Chapter 02
The Chemical Basis of Life I: Atoms, Molecules, and Water

Multiple Choice Questions

1. The atomic number of an atom is
A. the number of protons in the atom.
B. the number of neutrons in the atom.
C. the number of protons and electrons in the atom.
D. the number of protons and neutrons in the atom.
E. None of these choices are correct.

Blooms Level: 1. Remember
Gradable: automatic
LO: 02.01.03 Relate atomic structure to the periodic table of the elements.
Section: 02.01

2.

The smallest functional units of matter that cannot be further broken down by ordinary chemical or physical means are

A.

atoms.

B.

molecules.

C.

proteins.

D.

shells.

E.

bonds.

Blooms Level: 1. Remember
Gradable: automatic
LO: 02.01.01 Understand the general structure of atoms and their constituent particles.
Section: 02.01

Check All That Apply Questions

3. With an atomic mass of 16 and an atomic number of 8, it follows that oxygen
__X__ has eight electrons.
_____ has 16 neutrons.
__X__ can readily form bonds with 2 other atoms.
_____ weighs 16 grams.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.03 Relate atomic structure to the periodic table of the elements.
Section: 02.01

Multiple Choice Questions

4. The nucleus of an atom is composed of
A. protons.
B. neutrons.
C. electrons.
D. protons and neutrons.
E. protons and electrons.

Blooms Level: 1. Remember
Gradable: automatic
LO: 02.01.01 Understand the general structure of atoms and their constituent particles.
Section: 02.01

5. Ernest Rutherford's key experiment on alpha particle bombardment of gold foil was important to the development of
A. detection methods for protons.
B. alpha particle emitters.
C. gold as an element.
D. the modern model for atomic structure.
E. the concept that atoms have a homogenous distribution of protons throughout the atom.

Blooms Level: 1. Remember
Gradable: automatic
LO: 02.01.01 Understand the general structure of atoms and their constituent particles.
Section: 02.01

6.

If a scientist were to shoot protons through an atom as Rutherford did with gold foil, he or she would likely find that

A. most of the protons passed straight through the atom.
B. few of the protons passed straight through the atom.
C. most of the protons deflected or bounced back from the atom.
D.

most of the protons were absorbed by the atom.

E.

the atom emitted electrons.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.01 Understand the general structure of atoms and their constituent particles.
Section: 02.01

7.

The first, innermost energy shell of an atom

A. can have a maximum of 8 electrons.
B. can have a maximum of 2 electrons.
C. is called the 2p orbital.
D. is called the 1s orbital and can have a maximum of 8 electrons.
E. is called the 2p orbital and can have a maximum of 2 electrons.

Blooms Level: 1. Remember
Gradable: automatic
LO: 02.01.02 Discuss the way electrons orbit the nucleus of an atom within discrete energy levels.
Section: 02.01

8. Tritiated hydrogen (^{3}H) differs from hydrogen (^{1}H) in that
A. ^{3}H has 2 more protons than ^{1}H.
B. ^{3}H has 2 more electrons than ^{1}H.
C. ^{3}H has 2 more neutrons than ^{1}H.
D. ^{3}H has the same number of neutrons as ^{1}H.
E. ^{3}H has a different electron configuration than ^{1}H.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.05 Explain how a single element may exist in more than one form, called isotopes, and how certain isotopes have importance in human medicine.
Section: 02.01

9. Isotopes are different forms of the same element that
A. differ in their number of neutrons.
B. differ in their number of protons.
C. are all produced artificially.
D. cannot form covalent bonds.
E. cannot form ions.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.05 Explain how a single element may exist in more than one form, called isotopes, and how certain isotopes have importance in human medicine.
Section: 02.01

10. The element found in most abundance in living organisms is
A. calcium.
B. iron.
C. iodine.
D. hydrogen.
E. sodium.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.06 Know which elements make up most of the mass of all living organisms.
Section: 02.01

11. Nitrogen has 7 electrons and can form a maximum of _____ bonds with other elements.

A.

1.

B.

2.

C.

3.

D.

4.

E.

5.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

12. Molecules

A. are derived from the ionic bonding of two or more atoms.
B. have the same physical properties as the atoms from which they were derived.
C. are not important in biological processes.
D. can form from the covalent bonding of two or more atoms.
E. cannot have a charge.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

13. Identify the ion from below.

A.

Ca^{2+}.

B.

He.

C.

H_2.

D.

CO_2.

E.

KCl-.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

14. Carbon has 4 electrons and hydrogen has 1 electron in its outermost electron shell. A carbon atom can form covalent bonds with how many hydrogen atoms?
A. 0.
B. 1.
C. 2.
D. 3.
E. 4.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about covalent bonds with carbon.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of covalent bonds to predict how many can form.

Gather Content

- *What do you know about covalent bonds? What other information is related to the question?*
  o Covalent bonds form by sharing a pair of electrons between two atoms.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Carbon has four unpaired electrons, and each of these can pair with an electron from a hydrogen atom. So carbon can form covalent bonds with four hydrogen atoms.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of covalent bonds. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that the carbon atoms would pair with each other and not form covalent bonds with hydrogen? Did you think that each hydrogen could form more than one bond with carbon?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

15. When one atom loses an electron to another atom, it results in the formation of
A. a polar covalent bond and a new molecule.
B. cations and anions that can form ionic bonds.
C. a covalent bond between the two.
D. many hydrogen bonds.
E. a nonpolar covalent bond that is difficult to break.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

16. The strongest chemical bonds are
A. hydrogen bonds.
B. Van der Waal forces.
C. hydrophobic interactions.
D. ionic bonds.
E. covalent bonds.

Blooms Level: 1. Remember
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.

17. What type of bonding is likely to occur between two water molecules or strands of DNA?

A.

covalent.

B.

ionic.

C.

hydrogen.

D.

both hydrogen and covalent.

E.

both hydrogen and ionic.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

18. Carbon and hydrogen have similar electronegativities and combine together to form hydrocarbon molecules. What type of bonds form between these atoms?

A.

hydrogen.

B.

ionic.

C.

polar covalent.

D.

nonpolar covalent.

E.

electrostatic.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.02 Explain the concept of electronegativity and how it contributes to the formation of polar and nonpolar covalent bonds.
Section: 02.02

19. What type of bonds form from the unequal sharing of electrons?

A.

hydrogen.

B.

ionic.

C.

polar covalent.

D.

nonpolar covalent.

E.

electrostatic.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.02 Explain the concept of electronegativity and how it contributes to the formation of polar and nonpolar covalent bonds.
Section: 02.02

20. In water, $MgCl_2$ dissociates into Mg^{2+} and Cl^-. Based on this information what type of bond is involved in the formation of $MgCl_2$?

A.

hydrogen.

B.

ionic.

C.

polar covalent.

D.

nonpolar covalent.

E.

electrostatic.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

21. When one oxygen atom shares two pairs of electrons with another oxygen atom, O_2 is formed via a(n)

A. single covalent bond.
B. double covalent bond.
C. triple covalent bond.
D. ionic bond.
E. hydrogen bond.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.02 Explain the concept of electronegativity and how it contributes to the formation of polar and nonpolar covalent bonds.
Section: 02.02

22. The LEAST hydrophilic substance is
A. salt.
B. an ion.
C. oil.
D. an amphipathic molecule.
E. a gas.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.03.02 List the properties of water that make it a valuable solvent, and distinguish between hydrophilic and hydrophobic substances.
Section: 02.03

23. Amphipathic molecules
A. possess only hydrophilic properties.
B. possess only hydrophobic properties.
C. possess both hydrophilic and hydrophobic properties.
D. possess neither hydrophilic nor hydrophobic properties.
E. tend not to interact with other molecules.

Blooms Level: 1. Remember
Gradable: automatic
LO: 02.03.02 List the properties of water that make it a valuable solvent, and distinguish between hydrophilic and hydrophobic substances.
Section: 02.03

24. For water to vaporize
A. energy must be supplied.
B. energy must be released.
C. hydrogen bonds are broken.
D. both energy must be supplied and hydrogen bonds broken.
E. both energy must be released and hydrogen bonds broken.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.03.01 Describe how hydrogen bonding determines many properties of water.

25. The molarity of a solution is
A. a measure of solute concentration.
B. the weight of a solid substance.
C. often expressed as grams per unit volume.
D. reflects a measure of the amount of oil dissolved in water.
E. a scientific term for determining the solubility of a substance in water.

Blooms Level: 1. Remember
Gradable: automatic
LO: 02.03.03 Understand how the molarity of a solution the number of moles of a solute per liter of solution is used to measure the concentration of solutes in solution.
Section: 02.03

26. Based on the colligative properties of water, what would happen if one were to add a solute to water?
A. The freezing point of water would decrease.
B. The freezing point of water would increase.
C. The boiling point of water would increase.
D. Both the freezing point of water would decrease and the boiling point of water would increase.
E. Nothing would change with respect to the freezing point or boiling point of water.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about the effect of a solute on the freezing and boiling points of water.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge to predict the effect of a solute on the freezing and boiling points of water.

Gather Content

- *What do you know about the effect of a solute on the freezing and boiling points of water? What other information is related to the question?*
  o Adding a solute, such as a salt, to water causes the water molecules to orient themselves around the salt molecules which makes it harder to move them into a vapor. Salt also disrupts the hydrogen bonds in water preventing them from forming ice crystals.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Adding salt to water makes it more difficult for water molecules to go into a vapor state. So more heat needs to be added to cause water to boil, raising the boiling point. Adding salt to water interferes with the formation of hydrogen bonds between water molecules which makes it harder for ice crystals to form. As a result the temperature needed for freezing is lowered.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of colligative properties to predict the effect on the boiling and freezing points of water. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you know that salt would cause water molecules to bind to the salt? Did you realize that salt would interfere with the formation of ice cyrstals?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.03.02 List the properties of water that make it a valuable solvent, and distinguish between hydrophilic and hydrophobic substances.

27. Water
A. is nonpolar.
B. has a low heat of vaporization.
C. has cohesive properties.
D. evaporates and increases body temperature.
E. is a relatively poor solvent.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.03.02 List the properties of water that make it a valuable solvent, and distinguish between hydrophilic and hydrophobic substances.
Section: 02.03

28.

If orange juice has a pH of 4, then it can be described as

A.

having a H^+ concentration of 4.

B.

an acidic solution.

C. an alkaline solution.
D. an acidic solution with a H^+ concentration of 4.
E. None of these choices are correct.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.03.05 Explain how water has the ability to ionize into hydroxide ions and into hydrogen ions and how the H concentration is expressed as a solution's pH.
Section: 02.03

29. The most significant role played by pH buffers is to
A. prevent fluctuations in the acidity of solutions.
B. increase the strength of acids and bases.
C. prevent fluctuations in the salinity of solutions.
D. limit major shifts in the amount of H^+ and OH^- in solution.
E. keep pH low.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.03.06 Give examples of how buffers maintain a stable environment in an animal's body fluids.
Section: 02.03

30. An example of one of the ways a pH buffer helps to maintain homeostasis is to
A. increase the H^+ concentration if pH decreases.
B. reduce the H^+ concentration if pH decreases.
C. reduce the H^+ concentration if pH increases.
D. increase the OH^- concentration if pH increases.
E. reduce the OH^- concentration if pH decreases.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about buffers.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of buffers to predict how one would respond to a change in pH.

Gather Content

- *What do you know about buffers? What other information is related to the question?*
  o Buffers keep pH relatively constant by increasing either the H+ or OH- concentration.pH is inversely related to the acidity, so the higher the H+ concentration, the lower the pH. If pH decreases then either the H+ concentration can be reduced or the OH- concentration increased. If pH increases then either the H+ concentration can be increased or the OH- concentration reduced.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Of the answers the only one that is consistent is that if the pH decreases then the amount of H+ ions should be reduced.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of buffers to explain what would happen if the pH changed. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall that as pH goes down the H+ ion concentration goes up? Did you realize that the buffer would be countering the direction the pH was changing?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.03.05 Explain how water has the ability to ionize into hydroxide ions and into hydrogen ions and how the H concentration is expressed as a solution's pH.
Section: 02.03

31. The addition of a strong acid like HCl to an aqueous solution would result in
A. the release of H^+ into the solution.
B. an increase in pH.
C. a decrease in pH.
D. both the release of H^+ and an increase in pH.
E. both the release of H^+ and a decrease in pH.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.03.05 Explain how water has the ability to ionize into hydroxide ions and into hydrogen ions and how the H concentration is expressed as a solution's pH.
Section: 02.03

True / False Questions

32. One gram of hydrogen, which has an atomic mass of 1, would have fewer atoms than 1 gram of carbon that has an atomic mass of 12.
FALSE

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about the number of atoms in different masses.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of atomic mass.

Gather Content

- *What do you know about atomic mass to calculate the number of atoms? What other information is related to the question?*
  o Hydrogen has an atomic mass of 1 gram/mole while carbon has an atomic mass of 12 grams/mole. Each mole has the same number of atoms. So we can compare the numbers of moles in each sample to see if they have the same numbers of atoms.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Since we have 1 gram of each sample simply divide the 1 gram by the atomic mass to see how many moles of each are in the sample. For hydrogen this is 1 gram/ 1gram/mole = 1 mole. For hydrogen this is 1 gram/ 12grams/mole = 1/12 mole. So the hydrogen sample will contain 12 times as many atoms as the carbon sample.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply the definition of atomic mass and moles to calculate the relative numbers of atoms in a sample. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that 1 gram of each sample meant the samples had the same number of atoms? Did you think that with an atomic mass of 12, the carbon samples would have more atoms per gram instead of fewer?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.01.03 Relate atomic structure to the periodic table of the elements.
Section: 02.01

33. Isotopes are different forms of the same element.
TRUE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.05 Explain how a single element may exist in more than one form, called isotopes, and how certain isotopes have importance in human medicine.
Section: 02.01

34. Sulfur 35 (^{35}S) is an isotope of ^{32}S. These elements differ in their number of neutrons.
TRUE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.05 Explain how a single element may exist in more than one form, called isotopes, and how certain isotopes have importance in human medicine.
Section: 02.01

35. Helium is an inert gas that rarely reacts with other elements because it has the maximum number of valence electrons in its outer shell.
TRUE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.01 Understand the general structure of atoms and their constituent particles.
Section: 02.01

36. If lithium has an atomic number of 3 then it will have 1 valence electron.
TRUE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.03 Relate atomic structure to the periodic table of the elements.
Section: 02.01

37. The electronegativity of an atom is a measure of its ability to attract electrons to its outer shell from another atom.
TRUE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.02 Explain the concept of electronegativity and how it contributes to the formation of polar and nonpolar covalent bonds.
Section: 02.02

38. Table salt forms from sodium and chloride via hydrogen bonding.
FALSE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

39. Molecules are generally rigid structures and rarely change shape.
FALSE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.03 Describe how a molecule's shape is important for its ability to interact with other molecules.
Section: 02.02

40. The presence of salt helps prevent oceans from freezing.
TRUE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.03.02 List the properties of water that make it a valuable solvent, and distinguish between hydrophilic and hydrophobic substances.
Section: 02.03

41. A dehydration reaction that builds larger molecules from smaller units requires the addition of a water molecule.
FALSE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.04 Understand the concepts of a chemical reaction and chemical equilibrium.
Section: 02.02

42. The hydroxyl (OH^-) concentration of a solution with a pH of 8 would be 10^{-6} molar.
TRUE

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about pH.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of pH to calculate OH- concentration.

Gather Content

- *What do you know about pH? What other information is related to the question?*
  o pH is equal to –log[H+]. So a sample with a pH of 8 would have a H+ concentration of 10-8 molar. Pure water is pH 7, and the concentration of both H+ and OH- are equal at concentration of 10-7 molar. As the H+ concentration decreases the OH- concentration will increase proportionally.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o The H+ concentration of H+ has decreased 10-fold from 10-7 molar in pure water to 10-8 molar. In response the OH- concentration will increase 10-fold from 10-7 molar in pure water to 10-6 molar.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of pH to calculate the OH- concentration. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did think that as pH increases the H+ concentration increases? Did you think that as the H+ concentration increases the OH- concentration also increases? Did you realize that 10-7 molar is less than 10-6 molar?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.03.05 Explain how water has the ability to ionize into hydroxide ions and into hydrogen ions and how the H concentration is expressed as a solution's pH.
Section: 02.03

43. Most enzymes or bioactive molecules work effectively within a broad range of pH.
FALSE

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.03.06 Give examples of how buffers maintain a stable environment in an animal's body fluids.
Section: 02.03

Multiple Choice Questions

44. $Zn + 2H^+ = Zn2^+ + H_2$ is an example of a redox reaction. What is happening to the hydrogen ions during this reaction, in which a bond is formed between the two H atoms?
A. Oxidation reaction and acceptance of an electron.
B. Reduction reaction and acceptance of an electron.
C. Reduction reaction and donation of an electron.
D. Oxidation reaction and donation of an electron.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about redox reactions.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of redox reactions to a specific example.

Gather Content

- *What do you know about redox reactions? What other information is related to the question?*
  o In a redox reaction on atom or molecule releases an electron in an oxidation half reaction. This electron is then donated to another molecule in a reduction half reaction. Remember that electrons have a negative charge, so they will reduce the charge of whichever atom or molecule they are transferred to.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Hydrogen ions (H+) are gaining an electron in this reaction forming molecules of hydrogen gas (H2). So this is a reduction reaction.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of redox reactions to a specific example. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that H+ was being oxidized? Did you realize that H+ was gaining electrons?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

45. You notice that the majority of the electrons in NaCl spend their time around the chlorine. You also notice that the electrons in H_2 are evenly distributed among the two atoms. Which two types of bonds are represented in these molecules?
A. Covalent bonds in NaCl; ionic bonds in H_2.
B. Covalent bonds in NaCl; covalent bonds in H_2.
C. Ionic bonds in NaCl; ionic bonds in H_2.
D. Ionic bonds in NaCl; covalent bonds in H_2.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about different types of bonds.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of covalent and ionic bonds to a specific example.

Gather Content

- *What do you know about covalent and ionic bonds? What other information is related to the question?*
  o In covalent bonds two atoms share a pair of electrons. In an ionic bond one atom has a positive charge and has lost an electron, the other atom has a negative charge and has gained an electron.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Because electrons spend more time around Cl than Na, the Cl has a negative charge and the Na has a positive charge. These two ions then form an ionic bond. The two hydrogen atoms have the same pull on electrons and share them to form a covalent bond.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply to your understanding of different types of bonds to a specific example. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that electrons were equally shared in an ionic bond? Did you think that if one atom had more pull on electrons than another atom this would form a covalent bond?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

46. A bottle of Na in solution and a bottle of Cl in solution are mixed together and the water evaporated. What type of bond will be created between the atoms, and what will be the product?
A. Covalent bonds; sodium chlorine.
B. Ionic bonds; table salt.
C. Hydrogen bonds; sodium hydroxide.
D. Carbon bonds; carboxyl groups.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about NaCl.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of different bonds to predict what bonds NaCl would form.

Gather Content

- *What do you know about NaCl? What other information is related to the question?*
  o In solution Na would be positively charged and Cl would be negatively charged. As the water is removed the Na and Cl ions will be attracted to each other forming ionic bonds.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Na+ and Cl- form ionic bonds with each other. The common name for these NaCl crystals is table salt.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of chemical bonds to a specific example. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that Na or Cl would form hydrogen or covalent bonds with each other? Did you realize that NaCl is table salt?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

47. You've been asked to stabilize a compound whose general state is altered by excess electrons. The element you would add to the compound to most effectively stabilize the compound would be? Why?
A. Carbon, because it is capable of neutralizing electrons.
B. Nitrogen, because it have five electrons on its outer shell.
C. Fluorine, because it is has seven electrons in its outer shell.
D. Oxygen, because it can easily bind with the compound.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about stable outer shells of electrons.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of stable outer shells to a specific example.

Gather Content

- *What do you know about outer shells of electrons? What other information is related to the question?*
  o An atom is most stable with a full outer shell of electrons. If you have a molecule with excess electrons then adding atoms that can accept these electrons would help to stabilize the molecule. An atom with 7 electrons in the outer shell would become more stable by gaining one electron and having a full outer shell.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Among the choices fluorine has 7 valence electrons in its outer shell. By gaining one one electron it becomes more stable.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your knowledge of stable outer shells to a specific example. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that an atom like carbon could neutralize an electron? Did you realize that an atom that could gain an electron would stabilize the molecule?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.01.03 Relate atomic structure to the periodic table of the elements.
Section: 02.01

48. You want to simulate the production of carbon dioxide (CO_2) in a laboratory setting using carbon and oxygen atoms. What type of reactions do you need to facilitate in order to create CO_2?
A. An oxidation, or the gain of an electron, and a reduction, or the loss of an electron.
B.

An oxidation, or the loss of an electron, and a reduction, or the loss of an electron.

C. An oxidation, or the gain of an electron, and a reduction, or the gain of electron.
D. An oxidation, or the loss of an electron, and a reduction, or the gain of an electron.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

49. Five unknown compounds are added to water. Four of the compounds go into solution while one does not. What property does water possess that allows these four compounds to dissolve? Why might the fifth compound not dissolve?
A. The positive and negative charge in water will dissolve many substances; the substance is not structurally similar to water.
B. The negative charge of water dissolves many substances; the substance is too structurally similar to water.
C. The positive charge of water dissolves many substances; the substance is too structurally similar to water.
D. The nonpolar quality of water dissolves many substances; the substance is not structurally similar to water.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about solubility in water.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of solubility in water to specific examples.

Gather Content

- *What do you know about solubility in water? What other information is related to the question?*
  o Water is a polar molecule with partial positive and negative charges, this allows many charged and polar molecules to dissolve in water. Water can also form hydrogen bonds, so other molecules with structures similar to water can form hydrogen bonds with water and dissolve more easily.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o The partial charges on water allow many substances to dissolve in water. If something does not dissolve in water, it is probably non-polar and uncharged.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your knowledge of solubility in water to specific examples. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that water was non-polar? Did you think that water only has positive or negative charges? Did you think that molecules with structures different from water dissolve well in water?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.03.01 Describe how hydrogen bonding determines many properties of water.
Section: 02.03

50. 1 mole = 1000 millimoles (mmol); 1millimole = 1000 micromoles (µmol). If a solution contains 38231 µmol, what is that amount in mmol?
A. 382.31 mmol.
B. 38.231 mmol.
C. 3.8231 mmol.
D. 3823.1 mmol.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about conversion from micromole to millimole.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of metric conversions.

Gather Content

- *What do you know about metric conversions? What other information is related to the question?*
  o Micro- is 1/1000th of milli, so to convert from micromoles to millimoles simply divide by 1000.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o 38231 micromoles divided by 1000 = 38.231 millimoles.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply metric conversions. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall that micro is 1/1000th of milli, so you need to divide by 1000?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.03.03 Understand how the molarity of a solution the number of moles of a solute per liter of solution is used to measure the concentration of solutes in solution.
Section: 02.03

51. If 1000 millimoles make up a mole, how many grams of magnesium (Mg), which has an atomic mass of 24.305, will make a solution that contains 150 µmol of Mg?
A. 3.6mg.
B. 2.4mg.
C. 0.24mg.
D. 36mg.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about molecular weights.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of molecular weight to convert from grams to moles.

Gather Content

- *What do you know about molecular weight? What other information is related to the question?*
  o Molecular weight has units of grams/mole. Using metric conversions this can be rewritten as mg/mmole. Metric units change by 1000-fold. So there are 1000 micrograms in 1 milligram, and 1000 milligrams in 1 gram.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o 150. µmol = 0.15 mmole. The atomic mass of Mg is about 24 gm/mole = 24 mg/mmole.
  o 0.15 mmole x 24 mg/mmole = 3.6 mg.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply metric conversions. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that 1 µmol was 1/10th of a millimole? Could you use the molecular weight to convert from mg to mmoles?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.01.04 Quantify atomic mass using units such as daltons and moles.
Section: 02.01

52. Using the periodic table as your tool, identify the atomic characteristic that would most quickly and efficiently identify any single element:
A. number of shells.
B. number of neutrons.
C. number of protons and electrons.
D. number of neutrons and electrons.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.03 Relate atomic structure to the periodic table of the elements.
Section: 02.01

53. In the periodic table, the value that refers to the number of protons and neutrons is:
A. atomic mass.
B. molecular molarity.
C. atomic molarity.
D. molecular number.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.03 Relate atomic structure to the periodic table of the elements.
Section: 02.01

54. You have been asked to synthesize a new isotope for cadmium. Which part of the original atom would you need to manipulate in order to create an isotope?

A.

Neutrons.

B.

Protons.

C.

Protons and neutrons.

D.

Electrons.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.01.05 Explain how a single element may exist in more than one form, called isotopes, and how certain isotopes have importance in human medicine.
Section: 02.01

55. The single atom you would choose to remove from living organisms in order to remove the highest percentage of atoms would be:
A. Oxygen.
B. Nitrogen.
C. Hydrogen.
D. Carbon.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about the most common atom in biological molecules.
- What type of thinking is required?
  o You are being asked to apply your knowledge of biological molecules to predict the most common atom.

Gather Content

- *What do you know about the most common element in biological molecules? What other information is related to the question?*
  o The backbone of biological molecules is carbon. Oxygen and nitrogen are common atoms attached to this backbone.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o The most abundant atom is hydrogen, it is attached to carbon, oxygen and nitrogen in biological molecules.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of biological molecules to identify the most common element. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that carbon was more common than hydrogen because it is the backbone of organic molecules? Did you think that oxygen or nitrogen were more abundant because their mass is larger?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.03.04 Discuss the properties of water that are critical for the survival of living organisms.
Section: 02.03

56. You have been given vials of H_2, Na, H_2O, Hg, and CH_4. What are the majority of your vials filled with?

A. Liquids at room temperature.

B.

Gases.

C.

Molecules.

D.

Carboxyls.

Blooms Level: 2. Understand
Gradable: automatic
LO: 02.02.01 Compare and contrast the types of atomic interactions that lead to the formation of molecules.
Section: 02.02

57. Water has fewer hydrogen atoms than lemon juice and a pH of around 7. Predict what will happen to the pH level of water when lemon juice is added.
A. The pH will become higher.
B. The pH will become lower.
C. The pH will remain the same.
D. There is not enough information to decide.

Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about how adding an acid to water will affect pH.
- *What type of thinking is required?*
  o You are being asked to apply your knowledge of acids on pH.

Gather Content

- *What do you know about pH? What other information is related to the question?*
  o pH is inversely related to acid concentration. If lemon juice has more hydrogen ions than water, it would have a lower pH.

Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Adding lemon juice to water would add more hydrogen ions and would lower the pH.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of pH. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that increasing hydrogen ions in water would increase pH? Did you think that lower hydrogen ions meant a lower pH?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.03.05 Explain how water has the ability to ionize into hydroxide ions and into hydrogen ions and how the H concentration is expressed as a solution's pH.
Section: 02.03

58. Water has fewer hydrogen atoms than lemon juice and a pH of around 7. Predict what will happen to the pH level of water when lemon juice is added.
A. The pH will become higher.
B. The pH will become lower.
C. The pH will remain the same.
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Clarify Question

- *What is the key concept addressed by the question?*
  o The question asks about how adding an acid to water will affect pH.
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Choose Answer

- *Given what you now know, what information is most likely to produce the correct answer?*
  o Adding lemon juice to water would add more hydrogen ions and would lower the pH.

Reflect on Process

- *Did your problem-solving process lead you to the correct answer? If not, where did the process break down or lead you astray? How can you revise your approach to produce a more desirable result?*
  o This question asked you to apply your understanding of pH. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that increasing hydrogen ions in water would increase pH? Did you think that lower hydrogen ions meant a lower pH?

Blooms Level: 3. Apply
Gradable: automatic
LO: 02.03.05 Explain how water has the ability to ionize into hydroxide ions and into hydrogen ions and how the H concentration is expressed as a solution's pH.
Section: 02.03