CHAPTER 5: Patterns in Nature: Minerals

MULTIPLE CHOICE

1. Fewer than 50 minerals are
   a. found on the Earth.
   b. used for industrial purposes.
   c. found in the crust.
   d. commonly found in rocks.

   ANS: D DIF: Moderate REF: 5.1
   OBJ: 5A. Explain why the term mineral has a very special meaning in a geologic context.
   MSC: Remembering

2. Of the ~4,000 known minerals, the vast majority
   a. are common.
   b. are rare.
   c. form only near volcanoes.
   d. are characterized as gems.

   ANS: B DIF: Moderate REF: 5.1
   OBJ: 5A. Explain why the term mineral has a very special meaning in a geologic context.
   MSC: Understanding

3. When a solution becomes oversaturated, new solid particles are said to
   a. precipitate from the solution.
   b. dissolve into the solution.
   c. react with the solution and produce heat.
   d. rapidly expand, causing an explosion.

   ANS: A DIF: Difficult REF: 5.1
   OBJ: 5B. Describe the processes by which minerals can form. MSC: Remembering

4. The atomic number of an element corresponds to the
   a. number of electrons.
   b. number of protons.
   c. number of neutrons.
   d. total weight of one atom.

   ANS: B DIF: Easy REF: 5.1 | Box 5.1
   OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes.
   MSC: Understanding

5. Which of the following choices lists atomic particles ordered from smallest to largest in size?
   a. atom, nucleus, proton, electron
   b. electron, proton, nucleus, atom
   c. proton, electron, nucleus, atom
   d. atom, electron, nucleus, proton

   ANS: B DIF: Moderate REF: 5.1 | Box 5.1
   OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes.
   MSC: Applying

6. The atomic mass of an element approximately equals the number of
   a. electrons.
   b. protons plus neutrons.
   c. neutrons.
   d. protons.

   ANS: B DIF: Easy REF: 5.1 | Box 5.1
   OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes.
   MSC: Understanding

7. Which of the following are good conductors due to the ability of the electrons in the atoms to move around freely?
   a. native metals
   b. sulfides
   c. silicates
   d. carbonates

   ANS: A DIF: Difficult REF: 5.1 | Box 5.1
   OBJ: 5E. Identify common mineral specimens based on their properties.
   MSC: Understanding

8. Minerals are all naturally occurring solid substances with a definable chemical composition. They must also possess
   a. the ability to be synthesized in the laboratory as well as be found in nature.
   b. metallic elements, such as iron, calcium, or magnesium.
   c. metallic luster.
   d. a fixed crystalline structure (spatial arrangement of atoms and ions).

   ANS: D DIF: Moderate REF: 5.2
   OBJ: 5A. Explain why the term mineral has a very special meaning in a geologic context.
   MSC: Understanding

9. Naturally forming glass (such as obsidian) is NOT considered a mineral because it
   a. is not produced by geologic processes.
   b. is organic.
   c. does not have a fixed crystalline structure.
   d. can be made synthetically as well as occur naturally.

   ANS: C DIF: Moderate REF: 5.2
   OBJ: 5A. Explain why the term mineral has a very special meaning in a geologic context.
   MSC: Understanding

10. Which of the following is NOT true about minerals?
    a. All minerals are compounds of more than one element.
    b. All minerals are naturally made.
    c. Some minerals are precipitated by organisms.
    d. All minerals can be expressed as chemical formulas.

    ANS: A DIF: Moderate REF: 5.2
    OBJ: 5A. Explain why the term mineral has a very special meaning in a geologic context.
    MSC: Understanding

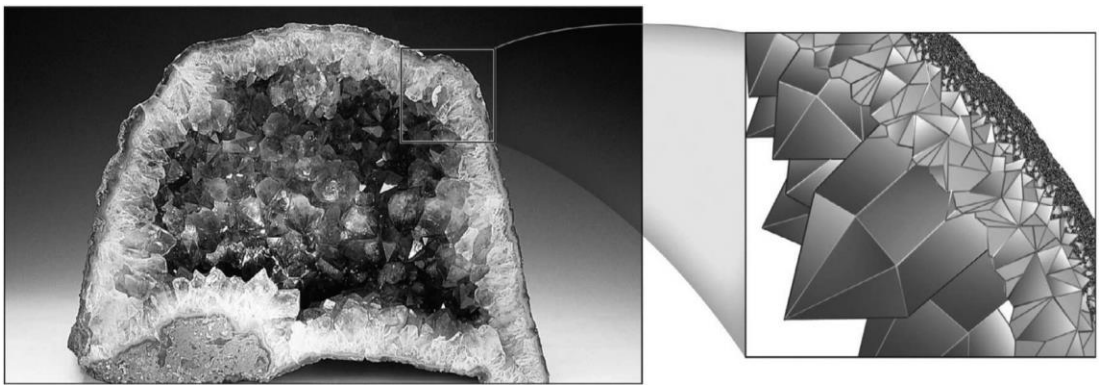
11. Which of the following is a mineral?
    a. petroleum (oil), which is a liquid
    b. cubic zirconia, which is a synthetic diamond substitute
    c. ice, which is water in the solid state
    d. obsidian, a type of volcanic glass

    ANS: C DIF: Difficult REF: 5.2
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Analyzing

12. Crystals that exhibit well-formed faces are referred to as
    a. pristine.
    b. anhedral.
    c. subhedral.
    d. euhedral.

ANS: D DIF: Moderate REF: 5.3
OBJ: 5B. Describe the processes by which minerals can form. MSC: Remembering

13. Minerals in geodes (as seen below) form spectacular euhedral crystals because



a. all of the elements incorporated in the crystals are in plentiful supply.
b. the crystals have abundant room to grow in their hollow surroundings.
c. minerals within geodes are always framework silicates.
d. minerals within geodes always contain iron.

ANS: B DIF: Moderate REF: 5.3
OBJ: 5B. Describe the processes by which minerals can form. MSC: Applying

14. Minerals can crystallize in all of the following ways EXCEPT
a. solidification of a melt (lava/magma).
b. bonding carbon to oxygen atoms to form organic compounds.
c. solid-state diffusion.
d. biomineralization.

ANS: B DIF: Moderate REF: 5.3
OBJ: 5B. Describe the processes by which minerals can form. MSC: Applying

15. The most recently formed portion of any crystal is always found
a. deep within the interior.
b. on the outer edges.
c. on whichever side is currently facing upward.
d. There is no consistent pattern for crystal formation.

ANS: B DIF: Moderate REF: 5.3
OBJ: 5B. Describe the processes by which minerals can form. MSC: Applying

16. SiO_4^{4-}, S^{2-}, and CO_3^{2-} are all examples of
a. organic compounds.
b. silicate minerals.
c. anions.
d. cations.

ANS: C DIF: Easy REF: 5.3
OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes.

17. The pattern of atoms in a crystal can be detected using
a. magnetic resonance imaging (MRI).
b. X-ray diffraction.
c. thermal ionization mass spectrometry (TIMS).
d. cathodized axial tomography (CAT).

ANS: B DIF: Easy REF: 5.3
OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes.
MSC: Remembering

18. When two different minerals have the same chemical formula but different crystal structures, they are said to be
    a. polymorphs.
    b. polyliths.
    c. monoliths.
    d. pseudomorphs.

    ANS: A DIF: Easy REF: 5.3
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Remembering

19. Diamond and graphite are both polymorphs of
    a. silicon.
    b. iron.
    c. magnesium.
    d. carbon.

    ANS: D DIF: Easy REF: 5.3
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Remembering

20. Which of the following minerals is more commonly known as table salt?
    a. gypsum
    b. feldspar
    c. halite
    d. quartz

    ANS: C DIF: Easy REF: 5.4
    OBJ: 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified. MSC: Applying

21. Ore minerals, such as galena and hematite, tend to be different from typical minerals in that they have a
    a. very dark color.
    b. diamond-like crystal habit.
    c. high specific gravity.
    d. vitreous luster.

    ANS: C DIF: Moderate REF: 5.4
    OBJ: 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified. | 5E. Identify common mineral specimens based on their properties.
    MSC: Applying

22. Which of the following common minerals is softest?
    a. quartz
    b. calcite
    c. talc
    d. fluorite

    ANS: C DIF: Moderate REF: 5.4
    OBJ: 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified. | 5E. Identify common mineral specimens based on their properties.
    MSC: Understanding

23. Which of the following common minerals is hardest?
    a. quartz
    b. calcite
    c. talc
    d. fluorite

    ANS: A DIF: Moderate REF: 5.4
    OBJ: 5D. Specify which minerals are the most common ones on the Earth, and describe how they are

classified. | 5E. Identify common mineral specimens based on their properties.
MSC: Understanding

24. The color of a mineral in powdered form is termed
    a. color.
    b. specific gravity.
    c. luster.
    d. streak.

    ANS: D DIF: Easy REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Remembering

25. Which of the following is NOT true concerning the color of minerals?
    a. Some minerals have a consistent color, but many have a range of possible colors.
    b. The streak color tends to be less variable than the color of a whole mineral.
    c. Color is often controlled by impurities or minor chemical components of the mineral.
    d. A mineral's color reflects the wavelengths of light that are absorbed by the mineral.

    ANS: D DIF: Difficult REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Analyzing

26. The way a mineral scatters light is a diagnostic property termed
    a. color.
    b. reflectivity.
    c. luster.
    d. streak.

    ANS: C DIF: Easy REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Remembering

27. The tendency for minerals to break along distinct planar surfaces that have a specific orientation in relation to the crystal structure is called
    a. fracture.
    b. cleavage.
    c. specific gravity.
    d. hardness.

    ANS: B DIF: Easy REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Remembering

28. Minerals that do not possess cleavage are said to possess
    a. invulnerability.
    b. fracture.
    c. solidity.
    d. massiveness.

    ANS: B DIF: Easy REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Remembering

29. Hardness refers to a mineral's ability to resist
    a. breaking.
    b. being scratched.
    c. chemically reacting with other substances.
    d. weathering.

    ANS: B DIF: Moderate REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.

MSC: Understanding

30. For the majority of minerals, the streak obtained when the mineral is scratched against a porcelain plate is
    a. only useful if the mineral is softer than the porcelain streak plate.
    b. always diagnostic of that mineral.
    c. not useful, because the porcelain will often chemically react with the mineral.
    d. always dark brown or black.

    ANS: A DIF: Moderate REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Applying

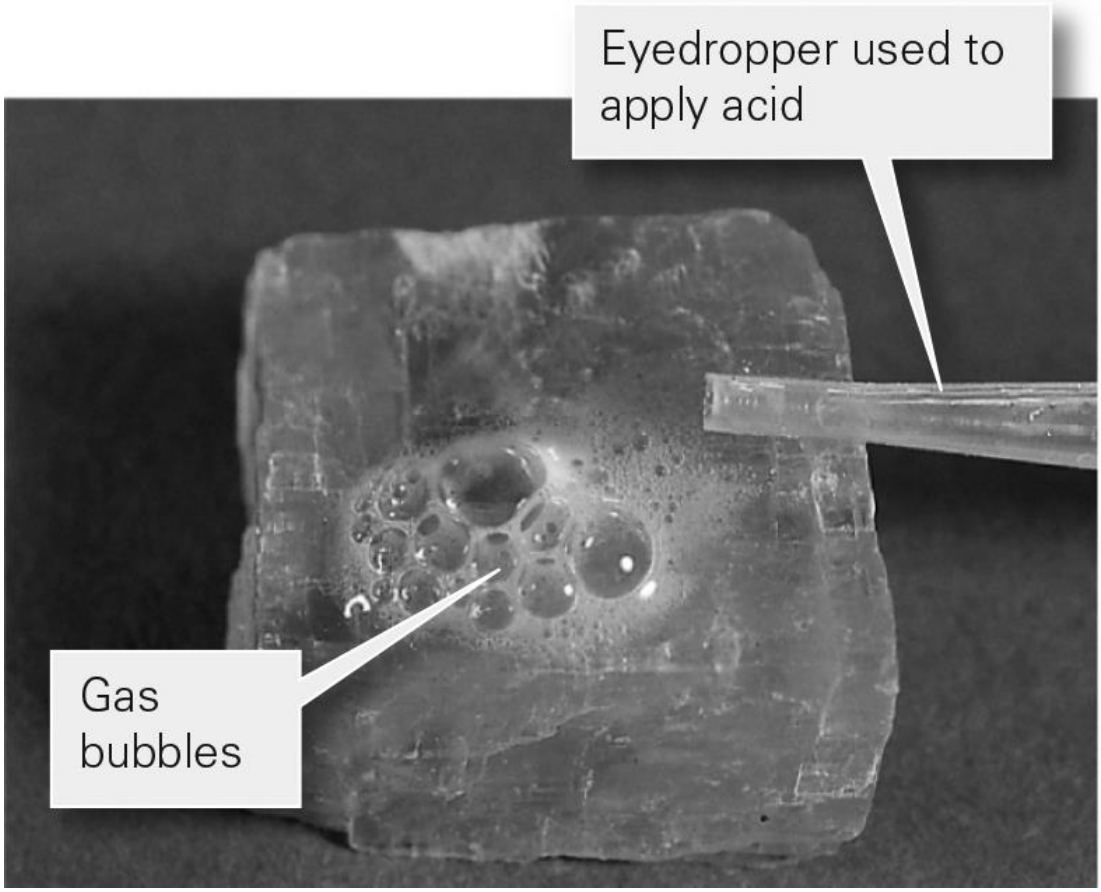
31. A mineral property defined as the density of the mineral sample divided by the density of water (1.0 g/cm^3) is
    a. mass.
    b. specific gravity.
    c. luster.
    d. streak.

    ANS: B DIF: Easy REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Understanding

32. Which of the following is the most important characteristic used to identify minerals?
    a. color
    b. luster
    c. cleavage
    d. Multiple properties must be used to identify a mineral.

    ANS: D DIF: Moderate REF: 5.4
    OBJ: 5E. Identify common mineral specimens based on their properties.
    MSC: Understanding

33. The image below shows a mineral with hydrochloric acid applied to it. Based on the reaction and presence of gas bubbles, which of the following minerals is this most likely to be?



a. quartz
b. halite
c. calcite
d. fluorite

ANS: C DIF: Moderate REF: 5.4
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Applying

34. Glass and quartz crystals exhibit a smoothly curving, clamshell-shaped fracture pattern termed
a. glassy fracture.
b. conchoidal fracture.
c. one-directional cleavage.
d. obtuse fracture.

ANS: B DIF: Easy REF: 5.4
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Understanding

35. The image below shows a mineral specimen of pyrite. What is the term for the thin parallel corrugations or stripes shown on the crystal faces below?

a. conchoidal fractures
b. facets
c. cleavage planes
d. striations

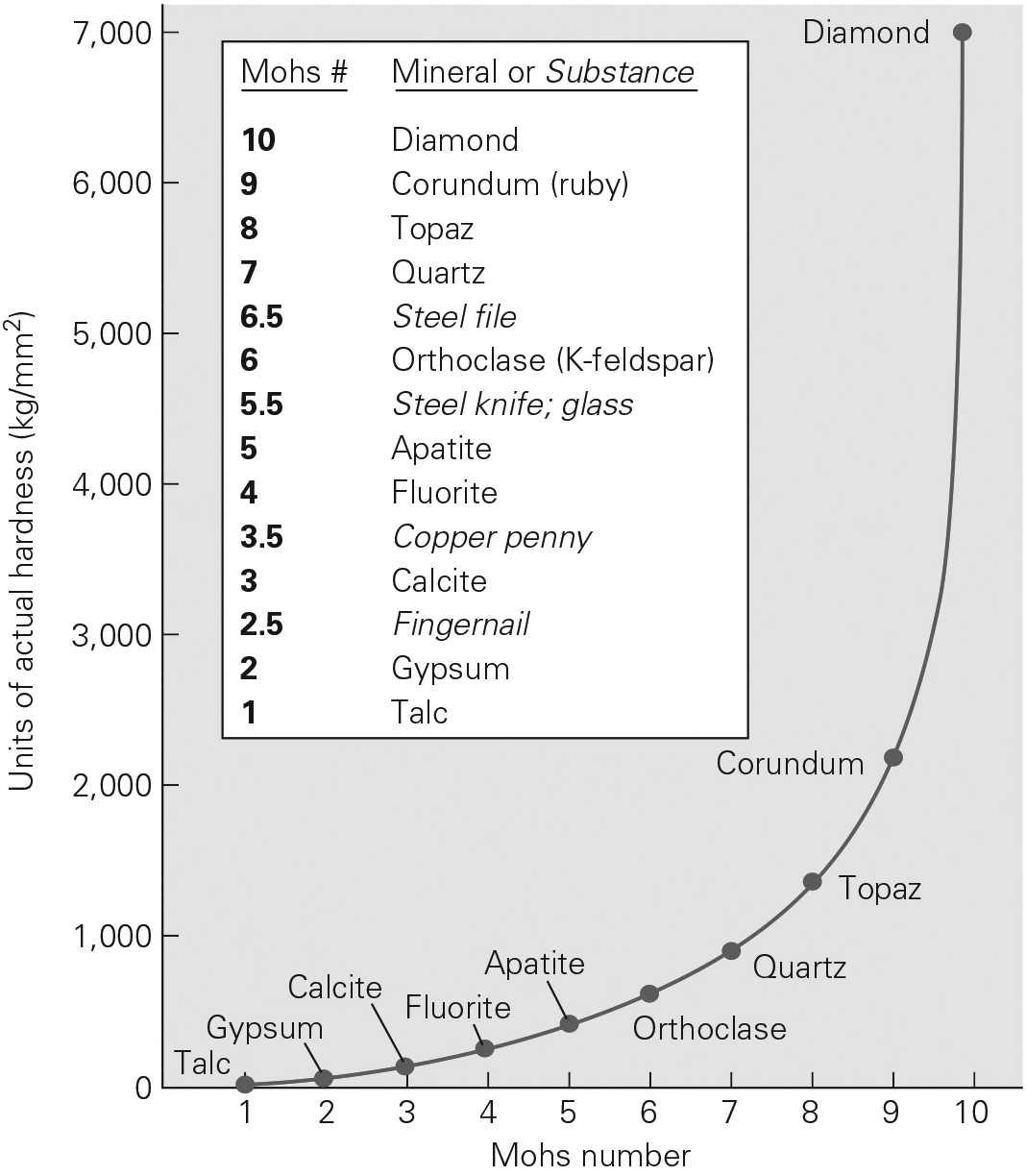
ANS: D DIF: Easy REF: 5.4
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Understanding

36. The image below shows a mineral specimen of quartz. What is the term for the smoothly curving, clamshell-shaped surface on the sample?

a. conchoidal fracture
b. facet
c. cleavage plane
d. striation

ANS: A DIF: Difficult REF: 5.4
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Understanding

37. Using the Mohs hardness scale below, which of the following statements is false?



Mohs's numbers are relative—in reality, diamond is 3.5 times harder than corundum, as the graph shows.

a. Your fingernail can scratch a sample of gypsum.
b. Diamonds are twice as hard as apatite.
c. Diamonds are more than seven times as hard as quartz.
d. Quartz will scratch anything made of steel.

ANS: B DIF: Difficult REF: 5.4
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Analyzing

38. Calcite ($CaCO_3$) is in which mineral class?
a. silicates
b. carbonates
c. oxides
d. sulfides

ANS: B DIF: Moderate REF: 5.5

OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes.
MSC: Applying

39. Minerals are grouped into mineral classes primarily on the basis of
    a. chemistry, specifically the cations within the chemical formula.
    b. chemistry, specifically the anions within the chemical formula.
    c. hardness; hard, soft, and medium are the three primary classes.
    d. the number of cleavage directions present.

    ANS: B DIF: Moderate REF: 5.5
    OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes.
    MSC: Understanding

40. Pyrite (FeS_2) is in which mineral class?
    a. silicates
    b. carbonates
    c. oxides
    d. sulfides

    ANS: D DIF: Moderate REF: 5.5
    OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes. | 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified.
    MSC: Applying

41. Silicate minerals are subdivided into six groups based on the way silica tetrahedra are
    a. bonded to anions.
    b. bonded to iron atoms.
    c. arranged and bonded.
    d. arranged and charged.

    ANS: C DIF: Difficult REF: 5.5
    OBJ: 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified. MSC: Understanding

42. The mineral class that makes up more than 95 percent of the continental crust is termed the
    a. silicates.
    b. carbonates.
    c. halides.
    d. oxides.

    ANS: A DIF: Easy REF: 5.5
    OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes. | 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified.
    MSC: Remembering

43. In silicate minerals, the SiO_4 tetrahedron can be chemically bonded to form all of the following EXCEPT
    a. sheets.
    b. independent tetrahedra.
    c. double chains.
    d. triple chains.

    ANS: D DIF: Moderate REF: 5.5
    OBJ: 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified. MSC: Analyzing

44. In which type of silicates are the greatest proportion of oxygen atoms shared by pairs of adjacent tetrahedra?
    a. chain silicates
    b. framework silicates
    c. sheet silicates

d. ring silicates.

ANS: B DIF: Difficult REF: 5.5
OBJ: 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified. MSC: Analyzing

45. Trace amounts of impurity can produce significant differences in _____ among individual crystals of a mineral species.
a. color
b. cleavage
c. luster
d. streak

ANS: A DIF: Moderate REF: 5.4
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Applying

46. Which two gems are varieties of the mineral corundum (Al_2O_3)?
a. emeralds and rubies
b. emeralds and sapphires
c. aquamarines and emeralds
d. sapphires and rubies

ANS: D DIF: Difficult REF: 5.6
OBJ: 5F. Distinguish ordinary minerals from gems, and describe how to produce the shiny facets of gems. MSC: Applying

47. Which common gemstone results from biomineralization?
a. diamond
b. garnet
c. pearl
d. sapphire

ANS: C DIF: Moderate REF: 5.6
OBJ: 5F. Distinguish ordinary minerals from gems, and describe how to produce the shiny facets of gems. MSC: Remembering

48. Gemstones are often found in pegmatites, which are igneous rocks that are
a. exceptionally mafic.
b. extrusive, forming from lava.
c. exceptionally coarse grained.
d. exceptionally fine grained.

ANS: C DIF: Moderate REF: 5.6
OBJ: 5F. Distinguish ordinary minerals from gems, and describe how to produce the shiny facets of gems. MSC: Understanding

49. Diamonds are usually found in a rock called
a. graphite.
b. kimberlite.
c. gabbro.
d. diorite.

ANS: B DIF: Moderate REF: 5.6
OBJ: 5F. Distinguish ordinary minerals from gems, and describe how to produce the shiny facets of gems. MSC: Remembering

50. The diamonds we typically see today in engagement rings do not display their natural crystal faces but rather _____, which are made by grinding the gem on a spinning lap.
a. striations
b. facets
c. cleavage planes
d. facades

ANS: B DIF: Moderate REF: 5.6
OBJ: 5F. Distinguish ordinary minerals from gems, and describe how to produce the shiny facets of gems. MSC: Understanding

SHORT ANSWER

1. Why are minerals often referred to as "the building blocks of Earth?"

   ANS:
   The Earth is made up of many different types of rocks, and rocks are composed of a mixture of minerals in various forms. Thus, minerals can be considered basic building blocks of the Earth.

   DIF: Easy REF: 5.1
   OBJ: 5A. Explain why the term mineral has a very special meaning in a geologic context.
   MSC: Understanding

2. Based on the definition of a mineral, explain why a diamond created in a laboratory is not considered a mineral.

   ANS:
   Lab-grown diamonds are human-made; therefore, they are unnaturally formed and cannot be considered a true example of a mineral.

   DIF: Easy REF: 5.2
   OBJ: 5A. Explain why the term mineral has a very special meaning in a geologic context.
   MSC: Understanding

3. Diamond is a polymorph of graphite. What is a polymorph, and explain how graphite is different from a diamond.

   ANS:
   Polymorphs are minerals that have the same chemical composition but different crystal structures. Diamond and graphite are both elemental carbon; in graphite carbon, atoms are arranged as sheets (a weak structure) while in diamond carbon atoms are arranged as tetrahedra (a strong structure). These atomic arrangements explain why graphite is soft and diamond is hard.

   DIF: Moderate REF: 5.3
   OBJ: 5B. Describe the processes by which minerals can form. MSC: Analyzing

4. What are the ways a mineral can crystallize in nature? List and explain each in some detail.

   ANS:
   Minerals can form during solidification of a melt (atoms or ions lock into lattice positions at the surface of a crystal), precipitation from a liquid solution (ions dissolved in liquid bond together, forming a solid crystal that separates from the liquid), diffusion in solids (the migration of atoms or molecules through a material), biomineralization (metabolic processes in living organisms cause atoms to precipitate either within or on the organisms' cells or immediately adjacent to their cells), and as precipitates from volcanic gases around volcanic vents.

   DIF: Moderate REF: 5.3
   OBJ: 5B. Describe the processes by which minerals can form. MSC: Analyzing

5. How are diamonds formed?

   ANS:

Diamonds are typically found in kimberlites—volcanic rocks that originated as magmas that formed at great depth (> 150 km) below Earth's surface. These magmas rose quickly to the surface, bringing with them diamonds that equilibrated under greater pressures at depth. The kimberlite is deposited as a carrot-shaped, pipe-like intrusion. Diamonds are found embedded within the intrusion as crystals, which can be extracted through mining processes.

DIF: Moderate REF: 5.6 | Box 5.3
OBJ: 5F. Distinguish ordinary minerals from gems, and describe how to produce the shiny facets of gems. MSC: Understanding

6. Some physical properties are more useful for certain minerals than others. Explain how color may NOT be useful to identify some minerals.

ANS:
Color can vary significantly in crystals of the same mineral species. For example, quartz may exhibit a variety of colors, including clear, pink, purple, and black. Consequently, while it may be useful for identifying some species, color is not always an identification by itself.

DIF: Moderate REF: 5.4
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Analyzing

7. What are cleavage and fracture? How are these physical properties similar? How are they different?

ANS:
Cleavage and *fracture* are terms that refer to the manner in which minerals break. Cleavage planes are planar features in which the mineral breaks parallel to atomic planes in the crystal lattice. Fracture occurs when a mineral breaks in an irregular (or nonplanar) fashion.

DIF: Moderate REF: 5.4
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Analyzing

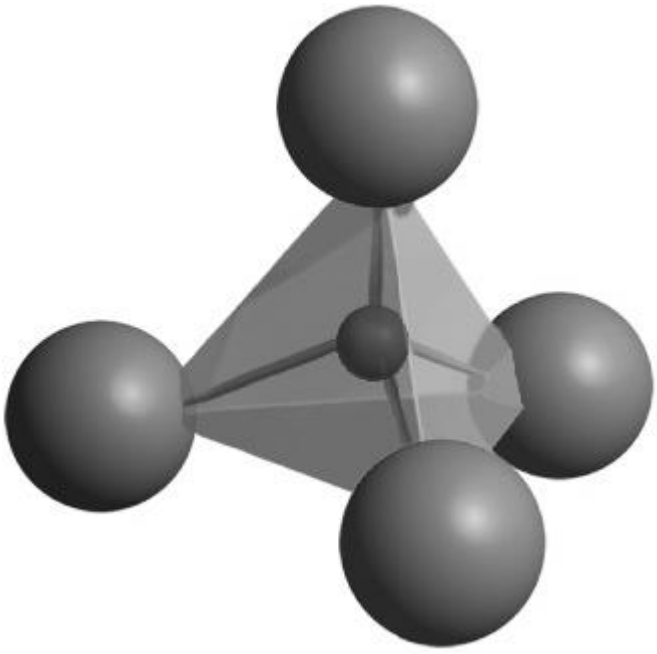
8. Describe several examples of minerals that can be harmful and the hazards they pose.

ANS:
Asbestos is a term used to describe a group of fibrous silicate minerals that are useful as insulators because of their high heat tolerance and strength. Although useful, asbestos minerals are hazardous if inhaled. Some other silicate minerals such as quartz and feldspar (and others) also pose an inhalation risk if they are pulverized into a powder. Some minerals contain poisonous elements such as arsenic, which can become mobile if the mineral is chemically altered or weathered.

DIF: Difficult REF: 5.4 | Box 5.2
OBJ: 5E. Identify common mineral specimens based on their properties.
MSC: Analyzing

9. Draw and label a silicon-oxygen tetrahedron.

ANS:



DIF: Difficult REF: 5.5
OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes.
MSC: Applying

10. How are minerals classified? List the major classes of minerals and their pertinent anions.

ANS:
Minerals are classified based on their pertinent anions. The major classes of minerals include silicates (SiO_4^{4-}), sulfides (S^{2-}), oxides (O^{2-}), halides (halogen ions such as Cl^- and F^-), carbonates (CO_3^{2-}), native metals (single metals), and sulfates (SO_4^{2-}).

DIF: Easy REF: 5.5
OBJ: 5C. Explain how geologists organize thousands of different minerals into just a few classes. | 5D. Specify which minerals are the most common ones on the Earth, and describe how they are classified.
MSC: Understanding