Understanding Biology 2nd edition Mason Test Bank

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Understanding Biology, 2e **(Mason)**
Chapter 2 The Nature of Molecules and the Properties of Water

1) Matter is composed of
A) atoms.
B) energy.
C) mass.
D) molecules.

Answer: A
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
Bloom's: 1. Remember
Gradable: automatic

2) All atoms possess the ability to do work. The term that is defined as the ability to do work is
A) matter.
B) energy.
C) molecules.
D) space.

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.03 Explain how energy is quantized in atoms.
Bloom's: 1. Remember
Gradable: automatic

3) The number of protons in a given atom is equal to its
A) atomic number.
B) mass.
C) neutron number.
D) molecular number.

Answer: A
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

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4) Isotopes that are unstable and decay when their nucleus breaks up into elements with lower atomic numbers, emitting significant amounts of energy in the process, are called
A) energetic.
B) ionic.
C) radioactive.
D) isometric.

Answer: C
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

5) Atoms containing a specific number of protons are called
A) minerals.
B) elements.
C) metals.
D) molecules.

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

6) Which chemical group forms hydrogen bonds with water and is most likely to explain why sugars dissolve well in water?
A) -O-H
B) -N-H
C) -C-H
D) -C-C

Answer: A
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.01 Explain how the structure of water leads to hydrogen bond formation.
Bloom's: 2. Understand
Gradable: automatic

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7) The negative logarithm of the hydrogen ion concentration in the solution is referred to as
A) pH.
B) atomic mass.
C) OH^- concentration.
D) electronegativity.
E) specific heat.

Answer: A
Section: 02.05
Topic: Water Molecules Can Dissociate into Ions
Learning Objective: 02.05.01 Calculate the pH of a solution based on the molar concentration of H.
Bloom's: 1. Remember
Gradable: automatic

8) Bicarbonate ions in the blood can absorb hydrogen ions, keeping the pH balanced. Therefore bicarbonate is acting as a _____ in the blood.
A) buffer
B) acid
C) base
D) alkaline

Answer: A
Section: 02.05
Topic: Water Molecules Can Dissociate into Ions
Learning Objective: 02.05.01 Calculate the pH of a solution based on the molar concentration of H.
Bloom's: 2. Understand
Gradable: automatic

9) Atomic nuclei contain protons and _____.
A) isomers
B) ions
C) moles
D) neutrons

Answer: D
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
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10) Carbon-12, carbon-13 and carbon-14 are examples of:
A) ions
B) isotopes
C) isomers
D) molecules

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
Bloom's: 2. Understand
Gradable: automatic

11) Organisms are composed of molecules, which are collections of smaller units, termed
A) monomers.
B) atoms.
C) electrons.
D) polymers.
E) ions.

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

12) Negatively charged subatomic particles that have almost no mass are called
A) electrons.
B) protons.
C) neutrons.
D) ions.
E) polymers.

Answer: A
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
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Gradable: automatic

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13) Atoms of a single element that possess different numbers of neutrons are called
A) polymers.
B) ions.
C) monomers.
D) isomers.
E) isotopes.

Answer: E
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

14) $Cl + e^- \rightarrow Cl^-$ is an example of a _____ reaction.
A) oxidation
B) reduction
C) polymerization
D) ionization

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.03 Explain how energy is quantized in atoms.
Bloom's: 2. Understand
Gradable: automatic

15) When atoms gain or lose electrons, they can become negatively or positively charged. These negatively or positively charged atoms are known as
A) isotopes.
B) ions.
C) isomers.
D) unstable atoms.

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
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Gradable: automatic

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16) When two atoms share a pair of electrons, the bonding is referred to as
A) ionic.
B) covalent.
C) unstable.
D) hydrogen.

Answer: B
Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.02 Explain how covalent bonds hold atoms together.
Bloom's: 1. Remember
Gradable: automatic

17) Water molecules are polar with ends that exhibit partial positive and negative charges. These opposite charges allow water molecules to attract each other through
A) ionic bonds.
B) covalent bonds.
C) hydrogen bonds.
D) peptide bonds.

Answer: C
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.01 Explain how the structure of water leads to hydrogen bond formation.
Bloom's: 2. Understand
Gradable: automatic

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18) An atom has 20 electrons and 20 neutrons. What is the mass of this atom?
A) 10
B) 20
C) 40
D) 80

Answer: C
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about calculating the mass of an atom.
• ***What type of thinking is required?*** You are being asked to apply the definition of atomic mass to calculate an atomic mass.
• ***What key words does the question contain and what do they mean?***
o Atomic mass is the sum of the masses of protons and neutrons in an atom. We assume the mass of electrons is so small it doesn't contribute to total mass.

Gather Content
• ***What do you know about atomic mass? How does it relate to the question?***
o The masses of a proton and of a neutron are both 1.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o There are 20 protons and 20 neutrons each with a mass of 1 in this atom.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o 20 protons + 20 neutrons = an atomic mass of 40.

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 to calculate an atomic mass. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you confuse atomic number (the number of protons alone) with the atomic mass (the sum of protons and neutrons)?
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 3. Apply
Gradable: automatic

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19) Sue was monitoring the oil spill into the Gulf of Mexico from an oil tanker. From her observations, she noted that the oil was moving as large patches in the water. It did not appear as though the oil was dissolving into the water. Why did the oil not dissolve into the water?
A) hydrophobic interactions
B) surface tension
C) sea water acts as a solvent
D) water forms hydration shells
E) water has a high heat of vaporization

Answer: A
Explanation:

Clarify Question
• **What is the key concept addressed by the question?** The question asks why oil and water don't mix.
• **What type of thinking is required?** You are being asked to apply your knowledge of the properties of water and oil to explain why the oil does not dissolve in water.
• **What key words does the question contain and what do they mean?**
o Dissolve – this means one compound mixes completely with a solvent like water.

Gather Content
• ***What do you know about water as a solvent? How does it relate to the question?***
o Water is a polar molecule, this means that other polar molecules or ions will dissolve in it. These water loving molecules are called hydrophilic.
o Oil is a non-polar molecule and will dissolve better in a non-polar solvent. These molecules are called hydrophobic, or water fearing.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Water is a solvent with a high heat of vaporization and surface tension. Water also forms surface tension. However, none of these properties explain why oil does not dissolve in water.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o The best answer is that oil is hydrophobic, meaning it does not interact well with water. This is because water is a polar molecule and oil is non-polar. Water has O-H bonds which do not share electrons equally giving the O a partial negative charge and the H a partial positive charge. In contrast oil is made up of C-H bonds and the electrons are shared more equally leading to no partial charges. Because oil does not have these charges it is not attracted to the charges in water and does not dissolve well in water.

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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 properties of water to explain why oil and water do not mix well. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you know what the word hydrophobic meant? Did you have difficulty remembering which properties of water make it a good solvent for other polar molecules?

Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.07 Explain why oil will not dissolve in water.
Bloom's: 3. Apply
Gradable: automatic

20) The atomic number of an element is equal to the number of
A) protons only.
B) neutrons only.
C) protons plus electrons.
D) protons plus neutrons.
E) neutrons plus electrons.

Answer: A
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

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21) Oxygen has an atomic mass of 16 and an atomic number of 8. How many neutrons are present?
A) 24
B) 8
C) 16
D) 4

Answer: B
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks you to calculate the number of neutrons from the atomic mass and number of an atom.
• **What type of thinking is required?** You are being asked to apply your knowledge of how atomic mass and atomic number are calculated.
• ***What key words does the question contain and what do they mean?***
o Atomic mass – the number of neutrons plus protons in an atom.
o Atomic number – the number of protons in an atom.

Gather Content
• ***What do you know about the number of neutrons in an atom? How does it relate to the question?***
o Atomic mass contains both the neutrons and protons in an atom.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Atomic number is defined by the number of protons in an atom.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o To calculate the number simply take Atomic mass (P + N) minus Atomic number (P).
o In this example this is 16 – 8 = 8 neutrons

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 structure of an atom to predict some of its properties. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you know the definitions of how atomic mass and atomic numbers? Did you have difficulty figuring out how to calculate the number of neutrons by subtracting atomic mass from atomic number?
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 3. Apply
Gradable: automatic

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22) The pH of your small intestines is around 7.5 and the pH of your large intestine can be 5.5. As substances travel from the small intestines to the large intestine, what would happen to the H^+ ion concentration?
A) It decreases 100 fold.
B) It increases by 100 fold.
C) It increases 10 fold.
D) It increases 2 fold.
E) It decreases 10 fold.

Answer: B
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about relating pH to H+ concentration.
• ***What type of thinking is required? You are being asked to apply the definition of pH to a specific example.***
• ***What key words does the question contain and what do they mean?***
o pH – this is the –log[H+]

Gather Content
• ***What do you know about the link between H+ concentration and pH? How does it relate to the question?***
o Because the relationship between H+ concentration and pH is a log scale, a change in pH of 1 is a change in H+ concentration of 10-fold.
o Because the relationship between is negative, an increase in pH of 1 is a decrease in H+ concentration by 10-fold.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o In moving from the small intestines to the large intestines the pH goes from 7.5 to 5.5, which means the substance is moving to a more acidic environment. This means that the H+ concentration will increase.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Because the pH drops by 2 pH units, the H+ concentration increases by 10×10 or 10^2 or 100 fold.

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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 pH to calculate H+ concentration. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall that pH is a log scale? Did you recall that pH has a negative relationship to H+ concentration, so an increase in pH leads to a decrease in H+ concentration?

Section: 02.05
Topic: Water Molecules Can Dissociate into Ions
Learning Objective: 02.05.01 Calculate the pH of a solution based on the molar concentration of H.
Bloom's: 3. Apply
Gradable: automatic

23) Oxygen-16 is abundant and has 8 protons and 8 neutrons. Oxygen-18 is a(n) _____ of oxygen-16.
A) ion
B) isotope
C) isomer
D) dimer

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 2. Understand
Gradable: automatic

24) Which element's isotope is commonly used to determine when biological samples such as fossils, were formed?
A) oxygen
B) hydrogen
C) carbon
D) nitrogen
E) sulfur

Answer: C
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

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25) Atoms in which the number of electrons does not equal the number of protons are known as
A) valences.
B) ions.
C) isotopes.
D) isomers.

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
Bloom's: 1. Remember
Gradable: automatic

26) The area around a nucleus where an electron is most likely to be found is the
A) electrical space.
B) energy level.
C) polar space.
D) orbital.

Answer: D
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

27) Regardless of its shape, a given orbital may contain no more than
A) 1 electron.
B) 4 electrons.
C) 8 electrons.
D) 2 electrons.

Answer: D
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
Bloom's: 1. Remember
Gradable: automatic

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28) All atoms tend to fill their outer energy levels with the maximum number of electrons, usually eight. Depending on whether atoms satisfy the octet rule will predict
A) the chemical behavior of the atoms.
B) whether they will be found in nature.
C) whether they will dissolve in water.
D) their radioactive energy.

Answer: A
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
Bloom's: 2. Understand
Gradable: automatic

29) Mendeleev found that when he arranged the known elements according to their atomic mass, the entries in the table exhibited a pattern of chemical properties that repeated itself in groups of eight elements. This led to the generalization now known as
A) an atomic model.
B) valance electrons.
C) the periodic table.
D) the octet rule.

Answer: D
Section: 02.02
Topic: The Elements in Living Systems Have Low Atomic Masses
Learning Objective: 02.02.01 Relate the periodic table to the chemical reactivity of different elements.
Bloom's: 1. Remember
Gradable: automatic

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30) Sodium has 11 electrons arranged in three energy levels. In order to become stable, sodium forms an ion with
A) no charge.
B) –1 charge.
C) –8 charge.
D) +1 charge.
E) +8 charge.

Answer: D
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about predicting if an atom will form an ion.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of the structure of an atom to predict ion formation.
• ***What key words does the question contain and what do they mean?***
o Energy levels – the first level holds 2 electrons and each higher level holds 8 electrons.

Gather Content
• ***What do you know about the structure of atoms? How does it relate to the question?***
o If you make a diagram of the structure of a sodium atom there are 2 electrons in the first shell, 8 in the second shell and 1 in the outer (valence) shell.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o If there is one valence electron then the atom could lose that electron or gain 7 more to have a full outer shell.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o The atom will lose its single valence electron, losing a -1 charge carried by the electron. This will give the Na ion a +1 charge.

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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 structure of an atom to predict if it will form an ion. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you have trouble drawing the structure of a sodium ion? Did you recognize that the sodium atom would lose an electron to have a stable outer shell?

Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
Bloom's: 3. Apply
Gradable: automatic

31) In the crystal matrix of ordinary salt, the sodium and chlorine are held together by
A) peptide bonds.
B) covalent bonds.
C) ionic bonds.
D) hydrogen bonds.
E) nonpolar bonds.

Answer: C
Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.01 Explain how ionic bonds promote crystal formation.
Bloom's: 1. Remember
Gradable: automatic

32) Two carbon atoms joined to each other by the sharing of two pairs of electrons form a(n)
A) single bond.
B) ionic bond.
C) hydrogen bond.
D) double covalent bond.

Answer: D
Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.02 Explain how covalent bonds hold atoms together.
Bloom's: 1. Remember
Gradable: automatic

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33) In a chemical analysis of an animal tissue sample, which element would be in the least quantity?
A) carbon
B) hydrogen
C) nitrogen
D) oxygen
E) iodine

Answer: E
Section: 02.02
Topic: The Elements in Living Systems Have Low Atomic Masses
Learning Objective: 02.02.01 Relate the periodic table to the chemical reactivity of different elements.
Bloom's: 2. Understand
Gradable: automatic

34) Life is thought to have evolved from complex molecules formed by the interaction of smaller molecules in oceans and the atmosphere. The substance which brought these molecules together to interact is
A) hydrogen.
B) acids.
C) water.
D) buffers.
E) salts.

Answer: C
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.01 Explain how the structure of water leads to hydrogen bond formation.
Bloom's: 2. Understand
Gradable: automatic

35) Because oxygen is more electronegative than hydrogen, the water molecule is
A) hydrophobic.
B) hydrophilic.
C) nonpolar.
D) ionic.
E) polar.

Answer: E
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.01 Explain how the structure of water leads to hydrogen bond formation.
Bloom's: 1. Remember
Gradable: automatic

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36) Water molecules are attracted to each other due to the opposite charges created by partial charge separations within the molecules. These attractions are called
A) peptide bonds.
B) covalent bonds.
C) ionic bonds.
D) hydrogen bonds.
E) double bonds.

Answer: D
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.01 Explain how the structure of water leads to hydrogen bond formation.
Bloom's: 2. Understand
Gradable: automatic

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37) An oxygen atom in water has two covalent bonds with hydrogen atoms and two unpaired electrons. How many hydrogen bonds can a water molecule form?
A) 1
B) 2
C) 3
D) 4
E) 5

Answer: D
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the formation of hydrogen bonds in water.
• **W*hat type of thinking is required?*** You are being asked to apply your knowledge of the structure of water to predict the formation of hydrogen bonds.
• ***What key words does the question contain and what do they mean?***
o Hydrogen bonds – these are weak ionic interactions between a partial positive charge on one atom and partial negative charge on another atom.
o Water has the structure H-O-H

Gather Content
• ***What do you know about hydrogen bonds? How does it relate to the question?***
o Oxygen has a stronger attraction for electrons than hydrogen and ends up with two partial negative charges.
o Hydrogen has a weaker attraction for electrons than oxygen and ends up with a partial positive charge.
o Hydrogen bonds will form between the H atom on one water molecule and the O atom on a second water molecule.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Water has the structure H-O-H.
o Each H atom can form one hydrogen bond with an O atom on another water molecule.
o Each O atom can form hydrogen bonds with two H atoms on other water molecules.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Water can form hydrogen bonds with 4 water molecules. Two bonds will be through the H atoms and two through the O atom.

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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 structure of a water molecule to predict how many hydrogen bonds it can form. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Could you draw the structure of a water molecule? Could you identify which atoms would be involved in forming a hydrogen bond?

Section: 02.04

Topic: The Properties of Water Result from Its Polar Nature

Learning Objective: 02.04.01 Explain how the structure of water leads to hydrogen bond formation.

Bloom's: 3. Apply

Gradable: automatic

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38) Nitrogen has a higher electronegativity than hydrogen. As a result you would expect that ammonia (NH_3) molecules can form _____ with each other.

A) hydrogen bonds
B) hydrophilic bonds
C) ionic bonds
D) covalent bonds
E) cohesive bonds

Answer: A
Explanation:

Clarify Question

• ***What is the key concept addressed by the question?*** The question asks about electronegativity.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of electronegativity to predict what types of bonds a molecule could form.
• ***What key words does the question contain and what do they mean?***
o Electronegativity – the pull of an atom on an electron.

Gather Content

• ***What do you know about electronegativity? How does it relate to the question?***
o Nitrogen has a higher electronegativity than hydrogen. This means that the nitrogen atoms will have a partial negative charge and the hydrogen atoms will have a partial positive charge.

Consider Possibilities

• ***What other information is related to the question? Which information is most useful?***
o The partial charges on N and H atoms on adjacent NH_3 molecules will be attracted to each other.
o These are not covalent bonds which share electrons.
o These are partial charges, so they are not ionic bonds.
o Because these are charged they are hydrophilic and not hydrophobic.

Choose Answer

• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o The best answer is that the attraction through partial charges is a hydrogen bond between the N on one NH_3 and the H on another.

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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 structure of a molecule to predict some of its properties. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Could you draw the structure of an NH_3 molecule? Did you realize how hydrogen bonds form?

Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.01 Explain how the structure of water leads to hydrogen bond formation.
Bloom's: 3. Apply
Gradable: automatic

39) When water ionizes, it produces equal amounts of hydrogen and hydroxide ions that can reassociate with each other. The pH of water is: 5-9-2013

A) 3
B) 4
C) 5
D) 6
E) 7

Answer: E
Section: 02.05
Topic: Water Molecules Can Dissociate into Ions
Learning Objective: 02.05.01 Calculate the pH of a solution based on the molar concentration of H.
Bloom's: 1. Remember
Gradable: automatic

40) A scientist conducts a procedure that causes nitrogen atoms to gain neutrons. The resulting atoms will be

A) ions of nitrogen.
B) positively charged.
C) negatively charged.
D) isotopes of nitrogen.
E) new elements with higher atomic numbers.

Answer: D
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 2. Understand
Gradable: automatic

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41) The half-life of carbon-14 is approximately 5,700 years. Using this information scientists have been able to determine the age of some artifacts left by humans. A scientist wants to know approximately how old a piece of wood was that she found on the floor in an old cave that had recently been discovered. She removed the wood (with permission) to her laboratory. Her wood sample contained 2 grams of carbon-14. If the age of the wood was determined to be 22,800 years old, how much carbon-14 originally existed in this piece of wood?
A) 32 grams
B) 16 grams
C) 12 grams
D) 8 grams
E) 4 grams

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about radioactive.
• ***What type of thinking is required?*** You are being asked to analyze data on radioactive decay.
• ***What key words does the question contain and what do they mean?***
o Half-life – this is the amount of time in which half of a dose of radioactivity in a sample will be lost to decay.

Gather Content
• ***What do you know about half life? How does it relate to the question?***
o The first step is to figure out how many half-lives have occurred. $22{,}800 \div 5{,}700 = 4$.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o In 4 half-lives the amount of radiation will have been cut in half 4 times.
o $2 \times 2 \times 2 \times 2 = 2^4 = 16$, which means that the total amount of radiation will be decreased 16-fold.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o If 2 grams of Carbon-14 remain now and this represents the amount left after a 16-fold decrease, the original amount would be 2 grams × 16 = 32 grams.

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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 analyze radioactive decay data to calculate the amount of radioactive carbon in an initial sample. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall that the amount of sample could be cut in half with each decay? One common misconception is to think that 4 rounds of decay would decrease the radioactivity 4-fold. Each round cuts the amount of radioactivity in half, so this leads to a 16-fold decrease.

Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 4. Analyze
Gradable: automatic

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42) Plants transport water to their leaves through the xylem when water evaporates from the leaves. The evaporating water pulls other water molecules up the xylem through _____.
A) hydrogen bonds
B) ionic bonds
C) covalent bonds
D) hydrophobic interactions

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about attractive interactions between water molecules.
• ***What type of thinking is required?*** You are being asked to apply your knowledge about the properties of water.
• ***What key words does the question contain and what do they mean?***
o Ionic bonds – a full positive charge on one molecule attracted to a full negative charge on another
o Hydrophobic interactions – hydrophobic groups repel water and clump together
o Hydrogen bonds – a partial negative charge on one atom is attracted to a partial positive charge on a hydrogen atom
o Covalent bonds – sharing a pair of electrons between two atoms

Gather Content
• ***What do you know about the properties of water? How does it relate to the question?***
o Water is a polar molecule with partial negative charges on oxygen atoms and partial positive charges on hydrogen atoms.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Covalent bonds form between atoms within a molecule, the question refers to interactions between water molecules, so these cannot be covalent.
o Ionic bonds involve full charges, water has partial charges.
o Hydrophobic interactions are found in non-polar molecules, water is polar.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o The best answer is that hydrogen bonds form between water molecules. As one water molecule evaporates it pulls the next water molecule up, moving water through the xylem.

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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 principles of hydrogen bonding to the properties of water. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall the structure of water and types of bonds it forms?

Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.02 Distinguish adhesion from cohesion.
Bloom's: 3. Apply
Gradable: automatic

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43) Water is most dense and thus heaviest at 4°C. At 0°C, ice forms and can float on liquid water. Suppose ice were most dense at 0°C. What would happen in a lake at this temperature?
A) The ice would cover the surface of the aquatic system and would never melt.
B) The ice would cover the bottom of the aquatic system and would build up in layers over time.
C) Ice would not form because solids are always less dense than liquids.
D) The cold temperatures and the subsequent ice formation would prevent hydrogen bonds from forming between the water molecules, thus causing the existing ice crystals to become disassociated from each other.

Answer: B
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the properties of liquid water and ice.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of the relative densities of liquid water and ice to what happens in a lake in the winter.
• ***What key words does the question contain and what do they mean?***
o Density – this is the measure of mass/volume.

Gather Content
• ***What do you know about ice? How does it relate to the question?***
o Because ice has more rigid structure than liquid water it occupies more volume. Thus the same mass of liquid water and ice vary in their density. Because liquid water occupies less volume it has a larger density than ice. This is why ice floats on top of liquid water.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o With many molecules solids are denser than liquids. The question asks you to predict what would happen if ice was denser than liquid water.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o If ice were denser than water it would sink to the bottom of a lake during the winter. Over time the ice would fill in the lake from the bottom up, freezing everything in the lake.

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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 properties of water to predict what would happen if ice was denser than water. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you realize that if ice was denser than liquid water it would sink? The density would not affect the ability to form or break hydrogen bonds.

Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.05 Explain why ice floats.
Bloom's: 3. Apply
Gradable: automatic

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44) Your dog becomes ill and you rush him to the veterinarian's office. A technician draws blood from your dog's leg for a vet-ordered lab test. After a few minutes the lab results are given to the vet, who immediately grabs a bottle from a shelf and begins to fill a syringe with an unknown fluid. You inquire about the fluid, and the vet informs you that the fluid is necessary to manage your dog's metabolic acidosis. Based on the information provided, what is acidosis, and what is the likely effect of the veterinarian's injection?
A) Acidosis means that your dog's blood pH has dropped from its normal level, and an injection of saline is required to reverse the condition.
B) Acidosis means that your dog's blood pH has increased from its normal level, and an injection of saline is required to reverse the condition.
C) Acidosis means that your dog's blood pH has decreased from its normal level, and an injection of buffering solution is required to reverse the condition.
D) Acidosis means that your dog's blood pH has increased from its normal level, and an injection of buffering solution is required to reverse the condition.

Answer: C
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the treatment of acidosis.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of acids to explain how acidosis is treated.
• ***What key words does the question contain and what do they mean?***
  o Acidosis – this means that the blood is more acidic.
  o Buffers – these are used to adjust the pH of a solution.
  o Saline – this is a salt solution with the same osmolarity as blood.

Gather Content
• ***What do you know about acids and buffers? How does it relate to the question?***
  o Acids will lower the pH of a solution.
  o Buffers can be used to neutralize acids.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
  o Saline is a salt solution and will not affect pH.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
  o If your dog has acidosis then the pH of his blood is too low. A buffer will be used to neutralize the acid and raise the pH back to a healthy level.

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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 properties of a buffer to neutralize an acid. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall that acids will lower pH? Did you recall that buffers will neutralize a pH?

Section: 02.05
Topic: Water Molecules Can Dissociate into Ions
Learning Objective: 02.05.01 Calculate the pH of a solution based on the molar concentration of H.
Bloom's: 4. Analyze
Gradable: automatic

45) As you and a friend are entering a chemistry laboratory at your university, you see a sign that states: DANGER—RADIOACTIVE ISOTOPES IN USE. Your friend is an accounting major and has not had any science courses yet. She asks you what a radioactive isotope is and you respond correctly with

A) radioactive isotopes are atoms that are unstable and as a result emit energy in a process called radioactive decay.
B) radioactive isotopes are atoms that are stable and as a result emit energy in a process called radioactive decay.
C) radioactive isotopes are atoms that are stable and as a result only emit energy if they are exposed to higher temperatures.
D) radioactive isotopes are atoms that are unstable but unless actively disturbed by some chemical process will remain intact and pose no problems.

Answer: A
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 2. Understand
Gradable: automatic

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46) An effective way to increase the rate of the reaction A+B → C would be to
A) add more C.
B) decrease the temperature.
C) add more A or B.
D) remove the catalyst.

Answer: C
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?***
o The question asks about factors that affect the rate of a reaction.
• ***What type of thinking is required?***
o You are being asked to apply your knowledge of factors that affect the rate of a reaction.

Gather Content
• ***What do you know about factors that affect the rate of a reaction? What other information is related to the question***?
o If you want to increase the rate of a reaction, more of the reactants are added to increase the probability that they will interact and form a product. Enzymes catalyze reactions, making them go faster. Temperature can also increase the rate of a reaction.

Choose Answer
• ***Given what you now know, what information is most likely to produce the correct answer***?
o C is a product of the reaction, so increasing its concentration would slow down the reaction. Similarly removing an enzyme catalyst or decreasing the temperature would decrease the rate of the reaction.
Increasing the concentration of the reactants, A and B, would drive the reaction forward and increase the rate.

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 factors that affect the rate of a reaction. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that adding more of the product would increase the rate of the reaction? Did you realize that removing an enzyme catalyst or decreasing the temperature would slow down a reaction?
Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.05 Identify three factors that influence which chemical reactions occur within cells.
Bloom's: 3. Apply
Gradable: automatic

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47) The two nitrogen atoms in nitrogen gas (N_2) share six electrons forming a _____.
A) triple covalent bond
B) double covalent bond
C) single covalent bond
D) hydrogen bond
E) double bond

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the formation of covalent bonds.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of covalent bonds to predict how many bonds are present in N_2.
• ***What key words does the question contain and what do they mean?***
o Covalent bonds – two atoms share a pair of electrons to form a covalent bond.

Gather Content
• ***What do you know about covalent bonds? How does it relate to the question?***
o Two atoms share a pair of electrons to form a covalent bond.
o Atoms can form more than one covalent bond.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o If the two N atoms are sharing 6 electrons, and there are 2 electrons shared in one covalent bond, then there are $6 \div 2 = 3$ covalent bonds.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o There are 3 covalent bonds between the two N atoms in N_2.

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 structure of a covalent bond to predict the number formed in N_2. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you realize that a covalent bond contains 2 shared electrons? Did you realize that two atoms can have more than one covalent bond?
Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.02 Explain how covalent bonds hold atoms together.
Bloom's: 3. Apply
Gradable: automatic

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48) Capillary action is one of the forces that aids water's upward movement in plants. The narrower the diameter of the tube, the farther the water column will rise. Capillary action is a result of water molecules
A) storing heat and thus moving faster because of heat of vaporization.
B) producing sufficient surface tension to overcome the pull of gravity.
C) having a strong cohesive force and attaching to the surrounding vessel walls.
D) having an adhesive force, which allows them to attach to the vessel walls.
E) being associated with hydrophobic molecules, which can result in upward movement.

Answer: D
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.02 Distinguish adhesion from cohesion.
Bloom's: 2. Understand
Gradable: automatic

49) Which atomic particle has no charge and is located in the nucleus?
A) electron
B) ion
C) neutron
D) proton
E) isotope

Answer: C
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

50) The subatomic particle with a positive charge is _____.
A) an electron
B) an ion
C) a neutron
D) a proton
E) an isotope

Answer: D
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

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51) The smallest subatomic particle is the _____.
A) electron
B) ion
C) isotope
D) neutron
E) proton

Answer: A
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

52) An atom that is negatively charged because it has accepted an electron is a(n)
A) isomer.
B) ion.
C) isotope.
D) monomer.

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.02 Relate the arrangement of electrons in an atom to its chemical behavior.
Bloom's: 1. Remember
Gradable: automatic

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53) One mole of a substance contains 6.02 x 10^{23} molecules. The atomic number of Li is 3 and the atomic mass is approximately 7. If you have three moles of Li, how many grams does it weigh?
A) 9
B) 21
C) $7 \times 6.02 \times 10^{23}$
D) $3 \times 6.02 \times 10^{23}$

Answer: B
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about calculating the mass of 3 moles of Li.
• ***What type of thinking is required?*** You are being asked to apply the atomic mass of a compound to calculate the mass of 3 moles.
• ***What key words does the question contain and what do they mean?***
  o Atomic mass – the mass (grams) in one mole of an element
  o Atomic number – the number of protons in an atom
  o 6.02×10^{23} atoms/mole – this is Avagadro's number, and is universal for each atom.

Gather Content
• ***What do you know about converting from moles to mass? How does it relate to the question?***
  o If you have 3 moles of Li you want to multiply that by a factor with the units grams/mole so the moles cancel and you are left with grams.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
  o Atomic number has the units protons/atom and won't be useful in calculating grams.
  o Avagadro's number has the units atoms/mole and won't be useful in calculating grams.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
  o Atomic mass has the units grams/mole.
  o 3 moles of Li × 7 grams/mole = 21 grams of Li

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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 concept of moles and atomic mass to calculate the mass of 3 moles of Li. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall the units for atomic mass, atomic number, and Avagadro's number? Were you able to set up the calculation properly?

Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 4. Analyze
Gradable: automatic

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54) After taking your biology exam, you return to your car only to find that you had left the lights on and now the car battery is dead. Your friend offers to jump-start your car, but when you go to hook up the jumper cables you find that the battery terminals are covered with corrosion due to battery acid condensation. Based off your knowledge, what substance could be used to clean the corrosion?
A) coffee (pH of 5)
B) water (pH of 7)
C) vinegar (pH of 3)
D) baking soda (pH of 9)

Answer: D
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about pH.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of pH to neutralize an acid.
• ***What key words does the question contain and what do they mean?***
o Acids have a pH less than 7.
o Bases have a pH greater than 7

Gather Content
• ***What do you know about acids? How does it relate to the question?***
o Acids have a pH less than 7, to neutralize the acid you want to use a base with a pH greater than 7.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Water is neutral (pH 7) and will not neutralize an acid.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o The only base on the list of answers is baking soda (pH 9). Adding a base with a high pH will neutralize an acid with a low pH.

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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 an acid to neutralize an acid. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall that acids have a low pH? Did you realize that a base with a high pH would neutralize an acid?

Section: 02.05
Topic: Water Molecules Can Dissociate into Ions
Learning Objective: 02.05.01 Calculate the pH of a solution based on the molar concentration of H.
Bloom's: 3. Apply
Gradable: automatic

55) The amino acid glycine ($C_3NO_2H_6$) is a(n):

A) organic molecule
B) inorganic molecule
C) element
D) vitamin

Answer: A
Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.02 Explain how covalent bonds hold atoms together.
Bloom's: 2. Understand
Gradable: automatic

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56) Consider the following electronegativity values:
Boron (B) = 1.8
Carbon (C) = 2.5
Chlorine (Cl) = 3.2
Selenium (Se) = 2.6
Which of the following bonds is the most polar?
A) B-Cl
B) C-Cl
C) Se-Cl
D) cannot determine from the information provided

Answer: A
Explanation:

Clarify Question
• **What is the key concept addressed by the question?** The question asks about the link between electronegativity and polar bonds.
• **What type of thinking is required?** You are being asked to analyze the relative electronegativities of two atoms in a bond to predict which would be the most polar.
• **What key words does the question contain and what do they mean?**
o Electronegativity – the attraction of an atom for an electron.
o Polar bond – a covalent bond in which the electrons are not shared equally.

Gather Content
• **What do you know about polar bonds? How does it relate to the question?**
o The greater the difference in electronegativity between two atoms in a covalent bond the more polar the bond will be.

Consider Possibilities
• **What other information is related to the question? Which information is most useful?**
o To calculate the relative polarity of the bonds, simply subtract the electronegativities of each atom in the bond.

Choose Answer
• **Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?**
o Se-Cl; 3.2-2.6 = 0.6
o C-Cl; 3.2-2.5 = 0.7
o B-Cl; 3.2-1.8 = 1.4
o The largest difference is between B and Cl, so the B-Cl bond will be the most polar with Cl pulling the electrons away from B.

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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 electronegativity to predict the polarity of a covalent bond. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you know what electronegativity and polar bonds were? Did you know to compare the difference in electronegativity between the two atoms to determine the polarity of the bond?

Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.02 Explain how covalent bonds hold atoms together.
Bloom's: 3. Apply
Gradable: automatic

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57) The reaction ($H_2 + F_2 \rightarrow 2HF$) is an example of a redox reaction. In reality, two half reactions are occurring. The half reaction ($H_2 \rightarrow 2H^+ + 2e^-$) is a(n)
A) reduction reaction.
B) oxidation reaction.
C) redox reaction.
D) potential energy reaction.

Answer: B
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about redox reactions.
• ***What type of thinking is required?*** You are being asked to apply the definition of reactions that lose an electron.
• ***What key words does the question contain and what do they mean?***
o Redox reaction – contains an oxidation and a reduction reaction.
o Oxidation – loss of an electron
o Reduction – gain of an electron (the charge of the atom or molecule gaining the electron is reduced)

Gather Content
• ***What do you know about redox reactions? How does it relate to the question?***
o In a redox reaction electron(s) are transferred from one atom or molecule to another.
o This is made up of an oxidation half reaction where the electrons are lost by one reactant, and a reduction half reaction where the electrons are gained by the second reactant.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o In the half reaction $H_2 \rightarrow 2H^+ + 2e^-$, H2 is losing 2 electrons

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Because H_2 is losing 2 electrons this is an oxidation half reaction.
o This would be balanced by the reduction half reaction $F_2 + 2e^- \rightarrow 2F^-$
o Finally the $2H^+ + 2F^- \rightarrow 2HF$
o Putting this all together you get the reaction: $H_2 + F_2 \rightarrow 2HF$

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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 an oxidation reaction. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you have trouble recognizing that an oxidation half reaction was being shown? Did the mention of a redox reaction confuse the problem for you?

Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.03 Explain how energy is quantized in atoms.
Bloom's: 3. Apply
Gradable: automatic

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58) The electronic configuration of the noble gas neon, which has an atomic number of 10, can be written as follows: $1s^2 2s^2 2p^6$. What is the electronic configuration of the noble gas argon, which has an atomic number of 18?
A) $1s^2 2s^2 3p^6 4s^2 5p^6$
B) $1s^2 2s^6 2p^2 3s^6 3p^2$
C) $1s^2 2s^2 2p^6 3s^2 3p^6$
D) $1s^2 2s^8 3p^8$

Answer: C
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the configuration of electrons in an atom.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of electron configuration to create one for Argon.
• ***What key words does the question contain and what do they mean?***
o Electron configuration – the occupancy of electrons in different shells.
o Atomic number – number of protons in an atom, and thus also the number of electrons.

Gather Content
• ***What do you know about electron configuration? How does it relate to the question?***
o The first shell contains 2 electrons in an "s" orbital. A full first shell is represented $1s^2$.
o The next shells each contain 8 electrons, 2 electrons in an "s" orbital and 6 electrons in a "p" orbital. A full second shell is represented $2s^2 2p^6$.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Argon has an atomic number 18 and Neon is 10. Thus Argon has 8 more electrons than Neon, which adds one more shell.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Adding a third shell to Neon will add 8 more electrons, 2 electrons in an "s" orbital and 6 electrons in a "p" orbital.
o Following the same numbering as with Neon this would add $2s^2 2p^6$.
o The complete electron configuration for Argon will be $1s^2 2s^2 2p^6 3s^2 3p^6$.

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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 orbitals of electrons in an atom to write an electron configuration. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you have trouble understanding what was being represented in the numbering system of an electron configuration? Did you realize that the 8 electrons in shells 2 and 3 were split between "s" and "p" orbitals.

Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.03 Explain how energy is quantized in atoms.
Bloom's: 3. Apply
Gradable: automatic

59) You identify an enzyme involved in a cellular reaction. How does the enzyme affect the reaction equilibrium between reactants and products and the time needed to reach equilibrium?
A) It alters the reaction equilibrium and shortens the time needed to reach equilibrium.
B) The reaction equilibrium is unaffected, but it shortens the time needed to reach equilibrium.
C) It alters the reaction equilibrium and lengthens the time needed to reach equilibrium.
D) The reaction equilibrium is unaffected, but it lengthens the time needed to reach equilibrium.

Answer: B
Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.05 Identify three factors that influence which chemical reactions occur within cells.
Bloom's: 2. Understand
Gradable: automatic

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60) You walk down into your basement to find that the carpeting on the floor is damp. Concerned, you look around for large puddles of water or broken pipes, but find none. In fact, only the basement floor and carpeting is damp. You realize that water must have wicked into the carpet from the floor by _____.
A) adhesion and cohesion
B) adhesion and solubility
C) adhesion, cohesion, and solubility
D) cohesion and solubility

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about properties of water.
• ***What type of thinking is required?*** You are being asked to apply your understanding of properties of water to explain an observation.
• ***What key words does the question contain and what do they mean?***
o Wicked – this means the water moved upwards, in this case from the floor to the carpet

Gather Content
• ***What do you know about properties of water? How does it relate to the question?***
o Water is a polar molecule that forms hydrogen bonds with other water molecules and polar compounds. This allows water to move upwards by wicking.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Adhesion – water sticking to other molecules through hydrogen bonds.
o Cohesion – water molecules sticking to each other.
o Solubility – substances dissolving in water.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Both adhesion and cohesion will allow water molecules to bind to polar molecules in the carpet and wick upwards from the floor.

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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 properties of water to explain wicking. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall the definitions of adhesion, cohesion, and solubility?

Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.02 Distinguish adhesion from cohesion.
Bloom's: 3. Apply
Gradable: automatic

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61) You recently discovered a new element and find that this particular element has one electron in its outer energy level. What would you expect will happen to an atom of this element if placed in water?
A) It will lose an electron forming a positive ion.
B) It will lose an electron forming a negative ion.
C) It will gain an electron forming a positive ion.
D) It will gain an electron forming a negative ion.

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the formation of ions.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of electron energy levels to the formation of ions.
• ***What key words does the question contain and what do they mean?***
o Outer energy level – an atom is most stable when it's outer energy level is full.

Gather Content
• ***What do you know about ions? How does it relate to the question?***
o To be most stable, an atom may gain or lose electrons to end up with a full outer shell of electrons.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o This atom has one extra electron in its outer shell.
o If it gains an electron it will still have a partially full shell (2 electrons).
o If the atom loses an electron it will have a full outer shell (8 electrons).

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Losing an electron will give the atom a full outer shell.
o Because an electron has a -1 charge, losing the electron will give the atom a +1 charge, forming a positive ion.

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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 structure of an atom to predict the formation of an ion. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you realize that the atom would be most stable if it lost an electron? Did you recognize that losing an electron would lead to the formation of a positively charged ion?

Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.01 Explain how ionic bonds promote crystal formation.
Bloom's: 3. Apply
Gradable: automatic

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62) Sulfur is found directly below oxygen on the periodic table. What type of bond would you predict S-H would form?
A) polar covalent
B) ionic
C) hydrogen bond
D) nonpolar covalent bond

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?***
o The question asks about the properties of atoms based on their location in the periodic table.
• ***What type of thinking is required?***
o You are being asked to apply your knowledge of the properties of atoms based on their location in the periodic table.

Gather Content
• ***What do you know about the properties of atoms based on their location in the periodic table? What other information is related to the question?***
o When one atom like oxygen has a higher attraction for electrons (electronegativity) than another atom like hydrogen sharing the electrons in a covalent bond, the electrons spend more time closer to the atom with the higher electronegativity. This causes a partial positive charge on the atom with a lower electronegativity and a partial negative charge on the atom with a higher electronegativity. This causes the covalent bond to have polarity.
o In an O-H bond, oxygen has a partial negative charge and hydrogen a partial positive charge. S is right below O on the periodic table, so it will have a similar electronegativity.

Choose Answer
• ***Given what you now know, what information is most likely to produce the correct answer?***
o A hydrogen bond is not a covalent bond between two ions, but relies on the attraction between two polar covalent bonds. Ionic interactions occur when two ions are attracted to each other. A covalent bond in which the electrons are shared equally is a non-polar covalent bond.
o An S-H bond will be similar to an O-H bond and will be a polar covalent bond.

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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 the properties of atoms based on their location in the periodic table. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall that S would have similar properties to O because of its location on the periodic table? Did you understand that and O-H bond would be a polar covalent bond?

Section: 02.02
Topic: The Elements in Living Systems Have Low Atomic Masses
Learning Objective: 02.02.01 Relate the periodic table to the chemical reactivity of different elements.
Bloom's: 3. Apply
Gradable: automatic

63) Why is it necessary to take special safety precautions when using radioactivity?
A) Radioactive substances will ionize cells.
B) Radioactive substances have the potential to cause damage to living cells.
C) Radioactive substances decay.
D) Radioactive substances will perforate plasma membranes.

Answer: B
Section: 02.01
Topic: All Matter Is Composed of Atoms
Learning Objective: 02.01.01 Describe the structure of the Bohr atom.
Bloom's: 1. Remember
Gradable: automatic

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64) The high heat of vaporization of water helps you to feel cooler when you sweat because the transition of water from a liquid to a gas requires a _____ of energy to break hydrogen bonds. The energy is _____ from heat produced by your body, thus helping to lower the surface temperature of your body.
A) release; released
B) release; obtained
C) input; obtained
D) input; released

Answer: C
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?***
o The question asks about evaporation of water.
• ***What type of thinking is required?***
o You are being asked to apply your knowledge of evaporation of water.

Gather Content
• ***What do you know about evaporation of water? What other information is related to the question?***
o Water molecules are attracted to each other by hydrogen bonds, with the partial negative charge on one water molecule being attracted to the partial positive charge on the hydrogen in a neighboring water molecule. To overcome this attraction heat is needed to break these hydrogen bonds and allow a water molecule to move from being a liquid to being a gas.

Choose Answer
• ***Given what you now know, what information is most likely to produce the correct answer***?
o Because of hydrogen bonding between water molecules, more heat is required to convert the water into a gas. This means that more heat is released from your body as you sweat.
o Based on this logic, more heat is input into water and is obtained from your body leading to cooling.

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 evaporation. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you think that when water goes from a liquid to a gas it would release heat? Did you think that heat would be delivered to your body as your sweat evaporated from your skin?
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.04 Explain why sweating cools.
Bloom's: 3. Apply
Gradable: automatic

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65) Salt is often used to melt ice on roads during the winter because it lowers the freezing/melting point of water. When salt dissolves in water, individual Na^+ and Cl^- ions break away from the salt lattice and become surrounded by water molecules. Why would this cause ice to melt?
A) Hydrogen bonds are broken, and the salt ions interfere with interactions between H and O. As a result, it is more difficult for water molecules to bond and form ice.
B) Hydrogen bonds are formed, and the salt ions bond with O. As a result, it is more difficulty for water molecules to bond and form ice.
C) Hydrogen bonds are broken, and the salt ions bond with O and H respectively. As a result, it is more difficult for water molecules to bond and form ice.

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about how salt would prevent ice from forming.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of the properties of water to explain how salt melts ice.
• ***What key words does the question contain and what do they mean?***
o Freezing point – the temperature below which water molecules hydrogen bond to each other in a solid lattice commonly known as ice

Gather Content
• ***What do you know about ice? How does it relate to the question?***
o Ice forms because the water molecules are in a 3-dimensional lattice with each water molecule hydrogen bonded to 4 other water molecules.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o When salt dissolves in water the NaCl dissociates into Na^+ and Cl^- ions. Each of these ions interact with water molecules. The Na^+ will be attracted to the partial negative charge on O in water and the Cl^- ions will be attracted to the partial positive charge on H in water.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Because the Na^+ and Cl^- ions interact with water molecules through the partial charges on water, these interfere with the ability of water molecules to hydrogen bond with each other.
o Because water molecules can no longer form hydrogen bonds with each other, they cannot form a lattice and ice does not form.

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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 properties of water to explain why salt melts ice. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you realize that ice forms because of hydrogen bonding between water molecules? Did you understand that salt ions interfere with this hydrogen bonding, reducing water's ability to form ice?

Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.06 Explain why salt dissolves in water.
Bloom's: 3. Apply
Gradable: automatic

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66) A chemist adds a chemical to pure water and there is a 100-fold increase in the concentration of hydrogen ions. What is the best approximation of the new pH value?
A) 0
B) 5
C) 7
D) 9
E) 14

Answer: B
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the relationship between pH and hydrogen ion concentration.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of pH to predict what would happen to water when the hydrogen ion concentration is increased.
• ***What key words does the question contain and what do they mean?***
o pH – this is the –log[H+]

Gather Content
• **What do you know about pH? How does it relate to the question?**
o Because pH is the –log[H+] as the H+ concentration goes up the pH goes down.
o Because it is a log scale, each 10-fold change in H+ concentration is a change in pH of 1.
o In this case a 100-fold increase in H+ concentration would lead to a decrease in pH of 2.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Next we need to figure out what the pH was before the chemical was added to water. Pure water has a pH of 7.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Pure water has a pH of 7 and the chemical dropped the pH by 2, so the new pH will be about 5.

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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 pH to predict what would happen if a chemical was added that raised the H+ concentration. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you have trouble using the equation of pH? Did you recall that this was a negative log relationship between pH and H+ concentration, so the pH decreased? Did you recall that the pH of water is 7?

Section: 02.05

Topic: Water Molecules Can Dissociate into Ions

Learning Objective: 02.05.01 Calculate the pH of a solution based on the molar concentration of H.

Bloom's: 3. Apply

Gradable: automatic

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67) The electronegativity of nitrogen (N) is 3.0, while the electronegativity of hydrogen (H) is 2.1. Knowing this, consider how the electrons will be shared in ammonia (NH_3). What do you predict about the polarity of ammonia?
A) Each H atom has a partial positive charge.
B) The N atom has a partial positive charge.
C) Each H atom has a partial negative charge.
D) The N atom has a strong positive charge.

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about electronegativity.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of electronegativity to predict the effect on the partial charge of an atom.
• ***What key words does the question contain and what do they mean?***
o Electronegativity – the attraction of an atom for an electron.
o Partial charges – if two atoms in a covalent bond have different attractions for an electron this is called a polar covalent bond.
o The atom with the stronger attraction will have a partial negative charge and the atom with the weaker attraction will have a partial positive charge.

Gather Content
• ***What do you know about electronegativity? How does it relate to the question?***
o The electronegativity of N is 3.0 and that of H is 2.1.
o N has a stronger attraction for the electrons in its covalent bond with H.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Because electrons have a negative charge, the N will have a partial negative charge.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Based on the same logic, each H atom will have a partial positive charge as the electrons are pulled towards N.

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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 electronegativity to predict the partial charges on atoms in a polar covalent bond. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recognize that the higher electronegativity on N meant it had more attraction for electrons than H? Did you realize that a stronger pull for electrons gave N a partial negative charge, while this led to a partial positive charge on each H?

Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.02 Explain how covalent bonds hold atoms together.
Bloom's: 3. Apply
Gradable: automatic

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68) Magnesium chloride is a salt formed with ionic bonds between one magnesium ion and two chloride ions. Magnesium has two electrons in its outer shell and chlorine has seven electrons in its outer shell. How are the electrons transferred between these atoms?
A) Both magnesium and chlorine are reduced.
B) Both magnesium and chlorine are oxidized.
C) Chlorine is oxidized and magnesium is reduced.
D) Magnesium is oxidized and chlorine is reduced.

Answer: D
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about reduction and oxidations.
• ***What type of thinking is required?*** You are being asked to apply your knowledge to the formation of ions through reduction and oxidation.
• ***What key words does the question contain and what do they mean?***
o Outer shell of electrons – an atom is most stable with a full outer shell of electrons. It can obtain this by gaining or losing electrons.

Gather Content
• ***What do you know about oxidations and reductions? How does it relate to the question?***
o If an atom loses an electron it becomes oxidized and forms a positive charge.
o If an atom gains an electron it becomes reduced and forms a negative charge.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Mg has 2 extra electrons in its outer shell, so it will be most stable losing two electrons.
o Cl has 7 electrons in its outer shell, so it will be most stable gaining one electron.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Mg will lose two electrons, forming Mg^{2+} and be oxidized in the process.
o Cl will gain one electron, forming Cl^{-} and be reduced in the process.

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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 structure of an atom to predict if it would become reduced or oxidized in forming an ion. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you realize that Mg would lose electrons and Cl would gain them? Did you remember that oxidations lose electrons and reductions gain electrons?

Section: 02.01
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.01.03 Explain how energy is quantized in atoms.
Bloom's: 3. Apply
Gradable: automatic

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69) The carbonic acid and bicarbonate buffer in blood is extremely important to help maintain homeostasis. What would happen to the pH of the blood if bicarbonate were removed?
A) Removing bicarbonate from the blood would increase the pH.
B) Removing bicarbonate from the blood would decrease the pH.
C) Removing bicarbonate from the blood would not affect the pH.

Answer: B
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about buffers.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of buffers to predict what would happen if a base was removed.
• ***What key words does the question contain and what do they mean?***
o Carbonic acid – this is the acid of the buffer.
o Bicarbonate – this is the base of the buffer.

Gather Content
• ***What do you know about buffers? How does it relate to the question?***
o Buffers contain an acid and its complementary base.
o Acids lower the pH of a solution and bases raise the pH.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o If the bicarbonate was removed from the solution all that would be left is the carbonic acid.

Choose Answer

• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o Acids lower the pH of a solution, so the pH of blood would drop.

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 a buffer to determine what would happen if the base was removed. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you realize that bicarbonate was the base in the problem? One clue was that carbonic acid had to be the acid, based on its name. Did you recall that acids lower the pH and bases raise the pH?
Section: 02.05
Topic: Water Molecules Can Dissociate into Ions
Learning Objective: 02.05.01 Calculate the pH of a solution based on the molar concentration of H.
Bloom's: 3. Apply
Gradable: automatic

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70) The common basilisk lizard will run across water on its hind legs in an erect position when startled by predators. This lizard has large feet and flaps of skin along its toes. What properties of water allow this lizard to walk on water?
A) Hydrogen bonds absorb heat when they break and release heat when they form. This helps to minimize temperature changes.
B) The surface tension created by hydrogen bonds is greater than the weight of the lizard initially.
C) Polar molecules are attracted to ions and polar compounds, making these compounds soluble.
D) Hydrogen bonds hold water molecules together; many hydrogen bonds must be broken for water to evaporate.

Answer: B
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.02 Distinguish adhesion from cohesion.
Bloom's: 2. Understand
Gradable: automatic

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71) Cl has 7 electrons in its outer shell and K has 1 electron in its outer shell. How is the bond in Cl_2 different from the bond in KCl?

A) Cl_2 is covalent and KCl is ionic.

B) Cl_2 and KCl are both ionic.

C) Cl_2 is ionic and KCl is covalent.

Answer: A
Explanation:

Clarify Question

• ***What is the key concept addressed by the question?***

o The question asks about differences between covalent and ionic bonds.

• ***What type of thinking is required?***

o You are being asked to apply your knowledge of differences between covalent and ionic bonds.

Gather Content

• ***What do you know about differences between covalent and ionic bonds? What other information is related to the question?***

o In an ionic bond, atoms gain or lose electrons to form a stable outer shell forming either negative or positive ions respectively. In a covalent bond, two atoms share a pair of electrons filling their outer shells.

Choose Answer

• ***Given what you now know, what information is most likely to produce the correct answer?***

o Cl has 7 electrons in its outer shell. If it gains one electron it will form a Cl- ion. K has 1 electron in its outer shell, so if it loses one electron it will form a K+ ion. The Cl- and K+ ions will be attracted to each other through an ionic bond.

o In Cl, 6 of the electrons in the outer shell form pairs, leaving one unpaired electron. If two Cl atoms share their unpaired electrons, that gives each atom a total of 8 electrons in their outer shell and forms 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 your understanding of differences between covalent and ionic bonds. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you confuse covalent and ionic bonds? Did you understand that covalent bonds were formed by sharing electrons while ionic bonds were formed when atoms gained or lost electrons?

Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.01 Explain how ionic bonds promote crystal formation.
Bloom's: 3. Apply
Gradable: automatic

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72) Carbon has four valence electrons and oxygen has six. Carbon dioxide would contain _____.
A) one single covalent bond
B) four hydrogen bonds
C) two double covalent bonds
D) two single covalent bonds

Answer: C
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the formation of covalent bonds.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of the structure of atoms to predict how many covalent bonds carbon dioxide could form.
• ***What key words does the question contain and what do they mean?***
o Valence electrons – these are the electrons in the outer shell of an atom.

Gather Content
• ***What do you know about covalent bonds? How does it relate to the question?***
o Typically an atom is most stable if it has a full outer shell. This can be accomplished by gaining, losing, or sharing electrons. When two electrons are shared between two atoms this forms a covalent bond.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o The name carbon dioxide indicates that there are one carbon atom and two oxygen atoms in this molecule.
o Carbon has 4 valence electrons, so it needs to share 4 more electrons to get a full outer shell. This means it can form 4 covalent bonds.
o Oxygen has 6 valence electrons, so it needs to share 2 more electrons to get a full outer shell. This means each oxygen atom can form 2 covalent bonds

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o The carbon atom can form a double bond with each of the oxygen atoms. That will give the carbon atom 4 bonds and each oxygen atom 2 bonds needed to fill their outer shells. The structure O=C=O would thus contain two double covalent bonds.

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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 structure of an atom to predict how many bonds would form in carbon dioxide. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you have trouble figuring out how many bonds carbon and oxygen each needed to form to be stable? Were you confused on whether all of the bonds were between C and O or did you try to make some O-O bonds?

Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.02 Explain how covalent bonds hold atoms together.
Bloom's: 3. Apply
Gradable: automatic

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73) If water were nonpolar it would not form hydrogen bonds. At normal room temperatures this nonpolar water would be _____.
A) a gas
B) a liquid
C) a solid

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?***
o The question asks about vaporization of water.
• ***What type of thinking is required?***
o You are being asked to apply your knowledge of the vaporization of water.

Gather Content
• ***What do you know about the vaporization of water? What other information is related to the question?***
o Hydrogen bonds between polar water molecules cause attractions that make it harder for a single water molecule to move from liquid to a gas. Other molecules like carbon dioxide (CO_2) and oxygen (O_2) are about the same size as water, but cannot form hydrogen bonds and these molecules are gasses at room temperature.

Choose Answer
• ***Given what you now know, what information is most likely to produce the correct answer?***
o If water was non-polar, the molecules would not be attracted to each other and water would be a gas instead of a liquid at room temperature.

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 the vaporization of water. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you recall that hydrogen bonds cause water molecules to be attracted to each other and form a liquid? Did you think that a lack of hydrogen bonds would make water become a solid instead of a gas?
Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.01 Explain how the structure of water leads to hydrogen bond formation.
Bloom's: 3. Apply
Gradable: automatic

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74) Proteins are three dimensional molecules made of strands of amino acids (imagine a ball of string). There are 20 different amino acids used in proteins found in living organisms. Some of these amino acids are polar and others are nonpolar. Where would a series of nonpolar amino acids most likely be located in a protein that is found in the cytosol of an animal cell?
A) on the surface of the protein
B) in the interior of the protein
C) at the very top of the protein
D) at the very bottom of the protein

Answer: B
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about non-polar amino acids.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of polarity to predict how this would affect the structure of a protein.
• ***What key words does the question contain and what do they mean?***
o Polar – these are molecules in which electrons are not shared equally between atoms, leading to partial charges on the atoms.
o Non-polar – these are molecules in which electrons are shared equally between atoms, leading to no partial charges.

Gather Content
• ***What do you know about non-polar molecules? How does it relate to the question?***
o Non-polar molecules do not interact well with water, which is a polar molecule. These non-polar molecules actually interfere with the formation of hydrogen bonds between water molecules.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o The inside of an animal cell contains cytoplasm which is made up of a lot of water. Thus the inside of the cell is a polar environment.
o Non-polar amino acids in the inside of a cell do not interact well with the water and are repelled by the water.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o The repulsion of non-polar amino acids by water will cause them to cluster in the center of the protein where they are shielded from water. This is why most proteins are ball shaped, with the non-polar or hydrophobic amino acids in the center of the ball.

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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 polar and non-polar definitions to predict the structure of a protein. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you understand the difference between polar and non-polar amino acids? Did you realize that the inside of the cell would be a polar environment? Did you know that non-polar groups will cluster near each other to be shielded from water?

Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.07 Explain why oil will not dissolve in water.
Bloom's: 3. Apply
Gradable: automatic

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75) According to most car mechanics, plain water is the best coolant to use in an engine provided the engine is not being exposed to freezing temperatures. If the car is subject to freezing temperatures, then a mixture of water and ethylene glycol (antifreeze) is recommended, but it does not cool as efficiently as plain water. Why would ethylene glycol reduce the cooling efficiency of water?
A) Ethylene glycol has a lower heat capacity than water.
B) Ethylene glycol has a higher heat capacity than water.
C) Hydrogen bonds in water allow high levels of heat absorption and a large increase in temperature.
D) Ethylene glycol raises the freezing point of water.

Answer: A
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about the ability of water to absorb heat.
• ***What type of thinking is required?*** You are being asked to apply your understanding of the properties of water to explain the effect of adding antifreeze.
• ***What key words does the question contain and what do they mean?***
o Cooling efficiency – this is a measure of how well a solution can absorb heat.

Gather Content
• ***What do you know about the properties of water? How does it relate to the question?***
o Water has a very high heat capacity. This means that it can absorb a lot of heat.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o Adding ethylene glycol decreases the cooling efficiency of the water in the radiator. This is done to lower the freezing point of water, which keeps the radiator from freezing solid in the winter.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o The ethylene glycol has a lower heat capacity than water, so adding ethylene glycol to the radiator decreases the amount of heat that the water can absorb.

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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 properties of water to explain the ability of water to absorb heat. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you realize that the property of water relevant to cooling efficiency was its heat capacity? Did you recognize that the question was not asking about changes in the freezing point?

Section: 02.04
Topic: The Properties of Water Result from Its Polar Nature
Learning Objective: 02.04.03 Explain why water heats up so slowly.
Bloom's: 3. Apply
Gradable: automatic

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76) Dennis had a history of heart disease in his family and was reducing his intake of saturated fats. Saturated means each carbon atom is bonded to as many hydrogen atoms as it can accept. If a carbon were bonded to two carbons, how many hydrogens could it accept?
A) 0
B) 1
C) 2
D) 3
E) 4

Answer: C
Explanation:

Clarify Question
• ***What is the key concept addressed by the question?*** The question asks about forming covalent bonds.
• ***What type of thinking is required?*** You are being asked to apply your knowledge of the structure of an atom to predict how many bonds it can form.
• ***What key words does the question contain and what do they mean?***
o Saturated fat – these fats have a backbone of C-C bonds with as many C-H bonds as possible.

Gather Content
• ***What do you know about covalent bonds? How does it relate to the question?***
o Carbon has 4 valence electrons, and needs to share an additional 4 electrons to have a full outer shell. This means it needs to form 4 covalent bonds.

Consider Possibilities
• ***What other information is related to the question? Which information is most useful?***
o In a saturated fat there is a backbone of C atoms attached by covalent bonds giving a structure like: -C-C-C-
o These covalent bonds provide 2 additional electrons, leaving a need for 2 more for carbon to have a full outer shell.

Choose Answer
• ***Given what you now know, what information and/or problem solving approach is most likely to produce the correct answer?***
o To obtain the remaining 2 electrons, each C atom forms covalent bonds with two H atoms.

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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 structure of an atom to predict how many bonds would form in a saturated fat. If you got the correct answer, great job! If you got an incorrect answer, where did the process break down? Did you understand what was meant by a saturated fat? Could you figure out how many total covalent bonds each C atom would form?

Section: 02.03
Topic: Molecules Are Collections of Atoms Held Together by Chemical Bonds
Learning Objective: 02.03.02 Explain how covalent bonds hold atoms together.
Bloom's: 3. Apply
Gradable: automatic

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