Ohio Science - Extended Learning Standards

Physical Geology

Minerals

1 Atoms and elements PG.M.1

Complexity a

a Identify parts of an atom (e.g., protons, neutrons, electrons). PG.M.1.A

Complexity b

b Identify a diagram or model of an atom. PG.M.1.B

Complexity c

c Identify that all matter is made of atoms. PG.M.1.C

Learning Progression

- Build or recognize a model of an atom including protons, neutrons or electrons. PG.M.1.LP.A
- Identify that protons have a positive charge, neutrons are neutral, and electrons have a negative charge. PG.M.1.LP.B
- Recognize that valence electrons are in the outside layer of an atom. PG.M.1.LP.C
- Identify the valence electrons on a drawing or model on an atom. PG.M.1.LP.D
- Place labels (protons, neutrons, electrons) on a drawing of an atom. PG.M.1.LP.E
- Select the diagram that shows an atom from a set of drawings. PG.M.1.LP.F
- Engage with models or various visual representations of an atom. PG.M.1.LP.G

2 Chemical bonding (ionic, covalent, metallic) PG.M.2

Complexity a

a Represent a chemical compound with a ball-and-stick model or chemical formula. PG.M.2.A

Complexity b

b Recognize that a model (balland-stick or molecular geometries) or chemical formula represents a chemical compound. PG.M.2.B

Complexity c

c Identify that two elements combine to form a compound. PG.M.2.C

Learning Progression

- Use an atomic model and/or video to investigate that atoms interact to achieve 8 valence electrons (view the product). PG.M.2.LP.A
- Recognize that different atoms react in different ways (ionic and covalent bonding). PG.M.2.LP.B
- Recognize an ion as an atom that has gained or lost valence electrons (which changes their electrical charge). PG.M.2.LP.C
- Recognize that ionic bonding is an attraction between oppositely charged ions. PG.M.2.LP.D
- Recognize that in covalent bonding atoms share valence electrons so that each have 8. PG.M.2.LP.E
- Identify common minerals that are bonded ionically and covalently. PG.M.2.LP.F
- Recognize that an atom's reactivity is based on its valence electrons. PG.M.2.LP.G
- Identify the valence electrons on a drawing or model on an atom. PG.M.2.LP.H
- Recognize that valence electrons are in the outside layer of an atom. PG.M.2.LP.I
- Engage with a model of an atom to locate the valence (outermost) electrons. PG.M.2.LP.J

3 Crystallinity (crystal structure) PG.M.3

Learning Progression

Complex and advanced learning standards in Ohio's New Learning Standards are not included in the extended standards.

4 **Criteria of a mineral (crystalline solid, occurs in nature, inorganic, defined chemical composition)** PG.M.4

Complexity a

a Match minerals with rock types in which they are commonly found. PG.M.4.A

Complexity b

b Identify a common mineral in a common rock. PG.M.4.B

Complexity c

c Recognize that minerals can be found in rocks. PG.M.4.C

Learning Progression

- Use a crystal growing kit to illustrate how crystals form. PG.M.4.LP.A
- Examine a variety of rocks and note the size of the crystals in the structure. PG.M.4.LP.B
- Watch videos that show how minerals are formed in a variety of rocks. PG.M.4.LP.C

5 **Properties of minerals (hardness, luster, cleavage, streak, crystal shape, fluorescence, flammability, density/specific gravity, malleability)** PG.M.5

Complexity a

a Sort minerals by cleavage, streak, hardness and fracture. PG.M.5.A

Complexity b

b Identify hardness and fracture as two characteristics to identify a mineral. PG.M.5.B

Complexity c

c Match minerals by properties (e.g., cleavage, streak, magnetism). PG.M.5.C

Learning Progression

- Investigate a sample rock and determine its identity by testing its properties. PG.M.5.LP.A
- Match a sample rock to its origin given a set of characteristics (e.g., using pictures, maps, illustrations, etc.). PG.M.5.LP.B
- Manipulate rocks to identify textural characteristics of each. PG.M.5.LP.C
- Engage with rocks by feeling the surface of each. PG.M.5.LP.D

Igneous, Metamorphic and Sedimentary Rocks

1 **Igneous • Mafic and felsic rocks and minerals • Intrusive (igneous structures: dikes, sills, batholiths, pegmatites) • Earth's interior (inner core, outer core, lower mantle, upper mantle, Mohorovičić [Moho] discontinuity, crust) • Magnetic reversals and Earth's magnetic field • Thermal energy within Earth • Extrusive (volcanic activity, volcanoes: cinder cones, composite, shield) • Bowen's Reaction Series (continuous and discontinuous branches)** PG.IMS.1

Complexity a

a Compare how different environments change the type of igneous rock that is formed. PG.IMS.1.A

Complexity b

b Describe the properties of igneous rocks. PG.IMS.1.B

Complexity c

c Identify environments in which igneous rocks are formed. PG.IMS.1.C

Learning Progression

- Look at samples of igneous rock (e.g., granite, basalt), identify differences and recognize that they were formed in different environments. PG.IMS.1.LP.A
- Identify that granite makes up much of continental crust and basalt makes up much of our ocean floors. PG.IMS.1.LP.B
- View images or videos of volcanoes at various locations (e.g., edges of continents, mid-ocean spreading centers, hotspots). PG.IMS.1.LP.C
- Recognize that the cooled lava from volcanoes forms igneous rock (e.g., Hawaii). PG.IMS.1.LP.D
- View videos of volcanoes erupting. PG.IMS.1.LP.E

2 **Metamorphic • Pressure, stress, temperature, and compressional forces • Foliated (regional), nonfoliated (contact) • Parent rock and degrees of metamorphism • Metamorphic zones (where metamorphic rocks are found)** PG.IMS.2

Complexity a

a Compare how different environments change the type of metamorphic rock that is formed. PG.IMS.2.A

Complexity b

b Describe the properties of metamorphic rocks. PG.IMS.2.B

Complexity c

c Identify environments in which metamorphic rocks are formed. PG.IMS.2.C

Learning Progression

- Look at samples of metamorphic rocks and the rocks they formed from (e.g., slate from shale, marble from limestone), note the differences and similarities PG.IMS.2.LP.A
- Recognize that heat and pressure cause things to change. (e.g., examine a slice of white bread (crust removed), describe its properties, roll and squish it into a small ball, describe how its properties have changed, relate this to metamorphic rocks changing from other existing rocks (heat and pressure from your hand). PG.IMS.2.LP.B

3 **Sedimentary • Division of sedimentary rocks and minerals (chemical, clastic/physical, organic) • Depositional environments** PG.IMS.3

Complexity a

a Compare how different environments change the type of sedimentary rock that is formed. PG.IMS.3.A

Complexity b

b Describe the properties of sedimentary rocks. PG.IMS.3.B

Complexity c

c Identify environments in which sedimentary rocks are formed. PG.IMS.3.C

Learning Progression

- Predict what would happen if lots of pressure squeezed the sediments (they would cement together). PG.IMS.3.LP.A
- Describe locations where sedimentary rocks can form (e.g., desserts, oceans). PG.IMS.3.LP.B
- Build a model of the formation of sedimentary rock (e.g., shake sand and dirt in a jar of water, let it sit and describe what happens (settles to the bottom), relate this to sediments falling to the bottom of an ocean). PG.IMS.3.LP.C

4 **Ocean • Tides (daily, neap, and spring) • Currents (deep and shallow, rip and longshore) • Thermal energy and water density • Waves • Ocean features (ridges, trenches, island systems, abyssal zone, shelves, slopes, reefs, island arcs) • Passive and active continental margins • Transgressing and regressing sea levels • Streams (channels, streambeds, floodplains, cross-bedding, alluvial fans, deltas)** PG.IMS.4

Complexity a

a Use data to see how the sea level changes with the tides in a given location. PG.IMS.4.A

Complexity b

b Describe how the tides are controlled by the moon. PG.IMS.4.B

Complexity c

c Identify a reason for a change in sea level. (e.g., tides, currents, waves, etc.). PG.IMS.4.C

Learning Progression

- Given a tide table, identify the pattern (amount of time) that occurs between high and low tide and high tide to next high tide. PG.IMS.4.LP.A
- Watch videos on ocean currents (e.g., NASA, NOAA, Bill Nye) to look at patterns; understand that ocean currents move materials around the ocean and affect the climate on Earth. PG.IMS.4.LP.B
- View time lapse videos of tides in the ocean, recognize that the water level changes due to the tides. PG.IMS.4.LP.C
- Recognize that tides are controlled by the gravitational attraction between the moon and Earth. PG.IMS.4.LP.D
- Engage by watching convection in a tub of water to observe how temperature differences make water move in currents (heat a tub of water under one side only, sprinkle in pepper and watch the circulation pattern). PG.IMS.4.LP.E

Earth's History

1 **The geologic rock record • Relative and absolute age • Principles to determine relative age • Original horizontality • Superposition • Cross-cutting relationships • Absolute age • Radiometric dating (isotopes, radioactive decay) • Correct uses of radiometric dating • Combining relative and absolute age data • The geologic time scale • Comprehending geologic time • Climate changes evident through the rock record • Fossil record** PG.EH.1

Complexity a

a Describe how technology assists in determining the age of rocks (e.g., radiometric dating). PG.EH.1.A

Complexity b

b Identify that in a cross-section of rock, the layer on top is the youngest layer and the layer on the bottom is the oldest (assuming no geological process has shifted the layers). PG.EH.1.B

Complexity c

c Identify changes across layers (crosssection) of rocks. PG.EH.1.C

Learning Progression

- Explain that radiometric dating traces radioactive materials in the rock to determine age. PG.EH.1.LP.A
- Recognize that there are a variety of methods to determine the age of rock. PG.EH.1.LP.B
- Given a cross section of rock determine the relative age in an undisturbed section. PG.EH.1.LP.C
- Model the formation of rock layers and relate the age of the layers to the Law of Superposition. PG.EH.1.LP.D
- Identify the layers that can be seen within a cross section (e.g., highway cut, Grand Canyon). PG.EH.1.LP.E
- Engage with a model of a cross section of a highway cut or rock layers. PG.EH.1.LP.F

Plate Tectonics

1 **Internal Earth • Seismic waves • S and P waves • Velocities, reflection, refraction of waves** PG.PT.1

Complexity a

a Analyze which earthquake was larger based on a seismographic report or readout. PG.PT.1.A

Complexity b

b Describe how a Richter scale is used as a tool to measure the seismic waves of an earthquake. PG.PT.1.B

Complexity c

c Recognize that a Richter scale is a tool used to measure intensity of earthquakes. PG.PT.1.C

Learning Progression

- Recognize that the “wiggles” on the seismograph represents energy waves traveling through Earth. PG.PT.1.LP.A
- Given two seismograms choose the one that represents a stronger earthquake. PG.PT.1.LP.B
- Compare seismograms, recognize that large “wiggles” mean more shaking of the ground. PG.PT.1.LP.C
- Recognize that the Richter scale uses numbers to describe the strength of earthquakes (larger numbers are 10 times stronger than the number before). PG.PT.1.LP.D
- Recognize that earthquakes have different strengths. PG.PT.1.LP.E
- Watch video footage of small and large earthquakes. PG.PT.1.LP.F

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2 **Structure of Earth (Note: specific layers were part of grade 8) • Asthenosphere • Lithosphere • Mohorovičić (Moho) boundary • Composition of each of the layers of Earth • Gravity, magnetism and isostasy • Thermal energy (geothermal gradient and heat flow)** PG.PT.2

Learning Progression

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3 **Historical review (Note: this would include a review of continental drift and sea-floor spreading found in grade 8) • Paleomagnetism and magnetic anomalies • Paleoclimatology** PG.PT.3

Learning Progression

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4 **Plate motion (Note: introduced in grade 8) • Causes and evidence of plate motion • Measuring plate motion • Characteristics of oceanic and continental plates • Relationship of plate movement and geologic events and features • Mantle plumes** PG.PT.4

Complexity a

a Describe how the continents used to be connected in one super continent of Pangaea and have moved due to tectonic forces. PG.PT.4.A

Complexity b

b Recognize that the shape of the continents is evidence of plate motion (e.g., they fit together like puzzle pieces). PG.PT.4.B

Complexity c

c Identify the crust as the location of the continental plates. PG.PT.4.C

Learning Progression

- Recognize that plate motion has caused the continents to shift. Use video footage of Hawaii to illustrate this type of activity. PG.PT.4.LP.A
- Use cut outs of the modern continents, try to fit them together like a puzzle, understand that the fact they fit is evidence they were once joined. PG.PT.4.LP.B
- Review maps of Earth's continents over the past 300,000 years to identify changes. PG.PT.4.LP.C
- Recognize that the surface of Earth has changed. PG.PT.4.LP.D
- Identify the name of the previous supercontinent as Pangaea. PG.PT.4.LP.E
- Watch a video of a flower blooming or a glacier moving in real time and in fast motion, recognize that sometimes movement is too slow to see. PG.PT.4.LP.F

Earth's Resources

1 Energy resources • Renewable and nonrenewable energy sources and efficiency • Alternate energy sources and efficiency • Resource availability • Mining and resource extraction PG.ER.1

Complexity a

a Identify factors to consider before mining for mineral resources (e.g., cost, pollution, effects on wildlife). PG.ER.1.A

Complexity b

b Identify the effect that mining for a mineral resource has on an area. PG.ER.1.B

Complexity c

c Recognize that minerals are a resource. PG.ER.1.C

Learning Progression

- Provide pictures of mining sites and describe the changes to the environment. Describe how those changes impact wildlife. PG.ER.1.LP.A
- Understand that renewable means more can be made is a short period of time. PG.ER.1.LP.B
- Understand that nonrenewable means that once it is used there is no way to get more in a reasonable time frame. PG.ER.1.LP.C
- Recognize that minerals are a nonrenewable resource. PG.ER.1.LP.D
- Recognize that minerals are extracted through mining. PG.ER.1.LP.E
- Recognize that minerals are used in our everyday materials. PG.ER.1.LP.F
- Observe and manipulate various minerals. PG.ER.1.LP.G

2 Air • Primary and secondary contaminants • Greenhouse gases PG.ER.2

Complexity a

a Describe how greenhouse gas effects the atmosphere. PG.ER.2.A

Complexity b

b Identify a cause and effect of specific air pollution problem (e.g., smoke from a factory causes haze in the air). PG.ER.2.B

Complexity c

c Identify an air contaminant. PG.ER.2.C

Learning Progression

- Identify greenhouse gases (e.g., carbon dioxide, water vapor) and how they can impact the atmosphere and environment. PG.ER.2.LP.A
- Use Google Earth to view a local area to determine what exists in an area and what products are produced and how that impacts an area (e.g., farms, housing developments, industries, nature reserves). PG.ER.2.LP.B
- Identify an effect of a primary and secondary contaminant. PG.ER.2.LP.C
- Identify sources of air pollution. PG.ER.2.LP.D
- Recognize when there is a change in the air (hot, cold, odor, scent, humid). PG.ER.2.LP.E
- Engage with the air by taking a deep breath and exhaling. PG.ER.2.LP.F

3 Water • Potable water and water quality • Hypoxia, eutrophication PG.ER.3

Complexity a

a Describe why it is important to have clean drinking water. PG.ER.3.A

Complexity b

b Identify a water contaminant. PG.ER.3.B

Complexity c

c Identify a drinking water source. PG.ER.3.C

Learning Progression

- Sort water sources as potable and nonpotable. PG.ER.3.LP.A
- Describe characteristics of potable and nonpotable water or factors that make it potable/non potable. PG.ER.3.LP.B
- In your region, identify where your water originates. PG.ER.3.LP.C
- Recognize that the water used for drinking has to be processed to be used. PG.ER.3.LP.D
- Recognize that some water is potable and some is not. PG.ER.3.LP.E
- Identify various sources of water. PG.ER.3.LP.F
- Actively participate in a discussion about water that is good for drinking versus water that would not be. PG.ER.3.LP.G

4 Soil and sediment • Desertification • Mass wasting and erosion • Sediment contamination PG.ER.4

Complexity a

a Describe how erosion can change an environment. PG.ER.4.A

Complexity b

b Identify a reason for erosion. PG.ER.4.B

Complexity c

c Define erosion as the movement of Earth's materials. PG.ER.4.C

Learning Progression

- Identify the agents of erosion. PG.ER.4.LP.A
- Recognize a landform or area that resulted from erosion. PG.ER.4.LP.B
- Examine before and after images of erosion. PG.ER.4.LP.C
- Observe erosion (video) in action. PG.ER.4.LP.D

Glacial Geology

1 **Glaciers and glaciation • Evidence of past glaciers (including features formed through erosion or deposition) • Glacial deposition and erosion (including features formed through erosion or deposition) • Data from ice cores • Historical changes (glacial ages, amounts, locations, particulate matter, correlation to fossil evidence) • Evidence of climate changes throughout Earth's history • Glacial distribution and causes of glaciation • Types of glaciers: continental (ice sheets, ice caps), alpine/valley (piedmont, valley, cirque, ice caps) • Glacial structure, formation, and movement** PG.GG.1

Complexity a

a Describe land features that were formed through either erosion or deposition from glaciers. PG.GG.1.A

Complexity b

b Identify land features in Ohio that were formed by glaciers. PG.GG.1.B

Complexity c

c Identify that glaciers consist mainly of ice. PG.GG.1.C

Learning Progression

- Use a map to trace the movement of glaciers globally for the last 20 years. PG.GG.1.LP.A
- Identify features on a map that are a direct result of glaciation (e.g., the Great Lakes, glacial grooves on Kelleys Island). PG.GG.1.LP.B
- Use pictures to identify the different kinds of glaciers (e.g., valley, piedmont, glaciers, cirque, tidewater). PG.GG.1.LP.C
- Look at a series of pictures from around Ohio, sort them into glaciated and unglaciated areas. PG.GG.1.LP.D
- Actively engage in an activity that demonstrates movement and effects of a glacier. Push a large ice cube across a container of sand, dirt and pebbles, to recognize that ice blocks (glaciers) can move materials. Push down to make the ice cube dig a hole in the sand, relate this to the formation of the Great Lakes. PG.GG.1.LP.E