force that causes protons and/or neutrons in the nucleus to become unstable and leads to beta nuclear decay. This happens because the weak force causes an up or down quark to change its flavor. (This process is described in more detail in the section on the *Standard Model* of Particle Physics, starting on page 570.)
Relative Strength: 10^{-6} to 10^{-7} times the strength of the strong force.
Effective range: about $^1/_3$ the diameter of an average nucleus.

electromagnetic force: the force between electrical charges. If the charges are the same ("like charges")—both positive or both negative—the particles repel each other. If the charges are different ("opposite charges")—one positive and one negative—the particles attract each other.
Relative Strength: about $^1/_{137}$ as strong as the strong force.
Effective range: ∞, but gets smaller as (distance)^2.

gravitational force: the force that causes masses to attract each other. Usually only observable if one of the masses is very large (like a planet).
Relative Strength: only 10^{-39} times as strong as the strong force.
Effective range: ∞, but gets smaller as (distance)^2.

Use this space for summary and/or additional notes: