Earth and Space Science Syllabus

OVERVIEW: Earth and Space Science is an advanced course, which addresses Earth systems, structure and space. Students develop an understanding of the major topics of geology and astronomy including energy in Earth systems, the rock cycle, models and plate tectonics, volcanoes and earthquakes, early history of the universe, planetary geology, stellar evolution, geologic dating and climate change. Through a variety of experiences, students acquire the skills of inquiry, reflection, social implications and apply their understanding of scientific concepts.

Units of Study:

- **Space Systems**
- **The History of the Earth**
- **Earth Systems**
- **Human Sustainability**
- **Weather-time permitting**

Michigan Science Standards Covered:

ESS1.A:

- The star called the sun is changing and will burn out over a life span of approximately 10 billion years.
- The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe.
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
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- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.
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- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved (ccc)

PS1.C

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.
- The total number of neutrons plus protons does not change in any nuclear process.
    - Strong & weak nuclear interactions determine stability & processes
    - Strong forces hold nuclei together & determine nuclear binding energies
    - Fusion in star cores provides the light (energy) release of stars
    - The Big Bang produced mostly hydrogen with some helium & lithium. Over time, stars produced and dispersed the more massive atoms, starting from primordial low-mass elements, mainly hydrogen
    - Fission results in radioactive decay. Alpha (helium nucleus), beta (electrons or positrons), and gamma (photons). All are high energy emitted radiation & cause damage to biological tissue by ionizing atoms
    - Fission involves a weak interaction that can change neutrons into protons or vice versa along with the emission or absorption of electrons or positrons and neutrinos. Isolated neutrons decay by this process.
    - Exponential decay law is followed for spontaneous radioactive decay
    - Radioactive dating is used to determine the ages of rocks & other materials from isotope ratios present
    - Normal stars stop producing light after converting all core material to carbon (iron for massive stars). Elements more massive than iron are formed by fusion only during the extreme conditions of supernova explosions and are therefore relatively rare.

PS3.C:

- Force fields (gravitational, electric, and magnetic) contain energy and can transmit energy across space from one object to another.
- When two objects interacting through a force field change relative position, the energy stored in the force field is changed.
- Each force between the two interacting objects acts in the direction such that motion in that direction would reduce the energy in the force field between the objects. However, prior motion and other forces also affect the actual direction of motion.

PS4.B:

- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.
- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.

PS3.D:

- Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.

- Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy.