Minneapolis Public Schools
Physics – Grades 11-12
STANDARDS AND BENCHMARKS ADDRESSED

KEY TO THE FOLLOWING STANDARDS FORMAT:

- *Italics indicates language added to the state standards by Minneapolis teachers.*
- **Bold words indicate "Power Benchmarks" that should be addressed in detail.**
- The other benchmarks are to be addressed when possible but as time permits.

II. PHYSICAL SCIENCE

C. ENERGY TRANSFORMATIONS

The student will understand energy forms, transformations and transfers.

State Benchmarks:

1. The student will know that potential energy is stored energy and is associated with gravitational or electrical force, mechanical position or chemical composition.

2. ***The student will describe and explain the exchange between potential energy, kinetic energy, and internal energy for simple mechanical systems, such as a pendulum, a roller coaster, a spring, or a freely falling object.***

3. The student will differentiate between kinetic and potential energy and identify situations where kinetic energy is converted into potential energy and vice versa.

4. *The student will observe and explain energy conversions in real-world situations.*

5. *The student will predict velocities, heights, and spring compression based on energy conservation.*

6. **The student will differentiate between AC and DC current**.

7. *The student will explain how AC and DC are produced.*

8. *The student will explain the benefits of AC compared to DC, and DC compared to AC.*

9. **The student will describe *magnetism and* the production, storage and transmission of electricity.**

10. *The student will measure current and voltage in a circuit.*

11. *The student will use measurements to determine the resistance of a circuit element.*

12. *The student will measure and compare the resistance of conductors of various lengths and cross-sectional areas.*

13. ***The student will differentiate between simple series and parallel circuits.***

14. The student will draw and interpret circuit diagrams which include voltmeters and ammeters.

15. The student will use Ohm's Law to analyze circuits.

16. The student will describe applications of the different wavelengths of the electromagnetic spectrum.

17. *The student will compare the characteristics and interactions of waves.*

18. The student will identify nodes and antinodes in standing waves.

19. The student will differentiate between transverse and longitudinal waves.

20. The student will predict the superposition of two waves interfering constructively and destructively (indicating nodes, antinodes, and standing waves).

21. The student will describe energy, work and power both conceptually and quantitatively.

22. The student will be able to determine the power of a circuit, appliance, or system.

23. The student will determine the work in a mechanical system.

24. The student will calculate the mechanical advantage of a simple or compound machine.

D. Motion

The student will understand the nature of force and motion.

State Benchmarks:

1. **The student will *describe motion and* use Newton's three laws of motion to qualitatively and quantitatively describe the interaction of objects.**

2. *The student will construct and interpret graphs of position, velocity, or acceleration versus time.*

3. *The student will determine and interpret slopes and areas of motion graphs.*

4. ***The student will determine the resultant of two or more vectors graphically and/or algebraically.***

5. *The student will draw scaled force diagram using ruler and protractor.*

6. *The student will resolve a vector into perpendicular components: both graphically and/or algebraically.*

7. *The student will sketch the theoretical path of a projectile.*

8. *The student will use vector diagrams to analyze mechanical systems (equilibrium and nonequilibrium).*

9. *The student will verify Newton's Second Law for linear motion.*

10. *The student will verify Newton's Second Law for uniform circular motion.*

11. *The student will verify conservation of momentum.*

12. The student will describe the effect of friction and*/or* gravity on the motion of an object.

13. The student will determine the acceleration due to gravity near the surface of the Earth.

14. The student will determine the coefficient of friction for two surfaces.

15. The student will predict speed, distance, and acceleration of an object in free-fall.

16. *The student will explain the concept of terminal velocity.*

E. FORCES OF NATURE

The student will understand the forces of nature and their application.

State Benchmarks:

1. The student will recognize the factors that affect the presence and magnitude of gravitational, electromagnetic, weak and strong nuclear forces.

2. *The student will use the inverse square law to determine the magnitude of electric and gravitational forces.*

3. *The student will map the magnetic field of a permanent magnet, indicating the direction of the field between the N (north-seeking) and S (south-seeking) poles.*

4. *The student will use the Universal Law of Gravitation and Coulomb's Law to solve problems.*

5. **The student will identify *and explain* the dominant force or forces in a variety of interactions.**

III. EARTH AND SPACE SCIENCE

C (I). THE UNIVERSE

The student will relate the formation and components of our solar system to the conditions necessary for life.

State Benchmarks:

1. **The student will explain *and compare two or more models describing* how the Sun, Earth and solar system formed.**
2. *The student will compare two or more models that explain the formation of the solar system.*
3. **The student will compare *and contrast* the characteristics of Earth with the characteristics and movement patterns of the other planets, their satellites and other objects in our solar system.**
4. *The student will model the solar system.*
5. *The student will use Kepler's Law in describing a celestial motion.*
6. *The student will use Newton's Universal Law of Gravity, and Newton's Laws of Motion to explain celestial motion.*

C (II). THE UNIVERSE

The student will use astronomical data to reveal the structure, scale, and changes in the stars, galaxies and universe over time

State Benchmarks:

1. **The student will identify different types of stars and galaxies and describe how stars, galaxies and the universe change over time.**
2. *The student will differentiate between stars, planets, moons, constellations and galaxies.*
3. *The student will explain the life cycle of a star.*
4. *The student will explain the features of the H-R diagram.*
5. **The student will describe the evidence from current technologies that has been used to understand the composition and the early history of the universe.**
6. *The student will explain how atomic spectra can be used to deduce chemical and physical data for stars.*
7. *The student will compare and contrast theories of the origin of the universe, using supporting evidence.*
8. The student will explain how Doppler evidence indicates our universe is expanding in all directions.

I. HISTORY AND NATURE OF SCIENCE

A. SCIENTIFIC WORLD VIEW

The student will understand the ways of scientific thinking and that scientific knowledge changes and accumulates over time.

State Benchmarks:

1. **The student will be able to distinguish among hypothesis, theory and law as scientific terms and how they are used to answer a specific question.**

   Content Clarification (from the state TEST SPECS)
   - Items will addrerss students' understandings of the terms and where they are in the scheme of a specific investigation
   - A **fact** is defined as an observation that has been repeatedly confirmed. (National Academy of Sciences, *Teaching About Evolution and the Nature of Science,* [National Academy Press, 1998], 5.
   - A **law** is defined as a descriptive generalization about how some aspect of the natural world behaves under stated circumstances. (*Ibid.)*
   - A **hypothesis** is defined as a testable statement about the natural world that can be used to build more complex inferences and explanations, (*Ibid.)*
   - A **theory** is defined as a well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses. *(Ibid.)*

2. **The student will be able to explain how scientific and technological innovations as well as new evidence can challenge portions of or entire accepted theories and models including but not limited to cell theory, atomic theory, theory of evolution, plate tectonic theory, germ theory of disease and big bang theory.**

3. **The student will recognize that in order to be valid, scientific knowledge must meet certain criteria including that it: be consistent with experimental, observational and inferential evidence about nature; follow rules of logic and reporting both methods and procedures; and, be falsifiable and open to criticism.**

   Content clarification:
   - Items will address theories, models and the validity of scientific knowledge in the context of life science content.
   - "Criticism" is defined as peer review.
   - "Falsifiable" is defined as the ability to determine the relevant null hypothesis for a given hypothesis, with the goal of determining whether to reject the null hypothesis; items may address this concept or provide examples, but will NOT require students to determine the null hypothesis and will NOT use this term.

4. The student will explain how traditions of ethics, peer review, conflict and general consensus influences the conduct of science.

5. The student will recognize that some scientific ideas are incomplete, and opportunity exists in these areas for new advances.

B. SCIENTIFIC INQUIRY

The student will design and conduct a scientific investigation.

State Benchmarks:

1. **The student will design and complete a scientific experiment using scientific methods by determining a testable question, making a hypothesis, designing a scientific investigation with appropriate controls, analyzing data, making conclusions based on evidence and comparing conclusions to the original hypothesis and prior knowledge.**

2. **The student will distinguish between qualitative and quantitative data.**

3. **The student will apply mathematics and models to analyze data and support conclusions.**

4. **The student will identify possible sources of error and their effects on results.**

5. The student will know that professional scientists and engineers have ethical codes.

6. The student will give examples of how different domains of science use different bodies of scientific knowledge and employ different methods to investigate questions.

C. SCIENTIFIC ENTERPRISE

The student will understand the relationship between science and technology and how both are used.

State benchmarks:

1. The student will compare and contrast the purposes and career opportunities of engineering, technology and science.

2. The student will provide an example of a need or problem identified by science and solved by engineering or technology.

3. The student will provide an example of how technology facilitates new discoveries and the development of scientific knowledge.

4. The student will know that technological changes and scientific advances are often accompanied by social, political, environmental and economic changes.

5. The student will recognize that science and technology are influenced by cultural backgrounds and beliefs and by social needs, attitudes, values and limitations.

D. HISTORIC PERSPECTIVES

The student will recognize the historical and cultural context of scientific endeavors and how they influence each other.

State Benchmarks:

1. The student will be able to trace the development of a scientific advancement, invention or theory and its impact on society.

2. The student will provide examples of scientific advancements contributed by other civilizations and cultures.

3. The student will compare and contrast the differences between scientific theories and theories from other bodies of knowledge, and the importance of each in a science discussion.