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| **Resource Guide**  **to the Massachusetts Curriculum Frameworks**  for Students with Disabilities  **Science and Technology/Engineering**  **(“Legacy” Standards in the 2001/2006 STE Curriculum Framework)**  **• High School Chemistry**  **• High School Technology/Engineering** |

***Fall 2022***



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**Introduction**

**This version of the Resource Guideis based on the 2001/2006 “legacy” *Science and Technology/Engineering Curriculum Framework* and is intended primarily for use by teachers of students with disabilities in high school who will participate in the MCAS-Alt in the Science and Technology/Engineering (STE) disciplines of Chemistry and Technology/Engineering ONLY**. (**Note:** Students taking the MCAS-Alt in STE in grades 5 and 8, or in high school Biology or Introductory Physics should refer to the Resource Guide in STE based on the 2016 standards.)

The Fall 2022 *Resource Guide to the Massachusetts Curriculum Frameworks for Students with Disabilities* (“the Resource Guide”) is an instructional guide intended for students with disabilities in pre-kindergarten through grade 12 who have not yet mastered the performance expectations for students in their grade in science and technology/engineering. This guide is intended to ensure that all students receive instruction at a level that is challenging and attainable for each student. It is also intended to serve as a guide for teachers who work with students with significant cognitive disabilities who are participating in the MCAS Alternate Assessment (MCAS-Alt).

Students with disabilities are expected to achieve the same standards as their nondisabled peers. However, they may need to learn the required knowledge and skills differently, including their presentation at lower levels of complexity, in smaller segments, and at a slower pace. The Resource Guide identifies “entry points” for each standard that allow educators to teach standards-based knowledge and skills that encourage students to approach the grade-level standard. It is especially well-suited for instructing students with significant disabilities who take the MCAS Alternate Assessment (MCAS-Alt) because it aligns less complex skills and content with grade-level subject matter.

**Purpose of the Resource Guide**

This guide is intended for use by educators to align and develop instruction based on the Massachusetts Curriculum Frameworks for students with disabilities who cannot, in the judgment of their IEP team or as listed in their 504 plan, participate in standard MCAS tests even with the use of test accommodations. These students are required to participate in the MCAS-Alt and to maintain a structured collection of evidence for a portfolio that will be submitted to the state each spring. The entry points described in this guide provide students with disabilities access to the same standards as non-disabled students, as required by law.

Resource Guides in all four subjects are available [here](http://www.doe.mass.edu/mcas/alt/resources.html).

**How to Use this Resource Guide**

Educators should begin by referring to the standards at the grade level of the student for guidance in developing standards-based instructional goals for students with disabilities, since goals should be based on the general academic curriculum learned by all students. Educators should refer to the “entry points” listed in the Resource Guide to set realistic, yet challenging, measurable outcomes for students with disabilities that are aligned with grade-level standards, but at lower levels of complexity. Figure 1 will assist educators in identifying the appropriate level of complexity of entry points for each student.

**Organization of the Pre-Kindergarten through Grade 12 Standards in the Resource Guide**

The Resource Guide is organized by **STE discipline**, including:

* Physical Science (Chemistry and Physics)
* Technology/Engineering

The learning standards in each discipline are listed by grade. However, the entry points and access skills are listed by grade span, as follows:

* Grades PreK−2
* Grades 3−5
* Grades 6−8
* High School

Each strand begins with a **topic guide** indicating the pages on which the standards in each topic in the strand are found. On the pages following the topic guide, the standards are listed as they appear in the curriculum framework, followed by the **essence** (main ideas) of each standard.

On subsequent pages, the **entry points** are listed that describe academic outcomes linked to grade-specific standards, described at successively lower levels of complexity intended for students at varying levels who may be able to achieve them. **Access skills** are listed at the lowest grade level in the corresponding topic. These are intended for students with the *most* significant cognitive disabilities. Access skills must be addressed during instructional activities based on the grade-level standards so students will be exposed to the academic curriculum, although they will not address the standards directly.

**Figure 1**

**How to Select Entry Points and Access Skills for “Legacy” STE Standards**

**(Based on the 2001/2006 STE Curriculum Framework)**

* Conduct the MCAS-Alt Skills Survey in the discipline.
* Based on the results of the Skills Survey, select entry points in the discipline that the student can perform only occasionally (even with support), or not at all.
* Determine the grade in which the student is enrolled.
* Determine the High School STE discipline to be assessed

(either Chemistry or Technology/Engineering).

* Select three standards to assess in the discipline.

***Steps 1, 2 and 3***

***Step 6***

**NOTE:** In cases where the MCAS-Alt Skills Survey in this subject indicates that the student cannot yet address the standards even at the lowest level of complexity, the student should address access skills during age-appropriate standards-based activities in the domain.

***Steps 4 and 5***

Once entry points are selected in the core idea…

Design challenging instruction for the student.

**Definitions of Terms Used in the Resource Guide**

* **Access Skills** are developmental (communication or motor) skills that are addressed during instructional activities based on the standards in the content area being assessed. *For example*, a student may participate in a lesson on properties of matter by maintaining a grasp on the materials used during the lesson. Examples of access skills are listed at the lowest grade level in each topic in the Resource Guide. Incorporating access skills into standard-based activities provides opportunities for students with the most significant disabilities to:
* practice targeted skills in a variety of settings using a range of instructional approaches
* be exposed to materials and concepts based on the general education curriculum
* prepare *some* students with significant disabilities to address entry points based on grade-level standards in the future
* **Entry Points** describe academic outcomes at successively lower levels of complexity that are aligned with each cluster of standards. They are intended for use by educators to instruct students with disabilities who are performing below grade-level expectations. Entry points are:
* aligned with the grade-level standard(s) on which it is based
* modified below grade-level expectations
* listed on a continuum approaching grade-level complexity (i.e., less-to-more complex)
* intended to allow educators to identify challenging and attainable standards-based skills for students with a range of disabilities
* used to identify measurable outcomes for a student who is taking the MCAS-Alt
* **Standards** define what all students should understand and be able to do in a content area in each grade or grade span. Each standard in the Resource Guide is listed precisely as it appears in the *Massachusetts Science and Technology/Engineering**Curriculum Framework* (e.g., Learning Standard 1 – “Sort objects by observable properties such as size, shape, color, weight, and texture”).
* **Strands** are large clusters of standards in a related area of a science and technology/engineering discipline, such as Earth and Space Science, Life Science (Biology), Physical Sciences (Chemical and Physics), Technology/Engineering
* **Topic Guides** show the progression of a strand by grade span and topic, located at the beginning of each strand.

|  |  |  |  |
| --- | --- | --- | --- |
| PHYSICAL SCIENCE (CHEMISTRY) | | | |
| **Topics**  **Grades Pre-K – 2** | **Topics**  **Grades 3 – 5** | **Topics**  **Grades 6 – 8** | **Topics**  **High School** |
| **States of Matter, Kinetic Molecular Theory, and Thermochemistry**  Pages S7–S9 | **States of Matter, Kinetic Molecular Theory, and Thermochemistry**  Page S10–S11 | **States of Matter, Kinetic Molecular Theory, and Thermochemistry**  Page S12–S13 | **States of Matter, Kinetic Molecular Theory, and Thermochemistry**  Page S14–S15 |
| **--** | **Forms of Energy**  Pages S16–S18 | **Forms of Energy**  Page S19–S20 | **Forms of Energy**  Page S21 |
| **--** | **--** | **Elements, Compounds and Mixtures; Atomic Structure and Nuclear Chemistry**  Pages S22–S23 | **Elements, Compounds and Mixtures; Atomic Structure and Nuclear Chemistry**  Page S25, S28 |
| **--** | **--** | **--** | **Periodicity**  **Chemical Bonding**  **Reactions and Stoichiometry**  **Solutions, Rates of Reaction, and Equilibrium**  **Acids and Bases and Oxidation-Reduction Reactions**  Pages S25–S31 |

# **CONTENT** Science and Technology/Engineering

**STRAND** Physical Science (Chemistry)

**Learning Standards for:**

## Properties of Materials and Matter

## States of Matter, Kinetic Molecular Theory, and

## Thermochemistry

|  |  |  |  |
| --- | --- | --- | --- |
| Grade Level: Pre-K–2 | | | |
| Topic | Learning Standards as written | | Essence of the Standard(s) |
| States of Matter, Kinetic Molecular Theory, and Thermo-chemistry | **2** | Identify objects and materials as solid, liquid, or gas. Recognize that solids have a definite shape and that liquids and gases take the shape of their container. | * Identify objects and materials as solid, liquid, or gas * Recognize characteristics of solids, liquids, and gases |

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| ENTRY POINTS and ACCESS SKILLS to  Physical Science (Chemistry) Standards in Grades Pre-K−2 |

**Less Complex More Complex**

|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
| --- | --- | --- | --- | --- |
|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **States of Matter, Kinetic Molecular Theory, and Thermo-chemistry** | * Track materials related to states of matter, temperature of objects, or forms of energy * Shift focus from materials to speaker in an activity related to states of matter, temperature of objects, or forms of energy * Grasp materials related to states of matter, temperature of objects, or forms of energy * Use two hands to hold materials related to states of matter, temperature of objects, or forms of energy * Release materials related to states of matter, temperature of objects, or forms of energy (e.g., release materials to participate in experiments on changing water to ice and vice versa) | * Match objects that are liquids * Match objects that are solids * Group objects as solids, liquids, or gases | * Identify a given material or object as a solid, liquid, or gas * Describe the characteristics of solids, liquids, or gases | * Compare and contrast solids, liquids, or gases * Describe the effect of placing a solid, liquid, or gas into a container (e.g., changes based on shape of its container or remains unchanged)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Physical Science (Chemistry) Standards in Grades Pre-K−2 |

**Less Complex More Complex**

|  |  |  |
| --- | --- | --- |
|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **States of Matter, Kinetic Molecular Theory, and Thermo-chemistry (continued)** | * Move materials related to states of matter, temperature of objects, or forms of energy * Orient materials related to states of matter, temperature of objects, or forms of energy * Manipulate objects related to states of matter, temperature of objects, or forms of energy * Locate objects partially hidden or out of sight needed in an activity related to states of matter, temperature of objects, or forms of energy * Use one object to act on another in an activity related to states of matter, temperature of objects, or forms of energy * Turn on technology in an activity related to states of matter, temperature of objects, or forms of energy * Imitate action in an activity related to states of matter, temperature of objects, or forms of energy * Initiate cause-and-effect response during an activity related to states of matter, temperature of objects, or forms of energy * Sustain through response in an activity related to states of matter, temperature of objects, or forms of energy * Gain attention during activity related to states of matter, temperature of objects, or forms of energy * Make a request during an activity (e.g., request a turn) related to states of matter, temperature of objects, or forms of energy * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to states of matter, temperature of objects, or forms of energy * Respond to materials related to states of matter, temperature of objects, or forms of energy * Attend visually, aurally, or tactilely to materials related to states of matter, temperature of objects, or forms of energy |  |

**Science and Technology/ Engineering**

**Physical Science**

**(Chemistry)**

**3 – 5**

# **CONTENT** Science and Technology/Engineering

**STRAND** Physical Science (Chemistry)

**Learning Standards for:**

## Properties of Materials and Matter

## States of Matter, Kinetic Molecular Theory, and

## Thermochemistry

|  |  |  |  |
| --- | --- | --- | --- |
| Grade Level: 3–5 | | | |
| Topic | | Learning Standards as written | | Essence of the Standard(s) |
| States of Matter,  Kinetic Molecular Theory, and Thermo-chemistry | **2** | Compare and contrast solids, liquids, and gases based on the basic properties of these states of matter. | * Compare and contrast states of matter: solid, liquid, gas * Describe changes in states of water |
| **3** | Describe how water can be changed from one state to another by adding or taking away heat. |

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| ENTRY POINTS to  Physical Science (Chemistry) Standards in Grades 3–5 |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
| --- | --- | --- | --- |
| **States of Matter, Kinetic Molecular Theory, and Thermo-chemistry** | * Differentiate objects that are either solid, liquid, or gas * Identify the change in state of water from a liquid to a solid, and vice versa * Identify the solid, liquid, and gaseous states of the same material   *Continue to address earlier standards in this topic at a level that challenges the student* | * Compare changes from water (liquid) to gas (vapor) and vice versa * Compare changes from water (liquid) to ice (solid), and vice versa | * Describe the conditions needed to produce water, ice, and gas   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Physical Science**

**(Chemistry)**

**6 – 8**

**CONTENT**  Science and Technology/Engineering

**STRAND** Physical Science (Chemistry)

**Learning Standards for:**

## Properties of Materials and Matter

## States of Matter, Kinetic Molecular Theory, and

## Thermochemistry

|  |  |  |  |
| --- | --- | --- | --- |
| Grade Level: 6–8 | | | |
| Topic | Learning Standards as written | | Essence of the Standard(s) |
| States of Matter, Kinetic  Theory, and  Thermo-chemistry | **9** | Recognize that a substance (element or compound) has a melting point and a boiling point, both of which are independent of the amount of the sample. | * Define and differentiate between the following:   + melting and boiling points   + physical and chemical changes * Identify and explain heat and motion of particles |
| **10** | Differentiate between physical changes and chemical changes. |
| **15** | Explain the effect of heat on particle motion through a description of what happens to particles during a change in phase. |

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| ENTRY POINTS to  Physical Science (Chemistry) Standards in Grades 6–8 |

**Less Complex More Complex**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **The student will:** | **The student will:** | **The student will:** |
| **States of Matter, Kinetic Theory, and**  **Thermo-chemistry** | * Identify a physical change * Identify a chemical change * Identify the freezing and boiling points of water   *Continue to address earlier standards in this topic at a level that challenges the student* | * Distinguish between a physical change or chemical change * Describe how objects and materials undergo melting, boiling, or freezing | * Describe that liquids have different boiling and freezing points * Describe the difference between a physical change and a chemical change * Describe the effect of heat on particles   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Chemistry**

**High School**

# **CONTENT Science and Technology/Engineering**

**STRAND** Physical Science (Chemistry)

**Learning Standards for:**

## States of Matter, Kinetic Molecular Theory, and

## Thermochemistry

|  |  |  |  |
| --- | --- | --- | --- |
| Grade Level: High School | | | |
| Topic | Learning Standards as written | | Essence of the Standard(s) |
| States of Matter, Kinetic Molecular Theory, and  Thermo-chemistry | **1.1** | Identify and explain physical properties (such as density, melting point, boiling point, conductivity, and malleability) and chemical properties (such as the ability to form new substances). Distinguish between chemical and physical changes. | * Identify and describe the following:   + physical and chemical properties used to classify matter   + difference between chemical and physical changes   + three normal states of matter * Use various chemical laws to explain behavior of gases, and the relationships among pressure,   volume, temperature, and number of  particles in a gas sample   * Use the ideal gas law to perform calculations * Describe and contrast the properties of gases, liquids, and solids, using the kinetic molecular theory |
| **1.3** | Describe the three normal states of matter (solid, liquid, gas) in terms of energy, particle motion, and phase transitions. |
| **6.1** | Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle’s law), volume and temperature (Charles’s law), pressure and temperature (Gay-Lussac’s law), and the number of particles in a gas sample (Avogadro’s hypothesis). Use the combined gas law to determine changes in pressure, volume, and temperature. |
| **6.2** | Perform calculations using the ideal gas law. Understand the molar volume at 273K and 1 atmosphere (STP). |
| **6.3** | Using the kinetic molecular theory, describe and contrast the properties of gases, liquids, and solids. Explain, at the molecular level, the behavior of matter as it undergoes phase transitions. |

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| ENTRY POINTS to  Physical Science (Chemistry) Standards in High School |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
| --- | --- | --- | --- |
| **States of Matter, Kinetic Molecular Theory, and Thermo-chemistry** | * Identify physical properties of matter * Identify chemical properties of matter   *Continue to address earlier standards in this topic at a level that challenges the student* | * Give examples of physical properties of matter * Give examples of chemical properties of matter * Classify matter by physical properties * Classify matter by chemical properties * Identify materials that have undergone a physical change (can be returned to original material by performing a physical change; e.g., ice to water to ice) * Identify materials that have undergone a chemical change (cannot be returned to original material; e.g., rusting) * Describe changes in volume as a result of changes in temperature and/or pressure | * Compare and contrast physical and chemical properties of matter * Explain molecular level changes in a gas as the temperature/pressure changes * Describe how materials can undergo either a physical or chemical change * Distinguish between chemical and physical changes   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Physical Science (Chemistry)**

**3–5**

# **CONTENT** Science and Technology/Engineering

**STRAND** Physical Science (Chemistry)

**Learning Standards for:**

## Forms of Energy

|  |  |  |  |
| --- | --- | --- | --- |
| Grade Level: 3–5 | | | |
| Topic | | Learning Standards as written | | Essence of the Standard(s) |
| Forms of Energy | **4** | Identify the basic forms of energy (light, sound, heat, electrical, and magnetic). Recognize that energy is the ability to cause motion or create change. | * Identify basic forms of energy * Demonstrate the transference of energy from one form to another |
| **5** | Give examples of how energy can be transferred from one form to another. |

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| ENTRY POINTS and ACCESS SKILLS to  Physical Science (Chemistry) Standards in Grades 3–5 |

**Less Complex More Complex**

|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
| --- | --- | --- | --- | --- |
|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Forms of Energy** | * Track materials related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Shift focus from materials to speaker in an activity related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Grasp materials related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Use two hands to hold materials related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Release materials related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) | * Compare objects based on forms of energy (e.g., hot/cold, moving/still, loud/quiet, magnetic/ nonmagnetic) * Identify objects or visual representations of objects based on forms of energy (e.g., hot/cold, moving/still, loud/quiet, magnetic/ nonmagnetic) * Identify basic forms of energy | * Match each basic form of energy to its uses (e.g., electrical to light) | * Give examples of each basic form of energy   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Physical Science (Chemistry) Standards in Grades 3–5 |

**Less Complex More Complex**

|  |  |  |
| --- | --- | --- |
|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Forms of Energy (continued)** | * Move materials related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Orient materials related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Manipulate objects related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Locate objects partially hidden or out of sight needed in an activity related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Use one object to act on another in an activity related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) (e.g., use a drum stick to make a drum vibrate) * Turn on technology in an activity related to basic forms of energy(i.e., light, sound, heat, electrical, and/or magnetic) * Imitate action in an activity related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Initiate cause-and-effect response during an activity related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Sustain through response in an activity related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Gain attention during activity related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Make a request during an activity (e.g., request a turn) related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Respond to materials related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) * Attend visually, aurally, or tactilely to materials related to basic forms of energy (i.e., light, sound, heat, electrical, and/or magnetic) |  |

**Science and Technology/ Engineering**

**Physical Science (Chemistry)**

**6–8**

# **CONTENT** Science and Technology/Engineering

**STRAND** Physical Sciences (Chemistry and Physics)

**Learning Standards for:**

## Forms of Energy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Grade Level: 6 – 8 | | | | |
| Topic | | Learning Standards as written | | | Essence of the Standard(s) |
| Forms of Energy | | **13** | Differentiate between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa. | * Define and compare potential and kinetic energy * Identify and explain the following:   + states of matter at the molecular level   + heat movement and equilibrium |
| **14** | Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system. |
| **16** | Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium. |

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| ENTRY POINTS to  Physical Science (Chemistry) Standards in Grades 6–8 |

**Less Complex More Complex**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **The student will:** | **The student will:** | **The student will:** |
| **Forms of Energy** | * Demonstrate the impact of heating on the movement of molecules * Identify objects as having potential or kinetic energy * Record readings from a temperature gauge   *Continue to address earlier standards in this topic at a level that challenges the student* | * Identify that the energy of an object is related to its position (e.g., a car parked on a hill has potential energy; a moving car has kinetic energy) * Describe how the temperature of objects can be changed or controlled * Record predictions about an object or material based on the likelihood that its temperature will either rise or fall | * Compare and contrast kinetic and potential energy * Describe how heat moves and equilibrium is achieved (e.g., hot items will cool down over time) * Evaluate predictions about an object or material based on the likelihood that its temperature will either rise or fall   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Chemistry**

**High School**

# **CONTENT** Science and Technology/Engineering

**STRAND** Physical Science (Chemistry)

**Learning Standards for:**

## Forms of Energy

|  |  |  |  |
| --- | --- | --- | --- |
| Grade Level: High School | | | |
| Topic | | Learning Standards as written | | Essence of the Standard(s) |
| Forms of Energy | **6.4** | Describe the law of conservation of energy. Explain the difference between an endothermic process and an exothermic process. | * Explain the law of conservation of energy * Explain endothermic and exothermic processes * Recognize the tendency toward disorder and randomness |
| **6.5** | Recognize that there is a natural tendency for systems to move in a direction of disorder or randomness (entropy). |

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| ENTRY POINTS to  Physical Science (Chemistry) Standards in High School |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
| --- | --- | --- | --- |
| **Forms of Energy** | * Identify forms of electrical energy * Identify forms of mechanical energy * Classify processes as either an endothermic (absorbs energy) or exothermic (releases energy) process   *Continue to address earlier standards in this topic at a level that challenges the student* | * Explain the transfer of energy from one type to another (e.g., mechanical to heat, chemical to electrical) * Identify examples of endothermic and/or exothermic processes * Describe reactions that occur more readily when heat is added (e.g., dissolution of sugar in water) | * Illustrate how chemical reactions can produce heat (i.e., exothermic), such as explosions or plaster hardening * Explain how energy is transferred from an object when it strikes or collides with another object (e.g., bowling ball striking pins, marbles colliding)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Chemistry**

**6–8**

# **CONTENT** Science and Technology/Engineering

**STRAND** Physical Science (Chemistry)

**Learning Standards for:**

## Elements, Compounds and Mixtures; Atomic Structure

## and Nuclear Chemistry

|  |  |  |  |
| --- | --- | --- | --- |
| Grade Level: 6–8 | | | |
| Topic | Learning Standards as written | | Essence of the Standard(s) |
| Elements, Compounds, and Mixtures;  Atomic  Structure and Nuclear Chemistry | **5** | Recognize that there are more than 100 elements that combine in a multitude of ways to produce compounds that make up all of the living and nonliving things that we encounter. | * Define and differentiate between the following:   + elements and compounds   + atoms and molecules   + pure substances and mixtures |
| **6** | Differentiate between an atom (the smallest unit of an element that maintains the characteristics of that element) and a molecule (the smallest unit of a compound that maintains the characteristics of that compound). |
| **7** | Give basic examples of elements and compounds. |
| **8** | Differentiate between mixtures and pure substances. |

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| ENTRY POINTS and ACCESS SKILLS to  Physical Science (Chemistry) Standards in Grades 6−8 |

**Less Complex More Complex**

|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
| --- | --- | --- | --- | --- |
|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Elements, Com-pounds, and Mixtures; Atomic**  **Structure and Nuclear Chemistry** | * Match picture to picture using pictures of solid objects * Track materials related to pure substances or mixtures, or models of molecular structure * Shift focus from materials to speaker in an activity related to pure substances or mixtures, or models of molecular structure * Grasp materials related to pure substances or mixtures, or models of molecular structure * Use two hands to hold materials related to pure substances or mixtures, or models of molecular structure (e.g., use two hands to participate in experiments to remove salt from sand by adding water and filtering the mixture) | * Give examples of elements * Match elements to their symbol in the periodic table | * Describe elements that can combine to form a compound * Identify elements based on their symbols in the periodic table | * Illustrate how atoms combine to form molecules * Classify substances as either mixtures (soil, sea salt) or pure substances (water, diamonds, table salt)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Physical Science (Chemistry) Standards in Grades 6−8 |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Elements, Compounds, and Mixtures; Atomic Structure and Nuclear Chemistry (continued)** | * Release materials related to pure substances or mixtures, or models of molecular structure * Move materials related to pure substances or mixtures, or models of molecular structure * Orient materials related to pure substances or mixtures, or models of molecular structure * Manipulate objects related to pure substances or mixtures, or models of molecular structure * Locate objects partially hidden or out of sight needed in an activity related to pure substances or mixtures, or models of molecular structure * Use one object to act on another in an activity related to pure substances or mixtures, or models of molecular structure * Turn on technology in an activity related to pure substances or mixtures, or models of molecular structure * Imitate action in an activity related to pure substances or mixtures, or models of molecular structure * Initiate cause-and-effect response during an activity related to pure substances or mixtures, or models of molecular structure * Sustain through response in an activity related to pure substances or mixtures, or models of molecular structure * Gain attention during activity related to pure substances or mixtures, or models of molecular structure * Make a request during an activity (e.g., request a turn) related to pure substances or mixtures, or models of molecular structure * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to pure substances or mixtures, or models of molecular structure * Respond to materials related to pure substances or mixtures, or models of molecular structure * Attend visually, aurally, or tactilely to materials related to pure substances or mixtures, or models of molecular structure |  |

**Science and Technology/ Engineering**

**Physical Science**

**(Chemistry)**

**High School**

# **CONTENT** Science and Technology/Engineering

**STRAND** Physical Sciences (Chemistry and Physics)

**Learning Standards for:**

## Elements, Compounds and Mixtures; Atomic Structure

## and Nuclear Chemistry

## Periodicity

## Chemical Bonding

## Reactions and Stoichiometry

## Solutions, Rates of Reaction, and Equilibrium

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| --- | --- | --- | --- |
| Grade Level: High School | | | |
| Topic | | Learning Standards as written | | Essence of the Standard(s) |
| Elements, Compounds and  Mixtures; Atomic Structure and Nuclear Chemistry | **1.2** | Explain the difference between pure substances (elements and compounds) and mixtures. Differentiate between heterogeneous and homogeneous mixtures. | * Identify and describe the difference between pure substances and mixtures * Recognize the following discoveries leading to modern atomic theory   + major components of atoms   and their interaction   * + laws of conservation of mass,   + constant composition, and multiple proportions * Write electron configurations * Identify types and explain properties and process of radioactive decay * Compare nuclear fission and nuclear fusion |
| **2.1** | Recognize discoveries from Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of atom) and understand how these discoveries lead to the modern theory. |
| **2.2** | Describe Rutherford’s “gold foil” experiment that led to the discovery of the nuclear atom. Identify the major components (protons, neutrons, and electrons) of the nuclear atom and explain how they interact. |
| **2.3** | Interpret and apply the laws of conservation of mass, constant composition (definite proportions), and multiple proportions. |
| **2.4** | Write the electron configurations for the first twenty elements of the periodic table. |
| **2.5** | Identify the three main types of radioactive decay (alpha, beta, and gamma) and compare their properties (composition, mass, charge, and penetrating power). |
| **2.6** | Describe the process of radioactive decay by using nuclear equations and explain the concept of half-life for an isotope, for example, C-14 is a powerful tool in determining the age of objects. |
| **2.7** | Compare and contrast nuclear fission and nuclear fusion. |
| Periodicity | **3.1** | Explain the relationship of an element’s position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table. | * Explain positions on the periodic table of elements and relevance of position to atomic number * Use periodic table to identify three classes of elements * Compare and contrast position of an element on the periodic table to its electron configuration and reactivity * Identify trends on the periodic table |
| **3.2** | Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids. |
| Periodicity  (cont.) | **3.3** | Relate the position of an element on the periodic table to its electron configuration and compare its reactivity with other elements in the table. |
| **3.4** | Identify trends on the periodic table (ionization energy, electronegativity, and relative size of atoms and ions). |
| Chemical Bonding | **4.1** | Explain how atoms combine to form compounds through both ionic and covalent bonding. Predict chemical formulas based on the number of valence electrons. | * Explain how atoms combine to form compounds through ionic and covalent bonding * Draw Lewis dot structures * Explain the difference between polar and nonpolar covalent bonds * Predict the electron geometry of simple molecules * Identify the characteristics and   effects of hydrogen bonding in water   * Name and write chemical formulas for simple ionic and molecular compounds |
| **4.2** | Draw Lewis dot structures for simple molecules and ionic compounds. |
| **4.3** | Use electronegativity to explain the difference between polar and nonpolar covalent bonds. |
| **4.4** | Use valence-shell electron-pair repulsion theory (VSEPR) to predict the electron geometry (linear, trigonal planar, and tetrahedral) of simple molecules. |
| **4.5** | Identify how hydrogen bonding in water affects a variety of physical, chemical, and biological phenomena (such as, surface tension, capillary action, density, and boiling point). |
| **4.6** | Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain the polyatomic ions: ammonium, carbonate, hydroxide, nitrate, phosphate, and sulfate. |
| Reactions and Stoichiometry | **5.1** | Balance chemical equations by applying the laws of conservation of mass and constant composition (definite proportions). | * Balance chemical equations * Classify chemical reactions * Determine the number of particles * and molar mass using the mole concept * Determine percent compositions,   empirical formulas, and molecular  formulas   * Calculate the mass-to-mass stoichiometry and the percent yield   for a chemical reaction   * Calculate a percent yield for a chemical reaction |
| **5.2** | Classify chemical reactions as synthesis (combination), decomposition, single displacement, double displacement, and combustion. |
| **5.3** | Use the mole concept to determine the number of particles and the molar mass of elements and compounds. |
| **5.4** | Determine percent compositions, empirical formulas, and molecular formulas. |
| **5.5** | Calculate the mass-to-mass stoichiometry for a chemical reaction. |
| **5.6** | Calculate percent yield in a chemical reaction. |
| Solutions,  Rates of  Reaction, and Equilibrium | **7.1** | Describe the process by which solutes dissolve in solvents. | * Describe how solutes dissolve in   solvents   * Calculate concentration in terms of molarity * Describe factors affecting the rate at which solutes dissolve * Compare and contrast the properties of solutions and solvents |
| **7.2** | Calculate concentration in terms of molarity. Use molarity to perform solution dilution and solution stoichiometry. |
| **7.3** | Identify and explain the factors that affect the rate of dissolving, such as, temperature, concentration, surface area, pressure, and mixing. |
| Solutions, Rates of  Reaction, and  Equilibrium  (cont.) | **7.4** | Compare and contrast qualitatively the properties of solutions and pure solvents (colligative properties such as boiling point and freezing point). | * Identify factors that affect rate of a chemical reaction * Predict shift in equilibrium as a result of stress and other factors |
| **7.5** | Identify the factors that affect the rate of a chemical reaction (temperature, mixing, concentration, particle size, surface area, and catalyst). |
| **7.6** | Predict the shift in equilibrium when the system is subjected to a stress (LeChatelier’s principle) and identify the factors that can cause a shift in equilibrium (concentration, pressure, volume, temperature). |
| Acids and Bases and Oxidation- Reduction | **8.1** | Define the Arrhenius theory of acids and bases in terms of the presence of hydronium and hydroxide ions in water and the Bronsted-Lowry theory of acids and bases in terms of proton donor and acceptor. | * Give basic definitions of acids and bases * Understand the differences between the Arrhenius and Bronsted-Lowry   theories   * Apply the pH scale to measure, compare, and contrast strength for common acids and bases * Explain how a buffer works * Describe and give everyday examples of oxidation and reduction reactions |
| **8.2** | Relate hydrogen ion concentrations to the pH scale, and to acidic, basic, and neutral solutions. Compare and contrast the strength of various common acids and bases such as vinegar, baking soda, soap, and citrus juice. |
| **8.3** | Explain how a buffer works. |
| **8.4** | Describe oxidation and reduction reactions and give some every day examples, such as, fuel burning, corrosion. Assign oxidation numbers in a reaction. |

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| ENTRY POINTS and ACCESS SKILLS to  High School Chemistry |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
| **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Elements, Com-pounds, and Mixtures; Atomic Structure and Nuclear Chemistry** | *Access skills for this topic can be found under the Grades: 6–8 Learning Standards* | * Label parts of the atom (protons, neutrons, and electrons) * Label different atoms in a mixture * Label the compound formed when two or more atoms bond * Match electron configurations to one or more elements   *Continue to address earlier standards in this topic at a level that challenges the student* | * Classify familiar matter as a substance or mixture * Classify mixtures as heterogeneous or homogeneous * Describe the differences between protons, neutrons, and electrons * Compare electron configurations of one or more elements | * Describe the function or purpose of protons, neutrons, and/or electrons * Describe the difference between nuclear fission and nuclear fusion * Explain radioactive decay * Give examples of the three types of radioactive decay   *Continue to address skills and concepts in this strand that approach grade-level expectations* |
| **Periodicity** | * Track materials related to the Periodic Table or chemical bonding * Shift focus from materials to speaker in an activity related to the Periodic Table or chemical bonding * Grasp materials related to the Periodic Table or chemical bonding | * Classify elements in the Periodic Table as metals, non-metals, or metalloids * Match element to its atomic symbol and/or atomic number   *Continue to address earlier standards in this topic at a level that challenges the student* | * Identify the layout of the Periodic Table that allows recognition of features of a particular element * Identify metals and nonmetals using the Periodic Table | * Describe characteristics of elements based on their placement in the Periodic Table * Differentiate atoms that can bond with other atoms from those that cannot * Identify or illustrate the atomic composition of elements   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  High School Chemistry |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Periodicity (continued)** | * Use two hands to hold materials related to the Periodic Table or chemical bonding * Release materials related to the Periodic Table or chemical bonding * Move materials related to the Periodic Table or chemical bonding * Orient materials related to the Periodic Table or chemical bonding * Manipulate objects related to the Periodic Table or chemical bonding * Locate objects partially hidden or out of sight needed in an activity related to the Periodic Table or chemical bonding * Use one object to act on another in an activity related to the Periodic Table or chemical bonding * Turn on technology in an activity related to the Periodic Table or chemical bonding (e.g. activate a computer program to play a periodic table game) * Imitate action in an activity related to the Periodic Table or chemical bonding * Initiate cause-and-effect response during an activity related to the Periodic Table or chemical bonding * Sustain through response in an activity related to the Periodic Table or chemical bonding * Gain attention during activity related to the Periodic Table or chemical bonding * Make a request during an activity (e.g., request a turn) related to the Periodic Table or chemical bonding * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to the Periodic Table or chemical bonding * Respond to materials related to the Periodic Table or chemical bonding * Attend visually, aurally, or tactilely to materials related to the Periodic Table or chemical bonding |  |

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| ENTRY POINTS to  High School Chemistry |

**Less Complex More Complex**

|  | | **The student will:** | | **The student will:** | **The student will:** |
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| **Chemical Bonding** | * Identify new materials (compounds) that are formed by combining two or more elements   *Continue to address earlier standards in this topic at a level that challenges the student* | | * Describe properties of each substance in a compound (e.g., sodium + chloride 🡪 NaCl (salt) * Describe how atoms bond in order to create compounds and molecules * List properties of ionic and/or covalent compounds | | * Differentiate between ionic and covalent bonding * Illustrate how atoms seek stability by maximizing (completing) the outermost electron level * Illustrate that different properties exist between reactants and end product (Na + Cl 🡪 NaCl) * Describe the unique chemical and physical characteristics of water   *Continue to address skills and concepts in this strand that approach grade-level expectations* |
| **Reactions and Stoi-chiometry** | * Illustrate the creation of various mixtures and compounds at the molecular level   *Continue to address earlier standards in this topic at a level that challenges the student* | | * Describe the characteristics of chemical reactions * Classify chemical reactions as either synthesis (combination) or decomposition * Identify the mole as a way of counting the number of atoms | | * Create chemical equations to represent a chemical reaction between reactants and product (result) * Balance simple chemical equations * Determine the number of moles in a chemical equation (e.g., H2 + O 🡪 H2O means that two moles of H and one mole of O combine to make one mole of water)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ENTRY POINTS to  High School Chemistry |

**Less Complex More Complex**

|  | | **The student will:** | | **The student will:** | | **The student will:** |
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| **Solutions, Rates of Reactions, and Equil-ibrium** | * Identify the combination of various substances in which the substances dissolve in a liquid as a solution * Identify the combination of various substances in which the substances do not change characteristics as a mixture * Identify the solute and the solvent in a solution * Give examples of solutes that dissolve in solvents   *Continue to address earlier standards in this topic at a level that challenges the student* | | * Identify factors affecting the rate at which solutes dissolve   (e.g., temperature, mixing, concentration, surface area)   * Compare and contrast the properties of solutions and solvents * Identify solutes that dissolve more easily than others | | * Describe how various factors affect the rate at which solutes dissolve * Determine the concentration of a solution in terms of molarity   *Continue to address skills and concepts in this strand that approach grade-level expectations* | |
| **Acids and Bases and Oxidation- Reduction Reactions** | * Identify the characteristics of acids and/or bases * Give examples of acids * Give examples of bases   *Continue to address earlier standards in this topic at a level that challenges the student* | | * Classify acids/bases by the way they react using litmus paper (i.e., acids turn the paper red, bases turn the paper blue) * Explain the basic pH scale (i.e., 7 is neutral, >7 is basic, <7 is acidic) | | * Use the pH scale to classify substances that are more/less acidic, more/less basic * Provide real-life examples of simple oxidation and reduction reactions * Provide examples of real-life situations in which a pH buffer would be used   *Continue to address skills and concepts in this strand that approach grade-level expectations* | |

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| TECHNOLOGY/ENGINEERING | | | |
| **Topics**  **Grades Pre-K – 2** | **Topics**  **Grades 3 – 5** | **Topics**  **Grades 6 – 8** | **Topics**  **High School** |
| **Materials, Tools, and Machines**  Pages S33–S35 | **Materials, Tools, and Machines**  Pages S36–S37 | **Materials, Tools, and Machines**  Pages S38–S39 | **Materials, Tools, and Machines**  Page S40 |
| Engineering Design Pages S41–S43 | Engineering Design Pages S44–S45 | Engineering Design Pages S46–S47 | Engineering Design Pages S48–S49 |
| **--** | **--** | **Communication**  Pages S50, S52–S53 | **Communication**  Pages S62, S64 |
| **--** | **--** | **Manufacturing**  Pages S50, S54–S55 | **Manufacturing**  Pages S62, S65 |
| **--** | **--** | **Construction**  Pages S50–S51, S56–S57 | **Construction**  Pages S62–S63, S66 |
| **--** | **--** | **Transportation**  Pages S51, S58–S59 | **--** |
| **--** | **--** | **Bioengineering**  Pages S51, S60–S61 | **--** |
| **--** | **--** | **--** | **Fluid Systems**  Pages S63, S67–S68  **Thermal Systems**  Pages S63, S69–S70  **Electrical Systems**  Pages S63, S71–S72 |

**Science and Technology/ Engineering**

**Technology/ Engineering**

**Pre-K – 2**

# **CONTENT** Science and Technology/Engineering

**STRAND** Technology/Engineering

**Learning Standards for:**

## Materials, Tools, and Machines

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| --- | --- | --- | --- |
| Grade Level: Pre-K – 2 | | | |
| Topic | | Learning Standards as written | | Essence of the Standard(s) |
| Materials, Tools, and Machines | **1.1** | Identify and describe characteristics of natural materials (e.g., wood, cotton, fur, wool) and human-made materials (e.g., plastic, Styrofoam). | * Identify the following:   + characteristics/uses of natural materials   + characteristics/uses of human-made materials   + safe and proper use of tools and materials |
| **1.2** | Identify and explain some possible uses for natural materials (e.g., wood, cotton, fur, wool) and human-made materials (e.g., plastic, Styrofoam). |
| **1.3** | Identify and describe the safe and proper use of tools and materials (e.g., glue, scissors, tape, ruler, paper, toothpicks, straws, spools) to construct simple structures. |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in Grades Pre-K−2 |

**Less Complex More Complex**

|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
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|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Materials, Tools, and Machines** | * Match object-to-object, picture-to-picture or object-to-picture of machines or tools * Track objects related to materials, tools, and/or machines * Shift focus from objects to speaker in an activity related to materials, tools, and/or machines * Grasp objects related to materials, tools, and/or machines (e.g., grasp tape, paper, ruler, straw to construct a project) * Use two hands to hold materials, tools, or machines * Release objects related to materials, tools, and/or machines * Move objects related to materials, tools, and/or machines * Orient objects related to materials, tools, and/or machines | * Identify a variety of human-made materials (e.g., plastic, Styrofoam) * Identify a variety of natural materials (e.g., wood, cotton, fur, wool) * Identify a variety tool (e.g., scissors, tape, ruler, hammer) | * Describe the characteristics of natural and/or human-made materials * Match a simple tool to its function * Classify materials as human-made or naturally occurring * Document appropriate uses for human-made materials * Document appropriate uses for natural materials | * Indicate proper use of one or more tools and/or materials used to construct objects (e.g., glue, scissors, tape, ruler, paper, toothpicks, straws)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in Grades Pre-K−2 |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Materials, Tools, and Machines (continued)** | * Manipulate objects related to materials, tools, and/or machines * Locate objects partially hidden or out of sight needed in an activity related to materials, tools, and/or machines * Use one object to act on another in an activity related to materials, tools, and/or machines * Turn on technology in an activity related to materials, tools, and/or machines * Imitate action in an activity related to materials, tools, and/or machines (e.g. imitate a partner using a hammer) * Initiate cause-and-effect response during an activity related to materials, tools, and/or machines * Sustain through response in an activity related to materials, tools, and/or machines * Gain attention during activity related to materials, tools, and/or machines * Make a request during an activity (e.g., request a turn) related to materials, tools, and/or machines * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to materials, tools, and/or machines * Respond to materials related to materials, tools, and/or machines * Attend visually, aurally, or tactilely to materials, tools, and/or machines |  |

**Science and Technology/ Engineering**

**Technology/ Engineering**

**3 – 5**

# **CONTENT** Science and Technology/Engineering

**STRAND** Technology/Engineering

**Learning Standards for:**

## Materials, Tools, and Machines

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| --- | --- | --- | --- | --- |
| Grade Level: 3 – 5 | | | | |
| Topic | Learning Standards as written | | Essence of the Standard(s) |
| Materials, Tools, and Machines | | **1.1** | Identify materials used to accomplish a design task based on a specific property, i.e., weight, strength, hardness, and flexibility. | * Identify the following:   + appropriate materials to accomplish a design task based on specific properties of each material   + appropriate and safe use of tools in order to construct an object   + simple vs. complex machines |
|  | | **1.2** | Identify and explain the appropriate materials and tools (e.g., hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) to construct a given prototype safely. |
|  | | **1.3** | Identify and explain the difference between simple and complex machines, e.g., hand can opener that includes multiple gears, wheel, wedge gear, and lever. |

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| ENTRY POINTS to  Technology/Engineering Standards in Grades 3−5 |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
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| **Materials, Tools, and Machines** | * Identify one or more properties of materials used to accomplish a design task * Identify various materials according to a characteristic (e.g., hard, flexible, soft) * Identify the use a variety of familiar tools (e.g., paper clips, tape measure) to accomplish a design task * Identify simple machines (e.g., ramps, wedges, levers, pulleys, axles, gears, wheels)   *Continue to address earlier standards in this topic at a level that challenges the student* | * Match the appropriate use of materials to accomplish a design task (e.g., the use of steel to build a bridge is appropriate for its strength and flexibility) * Classify simple machines (e.g., ramps, wedges, levers, pulleys, axles, gears, wheels) * Compare simple and complex machines | * Identify specific properties of materials needed to accomplish a design task (e.g., weight, strength, hardness, flexibility) * Identify simple machines within a complex machine * Describe how simple machines combine to make complex machines (e.g., scissors are made up of a pair of levers)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Technology/ Engineering**

**6 – 8**

# **CONTENT** Science and Technology/Engineering

**STRAND** Technology/Engineering

**Learning Standards for:**

## Materials, Tools, and Machines

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| --- | --- | --- | --- | --- |
| Grade Level: 6 – 8 | | | | |
| Topic | Learning Standards as written | | Essence of the Standard(s) |
| Materials, Tools, and Machines | | **1.1** | Given a design task, identify appropriate materials  (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g., weight, strength, hardness, and flexibility). | * Identify and describe the following:   + appropriate materials used to accomplish a design task, based on specific properties and characteristics   + appropriate tools for specific applications   + appropriate and safe use of tools and machines |
|  | | **1.2** | Identify and explain appropriate measuring tools, hand tools, and power tools used to hold, lift, carry, fasten, and separate, and explain their safe and proper use. |
|  | | **1.3** | Identify and explain the safe and proper use of measuring tools, hand tools, and machines (e.g., band saw, drill press, sanders, hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) needed to construct a prototype of an engineering design. |

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| ENTRY POINTS to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
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| **Materials, Tools, and Machines** | * Identify measuring tools, hand tools, and/or power tools (e.g., band saw, drill, hammer, screwdriver, pliers, tape measure)   *Continue to address earlier standards in this topic at a level that challenges the student* | * Match measuring tools, hand tools, and/or power tools to their functions | * Choose measuring tools, hand tools, and/or power tools based on their specific properties in order to accomplish a specific design task * Describe and/or demonstrate the safe and proper use of complex tools (e.g., measuring tools, hand tools, and/or power tools)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Technology/ Engineering**

**High School**

# **CONTENT** Science and Technology/Engineering

**STRAND** Technology/Engineering

**Learning Standards for:**

## Materials, Tools, and Machines

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| --- | --- | --- | --- |
| Grade Level: High School | | | |
| Topic | | Learning Standards as written | | Essence of the Standard(s) |
| Materials, Tools, and Machines | **2.5** | Identify and demonstrate the safe and proper use of common hand tools and/or power tools and measurement devices used in construction. | * Identify, explain and/or demonstrate knowledge of safe and proper use of common hand and/or power tools and measurement devices |

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| ENTRY POINTS to  High School Technology/Engineering Standards |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
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| **Materials, Tools, and Machines** | * Identify common hand tools   *Continue to address earlier standards in this topic at a level that challenges the student* | * Match measurement devices to their appropriate function | * Document safe and proper use of common hand, power tools, and/or measurement devices   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Technology/ Engineering**

**Pre-K – 2**

# **CONTENT** Science and Technology/Engineering

**STRAND** Technology/Engineering

**Learning Standards for:**

## Engineering Design

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Grade Level: Pre-K – 2 | | | | |
| Topic | Learning Standards as written | | Essence of the Standard(s) |
| Engineering Design | | **2.1** | Identify tools and simple machines used for a specific purpose, e.g., ramp, wheel, pulley, lever. | * Identify tools and simple machines used for specific purposes * Describe human body parts that act as tools and their animal counterparts |
| **2.2** | Describe how human beings use parts of the body as tools (e.g., teeth for cutting, hands for grasping and catching) and compare their use with the ways in which animals use those parts of their bodies. |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in Grades Pre-K−2 |

**Less Complex More Complex**

|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
| --- | --- | --- | --- | --- |
|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Engineer-ing Design** | * Match object-to-object, picture-to-picture or object-to-picture of tools * Match object to diagrams/plans or representational picture of the object * Track materials related to simple machines and/or tools, or engineering design process * Shift focus from materials to speaker in an activity related to simple machines and/or tools, or engineering design process (e.g., shift focus from a diagram or a picture to a model made with Legos) * Grasp materials related to simple machines and/or tools, or engineering design process | * Identify parts of the human body that act as tools (e.g., teeth for cutting, fingers for grasping) * Identify body parts of animals that act as tools (e.g., webbed feet for paddling, long teeth for gnawing) * Identify tools used for specific purposes | * Describe how specific tools accomplish a given task * Describe the functions of simple machines (ramps, wedges, levers, pulleys, axles, gears, wheels) | * Describe how specific body parts are used to accomplish tasks (e.g., open the door by turning the doorknob with a hand, kick a soccer ball with a foot) * Describe how animals use parts of their bodies to accomplish certain tasks (e.g., a beaver uses its teeth to cut down a tree)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in Grades Pre-K−2 |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Engineering Design (continued)** | * Use two hands to hold materials related to simple machines and/or tools, or engineering design process * Release materials related to simple machines and/or tools, or engineering design process * Move materials related to simple machines and/or tools, or engineering design process * Orient materials related to simple machines and/or tools, or engineering design process * Manipulate objects related to simple machines and/or tools, or engineering design process (e.g., control a pulley to send a flag across the room ) * Locate objects partially hidden or out of sight needed in an activity related to simple machines and/or tools, or engineering design process * Use one object to act on another in an activity related to simple machines and/or tools, or engineering design process * Turn on technology in an activity related to simple machines and/or tools, or engineering design process * Imitate action in an activity related to simple machines and/or tools, or engineering design process * Initiate cause-and-effect response during an activity related to simple machines and/or tools, or engineering design process * Sustain through response in an activity related to simple machines and/or tools, or engineering design process * Gain attention during activity related to simple machines and/or tools, or engineering design process * Make a request during an activity (e.g., request a turn) related to simple machines and/or tools, or engineering design process * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to simple machines and/or tools, or engineering design process * Respond to materials related to simple machines and/or tools, or engineering design process * Attend visually, aurally, or tactilely to materials related to simple machines and/or tools, or engineering design process |  |

**Science and Technology/ Engineering**

**Technology/ Engineering**

**3 – 5**

# **CONTENT** Science and Technology/Engineering

**STRAND** Technology/Engineering

**Learning Standards for:**

## Engineering Design

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| --- | --- | --- | --- |
| Grade Level: 3 – 5 | | | |
| Topic | | Learning Standards as written | | Essence of the Standard(s) |
| Engineering Design | **2.1** | Identify a problem that reflects the need for shelter, storage, or convenience. | * Identify and describe the following:   + a problem that identifies a need for shelter, storage, or convenience   + ways to represent a problem   + design features for building or solving a problem   + natural and mechanical systems that serve similar purposes |
|  | **2.2** | Describe different ways in which a problem can be represented, e.g., sketches, diagrams, graphic organizers, and lists. |
|  | **2.3** | Identify relevant design features (e.g., size, shape, weight) for building a prototype of a solution to a given problem. |
|  | **2.4** | Compare natural systems with mechanical systems that are designed to serve similar purposes, e.g., a bird’s wings as compared to an airplane’s wings. |

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| ENTRY POINTS to  Technology/Engineering Standards in Grades 3−5 |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
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| **Engineering Design** | * Identify the uses of various shelters (e.g., protection from weather or predators, storage) * Distinguish between natural and mechanical systems intended to accomplish the same function   *Continue to address earlier standards in this topic at a level that challenges the student* | * Draw a picture/diagram of a specific object to be constructed * Identify the purposes of different body parts of animals; e.g., birds use wings to fly, bats use mouth and ears for vocalization, hearing, and echolocation (to navigate territory) * Identify mechanical systems that accomplish a function similar to a natural system (e.g., planes use wings to fly, ships use sonar to navigate territory) | * Describe and/or list various options and solutions to a design problem * Compare characteristics of common materials needed to build a prototype (e.g., hardness, durability, flexibility) * Compare natural systems with mechanical systems that are designed to serve similar purposes (e.g., a bird’s wings as compared to an airplane’s wings)   *Continue to address skills and concepts in this subject that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Technology/ Engineering**

**6 – 8**

# **CONTENT** Science and Technology/Engineering

**STRAND** Technology/Engineering

**Learning Standards for:**

## Engineering Design

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| --- | --- | --- | --- | --- |
| Grade Level: 6 – 8 | | | | |
| Topic | Learning Standards as written | | Essence of the Standard(s) |
| Engineering Design | | **2.1** | Identify and explain the steps of the engineering design process, i.e., identify the need or problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign. | * Identify and describe the following:   + steps of the engineering design process   + methods of representing solutions to a design problem   + purpose of a constructed prototype   + appropriate tools and materials needed to construct a prototype   + design features of a given prototype and their effects on the outcome and cost   + components of a universal systems model |
|  | | **2.2** | Demonstrate methods of representing solutions to a design problem, e.g., sketches, orthographic projections, multiview drawings. |
|  | | **2.3** | Describe and explain the purpose of a given prototype. |
|  | | **2.4** | Identify appropriate materials, tools, and machines needed to construct a prototype of a given engineering design. |
|  | | **2.5** | Explain how such design features as size, shape, weight, function, and cost limitations would affect the construction of a given prototype. |
|  | | **2.6** | Identify the five elements of a universal systems model: goal, inputs, processes, outputs, and feedback. |

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| ENTRY POINTS to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
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| **Engineer-ing Design** | * List steps in the design process * Describe a design problem * Match possible solutions to a design problem * Generate a list of tools/materials/machines that are needed to solve a design problem * Document results of experiments with different materials used to address a design problem * Represent the steps of the universal systems model * Represent the steps of the engineering design process   *Continue to address earlier standards in this topic at a level that challenges the student* | * Sequence steps in the design process * Provide one possible solution to a design problem * Generate a list of tools/materials/machines that are needed construct a prototype * Define input/output components of a given design * Label the steps in the engineering design process needed to solve a design problem (e.g., identify a need, research the problem, propose a solution, design, identify appropriate tools and materials, build, test, evaluate, revise) | * Revise the solution to a design problem based on testing and evaluation * Provide multiple solutions to a design problem * Communicate the effectiveness of a prototype constructed to address a design problem * Justify choice of materials selected to construct a prototype * Describe each component of a universal systems model * Apply steps in the engineering design process needed to solve a design problem (e.g., identify a need, research the problem, propose a solution, design, identify appropriate tools and materials, build, test, evaluate, revise)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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**Science and Technology/ Engineering**

**Technology/ Engineering**

**High School**

# **CONTENT** Science and Technology/Engineering

**STRAND** Technology/Engineering

**Learning Standards for:**

## Engineering Design

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| Grade Level: High School | | | | |
| Topic | | Learning Standards as written | | | Essence of the Standard(s) |
| Engineering Design | | **1.1** | Identify and explain the steps of the engineering design process. The design process steps are identify the problem; research the problem; develop possible solutions; select the best possible solution(s); construct prototypes and/or models; test and evaluate; communicate the solutions; and redesign. | * Identify and describe the following:   + steps of the engineering design process   + uses and applications of the engineering design process   + production and analysis of pictorial and multi-view drawings   + scale and proportion applied to drawings and projections * Production and analysis of pictorial and multi-view drawings * Read plans, diagrams, and/or drawings to construct a model or prototype of an object |
|  | | **1.2** | Understand that the engineering design process is used in the solution of problems and the advancement of society. Identify and explain examples of technologies, objects, and processes that have been modified to advance society. |
|  | | **1.3** | Produce and analyze multi-view drawings (orthographic projections) and pictorial (isometric, oblique, perspective) drawings using various techniques. |
|  | | **1.4** | Interpret and apply scale and proportion to orthographic projections and pictorial drawings, such as, ¼” = 1’0”, 1 cm = 1 m. |
|  | | **1.5** | Interpret plans, diagrams, and working drawings in the construction of prototypes or models. |

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| ENTRY POINTS to  High School Technology/Engineering Standards |

**Less Complex More Complex**

|  | **The student will:** | **The student will:** | **The student will:** |
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| **Engineering Design** | * Match an object on a scaled diagram to the object it represents * Identify drawings that are incorrectly scaled * Represent the solution to a design problem using technology, manipulatives, models, or drawing tools * Represent the prototype in a design problem using technology, manipulatives, models, or drawing tools * Determine the scale used in a plan, model, diagram, or working drawing   *Continue to address earlier standards in this topic at a level that challenges the student* | * Create a two-dimensional representation of a three-dimensional object in a design problem, using technology, manipulatives, models, or drawing tools * Create a scaled two-dimensional representation of an object in a design problem, using measuring tools * Represent multiple views of an object in a design problem * Evaluate the accuracy of a scaled drawing | * Identify that an object not drawn to scale looks somewhat different than the actual object, but may be useful in accentuating certain features or characteristics of the object * Create a drawing to scale of a material or product, using appropriate measurement techniques, and label the scale * Describe the features of an object based on plans, diagrams, or working drawings * Apply plans, diagrams, and/or working drawings in the construction of prototypes and models * Evaluate the solution to a design problem by suggesting ways it could be improved   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

**Science and Technology/ Engineering**

**Technology/ Engineering**

**6 – 8**

# **CONTENT Science and Technology/Engineering**

**STRAND** Technology/Engineering

**Learning Standards for:**

## Communication

## Manufacturing

## Construction

## Transportation

## Bioengineering

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| --- | --- | --- | --- | --- |
| Grade Level: 6 – 8 | | | | |
| Topic | | Learning Standards as written | | | Essence of the Standard(s) |
| Communi-cation | | **3.1** | Identify and explain the components of a communication system, i.e., source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination. | * Identify and describe the following:   + components of a communication system   + communication tools, machines, and electronic devices   + similarities and differences among different communication technologies and systems   + use of symbols and icons for communication purposes |
| **3.2** | Identify and explain the appropriate tools, machines, and electronic devices (e.g., drawing tools, computer-aided design, and cameras) used to produce and/or reproduce design solutions (e.g., engineering drawings, prototypes, and reports). |
| **3.3** | Identify and compare communication technologies and systems, i.e., audio, visual, printed, and mass communication. |
| **3.4** | Identify and explain how symbols and icons (e.g., international symbols and graphics) are used to communicate a message. |
| Manufacturing | | **4.1** | Describe and explain the manufacturing systems of custom and mass production. | * Identify and describe the following:   + manufacturing systems for custom and mass production   + impacts of modern manufacturing technologies   + manufacturing organization   + basic manufacturing processes |
| **4.2** | Explain and give examples of the impacts of interchangeable parts, components of mass-produced products, and the use of automation, e.g., robotics. |
| **4.3** | Describe a manufacturing organization, e.g., corporate structure, research and development, production, marketing, quality control, distribution. |
| **4.4** | Explain basic processes in manufacturing systems, e.g., cutting, shaping, assembling, joining, finishing, quality control, and safety. |
| Construction | | **5.1** | Describe and explain parts of a structure, e.g., foundation, flooring, decking, wall, roofing systems. | * Identify and describe the following:   + parts of a structure   + types of bridges and their performances/uses/effects on structural loads   + forces on bridges |
| **5.2** | Identify and describe three major types of bridges (e.g., arch, beam, and suspension) and their appropriate uses (e.g., site, span, resources, and load). |

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| Construction  (cont.) | **5.3** | Explain how the forces of tension, compression, torsion, bending, and shear affect the performance of bridges. |  |
| **5.4** | Describe and explain the effects of loads and structural shapes on bridges. |
| Transportation | **6.1** | Identify and compare examples of transportation systems and devices that operate on each of the following: land, air, water, and space. | * Identify and describe:   + transportation systems operating on land, air, water, space   + subsystems of a transportation vehicle or device   + lift, drag, friction, thrust, and gravity in a vehicle or device * Provide a solution to a transportation problem using the universal design systems model |
| **6.2** | Given a transportation problem, explain a possible solution using the universal systems model. |
| **6.3** | Identify and describe three subsystems of a transportation vehicle or device, i.e., structural, propulsion, guidance, suspension, control, and support. |
| **6.4** | Identify and explain lift, drag, friction, thrust, and gravity in a vehicle or device, e.g., cars, boats, airplanes, rockets. |
| Bio-engineering | **7.1** | Explain examples of adaptive or assistive devices, e.g., prosthetic devices, wheelchairs, eyeglasses, grab bars, hearing aids, lifts, braces. | * Identify and describe the following:   + adaptive/assistive devices   + adaptive/assistive bio-engineered products |
| **7.2** | Describe and explain adaptive and assistive bioengineered products, e.g., food, bio-fuels, irradiation, integrated pest management. |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
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|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Communi-cation** | * Match object-to-object, picture-to-picture or object-to-picture of a communication tool * Track materials related to types of communication, or flow of information, or tools and/or symbols * Shift focus from materials to speaker in an activity related to types of communication, or flow of information, or tools and/or symbols * Grasp materials related to types of communication, or flow of information, or tools and/or symbols * Use two hands to hold materials related to types of communication, or flow of information, or tools and/or symbols | * Identify tools that help people communicate with one another * Match icons and symbols to the messages they represent | * Identify icons and symbols and the messages they represent * Represent the components of the communication system (i.e., source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination) | * Compare the effectiveness of various communication technologies and systems (e.g., audio, visual, printed, mass communication) * Produce a design solution using an electronic tool or application   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Communi-cation** | * Release materials related to types of communication, or flow of information, or tools and/or symbols * Move materials related to types of communication, or flow of information, or tools and/or symbols * Orient materials related to types of communication, or flow of information, or tools and/or symbols (e.g., orient communication book or icon) * Manipulate objects related to types of communication, or flow of information, or tools and/or symbols * Locate objects partially hidden or out of sight needed in an activity related to types of communication, or flow of information, or tools and/or symbols * Use one object to act on another in an activity related to types of communication, or flow of information, or tools and/or symbols * Turn on technology in an activity related to types of communication, or flow of information, or tools and/or symbols (e.g., access text or communicate with other) * Imitate action in an activity related to types of communication, or flow of information, or tools and/or symbols * Initiate cause-and-effect response during an activity related to types of communication, or flow of information, or tools and/or symbols * Sustain through response in an activity related to types of communication, or flow of information, or tools and/or symbols * Gain attention during activity related to types of communication, or flow of information, or tools and/or symbols * Make a request during an activity (e.g., request a turn) related to types of communication, or flow of information, or tools and/or symbols * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to types of communication, or flow of information, or tools and/or symbols * Respond to materials related to types of communication, or flow of information, or tools and/or symbols * Attend visually, aurally, or tactilely to materials related to types of communication, or flow of information, or tools and/or symbols |  |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
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|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Manufactur-ing** | * Match object-to-object, picture-to-picture or object-to-picture for material used in an assembly line * Track materials related to assembly line, or manufacturing processes * Shift focus from materials to speaker in an activity related to assembly line, or manufacturing processes * Grasp materials related to assembly line, or manufacturing processes * Use two hands to hold materials related to assembly line, or manufacturing processes | * Identify custom-made materials/objects that are produced by a small number of individuals for specific applications * Identify mass-produced materials/objects * Identify the basic processes in manufacturing systems * Sequence the steps of the manufacturing process | * Classify items that have been custom-made or mass-produced * Describe how an object was originally assembled by disassembling an object, device, or machine * Identify components of a manufacturing organization (e.g., production, marketing, and distribution) | * Evaluate predictions involving the cost of an item based on the process used to make it (custom-made vs. mass-produced) * Describe the impact of automated machines and robots on the manufacturing process (e.g., speed, quality, and cost) * Describe components of a manufacturing organization (e.g., production, marketing, and distribution) * Identify how materials can be shaped and restructured (e.g., cutting, shaping, assembling), depending on their intended use   *Continue to address*  *skills and concepts in this strand that approach*  *grade-level expectations* |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Manufactur-ing (continued)** | * Move materials related to assembly line, or manufacturing processes * Orient materials related to assembly line, or manufacturing processes * Manipulate objects related to assembly line, or manufacturing processes * Locate objects partially hidden or out of sight needed in an activity related to assembly line, or manufacturing processes * Use one object to act on another in an activity related to assembly line, or manufacturing processes * Turn on technology in an activity related to assembly line, or manufacturing processes * Imitate action in an activity related to assembly line, or manufacturing processes * Initiate cause-and-effect response during an activity related to assembly line, or manufacturing processes * Sustain through response in an activity related to assembly line, or manufacturing processes * Gain attention during activity related to assembly line, or manufacturing processes * Make a request during an activity (e.g., request a turn) related to assembly line, or manufacturing processes * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to assembly line, or manufacturing processes * Respond to materials related to assembly line, or manufacturing processes * Attend visually, aurally, or tactilely to materials related to assembly line, or manufacturing processes |  |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

|  | | **ACCESS SKILLS** | **ENTRY POINTS** | | |
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|  | | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Construction** | * Match object-to-object, picture-to-picture or object-to-picture related to construction * Track materials related to activity related to construction * Shift focus from materials to speaker in an activity related to activity related to construction * Grasp materials related to activity related to construction (e.g., grasp materials needed to construct a bridge) * Use two hands to hold materials related to activity related to construction * Release materials related to activity related to construction * Move materials related to activity related to construction | | * Identify the components of a structure (e.g., foundation, roof, floor, deck, and walls) * Identify types of bridges * Make a simple construction of a house, building, or bridge and describe how it functions | * Compare and contrast bridge types (arch, beam, suspension) | * Describe the components of a structure (roof, floor, wall) * Evaluate predictions of load capacity on scale models of bridges   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Construction (continued)** | * Orient materials related to activity related to construction * Manipulate objects related to activity related to construction * Locate objects partially hidden or out of sight needed in an activity related to activity related to construction * Use one object to act on another in an activity related to activity related to construction * Turn on technology in an activity related to activity related to construction * Imitate action in an activity related to activity related to construction * Initiate cause-and-effect response during an activity related to construction * Sustain through response in an activity related to activity related to construction * Gain attention during activity related to activity related to construction * Make a request during an activity (e.g., request a turn) related to activity related to construction * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to activity related to construction * Respond to materials related to activity related to construction * Attend visually, aurally, or tactilely to materials related to activity related to construction |  |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

|  | | **ACCESS SKILLS** | | **ENTRY POINTS** | | | | |
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|  | | **The student will:** | | **The student will:** | | **The student will:** | | **The student will:** |
| **Transporta-tion** | * Match object-to-object, picture-to-picture or object-to-picture for modes of transportation * Track materials related to transportation * Shift focus from materials to speaker in an activity related to transportation * Grasp materials related to transportation * Use two hands to hold materials related to transportation * Release materials related to transportation * Move materials related to transportation (e.g., activate a switch to move a boat across a water table) * Orient materials related to transportation * Manipulate objects related to transportation | | * Identify different means of transportation * Identify the most appropriate and efficient mode(s) of transportation given a specific starting point and destination * Identify whether different means of transportation operate on land, on water, in the air, or in space | | * Compare and contrast two transportation systems * Identify lift, drag, friction, thrust, and gravity as forces that either work toward or against the movement of a transportation vehicle * Identify the subsystems of a transportation vehicle or device | | * Provide a solution to a transportation problem using the universal design systems model * Identify guidance and propulsion in a transportation system * Describe the subsystems of a transportation vehicle or device * Relate the terms lift, drag, friction, thrust, and/or gravity to a transportation mode (e.g., the air creates drag on a plane which is a force that holds it back; water creates drag on a boat which is a force that holds it back)   *Continue to address skills and concepts in this strand that approach grade-level expectations* | |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Transporta-tion (continued)** | * Locate objects partially hidden or out of sight needed in an activity related to transportation * Use one object to act on another in an activity related to transportation * Turn on technology in an activity related to transportation * Imitate action in an activity related to transportation * Initiate cause-and-effect response during an activity related to transportation * Sustain through response in an activity related to transportation * Gain attention during activity related to transportation * Make a request during an activity (e.g., request a turn) related to transportation * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to transportation * Respond to materials related to transportation * Attend visually, aurally, or tactilely to materials related to transportation |  |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

|  | **ACCESS SKILLS** | **ENTRY POINTS** | | |
| --- | --- | --- | --- | --- |
|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Bioengineer-ing** | * Match object-to-object, picture-to-picture or object-to-picture of assistive devices * Track materials related to adaptive assistive devices * Shift focus from materials to speaker in an activity related to adaptive assistive devices * Grasp materials related to adaptive assistive devices * Use two hands to hold materials related to adaptive assistive devices * Release materials related to adaptive assistive devices * Move materials related to adaptive assistive devices * Orient materials related to adaptive assistive devices * Manipulate objects related to adaptive assistive devices | * Identify a variety of adaptive/assistive devices (e.g., wheelchairs, prosthetic limbs, eyeglasses) * Identify familiar products that are bioengineered (e.g., food or bio-fuels) | * Explain the function of a variety of adaptive/assistive devices * Identify the purpose for which bioengineered products were created * Describe the pros and cons associated with the use of bioengineered products | * Identify how a variety of adaptive/assistive devices provide access to the environment (e.g., wheelchairs, prosthetic limbs, eyeglasses) * Evaluate the effects of bioengineered products   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in Grades 6−8 |

**Less Complex More Complex**

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Bioengineer-ing (continued)** | * Locate objects partially hidden or out of sight needed in an activity related to adaptive assistive devices * Use one object to act on another in an activity related to adaptive assistive devices * Turn on technology in an activity related to adaptive assistive devices * Imitate action in an activity related to adaptive assistive devices * Initiate cause-and-effect response during an activity related to adaptive assistive devices (e.g., initiate by switch activation of a cause- and -effect computer game) * Sustain through response in an activity related to adaptive assistive devices * Gain attention during activity related to adaptive assistive devices * Make a request during an activity (e.g., request a turn) related to adaptive assistive devices * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to adaptive assistive devices * Respond to materials related to adaptive assistive devices * Attend visually, aurally, or tactilely to materials related to adaptive assistive devices |  |

**CONTENT**  Science and Technology/Engineering

**Science and Technology/ Engineering**

**Technology/ Engineering**

**High School**

**STRAND** Technology/Engineering

**Learning Standards for:**

## Communication

## Manufacturing

## Construction

## Fluid Systems

## Thermal Systems

## Electrical Systems

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| --- | --- | --- | --- | --- |
| Grade Level: High School | | | | |
| Topic | | Learning Standards as written | | Essence of the Standard(s) |
| Com-munication | **6.1** | | Explain how information travels through the following media: electrical wire, optical fiber, air, and space. | * Identify, describe, and/or demonstrate knowledge of the   following:   * flow of information through electrical wires, optical fibers, air, and space   + digital and analog signals and devices using these technologies   + components and processes of a communication system   + applications of laser and fiber   optic technologies   * + application of electromagnetic signals in fiber optic technologies |
| **6.2** | | Differentiate between digital and analog signals. Describe how communication devices employ digital and analog technologies, such as, computers and cell phones. |
| **6.3** | | Explain how the various components and processes of a communication system function. The components are source, encoder, transmitter, receiver, decoder, destination, storage, and retrieval. |
| **6.4** | | Identify and explain the applications of laser and fiber optic technologies (such as, telephone systems, cable television, and photography). |
| **6.5** | | Explain the application of electromagnetic signals in fiber optic technologies, and include critical angle and total internal reflection. |
| Manufacturing | **7.1** | | Describe the manufacturing processes of casting and molding, forming, separating, conditioning, assembling, and finishing. | * Identify, explain, and/or demonstrate knowledge of the following: * specific manufacturing processes   + criteria for selection of tools, materials, and procedures in the manufacturing process   + advantages of using robotics |
| **7.2** | | Identify the criteria necessary to select the tools and procedures used in the safe production of products in the manufacturing process, such as material properties, required tolerances, and end-uses. |
| **7.3** | | Describe the advantages of using robotics in the automation of manufacturing processes, such as, increased production, improved quality, and safety. |
| Construction | **2.1** | | Identify and explain the engineering properties of materials used in structures, such as, elasticity, plasticity, R value, density, and strength. | * Identify, explain and/or demonstrate knowledge of the following:   + engineering properties of materials used in structures   + tension, compression, shear, and torsion   + selection of materials used in   structures   * + Bernoulli’s principle   + calculation of forces for live loads and dead loads   + purposes of zoning laws and building codes |
| **2.2** | | Distinguish among tension, compression, shear, and torsion, and explain how they relate to the selection of materials in structures. |
| **2.3** | | Explain Bernoulli’s principle and its effect on structures, such as buildings and bridges. |
|  | **2.4** | | Calculate the resultant force(s) for a combination of live loads and dead loads. |
| **2.6** | | Recognize the purpose of zoning laws and building codes in the design and use of structures. |
| Fluid Systems | **3.1** | | Explain the basic differences between open (such as, irrigation, forced hot air system, air compressors) and closed (such as, forced hot water system, hydraulic brakes) fluid systems. | * Identify and differentiate between open and closed fluid systems * Explain the differences and similarities between hydraulic and pneumatic systems and uses of each * Describe specific characteristics of hydraulic systems * Recognize the relationship between the velocity of a liquid in a pipe and its cross-sectional area * Identify and explain sources of resistance for water moving through a pipe |
| **3.2** | | Explain the differences and similarities between hydraulic and pneumatic systems and how each relates to manufacturing and transportation systems. |
| **3.3** | | Calculate and describe the ability of a hydraulic system to multiply distance, multiply force, and effect directional change. |
| **3.4** | | Recognize that the velocity of a liquid varies inversely with changes in cross-sectional area along the path of a moving liquid in a pipe. |
| **3.5** | | Identify and explain sources of resistance (such as, 45º elbow, 90º elbow, and changes in diameter) for water moving through a pipe. |
| Thermal Systems | **4.1** | | Differentiate among conduction, convection, and radiation in a thermal system, such as, heating and cooling a house and cooking. | * Identify, explain, and/or demonstrate knowledge of the following:   + conduction, convection, and radiation in a thermal system   + selection of materials in the design of a heating system   + environmental conditions and their influence on design of buildings   + alternatives to nonrenewable energies |
| **4.2** | | Give examples of how conduction, convection, and radiation are considered in the selection of materials for buildings and in the design of a heating system. |
| **4.3** | | Explain how environmental conditions such as wind, solar angle, and temperature influence the design of buildings. |
| **4.4** | | Identify and explain alternatives to nonrenewable energies, such as wind and solar energy conversion systems. |
| Electrical Systems | **5.1** | | Explain how to measure and calculate voltage, current, resistance, and power consumption in a series circuit and in a parallel circuit. Identify the instruments used to measure voltage, current, power consumption, and resistance. | * Identify, explain, and/or demonstrate knowledge of the following:   + components of a circuit   + Ohm’s law (relationships among resistance, voltage, current)   + external factors affecting resistance   + alternating current (AC) and direct current (DC) * Measurement and calculation of voltage, current, resistance, and power consumption in a series circuit and in a parallel circuit, using appropriate instruments |
| **5.2** | | Identify and explain the components of a circuit including sources, conductors, circuit breakers, fuses, controllers, and loads. Examples of some controllers are switches, relays, diodes, and variable resistors. |
| **5.3** | | Explain the relationship between voltage, current, and resistance in a simple circuit using Ohm’s law. |
| **5.4** | | Recognize that resistance is affected by external factors, such as temperature. |
| **5.5** | | Compare and contrast alternating current (AC) and direct current (DC) and give examples of each. |
| ENTRY POINTS to  Technology/Engineering Standards in High School | | | | |

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|  | **The student will:** | | | **The student will:** | **The student will:** |
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| **Communica-tion** | | * Identify examples of information traveling through different media (e.g., electrical wire, optical fiber, air, and space) * Identify one or more components of different communications systems, including “source,” “message,” “transmitter,” and “receiver” * Identify ways in which information can be stored and retrieved   *Continue to address earlier standards in this topic at a level that challenges the student* | * Describe how information travels through different media (e.g., electrical wire, optical fiber, air, and space) * Describe the route of a communication process, using the terms “source,” “transmitter,” “message,” and “receiver” * Identify at least three components of a communication system, (e.g., source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination) * Identify how different media and information travels through electrical wire, optical fiber, air, and/or space * Identify technologies as either digital or analog * Identify the function of one or more components of a communication system * Identify fiber optic and laser technologies | | * Identify uses of laser and fiber optic technology (e.g., fiber optic technology directs light through strands of glass—telephone cables are made up of fiber optics) * Describe how signals can travel through various media and through space * Describe the difference between analog signals (i.e., continuous waves) and digital signals (i.e., a code consisting of a series of on-off values) * Explain how information travels through any one type of media * Explain how one or more components of a communication system work * Identify uses of laser and fiber optic technology   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ENTRY POINTS to  Technology/Engineering Standards in High School |

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| **Manufacturing** | | * Identify various manufacturing processes (e.g., casting and molding, forming, separating, conditioning, assembling, finishing) * Identify ways in which materials can be shaped and restructured (e.g., cutting, shaping, assembling), depending on their intended uses * Select the appropriate hand tool(s) for a variety of simple construction applications: hammer, screwdriver, chisel, wrench * Select the right tool to use to construct a given product | * Describe one or more of the following manufacturing processes: casting and molding, forming, separating, conditioning, assembling, finishing * Describe why a given tool was or was not selected to construct a product * Identify the steps in designing and making a product (i.e., defining its purpose, then using materials, tools, and measurement to create it) * Identify the criteria for selecting one or more tools and/or procedures to use in the safe production of products during the manufacturing process * Provide reasons why a specific tool was or was not selected or used to construct a given product | * Describe the criteria for selection of tools used in the manufacturing process * Describe the criteria for selection of materials used in the manufacturing process * Describe the steps used in a manufacturing process * Describe the steps in assembling a product (i.e., putting together separate components to make a final product) * Identify ways in which the surface of a part or product is “finished” in order to protect or improve its appearance * Identify the advantages and/or disadvantages of using robotics for manufacturing processes   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ENTRY POINTS to  Technology/Engineering Standards in High School |

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| **Construction** | * Identify various building materials * Describe the effects of using different materials on the creation of models intended for a specific purpose * Identify examples of tension * Identify examples of compression * Identify examples of shear * Identify examples of torsion * Identify various materials by their properties (elasticity, plasticity, thermal conductivity and density) * Identify safe and proper uses of various hand tools * Identify an example of non-compressible flow * Identify an example of compressible flow   *Continue to address earlier standards in this topic at a level that challenges the student* | * Describe the properties of different materials that make them useful * Identify examples of tension, compression, shear, and/or torsion in everyday life * Sort materials in terms of their elasticity, plasticity, thermal conductivity, and/or density * Identify examples of “live loads” and “dead loads” * Define the forces of tension, compression, torsion, bend, or shear * Identify when forces are balanced vs. unbalanced * Sort flows into non-compressible and compressible * Describe how properties in construction materials make them useful for their intended purpose * Sort materials by properties (elasticity, plasticity, thermal conductivity and density) * Describe safe and proper use of basic hand tools | * Describe and give examples (or demonstrate) the meaning of tension, compression, shear, and * Describe the effects of live and dead loads on various structures (e.g., the effect of heavy snow on the roof of a barn; a large truck on a bridge; a skyscraper on the bottom floors) * Describe the qualities of the materials needed to build various structures in order to withstand the effects of the structural loads they are likely to experience (e.g., how much elasticity, plasticity, thermal conductivity, and density are needed) * Identify sections of a building by live/dead load * Describe the purposes of common zoning laws and building codes * Sort sections of a building by live/dead load * Demonstrate the use of forces (tension, compression, bending, shear, and torsion) * Demonstrate how elasticity is used in a construction project * Demonstrate how thermal conduction is used in a construction project * Demonstrate how thermal conductivity is useful in a construction project * Demonstrate how density is used in a construction project * Demonstrate how building codes/zoning laws provide for safe structures   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in High School |

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|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Fluid Systems** | * Track materials related to fluid, hydraulic, and/or pneumatic systems * Shift focus from materials to speaker in an activity related to fluid, hydraulic, and/or pneumatic systems * Grasp materials related to fluid, hydraulic, and/or pneumatic systems * Use two hands to hold materials related to fluid, hydraulic, and/or pneumatic systems (e.g., use two hands to move water through a tube on a water table) * Release materials related to fluid, hydraulic, and/or pneumatic systems | * Identify various devices that use hydraulic or pneumatic systems * Identify ways in which the velocity of water can be increased or decreased   *Continue to address earlier standards in this topic at a level that challenges the student* | * Identify specific factors that would increase or decrease the velocity of water in a pipe * Describe the effects of wide vs. narrow pipes on the flow of water * Describe the effects of adding “elbows” to a pipe on the flow of water through the pipe * Describe the effects of different forces that can be exerted on liquids and gases in the form of pressure * Identify examples of open and closed fluid systems | * Compare and contrast open and closed fluid systems * Identify specific applications to create energy or power using hydraulics * Identify specific applications to create energy or power using pneumatics * Compare and contrast hydraulic and pneumatic systems * Explain the effects of pipe size and design on the flow of fluids   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in High School |

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Fluid Systems (continued)** | * Move materials related to fluid, hydraulic, and/or pneumatic systems * Orient materials related to fluid, hydraulic, and/or pneumatic systems * Manipulate objects related to fluid, hydraulic, and/or pneumatic systems * Locate objects partially hidden or out of sight needed in an activity related to fluid, hydraulic, and/or pneumatic systems * Use one object to act on another in an activity related to fluid, hydraulic, and/or pneumatic systems * Turn on technology in an activity related to fluid, hydraulic, and/or pneumatic systems * Imitate action in an activity related to fluid, hydraulic, and/or pneumatic systems * Initiate cause-and-effect response during an activity related to fluid, hydraulic, and/or pneumatic systems * Sustain through response in an activity related to fluid, hydraulic, and/or pneumatic systems * Gain attention during activity related to fluid, hydraulic, and/or pneumatic systems * Make a request during an activity (e.g., request a turn) related to fluid, hydraulic, and/or pneumatic systems * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to fluid, hydraulic, and/or pneumatic systems * Respond to materials related to fluid, hydraulic, and/or pneumatic systems * Attend visually, aurally, or tactilely to materials related to fluid, hydraulic, and/or pneumatic systems |  |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in High School |

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|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Thermal Systems** | * Track materials related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Shift focus from materials to speaker in an activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Grasp materials related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy | * Identify ways to cool and heat oneself or another object * Identify ways to cool and heat a home * List examples of radiation * List examples of convection * List examples of conduction * Match examples of conduction, convection, and radiation   *Continue to address earlier standards in this topic at a level that challenges the student* | * Describe the characteristics of radiation * Describe the characteristics of convection * Describe the characteristics of conduction * Describe the relative efficiency of various materials to conduct heat * List characteristics and/or provide examples of conduction, convection, and/or radiation * Describe the properties of a range of power-generating systems (e.g., wind, solar, fuel, falling water) * Sort examples of conduction, convection, and radiation * Identify alternatives to nonrenewable energies | * Compare and contrast the principles of conduction and convection * Generalize conclusions about color, structure, and/or texture of objects in terms of efficiency in conducting heat * Describe the principles of heat transfer during familiar activities (e.g., heat conduction−touching something hot transfers heat to the person’s hand; convection−the heat from a drink travels to the ice cubes to melt them; radiation−the sun’s heat travels through the air to warm the earth; turning up a thermostat in a home causes heat generated by a heater to travel until the home is at a constant temperature) * Compare and contrast power-generating systems using nonrenewable fuels with those using wind, falling water, and heat from the earth * Identify the effect of various environmental conditions on heat conduction/insulation in buildings (e.g., plantings, awnings, roof type and color, building materials) * Describe the benefits/ advantages and risks/disadvantages of using different renewable and nonrenewable fuels for heating or cooling |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in High School |

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Thermal Systems (continued)** | * Use two hands to hold materials related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Release materials related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Move materials related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Orient materials related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Manipulate objects related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Locate objects partially hidden or out of sight needed in an activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Use one object to act on another in an activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Turn on technology in an activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy (e.g. conduct simple experiments on wind movement; activate a fan with a switch to play chimes, move a ping pong balls, blow out candles, move Mylar balloons) * Imitate action in an activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Initiate cause-and-effect response during an activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Sustain through response in an activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Gain attention during activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Make a request during an activity (e.g., request a turn) related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Respond to materials related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy * Attend visually, aurally, or tactilely to materials related to heating or cooling systems, and/or renewable (e.g., wind and/or solar) and nonrenewable energy | *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ENTRY POINTS and ACCESS SKILLS to  Technology/Engineering Standards in High School |

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|  | **The student will:** | **The student will:** | **The student will:** | **The student will:** |
| **Electrical Systems** | * Match object-to-object, picture-to-picture, or object-to-picture of electrical components * Track materials related to components of a circuit * Shift focus from materials to speaker in an activity related to components of a circuit * Grasp materials related to components of a circuit * Use two hands to hold materials related to components of a circuit * Release materials related to components of a circuit * Move materials related to components of a circuit * Orient materials related to components of a circuit | * Match basic components of a circuit to their role (e.g., source, conductor, etc.) * Identify the switch and the power source (e.g., battery) on a simple circuit diagram * Compare and contrast AC and DC currents * Identify the meanings of resistance (how much a circuit slows down the flow of current), voltage (strength of the current), and/or current (flow of electrons in a circuit) * Compare a closed circuit (one in which the current flows) and an open circuit (one with a switch that is turned off or a fuse that has blown so no current flows)   *Continue to address earlier standards in this topic at a level that challenges the student* | * Describe the role of one or more components of a circuit (e.g., source, conductor) * Identify and/or calculate the “resistance” (how much a circuit slows down the flow of current), “voltage” (the strength of the current), and/or “current” (the flow of electrons in a circuit) in a circuit * Identify series and parallel circuits * Identify open and closed circuits * Explain the role of basic components of a circuit (e.g., source, conductor, etc.) * Explain how AC and DC currents work * Use the terms resistance, current, and/or voltage in context of written, oral, or graphic presentation | * Compare and contrast AC and DC currents * Describe the relationship between resistance, voltage, and current * Describe the difference between a series and parallel circuit * Compare and contrast a closed circuit (in which the current flows) and an open circuit (with a switch that is turned off or a fuse that has blown so no current flows) * Explain Ohm’s Law (V+RI)   *Continue to address skills and concepts in this strand that approach grade-level expectations* |

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| ACCESS SKILLS (continued) to  Technology/Engineering Standards in High School |

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|  | **ACCESS SKILLS** | **ENTRY POINTS** |
| **The student will:** | **The student will:** |
| **Electrical Systems (continued)** | * Manipulate objects related to components of a circuit * Locate objects partially hidden or out of sight needed in an activity related to components of a circuit * Use one object to act on another in an activity related to components of a circuit * Turn on technology in an activity related to components of a circuit (e.g., activate a switch to complete a circuit that would turn on a device) * Imitate action in an activity related to components of a circuit * Initiate cause-and-effect response during an activity related to components of a circuit * Sustain through response in an activity related to components of a circuit * Gain attention during activity related to components of a circuit * Make a request during an activity (e.g., request a turn) related to components of a circuit * Choose within a specified amount of time (e.g., 30 seconds) from an errorless array in an activity related to components of a circuit * Respond to materials related to components of a circuit * Attend visually, aurally, or tactilely to materials related to components of a circuit |  |