### MISSOURI SCIENCE COURSE LEVEL EXPECTATIONS - PHYSICAL SCIENCE (DRAFT)

#### Strand 1: Properties and Principles of Matter and Energy

1. Changes in properties and states of matter provide evidence of the atomic theory of matter

   **Concept A. Objects, and the materials they are made of, have properties that can be used to describe and classify them**

   - a. Compare the densities of regular and irregular objects using their respective measures of volume and mass  
     - **SE:** 17, 47, 71, 150-151  
     - **TE:** 71, 150-151
   
   - b. Identify pure substances by their physical and chemical properties (i.e., color, luster/reflectivity, hardness, conductivity, density, pH, melting point, boiling point, specific heat, solubility, phase at room temperature, chemical reactivity)  
     - **SE:** 48-61, 68-70, 72-74, 551  
     - **TE:** 48-61, 68-71, 72-74
   
   - c. Classify a substance as being made up of one kind of atom (element) or a compound when given the molecular formula or structural formula (introduce electron dot diagram) for the substance  
     - **SE:** 158-161, 170-175  
     - **TE:** 124C, 158-159, 174
   
   - d. Compare and contrast the common properties of metals, nonmetals, metalloids (semi-conductors) and noble gases  
     - **SE:** 135-136, 140-149  
     - **TE:** 124D, 138-146

   **Concept B. Properties of mixtures depend upon the concentrations, properties, and interactions of particles**

   - a. Compare and contrast the properties of acidic, basic, and neutral solutions  
     - **SE:** 240-251  
     - **TE:** 240, 242, 244, 245, 248

   **Concept C. Properties of matter can be explained in terms of moving particles too small to be seen without tremendous magnification**

   Not assessed at this level

   **Concept D. Physical changes in states of matter due to thermal changes in materials can be explained by the Kinetic Theory of Matter**

   - a. Using the Kinetic Theory model, explain the changes that occur in the distance between atoms/molecules and temperature of a substance as energy is absorbed or released during a phase change  
     - **SE:** 84-91  
     - **TE:** 66D, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93
   
   - b. Predict the effect of a temperature change on the properties (i.e., pressure, density, volume) of a material (solids, liquids, gases)  
     - **SE:** 78, 80-81  
     - **TE:** 65D-66D, 75, 76, 79, 80

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**TE = Teacher’s Edition**
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<tr>
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</thead>
</table>
| **c. Predict the effect of pressure changes on the properties (i.e., temperature, volume, density) of a material (solids, liquids, gases)** | **SE: 75, 76, 77, 79, 80-81**  
**TE: 65D-66D, 80, 81** |

**Concept E. The atomic model describes the electrically neutral atom**

| a. Describe the atom as having a dense, positive nucleus surrounded by a cloud of negative electrons | **SE: 104-105**  
**TE: 98D-98E, 105** |
|---------------------------------------------------------------------|----------------|
| b. Calculate the number of protons, neutrons, and electrons of an element/isotopes given its mass number and atomic number | **SE: 110-111**  
**TE: 110-111** |
| c. Describe the information provided by the atomic number and the mass number (i.e., electrical charge, chemical stability) | **SE: 131-133**  
**TE: 131-133** |

**Concept F. The periodic table organizes the elements according to their atomic structure and chemical reactivity**

| a. Explain the structure of the periodic table in terms of the elements with common properties (groups/families) and repeating properties (periods) | **SE: 135-137**  
**TE: 135-137** |
|---------------------------------------------------------------------|----------------|
| b. Classify elements as metals, nonmetals, metalloids (semi-conductors), and noble gases according to their location on the Periodic Table | **SE: 130-133, 135, 136, 138-147**  
**TE: 130-133, 138-147** |
| c. Predict the chemical reactivity of elements, and the type of bonds that may result between them, using the Periodic Table | **SE: 158-161**  
**TE: 156C-156D** |

**Concept G. Properties of objects and states of matter can change chemically and/or physically**

| a. Distinguish between physical and chemical changes in matter | **SE: 45-53, 54-61**  
**TE: 45-53, 54-58, 60-61** |

**Concept H. Chemical bonding is the combining of different pure substances (elements, compounds) to form new substances with different properties**

| c. Describe how the valence electron configuration determines how atoms interact and may bond | **SE: 139, 159**  
**TE: 139** |
| d. Compare and contrast the types of chemical bonds (i.e., ionic, covalent) | **SE: 158-159, 161, 164, 165-172**  
**TE: 156C-156D, 158-159, 164, 165-172** |
<table>
<thead>
<tr>
<th>Concept I. Mass is conserved during any physical or chemical change</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Compare the mass of the reactants to the mass of the products in a chemical reaction or physical change as support for the Law of Conservation of Mass</td>
</tr>
<tr>
<td>SE: 193-195</td>
</tr>
<tr>
<td>TE: 193</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concept II. Energy has a source, can be stored, and can be transferred but is conserved within a system</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Differentiate between thermal energy (the total internal energy of a substance which is dependent upon mass), heat (thermal energy that transfers from one object or system to another due to a difference in temperature), and temperature (the measure of average kinetic energy of molecules or atoms in a substance)</td>
</tr>
<tr>
<td>SE: 474-475</td>
</tr>
<tr>
<td>TE: 472C, 475</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concept B. Mechanical energy comes from the motion (kinetic energy) and/or relative position (potential energy) of an object</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Relate kinetic energy to an object’s mass and its velocity</td>
</tr>
<tr>
<td>SE: 447-448</td>
</tr>
<tr>
<td>TE: 444C</td>
</tr>
</tbody>
</table>

| b. Relate an object’s gravitational potential energy to its weight and height relative to the surface of the Earth |
| SE: 449 |
| TE: 449 |

<p>| c. Distinguish between examples of kinetic and potential energy (i.e., gravitational) within a system |
| SE: 447-452 |
| TE: 444D, 449-451 |</p>
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</table>
| d. Describe the effect of work on an object’s kinetic and potential energy | SE: 447  
TE: 472D |
| Concept C. Electromagnetic energy from the Sun (solar radiation) is a major source of energy on Earth |  |
| Identify stars as producers of electromagnetic energy | SE: 452, 464, 828  
TE: 464, 828 |
| Describe how electromagnetic energy is transferred through space as electromagnetic waves of varying wavelength and frequency | SE: 454, 464, 532-535  
TE: 533-535 |
| Concept D. Chemical reactions involve changes in the bonding of atoms with the release or absorption of energy | Not assessed at this level |
| Concept E. Nuclear energy is a major source of energy throughout the universe |  |
| Describe how changes in the nucleus of an atom during a nuclear reaction (i.e., nuclear decay, fusion, fission) result in emission of radiation | SE: 292-295  
TE: 290C, 292, 293 |
| Identify the role of nuclear energy as it serves as a source of energy for the Earth, stars, and human activity (e.g., source of electromagnetic radiation, nuclear power plants, fuel for stars) | SE: 309-313, 314, 315  
TE: 312, 313, 314 |
| Concept F. Energy can be transferred within a system as the total amount of energy remains constant (i.e., Law of Conservation of Energy) |  |
| Describe the transfer of energy that occurs as energy changes from kinetic to potential within a system (e.g., car moving on rollercoaster track, child swinging, diver jumping off a board) (Do NOT assess calculations) | SE: 456-458, 460-461  
TE: 456-458, 460, 461 |
| Compare the efficiency of systems (recognizing that, as work is done, the amount of usable energy decreases) | SE: 425-426, 487  
TE: 472D, 488 |
| Classify the different ways to store energy (i.e., chemical, nuclear, thermal, mechanical, electromagnetic) and describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant, within a system (e.g., using gasoline to move a car, photocell generating electricity, electromagnetic motor doing work, energy generated by nuclear reactor) | SE: 446-458, 460-461  
TE: 446-461 |
Strand 2: Properties and Principles of Force and Motion

1. The motion of an object is described by its change in position relative to another object or point

   Concept A. The motion of an object is described as a change in position, direction, and speed relative to another object (frame of reference)

   Represent and analyze the motion of an object graphically
   - SE: 334, 347, 348, 349
   - TE: 326D, 334, 347, 348, 349

   Analyze the velocity of two objects in terms of distance and time (i.e., verbally, diagrammatically, graphically, mathematically)
   - SE: 332, 333, 334, 336-337
   - TE: 332, 333, 334, 336-337

   Concept B. An object that is accelerating is speeding up, slowing down, or changing direction

   Measure and analyze an object’s motion in terms of speed, velocity, and acceleration (i.e., verbally, diagrammatically, graphically)
   - SE: 342-349
   - TE: 342-349

   Concept C. Momentum depends on the mass of the object and the velocity with which it is traveling

   Compare the momentum of two objects in terms of mass and velocity (Do NOT assess calculations)
   - SE: 374-377
   - TE: 374-377

   Explain that the total momentum remains constant within a system
   - SE: 376
   - TE: 376

2. Forces affect motion

   Concept A. Forces are classified as either contact forces (pushes, pulls, friction, buoyancy) or non-contact forces (gravity, magnetism), that can be described in terms of direction and magnitude

   Identify and describe the forces acting on an object (i.e., type of force, direction, magnitude in Newtons) using a force diagram (do not assess calculations)
   - SE: 357-358, 361, 380, 381, 395, 398-399, 400, 401
   - TE: 357, 361, 358, 400

   Concept B. Every object exerts a gravitational force on every other object

   Describe gravity as an attractive force among all objects
   - SE: 380-382
   - TE: 380-382

   Compare and describe the gravitational forces between two objects in terms of their masses and the distances between them
   - SE: 380-382
   - TE: 380-382

   Describe weight in terms of the force of a planet’s or moon’s gravity acting on a given mass
   - SE: 368-369
   - TE: 369

   Recognize all free falling bodies accelerate at the same rate due to gravity regardless of their mass
   - SE: 343, 361
   - TE: 361
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<th>MISSOURI SCIENCE COURSE LEVEL EXPECTATIONS - PHYSICAL SCIENCE (DRAFT)</th>
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</thead>
<tbody>
<tr>
<td>Concept C. Magnetic forces are related to electrical forces as different aspects of a single electromagnetic force</td>
</tr>
<tr>
<td>Not assessed at this level</td>
</tr>
<tr>
<td>D. Newton’s Laws of Motion explain the interaction of mass and forces, and are used to predict changes in motion</td>
</tr>
<tr>
<td>Recognize that inertia is a property of matter that can be described as an object’s tendency to resist a change in motion, and is dependent upon the object’s mass (Newton’s First Law of Motion)</td>
</tr>
</tbody>
</table>
| SE: 363-365, 366
TE: 363-364 |
| Determine the effect (i.e., direction and magnitude) of the sum of the forces acting on an object (i.e., net force) |
| SE: 357, 358
TE: 354C, 357, 358 |
| Using information about net force and mass determine the effect on acceleration (Newton’s Second Law of Motion) |
| SE: 365, 367
TE: 365, 367 |
| Identify forces acting on a falling object (i.e., weight, air resistance) and how those forces affect the rate of acceleration |
| SE: 346, 370-371
TE: 370-371 |
| Analyze force pairs (i.e., action/reaction forces) when given a scenario (e.g., handball hits concrete wall, shotgun firing) and describe their magnitudes and directions. (Newton’s Third Law of Motion) |
| SE: 373
TE: 373 |
| E. Perpendicular forces act independently of each other |
| Predict the path of an object when the net force changes |
| SE: 362
TE: 362 |
| F. Work transfers energy into and out of a mechanical system |
| Describe the relationships among work, applied net force, and the distance an object moves |
| SE: 412-414
TE: 410C, 412-414 |
| Explain how the efficiency of a mechanical system can be expressed as a ratio of work output to work input |
| SE: 421-423
TE: 410D, 421-423 |
| Describe power in terms of work and time |
| SE: 414-415
TE: 410C, 414-415 |
| Describe and analyze the relationships among force, distance, work, efficiency, and power |
| SE: 412-414, 414-415, 421-423
TE: 410C, 410D, 412-414, 421-423, 414-415 |
### MISSOURI SCIENCE COURSE LEVEL EXPECTATIONS - PHYSICAL SCIENCE (DRAFT)

#### Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It

1. The universe has observable properties and structure

   **Concept A.** The Earth, Sun, and moon are part of a larger system that includes other planets and smaller celestial bodies

   No assessed at this level

   **Concept B.** The Earth has a composition and location suitable to sustain life

   Explain how Earth’s environmental characteristics and location in the universe (e.g., atmosphere, temperature, orbital path, magnetic field, mass-gravity, location in solar system) provide a life-supporting environment

   SE: 705-708, 747, 782, 803
   TE: 705-708, 747, 748, 782

   **Concept C.** Most of the information we know about the universe comes from the electromagnetic spectrum

   Identify information that the electromagnetic spectrum provides about the stars and the universe (e.g., chemical composition, temperature, age of stars, location of black holes, motion of celestial bodies)

   SE: 831-833, 836-837, 838-839
   TE: 831-833, 836-837, 838-839

2. Regular and predictable motions of objects in the universe can be described and explained as the result of gravitational forces

   **Concept A.** The apparent position of the Sun and other stars, as seen from Earth, changes in observable patterns

   Not assessed at this level

   **Concept B.** The apparent position of the moon, as seen from Earth, and its actual position relative to Earth changes in observable patterns

   Not assessed at this level

   **Concept C.** The regular and predictable motions of a planet and moon relative to the Sun explain natural phenomena, such as day, month, year, shadows, moon phases, eclipses, tides, and seasons

   Predict the moon rise/set times, phases of the moon, and/or eclipses when given the relative positions of the moon, planet, and Sun

   SE: 798, 799, 800
   TE: 798, 799, 800

   Explain how the gravitational forces, due to the relative positions of a planet, moon, and Sun, determine the height and frequency of tides

   SE: 801
   TE: 788D, 801
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Missouri Science Course Level Expectations - Physical Science (Draft)
(High School)

### Concept D. Gravity is a force of attraction between objects in the solar system that governs their motion

Explain orbital motions of moons around planets, and planets around the Sun, as the result of gravitational forces between those objects

SE: 792-793
TE: 788D, 792-793

### Strand 7: Scientific Inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking

Concept A. Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation

<table>
<thead>
<tr>
<th>Activity</th>
<th>SE</th>
<th>TE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment</td>
<td>SE: 8-9 TE: 8-9, 393</td>
<td></td>
</tr>
<tr>
<td>Design and conduct a valid experiment</td>
<td>SE: 1, 61, 327, 360, 429, 493, 531, 544 TE: 1, 61, 327, 360, 429, 531, 493, 544</td>
<td></td>
</tr>
<tr>
<td>Recognize it is not always possible, for practical or ethical reasons, to control some conditions (e.g., when sampling or testing humans, when observing animal behaviors in nature)</td>
<td>SE: 10, 46 TE: 393</td>
<td></td>
</tr>
<tr>
<td>Acknowledge some scientific explanations (e.g., explanations of astronomical or meteorological phenomena) cannot be tested using a controlled laboratory experiment, but instead by using a model, due to the limits of the laboratory environment, resources, and/or technologies</td>
<td>SE: 10, 316-217 TE: 316-217</td>
<td></td>
</tr>
<tr>
<td>Acknowledge there is no fixed procedure called “the scientific method”, but that some investigations involve systematic observations, carefully collected and relevant evidence, logical reasoning, and some imagination in developing hypotheses and other explanations</td>
<td>SE: 7-9 TE: 7</td>
<td></td>
</tr>
<tr>
<td>Evaluate the design of an experiment and make suggestions for reasonable improvements</td>
<td>SE: 1, 46, 316-317, 493 TE: 1, 46, 316-317, 393, 493</td>
<td></td>
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| Make qualitative and quantitative observations using the appropriate senses, tools and equipment to gather data (e.g., microscopes, thermometers, analog and digital meters, computers, spring scales, balances, metric rulers, graduated cylinders) | **SE: 8, 16-18, 20-21, 26-27, 196, 330**
| **TE: 8, 17, 20-21, 26-27, 196-197, 237, 330-331, 357** |
| Measure length to the nearest millimeter, mass to the nearest gram, volume to the nearest milliliter, force (weight) to the nearest Newton, temperature to the nearest degree Celsius, time to the nearest second | **SE: 8, 16-18, 20, 21, 26-27, 196, 330**
| **TE: 8, 20-21, 26-27, 196-197, 237, 330-331, 357** |
| Determine the appropriate tools and techniques to collect, analyze, and interpret data | **SE: 18, 331**
| **TE: 18, 331** |
| Judge whether measurements and computation of quantities are reasonable | **SE: 42, 150, 383, 463, 575, 872, 873**
| **TE: 42, 150, 383, 463, 575** |
| Calculate the range, average/mean, percent, and ratios for sets of data | **SE: 18-35, 255, 278, 383, 411, 439, 467, 659, 671, 745, 789, 827**
| **TE: 184-185, 411, 429, 439, 467, 648-649** |
| Recognize observation is biased by the experiences and knowledge of the observer (e.g., strong beliefs about what should happen in particular circumstances can prevent the detection of other results) | **SE: 3, 25** |
| Concept C. Scientific inquiry includes evaluation of explanations (laws/principles, theories/models) light of evidence (data) and scientific principle(understandings) | **SE: 151, 184-185, 411, 429, 439, 463, 648-649, 775, 783**
| **TE: 184-185, 411, 429, 439, 463, 648-649, 775, 783** |
| Use quantitative and qualitative data as support for reasonable explanations (conclusions) | **SE: 42, 184-185, 255, 278, 383, 411, 439, 467, 571, 648-649, 667, 739, 775, 783**
| **TE: 42, 184-185, 255, 278, 383, 411, 439, 467, 571, 648-649, 667, 739, 775, 783** |
| Analyze experimental data to determine patterns, relationships, perspectives, and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable) | **SE: 42, 184-185, 255, 278, 383, 411, 439, 467, 571, 648-649, 667, 739, 775, 783**
| **TE: 42, 184-185, 255, 278, 383, 411, 439, 467, 571, 648-649, 667, 739, 775, 783** |

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| Identify the possible effects of errors in observations, measurements, and calculations, on the validity and reliability of data and resultant explanations (conclusions) | SE: 18, 27  
TE: 18, 27 |
|---|---|
| Analyze whether evidence (data) and scientific principles support proposed explanations (laws/principles, theories/models) | SE: 383, 411, 648-649  
TE: 383, 411, 648-649, 808 |
| Concept D. The nature of science relies upon communication of results and justification of explanations |

**Communicate the procedures and results of investigations and explanations through:**

- **oral presentations**  
  SE: 1  
  TE: 1, 615, 791, 808, 819

- **drawings and maps**  
  SE: 776  
  TE: 776

- **data tables** (allowing for the recording and analysis of data relevant to the experiment such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities)  
  SE: 22, 92-93, 184-185, 254-255, 383, 429, 439, 463, 493, 775, 783  
  TE: 23, 92-93, 184-185, 254-255, 383, 429, 439, 463, 493, 775, 783

- **graphs** (bar, single, and multiple line)  
  SE: 23, 92-93, 349, 429, 467, 491, 648-649  
  TE: 23, 92-93, 349, 429, 467, 491, 648-649

- **equations and writings**  
  SE: 179, 375, 423  
  TE: 25, 179, 193, 268, 310, 423, 837, 375

- **Communicate and defend a scientific argument**  
  SE: 27, 42, 184-185, 349, 383  
  TE: 27, 42, 185-185, 349, 383

- **Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community (e.g., work and evidence must be critiqued, reviewed, and validated by peers; needed for subsequent investigations by peers; results can influence the decisions regarding future scientific work)**

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### Strand 8: Impact of Science, Technology and Human Activity

1. The nature of technology can advance, and is advanced by, science as it seeks to apply scientific knowledge in ways that meet human needs

   **Concept A.** Designed objects are used to do things better or more easily and to do some things that could not otherwise be done at all

   Not assessed at this level

   **Concept B.** Advances in technology often result in improved data collection and an increase in scientific information

   Recognize the relationships linking technology and science (e.g., how technological problems may create a demand for new science knowledge, how new technologies make it possible for scientists to extend research and advance science)

   SE: 3, 178-179, 312-313, 374-375, 422-423, 429, 518-519, 582-583, 806-807
   TE: 3, 4, 178, 312, 375, 422, 429, 518, 582

2. Historical and cultural perspectives of scientific explanations help to improve understanding of the nature of science and how science knowledge and technology evolve over time

   **Concept A.** People of different gender and ethnicity have contributed to scientific discoveries and the invention of technological innovations

   Recognize contributions to science are not limited to the work of one particular group, but are made by a diverse group of scientists representing various ethnic and gender groups

   TE: 115, 178, 312, 422, 518, 680

   Recognize gender and ethnicity of scientists often influence the questions asked and/or the methods used in scientific research and may limit or advance science knowledge and/or technology

   Concept B. Scientific theories are developed based on the body of knowledge that exists at any particular time and must be rigorously questioned and tested for validity

   Identify and describe how explanations (laws/principles, theories/models) of scientific phenomena have changed over time as a result of new evidence (e.g., model of the solar system, basic structure of matter, structure of an atom, Big Bang and nebular theory of the Universe)

   TE: 6, 114, 312, 676, 680, 790-791

   Identify and analyze current theories that are being questioned, and compare them to new theories that have emerged to challenge older ones (e.g., theories of evolution, extinction, global warming)

   SE: 110, 114-115, 309, 312-313, 680-681
   TE: 115, 312, 680, 791

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### Missourí Science Course Level Expectations - Physical Science (Draft)

#### Concept A. People, alone or in groups, are always making discoveries about nature and inventing new ways to solve problems and get work done

Not assessed at this level

#### Concept B. Social, political, economic, ethical and environmental factors strongly influence, and are influenced by, the direction of progress of science and technology

Identify and describe major scientific and technological challenges to society and their ramifications for public policy (e.g., global warming, limitations to fossil fuels, genetic engineering of plants, space and/or medical research)  

- **SE:** 59, 312-313, 281, 579, 608, 782  
- **TE:** 281, 312, 579, 608, 802, 782

Identify and evaluate the drawbacks (e.g., design constraints, unintended consequences, risks) and benefits of technological solutions to a given problem (e.g., use of alternative energies to reduce the use of carbon fuels, use of satellite communications to gather information)  

- **SE:** 59, 281, 313, 579, 608, 802  
- **TE:** 59, 281, 579, 608, 802

#### Concept C. Scientific ethics require that scientists must not knowingly subject people or the community to health or property risks without their knowledge and consent

Not assessed at this level

#### Concept D. Scientific information is presented through a number of credible sources, but is at times influenced in such a way to become non-credible

Evaluate a given source for its scientific credibility (e.g., articles in a new periodical quoting an “eye witness,” a scientist speaking within or outside his/her area of expertise)  

- **SE:** 25  
- **TE:** 25

Explain why accurate record-keeping, openness, and replication are essential for maintaining an investigator’s credibility with other scientists and society  

- **SE:** 25  
- **TE:** 25

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http://dese.mo.gov/divimprove/curriculum/GLE/SCcleall.html