# Grade 8 Math Standards

### » The Number System

#### Know that there are numbers that are not rational, and approximate them by rational numbers.

- 1. Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.
- 2. Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g.,  $\pi^2$ ). For example, by truncating the decimal expansion of  $\sqrt{2}$ , show that  $\sqrt{2}$  is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.

### » Expressions & Equations

#### Expressions and Equations Work with radicals and integer exponents.

- 1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example,  $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$ .
- 2. Use square root and cube root symbols to represent solutions to equations of the form  $x^2 = p$  and  $x^3 = p$ , where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that  $\sqrt{2}$  is irrational.
- 3. Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3 times 10<sup>8</sup> and the population of the world as 7 times 10<sup>9</sup>, and determine that the world population is more than 20 times larger.
- 4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology

#### Understand the connections between proportional relationships, lines, and linear equations.

- 5. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.
- 6. Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical axis at b.

#### Analyze and solve linear equations and pairs of simultaneous linear equations.

- 7. Solve linear equations in one variable.
  - a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form x = a, a = a, or a = b results (where a and b are different numbers).

- b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.
- 8. Analyze and solve pairs of simultaneous linear equations.
  - a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.
  - b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, 3x + 2y = 5 and 3x + 2y = 6 have no solution because 3x + 2y cannot simultaneously be 5 and 6.
  - c. Solve real-world and mathematical problems leading to two linear equations in two variables. *For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.*

### » Functions

#### Define, evaluate, and compare functions.

- 1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.
- 2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.
- 3. Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function  $A = s^2$  giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

#### Use functions to model relationships between quantities.

- 4. Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x*, *y*) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
- 5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

### » Geometry

#### Understand congruence and similarity using physical models, transparencies, or geometry software.

- 1. Verify experimentally the properties of rotations, reflections, and translations:
  - a. Lines are taken to lines, and line segments to line segments of the same length.
  - b. Angles are taken to angles of the same measure.
  - c. Parallel lines are taken to parallel lines.
- 2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits he congruence between them.
- 3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.
- 4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

5. Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.

#### Understand and apply the Pythagorean Theorem.

- 6. Explain a proof of the Pythagorean Theorem and its converse.
- 7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.
- 8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

#### Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.

9. Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

### » Statistics & Probability

#### Investigate patterns of association in bivariate data.

- 1. Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.
- 2. Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.
- 3. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.
- 4. Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. *For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?*

## **English Language Arts Standards** » Reading: Literature

#### Key Ideas and Details:

- 1. Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
- 2. Determine a theme or central idea of a text and analyze its development over the course of the text, including its relationship to the characters, setting, and plot; provide an objective summary of the text.
- 3. Analyze how particular lines of dialogue or incidents in a story or drama propel the action, reveal aspects of a character, or provoke a decision.

#### Craft and Structure:

- 4. Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
- 5. Compare and contrast the structure of two or more texts and analyze how the differing structure of each text contributes to its meaning and style.
- 6. Analyze how differences in the points of view of the characters and the audience or reader (e.g., created through the use of dramatic irony) create such effects as suspense or humor.

#### Integration of Knowledge and Ideas:

- 7. Analyze the extent to which a filmed or live production of a story or drama stays faithful to or departs from the text or script, evaluating the choices made by the director or actors.
- 8. (RL.8.8 not applicable to literature)
- 9. Analyze how a modern work of fiction draws on themes, patterns of events, or character types from myths, traditional stories, or religious works such as the Bible, including describing how the material is rendered new.

#### Range of Reading and Level of Text Complexity:

10. By the end of the year, read and comprehend literature, including stories, dramas, and poems, at the high end of grades 6-8 text complexity band independently and proficiently.

### » Reading: Informational Text

#### Key Ideas and Details:

- 1. Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
- 2. Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.
- 3. Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).

#### Craft and Structure:

- 4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
- 5. Analyze in detail the structure of a specific paragraph in a text, including the role of particular sentences in developing and refining a key concept.
- 6. Determine an author's point of view or purpose in a text and analyze how the author acknowledges and responds to conflicting evidence or viewpoints.

#### Integration of Knowledge and Ideas:

- 7. Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea.
- 8. Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
- 9. Analyze a case in which two or more texts provide conflicting information on the same topic and identify where the texts disagree on matters of fact or interpretation.

#### Range of Reading and Level of Text Complexity:

10. By the end of the year, read and comprehend literary nonfiction at the high end of the grades 6-8 text complexity band independently and proficiently.

### » Writing

#### Text Types and Purposes:

- 1. Write arguments to support claims with clear reasons and relevant evidence
  - a. Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
  - b. Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
  - c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
  - d. Establish and maintain a formal style.
  - e. Provide a concluding statement or section that follows from and supports the argument presented.
- 2. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
  - a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
  - b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
  - c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
  - d. Use precise language and domain-specific vocabulary to inform about or explain the topic.
  - e. Establish and maintain a formal style.
  - f. Provide a concluding statement or section that follows from and supports the information or explanation presented.
- 3. Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
  - a. Engage and orient the reader by establishing a context and point of view and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically.
  - b. Use narrative techniques, such as dialogue, pacing, description, and reflection, to develop experiences, events, and/or characters.
  - c. Use a variety of transition words, phrases, and clauses to convey sequence, signal shifts from one time frame or setting to another, and show the relationships among experiences and events.
  - d. Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events.
  - e. Provide a conclusion that follows from and reflects on the narrated experiences or events.

#### **Production and Distribution of Writing:**

- 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)
- 5. With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been

addressed. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grade 8)

6. Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas efficiently as well as to interact and collaborate with others.

#### Research to Build and Present Knowledge:

- 7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- 8. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- 9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
  - a. Apply *grade 8 Reading standards* to literature (e.g., "Analyze how a modern work of fiction draws on themes, patterns of events, or character types from myths, traditional stories, or religious works such as the Bible, including describing how the material is rendered new").
  - b. Apply *grade 8 Reading standards* to literary nonfiction (e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced").

#### Range of Writing:

10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

### » Speaking & Listening

#### Comprehension and Collaboration:

- 1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
  - a. Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
  - b. Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed.
  - c. Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
  - d. Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.
- 2. Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation.
- 3. Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.

#### Presentation of Knowledge and Ideas:

- 4. Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
- 5. Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

6. Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grade 8 Language standards 1 and 3 for specific expectations.)

### » Language

#### Conventions of Standard English:

- 1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
  - a. Explain the function of verbals (gerunds, participles, infinitives) in general and their function in particular sentences.
  - b. Form and use verbs in the active and passive voice.
  - c. Form and use verbs in the indicative, imperative, interrogative, conditional, and subjunctive mood.
  - d. Recognize and correct inappropriate shifts in verb voice and mood.
- 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
  - a. Use punctuation (comma, ellipsis, dash) to indicate a pause or break.
  - b. Use an ellipsis to indicate an omission.
  - c. Spell correctly.

#### Knowledge of Language:

- 3. Use knowledge of language and its conventions when writing, speaking, reading, or listening.
  - a. Use verbs in the active and passive voice and in the conditional and subjunctive mood to achieve particular effects (e.g., emphasizing the actor or the action; expressing uncertainty or describing a state contrary to fact).

#### Vocabulary Acquisition and Use:

- 4. Determine or clarify the meaning of unknown and multiple-meaning words or phrases based on *grade 8 reading and content,* choosing flexibly from a range of strategies.
  - a. Use context (e.g., the overall meaning of a sentence or paragraph; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.
  - b. Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word (e.g., *precede, recede, secede*).
  - c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.
  - d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
- 5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
  - a. Interpret figures of speech (e.g. verbal irony, puns) in context.
  - b. Use the relationship between particular words to better understand each of the words.
  - c. Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., *bullheaded, willful, firm, persistent, resolute*).
  - d. Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

# Science Standards » Inquiry, Reflection, and Social Implications

#### 1. Scientific Inquiry

- a. Generate new questions that can be investigated in the laboratory or field.
- b. Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.
- c. Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).
- d. Identify patterns in data and relate them to theoretical models.
- e. Describe a reason for a given conclusion using evidence from an investigation.
- f. Predict what would happen if the variables, methods, or timing of an investigation were changed.
- g. Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.
- h. Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.
- i. Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

#### 2. Scientific Reflection and Social Implications

- a. Critique whether or not specific questions can be answered through scientific investigations.
- b. Identify and critique arguments about personal or societal issues based on scientific evidence.
- c. Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.
- d. Evaluate scientific explanations in a peer review process or discussion format. Evaluate the future career and occupational prospects of science fields.
- e. Critique solutions to problems, given criteria and scientific constraints.
- f. Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- g. Describe the distinctions between scientific theories, laws, hypotheses, and observations.
- h. Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.
- i. Apply science principles or scientific data to anticipate effects of technological design decisions.
- j. Analyze how science and society interact from a historical, political, economic, or social perspective.

### » Earth Systems

- 1. Earth Systems Overview
  - a. Explain why the Earth is essentially a closed system in terms of matter.
  - b. Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.
  - c. Explain, using specific examples, how a change in one system affects other Earth systems.
- 2. Energy in Earth Systems
  - a. Describe the Earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).
  - b. Identify differences in the origin and use of renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [U-235]) sources of energy.
  - c. Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.
  - d. Identify the main sources of energy to the climate system.
  - e. Explain how energy changes form through Earth systems.
  - f. Explain how elements exist in different compounds and states as they move from one reservoir to another.
- 3. Biogeochemical Cycles
  - a. Explain how carbon exists in different forms such as limestone (rock), carbon dioxide (gas), carbonic acid (water), and animals (life) within Earth systems and how those forms can be beneficial or harmful to humans.
  - b. Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities (e.g., dead zone in the Gulf of Mexico, Lake Nyos in Africa, fluoride in drinking water).
  - c. Explain how the nitrogen cycle is part of the Earth system.

- d. Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (e.g., improve soils for agriculture) or harm (e.g., act as a pollutant) society.
- 4. Resources and Human Impacts on Earth Systems
  - a. Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.
  - b. Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.
  - c. Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion.
  - d. Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.

### » The Solid Earth

- 1. Landforms and Soils (prerequisite)
  - a. Explain the origin of Michigan landforms. Describe and identify surface features using maps and satellite images. (prerequisite)
  - b. Explain how physical and chemical weathering leads to erosion and the formation of soils and sediments. (prerequisite)
  - c. Describe how coastal features are formed by wave erosion and deposition.)
- 2. Rocks and Minerals (prerequisite)
  - a. Identify common rock-forming minerals (quartz, feldspar, biotite, calcite, hornblende). (prerequisite)
  - b. Identify common igneous (granite, basalt, andesite, obsidian, pumice), metamorphic (schist, gneiss, marble, slate, quartzite), and sedimentary (sandstone, limestone, shale, conglomerate) rocks and describe the processes that change one kind of rock to another. (prerequisite)
- 3. Basic Plate Tectonics (prerequisite)
  - a. Describe geologic, paleontologic, and paleoclimatalogic evidence that indicates Africa and South America were once part of a single continent.
  - b. Describe the three types of plate boundaries (divergent, convergent, and transform) and geographic features associated with them (e.g., continental rifts and mid-ocean ridges, volcanic and island arcs, deep-sea trenches, transform faults).
  - c. Describe the three major types of volcanoes (shield volcano, stratovolcano, and cinder cones) and their relationship to the Ring of Fire.
- 4. Advanced Rock Cycle
  - a. Discriminate between igneous, metamorphic, and sedimentary rocks and describe the processes that change one kind of rock into another.
  - b. Explain the relationship between the rock cycle and plate tectonics theory in regard to the origins of igneous, sedimentary, and metamorphic rocks.
  - c. Explain how the size and shape of grains in a sedimentary rock indicate the environment of formation (including climate) and deposition.
  - d. Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.
  - e. Explain how the texture (foliated, nonfoliated) of metamorphic rock can indicate whether it has experienced regional or contact metamorphism.
- 5. Interior of the Earth
  - a. Describe the interior of the Earth (in terms of crust, mantle, and inner and outer cores) and where the magnetic field of the Earth is generated.
  - b. Explain how scientists infer that the Earth has interior layers with discernable properties using patterns of primary (*P*) and secondary (*S*) seismic wave arrivals.
  - c. Describe the differences between oceanic and continental crust (including density, age, composition).
  - d. Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.
- 6. Plate Tectonics Theory
  - a. Explain how plate tectonics accounts for the features and processes (sea floor spreading, mid-ocean ridges, subduction zones, earthquakes and volcanoes, mountain ranges) that occur on or near the Earth's surface.
  - b. Explain why tectonic plates move using the concept of heat flowing through mantle convection, coupled with the cooling and sinking of aging ocean plates that result from their increased density.
  - c. Describe the motion history of geologic features (e.g., plates, Hawaii) using equations relating rate, time, and distance.
  - d. Distinguish plate boundaries by the pattern of depth and magnitude of earthquakes.
  - e. Predict the temperature distribution in the lithosphere as a function of distance from the mid-ocean ridge and how it relates to ocean depth. *(recommended).*

- f. Describe how the direction and rate of movement for the North American plate has affected the local climate over the last 600 million years. *(recommended)*
- 7. Earthquakes and Volcanoes
  - a. Use the distribution of earthquakes and volcanoes to locate and determine the types of plate boundaries.
  - b. Describe how the sizes of earthquakes and volcanoes are measured or characterized.
  - c. Describe the effects of earthquakes and volcanic eruptions on humans.
  - d. Explain how the chemical composition of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.
  - e. Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.
  - f. Explain why fences are offset after an earthquake, using the elastic rebound theory.

### **»** The Fluid Earth

- 1. Water Cycle (prerequisite)
  - a. Describe that the water cycle includes evaporation, transpiration, condensation, precipitation, infiltration, surface runoff, groundwater, and absorption. (prerequisite)
  - b. Analyze the flow of water between the elements of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater. (*prerequisite*)
  - c. Describe the river and stream types, features, and process including cycles of flooding, erosion, and deposition as they occur naturally and as they are impacted by land use decisions. (*prerequisite*)
  - d. Explain the types, process, and beneficial functions of wetlands.
- 2. Weather and the Atmosphere (prerequisite)
  - a. Describe the composition and layers of the atmosphere. (prerequisite)
  - b. Describe the difference between weather and climate. (prerequisite)
  - c. Explain the differences between fog and dew formation and cloud formation. (prerequisite)
  - d. Describe relative humidity in terms of the moisture content of the air and the moisture capacity of the air and how these depend on the temperature. (*prerequisite*)
  - e. Describe conditions associated with frontal boundaries (cold, warm, stationary, and occluded). (prerequisite)
  - f. Describe the characteristics and movement across North America of the major air masses and the jet stream. (prerequisite)
  - g. Interpret a weather map and describe present weather conditions and predict changes in weather over 24 hours. (prerequisite)
  - h. Explain the primary causes of seasons. (prerequisite)
  - i. Identify major global wind belts (trade winds, prevailing westerlies, and polar easterlies) and that their vertical components control the global distribution of rainforests and deserts. *(prerequisite)*
- 3. Glaciers (prerequisite)
  - a. Describe how glaciers have affected the Michigan landscape and how the resulting landforms impact our state economy. (prerequisite)
  - b. Explain what happens to the lithosphere when an ice sheet is removed. (prerequisite)
  - c. Explain the formation of the Great Lakes. (prerequisite)
- 4. Hydrogeology
  - a. Compare and contrast surface water systems (lakes, rivers, streams, wetlands) and groundwater in regard to their relative sizes as Earth's freshwater reservoirs and the dynamics of water movement (inputs and outputs, residence times, sustainability).
  - b. Explain the features and processes of groundwater systems and how the sustainability of North American aquifers has changed in recent history (e.g., the past 100 years) qualitatively using the concepts of recharge, residence time, inputs, and outputs.
  - c. Explain how water quality in both groundwater and surface systems is impacted by land use decisions.
- 5. Oceans and Climate
  - a. Describe the major causes for the ocean's surface and deep water currents, including the prevailing winds, the Coriolis effect, unequal heating of the earth, changes in water temperature and salinity in high latitudes, and basin shape.
  - b. Explain how interactions between the oceans and the atmosphere influence global and regional climate. Include the major concepts of heat transfer by ocean currents, thermohaline circulation, boundary currents, evaporation, precipitation, climatic zones, and the ocean as a major CO<sub>2</sub> reservoir.
  - c. Explain the dynamics (including ocean-atmosphere interactions) of the El Niño-Southern Oscillation (ENSO) and its effect on continental climates.
  - d. Identify factors affecting seawater density and salinity and describe how density affects oceanic layering and currents.

- e. Explain the differences between maritime and continental climates with regard to oceanic currents.
- f. Explain how the Coriolis effect controls oceanic circulation.
- g. Explain how El Niño affects economies (e.g., in South America). (recommended)

#### 6. Severe Weather

- a. Describe the various conditions of formation associated with severe weather (thunderstorms, tornadoes, hurricanes, floods, waves, and drought). \
- b. Describe the damage resulting from, and the social impact of thunderstorms, tornadoes, hurricanes, and floods.
- c. Describe severe weather and flood safety and mitigation.
- d. Describe the seasonal variations in severe weather.
- e. Describe conditions associated with frontal boundaries that result in severe weather (thunderstorms, tornadoes, and hurricanes).
- f. Describe how mountains, frontal wedging (including dry lines), convection, and convergence form clouds and precipitation.
- g. Explain the process of adiabatic cooling and adiabatic temperature changes to the formation of clouds.

### » The Earth in Space and Time

- 1. Sky Observations
  - a. Describe the motions of various celestial bodies and some effects of those motions. (prerequisite)
  - b. Explain the primary cause of seasons. (prerequisite)
  - c. Explain how a light year can be used as a distance unit. (prerequisite)
  - d. Describe the position and motion of our solar system in our galaxy. (prerequisite)
- 2. The Earth in Space
  - a. Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.
  - b. Describe how the Big Bang theory accounts for the formation of the universe.
  - c. Explain how observations of the cosmic microwave background have helped determine the age of the universe.
  - d. Differentiate between the cosmological and Doppler red shift.
- 3. The Sun
  - a. Identify patterns in solar activities (sunspot cycle, solar flares, solar wind).
  - b. Relate events on the Sun to phenomena such as auroras, disruption of radio and satellite communications, and power grid disturbances.
  - c. Describe how nuclear fusion produces energy in the Sun.
  - d. Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.
- 4. Stellar Evolution
  - a. Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).
  - b. Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
  - c. Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
  - d. Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.
- 5. Earth History and Geologic Time
  - a. Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 Ga (billion years ago).
  - b. Describe the process of radioactive decay and explain how radioactive elements are used to date the rocks that contain them.
  - c. Relate major events in the history of the Earth to the geologic time scale, including formation of the Earth, formation of an oxygen atmosphere, rise of life, Cretaceous-Tertiary (K-T) and Permian extinctions, and Pleistocene ice age.
  - d. Describe how index fossils can be used to determine time sequence.
- 6. Geologic Dating
  - a. Determine the approximate age of a sample, when given the half-life of a radioactive substance (in graph or tabular form) along with the ratio of daughter to parent substances present in the sample.
  - b. Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot.
  - c. Identify a sequence of geologic events using relative-age dating principles
- 7. Climate Change
  - a. Explain the natural mechanism of the greenhouse effect, including comparisons of the major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone).
  - b. Describe natural mechanisms that could result in significant changes in climate (e.g., major volcanic eruptions, changes in sunlight received by the earth, and meteorite impacts).

- c. Analyze the empirical relationship between the emissions of carbon dioxide, atmospheric carbon dioxide levels, and the average global temperature over the past 150 years.
- d. Based on evidence of observable changes in recent history and climate change models, explain the consequences of warmer oceans (including the results of increased evaporation, shoreline and estuarine impacts, oceanic algae growth, and coral bleaching) and changing climatic zones (including the adaptive capacity of the biosphere).
- e. Based on evidence from historical climate research (e.g. fossils, varves, ice core data) and climate change models, explain how the current melting of polar ice caps can impact the climatic system .
- f. Describe geologic evidence that implies climates were significantly colder at times in the geologic record (e.g., geomorphology, striations, and fossils).
- g. Compare and contrast the heat-trapping mechanisms of the major greenhouse gases resulting from emissions (carbon dioxide, methane, nitrous oxide, fluorocarbons) as well as their abundance and heat- trapping capacity.
- h. Use oxygen isotope data to estimate paleotemperature. (recommended)
- i. Explain the causes of short-term climate changes such as catastrophic volcanic eruptions and impact of solar system objects. *(recommended)*
- j. Predict the global temperature increase by 2100, given data on the annual trends of CO<sub>2</sub> concentration increase. *(recommended)*

# **Social Studies Standards**

### » Political and Intellectual Transformations:

- Describe the ideas, experiences, and interactions that influenced the colonists' decisions to declare independence by analyzing

   colonial ideas about government (e.g., limited government, republicanism, protecting individual rights and promoting the
   common good, representative government, natural rights) (C2)
  - experiences with self-government (e.g., House of Burgesses and town meetings) (C2)
  - changing interactions with the royal government of Great Britain after the French and Indian War (C2)
- 2. Using the Declaration of Independence, including the grievances at the end of the document, describe the role this document played in expressing
  - colonists' views of government
  - their reasons for separating from Great Britain. (C2)
- 3. Describe the consequences of the American Revolution by analyzing the
  - birth of an independent republican government (C2)
    - creation of Articles of Confederation (C2)
    - changing views on freedom and equality (C2)
  - and concerns over distribution of power within governments, between government and the governed, and among people (C2)

### » USHG ERA 3 – Revolution and the New Nation

#### Creating New Government(s) and a New Constitution:

- 1. Explain the challenges faced by the new nation and analyze the development of the Constitution as a new plan for governing. [Foundations for Civics HSCE Standard 2.2.]
  - a. Explain the reasons for the adoption and subsequent failure of the Articles of Confederation (e.g., why its drafters created a weak central government, challenges the nation faced under the Articles, Shays' Rebellion, disputes over western lands). (C2)
  - b. Identify economic and political questions facing the nation during the period of the Articles of Confederation and the opening of the Constitutional Convention. (E1.4)
  - c. Describe the major issues debated at the Constitutional Convention including the distribution of political power, conduct of foreign affairs, rights of individuals, rights of states, election of the executive, and slavery as a regional and federal issue.
  - d. Explain how the new constitution resolved (or compromised) the major issues including sharing, separating, and checking of power among federal government institutions, dual sovereignty (state-federal power), rights of individuals, the Electoral College, the Three-Fifths Compromise, and the Great Compromise.
  - e. Analyze the debates over the ratification of the Constitution from the perspectives of Federalists and Anti-Federalists and describe how the states ratified the Constitution. (C2)
  - f. Explain how the Bill of Rights reflected the concept of limited government, protections of basic freedoms, and the fear of many Americans of a strong central government. (C3)

g. Using important documents (e.g., Mayflower Compact, Iroquois Confederacy, Common Sense, Declaration of Independence, Northwest Ordinance, Federalist Papers), describe the historical and philosophical origins of constitutional government in the United States using the ideas of social compact, limited government, natural rights, right of revolution, separation of powers, bicameralism, republicanism, and popular participation in government. (C2)

### » USHG ERA 4 – Expansion and Reform (1792-1861)

#### Challenges to an Emerging Nation:

1. Analyze the challenges the new government faced and the role of political and social leaders in meeting these challenges.

- a. Washington's Farewell Use Washington's Farewell Address to analyze the most significant challenges the new nation faced and the extent to which subsequent Presidents heeded Washington's advice. (C4)
- b. Establishing America's Place in the World Explain the changes in America's relationships with other nations by analyzing treaties with American Indian nations, Jay's Treaty (1795), French Revolution, Pinckney's Treaty (1795), Louisiana Purchase, War of 1812, Transcontinental Treaty (1819), and the Monroe Doctrine. (C4) (National Geography Standard 13, p. 169)\
- c. Challenge of Political Conflict Explain how political parties emerged out of the competing ideas, experiences, and fears of Thomas Jefferson and Alexander Hamilton (and their followers), despite the worries the Founders had concerning the dangers of political division, by analyzing disagreements over
  - relative power of the national government (e.g., Whiskey Rebellion, Alien and Sedition Acts) and of the executive branch (e.g., during the Jacksonian era) (C3) (*National Geography Standard 13, p. 169*)
  - foreign relations (e.g., French Revolution, relations with Great Britain) (C3) (National Geography Standard 13, p. 169)
  - economic policy (e.g., the creation of a national bank, assumption of revolutionary debt) (C3, E2.2)
- d. Establishing a National Judiciary and Its Power Explain the development of the power of the Supreme Court through the doctrine of judicial review as manifested in *Marbury* v. *Madison* (1803) and the role of Chief Justice John Marshall and the Supreme Court in interpreting the power of the national government (e.g., *McCullouch* v. *Maryland, Dartmouth College* v. *Woodward, Gibbons* v. *Ogden*). (C3, E1.4, 2.2)

#### Regional and Economic Growth:

- 2. Describe and analyze the nature and impact of the territorial, demographic, and economic growth in the first three decades of the new nation using maps, charts, and other evidence.
  - a. Comparing Northeast and the South Compare and contrast the social and economic systems of the Northeast and the South with respect to geography and climate and the development of
    - agriculture, including changes in productivity, technology, supply and demand, and price(E1.3,1.4) (National Geography Standard 14, p. 171)
    - industry, including entrepreneurial development of new industries, such as textiles (E1.1)
    - the labor force including labor incentives and changes in labor forces (E1.2)
    - transportation including changes in transportation (steamboats and canal barges) and impact on economic markets and prices (E1.2,1.3) (*National Geography Standard 3, p. 148*)
    - immigration and the growth of nativism (National Geography Standard 9, p. 160)
    - race relations
    - class relations
  - b. The Institution of Slavery Explain the ideology of the institution of slavery, its policies, and consequences.
  - c. Westward Expansion Explain the expansion, conquest, and settlement of the West through the Louisiana Purchase, the removal of American Indians (Trail of Tears) from their native lands, the growth of a system of commercial agriculture, the Mexican-American War, and the idea of Manifest Destiny. (E2.1) (National Geography Standard 6, p. 154)
  - d. Consequences of Expansion Develop an argument based on evidence about the positive and negative consequences of territorial and economic expansion on American Indians, the institution of slavery, and the relations between free and slaveholding states. (C2)

#### **Reform Movements:**

- 3. Analyze the growth of antebellum American reform movements.
  - a. Explain the origins of the American education system and Horace Mann's campaign for free compulsory public education. (C2)

- Describe the formation and development of the abolitionist movement by considering the roles of key abolitionist leaders (e.g., John Brown and the armed resistance, Harriet Tubman and the Underground Railroad, Sojourner Truth, William Lloyd Garrison, and Frederick Douglass), and the response of southerners and northerners to the abolitionist movement. (C2)
- Analyze the antebellum women's rights (and suffrage) movement by discussing the goals of its leaders (e.g., Susan B. Anthony and Elizabeth Cady Stanton) and comparing the Seneca Falls Resolution with the Declaration of Independence.
   (C2)
- d. Analyze the goals and effects of the antebellum temperance movement. (C2)
- e. Evaluate the role of religion in shaping antebellum reform movements. (C2)

### » USGH ERA 5 – Civil War and Reconstruction (1850-1877)

#### The Coming of the Civil War:

1. Analyze and evaluate the early attempts to abolish or contain slavery and to realize the ideals of the Declaration of Independence.

- a. Explain the differences in the lives of free blacks (including those who escaped from slavery) with the lives of free whites and enslaved peoples. (C2)
- b. Describe the role of the Northwest Ordinance and its effect on the banning of slavery (e.g., the establishment of Michigan as a free state). (*National Geography Standard 12, p. 167*)
- c. Describe the competing views of Calhoun, Webster, and Clay on the nature of the union among the states (e.g., sectionalism, nationalism, federalism, state rights). (C3)
- d. Describe how the following increased sectional tensions
  - the Missouri Compromise (1820)
  - the Wilmot Proviso (1846)
  - the Compromise of 1850 including the Fugitive Slave Act
  - the Kansas-Nebraska Act (1854) and subsequent conflict in Kansas
  - the Dred Scott v. Sandford decision (1857)
  - changes in the party system (e.g., the death of the Whig party, rise of the Republican party and division of the Democratic party) (C2; C3) (National Geography Standard 13, p. 169)
- e. Describe the resistance of enslaved people (e.g., Nat Turner, Harriet Tubman and the Underground Railroad, John Brown, Michigan's role in the Underground Railroad) and effects of their actions before and during the Civil War. (C2)
- *f.* Describe how major issues debated at the Constitutional Convention such as disagreements over the distribution of political power, rights of individuals (liberty and property), rights of states, election of the executive, and slavery help explain the Civil War. (C2) (*National Geography Standard 13, p. 169*)

#### Civil War:

- 2. Evaluate the multiple causes, key events, and complex consequences of the Civil War.
  - a. Explain the reasons (political, economic, and social) why Southern states seceded and explain the differences in the timing of secession in the Upper and Lower South. (C3, E1.2) (National Geography Standard 6, p. 154)
  - b. Make an argument to explain the reasons why the North won the Civil War by considering the
    - critical events and battles in the war
    - the political and military leadership of the North and South
    - the respective advantages and disadvantages, including geographic, demographic, economic and technological (E1.4) (*National Geography Standard 15, p. 173*)
  - c. Examine Abraham Lincoln's presidency with respect to
    - his military and political leadership
    - the evolution of his emancipation policy (including the Emancipation Proclamation)
    - and the role of his significant writings and speeches, including the Gettysburg Address and its relationship to the Declaration of Independence (C2)
  - d. Describe the role of African Americans in the war, including black soldiers and regiments, and the increased resistance of enslaved peoples.
  - e. Construct generalizations about how the war affected combatants, civilians (including the role of women), the physical environment, and the future of warfare, including technological developments. (National Geography Standard 14, p. 171)

#### **Reconstruction:**

3. Using evidence, develop an argument regarding the character and consequences of Reconstruction.

- a. Describe the different positions concerning the reconstruction of Southern society and the nation, including the positions of President Abraham Lincoln, President Andrew Johnson, Republicans, and African Americans.
- b. Describe the early responses to the end of the Civil War by describing the
  - policies of the Freedmen's Bureau (E2.2)
  - restrictions placed on the rights and opportunities of freedmen, including racial segregation and Black Codes (C2, C5)
- c. Describe the new role of African Americans in local, state and federal government in the years after the Civil War and the resistance of Southern whites to this change, including the Ku Klux Klan. (C2, C5) (*National Geography Standard 10, p. 162*)
- d. Analyze the intent and the effect of the Thirteenth, Fourteenth, and Fifteenth Amendments to the Constitution.
- e. Explain the decision to remove Union troops in 1877 and describe its impact on Americans.

# » USHG ERA 6 – The Development of an Industrial, Urban, and Global United States (1870-1930)

#### America in the Last Half of the 19<sup>th</sup> Century:

1. Analyze the major changes in communication, transportation, demography, and urban centers, including the location and growth of cities linked by industry and trade, in last half of the 19th century.

America at Century's End – Compare and contrast the United States in 1800 with the United States in 1898 focusing on similarities and differences in

• territory, including the size of the United States and land use (National Geography Standards 1and 16, pp. 144 and 196)

• population, including immigration, reactions to immigrants, and the changing demographic structure of rural and urban America(E3.2) (*National Geography Standards 9 and 12, pp. 160 and 167*)

• systems of transportation (canals and railroads, including the Transcontinental Railroad), and their impact on the economy and society (E1.4, 3.2) (National Geography Standard 11, p. 164)

• governmental policies promoting economic development (e.g., tariffs, banking, land grants and mineral rights, the Homestead Act) (E.2.2) (*National Geography Standard 16, p. 176*)

• economic change, including industrialization, increased global competition, and their impact on conditions of farmers and industrial workers(E1.4, 2.1, 3.2) (*National Geography Standard 11, p. 164*)

• the treatment of African Americans, including the rise of segregation in the South as endorsed by the Supreme Court's decision in *Plessy* v. *Ferguson*, and the response of African Americans

• the policies toward American Indians, including removal, reservations, the Dawes Act of 1887, and the response of American Indians (*National Geography Standard 13, p. 169*)

#### Investigation Topics and Issue Analysis:

2. Use the historical perspective to investigate a significant historical topic from United States History Eras 3-6 that also has significance as an issue or topic in the United States today.

a. United States History Investigation Topic and Issue Analysis, Past and Present – Use historical perspectives to analyze issues in the United States from the past and the present; conduct research on a historical issue or topic, identify a connection to a contemporary issue, and present findings (e.g., oral, visual, video, or electronic presentation, persuasive essay, or research paper); include causes and consequences of the historical action and predict possible consequences of the contemporary action. (*National Geography Standards 9 and 10, pp. 160 and 162*)

### »Public Discourse, Decision Making, and Citizen Involvement

#### *Identifying and Analyzing Issues, Decision Making, Persuasive Communication About a Public Issue, and Citizen Involvement:*

- 1. Identify, research, analyze, discuss, and defend a position on a national public policy issue.
  - Identify a national public policy issue.
  - Clearly state the issue as a question of public policy orally or in written form.
  - Use inquiry methods to trace the origins of the issue and to acquire data about the issue.
  - Generate and evaluate alternative resolutions to the public issue and analyze various perspectives (causes, consequences, positive and negative impact) on the issue.
  - Identify and apply core democratic values or constitutional principles.
  - Share and discuss findings of research and issue analysis in group discussions and debates.
  - Compose a persuasive essay justifying the position with a reasoned argument.
  - Develop an action plan to address or inform others about the issue

#### Citizen Involvement:

- 1. Act constructively to further the public good.
  - a. Demonstrate knowledge of how, when, and where individuals would plan and conduct activities intended to advance views in matters of public policy, report the results, and evaluate effectiveness.
  - b. Engage in activities intended to contribute to solving a national or international problem studied.
  - c. Participate in projects to help or inform others (e.g., service learning projects).