# SINGAPORE AMERICAN SCHOOL
# HIGH SCHOOL SCIENCE STANDARDS
# AP PHYSICS B

**EARTH AND SPACE SCIENCES**
**Standard 1:**
- **Understands atmospheric processes and the water cycle.**

**Benchmarks**
- None apply to Standard 1.

**EARTH AND SPACE SCIENCES**
**Standard 2:**
- **Understands earth's composition and structure.**

**Benchmarks**
- None apply to Standard 2.

**EARTH AND SPACE SCIENCE**
**Standard 3:**
- **Understands the composition and structure of the universe and the earth's place in it.**

**Benchmarks**
- None apply to Standard 3

**LIFE SCIENCES**
**Standard 4:**
- **Understands the principles of heredity and related concepts.**

**Benchmarks**
- None apply to Standard 4.

**LIFE SCIENCES**
**Standard 5:**
- **Understands the structure and function of cells and organisms.**

**Benchmarks**
- None apply to Standard 5.

**LIFE SCIENCES**
**Standard 6:**
- **Understands relationships among organisms and their physical environment.**

**Benchmarks**
- None apply to standard 6

**LIFE SCIENCES**
**Standard 7:**
- **Understands biological evolution and the diversity of life.**

**Benchmarks**
- None apply to Standard 7.

**PHYSICAL SCIENCES**
**Standard 8:**
- **Understands the structure and the properties of matter.**

**Benchmarks**
*Students will:*

8.1 Know the structure of an atom;
- Negative electrons occupy most of the space in the atom;
- Neutrons and positive protons make up the nucleus of the atom;
- Protons and neutrons are almost two thousand times heavier than an electron;
- The electric force between the nucleus and electrons holds the atom together.

8.2 Understand how elements are arranged in the periodic table, and how this arrangement shows repeating patterns among elements with similar properties:
- Number of protons, neutrons, and electrons;
- Relation between atomic number and atomic mass.

8.3 Know that the number of electrons in an atom determines whether the atom is electrically neutral or an ion:
- Electrically neutral atoms contain equal numbers of protons and electrons;
- A positively charged atom has lost one or more electrons;

- A negatively charged atom has gained one or more electrons.

8.4 Know that most elements have two or more isotopes (i.e., atoms that differ in the number of neutrons in the nucleus); although the number of neutrons has little effect on how the atom interacts with others, it does affect the mass and stability of the nucleus;

8.5 Know how radioactive isotopes can be used to estimate the age of materials that contain them because radioactive isotopes undergo spontaneous nuclear reactions and emit particles and/or wavelike radiation; the decay of any one nucleus cannot be predicted, but a large group of identical nuclei decay at a predictable rate, which can be used to estimate the material's age.

**Performance Examples**

*Examples of activities in which students might demonstrate the above include:*

- Laboratory simulation radioactive decay and half-life using M&Ms;
- Computer simulations of energy levels of an atom;
- View video program "Mechanical Universe" on properties of the atom;
- Demonstration on electrically charging an object via conduction versus charging via induction.

**PHYSICAL SCIENCES**
**Standard 9:**
- **Understands the sources and properties of energy.**

**Benchmarks**

*Students will:*

9.1 Understand the concept of entropy:
- Although the total energy of the universe remains constant, matter tends to become steadily less ordered as various energy transfers occur;
- The energy tends to spread out uniformly, thereby decreasing the amount of useful energy.

9.2 Know that all energy can be considered to be either:
- Kinetic energy (energy of motion);
- Potential energy (depends on relative position);
- Energy contained by a field (electromagnetic waves).

9.3 Understand the relationship between heat and temperature:
- Heat energy consists of the random motion and vibrations of atoms, molecules, and ions;
- The higher the temperature, the greater the atomic or molecular motion.

9.4 Know how the energy associated with individual atoms and molecules can be used to identify the substances they comprise;
- Each kind of atom or molecule can gain or lose energy only in particular discrete amounts, and thus can absorb and emit light only at wavelengths corresponding to these amounts;

9.5 Know that nuclear reactions convert a fraction of the mass of interacting particles into energy (fission involves the splitting of a large nucleus into smaller pieces; fusion is the joining of two nuclei at extremely high temperature and pressure) and release much greater amounts of energy than atomic interactions;

*9.6* Know that waves (eg: sound, seismic, water, light) have energy and can transfer energy when they interact with matter;

*9.7* Know the range of the electromagnetic spectrum:
- Radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, x-rays, gamma rays;
- Electromagnetic waves result when a charged object is accelerated or decelerated;
- The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.

**Performance Examples**

Examples of activities in which students might demonstrate the above include:

- Demonstration of the "Faraday cage" effect;
- Computer simulations of energy levels of an atom;
- Laboratory investigation of the photoelectric effect;
- Laboratory investigation regarding the emission spectrum of atoms;
- Web-based simulations of Bremsstrahlung radiation;
- Laboratory investigation regarding the potential energy stored in a spring;

- Laboratory investigation regarding "heat" transfer: calorimetry;
- Demonstration of the increase in thermal energy as work is done on falling lead or a stretching rubber band.

**PHYSICAL SCIENCES**
**Standard 10:**
- **Understands forces and motion.**

**Benchmarks**
*Students will:*

10.1 Know that magnetic forces are very closely related to electric forces and can be thought of as different aspects of a single electromagnetic force:
- Moving electric charges produce magnetic forces and moving magnets produce electric forces;
- The interplay of these forces is the basis for electric motors, generators, radio, television, and many other modern technologies.

10.2 Know that nuclear forces are much stronger than electromagnetic forces, which are vastly stronger than gravitational forces; the strength of nuclear forces explains why great amounts of energy are released from the nuclear reactions in atomic or hydrogen bombs, and in the sun and other stars;

10.3 Know that the strength of the gravitational force between two masses is proportional to the masses and inversely proportional to the square of the distance between them;

10.4 Know that the strength of the electric force between two charged objects is proportional to the charges (opposite charges attract whereas like charges repel) and, as with gravitation, inversely proportional to the square of the distance between them;

10.5 Know that electromagnetic forces exist within and between atoms:
- Electric forces between oppositely charged electrons and protons hold atoms and molecules together, and are involved in all chemical reactions;
- Electric forces hold solid and liquid materials together and act between objects when they are in contact.

10.6 Know how different kinds of materials respond to electric forces:
- As insulators, semiconductors, conductors, superconductors.

10.7 Know that materials that contain equal proportions of positive and negative charges are electrically neutral, but a very small excess or deficit of negative charges in a material produces noticeable electric forces;

10.8 Know that laws of motion can be used to determine the effects of forces on the motion of objects:
- Objects change their motion only when a net force is applied;
- Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object; the magnitude of the change in motion can be calculated using the relationship F=ma, which is independent of the nature of the force.

10.9 Know that apparent changes in wavelength can provide information about changes in motion because the observed wavelength of a wave depends upon the relative motion of the source and the observer; if either the source or observer is moving toward the other, the observed wavelength is shorter; if either is moving away, the wavelength is longer.

**Performance Examples**
*Examples of activities in which students might demonstrate the above include:*
- Laboratory investigation of Newton's 2nd Law;
- Laboratory investigation of frictional forces;
- Project requiring the construction of a simple electric motor;
- Computer simulation using then software Interactive Physics software to design virtual solar systems;
- Use web-based simulations of the Doppler effect;
- View the video Mechanical Universe on the Doppler effect;
- Use Bernoulli's Principle to determine fluid velocity in straws;
- Laboratory investigation of a ballistic pendulum;
- Laboratory investigation measuring Earth's magnetic field;
- Demonstration of Lenz' Law.

**NATURE OF SCIENCE**
**Standard 11:**
- **Understands the nature of scientific knowledge.**

**Benchmarks**
- None apply to Standard 11.

**NATURE OF SCIENCE**
**Standard 12:**
- **Understands the nature of scientific inquiry.**

**Benchmarks**
*Students will:*

12.1 Understand the use of hypotheses in science:
- Selecting and narrowing the focus of data;
- Determining additional data to be gathered;
- Guiding the interpretation of data.

12.2 Design and conduct scientific investigations:
- Formulate testable hypotheses;
- Identify and clarify the method, controls, and variables;
- Organizes, display, and analyze data;
- Revise methods and explanations;
- Present results;
- Receive critical response from others.

12.3 Use technology (eg: hand tools, measuring instruments, calculators, computers) and mathematics (eg: measurement, formulas, charts, graphs) to perform accurate scientific investigations and communications.

**Performance Examples**
*Examples of activities in which students might demonstrate the above include:*
- Use PASCO probes interfaced with a laptop to gather data;
- Use software Graphical Analysis to plot an analyze data;
- Design laboratory investigation to determine the period of a physical pendulum.

**NATURE OF SCIENCE**
**Standard 13:**
- **Understands the scientific enterprise.**

**Benchmarks**
- None apply to Standard 13.