

## ch2

Student: \_\_\_\_\_

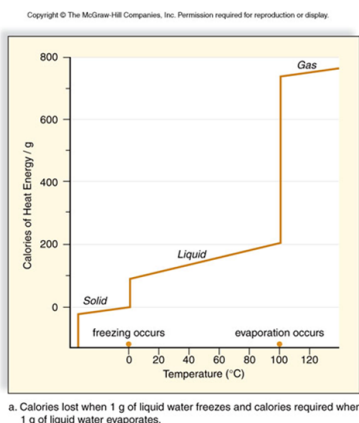
- Which of the following elements would be more reactive with other elements?
  - boron, #5
  - neon, #10
  - argon, #18
  - helium, #2
- Which of the following would be a proposed mechanism by which stomach antacids work?
  - Antacids dilute the solution, therefore lowering the pH.
  - Antacids are bases and by definition can absorb  $H^+$  out of a solution.
  - Antacids are bases and by definition can absorb  $OH^-$  out of a solution.
  - Antacids contain mostly water and so they neutralize the solution.
- If you place the corner of a paper towel into a droplet of water the water moves across the paper towel. Which of the following would explain the movement of the water?
  - surface tension
  - cohesion
  - adhesion
  - both cohesion and adhesion
- Which of the following elements is NOT one of the six most common in living organisms?
  - carbon
  - oxygen
  - iron
  - nitrogen
  - hydrogen
- There are \_\_\_\_\_ naturally occurring elements.
  - 57
  - 108
  - 95
  - 92
  - 87
- Which statement is NOT true about elements?
  - An element cannot be broken down into substances with different properties.
  - An element consists of atoms and molecules.
  - There is only one kind of atom in each type of element.
  - All atoms of an element contain the same number of protons.
  - Atoms of an element may contain different numbers of neutrons.
- If the atomic number of an element is 6 and the atomic mass is 12.01, how many protons are there in the nucleus?
  - 12
  - 6
  - 24
  - 52

8. Which of the following is/are an atom, an isotope and an ion?
- $\text{H}^+$
  - $^2\text{H}$  or deuterium
  - $^3\text{H}$  or tritium
  - $\text{H}_2$  or hydrogen gas
  - All of the choices are atoms, isotopes and ions.

Radioactive Isotope	Half-life	Energy of Particles Emitted
$^{131}\text{I}$ ("iodine-131")	8.1 days	0.8 MeV
$^{32}\text{P}$ ("phosphorus-32")	14.3 days	1.7 MeV
$^{33}\text{P}$ ("phosphorus-33")	25.5 days	0.25 MeV
$^{35}\text{S}$ ("sulfur-35")	87.5 days	0.2 MeV
$^3\text{H}$ ("tritium")	12.4 years	0.02 MeV
$^{14}\text{C}$ ("carbon-14")	5730 years	0.2 MeV

9. From the above table of radioisotopes and their properties, it is obvious that
- the longer the half-life, the more energy emitted by the particles.
  - the longer the half-life, the less energy emitted by the particles.
  - radioisotopes of the same element must emit the same amount of energy in their emissions and decay at the same rate.
  - adjusted for time, radioisotopes emit the same amount of energy in their emissions.
  - energy and half-life are not directly related.
10. Which statement is NOT true about subatomic particles?
- Protons are found in the nucleus.
  - Neutrons have no electrical charge.
  - Electrons contain much less mass than neutrons.
  - Electrons are found in orbitals around the nucleus.
  - All electrons in an atom contain the same amount of energy.
11. Which is NOT true about the electrical charges in chemistry?
- Protons carry a positive charge.
  - In an atom, the number of protons and neutrons must be equal.
  - An atom is neutral when the positive and negative charges balance.
  - An ion contains one or more positive or negative charges.
12. In a water molecule,
- the oxygen atom is more electronegative than the hydrogen atoms.
  - the oxygen atom has an overall negative charge with the hydrogen atoms having an overall positive charge.
  - unequal sharing of electrons results in a polar molecule.
  - All of the choices are correct.
13. An atom's atomic mass is best described as the mass of
- the protons it contains.
  - the neutrons it contains.
  - electrons in the outermost shell.
  - protons and neutrons it contains.
  - protons and electrons it contains.

14. A research article indicates that researchers have used an isotope  $^3\text{H}$  to trace a certain metabolic process. From the symbol that is given, we know this is a hydrogen isotope with
- three protons.
  - three neutrons.
  - three electrons.
  - one proton and two neutrons.
  - two protons and one neutron.
15. Both  $^{18}\text{O}$  and  $^{16}\text{O}$  are found in nature. However,  $^{16}\text{O}$  is the most common. Therefore,
- these are different elements.
  - oxygen atoms can have eight or 10 neutrons.
  - $^{18}\text{O}$  has two additional electrons in its outer shell.
  - $^{18}\text{O}$  is the form of oxygen that provides living cells with life.
  - only the common form of  $^{16}\text{O}$  can bond with hydrogen atoms to form  $\text{H}_2\text{O}$ .
16. To determine the age of fairly recent fossils and organic artifacts, it is possible to analyze the amounts of the isotopes  $^{14}\text{C}$  and  $^{14}\text{N}$ , because over time the  $^{14}\text{C}$ -which originated in the atmosphere-breaks down into  $^{14}\text{N}$ . What net change occurred for this to happen?
- The  $^{14}\text{C}$  lost an electron.
  - The  $^{14}\text{C}$  gained an electron.
  - The  $^{14}\text{C}$  lost a proton.
  - The  $^{14}\text{C}$  gained a proton.
  - The  $^{14}\text{C}$  gained a neutron.
17. What does this graph reveal about the heat of vaporization and the heat of fusion?



18. Which of the following statements is NOT true about electron configurations?
- If an atom has only one shell, it is complete with two electrons.
  - If an atom has two or more shells, the octet rule applies.
  - If an atom has two or more shells, the outer shell is complete with eight electrons.
  - Atoms with more than eight electrons in the outer shell react by gaining electrons.
  - Atoms with eight electrons in the outer shell are not reactive at all.
19. An orbital is best described as
- the electron shell closest to the nucleus.
  - the outermost electron shell of an atom.
  - the volume of space in which electrons are most often found.
  - the original energy level of electrons in photosynthesis.

20. Prior to prescription medications to control stomach acid and "heart burn" people consumed baking soda (sodium bicarbonate) to decrease their discomfort. This would indicate that sodium bicarbonate
  - A. effectively buffers stomach acid by releasing  $H^+$
  - B. should be sold as a prescription drug
  - C. blocks acid production by combining with  $OH^-$
  - D. neutralizes stomach acid by combining with excess  $H^+$
21. Which statement is NOT true about ionic bonds?
  - A. One atom acts as an electron donor and another atom acts as an electron acceptor.
  - B. Electrons are completely lost or gained in ion formation.
  - C. An ion has the same number of electrons as a nonionic atom of the same element.
  - D. An ionic bond occurs between positive ions and negative ions.
  - E. A salt such as NaCl is formed by an ionic reaction.
22. Which statement is NOT true about covalent bonds?
  - A. Covalent bonds form when an electron is completely lost or gained from an atom.
  - B. A covalent molecule contains one or more covalent bonds.
  - C. A single covalent bond is drawn as a line between two atoms.
  - D. A pair of electrons is shared between two atoms for each covalent bond.
  - E. Shared electrons allow an atom to complete its outer electron shell in a covalent molecule.
23. Which statement is NOT true about polar covalent bonds?
  - A. Most covalent bonds are nonpolar, with electrons shared fairly equally between the atoms.
  - B. Polar covalent bonds are important in the characteristics of water.
  - C. Electrons are shared unequally in a polar covalent bond.
  - D. The larger atom in a polar bond attracts the electron more strongly than the smaller atom.
  - E. The oxygen of a water molecule is electropositive relative to the hydrogen.
24. An abandoned Indiana coal mine spoil bank contains chunks of pyrite minerals. Under constant erosion and weathering, the pyrites leech large amounts of sulfuric acid ( $H_2SO_4$ ). The spoil banks are also mixed with large quantities of basic limestone and clay carbonates. What should occur over time?
  - A. The pH level will drop until all acid has washed out.
  - B. The pH level will remain at 7.0 because of constant washing with rain.
  - C. The pH level will remain at 7.0 because all acid will be immediately neutralized by bases.
  - D. The pH levels will be spotty and vary over time, first more acidic but drifting back toward 7.0.
  - E. Bases always dominate over acids.

Which of the following statements is/are true about the pH scale?

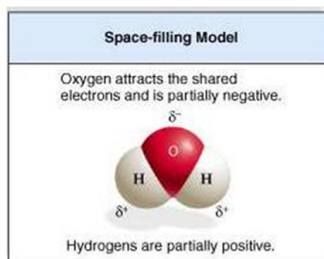
25. The scale indicates the relative concentrations of hydrogen and hydroxyl ions in a solution.  
True    False
26. The scale ranges from 1 to 15.  
True    False
27. pH 7 has a balanced level of  $H^+$  and  $OH^-$ .  
True    False
28. Anything below pH 7 is acidic and above pH 7 is basic.  
True    False
29. A change of one pH unit represents a ten-fold increase or decrease in hydroxyl ion concentration.  
True    False

30. The blood buffer reactions described by  $\text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$  indicates that
- scientists are uncertain which direction the equation flows.
  - the reaction can flow either direction depending on whether there is an excess of hydrogen or hydroxide ions.
  - any reaction in one direction causes an immediate reverse reaction.
  - chemicals can swing wildly from acid to basic.
  - there is really no difference in chemistry whether a molecule is formed or dissociated.

Bond	Energy (kcal/mol)	Bond	Energy (kcal/mol)
H—H	104	P—O	100
H—O	110	N—O	53
C—H	99	S—H	81
C—O	84	C=C	146
C—C	83	C=N	147
C—N	70	P=O	120
C—S	62	C=O	170
S—S	51	C≡C	195

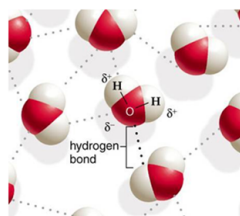
31. From the above table, it is apparent that:
- triple bonds are stronger than double bonds; double bonds are stronger than single bonds.
  - triple bonds are weaker than double bonds; double bonds are weaker than single bonds.
  - carbon bonds are stronger than other bonds; hydrogen bonds are always weakest.
  - carbon forms only single bonds
32. The characteristic way in which atoms of an element react is most related to the
- number of electrons in the outermost shell.
  - number of electrons in the innermost shell.
  - number of neutrons in the nucleus.
  - size of the nucleus.
33. As a solid, water floats. This means that
- solid water is less dense than liquid water.
  - organisms in ponds, lakes, and reservoirs can survive under the ice cover.
  - this is due to hydrogen bonding changes.
  - All of the choices are correct.
34. A coastal climate is moderated primarily by which of the following properties of water? Water
- is the universal solvent.
  - is cohesive and adhesive.
  - resists changes of state.
  - has a high surface tension.
35. Human blood has a pH of about 7.4. This is
- neutral.
  - very acidic.
  - slightly acidic.
  - slightly basic.

36. All of the following reflect harm due to acid deposition from rain EXCEPT
- A. leaching of aluminum from the soil into lakes which results in the formation of toxic methyl mercury from mercury in the lake sediments
  - B. weakens trees in the forests and kills seedlings
  - C. increased agricultural yields
  - D. damage to marble and limestone monuments
37. Draw the structural formula of a single water molecule. Note the location of partial positive and negative



charges. Label the covalent bonds.

38. Draw three water molecules and the hydrogen bonding that may occur between the molecules. Define



hydrogen bonding and explain how and why it occurs.

39. Study the figures to determine which is liquid water and which is frozen water (ice). Explain your answer

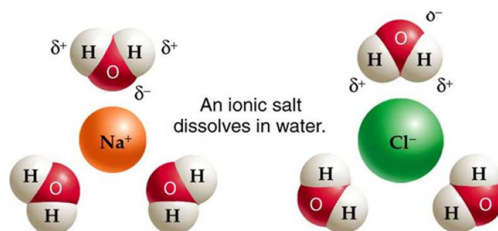


and predict if the water in Figure 2 would float or sink in the water in Figure 1.



Fig. 2

40. Draw several (5 or 6) individual, unbonded water molecules. Simulate what happens when table salt ( $\text{Na}^+\text{Cl}^-$ ) is added to water. Use the model you created to explain why salt is added to the roads in



a 'snowy', cold climate.

41. Following nitrogen (78%) and oxygen (21%), argon is the next most common gas in the atmosphere (less than 1%). Checking the table of elements, you discover that argon is one of a family of atoms with outer shells already full of electrons. How is this related to the fact that these atoms have virtually no biological importance?

42. Classify the following substances as either hydrophobic or hydrophilic:

- |                        |             |       |
|------------------------|-------------|-------|
| 1. Nonpolar substances | hydrophilic | _____ |
| 2. Polar substances    | hydrophilic | _____ |
| 3. Ionic substances    | hydrophobic | _____ |

43.

[H <sup>+</sup> ] (moles per liter)		pH
0.000001	= $1 \times 10^{-6}$	6
0.0000001	= $1 \times 10^{-7}$	7
0.00000001	= $1 \times 10^{-8}$	8

Study the chart to determine the relationship between H<sup>+</sup> concentration and pH. If you were to create a herbal remedy to decrease excess stomach acid, would you create a solution with a relatively greater or lesser number of hydrogen ions.

44. A solution with a pH of 7.0 has \_\_\_\_\_ times \_\_\_\_\_ H<sup>+</sup> than a solution of pH 10.

- A. 30; more
- B. 300; less
- C.  $10^3$ ; more
- D.  $10^{-3}$ ; less
- E. none of the above

45. A solution with a pH of 6 has \_\_\_\_\_ time \_\_\_\_\_ OH<sup>-</sup> than a solution with a pH of 10.

- A. 40; more
- B. 4000; less
- C.  $10^4$ ; less
- D. 4; less
- E.  $10^{-4}$  more

46. This system of chemicals,  $\text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$ , act as a buffer in the blood. If hydrogen ions are added to blood which of the following reactions would occur?

- A.  $\text{H}^+ + \text{HCO}_3^- \rightarrow \text{H}_2\text{CO}_3$
- B.  $\text{OH}^- + \text{H}_2\text{CO}_3 \rightarrow \text{HCO}_3^- + \text{H}_2\text{O}$

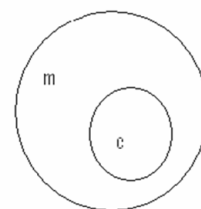
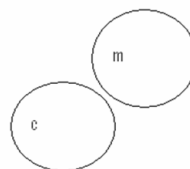
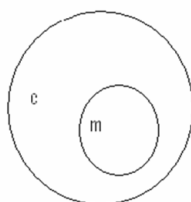


47. Which of the following concept circles best depicts the relationship between molecules and compounds (c

A.

B.

C.



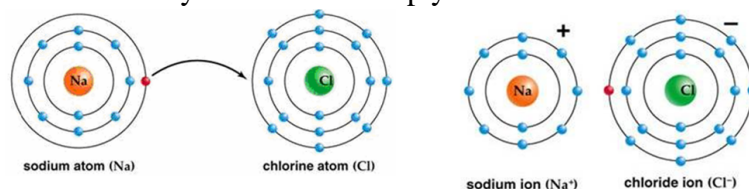
= compound and m = molecule).

A. Option A

B. Option B

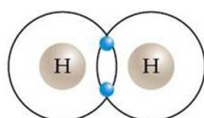
C. Option C

48. Use Bohr's model to draw a sodium (Na) atom and a chlorine (Cl) atom. Using your model, explain what happens when sodium reacts with chlorine to form table salt. Include in your explanation ion and ionic bond formation. Use your model to help you to decide whether NaCl is hydrophilic or



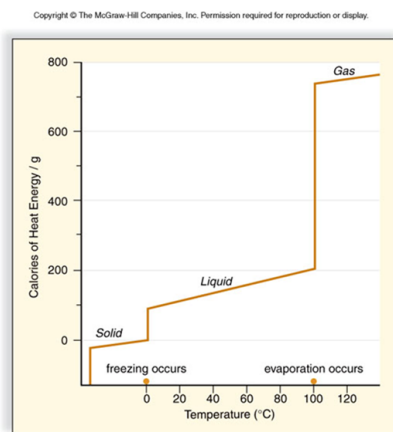
hydrophobic.

49. Draw two hydrogen atoms using Bohr's model. Now bond them to form a molecule of hydrogen gas. Write the molecular formula. Explain what type of bond you've created and why this is a stable



situation.

50. All living things are 70 - 90% water. Use this graph to explain what characteristics of water protect living



a. Calories lost when 1 g of liquid water freezes and calories required when 1 g of liquid water evaporates.

organisms from rapid temperature changes.

51. The electrons are unequally shared in \_\_\_\_\_, and transferred in \_\_\_\_\_.

- A.  $\text{CH}_4$ ,  $\text{Na}^+\text{Cl}^-$
- B.  $\text{O}_2$ ,  $\text{CH}_4$
- C.  $\text{Na}^+\text{Cl}^-$ ,  $\text{H}_2\text{O}$
- D.  $\text{H}_2\text{O}$ ,  $\text{N}_2$

## ch2 Key

1. Which of the following elements would be more reactive with other elements?

**A.** boron, #5  
B. neon, #10  
C. argon, #18  
D. helium, #2

Incorrect Answers: B. Atoms with fewer than eight electrons in the outer shell react with other atoms. Neon has eight electrons in the outer shell, is a noble gas, and rarely reacts with other elements;C. Atoms with fewer than eight electrons in the outer shell react with other atoms. Argon has eight electrons in the outer shell, is a noble gas, and rarely reacts with other elements;D. Atoms with fewer than eight electrons in the outer shell react with other atoms. Helium has a full outer shell, is a noble gas, and rarely reacts with other elements.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #1  
Question type: Multiple Choice  
Topic area: Chemistry

2. Which of the following would be a proposed mechanism by which stomach antacids work?

A. Antacids dilute the solution, therefore lowering the pH.  
**B.** Antacids are bases and by definition can absorb  $H^+$  out of a solution.  
C. Antacids are bases and by definition can absorb  $OH^-$  out of a solution.  
D. Antacids contain mostly water and so they neutralize the solution.

Incorrect Answers: A. Antacids are bases and by definition can absorb  $H^+$  out of a solution;C. Antacids are bases and by definition can absorb  $H^+$  out of a solution;D. Antacids are bases and by definition can absorb  $H^+$  out of a solution.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #2  
Question type: Multiple Choice  
Topic area: Chemistry

3. If you place the corner of a paper towel into a droplet of water the water moves across the paper towel. Which of the following would explain the movement of the water?

A. surface tension  
B. cohesion  
C. adhesion  
**D.** both cohesion and adhesion

Incorrect Answers: A. Both cohesion and adhesion explain the movement of water through a paper towel;B. Both cohesion and adhesion explain the movement of water through a paper towel;C. Both cohesion and adhesion explain the movement of water through a paper towel.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #3  
Question type: Multiple Choice  
Topic area: Chemistry

4. Which of the following elements is NOT one of the six most common in living organisms?
- A. carbon
  - B. oxygen
  - C. iron**
  - D. nitrogen
  - E. hydrogen

Incorrect Answers: A. Carbon is one of the six most common elements in living organisms; B. Oxygen is one of the six most common elements in living organisms; D. Nitrogen is one of the six most common elements in living organisms; E. Hydrogen is one of the six most common elements in living organisms.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #4  
Question type: Multiple Choice  
Topic area: Chemistry

5. There are \_\_\_\_\_ naturally occurring elements.
- A. 57
  - B. 108
  - C. 95
  - D. 92**
  - E. 87

Incorrect Answers: A. There are 92 naturally occurring elements; B. There are 92 naturally occurring elements; C. There are 92 naturally occurring elements; E. There are 92 naturally occurring elements.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #5  
Question type: Missing Word Sentence  
Topic area: Chemistry

6. Which statement is NOT true about elements?
- A. An element cannot be broken down into substances with different properties.
  - B. An element consists of atoms and molecules.**
  - C. There is only one kind of atom in each type of element.
  - D. All atoms of an element contain the same number of protons.
  - E. Atoms of an element may contain different numbers of neutrons.

Incorrect Answers: A. It is true that an element can not be broken down into substances with different properties; C. Each element consists of one type of atom; D. It is true that all atoms of an element contain the same number of protons; E. It is true that atoms of an element may contain different numbers of neutrons.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #6  
Question type: Multiple Choice  
Topic area: Chemistry

7. If the atomic number of an element is 6 and the atomic mass is 12.01, how many protons are there in the nucleus?
- A. 12  
**B. 6**  
 C. 24  
 D. 52

Incorrect Answers: A. The number of protons in the nucleus is the atomic number;C. The number of protons in the nucleus is the atomic number;D. The number of protons in the nucleus is the atomic number; Variations: atomic number 12 - atomic mass 24; answer = A atomic number 24 - atomic mass 52; answer = C

Chapter reference: 2  
 Figure/section reference: 2.1  
 Level of difficulty: Application/Analysis  
 Mader - Chapter 02 #7  
 Question type: Variable - Multiple Choice  
 Topic area: Chemistry

8. Which of the following is/are an atom, an isotope and an ion?
- A.  $H^+$**   
 B.  $^2H$  or deuterium  
 C.  $^3H$  or tritium  
 D.  $H_2$  or hydrogen gas  
 E. All of the choices are atoms, isotopes and ions.

Incorrect Answers: B.  $H^+$  is an atom, an isotope and an ion. Deuterium is not an ionC.  $H^+$  is an atom, an isotope and an ion. Tritium is not an ion;D. Hydrogen gas is a molecule made of two atoms;E. Only  $H^+$  is an atom, an isotope and an ion.

Chapter reference: 2  
 Figure/section reference: 2.1  
 Level of difficulty: Application/Analysis  
 Mader - Chapter 02 #8  
 Question type: Multiple Choice  
 Topic area: Chemistry

Radioactive Isotope	Half-life	Energy of Particles Emitted
$^{131}I$ ("iodine-131")	8.1 days	0.8 MeV
$^{32}P$ ("phosphorus-32")	14.3 days	1.7 MeV
$^{33}P$ ("phosphorus-33")	25.5 days	0.25 MeV
$^{35}S$ ("sulfur-35")	87.5 days	0.2 MeV
$^3H$ ("tritium")	12.4 years	0.02 MeV
$^{14}C$ ("carbon-14")	5730 years	0.2 MeV

9. From the above table of radioisotopes and their properties, it is obvious that
- A. the longer the half-life, the more energy emitted by the particles.
  - B. the longer the half-life, the less energy emitted by the particles.
  - C. radioisotopes of the same element must emit the same amount of energy in their emissions and decay at the same rate.
  - D. adjusted for time, radioisotopes emit the same amount of energy in their emissions.
  - E. energy and half-life are not directly related.**

Incorrect Answers: A. Energy and half-life are not directly related.B. Energy and half-life are not directly related.C. Energy and half-life are not directly related.D. Energy and half-life are not directly related.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #9  
Question type: Multiple Choice  
Topic area: Chemistry

10. Which statement is NOT true about subatomic particles?
- A. Protons are found in the nucleus.
  - B. Neutrons have no electrical charge.
  - C. Electrons contain much less mass than neutrons.
  - D. Electrons are found in orbitals around the nucleus.
  - E. All electrons in an atom contain the same amount of energy.**

Incorrect Answers: A. It is true that protons are found in the nucleus;B. It is true that neutrons have no electrical charge;C. It is true that electrons contain less mass than neutrons;D. It is true that electrons are found in orbitals around the nucleus.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #10  
Question type: Multiple Choice  
Topic area: Chemistry

11. Which is NOT true about the electrical charges in chemistry?
- A. Protons carry a positive charge.
  - B. In an atom, the number of protons and neutrons must be equal.**
  - C. An atom is neutral when the positive and negative charges balance.
  - D. An ion contains one or more positive or negative charges.

Incorrect Answers: A. It is true that protons carry a positive charge;C. It is true that an atom is neutral when the positive and negative charges balance;D. It is true that an ion contains one or more positive or negative charges.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #11  
Question type: Multiple Choice  
Topic area: Chemistry

12. In a water molecule,  
A. the oxygen atom is more electronegative than the hydrogen atoms.  
B. the oxygen atom has an overall negative charge with the hydrogen atoms having an overall positive charge.  
C. unequal sharing of electrons results in a polar molecule.  
**D.** All of the choices are correct.

Incorrect Answers: A. All of the choices are correct;B. All of the choices are correct;C. All of the choices are correct.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #12  
Question type: Multiple Choice  
Topic area: Chemistry

13. An atom's atomic mass is best described as the mass of  
A. the protons it contains.  
B. the neutrons it contains.  
C. electrons in the outermost shell.  
**D.** protons and neutrons it contains.  
E. protons and electrons it contains.

Incorrect Answers: A. An atom's atomic mass is best described as the mass of protons and neutrons it contains;B. An atom's atomic mass is best described as the mass of protons and neutrons it contains;C. An atom's atomic mass is best described as the mass of protons and neutrons it contains;E. An atom's atomic mass is best described as the mass of protons and neutrons it contains.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #13  
Question type: Multiple Choice  
Topic area: Chemistry

14. A research article indicates that researchers have used an isotope  $^3\text{H}$  to trace a certain metabolic process. From the symbol that is given, we know this is a hydrogen isotope with  
A. three protons.  
B. three neutrons.  
C. three electrons.  
**D.** one proton and two neutrons.  
E. two protons and one neutron.

Incorrect Answers: A. From the symbol that is given, we know this is a hydrogen isotope with one proton and two neutrons;B. From the symbol that is given, we know this is a hydrogen isotope with one proton and two neutrons;C. From the symbol that is given, we know this is a hydrogen isotope with one proton and two neutrons;E. From the symbol that is given, we know this is a hydrogen isotope with one proton and two neutrons.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #14  
Question type: Multiple Choice  
Topic area: Chemistry

15. Both  $^{18}\text{O}$  and  $^{16}\text{O}$  are found in nature. However,  $^{16}\text{O}$  is the most common. Therefore,
- A. these are different elements.
  - B.** oxygen atoms can have eight or 10 neutrons.
  - C.  $^{18}\text{O}$  has two additional electrons in its outer shell.
  - D.  $^{18}\text{O}$  is the form of oxygen that provides living cells with life.
  - E. only the common form of  $^{16}\text{O}$  can bond with hydrogen atoms to form  $\text{H}_2\text{O}$ .

Incorrect Answers: A. Oxygen atoms can have eight or 10 neutrons. These are the same element;C. Oxygen atoms can have eight or 10 neutrons;D Oxygen atoms can have eight or 10 neutrons;E. Oxygen atoms can have eight or 10 neutrons.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #15  
Question type: Multiple Choice  
Topic area: Chemistry

16. To determine the age of fairly recent fossils and organic artifacts, it is possible to analyze the amounts of the isotopes  $^{14}\text{C}$  and  $^{14}\text{N}$ , because over time the  $^{14}\text{C}$ -which originated in the atmosphere-breaks down into  $^{14}\text{N}$ . What net change occurred for this to happen?
- A. The  $^{14}\text{C}$  lost an electron.
  - B. The  $^{14}\text{C}$  gained an electron.
  - C. The  $^{14}\text{C}$  lost a proton.
  - D.** The  $^{14}\text{C}$  gained a proton.
  - E. The  $^{14}\text{C}$  gained a neutron.

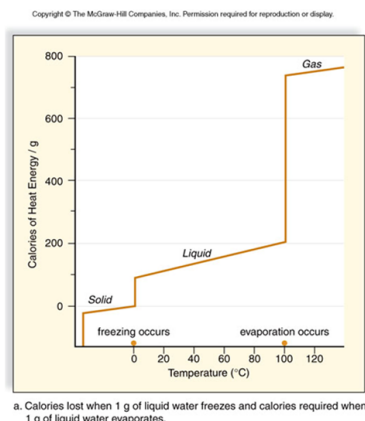
Incorrect Answers:

A. The change occurred because  $^{14}\text{C}$  gained a proton;B. The change occurred because  $^{14}\text{C}$  gained a proton;C. The change occurred because  $^{14}\text{C}$  gained a proton;E. The change occurred because  $^{14}\text{C}$  gained a proton

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #16  
Question type: Multiple Choice  
Topic area: Chemistry



17. What does this graph reveal about the heat of vaporization and the heat of fusion?



After studying the graph, one sees that it takes over 500 calories of heat to convert 1 gm of the hottest liquid water to a gas. To convert 1 gm of the coldest liquid water to a solid requires the loss of about 80 calories.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #17  
Question type: Essay/Art-based  
Topic area: Chemistry

18. Which of the following statements is NOT true about electron configurations?
- A. If an atom has only one shell, it is complete with two electrons.
  - B. If an atom has two or more shells, the octet rule applies.
  - C. If an atom has two or more shells, the outer shell is complete with eight electrons.
  - D.** Atoms with more than eight electrons in the outer shell react by gaining electrons.
  - E. Atoms with eight electrons in the outer shell are not reactive at all.

Incorrect Answers: A. It is true that if an atom has only one shell, it is complete with two electrons;B. It is true that if an atom has two or more shells, the octet rule applies;C. It is true that if an atom has two or more shells, the outer shell is complete with eight electrons;E. It is true that atoms with eight electrons in the outer shell are not reactive.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #18  
Question type: Multiple Choice  
Topic area: Chemistry

19. An orbital is best described as
- A. the electron shell closest to the nucleus.
  - B. the outermost electron shell of an atom.
  - C.** the volume of space in which electrons are most often found.
  - D. the original energy level of electrons in photosynthesis.

Incorrect Answers: A. An orbital is best described as the volume of space in which electrons are most often found;B. An orbital is best described as the volume of space in which electrons are most often found;D. An orbital is best described as the volume of space in which electrons are most often found.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #19  
Question type: Multiple Choice  
Topic area: Chemistry

20. Prior to prescription medications to control stomach acid and "heart burn" people consumed baking soda (sodium bicarbonate) to decrease their discomfort. This would indicate that sodium bicarbonate
- A. effectively buffers stomach acid by releasing  $H^+$
  - B. should be sold as a prescription drug
  - C. blocks acid production by combining with  $OH^-$
  - D. neutralizes stomach acid by combining with excess  $H^+$**

Incorrect Answers: A. Sodium bicarbonate neutralizes stomach acid by combining with excess  $H^+$ ; B. Sodium bicarbonate neutralizes stomach acid by combining with excess  $H^+$ ; C. Sodium bicarbonate neutralizes stomach acid by combining with excess  $H^+$

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #20  
Question type: Multiple Choice  
Topic area: Chemistry

21. Which statement is NOT true about ionic bonds?
- A. One atom acts as an electron donor and another atom acts as an electron acceptor.
  - B. Electrons are completely lost or gained in ion formation.
  - C. An ion has the same number of electrons as a nonionic atom of the same element.**
  - D. An ionic bond occurs between positive ions and negative ions.
  - E. A salt such as NaCl is formed by an ionic reaction.

Incorrect Answers: A. It is true that in ionic bonding, one atom acts as an electron donor and another as an electron acceptor; B. It is true that electrons are completely lost or gained in ion formation; D. It is true that an ionic bond occurs between positive ions and negative ions; E. It is true that a salt such as NaCl is formed by an ionic reaction.

Chapter reference: 2  
Figure/section reference: 2.2  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #21  
Question type: Multiple Choice  
Topic area: Chemistry

22. Which statement is NOT true about covalent bonds?
- A. Covalent bonds form when an electron is completely lost or gained from an atom.**
  - B. A covalent molecule contains one or more covalent bonds.
  - C. A single covalent bond is drawn as a line between two atoms.
  - D. A pair of electrons is shared between two atoms for each covalent bond.
  - E. Shared electrons allow an atom to complete its outer electron shell in a covalent molecule.

Incorrect Answers: B. It is true that a covalent molecule contains one or more covalent bonds; C. It is true that a single covalent bond is drawn as a line between two atoms; D. It is true that a pair of electrons is shared between two atoms for each covalent bond; E. It is true that shared electrons allow an atom to complete its outer electron shell in a covalent molecule.

Chapter reference: 2  
Figure/section reference: 2.2  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #22  
Question type: Multiple Choice  
Topic area: Chemistry

23. Which statement is NOT true about polar covalent bonds?
- A. Most covalent bonds are nonpolar, with electrons shared fairly equally between the atoms.
  - B. Polar covalent bonds are important in the characteristics of water.
  - C. Electrons are shared unequally in a polar covalent bond.
  - D. The larger atom in a polar bond attracts the electron more strongly than the smaller atom.
  - E.** The oxygen of a water molecule is electropositive relative to the hydrogen.

Incorrect Answers: A. It is true that most covalent bonds are nonpolar, with electrons shared fairly equally between the atoms; B. It is true that polar covalent bonds are important in the characteristics of water; C. It is true that electrons are shared unequally in a polar covalent bond; D. It is true that the larger atom in a polar bond attracts the electron more strongly than the smaller atom.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #23  
Question type: Multiple Choice  
Topic area: Chemistry

24. An abandoned Indiana coal mine spoil bank contains chunks of pyrite minerals. Under constant erosion and weathering, the pyrites leech large amounts of sulfuric acid ( $\text{H}_2\text{SO}_4$ ). The spoil banks are also mixed with large quantities of basic limestone and clay carbonates. What should occur over time?
- A. The pH level will drop until all acid has washed out.
  - B. The pH level will remain at 7.0 because of constant washing with rain.
  - C. The pH level will remain at 7.0 because all acid will be immediately neutralized by bases.
  - D.** The pH levels will be spotty and vary over time, first more acidic but drifting back toward 7.0.
  - E. Bases always dominate over acids.

Incorrect Answers: A. The pH levels will be spotty and vary over time, first more acidic but drifting back toward 7.0; B. The pH levels will be spotty and vary over time, first more acidic but drifting back toward 7.0; C. The pH levels will be spotty and vary over time, first more acidic but drifting back toward 7.0; E. The pH levels will be spotty and vary over time, first more acidic but drifting back toward 7.0.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Synthesis/Evaluation  
Mader - Chapter 02 #24  
Question type: Multiple Choice  
Topic area: Chemistry

Which of the following statements is/are true about the pH scale?

25. The scale indicates the relative concentrations of hydrogen and hydroxyl ions in a solution.  
**TRUE**

Incorrect Answer: It is true that the scale indicates the relative concentrations of hydrogen and hydroxyl ions in a solution.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #25  
Question type: True/False  
Topic area: Chemistry

26. The scale ranges from 1 to 15.

**FALSE**

Incorrect Answer: The scale ranges from 1 to 14.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #26  
Question type: True/False  
Topic area: Chemistry

27. pH 7 has a balanced level of  $H^+$  and  $OH^-$ .

**TRUE**

Incorrect Answer: It is true that pH 7 has a balanced level of  $H^+$  and  $OH^-$ .

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #27  
Question type: True/False  
Topic area: Chemistry

28. Anything below pH 7 is acidic and above pH 7 is basic.

**TRUE**

Incorrect Answer: It is true that anything below pH 7 is acidic and above pH 7 is basic.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #28  
Question type: True/False  
Topic area: Chemistry

29. A change of one pH unit represents a ten-fold increase or decrease in hydroxyl ion concentration.

**TRUE**

Incorrect Answer: It is true that a change of one pH unit represents a ten-fold increase or decrease in hydroxyl ion concentration.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #29  
Question type: True/False  
Topic area: Chemistry

30. The blood buffer reactions described by  $\text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$  indicates that
- scientists are uncertain which direction the equation flows.
  - B.** the reaction can flow either direction depending on whether there is an excess of hydrogen or hydroxide ions.
  - any reaction in one direction causes an immediate reverse reaction.
  - chemicals can swing wildly from acid to basic.
  - there is really no difference in chemistry whether a molecule is formed or dissociated.

Incorrect Answers: A. the reaction can flow either direction depending on whether there is an excess of hydrogen or hydroxide ions; C. the reaction can flow either direction depending on whether there is an excess of hydrogen or hydroxide ions; D. the reaction can flow either direction depending on whether there is an excess of hydrogen or hydroxide ions; E. the reaction can flow either direction depending on whether there is an excess of hydrogen or hydroxide ions.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #30  
Question type: Multiple Choice  
Topic area: Chemistry

Bond	Energy (kcal/mol)	Bond	Energy (kcal/mol)
H—H	104	P—O	100
H—O	110	N—O	53
C—H	99	S—H	81
C—O	84	C=C	146
C—C	83	C=N	147
C—N	70	P=O	120
C—S	62	C=O	170
S—S	51	C≡C	195

31. From the above table, it is apparent that:
- A.** triple bonds are stronger than double bonds; double bonds are stronger than single bonds.
  - triple bonds are weaker than double bonds; double bonds are weaker than single bonds.
  - carbon bonds are stronger than other bonds; hydrogen bonds are always weakest.
  - carbon forms only single bonds

Incorrect Answers: B. Triple bonds are stronger than double bonds; double bonds are stronger than single bonds; C. Triple bonds are stronger than double bonds; double bonds are stronger than single bonds; D. Triple bonds are stronger than double bonds; double bonds are stronger than single bonds

Chapter reference: 2  
Figure/section reference: 2.2  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #31  
Question type: Graph Analysis/Multiple Choice  
Topic area: Chemistry

32. The characteristic way in which atoms of an element react is most related to the  
A. number of electrons in the outermost shell.  
B. number of electrons in the innermost shell.  
C. number of neutrons in the nucleus.  
D. size of the nucleus.

Incorrect Answers: B. The characteristic way in which atoms of an element react is most related to the number of electrons in the outermost shell;C. The characteristic way in which atoms of an element react is most related to the number of electrons in the outermost shell;D. The characteristic way in which atoms of an element react is most related to the number of electrons in the outermost shell.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #32  
Question type: Multiple Choice  
Topic area: Chemistry

33. As a solid, water floats. This means that  
A. solid water is less dense than liquid water.  
B. organisms in ponds, lakes, and reservoirs can survive under the ice cover.  
C. this is due to hydrogen bonding changes.  
D. All of the choices are correct.

Incorrect Answers: A. All of the choices are correct;B. All of the choices are correct;C. All of the choices are correct.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #33  
Question type: Multiple Choice  
Topic area: Chemistry

34. A coastal climate is moderated primarily by which of the following properties of water? Water  
A. is the universal solvent.  
B. is cohesive and adhesive.  
C. resists changes of state.  
D. has a high surface tension.

Incorrect Answers: A. A coastal climate is moderated primarily because water resists changes of state;B. A coastal climate is moderated primarily because water resists changes of state;D. A coastal climate is moderated primarily because water resists changes of state.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #34  
Question type: Multiple Choice  
Topic area: Chemistry

35. Human blood has a pH of about 7.4. This is  
A. neutral.  
B. very acidic.  
C. slightly acidic.  
**D. slightly basic.**

Incorrect Answers: A. Human blood has a pH of about 7.4. This is slightly basic;B. Human blood has a pH of about 7.4. This is slightly basic;C. Human blood has a pH of about 7.4. This is slightly basic.

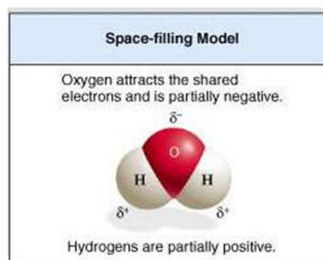
Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #35  
Question type: Multiple Choice  
Topic area: Chemistry

36. All of the following reflect harm due to acid deposition from rain EXCEPT  
A leaching of aluminum from the soil into lakes which results in the formation of toxic methyl  
mercury from mercury in the lake sediments  
B. weakens trees in the forests and kills seedlings  
**C. increased agricultural yields**  
D. damage to marble and limestone monuments

Incorrect Answers: A. Acid rain does cause leaching of aluminum from the soil into lakes which results in the formation of toxic methyl mercury from mercury in the lake sediments;B. Acid rain weakens trees in the forests and kills seedlings;D. Acid rain damages marble and limestone monuments.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #36  
Question type: Multiple Choice  
Topic area: Chemistry

37. Draw the structural formula of a single water molecule. Note the location of partial positive and

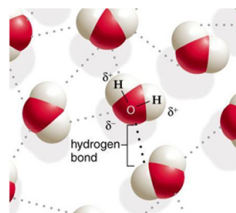


negative charges. Label the covalent bonds.

Note the diagrams above. The covalent bonds occur between the hydrogen and oxygen molecules. There are two covalent bonds in every water molecule.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #37  
Question type: Art-based  
Topic area: Chemistry

38. Draw three water molecules and the hydrogen bonding that may occur between the molecules. Define

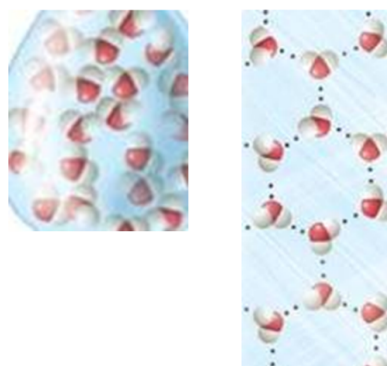


hydrogen bonding and explain how and why it occurs.

The hydrogen bonding is shown as dotted lines between the water molecules. Hydrogen bonding is the weak attraction between a covalently bonded hydrogen atom and an electronegative atom taking part in another covalent bond. It occurs between a partially positive hydrogen in one water molecule and a partially negative oxygen in another water molecule. The hydrogen has a partially positive charge and the oxygen has a partially negative charge because of the unequal sharing of electrons.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #38  
Question type: Art-based; Short Essay  
Topic area: Chemistry

39. Study the figures to determine which is liquid water and which is frozen water (ice). Explain your answer and predict if the water in Figure 2 would float or sink in the water in Figure



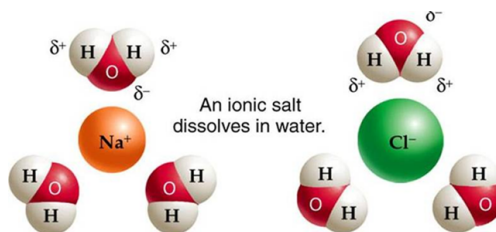
1. Fig. 2

Figure 1 is liquid water, while Figure 2 is ice. Hydrogen bonding becomes more rigid and more open as water freezes, which is depicted in Figure 2. Frozen water is less dense than liquid water. The ice in Figure 2 will float in the liquid water of Figure 1.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Synthesis/Evaluation  
Mader - Chapter 02 #39  
Question type: Art-based; Short Essay  
Topic area: Chemistry



40. Draw several (5 or 6) individual, unbonded water molecules. Simulate what happens when table salt ( $\text{Na}^+\text{Cl}^-$ ) is added to water. Use the model you created to explain why salt is added to the roads in



a 'snowy', cold climate.

There is an attraction of positively charged sodium ions to the partially negative oxygen in water. The negatively charged chloride ions are attracted to the partially positively charged hydrogen atoms in water molecules.

The presence of the sodium and chloride ions interferes with hydrogen bonding between water molecules and thus depresses the freezing point of water. This lowers the temperature at which ice will form on the roads.

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Synthesis/Evaluation  
Mader - Chapter 02 #40  
Question type: Art-based; Short Essay  
Topic area: Chemistry

41. Following nitrogen (78%) and oxygen (21%), argon is the next most common gas in the atmosphere (less than 1%). Checking the table of elements, you discover that argon is one of a family of atoms with outer shells already full of electrons. How is this related to the fact that these atoms have virtually no biological importance?

Argon has an outer shell with eight electrons. Atoms are stable, ordinarily not reacting with other atoms, when their outer shell holds eight electrons.

Chapter reference: 2  
Figure/section reference: 2.1  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #41  
Question type: Short Essay  
Topic area: Chemistry

42. Classify the following substances as either hydrophobic or hydrophilic:
- |                        |             |          |
|------------------------|-------------|----------|
| 1. Nonpolar substances | hydrophilic | <u>3</u> |
| 2. Polar substances    | hydrophilic | <u>2</u> |
| 3. Ionic substances    | hydrophobic | <u>1</u> |

Chapter reference: 2  
Figure/section reference: 2.3  
Level of difficulty: Knowledge/Comprehension  
Mader - Chapter 02 #42  
Question type: Matching  
Topic area: Chemistry

43.

[H <sup>+</sup> ] (moles per liter)		pH
0.000001	= 1 × 10 <sup>-6</sup>	6
0.0000001	= 1 × 10 <sup>-7</sup>	7
0.00000001	= 1 × 10 <sup>-8</sup>	8

Study the chart to determine the relationship between H<sup>+</sup> concentration and pH. If you were to create a herbal remedy to decrease excess stomach acid, would you create a solution with a relatively greater or lesser number of hydrogen ions.

Study of the chart confirms that as pH decreases, the concentration of H<sup>+</sup> increases. Acidity is associated with pHs below 7.0. Therefore, as the pH decreases and acidity increases, the concentration of H<sup>+</sup> increases. There is an inverse relationship between the pH and H<sup>+</sup> concentration. To neutralize excess stomach acid, one would create an herbal medication with lower concentrations of H<sup>+</sup>. Solutions with lower concentrations of H<sup>+</sup> would have relatively higher pHs.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Synthesis/Evaluation  
Mader - Chapter 02 #43  
Question type: Essay  
Topic area: Chemistry

44. A solution with a pH of 7.0 has \_\_\_\_\_ times \_\_\_\_\_ H<sup>+</sup> than a solution of pH 10.
- A. 30; more  
B. 300; less  
**C. 10<sup>3</sup>; more**  
D. 10<sup>-3</sup>; less  
E. none of the above

Incorrect Answer: A. A solution with a pH of 7.0 has 10<sup>3</sup> times more H<sup>+</sup> than a solution of pH 10;B. A solution with a pH of 7.0 has 10<sup>3</sup> times more H<sup>+</sup> than a solution of pH 10;D. A solution with a pH of 7.0 has 10<sup>3</sup> times more H<sup>+</sup> than a solution of pH 10;E. A solution with a pH of 7.0 has 10<sup>3</sup> times more H<sup>+</sup> than a solution of pH 10.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #44  
Question type: Multiple Choice  
Topic area: Chemistry

45. A solution with a pH of 6 has \_\_\_\_\_ time \_\_\_\_\_ OH<sup>-</sup> than a solution with a pH of 10.
- A. 40; more  
B. 4000; less  
**C. 10<sup>4</sup>; less**  
D. 4; less  
E. 10<sup>-4</sup> more

Incorrect Answer: A. A solution with a pH of 6.0 has 10<sup>4</sup> times less OH<sup>+</sup> than a solution of pH 10;B. A solution with a pH of 6.0 has 10<sup>4</sup> times less OH<sup>+</sup> than a solution of pH 10;D. A solution with a pH of 6.0 has 10<sup>4</sup> times less OH<sup>+</sup> than a solution of pH 10;E. A solution with a pH of 6.0 has 10<sup>4</sup> times less OH<sup>+</sup> than a solution of pH 10.

Chapter reference: 2  
Figure/section reference: 2.4  
Level of difficulty: Application/Analysis  
Mader - Chapter 02 #45  
Question type: Multiple Choice  
Topic area: Chemistry