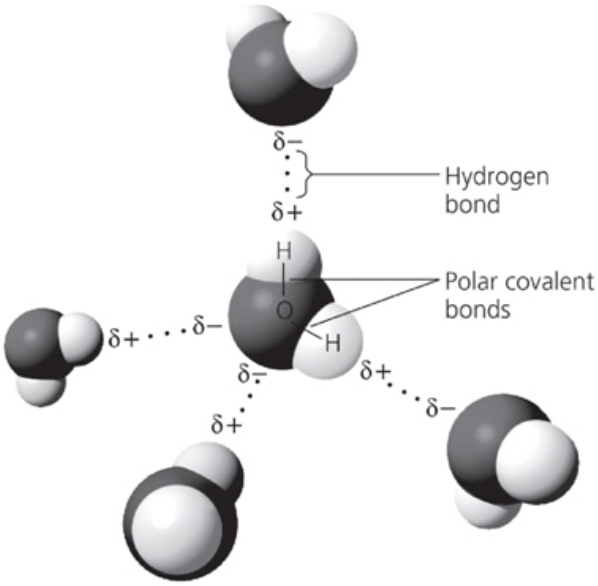
Ch. 3 Assessment

Due: 8:30am on Monday, September 9, 2024

To understand how points are awarded, read the Grading Policy for this assignment.

AP Exam Prep Question 1

Part A



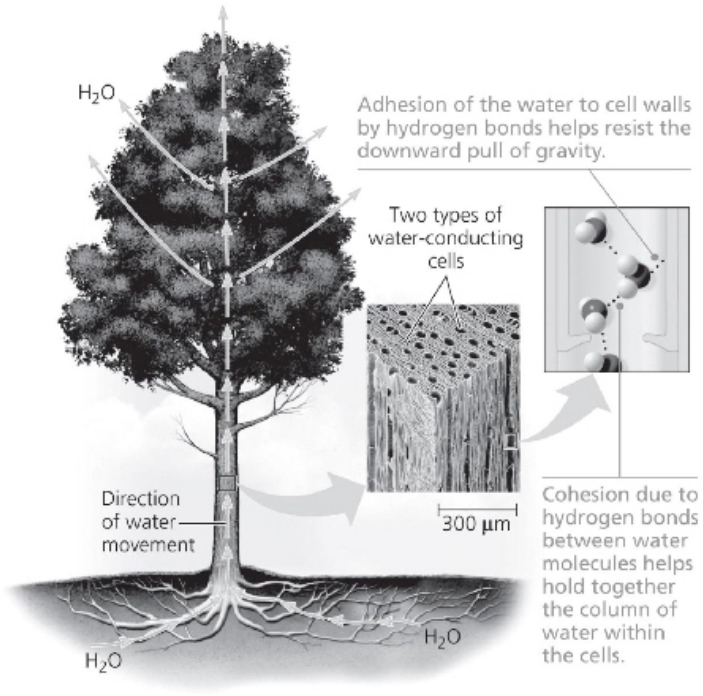
If each of the water molecules in the diagram had all of its potential hydrogen bonding sites filled, like the water molecule in the center of the diagram, what would be the total number of water molecules represented?

ANSWER:

- 5
- 20
- 8
- 17

AP Exam Prep Question 2

Part A



The water molecules in the diagram are attracted to the cell walls of water-conducting cells by adhesion due to hydrogen bonds. What conclusion is supported by this information?

ANSWER:

- Cell walls of plants contain molecular grooves that physically hold the water molecule.
- Cell walls of plants are composed of non-polar molecules.
- Cell walls of plants contain oxygen and/or nitrogen and are therefore polar.
- Cell walls of plants are formed from the products of photosynthesis.

AP Exam Prep Question 3

Part A

The loss of water from a plant by transpiration cools the leaf. Movement of water in transpiration requires both adhesion to the conducting walls and wood fibers of the plant and cohesion of the molecules to each other. A scientist wanted to increase the rate of transpiration of a crop species to extend its range into warmer climates. The scientist substituted a nonpolar solution with an atomic mass similar to that of water for hydrating the plants. What do you expect the scientist's data will indicate from this experiment?

ANSWER:

- The rate of transpiration will be slightly lower with the nonpolar substance as the plant will not have evolved with the nonpolar compound.
- The rate of transpiration will be the same for both water and the nonpolar substance.
- Transpiration rates will increase as nonpolar compounds undergo adhesion and cohesion with wood fibers more readily than water.
- Transpiration rates will fall to zero as nonpolar compounds do not have the properties necessary for adhesion and cohesion.

AP Exam Prep Question 4

Part A

In living systems molecules involved in hydrogen bonding almost always contain either oxygen or nitrogen or both. How do you explain this phenomenon?

ANSWER:

- Oxygen and nitrogen are elements found in fats and carbohydrates.
- Oxygen and nitrogen are elements found in both nucleic acids and proteins.
- Oxygen and nitrogen are elements with very high attractions for their electrons.
- Oxygen and nitrogen were both components of gases that made up the early atmosphere on Earth.

Science in the Classroom: Take the Heat

Effectively navigating and understanding primary literature is an important step in your journey as a scientist. Primary literature is where scientists share their work with other scientists and contribute new findings to their field. What makes primary literature different from other sources, like magazines or news web sites, is that it is peer reviewed, which means that other scientists review the paper before it is published.

This exercise will allow you to practice reading a research paper from the primary literature journal *Science*. You will explore an annotated version of the paper and do the following:

1. Identify why the research is important.
2. Describe how the research relates to the biology you're learning in your course.
3. Analyze results from experiments described in the paper.
4. Summarize how the findings of this research advance the field.

Read the Take the Heat paper on the AAAS Science in the Classroom web site. Then answer the following questions.

Part A - Why is this research important?

Among the many threats to water quality posed by human activities is the burning of fossil fuels, which releases CO_2 into the atmosphere. The resulting increase in atmospheric CO_2 has caused global warming and other climate change-related issues like ocean acidification.

Why is this study about corals' response to warmer water important?
***Hint*: Turn on the "Results and conclusions" learning lens to highlight this study's significant findings.**

ANSWER:

- Environmental changes, such as climate change, can outpace the evolutionary response of sensitive organisms, such as marine coral. As a result, some organisms die and may become extinct.
- This research shows that sensitive organisms, such as marine coral, can adjust their genetic responses rapidly to cool the water in the environment.
- This research shows that sensitive organisms, such as marine coral, can *adapt* to become more tolerant of climate change over a timespan shorter than expected.
- This research shows that sensitive organisms, such as marine coral, can *acclimatize* to become more tolerant of climate change over a timespan shorter than can allow for evolutionary change.

Part B - How does this research relate to your biology course?

Acclimatization (acclimation) and adaptation are two important concepts in biology. A common misconception is that these two terms are synonyms and can be used interchangeably. However, several differences exist between these concepts.

Sort each description to align with the appropriate concept.
***Hint*: Watch the short video embedded in the article of Steve Palumbi explaining the difference between acclimatization and adaptation.**

ANSWER:

Reset Help

requires multiple generations | occurs at the level of a population | occurs within a single generation | occurs at the level of the individual | physiological adjustment to change | genetic change over time

Acclimatization / Acclimation	Adaptation

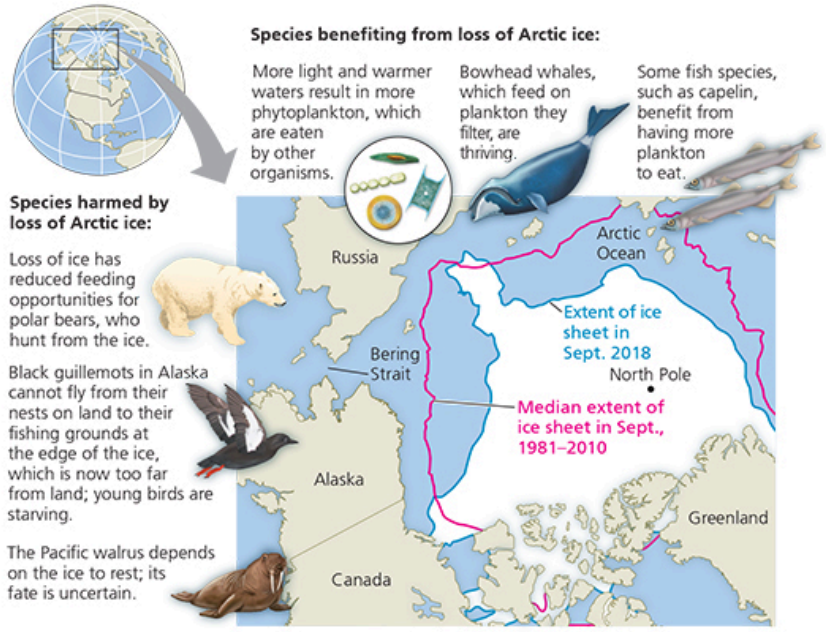
Part C

Water is vital to life on Earth. All organisms are made mostly of water, and water has extraordinary properties contributing to the suitability of environments to sustain life. With that said, climate change is having profound effects on aquatic environments around the globe, from the Arctic to the Equator.

Based on the Take the Heat article and the information in your textbook, select all the statements that describe adverse effects of climate change on organisms.

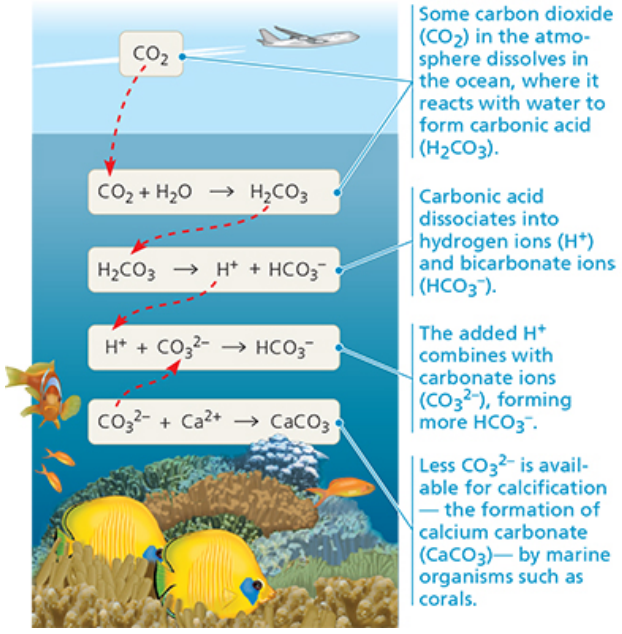
Hint 1. The effects of climate change on animals in the Arctic

This figure shows examples of species harmed by the loss of Arctic ice.



Hint 2. How ocean acidification works

This figure shows how excess CO_2 in ocean water affects the calcification process of certain marine organisms.



ANSWER:

- [ ] Higher levels of CO_2 in ocean water react with water to form carbonic acid, lowering the ocean pH and altering the balanced environmental conditions required for marine organisms.
- [ ] Higher levels of CO_2 in ocean water react with water to form carbonic acid, lowering the ocean pH. This lower pH increases calcification, leading to harder reefs and shells.
- [ ] Warmer ocean water temperatures can cause corals to eject their photosynthetic endosymbiont, which bleaches the coral and can lead to coral death.
- [ ] Higher ocean water temperatures cause sea ice and glaciers to melt, increasing the distance between nesting and feeding sites of some birds. As a result, young birds are starving.
- [ ] Warmer temperatures in the Arctic cause more sea ice to melt in the summer, reducing feeding opportunities for polar bears who hunt from the ice shelves.

Part D - What can you learn about the process of science from this research?

When choosing an organism to use in research, scientists consider several things related to the specific experimental question of the research. Dr. Palumbi's lab selected the coral *Acropora hyacinthus* for several reasons.

Select all the statements that support the use of *A. hyacinthus* in this study.
Hint: **Turn on the "Author's experiments" and "Connect to learning standards" learning lenses.**

ANSWER:

- [ ] *A. hyacinthus* makes up a large percentage of hard coral on Pacific reefs.
- [ ] *A. hyacinthus* shows low levels of bleaching during large-scale bleaching events.
- [ ] *A. hyacinthus* is native to the moderately variable and highly variable pools of Ofu Island.
- [ ] *A. hyacinthus* is sensitive to environmental stress.

Part E - Can you interpret some results from the paper?

This study compared chlorophyll retention in coral colonies exposed to experimental heat stress with chlorophyll retention in non-stressed controls. Figure 1 in the paper shows the results under different conditions.

Corals were tested in their native pools—highly variable (HV) or moderately variable (MV). In addition, HV corals were transplanted to MV pools, and MV corals were transplanted to HV pools. In Figure 1, the *x*-axis shows the fraction of chlorophyll measured in colonies *after* heat stress divided by the amount of chlorophyll measured in colonies of the same coral *not* exposed to heat stress. If a heated coral experienced no bleaching at all, the ratio was 1.0. The smaller the fraction, the more bleaching (loss of chlorophyll) that occurred under heat stress. The *y*-axis shows the frequency of corals with each level of bleaching.

Is the following statement supported or not supported by the data in Figure 1?

ANSWER:

MV corals transplanted to the HV pool (Panel D) retained *more* chlorophyll in heat stress experiments than corals native to the HV pool (Panel C).

- ○ Supported by the data
- ○ Not supported by the data
- ○ Cannot be determined from the data

Part F - How might this study lead to other research?

Survival of populations through climate change demands biogeographic shifts, adaptation of populations, or local acclimatization of individuals. The results of this study show that acclimatization can allow *A. hyacinthus* corals to acquire substantial high-temperature resistance over a timespan shorter than can allow for evolutionary change. This study opens other research questions illustrating how science perpetuates science.

Select all the questions that represent future research opportunities that stem from this study.

ANSWER:

- ☐ Is there an upper water temperature limit to acclimatization or adaptation?
- ☐ Do all coral species have equal acclimatization ability in temperatures that exceed normal temperatures?
- ☐ Do multiple stressors (for example, pH and temperature change) reduce the ability of corals to respond to environmental change?
- ☐ Do current climate change models reflect biogeographic shifts, adaptation of populations, and local acclimatization of individuals?

Misconception Question 14

Part A

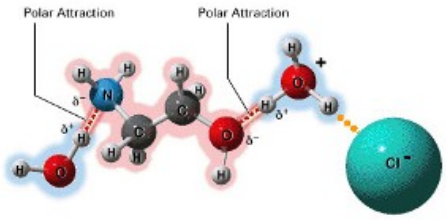
Identify all correct statements about the ionization of water.

Check all that apply.

ANSWER:

- ☐ Dissociation of water produces equal masses of OH^- and H^+.
- ☐ Dissociation of water is reversible.
- ☐ Water ionizes to form hydroxide and hydronium ions.
- ☐ Water ionizes to form peroxide and hydronium ions.
- ☐ Dissociation of water is not reversible.
- ☐ Dissociation of water produces equal numbers of OH^- and H^+.

Chemistry Review - Atoms & Molecules: Polar Attractions



Review the Polar Attractions tutorial.

Then answer the questions.

Part A

Polar attractions are ...

ANSWER:

- (a) forces between atoms with partial charges.
- (b) weaker than covalent bonds.
- (c) important because they are numerous.
- (a) and (b) are true. (c) is false.
- (a), (b), and (c) are correct.

Part B

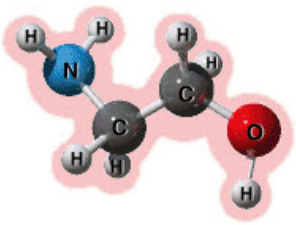
Hydrogen bonds ...

ANSWER:

- can form between H and N.
- occur within a water molecule.
- share electrons between the two bonded atoms.
- are covalent bonds.
- All of the above.

Part C

How many atoms in the pictured molecule can form hydrogen bonds with water molecules?

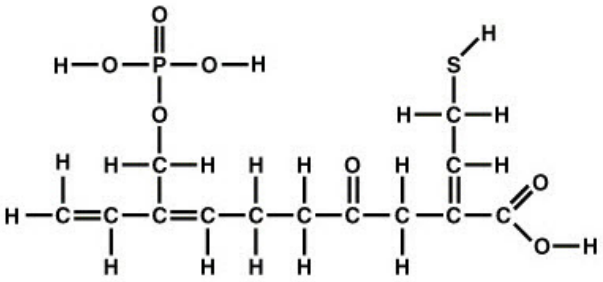


ANSWER:

- 2
- 3
- 7
- 5
- 8

Part D

In the molecule below, how many atoms could make hydrogen bonds with water?



ANSWER:

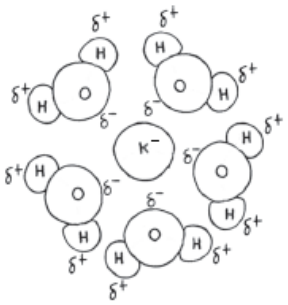
- 5
- 7
- 10
- 12

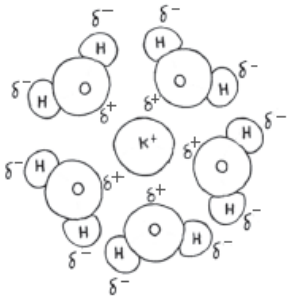
Chapter 3 Question 6

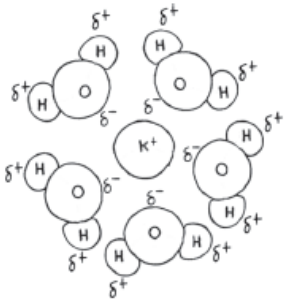
Part A

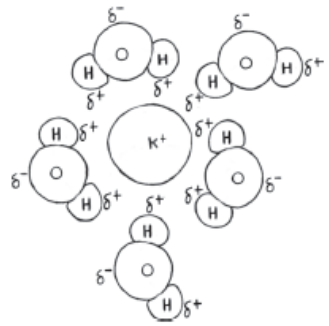
Choose the hydration shells that form around a potassium ion when potassium chloride (KCl) dissolves. Notice the positive, negative, and partial charges.

ANSWER:





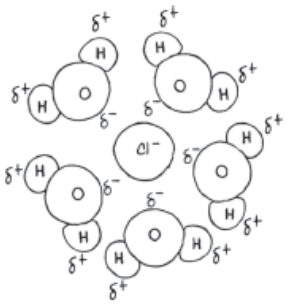


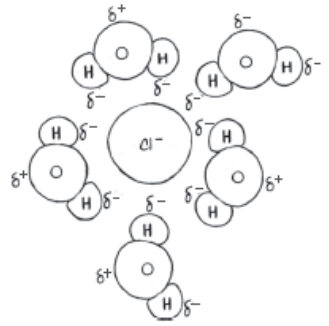


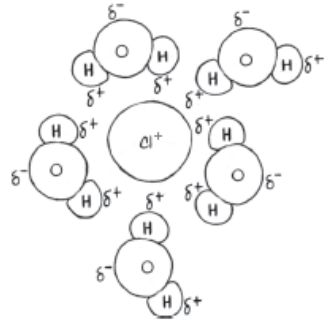
Part B

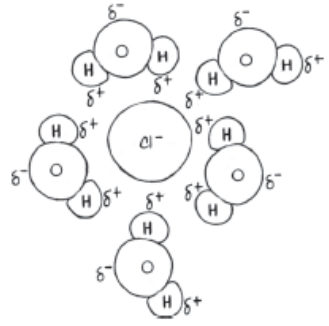
Choose the hydration shell that forms around a chloride ion when potassium chloride (KCl) dissolves. Notice the positive, negative, and partial charges.

ANSWER:









Chapter 3 Pre-Test Question 1

Part A

Water molecules have a polarity, which allows them to be electrically attracted to other water molecules and other polar molecules by weak chemical bonds known as _____. See Concept 3.1 (Page)

You did not open hints for this part.

ANSWER:

- ionic bonds
- polar covalent bonds
- nonpolar covalent bonds
- hydrogen bonds
- Van der Waals interactions

Chapter 3 Question 5

Part A

Which of the following statements is incorrect?

ANSWER:

- Water can form intermolecular hydrogen bonds.
- Water can form hydrogen bonds with other water molecules.
- Water can form intramolecular hydrogen bonds.
- Water can form hydrogen bonds with compounds that form polar covalent bonds.

Chapter 3 Question 6

Part A

When carbon dioxide in the atmosphere dissolves with the raindrops, what is the expected change in pH of the raindrops?

ANSWER:

- depends on the altitude where rain drops are formed
- slightly acidic
- slightly basic
- same as pure water

Chapter 3 Question 7

Part A

Which of the following properties of water is responsible for the formation of raindrops?

ANSWER:

- adhesion property
- cohesion property
- high kinetic energy
- high thermal energy

Chapter 3 Question 1

Part A

What kind of bond is formed between the two hydrogen atoms and the single oxygen atom?

ANSWER:

- nonpolar covalent bonds
- polar covalent bonds
- hydrogen bonds
- ionic bonds

Chapter 3 Question 3

Part A

The partial negative charge in a molecule of water occurs because _____.

ANSWER:

- the electrons shared between the oxygen and hydrogen atoms spend more time around the oxygen atom nucleus than around the hydrogen atom nucleus
- one of the hydrogen atoms donates an electron to the oxygen atom
- the oxygen atom donates an electron to each of the hydrogen atoms
- the oxygen atom has two pairs of electrons in its valence shell that are not neutralized by hydrogen atoms

Chapter 3 Question 4

Part A

Sulfur is in the same column of the periodic table as oxygen but it is less electronegative than oxygen. Compared to water molecules, how will the H_2S molecules behave?

ANSWER:

- have a greater tendency to form hydrogen bonds with each other
- have greater cohesion to other H_2S molecules
- not be able to form hydrogen bonds with each other
- have a higher capacity to absorb heat for the same change in temperature

Chapter 3 Question 2

Part A

How are the hydrogen bonds formed between water molecules?

ANSWER:

- by sharing of electrons between two water molecules
- by the attraction between the positive end of one water molecule with the negative end of the other
- by sharing protons between two water molecules
- by the transfer of electrons from one water molecule to the other

Hydrogen Bonding and Water

Water molecules (H_2O) can form hydrogen bonds because of their molecular structure. Water exhibits many important properties because of hydrogen bonding.

Part A - Hydrogen bonding

Label the following diagram of water molecules, indicating the location of bonds and the partial charges on the atoms.

Drag the labels to their appropriate locations on the diagram of the water molecules below. Labels can be used once, more than once, or not at all.

You did not open hints for this part.

ANSWER:

Reset Help

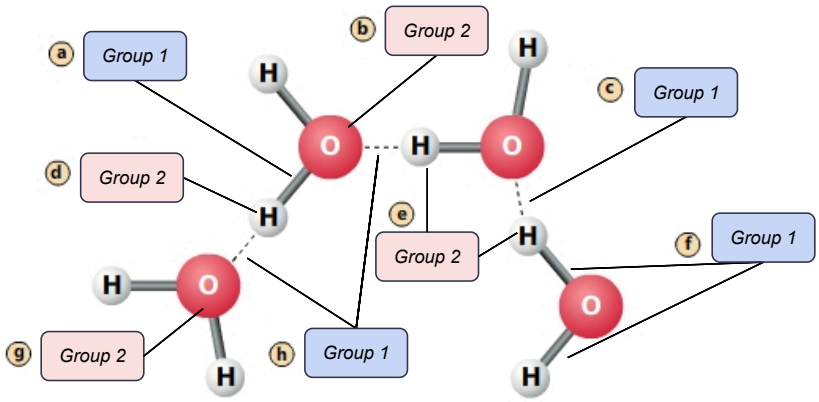
δ−

δ+

covalent bond

ionic bond

hydrogen bond



Part B - Properties of water

Classify each statement as an example of adhesion, cohesion, or surface tension.

Drag each statement to the appropriate bin.

Hint 1. Can you match properties of water to their definitions?

Drag the terms on the left to the appropriate blanks on the right to complete the sentences. Not all terms will be used.

ANSWER:

Reset Help

adhesion

cohesion

heat

surface tension

1. [ ] is a measure of how difficult it is to stretch or break the surface of a liquid.

2. [ ] is an attraction between different kinds of molecules.

3. [ ] is an attraction between like molecules.

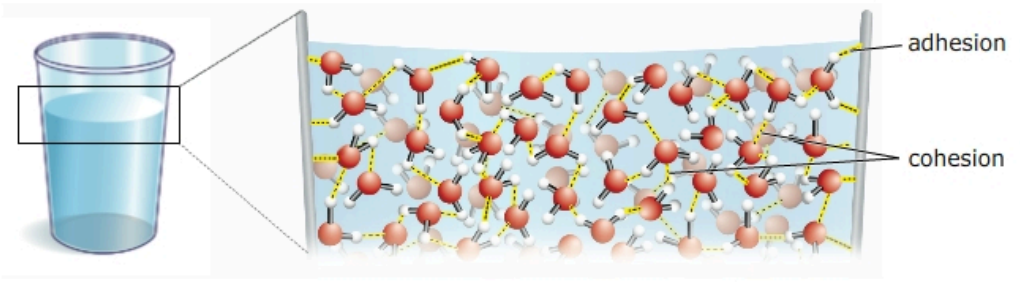
Hint 2. The role of hydrogen bonding in adhesion, cohesion, and surface tension in water

Water exhibits adhesion, cohesion, and surface tension due to water molecules' ability to form hydrogen bonds.

- Adhesion is a result of hydrogen bonding between water molecules and another type of molecule.
- Cohesion and surface tension are a result of hydrogen bonding between water molecules.

Hint 3. Example of adhesion and cohesion in water

The image below shows an example of adhesion and cohesion in a glass of water. The water molecules are attracted to the side of the glass (adhesion) and to each other (cohesion).



Adapted from *Biological Science* by Freeman © 2008 Pearson Education, Inc.

ANSWER:

Reset Help

Water molecules cling to the side of a beaker.

Water molecules cling to plant cell walls.

A drop of water spilled on a table forms a drop on the table, rather than spreading out over the surface.

Water molecules are attracted to each other.

A water strider runs across a pond without breaking the surface.

A sewing needle floats when it is placed gently on top of water in a bucket.

adhesion	cohesion	surface tension

Part C - Specific heat of water

The table shown here lists the specific heat of several substances.

Substance	Specific heat $\mathrm{J/g/^{\circ}C}$
water	4.18
ethyl alcohol	2.44
benzene	1.80
sulfuric acid	1.40

Which of the following statements are true?

Select all that apply.

Hint 1. Definition of specific heat

The specific heat of a substance is defined as the amount of heat that must be absorbed or lost for 1 g of that substance to change its temperature by 1 $^{\circ}\mathrm{C}$. Specific heat may be written in several different units including joules per gram of substance per degree Celsius ($\mathrm{J/g/^{\circ}C}$) or calories per gram of substance per degree Celsius ($\mathrm{cal/g/^{\circ}C}$).

Hint 2. Hydrogen bonding and specific heat

Recall that temperature is a measure of the average kinetic energy (energy of motion) of a substance's molecules. By heating a substance, you increase the speed of its molecules, and thus its temperature.

It takes more energy to raise the temperature of a substance that exhibits a high degree of hydrogen bonding among its molecules. The reason for this is that much of the heat added to the substance is used to break those hydrogen bonds before the molecules can begin moving faster. This explains why water has a relatively high specific heat. The more hydrogen bonds that have to be broken, the more heat that must be added to raise the temperature. In summary, more hydrogen bonding means higher specific heat.

Hint 3. What are characteristics of substances with high specific heat and low specific heat?

Compare the general characteristics of a substance with high specific heat and a substance with low specific heat.

Drag each phrase to the appropriate bin.

ANSWER:

Reset Help

requires more heat to change the temperature of the substance

least likely to exhibit hydrogen bonding

more resistant to temperature change

most likely to exhibit hydrogen bonding

less resistant to temperature change

requires less heat to change the temperature of the substance

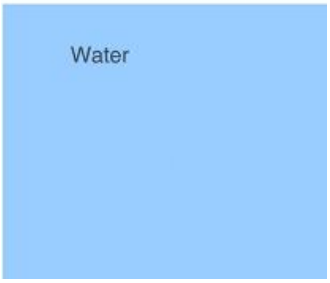
substance with a high specific heat	substance with a low specific heat

ANSWER:

- [ ] Water has a high specific heat due to the hydrogen bonding between water molecules.
- [ ] More heat is required to raise the temperature of 1 g of benzene 1 $^{\circ}\mathrm{C}$ than to raise the temperature of 1 g of water 1 $^{\circ}\mathrm{C}$.
- [ ] Sulfuric acid is less resistant to temperature change than water.
- [ ] Water is less resistant to temperature change than ethyl alcohol.
- [ ] Benzene is more resistant to temperature change than sulfuric acid.
- [ ] More heat is required to raise the temperature of 1 g of water 1 $^{\circ}\mathrm{C}$ than to raise the temperature of 1 g of ethyl alcohol 1 $^{\circ}\mathrm{C}$.
- [ ] Ethyl alcohol likely exhibits more hydrogen bonding than water.

Activity: The Polarity of Water

Polarity of Water



Watch the animation and answer the questions.

Part A

A water molecule can bond to up to _____ other water molecules by ____ bonds.

ANSWER:

- three ... ionic
- two ... polar covalent
- two ... hydrogen
- four ... hydrogen
- four ... polar covalent

Part B

The unequal sharing of electrons within a water molecule makes the water molecule _____.

ANSWER:

- ionic
- change easily from a liquid to gaseous form
- hydrophobic
- have a low surface tension
- polar

Part C

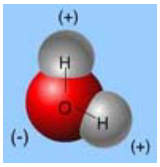
The tendency of an atom to pull electrons toward itself is referred to as its _____.

ANSWER:

- polarity
- covalency
- tonicity
- electronegativity
- ionic potential

Part D

In this molecule, what type of bond is found between the oxygen and hydrogens?



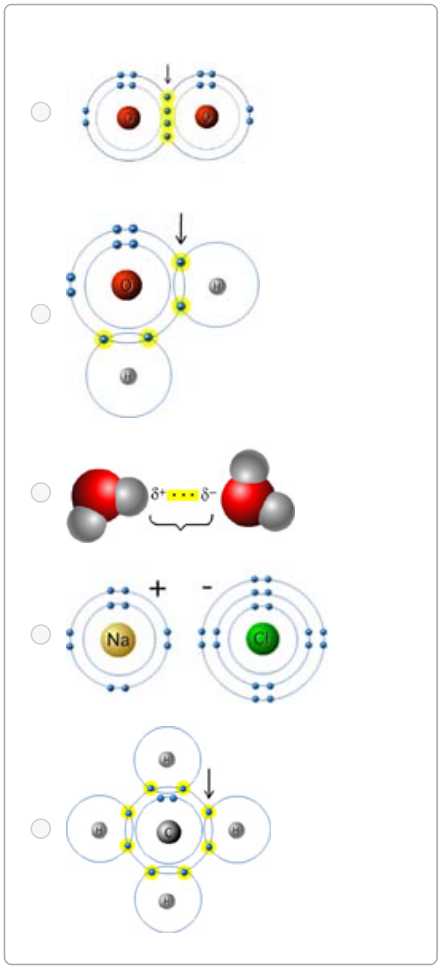
ANSWER:

- ionic
- polar covalent
- hydrophilic
- nonpolar covalent
- hydrophobic

Part E

Which of these bonds is weakest?

ANSWER:



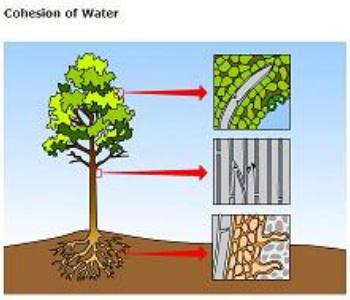
Part F

Why isn't this insect drowning?

ANSWER:

- The insect is very light.
- It is difficult to change the temperature of water.
- The insect is swimming.
- The insect is flying just above the water surface.
- Surface tension.

Activity: Cohesion of Water



Click here to complete this activity.

Then answer the questions.

Part A

What process exerts the pull on water molecules that is relayed from leaf to root via cohesion?

ANSWER:

- evaporation
- gravity
- precipitation
- antigravity

Misconception Question 12

Part A

Which property of water allows a paper towel to pick up a puddle of water?

ANSWER:

- adhesion of water molecules to other kinds of molecules
- water’s high surface tension
- water’s high heat of vaporization

Misconception Question 13

Part A

Which property of water allows a water strider to walk on water?

ANSWER:

- adhesion of water molecules to other kinds of molecules
- the formation of covalent bonds between water molecules
- water's high surface tension

Misconception Question 11

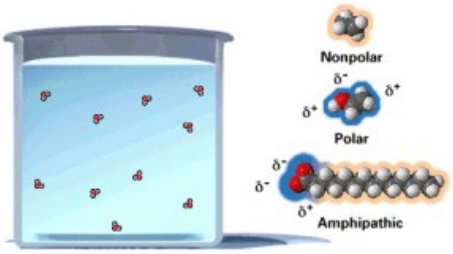
Part A

Which property of water allows dogs to cool themselves by panting?

ANSWER:

- water's high heat of vaporization
- water's high surface tension
- the formation of covalent bonds between water molecules

Chemistry Review - Water: Properties of Water



Review the Properties of Water tutorial.

Then answer the questions.

Part A

Which statement must be mentioned in explaining why amphipathic molecules line up at a water surface?

ANSWER:

- Nonpolar groups repel water.
- Polar groups attract one another.
- Nonpolar groups attract one another.
- Polar groups repel water.
- All of the above.

Part B

Dissolving is best described as ...

ANSWER:

- breaking covalent bonds.
- molecules breaking into ions.
- a change from a solid to a liquid.
- a mingling of molecules and/or ions.
- a separation of molecules into neutral atoms.

Part C

Water is a source of _____ for chemical reactions in cells.

ANSWER:

- (a) hydrogen atoms
- (b) oxygen atoms
- (c) energy
- Both (a) and (b)
- (a), (b), and (c).

Part D

Which statement is true of water's tensile strength?

ANSWER:

- (a) It results from hydrogen bonding.
- (b) It helps to pull water through plants.
- (c) It involves both cohesion and adhesion.
- Both (a) and (b).
- (a), (b), and (c).

Part E

Water has surface tension because ...

ANSWER:

- hydrogen bonds between surface water molecules resist being stretched.
- there is positive pressure inside the water mass.
- water tends to evaporate from the surface.
- molecules at the surface make more hydrogen bonds.
- cohesion forces are weaker at the surface.

Part F

Which of the following helps most to explain why water has a high specific heat?

ANSWER:

- (a) A water molecule can make 4 hydrogen bonds.
- (b) The water molecule has exceptionally strong covalent bonds.
- (c) Water temperature is exceptionally sensitive to heat.
- Both (a) and (b).
- Both (b) and (c).

Part G

Which factor is important in making it possible to cool yourself by sweating? Think carefully!

ANSWER:

- (a) Molecules collide with varied angles and speeds.
- (b) Hydrogen bonds are relatively weak.
- (c) Water has more energy at the body surface.
- Both (a) and (b).
- (a), (b), and (c).

Part H

Though you add heat, the temperature of boiling water remains constant because ...

ANSWER:

- it takes energy to circulate water.
- it takes energy to break covalent bonds.
- it takes energy to break hydrogen bonds.
- water has a constant boiling temperature.
- None of the above. The temperature rises during boiling.

Part I

Which statement helps to explain why ice is less dense than liquid water?

ANSWER:

- (a) Water molecules make hydrogen bonds at definite angles.
- (b) Cold molecules move less than warm molecules.
- (c) Hydrogen bonds lengthen in the cold.
- All of the above.
- Both (a) and (b).

Part J

The open spaces in water's crystal structure make it possible for ...

ANSWER:

- (a) aquatic life to exist at the North Pole.
- (b) water to have a low boiling point.
- (c) life to occur in hot springs.
- Both (b) and (c).
- (a), (b), and (c).

Part K

Why doesn't oil mix with water?

ANSWER:

- (a) Nonpolar molecules repel water molecules.
- (b) Polar molecules repel nonpolar molecules.
- (c) Polar molecules attract one another.
- (d) Nonpolar molecules attract one another.
- Both (a) and (d).

Chapter 3 Question 1

Part A

Which of the following is a hydrophobic material?

ANSWER:

- paper
- wax
- sugar
- table salt

Chapter 3 Question 2

Part A

We can be sure that a mole of table sugar and a mole of vitamin C are equal in their

ANSWER:

- number of molecules.
- mass.
- number of atoms.
- volume.

Chapter 3 Question 3

Part A

Measurements show that the pH of a particular lake is 4.0. What is the hydrogen ion concentration of the lake?

ANSWER:

- $10^{-4} M$
- $10^{-10} M$
- $4.0\ M$
- $10^{4} M$

Chapter 3 Question 4

Part A

Measurements show that the pH of a particular lake is 4.0. What is the *hydroxide* ion concentration of the lake?

ANSWER:

- $10^{-4} M$
- $10^{-7} M$
- $10.0\ M$
- $10^{-10} M$

Chapter 3 Question 5

Part A

A slice of pizza has 500 kcal. If we could burn the pizza and use all the heat to warm a 50-L container of cold water, what would be the approximate increase in the temperature of the water? (*Note*: A liter of cold water weighs about 1 kg.)

ANSWER:

- $5^{\circ}\mathrm{C}$
- $10^{\circ}\mathrm{C}$
- $50^{\circ}\mathrm{C}$
- $100^{\circ}\mathrm{C}$

Chapter 3 Question 7

Part A

Right before a predicted overnight freeze, farmers spray water on crops to protect the plants. Use the properties of water to explain how this method works. Be sure to identify why hydrogen bonds are responsible for this phenomenon.

ANSWER:

- Due to intermolecular hydrogen bonds, water has low specific heat. When water is cooled, many of these bonds are formed, which releases a significant amount of heat. This can provide some protection against freezing of the plants' leaves, but no protection to cells from damage.
- Due to intermolecular hydrogen bonds, water has high specific heat. When water is cooled, many of these bonds are formed, which releases a significant amount of heat. This can provide some protection against freezing of the plants' leaves, thus protecting the cells from damage.
- Due to intermolecular hydrogen bonds, water has high specific heat. When water is cooled, many of these bonds are broken down, which releases a significant amount of heat. This can provide some protection against freezing of the plants' leaves, thus protecting the cells from damage.
- Due to intermolecular hydrogen bonds, water has low specific heat. When water is cooled, many of these bonds are formed, which releases a significant amount of heat. This can provide some protection against freezing of the plants' leaves, thus protecting the cells from damage.

Chapter 3 Question 8

Part A

What do climate change and ocean acidification have in common?

ANSWER:

- They are caused by increasing levels of $\mathrm{CO_2}$ in the atmosphere.
- They are caused by an increasing water level.
- They are caused by increasing temperature of the atmosphere.
- They are caused by decreasing pH levels in the ocean.

Chapter 3 Question 12

Part A

How do cats drink? Scientists using high-speed video have shown that cats use an interesting technique to drink aqueous substances like water and milk. Four times a second, the cat touches the tip of its tongue to the water and draws a column of water up into its mouth, which then shuts before gravity can pull the water back down.

Describe how the properties of water allow cats to drink in this fashion, including how water's molecular structure contributes to the process.

Match the terms in the left column to the appropriate blanks in the sentences on the right. Terms can be used once, more than once, or not at all.

ANSWER:

Reset Help

cohesion
ionic
surface tension
temperature
hydrogen
adhesion
covalent

Water molecules stay close to each other as a result of existence of [ ] bonds. Collectively, [ ] bonds hold the substance together, this phenomenon is called [ ]. The clinging of one substance to another, which is called [ ], also plays a role. In this way, [ ] of water through [ ] bonds to the molecules, which comprise the villi on the cat's tongue, helps counter the downward pull of gravity. As a result, such a phenomenon as [ ] helps drops of water stay whole and attached to each other. At the same time, [ ] allows drops to be transported against gravity.

Chapter 3 Pre-Test Question 2

Part A

Many of water's emergent properties, such as its cohesion, high specific heat, and high heat of vaporization, result from the fact that water molecules _____.

You did not open hints for this part.

ANSWER:

- are in constant motion
- are extremely large
- are attracted to each other by partial negative and positive charges on the oxygen and hydrogen atoms, respectively
- tend to repel each other
- are very small

Chapter 3 Pre-Test Question 3

Part A

The amount of energy that must be absorbed or lost to raise or lower the temperature of 1gram of liquid water by 1°C _____.

You did not open hints for this part.

ANSWER:

- is 1 calorie
- is 1,000 joules
- is 1,000 calories
- depends on the initial temperature of the water sample
- is 1 kilocalorie
- is 1,000 kilocalories

Chapter 3 Pre-Test Question 4

Part A

Because organisms are made primarily of water, they resist rapid temperature changes. This useful quality is based on water's _____.

You did not open hints for this part.

ANSWER:

- lower density in the solid phase
- buffering activity
- cohesion
- high specific heat
- properties as a solvent.

Chapter 3 Pre-Test Question 5

Part A

Sodas typically contain flavorings, coloring agents, sugar, and carbon dioxide dissolved in water. The best term to describe this mixture would be _____.

You did not open hints for this part.

ANSWER:

- an aqueous solution
- an aqueous solvent
- a solute
- a solvent
- a suspension

Chapter 3 Pre-Test Question 6

Part A

If the molecular mass of a carbon atom is 12, the mass of a hydrogen atom is 1, and the mass of an oxygen atom is 16 daltons, how many molecules does one mole of table sugar (sucrose; $C_{12}H_{22}O_{11}$) contain?

You did not open hints for this part.

ANSWER:

- 45
- 342
- 6.02×10^{23}
- $(6.02 \times 10^{23})(342)$
- $6.02 \times 10^{23}/342$

Chapter 3 Question 11

Part A

Several emergent properties of water contribute to the suitability of the environment for life. How does the ability of water to function as a versatile solvent arise from the structure of water molecules?

Select all that apply.

ANSWER:

- [ ] The partial positive regions of water molecules are attracted to negatively charged ions, forming oxygen shells around ions that separate them from each other and dissolve them.
- [ ] The partially charged regions of water molecules are attracted to oppositely charged ions.
- [ ] Water's versatility as a solvent arises from the polar covalent bonds of water molecules.
- [ ] Water molecules form hydrogen bonds with atoms that are part of polar covalent bonds in other molecules.
- [ ] Hydrogen has higher electronegativity, so the shared electrons are attracted more to the oxygen at the apex of this V-shaped molecule.

Chapter 3 Question 9

Part A

Which of the following statements is true for water in its liquid state?

ANSWER:

- It is nonpolar.
- It has a specific heat lower than most other substances.
- It is less dense than ice.
- It has a heat of vaporization higher than most other substances.

Chapter 3 Question 8

Part A

What kind of bonds are responsible for the unique cohesion, surface tension, and adhesion properties of water molecules?

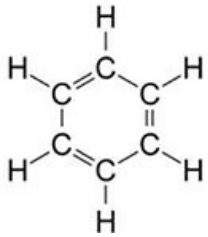
ANSWER:

- hydrophobic bonding
- polar covalent bonding
- ionic bonding
- hydrogen bonding

Chapter 3 Question 28

Part A

Use the following figure to answer the question.



How many grams of the compound in the figure are required to make 1 liter of a 0.5 M solution? (Note: The atomic masses, in daltons, are approximately 12 for carbon, 1 for hydrogen.)

ANSWER:

- 78
- 156
- 39
- 72

Chapter 3 Question 26

Part A

How does 0.5 M sucrose (molecular mass 342) solution compare to 0.5 M glucose (molecular mass 180) solution?

ANSWER:

- Both have 6.02×10^{23} molecules.
- Sucrose has 171 molecules, whereas glucose has 90.
- Sucrose has 171 mg/L, whereas glucose has 90 mg/L.
- Both have 3.01×10^{23} molecules.

Chapter 3 Question 25

Part A

How many grams of NaCl are required to prepare 50 mL of a solution of 1 M NaCl?

(MW of NaCl=58.44g)

ANSWER:

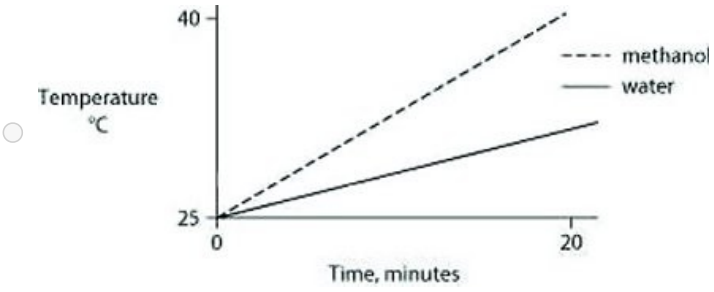
- 5.844g
- 2.72g
- 58.44g
- 2.922g

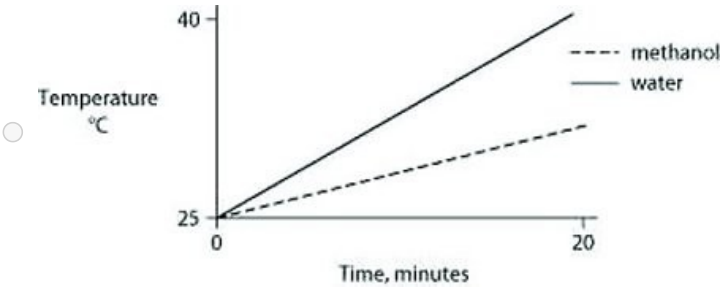
Chapter 3 Question 29

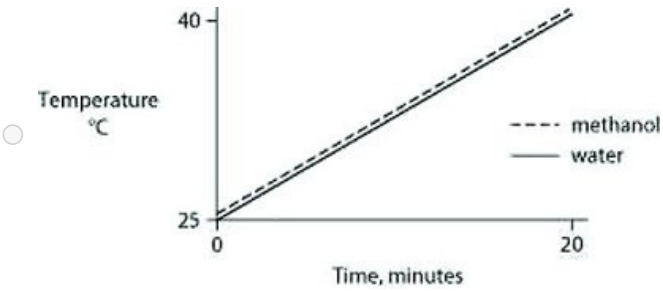
Part A

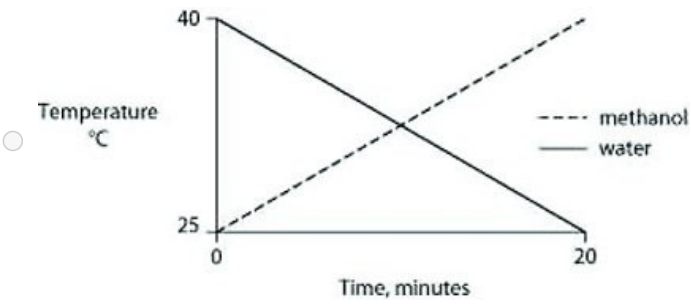
Identical heat lamps are arranged to shine on two identical containers, one containing water and one methanol (wood alcohol), so that each liquid absorbs the same amount of energy minute by minute. The covalent bonds of methanol molecules are nonpolar, so there are no hydrogen bonds among methanol molecules. Which of the following graphs correctly describes what will happen to the temperature of the water and the methanol?

ANSWER:





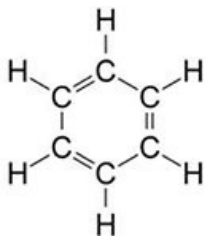




Chapter 3 Question 27

Part A

Use the following figure to answer the question.



Three moles of the compound in the figure would weigh how many grams? (Note: The atomic masses, in daltons, are approximately 12 for carbon, 1 for hydrogen.)

ANSWER:

- 234
- 72
- 78
- 216

Chapter 3 Question 23

Part A

When an ionic compound such as sodium chloride (NaCl) is placed in water, the component atoms of the NaCl crystal dissociate into individual sodium ions (Na^+) and chloride ions (Cl^-). In contrast, the atoms of covalently bonded molecules (e.g., glucose, sucrose, glycerol) do not generally dissociate when placed in aqueous solution. Which of the following solutions would be expected to contain the greatest number of solute particles (molecules or ions)?

ANSWER:

- 1 liter of 0.5 M NaCl
- 1 liter of 1.0 M NaCl
- 1 liter of 1.0 M glucose
- 1 liter of 1.0 M NaCl and 1 liter of 1.0 M glucose will contain equal numbers of solute particles.

Chapter 3 Question 22

Part A

One mole (mol) of glucose (molecular mass = 180 daltons) is _____.

ANSWER:

- 1 kilogram of glucose dissolved in 1 liter of solution
- 180 mL of dissolved glucose
- 180×10^{23} molecules of glucose
- 180 grams of glucose

Chapter 3 Question 19

Part A

Which of the following statements correctly describes the property of hydrophobic substances such as vegetable oil?

ANSWER:

- polar substances that have an affinity for water
- nonpolar substances that have an attraction for water molecules
- polar substances that repel water molecules
- nonpolar substances that repel water molecules

Chapter 3 Question 18

Part A

Which answer best describes why does ice float in liquid water?

ANSWER:

- The high surface tension of liquid water keeps the ice on top.
- The crystalline lattice of ice causes it to be denser than liquid water.
- The ionic bonds between the molecules in ice prevent the ice from sinking.
- Stable hydrogen bonds keep water molecules of ice farther apart than water molecules of liquid water.

Chapter 3 Question 14

Part A

Is the thermal energy of a full bathtub higher or lower than the thermal energy of a pot of freshly brewed coffee (even though the coffee has a higher temperature than the bathwater)? Why?

ANSWER:

- higher; greater volume
- lower; low temperature
- higher; high kinetic energy
- lower; low density

Chapter 3 Question 24

Part A

0.660 moles of NaCl are dissolved in 95.0 mL of water. Calculate the molarity of the NaCl solution.

ANSWER:

- 0.0069 M
- 0.069 M
- 6.95 M
- 62.7 M

Chapter 3 Question 21

Part A

Melting of ice and thus reduced feeding opportunities for polar bears is occurring because of the _____.

ANSWER:

- constant breaking and reforming of hydrogen bonds in water
- increase in CO_2 and other greenhouse gases in the atmosphere
- increase in phytoplankton population
- drying up of lakes and streams

Chapter 3 Question 20

Part A

Which of the following reasons explains why a steam burn is more severe than a hot water burn?

ANSWER:

- Steam can penetrate the skin.
- Burns caused by liquids are always milder.
- Steam contains more energy than water.
- Water evaporates and leaves the surface faster and helps in cooling.

Chapter 3 Question 17

Part A

The nutritional label on a box of cookies says "150 kilocalories/cookie." How many joules of energy each cookie contains when 1 cal = 4.16 J?

ANSWER:

- 6.24×10^5 J
- 624 J
- 150 J
- 6.24×10^6 J

Chapter 3 Question 16

Part A

Which of the following best defines 'one kilocalorie'?

ANSWER:

- 1,000 calories, or the amount of heat required to raise the temperature of 100 g of water by 100°C
- 1,000 calories, or the amount of heat required to raise the temperature of 1 kg of water by 1°C
- 1,000 calories, or the amount of heat required to raise the temperature of 1 g of water by 1°C
- 10,000 calories, or the amount of heat required to raise the temperature of 1 kg of water by 1°F

Chapter 3 Question 15

Part A

Rubbing alcohol swab on the skin feels cool because _____.

ANSWER:

- liquid alcohol transfers cold temperature to the skin
- the density of alcohol is less than water
- skin transfers heat to the liquid alcohol and the alcohol evaporates
- alcohol destroys skin microorganisms and they give off cold heat as they die

Chapter 3 Question 10

Part A

Which of the following can be attributed to water's high specific heat?

ANSWER:

- Ice floats on water.
- A lake heats up more slowly than the air around it.
- Sugar dissolves in hot tea faster than in iced tea.
- Oil and water do not mix well.

Chapter 3 Question 13

Part A

Which of the following effects can occur because of the high surface tension of water?

ANSWER:

- Sweat can evaporate from the skin, helping to keep people from overheating.
- Organisms can resist temperature changes, although they give off heat due to chemical reactions.
- A raft spider can walk across the surface of a small pond.
- Lakes cannot freeze solid in winter, despite low temperatures.

Chapter 3 Question 12

Part A

To act as an effective coolant in a car's radiator, a substance has to have the capacity to absorb a great deal of heat. Which physical property is the best indicator for a good coolant?

ANSWER:

- heat of vaporization
- specific heat
- density at room temperature
- pH

Chapter 3 Question 11

Part A

On a hot day, temperature of land rises more quickly than that of sea. Which of the following statements best describe the process?

ANSWER:

- It rains more over the sea.
- specific heat of soil is less than water
- specific heat of soil is more than water
- Dry soil soaks more water.

The pH Scale

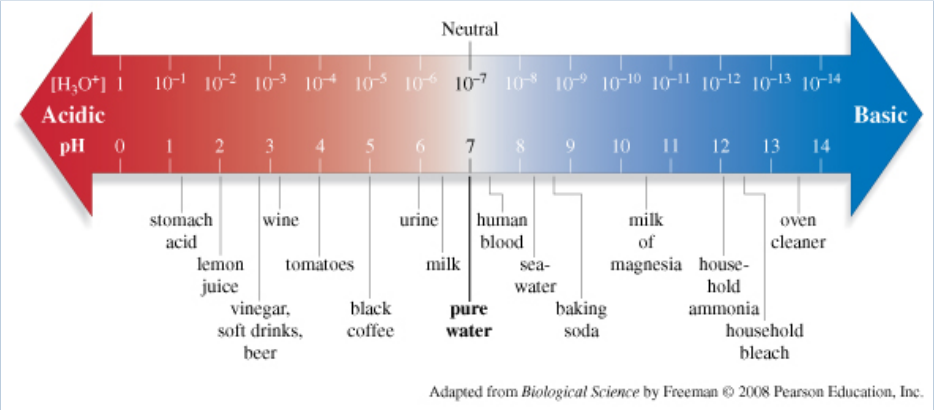
pH expresses the molar concentration of hydronium ions in an aqueous solution on a logarithmic scale. (Note that it is common to use the hydrogen ion, H^+, to represent the hydronium ion, H_3O^+.)

$$\mathrm{pH} = -\log[\mathrm{H_3O^+}]$$

$$[\mathrm{H_3O^+}] = 10^{-\mathrm{pH}}$$

As pH decreases, acidity increases. As pH increases, acidity decreases.

- Acidic solution: pH < 7
- Neutral solution: pH = 7
- Basic solution: pH > 7



Part A - Calculating pH

What is the pH of an aqueous solution with the hydronium ion concentration $[H_3O^+] = 2 \times 10^{-14}$ *M* ?

Make sure that your answer has the correct number of significant figures. For help determining the correct number of significant figures, see Hint 3.

You did not open hints for this part.

ANSWER:

Part B - Determining hydronium ion concentrations

Carbonated cola is more acidic than coffee or even orange juice because cola contains phosphoric acid.

What is the molar concentration of $[H_3O^+]$ in a cola that has a pH of 3.120? (For help with significant figures, see Hint 3.)

You did not open hints for this part.

ANSWER:

- 7.58×10^{-4}
- 7.59×10^{-4}
- 7.6×10^{-4}
- 3.120×10^{-3}
- 0.494
- 1.318×10^{3}

Part C - The relationship between pH and acidity

Rank the following from most acidic to least acidic.

Rank these items from most acidic to least acidic. To rank items as equivalent, overlap them.

You did not open hints for this part.

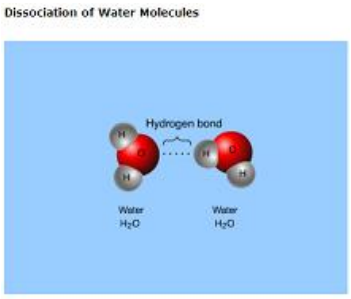
ANSWER:

Reset Help

$\mathrm{pH} = 14$ $\mathrm{pH} = 5$ $[\mathrm{H_3O^+}] = 10^{-2}$ $[\mathrm{H_3O^+}] = 10^{-6}$ $\mathrm{pH} = 3$

most acidic				least acidic

Activity: Dissociation of Water Molecules

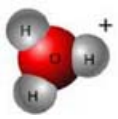


Watch the animation.

Then answer the questions.

Part A

What name is given to this molecule?

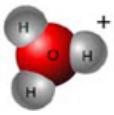


ANSWER:

- water
- methane
- glucose
- hydroxide ion
- hydronium ion

Part B

How did this molecule form?

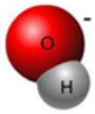


ANSWER:

- Evaporation.
- A hydrogen molecule bonded with an OH^- molecule.
- A water molecule split in half.
- Two water molecules bonded.
- A water molecule gained an hydrogen ion from another water molecule.

Part C

What name is given to this molecule?



ANSWER:

- hydroxide ion
- DNA
- hydronium ion
- water
- glucose

Part D

Which of these is the correct equation for the dissociation of water?

ANSWER:

- H_2O <==> $H^+ + OH^-$
- $H_2O + H_2O^+$ <==> $H_2O + OH^-$
- $H_2O + H_2O$ <==> $H_3O^+ + OH^-$
- $H_2O + OH^-$ <==> H_2O^+
- H^+ <==> $H_2O + H_2O^+$

Part E

What is the charge on a hydronium ion?

ANSWER:

- 2+
- 1-
- 0
- 1+
- 2-

Part F

What is the charge on a hydroxide ion?

ANSWER:

- 2+
- 1-
- 2-
- 0
- 1+

Part G

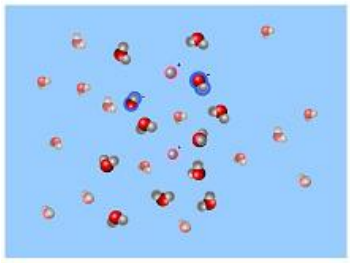
About _____ molecules in a glass of water are dissociated.

ANSWER:

- 1 in 500,000,000
- 1 in 1,000,000
- 1 in 5,000,000
- 1 in 1,000,000,000
- 1 in 2

Activity: Acids, Bases, and pH

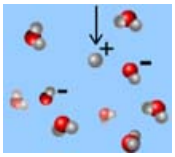
Acids, Bases, and pH



Watch the animation and answer the questions.

Part A

What is the arrow pointing to?

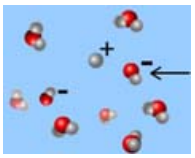


ANSWER:

- water molecule
- hydroxide ion
- electron
- hydrogen ion
- hydronium ion

Part B

What is the arrow pointing to?



ANSWER:

- hydronium ion
- proton
- hydroxide ion
- water
- hydrogen ion

Part C

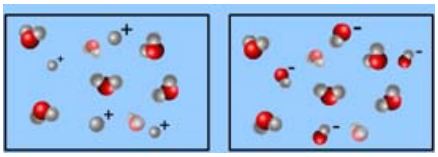
In a neutral solution the concentration of _____.

ANSWER:

- hydrogen ions is less than the concentration of hydroxide ions
- water molecules is less than the concentration of hydroxide ions
- water molecules is less than the concentration of hydrogen ions
- hydrogen ions is equal to the concentration of hydroxide ions
- hydrogen ions is greater than the concentration of hydroxide ions

Part D

How does the pH of the solution on the right compare with that of the solution on the left?

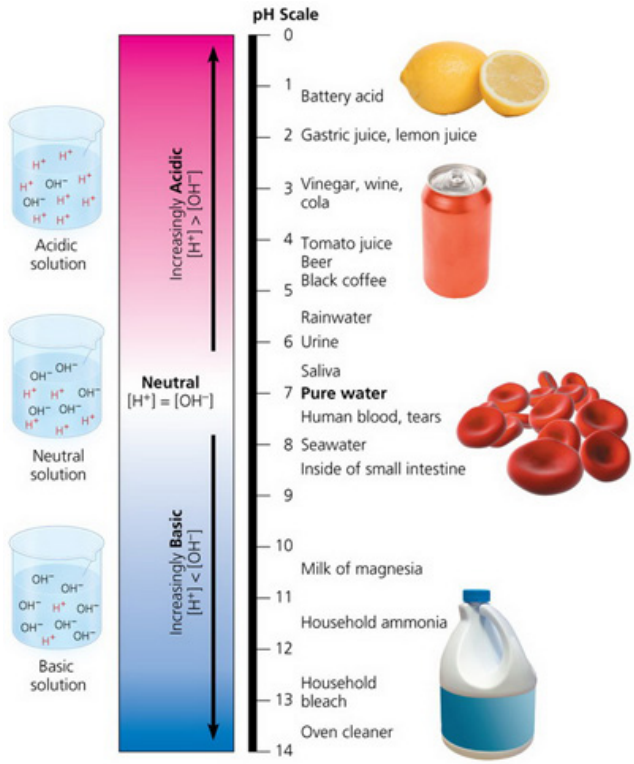


ANSWER:

- Both of these solutions are equally acidic.
- The solution on the right is neutral relative to the solution on the left.
- Both of these solutions are equally basic.
- The solution on the right is acidic relative to the solution on the left.
- The solution on the right is basic relative to the solution on the left.

Misconception Question 15

Part A

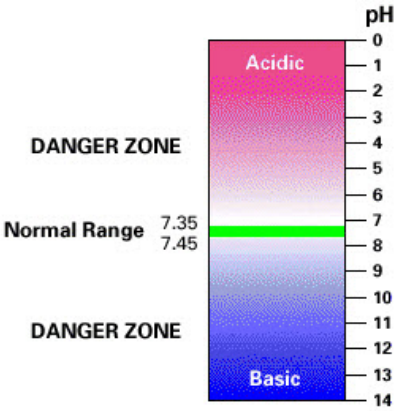


Look at the figure showing the pH values of some familiar aqueous solutions. What is the difference between H^+ concentration in an acidic solution such as lemon juice (pH 2) and a basic solution such as household bleach (pH 13)?

ANSWER:

- The H^+ concentration of lemon juice is higher than the H^+ concentration of household bleach by a factor of 10^{11} (100 billion).
- The H^+ concentration of household bleach is higher than the H^+ concentration of lemon juice by a factor of 10^{11} (100 billion).
- The H^+ concentration of lemon juice is higher than the H^+ concentration of household bleach by a factor of 11.

Chemistry Review - Acids, Bases, & pH: Buffers



Review the Buffers tutorial.

Then answer the questions.

Part A

Which statement is true of pH buffers?

ANSWER:

- (a) They consist of strong acids and strong bases.
- (b) They keep the pH of the blood constant.
- (c) They consist of weak acids and weak bases.
- Both (a) and (b).
- Both (b) and (c).

Part B

A buffer consists of undissociated acid (HA) and the ion made by dissociating the acid (A^-). How does this system buffer a solution against decreases in pH?

ANSWER:

- (a) HA dissociates and releases H^+ and A^- into solution.
- (b) A^- reacts with H^+ to become HA.
- (c) As the solution loses H^+, HA replaces the lost H^+.
- Both (a) and (c).
- None of the above.

Part C

Buffers work best when ...

ANSWER:

- nearly all of the buffer molecules are dissociated.
- about half of the buffer molecules are dissociated.
- the ratio of H^+ to OH^- is close to 1.0.
- nearly all of the buffer molecules are undissociated.
- the pH is nearly neutral.

Part D

How does the way a buffer stabilizes pH during addition of acid differ from the way the same buffer stabilizes pH during addition of base?

ANSWER:

- In one case the buffer is strong; in the other case it's weak.
- The same buffer can't work for both acid and base.
- In one case it adds H^+; in the other case it adds OH^-.
- It's the same reaction running backward or forward.

Part E

Which answer helps to explain why all living cells need pH buffers?

ANSWER:

- Nucleic acids must have positive charges to form double helices.
- Hydrogen bonds only form at medium pH values.
- ATP will not deliver energy if it is ionized.
- Amino acid side chains have many carboxyl and amino groups.

Part F

To make a buffer, you need to ...

ANSWER:

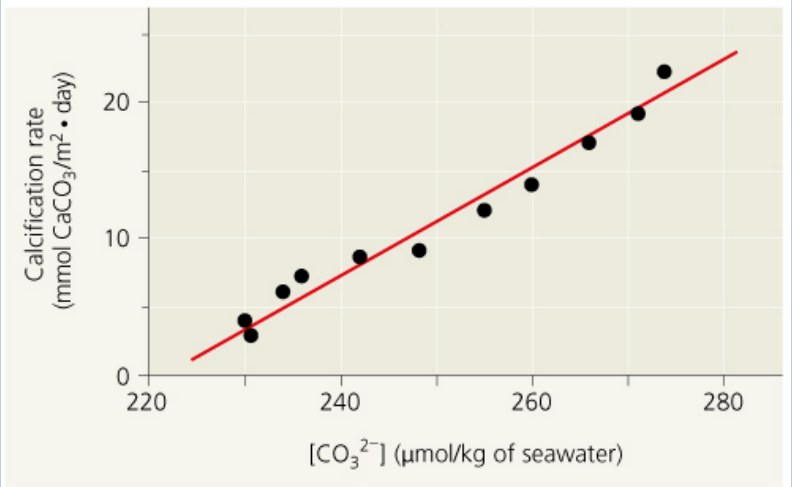
- (a) combine equal amounts of a strong acid and a strong base in water.
- (b) put either a strong acid or a strong base in water.
- (c) adjust the pH to 7.0.
- (d) have a weak acid or a weak base half ionized in water.
- Both (a) and (c).

Scientific Skills Exercise: Interpreting a Scatter Plot with a Regression Line

How does the carbonate ion concentration of seawater affect the calcification rate of a coral reef?

Scientists predict that acidification of the ocean due to higher levels of atmospheric CO_2 will lower the concentration of dissolved carbonate ions (CO_3^{2-}), which living corals use to build calcium carbonate ($CaCO_3$) reef structures. In this exercise, you will analyze data from a controlled experiment in the Biosphere 2 aquarium that examined the effect of different carbonate ion concentrations in seawater on the rate of calcium carbonate deposition by reef organisms, a process called calcification.

The graph shows the data from the experiment. The black data points form a scatter plot. The red line is a linear regression, or best-fitting line, to the points.



Data from C. Langdon et al., Effect of calcium carbonate saturation state on the calcification rate of an experimental coral reef, *Global Biogeochemical Cycles* 14:639-654 (2000).

Part A - Understanding the parts of the graph

What is shown on the *x*-axis, and in what units?

ANSWER:

- the calcium carbonate ($CaCO_3$) concentration of seawater, in micromoles per kilogram of seawater
- the calcification rate in millimoles of calcium carbonate ($CaCO_3$) accumulated per square meter of reef per day
- the calcification rate in micromoles per kilogram of seawater
- the carbonate ion (CO_3^{2-}) concentration of seawater, in micromoles per kilogram of seawater

Part B

What is shown on the *y*-axis, and in what units?

ANSWER:

- the carbonate ion (CO_3^{2-}) concentration of seawater, in micromoles per kilogram of seawater
- the calcification rate in millimoles of calcium carbonate ($CaCO_3$) accumulated per square meter of reef per day
- the total calcium carbonate ($CaCO_3$) accumulation on the reef in millimoles per day
- the calcification rate in millimoles of carbonate ion (CO_3^{2-}) accumulated per square meter of reef per day

Part C

Which variable is the independent variable in this experiment--the variable that was *manipulated* by the researchers?

ANSWER:

- carbonate ion concentration in the seawater
- calcification rate
- the surface area of the reef
- how many days the reef was measured

Part D

Which variable is the dependent variable--the variable that responded to or depended on the treatment, and was *measured* by the researchers?

ANSWER:

- carbonate ion concentration in the seawater
- calcification rate
- the surface area of the reef
- the acidity of the seawater

Part E - Reading the graph

Based on this graph, what is the relationship between carbonate ion concentration and calcification rate?

ANSWER:

- As the rate of calcification is increased, the concentration of carbonate ions increases.
- As the acidity of the seawater is increased, the rate of calcification decreases.
- As the concentration of carbonate ions is increased, the rate of calcification increases.
- As the concentration of carbonate ions is increased, the rate of calcification decreases.

Part F - Using data from the graph

You can determine the rate of calcification at any given carbonate ion concentration as follows: Draw a vertical line up from the *x*-axis at that concentration value until it intersects the red linear regression line; then draw a horizontal line from the intersection over to the *y*-axis to see what the calcification rate is at that carbonate ion concentration.

If the seawater carbonate ion (CO_3^{2-}) concentration is 270 µmol/kg, a) what is the approximate rate of calcification, and b) approximately how many days would it take 1 square meter of reef to accumulate 30 mmol of calcium carbonate ($CaCO_3$)?

ANSWER:

- 10 mmol $CaCO_3$ per m^2 per day; 3 days
- 20 mmol $CaCO_3$ per m^2 per day; 0.67 days
- 20 mmol $CaCO_3$ per m^2 per day; 1.5 days
- 20 mmol $CaCO_3$ per m^2 per day; 600 days

Part G

If the seawater carbonate ion concentration is 250 µmol/kg, a) what is the approximate rate of calcification, and b) approximately how many days would it take 1 square meter of reef to accumulate 30 mmol of calcium carbonate?

ANSWER:

- 5 mmol $CaCO_3$ per m^2 per day; 6 days
- 10 mmol $CaCO_3$ per m^2 per day; 0.33 days
- 10 mmol $CaCO_3$ per m^2 per day; 3 days
- 10 mmol $CaCO_3$ per m^2 per day; 300 days

Part H - Interpreting the graph

What happens when carbonate ion concentration in seawater *decreases*?

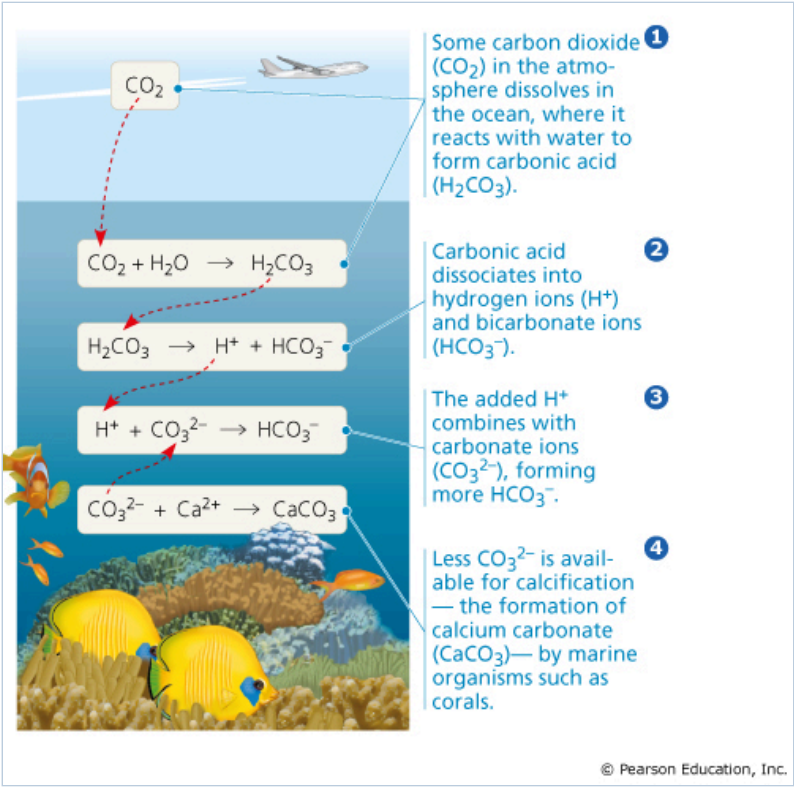
ANSWER:

- The rate of calcification decreases, and it takes less time for the reef coral to grow.
- The rate of calcification increases, and it takes less time for the reef coral to grow.
- The rate of calcification decreases, and it takes longer for the reef coral to grow.
- The rate of calcification increases, and it takes longer for the reef coral to grow.

Part I

Review the figure showing the effect of atmospheric CO_2 on the oceans. (Select Figure 2 in the drop-down menu above the graph.)

Which step of the process shown in that figure was measured in the Biosphere 2 experiment?



ANSWER:

- the first step
- the second step
- the third step
- the fourth step

Part J - Evaluating a hypothesis

Consider the hypothesis that increased atmospheric concentrations of CO_2 will slow the growth of coral reefs, as the series of reactions in Figure 2 suggest. Do the results of the Biosphere 2 experiment support that hypothesis? Why or why not?

ANSWER:

- No; more atmospheric CO_2 dissolving into the oceans causes an *increase* in the amount of CO_3^{2-} in seawater, leading to a *higher* rate of calcification and faster reef growth.
- Yes; more CO_2 dissolving into the oceans causes a *decrease* in the amount of CO_3^{2-} in seawater, leading to a *lower* rate of calcification and slower reef growth.
- No; more atmospheric CO_2 dissolving into the oceans causes a *decrease* in the amount of CO_3^{2-} in seawater, leading to a *higher* rate of calcification and faster reef growth.
- Yes; more CO_2 dissolving into the oceans causes an *increase* in the amount of CO_3^{2-} in seawater, leading to a *lower* rate of calcification and slower reef growth.

Chapter 3 Pre-Test Question 7

Part A

An acid is a substance that _____.

You did not open hints for this part.

ANSWER:

- forms covalent bonds with other substances
- increases the hydrogen ion concentration of an aqueous solution
- contains hydrogen
- is a versatile solvent
- reduces the hydrogen ion concentration of a solution

Chapter 3 Pre-Test Question 8

Part A

A pH of 6 is how many times more acidic than a pH of 9?

You did not open hints for this part.

ANSWER:

- 100
- 300
- 30
- 3
- 1,000

Chapter 3 Pre-Test Question 9

Part A

Select the statement that best describes a *buffer*.

You did not open hints for this part.

ANSWER:

- A buffer prevents the pH of a solution from changing when an acid or base is added.
- A buffer stabilizes the pH of a solution by preventing acids or bases from dissociating.
- Buffered solutions are always neutral with a pH of 7.
- A buffer resists change in pH by accepting hydrogen ions when acids are added to the solution and donating hydrogen ions when bases are added.
- A buffer causes acidic solutions to become alkaline and alkaline solutions to become acidic.

Chapter 3 Pre-Test Question 10

Part A

Global warming is causing atmospheric CO_2 levels to increase, which is expected to cause ocean acidification. Which of the following is NOT a consequence of increased atmospheric CO_2 levels?

You did not open hints for this part.

ANSWER:

- increase in the concentration of hydrogen ions in the oceans
- decrease in the amount of calcium carbonate produced in the oceans
- decrease in the concentration of carbonate ions in the oceans
- increase in the amount of carbonic acid formed in the oceans
- decrease in the concentration of bicarbonate ions in the oceans

Chapter 3 Question 9

EVOLUTION CONNECTION

Until fairly recently, scientists assumed that physical requirements for life, except water, included a moderate range of temperature, pH, atmospheric pressure, and salinity, as well as low levels of toxic chemicals. That view has changed with the discovery of organisms known as extremophiles, which flourish in hot, acidic sulfur springs, around hydrothermal vents deep in the ocean, and in soils with high levels of toxic metals.

Part A

Why would astrobiologists study extremophiles?

ANSWER:

- Extreme environments on Earth may be similar to those found on other planets. The fact that life probably evolved and continues to flourish in such extreme environments here on Earth suggests that some form of life may have evolved on other planets.
- Extremophiles might be the key to the future survival of the human race when the climate on Earth changes dramatically.
- The study of extremophiles might help to prepare humanity for colonization and survival on other planets.
- Extremophiles might be the organisms brought on Earth with meteorites millions of years ago. Their ability to live in extreme climates might be the key point for astrobiologists to find life on other planets.

Part B

What does the existence of life in such extreme environments say about the possibility of life on other planets?

Match the terms in the left column to the appropriate blanks in the sentences on the right. Not all terms will be used.

ANSWER:

Reset Help

organic compounds
water
incapable of supporting life
carbon
uninhabited

In addition to seeking evidence for the past or current presence of [ ] on Mars or other celestial bodies, scientists now know to search in environments that previously would have been thought [ ] .

Chapter 3 Question 10

Part A

SCIENTIFIC INQUIRY

Design a controlled experiment to test the hypothesis that water acidification caused by acidic rain would inhibit the growth of *Elodea*, a freshwater plant.

Match the terms in the left column to the appropriate blanks in the sentences on the right. Not all terms will be used.

ANSWER:

Reset Help

3 (fairly acidic)
in water pH and nutrient availability
average
are identical in each water bath
only in water pH
are not taken into account
maximum
11 (fairly alkaline)
declines
rises

Hypothesis: The growth rate of the freshwater plant *Elodea* declines as water pH [ ] from 7 (neutral) to [ ] .

Experiment: Set up a number of water baths for each pH value. The water baths vary [ ] . The same mass of *Elodea* is added to each water bath at the beginning of the experiment. All other relevant variables [ ] . The mass of *Elodea* in each water bath is measured weekly. At the end of the experiment, the [ ] growth rate of *Elodea* is calculated for each pH treatment, and growth rates at different pH values are compared.

Chapter 3 Question 36

Part A

A solution contains 0.0000001 (10^{-7}) moles of hydrogen ions [H^+] per liter. Which of the following best describes this solution?

ANSWER:

- acidic: H^+ donor
- acidic: H^+ acceptor
- basic: H^+ acceptor
- neutral

Chapter 3 Question 35

Part A

What is the pH of a solution with a hydroxyl ion (OH^-) concentration of 10^{-10} M?

ANSWER:

- pH 2
- pH 4
- pH 10
- pH 12

Chapter 3 Question 31

Part A

A solution of pH 7 is _____ than a solution of pH 8.

ANSWER:

- 100% more acidic
- twice as acidic
- 100% less acidic
- ten times as acidic

Chapter 3 Question 48

Part A

How would acidification of seawater affect marine organisms?

ANSWER:

- It will increase dissolved carbonate concentrations and hinder growth of corals and shell-building animals.
- It will increase dissolved carbonate concentrations and promote faster growth of corals and shell-building animals.
- It will decrease dissolved carbonate concentrations and promote faster growth of corals and shell-building animals.
- It will decrease dissolved carbonate concentrations and hinder growth of corals and shell-building animals.

Chapter 3 Question 47

Part A

Increased atmospheric CO_2 concentrations might have what effect on seawater?

ANSWER:

- There will be no change in the pH of seawater, because carbonate will turn to bicarbonate.
- Seawater will become more acidic, and carbonate concentrations will decrease.
- Seawater will become more acidic, and carbonate concentrations will increase.
- Seawater will become more alkaline, and carbonate concentrations will decrease.

Chapter 3 Question 46

Part A

A beaker contains 100 milliliters (mL) of NaOH solution at pH = 13. A technician carefully pours into the beaker 10 mL of HCl at pH = 1. Which of the following statements correctly describes the result of this mixing?

ANSWER:

- The concentration of Na+ ions will rise.
- The pH of the beaker's contents will decrease.
- The pH of the beaker's contents will increase.
- The pH of the beaker's contents will be neutral.

Chapter 3 Question 44

Part A

Dilution of a buffer solution with a small amount of water will _____ the pH of the solution.

ANSWER:

- lower
- raise
- immediately raise then lower
- not bring major change in

Chapter 3 Question 41

Part A

As the $[H_3O^{+}]$ of the solution decreases, the $[OH^{-}]$ _____.

ANSWER:

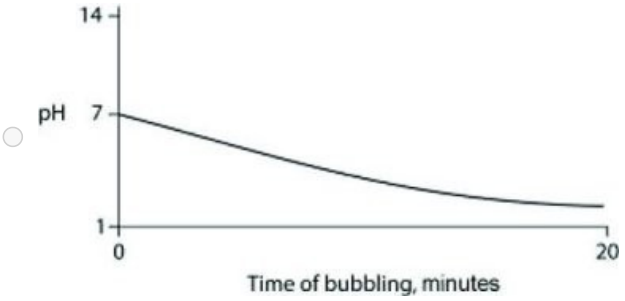
- decreases and thus the pH decreases
- decreases and thus the pH increases
- increases and thus pH decreases
- increases and thus pH increases

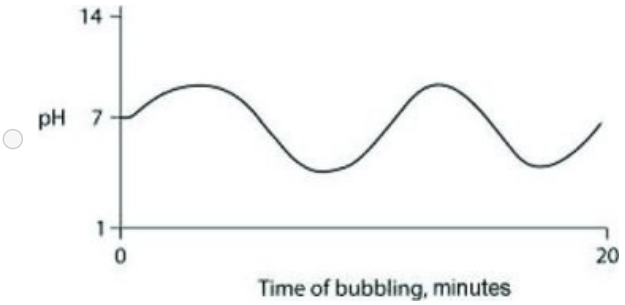
Chapter 3 Question 49

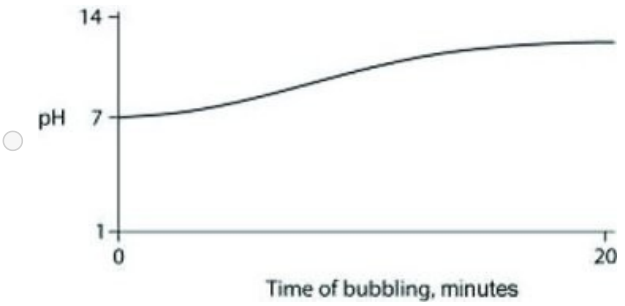
Part A

Carbon dioxide (CO_2) is readily soluble in water, according to the equation $CO_2 + H_2O \leftrightarrow H_2CO_3$. Carbonic acid ($H_2CO_3$) is a weak acid. If CO_2 is bubbled into a beaker containing pure, freshly distilled water, which of the following graphs correctly describes the results?

ANSWER:







Chapter 3 Question 42

Part A

What is the reason why Hydrochloric acid is such a strong acid?

ANSWER:

- HCl produces a gaseous product when it is neutralized
- aqueous solutions of HCl contain equal concentrations of $H^+(aq)$ and $OH^-(aq)$
- HCl dissociates completely to $H^+(aq)$ and $Cl^-(aq)$ in water
- HCl does not dissociate at all when it is dissolved in water

Chapter 3 Question 39

Part A

Assume that acid rain has lowered the pH of a lake to pH 5.0. What is the hydroxide ion concentration of this lake?

ANSWER:

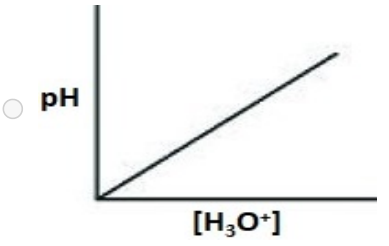
- 1×10^{-5} mol of hydroxide ions per liter of lake water
- 5.0×10^{-5} mol of hydroxide ions per liter of lake water
- 5.0 M hydroxide ion
- 1×10^{-9} mol of hydroxide ions per liter of lake water

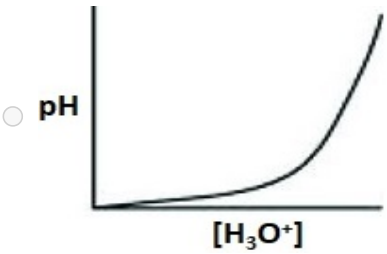
Chapter 3 Question 45

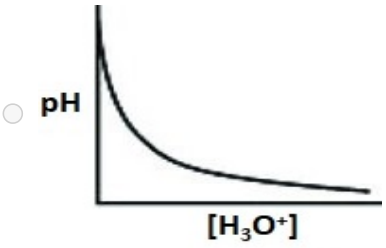
Part A

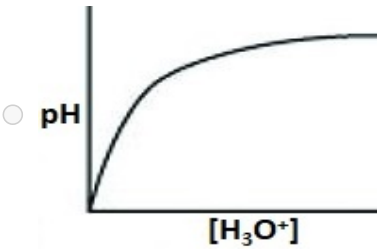
Which of the following graphs describes the relationship between $[H_3O^+]$ and pH?

ANSWER:









Chapter 3 Question 43

Part A

How would you describe a buffer solution?

ANSWER:

- weak acid and its conjugate base
- weak base and its conjugate acid
- strong acid and its conjugate base
- strong base and its conjugate acid

Chapter 3 Question 40

Part A

Consider two solutions: solution X has a pH of 4; solution Y has a pH of 7. From this information, we can reasonably conclude that _____.

ANSWER:

- the concentration of hydrogen ions in solution X is 1000 times as great as the concentration of hydrogen ions in solution Y
- the concentration of hydrogen ions in solution X is 3 times as great as the concentration of hydrogen ions in solution Y
- the concentration of hydrogen ions in solution Y is 1000 times as great as the concentration of hydrogen ions in solution X
- solution Y has no free hydrogen ions (H^+)

Chapter 3 Question 38

Part A

If a few drops of HCl is added to the buffer solution with the following equilibrium, _____.

$NH_4^+(aq) + H_2O_{(1)} \Leftarrow H_3O^+_{(aq)} + NH_{3(aq)}$

ANSWER:

- the concentrations of both NH_3 and NH_4^+ increase
- the concentration of NH_3 increases but NH_4^+ decreases
- the concentrations of both NH_3 and NH_4^+ decrease
- the concentration of NH_3 decreases but NH_4^+ increases

Chapter 3 Question 37

Part A

What will be the most likely change in pH when the H^+ ions in the solution is increased to twice its original concentration?

ANSWER:

- 1.6 to 1.3
- 4.0 to 2.0
- 9.5 to 6.5
- 5.0 to 2.5

Chapter 3 Question 34

Part A

What is the concentration of hydroxide ions in a solution of pH 5?

ANSWER:

- 10^{-9} M
- 10^{-5} M
- 10^{-12} M
- 10^{-10} M

Chapter 3 Question 33

Part A

Which of the following is considered to be a strong base (alkali)?

ANSWER:

- $H_2CO_3 \leftrightarrow HCO_3^- + H^+$
- $HCl \rightarrow H^+ + Cl^-$
- $NH_3 + H^+ \leftrightarrow NH_4^+$
- $NaOH \rightarrow Na^+ + OH^-$

Chapter 3 Question 32

Part A

Consider the following reaction at equilibrium: $CO_2 + H_2O \Leftrightarrow H_2CO_3$. What would be the effect of adding additional H_2O?

ANSWER:

- It would drive the equilibrium dynamics to the right.
- It would drive the equilibrium dynamics to the left.
- Nothing would happen because the reactants and products are in equilibrium.
- Reactions in both the directions will slow down.

Chapter 3 Question 30

Part A

Rank, from low to high, the pH of blood, stomach acid, and urine.

ANSWER:

- blood, urine, and stomach acid
- urine, blood, stomach acid
- stomach acid, urine, blood
- stomach acid, blood, and urine

Get Ready for This Chapter: Chapter 3 Question 1

In this chapter, you will learn how the structure of water endows it with unique properties that enable life on Earth. Before beginning this chapter, you should be able to explain what electronegativity is (see Concept 2.3, section entitled “Covalent Bonds”). The following question provides a quick check of your basic knowledge in this area.

Part A

Electronegativity is

ANSWER:

- the attraction of an atom for the electrons in a covalent bond.
- the repulsion of electrons in one atom for electrons in another atom.
- the negative charge surrounding the nucleus of an atom.
- the number of electrons in the outermost electron shell.

Get Ready for This Chapter: Chapter 3 Question 2

In this chapter, you will learn how the structure of water endows it with unique properties that enable life on Earth. Before beginning this chapter, you should be able to describe polar covalent bonds (see Concept 2.3, section entitled “Covalent Bonds”). The following question provides a quick check of your basic knowledge in this area.

Part A

A polar covalent bond between two atoms results from

ANSWER:

- whether the bond is single or not.
- two atoms that do not have similar electronegativities.
- the presence of two ions close to each other.
- the shape of the molecule that has the bond.

Get Ready for This Chapter: Chapter 3 Question 3

In this chapter, you will learn how the structure of water endows it with unique properties that enable life on Earth. Before beginning this chapter, you should be able to describe how the structure of water results in hydrogen bonds (see Figures 2.11 and 2.14). The following question provides a quick check of your basic knowledge in this area.

Part A

Which of the following statements helps to explain why water molecules form hydrogen bonds?

ANSWER:

- Water is an electronegative molecule.
- The electrons spend more time around the hydrogen atoms because hydrogen is more electronegative than oxygen.
- There is a partial negative charge on each hydrogen atom and two partial positive charges on the oxygen atom in a water molecule.
- Attractions form between opposite partial charges.