INSPIRED STANDARDS MATCH FOR FLORIDA

Sunshine State Standards: Science

Meeting curriculum standards is a major focus in education today. This document highlights the correlation of Inspiration® with the Florida Sunshine State Standards: Science.

The Inspired Standards Match is designed to demonstrate the many ways Inspiration supports the standards and to give educators ideas for using this tool to meet learning goals across the curriculum.

How to read the Inspired Standards Match:

- Pink highlight indicates a standard or objective that is supported by the use of Inspiration
- Green note annotation includes names of an Inspiration template that corresponds to the highlighted standard. These templates are part of the software program and act as starters or frameworks for student work.

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Sunshine State Standards
Grade Level Expectations
Science

Introduction

Development of Grade Level Expectations

Sunshine State Standards

The Sunshine State Standards are the centerpiece of a reform effort in Florida to align curriculum, instruction and assessment. They identify what students should know and be able to do to for 21st century and are thus both content standards and performance standards. The standards are benchmarked at the developmental levels of PreK-2, 3-5, 6-8, 9-12 for the subjects of language arts, mathematics, science, social studies, the arts, health and physical education, and foreign languages. School districts are required to incorporate provisions for instruction of the Sunshine State Standards into their Pupil Progression.

Tools for Implementing the Sunshine State Standards

Implementation of the Sunshine State Standards is both state and locally guided. Districts and schools have the responsibility of designing instruction to teach the state standards. To assist them, the Department of Education has developed a number of implementation tools.

- *Florida Curriculum Frameworks* present the content standards with sample performance descriptions and correlations to Florida Education Goal 3's SCANS-like process standards as well as overviews of best practices in instruction, curriculum development, interdisciplinary instruction, classroom assessment, and program improvement. The frameworks have been distributed to every district, school, college of education, universities, teacher-preparation institutions, community colleges and others in print and on CD-ROM. A new curriculum framework for the elementary program addressing all subjects was distributed in early 1999.
- Selected state course descriptions for grades 6-12 incorporate the standards.
- The Curriculum Planning Tools, software for writing learning activities correlated to the standards have been distributed
- A multimedia best practices series on CD-ROM is under development.
- A number of training programs are available which address awareness of the standards initiative; local curriculum development; improving instruction; connections between curriculum, instruction and assessment; authentic assessment tools; assessing students with disabilities.

- Publishers are now required to correlate instructional materials submitted for state adoption to the standards.

Most of these products are accessible on the Internet at the DOE home page: *www.firn.edu.doe.*

The new High Quality Education initiative stresses accountability for student achievement at each grade. The original Sunshine State Standards were structured to be benchmarked at grade clusters. This was done to provide flexibility to districts in designing curriculum based on local needs. However, a number of things have resulted in the state's decision to produce statewide grade level expectations. These include:

- the expanding national trend toward standards-based reform and accountability;
- section 232.245, Florida Statutes, (SB1956) which mandates each district develop expectations and assessments in reading, writing, and mathematics at each grade;
- concern for fully addressing low-achieving students' needs;
- the widely expressed need for providing teachers at each grade more precise information about what is expected of their students and of them;
- the plan to develop an expanded state assessment program that tests at grades 3-10.

As a result, Commissioner of Education Tom Gallagher charged the Curriculum Services Section in the Bureau of Curriculum, Instruction and Assessment to develop expectations for student achievement for each grade K-8. These Grade Level Expectations are based on the Sunshine State Standards and are organized by the Benchmarks. They have been developed in the subjects of language arts, mathematics, science and social studies.

In January 1999, committees of Florida educators met in Tallahassee to develop first drafts of the Grade Level Expectations based on work already done by Florida school districts and other states. During February and March, the Area Centers for Educational Enhancement (ACEEs) organized reviews of these drafts by focus groups that were representative of education stakeholders. In addition, district subject-area specialists, selected university faculty and other experts were sent copies to review. The Mid-Continent Regional Education Laboratory (McREL), nationally known as an expert in standards for education, also analyzed and made recommendations on the drafts before they were finalized by the Department of Education.

These Grade Level Expectations are recommended, not mandated, by the state, but they will eventually become the basis for state assessments at each grade 3-10 in reading and mathematics. Districts that have already developed grade level expectations may continue to use them, but should ensure they correlate to the new state Grade Level Expectations.

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The following guidelines were used to develop and review the drafts of the Grade Level Expectations.

General Guidelines

The Grade Level Expectations statements will

1. be based on current, accepted, and essential academic knowledge;
2. balance the mastery of important facts, ideas, and key terms with essential intellectual and practical skills that address present and future real-life needs of students;
3. require academic rigor of all students;
4. address the diversity of Florida's growing population as well as the international communities that make up the global society and economy;
5. reflect current and accepted instructional practices that address how students best learn;
6. be understandable by all education stakeholders;
7. provide the basis for further local curriculum development;
8. provide the basis for state, district, school, teacher and student accountability.

Specific Guidelines

The Grade Level Expectations statements will

1. be new or more specific statements, when appropriate, of what students need to know and be able to do at each grade level to achieve the grade-cluster benchmark and ultimately the exit standard; this requires that specific incremental prerequisite skills be assigned to benchmarks to various grades; in some cases, however, when a benchmark is addressed at only one grade in a grade cluster, the benchmark may be incorporated as is into the Grade Level Expectation;
2. be written at levels appropriate to student developmental abilities at the specified grades;
3. provide, if appropriate, more specificity and/or focus on smaller clusters of content than the benchmarks.

Using the Grade Level Expectations

The Sunshine State Standards provide direction for student learning of science content and processes. The Sunshine State Standards are divided into eight strands categorizing broad areas of knowledge within science. This division does not mean that learning should be fragmented. The science strands and expectations are interdependent. In fact, several expectations might often be combined in a single teaching or assessment activity. Further, when used effectively, instructional activities will include grade level expectations from other science strands and from other subjects. Research indicates that learning is most effective when new information is related to previous knowledge and has some immediate application in the life of the learner.

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The Grade Level Expectations are not intended to take the place of a curriculum guide, but rather to serve as the basis for curriculum development to ensure that the curriculum is rich in content and is delivered through effective instructional activities. The Grade Level Expectations are in no way intended to limit learning, but rather to ensure that all students across the state receive a good educational foundation that will prepare them for a productive life. Districts, schools, teachers, and students are encouraged to extend the content and achievement expected as they feel it is appropriate.

In middle school, districts are required to offer courses as listed in the Course Code Directory. In science, districts have the choice of offering discipline specific courses (MJ Earth Space Science, MJ Life Science, MJ Physical Science) or a spiraling comprehensive set of courses (MJ Comprehensive Science 1, 2, 3). The grade level expectations may be different in each scenario. However, no matter which approach is taken, students should have the opportunity to achieve all science benchmarks for grades 6-8 by the end of the eighth grade.

Several approaches for wording and formatting are found in the Grade Level Expectations.

Concepts that are important for students to know and use at each grade are repeated at more than one grade. In some such cases, the repeated expectations are differentiated by higher level applications or by different examples as the student progresses through the grades. In other cases the expectations are stated in the same language. In all cases, it is expected that students will be achieving the grade expectation using materials and tasks appropriate to that grade. The district, school, or classroom teacher must make decisions as to which instructional materials and activities and which tasks to assess achievement of the expectations are appropriate.

Some expectations may appear to require students to know a broad expanse of knowledge about a topic. Such expectations do not require second graders to know all things about the topic. The district or school must choose curriculum materials or the teacher would need to select for study some things that would contribute to the student's understanding of the topic. Instruction at each grade should do its part to prepare students to achieve the more general expectations for students at the end of twelfth grade that comprise the standards.

Higher order thinking terms like *understands* or *knows* are used unless more specific demonstrations of behavior, such as *applies*, are more appropriate. Assessment developers, whether at the state, district or classroom level, need to identify specific behavior required by each assessment item, but at the Sunshine State Standards level, the terms *understanding* and *knowing* are the primary terms for expectations.

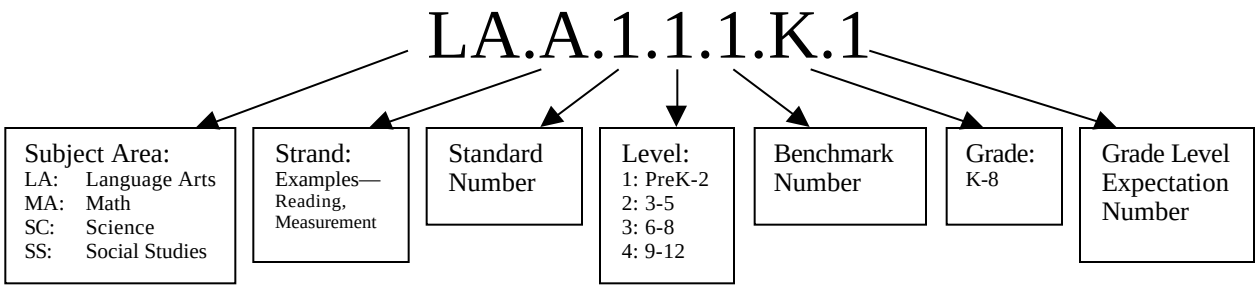
As you examine these expectations for each grade that were derived from the benchmarks, please work to find as many ways as possible to integrate and implement the expectations into the

curriculum. It may be necessary to modify existing curriculum. Please give attention to the research on teaching and learning and to your students and their needs to provide the most effective classroom instruction.

Short lists of content examples are included in many of the grade level expectations. These are included to provide guidance to teachers and curriculum developers and are not meant to define or limit instruction.

Numbering System for the Grade Level Expectations

For easy reference, each Grade Level Expectation has been assigned a unique identification code. The numbering system used builds upon the already existing numbering system for the strands, standards, and benchmarks that make up the Sunshine State Standards.



Example: LA.A.1.1.1.K.1 The student uses titles and illustrations to make oral predictions.

Science

Grades 6-8

The Nature of Matter

Standard 1:

The student understands that all matter has observable, measurable properties. (SC.A.1.3)

1. identifies various ways in which substances differ (e.g., mass, volume, shape, density, texture, and reaction to temperature and light).
2. understands the difference between weight and mass.
3. knows that temperature measures the average energy of motion of the particles that make up the substance.
4. knows that atoms in solids are close together and do not move around easily; in liquids, atoms tend to move farther apart; in gas, atoms are quite far apart and move around freely.
5. knows the difference between a physical change in a substance (i.e., altering the shape, form, volume, or density) and a chemical change (i.e., producing new substances with different characteristics).
6. knows that equal volumes of different substances may have different masses.

Standard 2:

The student understands the basic principles of atomic theory. (SC.A.2.3)

1. describes and compares the properties of particles and waves.
2. knows the general properties of the atom (a massive nucleus of neutral neutrons and positive protons surrounded by a cloud of negative electrons) and accepts that single atoms are not visible.
3. knows that radiation, light, and heat are forms of energy used to cook food, treat diseases, and provide energy.

Energy

Standard 1:

The student recognizes that energy may be changed in form with varying efficiency. (SC.B.1.3)

1. identifies forms of energy and explains that they can be measured and compared.
2. knows that energy cannot be created or destroyed, but only changed from one form to another.
3. knows the various forms in which energy comes to Earth from the sun (e.g., visible light, infrared, and microwave).
4. knows that energy conversions are never 100% efficient (i.e., some energy is transformed to heat and is unavailable for further useful work).
5. knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature.
6. knows the properties of waves (e.g., frequency, wavelength, and amplitude); that each wave consists of a number of crests and troughs; and the effects of different media on waves.

Standard 2:

The student understands the interaction of matter and energy. (SC.B.2.3)

1. knows that most events in the universe (e.g., weather changes, moving cars, and the transfer of a nervous impulse in the human body) involve some form of energy transfer and that these changes almost always increase the total disorder of the system and its surroundings, reducing the amount of useful energy.
2. knows that most of the energy used today is derived from burning stored energy collected by organisms millions of years ago (i.e., nonrenewable fossil fuels).

Force and Motion

Standard 1:

The student understands that types of motion may be described, measured, and predicted. (SC.C.1.3)

1. knows that the motion of an object can be described by its position, direction of motion, and speed.
2. knows that vibrations in materials set up wave disturbances that spread away from the source (e.g., sound and earthquake waves).

Standard 2:

The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted. (SC.C.2.3)

1. knows that many forces (e.g., gravitational, electrical, and magnetic) act at a distance (i.e., without contact).
2. knows common contact forces.
3. knows that if more than one force acts on an object, then the forces can reinforce or cancel each other, depending on their direction and magnitude.
4. knows that simple machines can be used to change the direction or size of a force.
5. understands that an object in motion will continue at a constant speed and in a straight line until acted upon by a force and that an object at rest will remain at rest until acted upon by a force.
6. explains and shows the ways in which a net force (i.e., the sum of all acting forces) can act on an object (e.g., speeding up an object traveling in the same direction as the net force, slowing down an object traveling in the direction opposite of the net force).
7. knows that gravity is a universal force that every mass exerts on every other mass.

Processes that Shape the Earth

Standard 1:

The student recognizes that processes in the lithosphere, atmosphere, hydrosphere, and biosphere interact to shape the Earth. (SC.D.1.3)

1. knows that mechanical and chemical activities shape and reshape the Earth's land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers.
2. knows that over the whole Earth, organisms are growing, dying, and decaying as new organisms are produced by the old ones.
3. knows how conditions that exist in one system influence the conditions that exist in other systems.
4. knows the ways in which plants and animals reshape the landscape (e.g., bacteria, fungi, worms, rodents, and other organisms add organic matter to the soil, increasing soil fertility, encouraging plant growth, and strengthening resistance to erosion).
5. understands concepts of time and size relating to the interaction of Earth's processes (e.g., lightning striking in a split second as opposed to the shifting of the Earth's plates altering the landscape, distance between atoms measured in Angstrom units as opposed to distance between stars measured in light-years).

Standard 2:

The student understands the need for protection of the natural systems on Earth. (SC.D.2.3)

1. understands that quality of life is relevant to personal experience.
2. knows the positive and negative consequences of human action on the Earth's systems.

Earth and Space

Standard 1:

The student understands the interaction and organization in the Solar System and the universe and how this affects life on Earth. (SC.E.1.3)

1. understands the vast size of our Solar System and the relationship of the planets and their satellites.
2. knows that available data from various satellite probes show the similarities and differences among planets and their moons in the Solar System.
3. understands that our sun is one of many stars in our galaxy.
4. knows that stars appear to be made of similar chemical elements, although they differ in age, size, temperature, and distance.

Standard 2:

The student recognizes the vastness of the universe and the Earth's place in it. (SC.E.2.3)

1. knows that thousands of other galaxies appear to have the same elements, forces, and forms of energy found in our Solar System.

Processes of Life

Standard 1:

The student describes patterns of structure and function in living things. (SC.F.1.3)

1. understands that living things are composed of major systems that function in reproduction, growth, maintenance, and regulation.
2. knows that the structural basis of most organisms is the cell and most organisms are single cells, while some, including humans, are multicellular.
3. knows that in multicellular organisms cells grow and divide to make more cells in order to form and repair various organs and tissues.

4. knows that the levels of structural organization for function in living things include cells, tissues, organs, systems, and organisms.
5. explains how the life functions of organisms are related to what occurs within the cell.
6. knows that the cells with similar functions have similar structures, whereas those with different structures have different functions.
7. knows that behavior is a response to the environment and influences growth, development, maintenance, and reproduction.

Standard 2:

The student understands the process and importance of genetic diversity. (SC.F.2.3)

1. knows the patterns and advantages of sexual and asexual reproduction in plants and animals.
2. knows that the variation in each species is due to the exchange and interaction of genetic information as it is passed from parent to offspring.
3. knows that generally organisms in a population live long enough to reproduce because they have survival characteristics.
4. knows that the fossil record provides evidence that changes in the kinds of plants and animals in the environment have been occurring over time.

How Living Things Interact with Their Environment

Standard 1:

The student understands the competitive, interdependent, cyclic nature of living things in the environment. (SC.G.1.3)

1. knows that viruses depend on other living things.
2. knows that biological adaptations include changes in structures, behaviors, or physiology that enhance reproductive success in a particular environment.
3. understands that the classification of living things is based on a given set of criteria and is a tool for understanding biodiversity and interrelationships.
4. knows that the interactions of organisms with each other and with the nonliving parts of their environments result in the flow of energy and the cycling of matter throughout the system.
5. knows that life is maintained by a continuous input of energy from the sun and by the recycling of the atoms that make up the molecules of living organisms.

Standard 2:

The student understands the consequences of using limited natural resources. (SC.G.2.3)

1. knows that some resources are renewable and others are nonrenewable.
2. knows that all biotic and abiotic factors are interrelated and that if one factor is changed or removed, it impacts the availability of other resources within the system.
3. knows that a brief change in the limited resources of an ecosystem may alter the size of a population or the average size of individual organisms and that long-term change may result in the elimination of animal and plant populations inhabiting the Earth.
4. understands that humans are a part of an ecosystem and their activities may deliberately or inadvertently alter the equilibrium in ecosystems.

The Nature of Science

Standard 1:

The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.3)

1. knows that scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.
2. knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects.
3. knows that science disciplines differ from one another in topic, techniques, and outcomes, but that they share a common purpose, philosophy, and enterprise.
4. knows that accurate record keeping, openness, and replication are essential to maintaining an investigator's credibility with other scientists and society.
5. knows that a change in one or more variables may alter the outcome of an investigation.
6. recognizes the scientific contributions that are made by individuals of diverse backgrounds, interests, talents, and motivations.
7. knows that when similar investigations give different results, the scientific challenge is to verify whether the differences are significant by further study.

Standard 2:

The student understands that most natural events occur in comprehensible, consistent patterns. (SC.H.2.3)

1. recognizes that patterns exist within and across systems.

Standard 3:

The student understands that science, technology, and society are interwoven and interdependent. (SC.H.3.3)

1. knows that science ethics demand that scientists must not knowingly subject coworkers, students, the neighborhood, or the community to health or property risks.
2. knows that special care must be taken in using animals in scientific research.
3. knows that in research involving human subjects, the ethics of science require that potential subjects be fully informed about the risks and benefits associated with the research and of their right to refuse to participate.
4. knows that technological design should require taking into account constraints such as natural laws, the properties of the materials used, and economic, political, social, ethical, and aesthetic values.
5. understands that contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times, and are an intrinsic part of the development of human culture.
6. knows that no matter who does science and mathematics or invents things, or when or where they do it, the knowledge and technology that result can eventually become available to everyone.
7. knows that computers speed up and extend people's ability to collect, sort, and analyze data; prepare research reports; and share data and ideas with others.

Science

Grades 9-12

The Nature of Matter

Standard 1:

The student understands that all matter has observable, measurable properties. (SC.A.1.4)

1. knows that the electron configuration in atoms determines how a substance reacts and how much energy is involved in its reactions.
2. knows that the vast diversity of the properties of materials is primarily due to variations in the forces that hold molecules together.
3. knows that a change from one phase of matter to another involves a gain or loss of energy.
4. experiments and determines that the rates of reaction among atoms and molecules depend on the concentration, pressure, and temperature of the reactants and the presence or absence of catalysts.
5. knows that connections (bonds) form between substances when outer-shell electrons are either transferred or shared between their atoms, changing the properties of substances.

Standard 2:

The student understands the basic principles of atomic theory. (SC.A.2.4)

1. knows that the number and configuration of electrons will equal the number of protons in an electrically neutral atom and when an atom gains or loses electrons, the charge is unbalanced.
2. knows the difference between an element, a molecule, and a compound.
3. knows that a number of elements have heavier, unstable nuclei that decay, spontaneously giving off smaller particles and waves that result in a small loss of mass and release a large amount of energy.
4. knows that nuclear energy is released when small, light atoms are fused into heavier ones.
5. knows that elements are arranged into groups and families based on similarities in electron structure and that their physical and chemical properties can be predicted.
6. understands that matter may act as a wave, a particle, or something else entirely different with its own characteristic behavior.

Energy

Standard 1:

The student recognizes that energy may be changed in form with varying efficiency. (SC.B.1.4)

1. understands how knowledge of energy is fundamental to all the scientific disciplines (e.g., the energy required for biological processes in living organisms and the energy required for the building, erosion, and rebuilding of the Earth).
2. understands that there is conservation of mass and energy when matter is transformed.
3. knows that temperature is a measure of the average translational kinetic energy of motion of the molecules in an object.
4. knows that as electrical charges oscillate, they create time-varying electric and magnetic fields that propagate away from the source as an electromagnetic wave.
5. knows that each source of energy presents advantages and disadvantages to its use in society (e.g., political and economic implications may determine a society's selection of renewable or nonrenewable energy sources).
6. knows that the first law of thermodynamics relates the transfer of energy to the work done and the heat transferred.
7. knows that the total amount of usable energy always decreases, even though the total amount of energy is conserved in any transfer.

Standard 2:

The student understands the interaction of matter and energy. (SC.B.2.4)

1. knows that the structure of the universe is the result of interactions involving fundamental particles (matter) and basic forces (energy) and that evidence suggests that the universe contains all of the matter and energy that ever existed.

Force and Motion

Standard 1:

The student understands that types of motion may be described, measured, and predicted. (SC.C.1.4)

1. knows that all motion is relative to whatever frame of reference is chosen and that there is no absolute frame of reference from which to observe all motion.

2. knows that any change in velocity is an acceleration.

Standard 2:

The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted. (SC.C.2.4)

1. knows that acceleration due to gravitational force is proportional to mass and inversely proportional to the square of the distance between the objects.
2. knows that electrical forces exist between any two charged objects.
3. describes how magnetic force and electrical force are two aspects of a single force.
4. knows that the forces that hold the nucleus of an atom together are much stronger than electromagnetic force and that this is the reason for the great amount of energy released from the nuclear reactions in the sun and other stars.
5. knows that most observable forces can be traced to electric forces acting between atoms or molecules.
6. explains that all forces come in pairs commonly called action and reaction.

Processes that Shape the Earth

Standard 1:

The student recognizes that processes in the lithosphere, atmosphere, hydrosphere, and biosphere interact to shape the Earth. (SC.D.1.4)

1. knows how climatic patterns on Earth result from an interplay of many factors (Earth's topography, its rotation on its axis, solar radiation, the transfer of heat energy where the atmosphere interfaces with lands and oceans, and wind and ocean currents).
2. knows that the solid crust of Earth consists of slow-moving, separate plates that float on a denser, molten layer of Earth and that these plates interact with each other, changing the Earth's surface in many ways (e.g., forming mountain ranges and rift valleys, causing earthquake and volcanic activity, and forming undersea mountains that can become ocean islands).
3. knows that changes in Earth's climate, geological activity, and life forms may be traced and compared.
4. knows that Earth's systems and organisms are the result of a long, continuous change over time.

Standard 2:

The student understands the need for protection of the natural systems on Earth. (SC.D.2.4)

1. understands the interconnectedness of the systems on Earth and the quality of life.

Earth and Space

Standard 1:

The student understands the interaction and organization in the Solar System and the universe and how this affects life on Earth. (SC.E.1.4)

1. understands the relationships between events on Earth and the movements of the Earth, its moon, the other planets, and the sun.
2. knows how the characteristics of other planets and satellites are similar to and different from those of the Earth.
3. knows the various reasons that Earth is the only planet in our Solar System that appears to be capable of supporting life as we know it.

Standard 2:

The student recognizes the vastness of the universe and the Earth's place in it. (SC.E.2.4)

1. knows that the stages in the development of three categories of stars are based on mass: stars that have the approximate mass of our sun, stars that are two-to-three-stellar masses and develop into neutron stars, and stars that are five-to-six-stellar masses and develop into black holes.
2. identifies the arrangement of bodies found within and outside our galaxy.
3. knows astronomical distance and time.
4. understands stellar equilibrium.
5. knows various scientific theories on how the universe was formed.
6. knows the various ways in which scientists collect and generate data about our universe (e.g., X-ray telescopes, computer simulations of gravitational systems, nuclear reactions, space probes, and supercollider simulations).
7. knows that mathematical models and computer simulations are used in studying evidence from many sources to form a scientific account of the universe.

Processes of Life

Standard 1:

The student describes patterns of structure and function in living things. (SC.F.1.4)

1. knows that the body processes involve specific biochemical reactions governed by biochemical principles.
2. knows that body structures are uniquely designed and adapted for their function.
3. knows that membranes are sites for chemical synthesis and essential energy conversions.
4. understands that biological systems obey the same laws of conservation as physical systems.
5. knows that complex interactions among the different kinds of molecules in the cell cause distinct cycles of activity governed by proteins.
6. knows that separate parts of the body communicate with each other using electrical and / or chemical signals.
7. knows that organisms respond to internal and external stimuli.
8. knows that cell behavior can be affected by molecules from other parts of the organism or even from other organisms.

Standard 2:

The student understands the process and importance of genetic diversity. (SC.F.2.4)

1. understands the mechanisms of asexual and sexual reproduction and knows the different genetic advantages and disadvantages of asexual and sexual reproduction.
2. knows that every cell contains a "blueprint" coded in DNA molecules that specify how proteins are assembled to regulate cells.
3. understands the mechanisms of change (e.g., mutation and natural selection) that lead to adaptations in a species and their ability to survive naturally in changing conditions and to increase species diversity.

How Living Things Interact with Their Environment

Standard 1:

The student understands the competitive, interdependent, cyclic nature of living things in the environment. (SC.G.1.4)

1. knows of the great diversity and interdependence of living things.
2. understands how the flow of energy through an ecosystem made up of producers, consumers, and decomposers carries out the processes of life and that some energy dissipates as heat and is not recycled.
3. knows that the chemical elements that make up the molecules of living things are combined and recombined in different ways.

Standard 2:

The student understands the consequences of using limited natural resources. (SC.G.2.4)

1. knows that layers of energy-rich organic materials have been gradually turned into great coal beds and oil pools (fossil fuels) by the pressure of the overlying earth and that humans burn fossil fuels to release the stored energy as heat and carbon dioxide.
2. knows that changes in a component of an ecosystem will have unpredictable effects on the entire system but that the components of the system tend to react in a way that will restore the ecosystem to its original condition.
3. understands how genetic variation of offspring contributes to population control in an environment and that natural selection ensures that those who are best adapted to their surroundings survive to reproduce.
4. knows that the world ecosystems are shaped by physical factors that limit their productivity.
5. understands that the amount of life any environment can support is limited and that human activities can change the flow of energy and reduce the fertility of the Earth.
6. knows the ways in which humans today are placing their environmental support systems at risk (e.g., rapid human population growth, environmental degradation, and resource depletion).

The Nature of Science

Standard 1:

The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.4)

1. knows that investigations are conducted to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.
2. knows that from time to time, major shifts occur in the scientific view of how the world works, but that more often the changes that take place in the body of scientific knowledge are small modifications of prior knowledge.
3. understands that no matter how well one theory fits observations, a new theory might fit them as well or better, or might fit a wider range of observations, because in science, the testing, revising, and occasional discarding of theories, new and old, never ends and leads to an increasingly better understanding of how things work in the world, but not to absolute truth.
4. knows that scientists in any one research group tend to see things alike and that therefore scientific teams are expected to seek out the possible

sources of bias in the design of their investigations and in their data analysis.

5. understands that new ideas in science are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and usually grow slowly from many contributors.
6. understands that, in the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism and that, in the long run, theories are judged by how they fit with other theories, the range of observations they explain, how well they explain observations, and how effective they are in predicting new findings.
7. understands the importance of a sense of responsibility, a commitment to peer review, truthful reporting of the methods and outcomes of investigations, and making the public aware of the findings.

Standard 2:

The student understands that most natural events occur in comprehensible, consistent patterns. (SC.H.2.4)

1. knows that scientists assume that the universe is a vast system in which basic rules exist that may range from very simple to extremely complex, but that scientists operate on the belief that the rules can be discovered by careful, systemic study.
2. knows that scientists control conditions in order to obtain evidence, but when that is not possible for practical or ethical reasons, they try to observe a wide range of natural occurrences to discern patterns.

Standard 3:

The student understands that science, technology, and society are interwoven and interdependent. (SC.H.3.4)

1. knows that performance testing is often conducted using small-scale models, computer simulations, or analogous systems to reduce the chance of system failure.
2. knows that technological problems often create a demand for new scientific knowledge and that new technologies make it possible for scientists to extend their research in a way that advances science.
3. knows that scientists can bring information, insights, and analytical skills to matters of public concern and help people understand the possible causes and effects of events.
4. knows that funds for science research come from federal government agencies, industry, and private foundations and that this funding often influences the areas of discovery.
5. knows that the value of a technology may differ for different people and at different times.
6. knows that scientific knowledge is used by those who engage in design and technology to solve practical problems, taking human values and limitations into account.

Science Examples

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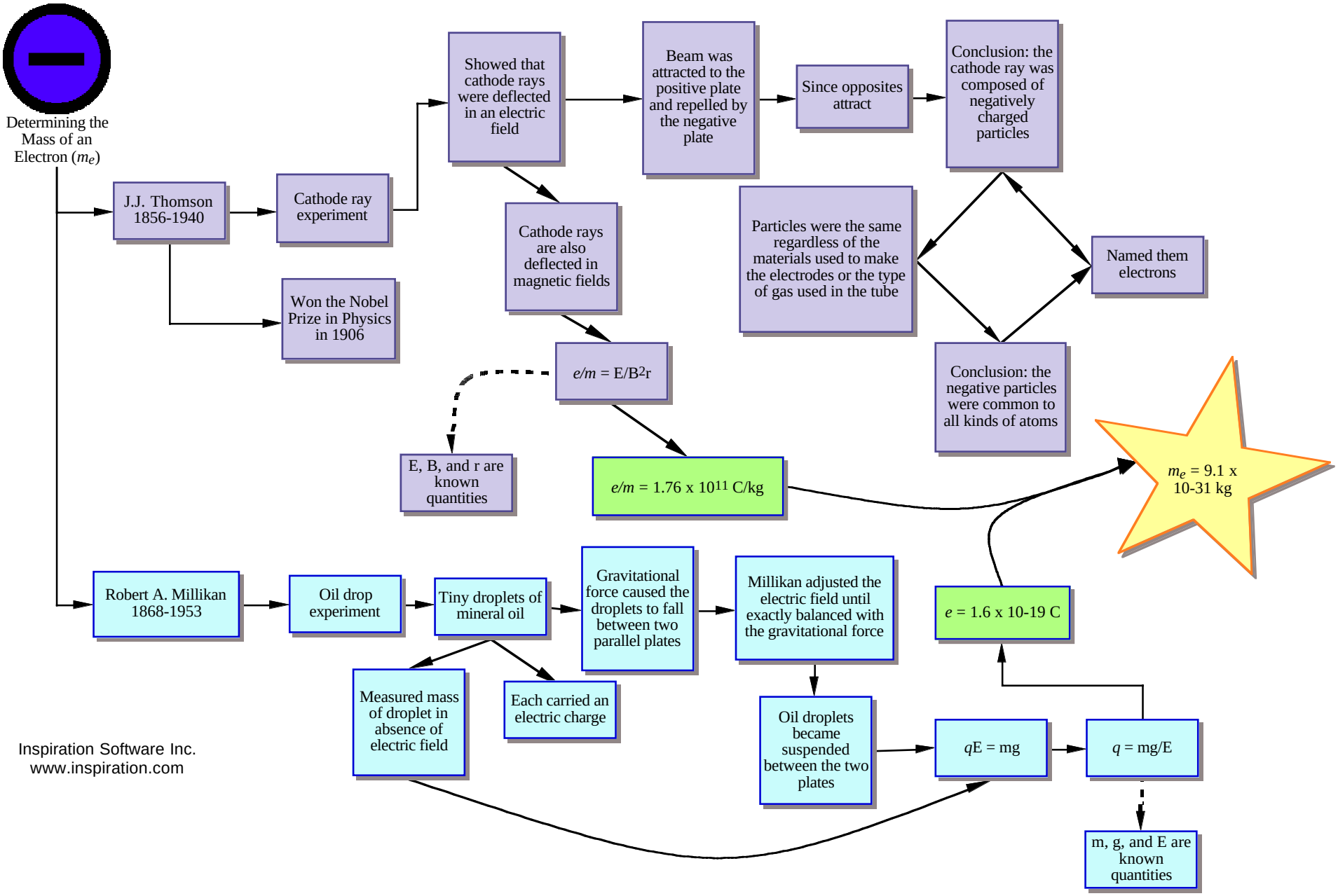
Determining the Mass of an Electron (m_e)
J.J. Thomson 1856-1940
Cathode ray experiment
Showed that cathode rays were deflected in an electric field
Beam was attracted to the positive plate and repelled by the negative plate
Since opposites attract
Conclusion: the cathode ray was composed of negatively charged particles
Won the Nobel Prize in Physics in 1906
Cathode rays are also deflected in magnetic fields
Particles were the same regardless of the materials used to make the electrodes or the type of gas used in the tube
Named them electrons
Conclusion: the negative particles were common to all kinds of atoms
$e/m = E/B^2r$
E, B, and r are known quantities
e/m = 1.76 x 10^{11} C/kg
m_e = 9.1 x 10-31 kg
Robert A. Millikan 1868-1953
Oil drop experiment
Tiny droplets of mineral oil
Gravitational force caused the droplets to fall between two parallel plates
Millikan adjusted the electric field until exactly balanced with the gravitational force
e = 1.6 x 10-19 C
Measured mass of droplet in absence of electric field
Each carried an electric charge
Oil droplets became suspended between the two plates
$qE = mg$
$q = mg/E$
m, g, and E are known quantities
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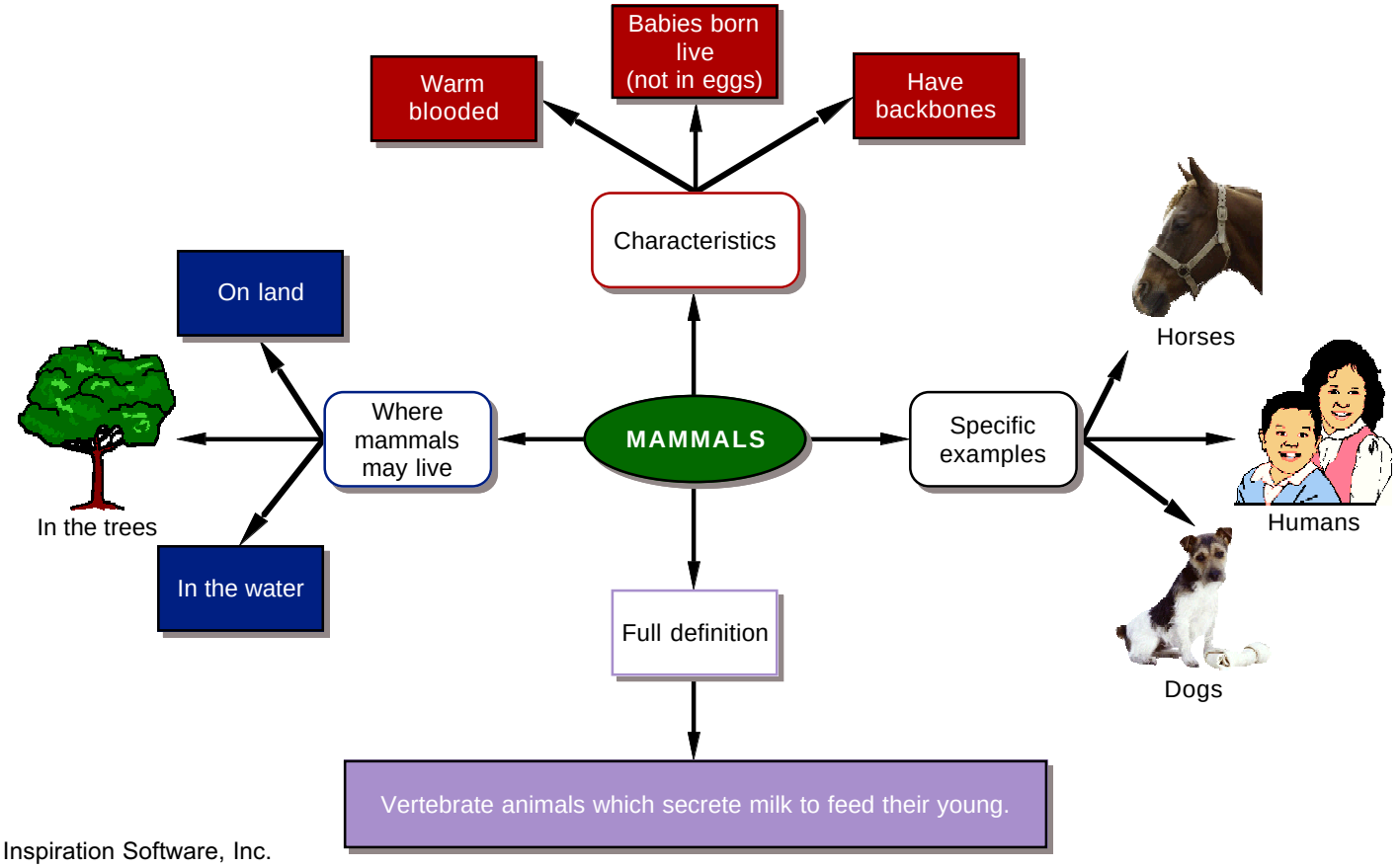

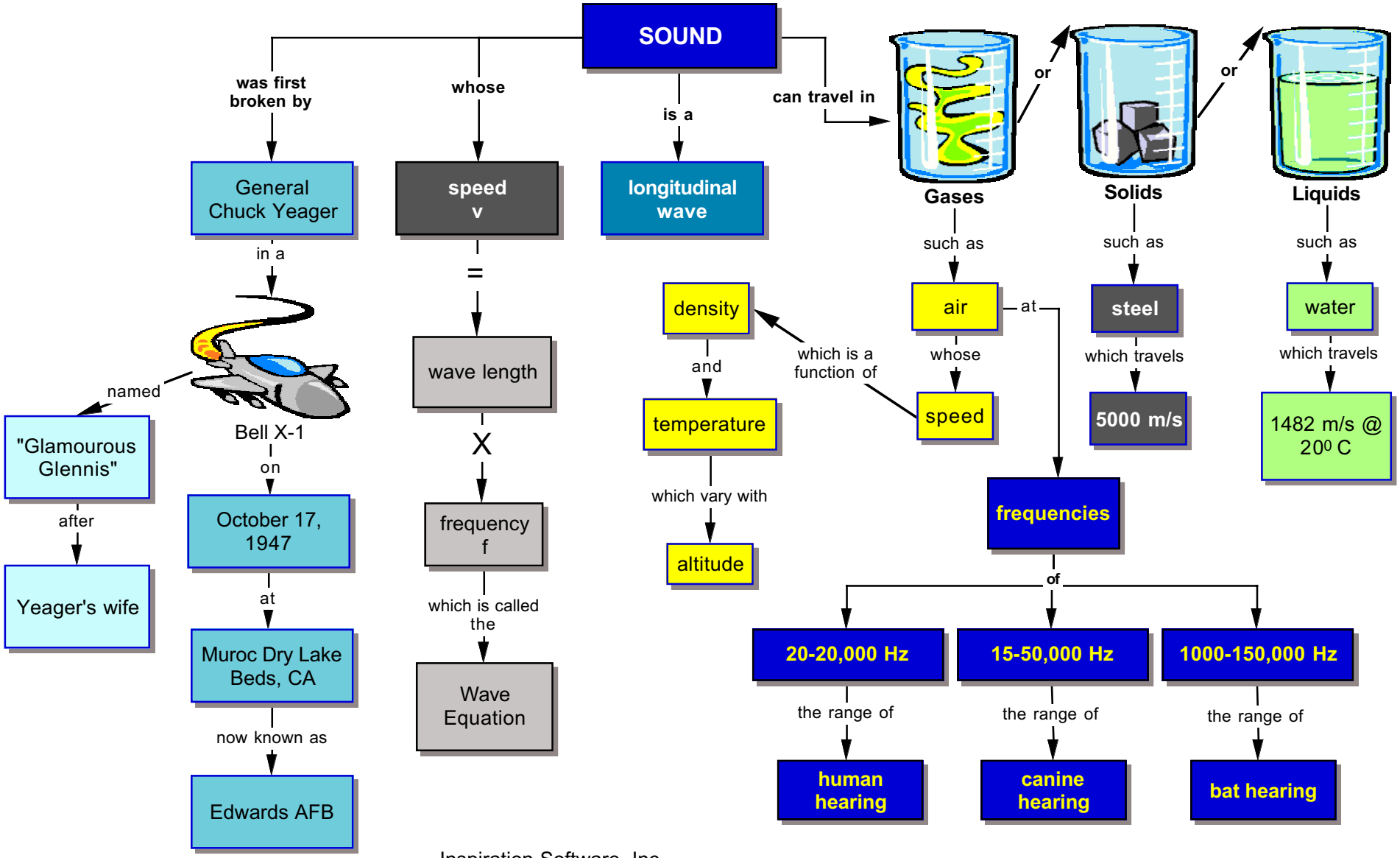

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