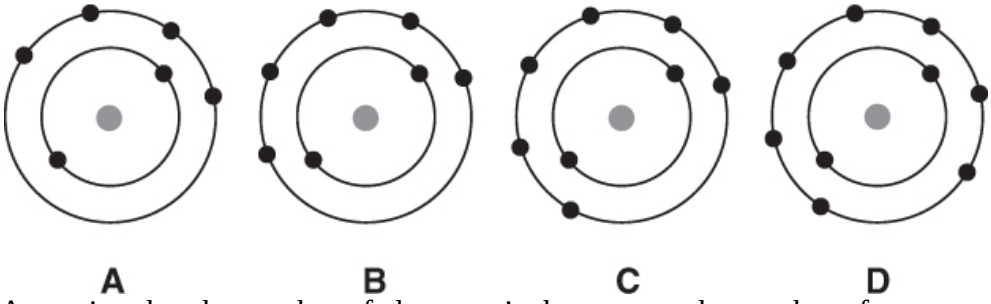
CHAPTER 7: ROCKS AND MINERALS

Self-Reflection Survey: Section 7.1, p. 175
Answers will vary…

Checkpoint 7.1, p. 177
Examine the atomic models below and answer the question that follows. The filled black circles represent electrons. (Note: Electrons and nucleus are not drawn to scale.)



Assuming that the number of electrons is the same as the number of protons, which picture represents the atom of carbon that has an atomic number of 6?

a) A b) B c) C d) D

This is an application-level problem to ensure students recognize that a neutral atom's atomic number matches the number if electrons for a neutral atom.

Checkpoint 7.2, p. 180
Which of the following mineral formulas represents a silicate?

a. FeS_2 **b. $KAlSi_3O_8$** c. Fe_2O_3 d. $CaSO_4 \cdot 2H_2O$

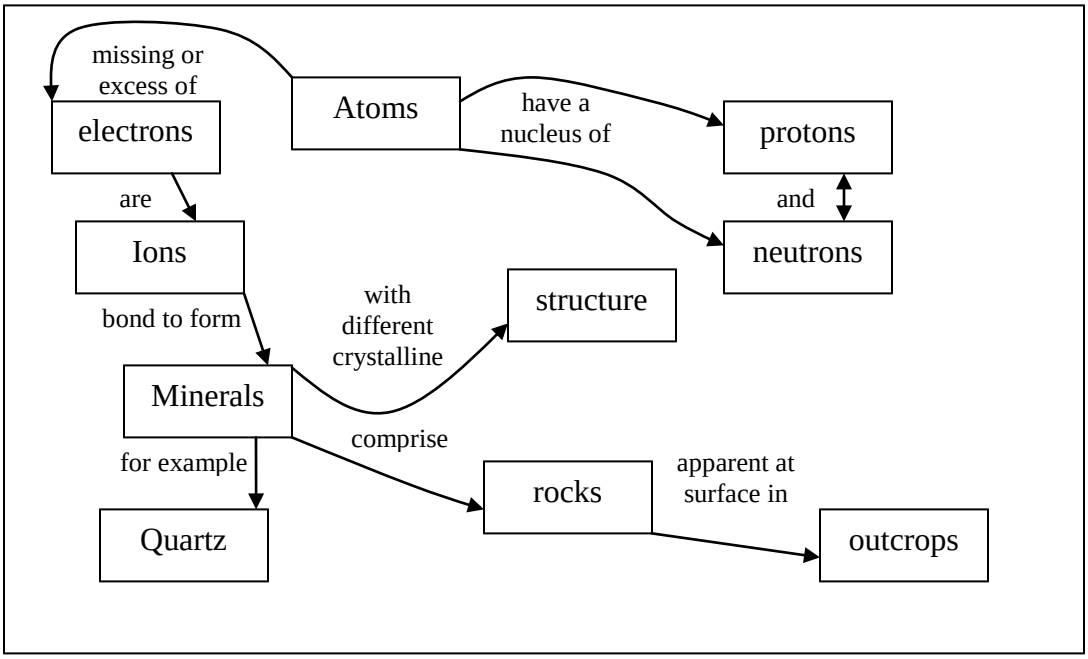
Checkpoint 7.3, p. 180
The total electrical charges of the ions of the elements in the mineral olivine must balance. Based on the data in Table 7.1, which is the most reasonable equation for the mineral?

a) $MgSiO_2$ b) $MgSiO_4$ **c) Mg_2SiO_4** d) Mg_4SiO_2

Checkpoint 7.4, p. 180
Construct a concept map that illustrates the relationship between atoms, elements, minerals, and rocks. Use the following 6 terms and add at least 3 more of your own choosing.

Atom Mineral Ion Electron Bond Quartz

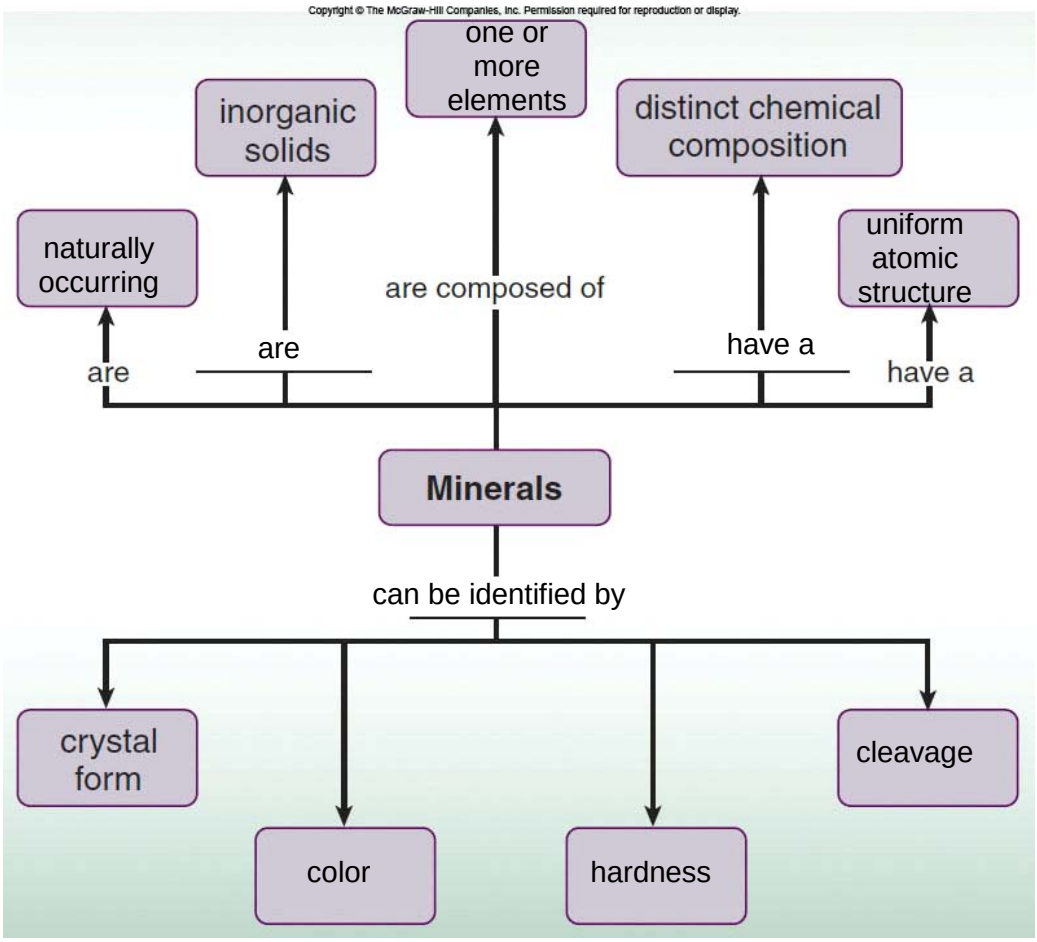
Possible added terms
Proton Neutron Structure Rock Outcrop



Checkpoint 7.5, p. 180
Which of the following cannot be classified as a mineral?
a. Salt b. Ice c. Diamond **d. Glass**

Salt is the mineral halite and diamond is also a mineral. The definition requires that minerals are inorganic, composed of one or more elements, have a definite chemical composition and have an orderly atomic structure. Ice meets all of these requirements. It is inorganic, composed of hydrogen and oxygen with a consistent atomic arrangement. In contrast, glass can have a variety of constituents and does not have a consistent atomic structure.

Checkpoint 7.6, p. 183
Finish the partially completed concept map for minerals provided here. Add additional levels to the concept map.



Checkpoint 7.7, p. 183

Examine the following images of the mineral halite, and identify how many cleavage planes are present.

You should observe 3 cleavage planes.

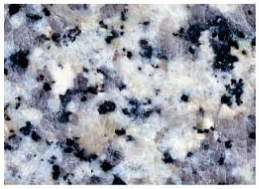
Checkpoint 7.8, p. 183
Which mineral characteristics discussed in this section are most closely tied to the bonding of atoms described in Section 7.2?

Properties such as crystal form and cleavage are tied directly to the bonding of atoms. Further, hardness is at least partially influenced by the types of bonds that hold elements together.

Checkpoint 7.9, p. 187
Geologists sometimes find a type of igneous rock known as porphyry, which contains both large and small crystals. Which is the best explanation for the formation of this rock?

a. The rock experienced a two-stage cooling process, with initial slow cooling at depth followed by rapid cooling at the surface.
b. The rock experienced a two-stage cooling process, with initial rapid cooling at depth followed by slow cooling at the surface.
c. The rock experienced a two-stage cooling process, with initial rapid cooling near the surface followed by slow cooling at depth.
d. The rock experienced a two-stage cooling process, with initial slow cooling near the surface followed by rapid cooling at depth.

Checkpoint 7.10, p. 187
Name each of the four igneous rocks pictured here. Describe how each of these rocks formed.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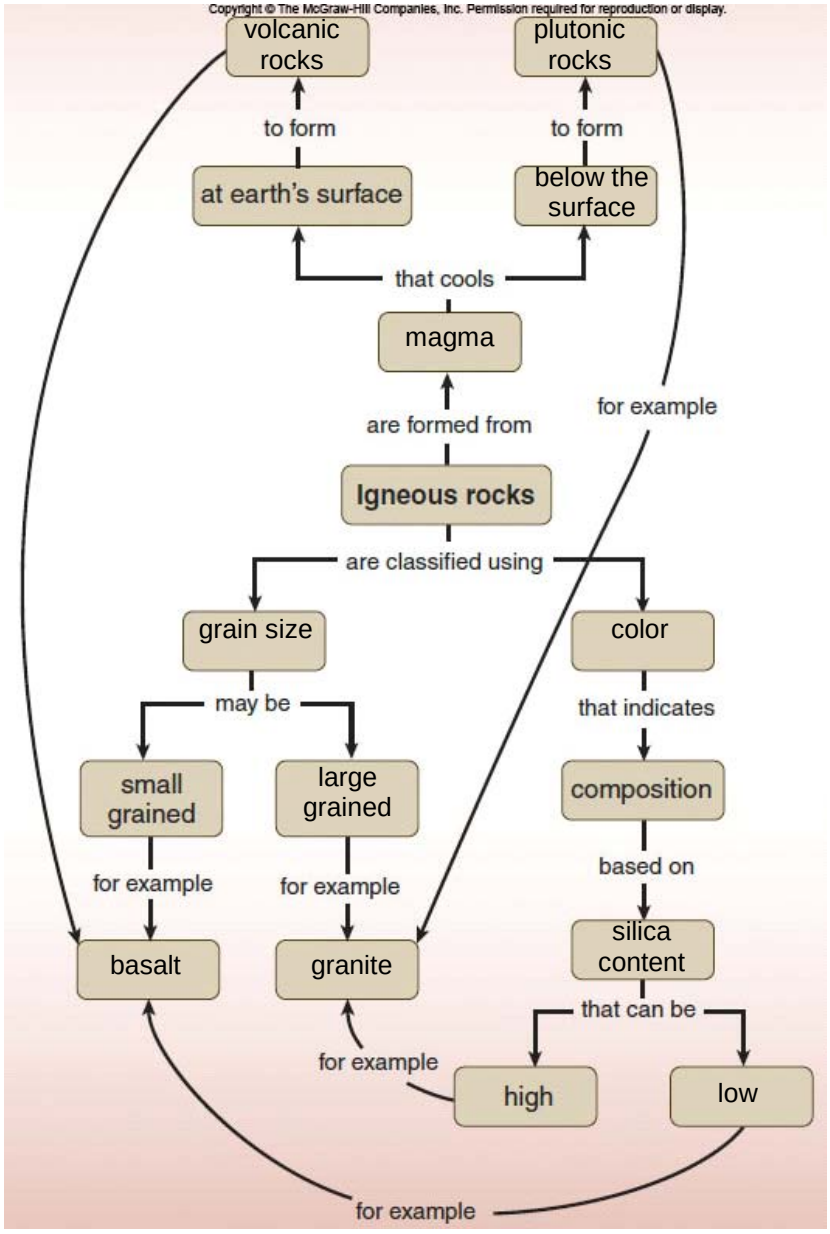
You should use color and texture to classify four igneous rocks. Correct answers are: a) granite; b) basalt; c) rhyolite; d) diorite. Individual grains are visible in a and d but not in b and c; a and c are light colored, b is dark, and d clearly has both light and dark minerals.

Checkpoint 7.11, p. 190
Complete the following table by identifying which of the characteristics in the left-hand column are present in volcanic and/or plutonic igneous rocks and placing a check mark in the appropriate column(s). Do not place a check mark in either column if the characteristic is not present. One characteristic has been completed as an example.

Characteristic	Volcanic igneous rocks	Plutonic igneous rocks
May form from basaltic magma	✓	✓
Form at Earth's surface	✓	
Have texture	✓	✓
Made of small grains	✓	
Granite is an example		✓
Form as a result of melting	✓	✓
May form from rhyolite magma	✓	✓
May form in the presence of water	✓	✓
Present at Earth's surface only after erosion		✓
Contains minerals	✓	✓
Andesite is an example	✓	
Classified based on color	✓	✓
Dark-colored examples have low silica content	✓	✓
Contain visible grains		✓

Checkpoint 7.12, p. 190
Finish the partially completed concept map for igneous rocks provided here by filling in the blanks with appropriate terms. Three of the appropriate terms are: magma, basalt, and plutonic rocks.



Checkpoint 7.13, p. 194
Suppose that you were given a plastic jar that is about one-third full with a mixture of gravel, sand, and silt. The jar is filled with water, sealed, and violently shaken. Draw a picture of what it would look like after the shaking stops and the jar is placed on the counter for a few minutes. How might the picture change after 10 hours?

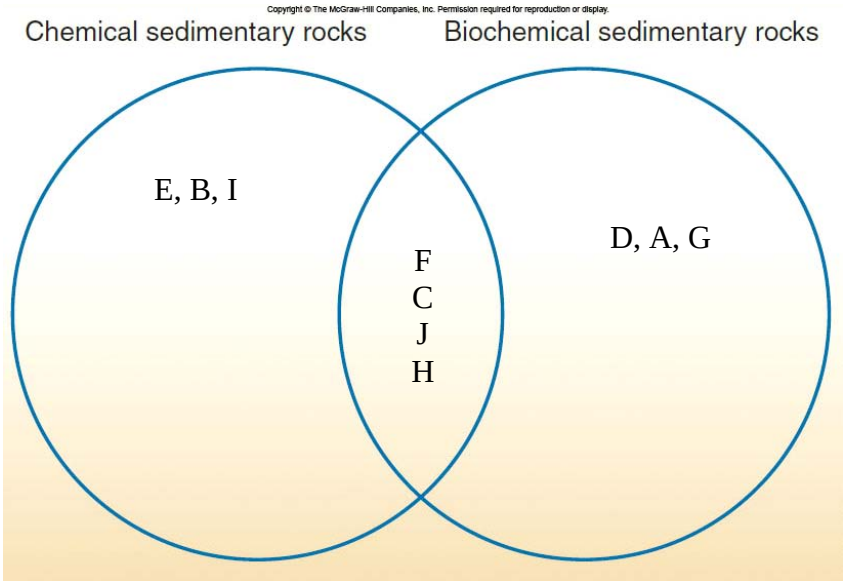
Poor response indicate that everything except the water is uniformly mixed after shaking stops. They will likely predict that water will become clearer after time, but not be able to explain why. Good responses will note that larger material settle first, followed by smaller and smaller materials. They will also note that some smaller material is trapped by the larger gravel, but there would be distinct layering. They would also predict clearer water over time, but indicate that the material would form a layer of fines at the top.

Checkpoint 7.14, p. 195
The following picture shows a typical section of clastic sediments that geologists might study. What observations about the grain size and arrangement of sediments that would help interpret their origin?

You should recognize that there are distinct layers with different-size materials. The size of the gains would relate to the velocity of the water that deposited them.

Checkpoint 7.15, p. 197
Venn Diagram: Chemical and Biochemical Sedimentary Rocks
Use the Venn diagram provided here to compare and contrast chemical and biochemical sedimentary rocks. Identify at least seven characteristics.

Poor responses include a few characteristics for each type, and no or few overlapping traits. Good responses include more terms but there is a limit to how many characteristics they will find. A sample set of terms that could be provided is shown with a solution below.



A

Chalk and coral form from living organisms

B Evaporites
C Used to interpret geological past
D Form from organisms (biosphere)
E Examples: gypsum; salt
F Form under shallow marine conditions
G Coal forms from dead plants
H Examples of sedimentary rocks
I Form due to changes in physical conditions
J Form by precipitation from a solution (seawater)

Checkpoint 7.16, p. 198
Similar organic-rich source rocks are present in rocks below two locations, Oiltown and Dryville. Oil and gas deposits formed in the overlying sedimentary rocks below Oiltown but did not form in rocks at Dryville. Suggest at least four potential explanations for this difference.

Good responses will note formation of oil reserves generally requires not only a good source, but appropriate temperature conditions, time, migration routes, and traps.

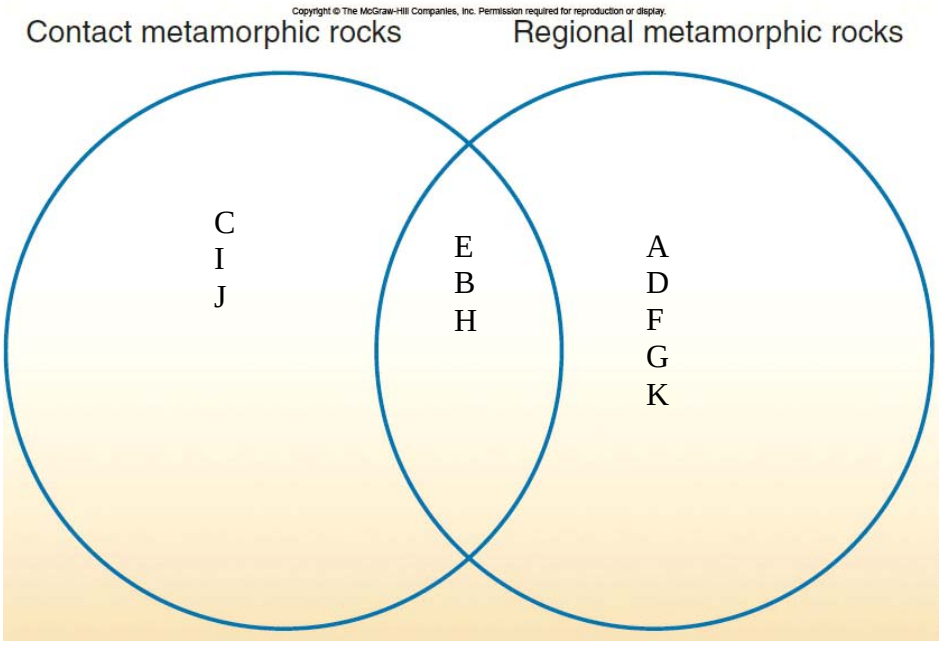
Checkpoint 7.17, p. 201
The conversion of bread to toast can be seen as an analog for the formation of a metamorphic rock by
a) contact metamorphism. b) regional metamorphism.

Checkpoint 7.18, p. 201

Characteristic	Rocks formed by . . .	
	contact metamorphism	regional metamorphism
Form at temperatures above 200°C	✓	✓
May originally have been an igneous rock	X	X
Form as a result of increasing pressures		✓
May surround plutonic igneous rocks	✓	
Slate is an example		✓
Form as a result of melting		
May underlie several adjacent states		✓
Found in mountain belts	**(✓)**	✓
May originally have been a sedimentary rock	✓	✓
May contain a foliation		✓
Marble is a possible example	✓	✓
Form on Earth's surface	✓	
Limestone is an example		
May have originally been a metamorphic rock	✓	✓

Checkpoint 7.19, p. 201
Use the Venn diagram provided here to compare and contrast metamorphic rocks formed by contact and regional metamorphism. Add at least eight items to the diagram.

Poor responses include 1-2 characteristics for each type, but no overlapping traits. Good responses include 3-5 characteristics/examples for each and multiple overlapping characteristics. Potential characteristics and a solution that could be used as a matching exercise are shown below.



A Rocks usually contain foliations
B Originally could be any type rock
C Associated with plutons
D Due to increased temperature and pressure
E May include marble and quartzite
F Associated with mountain building
G Regional – includes rocks in multiple states
H Temperature window – 200 to 1100 C
I Due to increasing temperature only
J Localized in area
K Examples: slate, schist, gneiss

Checkpoint 7.20, p. 201
Make a concept map that summarizes the characteristics of metamorphic rocks.

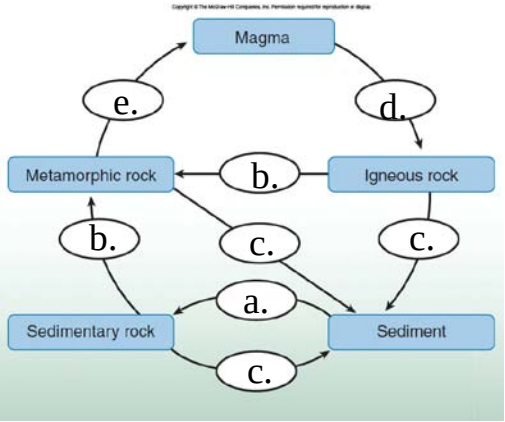
Good responses include multiple terms with cross connections. Poor responses show an inappropriate linear relation for terms.

Suggested terms could include: metamorphic rocks, regional, contact, mountain building, increase in grain size, heat only, heat and pressure, foliations, marble, schist

Checkpoint 7.21, p. 202
Cooking an egg could be seen as an analog for the formation of
a. igneous rock. **b. metamorphic rock**. c. sedimentary rock.

Concrete is formed by adding cement and water to a mixture of sand and gravel. This could be seen as an analog for the formation of what type of sedimentary rock?
a. Clastic b. Chemical c. Biochemical

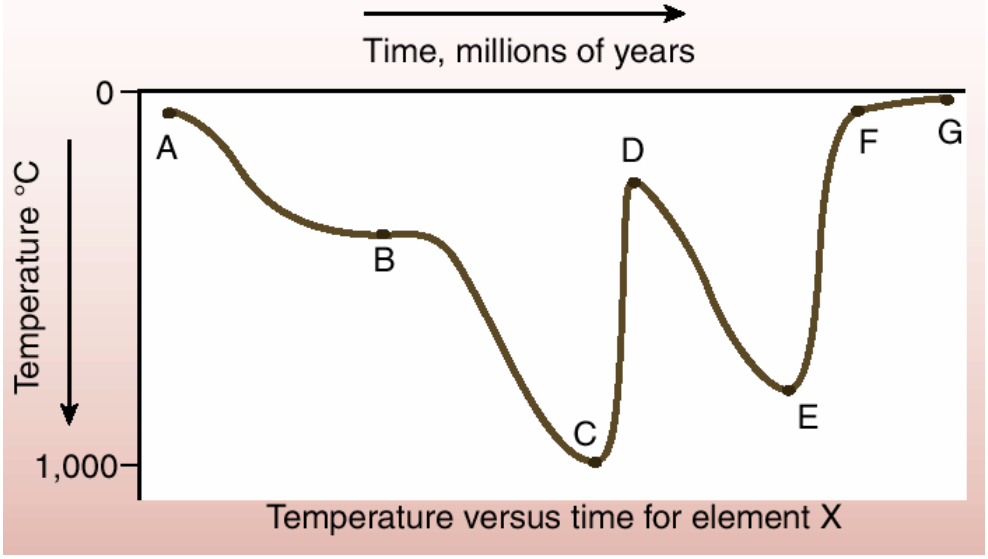
Checkpoint 7.22, p. 202
Rock Cycle Diagram
The following diagram illustrates the rock cycle. Match the lettered responses to the blank ovals on the diagram. Note: some letters are used more than once. Example: If you believe that metamorphic rock is converted to magma by cementation and compaction, enter "a" in the top left oval.
a. Cementation and compaction (lithification)
b. Heat and Pressure
c. Weathering, transportation, deposition
d. Cooling and solidification
e. Melting



Checkpoint 7.23, p. 203
Use information at the Minerals Information Institute (http://www.mii.org/commonminerals.php) or the USGS Minerals Yearbook (http://minerals.usgs.gov/minerals/pubs/ commodity/myb/) to make a list of 10 different minerals that are used to manufacture objects that you would use everyday. Try to find at least three minerals that you have not heard of before.

Answers will vary…

Checkpoint 7.24, p. 203
Element X and the Rock Cycle
The following graph illustrates the partial life cycle of a sample of an element (X) over several millions of years. At some points over its life, the sample experienced temperatures similar to those found at Earth's surface (A, G), while at other times it experienced high temperatures of approximately 1000 and 800°C, respectively (C, E).



Using what you know about rocks and how they form, write the life history of element X with special reference to what happened at and between times A-G on the graph. Assume that the element passed through several rock types during its life. To get you started, we provide the first few steps:
A Element X is weathered from a rock at Earth's surface and is carried in solution by a stream.
A-B Element X combines with another element to form a mineral in a pile of sediment and becomes part of a chemical sedimentary rock.
B Temperature is sufficient to convert the sedimentary rock to a metamorphic rock.
B-C The rock-containing element X is buried more deeply. As temperature increases some minerals begin to **melt**.
C At 1000°C the rock is converted to **magma** and is mixed with molten materials from other rocks.
C-D The **magma rises** toward Earth's surface, including element X, cooling as it rises.

D The magma crystallizes to form a **plutonic igneous rock**. Temperatures (approximately 300^{o}C) indicate rocks are still several kilometers below Earth's surface. D would be more silica-rich than C.

D-E The rock containing element X is again buried more deeply within Earth's crust or may be assimilated into another magma chamber. The rock initially undergoes **metamorphism** and some minerals eventually melt as temperature rises.

E The temperature of 800^{o}C is not sufficient to melt all the minerals in the rock. A more silica-rich **magma forms**.

E-F **Magma rises** through the crust to Earth's surface.

F **Magma crystallizes** to form a **volcanic rock** as lava or erupts from a volcano.

F-G The volcanic rock is exposed on Earth's surface and begins to break down by **weathering**. Element X is present in mineral fragments that form clastic sediment.