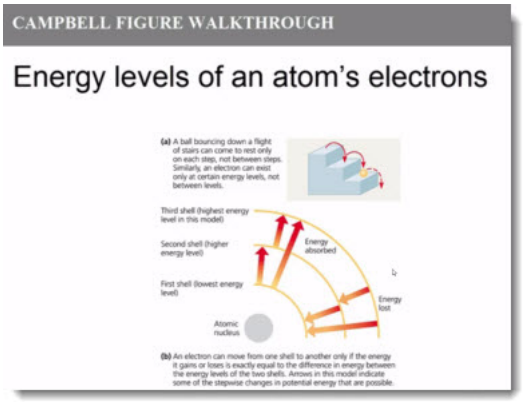
Ch. 2 Assessment

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

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

Campbell Figure Walkthrough: Energy Levels of an Atom's Electrons

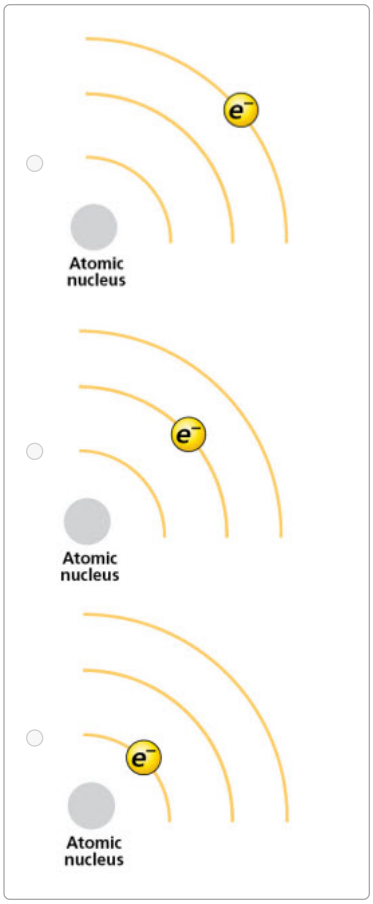
Watch this video and then answer the questions.



Part A

Compare the three atom diagrams. Which one shows the electron with the *highest* potential energy?

ANSWER:



Part B

Electrons are held in an atom by attraction to what particle or location?

ANSWER:

- Attraction to the magnetic neutrons in the nucleus
- Attraction to the positively charged protons in the nucleus
- Attraction to the lowest electron shell
- Attraction to the other electrons in the atom

Part C

What can happen to an electron when sunlight hits it?

Select all that apply.

ANSWER:

- [ ] It can stay in its original shell.
- [ ] It can collide with the nucleus.
- [ ] It can move out to a higher electron shell.
- [ ] It can drop down to a lower electron shell.

Part D

Drag the terms on the left to the appropriate blanks on the right to complete the sentences. Terms may be used more than once.

ANSWER:

Reset Help

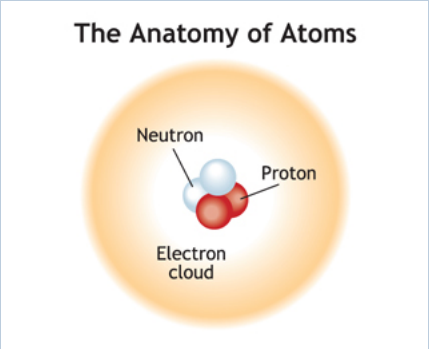
lower | **higher** | **farther from** | **closer to**

1. When an electron absorbs the required amount of light energy, it moves from a [ ] electron shell to a [ ] electron shell, which is [ ] the nucleus.

2. When an electron loses a discrete amount of energy, it moves from a [ ] electron shell to a [ ] electron shell, which is [ ] the nucleus.

The Anatomy of Atoms

All matter is made up of atoms. An atom has a nucleus consisting of positively charged protons and uncharged neutrons. Negatively charged electrons are found outside of the nucleus of the atom.



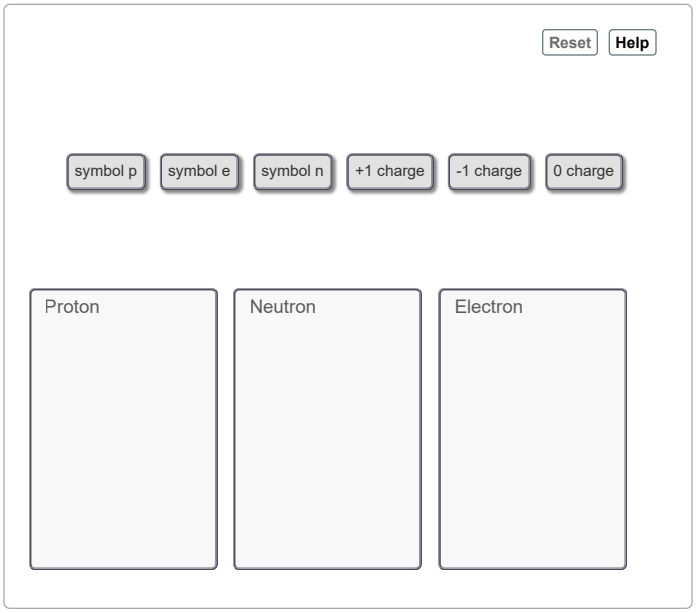
Part A

Match each property to the appropriate subatomic particle.

Drag each property into the correct bin.

You did not open hints for this part.

ANSWER:



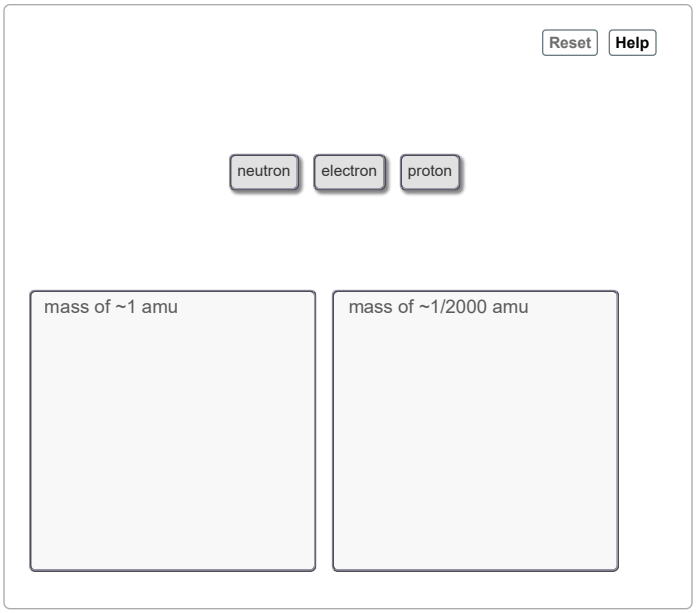
Part B

Sort the subatomic particles according to their masses.

Drag each subatomic particles into the correct bin.

You did not open hints for this part.

ANSWER:



Scientific Skills Exercise: Calibrating a Standard Radioactive Isotope Decay Curve and Interpreting Data

When did Neanderthals become extinct?

Neanderthals (*Homo neanderthalensis*) were living in Europe by 350,000 years ago and are thought to have coexisted with *Homo sapiens* in parts of Eurasia after *H. sapiens* arrived there. Researchers sought to more accurately determine the extent of their overlap by pinning down when Neanderthals became extinct. They used carbon-14 dating to determine the age of a Neanderthal fossil from the most recent (uppermost) archeological layer yet found to contain Neanderthal bones. In this exercise, you will calibrate a standard carbon-14 decay curve and use it to date this fossil. The age of the fossil will help you approximate the last time the two species may have coexisted at the site where the fossil was found--and therefore a date on or after which the Neanderthals went extinct.

Data from R. Pinhasi et al., Revised age of late Neanderthal occupation and the end of the Middle Paleolithic in the northern Caucasus, *Proceedings of the National Academy of Sciences USA* 147:8611–8616 (2011). doi 10.1073/pnas.1018938108

Part A - Reading the graph

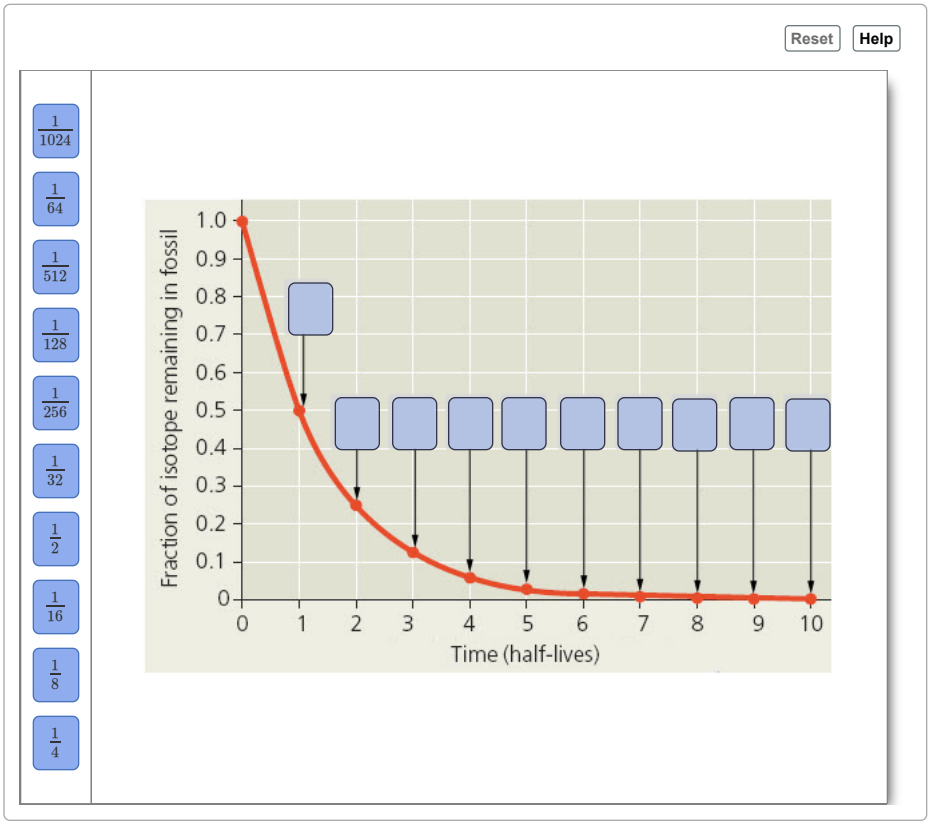
Carbon-14 (^{14}C) is a radioactive isotope of carbon that decays to ^{14}N at a constant rate. ^{14}C is present in the atmosphere in small amounts at a constant ratio to both ^{13}C and ^{12}C, two stable isotopes of carbon. When carbon is taken up from the atmosphere by a plant during photosynthesis, ^{12}C, ^{13}C, and ^{14}C isotopes are incorporated into the plant in the same proportions in which they are present in the atmosphere. These proportions remain the same in the tissues of an animal that eats the plant.

While an organism is alive, the ^{14}C in its body decays to ^{14}N but is continually replaced by new carbon from the environment. Once an organism dies, it stops taking in new ^{14}C, but the ^{14}C in its tissues continues to decay, while the ^{12}C in its tissues remains the same because it is not radioactive and does not decay. Thus, scientists can calculate how long the pool of original ^{14}C has been decaying in a fossil by measuring the ratio of ^{14}C to ^{12}C and comparing it to the ratio of ^{14}C to ^{12}C present originally in the atmosphere. The fraction of ^{14}C in a fossil compared to the original fraction of ^{14}C can be converted to years because we know that the half-life of ^{14}C is 5,730 years—in other words, half of the ^{14}C in a fossil decays every 5,730 years.

The graph below shows a standard graph of radioactive isotope decay. The red curve indicates the fraction of the radioactive isotope remaining (on the *y*-axis) over time in units of half-lives (on the *x*-axis). Recall that a half-life is the amount of time it takes for half of the radioactive isotope to decay.

Drag the fractions to indicate the amount of isotope remaining at each point in time.

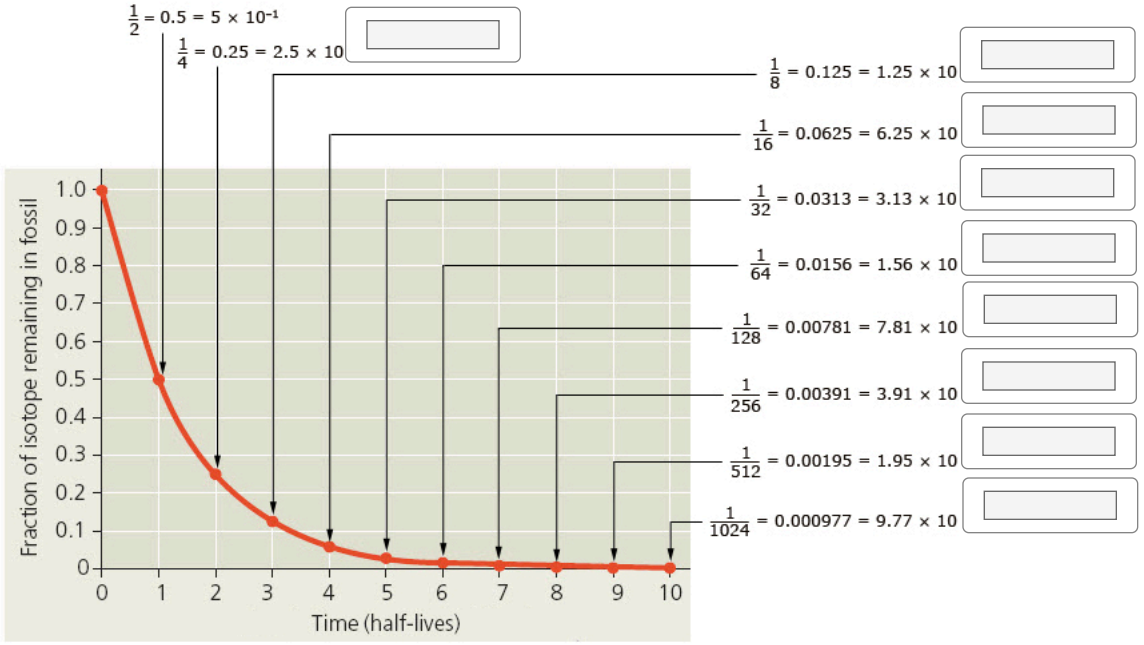
ANSWER:



Part B

The graph below is the same as in Part A, but with the fractions converted to decimal values. For each decimal value, fill in the exponent to complete the scientific notation. Don't forget to indicate if the exponent should be negative (-). The first one has been done for you.

ANSWER:



Part C - Calibrating the graph to ^{14}C decay

The graph you constructed so far applies to decay of any radioisotope. To calibrate it specifically to ^{14}C, you need to calculate how many years must pass to reach the amount of remaining isotope for each point of the half-life curve.

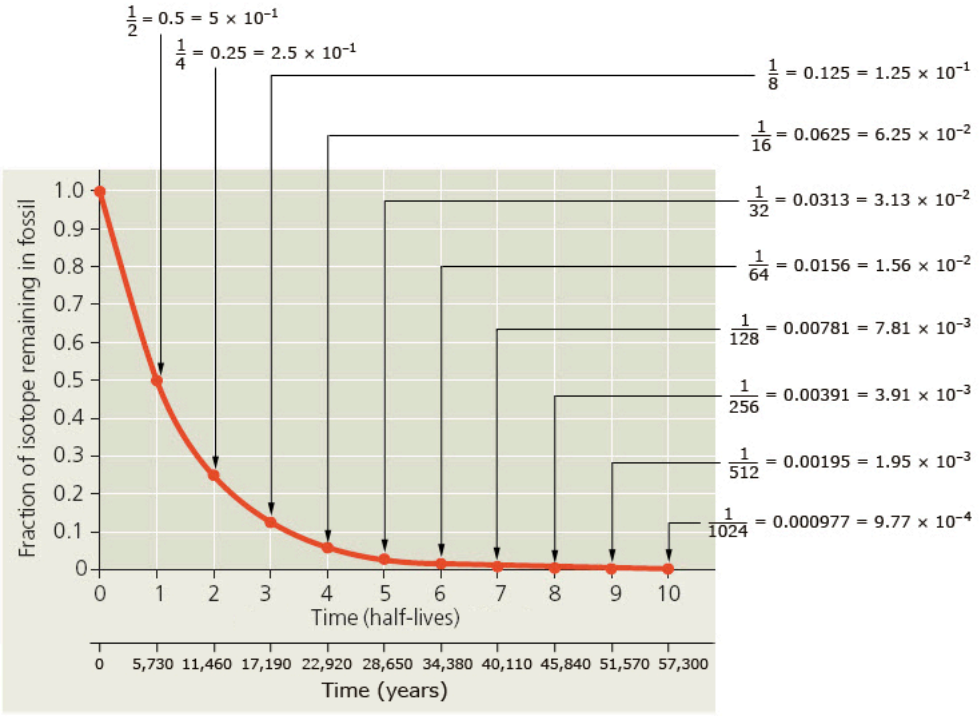
To calibrate the *x*-axis for ^{14}C decay, you have to convert half-lives to number of years. Recall that ^{14}C has a single half-life of 5,730 years. How many years make up 5 half-lives for ^{14}C?

ANSWER:

- 3.13×10^{-2} years
- 1,146 years
- 5,730 years
- 28,650 years

Part D - Using data from the graph

The graph below has the *x*-axis calibrated for ^{14}C decay.



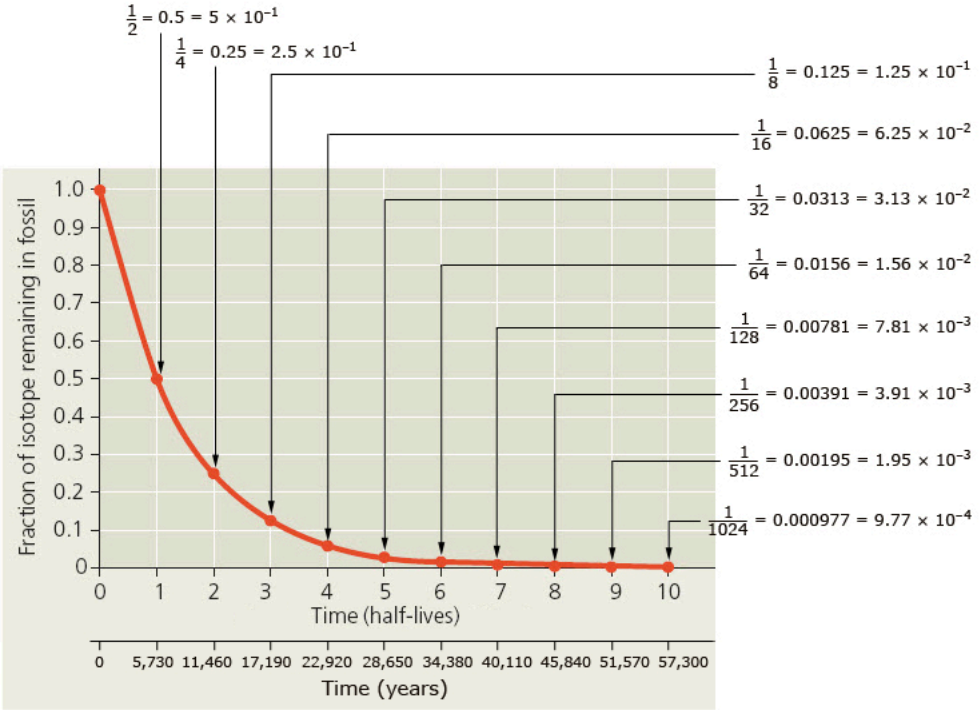
The researchers found that the Neanderthal fossil had approximately 7.80×10^{-3} as much ^{14}C as was present in the atmosphere around the living Neanderthal and the plants it ate.

Approximately how many half-lives have passed since the Neanderthal died?

ANSWER:

- 1/128 half-lives
- 6 half-lives
- 7 half-lives
- 8 half-lives

Part E



Using the ^{14}C calibration on the *x*-axis, what is the approximate age of the Neanderthal fossil?

ANSWER:

- 5,730 years old
- 34,380 years old
- 40,110 years old
- 45,840 years old

Part F - Interpreting the data

Recall that the analyzed fossil was found in the most historically recent (uppermost) layer containing Neanderthal bones of the excavated archeological site.

Approximately when did Neanderthals become extinct at this location, according to the study?

ANSWER:

- 40,110 years ago or less
- more than 40,110 years ago
- A fossil from the oldest (deepest) layer would need to be carbon dated to determine when Neanderthals went extinct.

Part G

The researchers cite evidence that modern humans (*H. sapiens*) became established in the same region as the last Neanderthals approximately 39,000–42,000 years ago.

What does this suggest about the possible overlap of Neanderthals and modern humans in the region?

ANSWER:

- Modern humans killed off the last of the Neanderthals when they moved into the same region, which led to the extinction of the Neanderthals.
- Neanderthals and modern humans may have lived in the same region for up to approximately 2,000 years, or they may not have overlapped at all.
- Neanderthals and modern humans could not have lived in the same region at the same time, so they would not have come in contact.

Part H - Dating other fossils

Carbon-14 dating works for fossils up to about 75,000 years old.

Most dinosaurs went extinct 65.5 million years ago. Can ^{14}C be used to date dinosaur bones?

ANSWER:

- Yes, the bones continued to take in ^{14}C, even after the dinosaur died.
- No, ^{14}C can only be used to date dinosaur teeth, which are much stronger than bones.
- Yes, the bones contained ^{14}C when the dinosaur died so it can be measured to determine the fossil's age.
- No, the ^{14}C present in the dinosaur when it died would decay too much to be measured after 65.5 million years.

Part I

Radioactive uranium-235 has a half-life of 704 million years. If it was incorporated into dinosaur bones, could it be used to date the dinosaur fossils?

ANSWER:

- No, only about one tenth of the ^{235}U would have decayed after 65.5 million years, not leaving enough to measure in the fossils.
- No, the dinosaurs went extinct too recently to use a radioisotope with a half-life of 704 million years.
- Yes, but only for dinosaurs that lived more than 704 million years ago.
- Yes, after 65.5 million years only about one tenth of the ^{235}U would have decayed, leaving plenty to measure in the fossils.

Atomic Number and Mass Number

Learning Goal:
To understand the relationship between atomic number and mass number.

Atoms are described by an atomic number and a mass number. The atomic number is the number of protons in the nucleus. The mass number represents the sum of the protons and the neutrons in the nucleus. If the number of negative electrons is equal to the number of positive protons, then the atom is neutral. If the number of protons and electrons are not equal, then the atom will have a charge.
For example, a phosphorus ion with 15 protons, 17 neutrons, and 18 electrons would have an atomic number of 15, a mass number of 32, and a charge of −3.

Part A

What is the mass number of an ion with 105 electrons, 159 neutrons, and a +1 charge?

Express your answer as an integer.

You did not open hints for this part.

ANSWER:

Building Vocabulary: Word Roots - Chemistry

Knowing the meaning of common prefixes, suffixes, and word roots can help you understand biology terms.

Part A

Can you match these prefixes, suffixes, and word roots with their definitions?

ANSWER:

Reset Help

poly-	four:
iso-	three:
co-	two:
di-	many:
mono-	against:
anti-	not:
***quad-* (or *quat-*)**	first:
prim-	with or together with:
non-	equal:
tri-	single:

Part B

Can you match these prefixes, suffixes, and word roots with their definitions?

ANSWER:

Reset Help

ad-	first:
-phil	to:
neutr-	to love:
lip-	water:
hydro-	fat:
proto-	to fear:
de-	of neither gender or type:
-phob	from, out of, remove:
-lysis	loosening, split apart:

Get Ready for This Chapter: Chapter 2 Question 1

In this chapter, you will learn about the structures of atoms and molecules and how bonding and chemical reactions are central to life processes. Before beginning this chapter, you should be able to list the levels of biological organization (see Figure 1.3). The following question provides a quick check of your basic knowledge in this area.

Part A

Which of the following lists some of the levels of biological organization from less complex to more complex?

ANSWER:

- molecules, atoms, cells, organs
- atoms, molecules, organs, cells
- atoms, cells, molecules, organs
- atoms, molecules, cells, organs

Get Ready for This Chapter: Chapter 2 Question 2

In this chapter, you will learn about the structures of atoms and molecules and how bonding and chemical reactions are central to life processes. Before beginning this chapter, you should be able to describe the interaction of energy and chemicals within an ecosystem (see Figure 1.9). The following question provides a quick check of your basic knowledge in this area.

Part A

Which of the following is a true statement about how living organisms use energy and chemicals to carry out life's activities?

ANSWER:

- Both energy and chemicals flow through an ecosystem.
- Both energy and chemicals cycle within an ecosystem.
- Energy flows through an ecosystem, but chemicals cycle within it.
- Energy cycles within an ecosystem, but chemicals flow through it.

Get Ready for This Chapter: Chapter 2 Question 3

In this chapter, you will learn about the structures of atoms and molecules and how bonding and chemical reactions are central to life processes. Before beginning this chapter, you should be able to explain how natural selection leads to the evolution of adaptations (see Concept 1.2, section entitled “Charles Darwin and the Theory of Natural Selection”). The following question provides a quick check of your basic knowledge in this area.

Part A

Which the following statements about Darwin’s theory of natural selection is true?

ANSWER:

- Natural selection, by its cumulative effects over long periods of time, could have caused random changes in ancestral species, thus giving rise to two or more descendant species.
- Individuals with inherited traits that are better suited to the local environment are more likely to survive and reproduce than less well-suited individuals.
- The natural environment consistently causes variation of certain traits in the population.
- In order to reproduce more successfully, an individual must evolve so that it adapts to its environment.

Chapter 2 Question 2

Part A

In the term *trace element*, the adjective *trace* means that

ANSWER:

- the element is very rare on Earth.
- the element is required in very small amounts.
- the element enhances health but is not essential for the organism's long-term survival.
- the element can be used as a label to trace atoms through an organism's metabolism.

Chapter 2 Pre-Test Question 2

Part A

Which of the following is a trace element found in the human body?

You did not open hints for this part.

ANSWER:

- hydrogen
- magnesium
- nitrogen
- carbon
- oxygen

Chapter 2 Question 10

Part A

EVOLUTION CONNECTION

The percentages of naturally occurring elements making up the human body are similar to the percentages of these elements found in other organisms. How could you account for this similarity among organisms?

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

evolved on Earth
essential
living under unusual conditions
less
more
naturally occurring
trace
genetically

All organisms [ ] (with its unique elemental composition), and all are [ ] related to one another. Species [ ] might differ more than others, though.

We also might predict that the more similar the percentages of [ ] elements are in two species, the [ ] closely related those two species are.

Chapter 2 Question 2

Part A

Trace elements are those required by an organism in only minute quantities. Which of the following is a trace element that is required by all forms of life?

ANSWER:

- iodine
- mercury
- arsenic
- iron

Chapter 2 Question 1

Part A

About 25 of the 92 natural elements are known to be essential to life. Four of these 25 elements make up approximately 96% of living matter. Which of the following elements account for most of the remaining 4% of an organism's mass?

ANSWER:

- carbon, oxygen, hydrogen, nitrogen
- carbon, hydrogen, nitrogen, oxygen
- calcium, potassium, phosphorus, sulfur
- oxygen, hydrogen, calcium, nitrogen

Chapter 2 Question 4

Part A

Which of the following are compounds?

ANSWER:

- H_2O and CH_4, but not O_2
- H_2O, O_2, and CH_4
- O_2 and CH_4
- H_2O and O_2

Chapter 2 Question 3

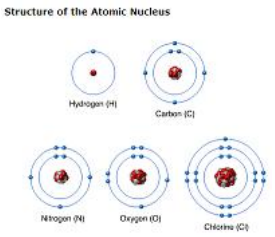
Part A

Which of the following statements is TRUE?

ANSWER:

- Carbon, hydrogen, oxygen, and calcium are the most abundant elements of living matter.
- All life requires the same essential elements.
- Some naturally occurring elements are toxic to organisms.
- A patient suffering from a goiter should not consume seafood.

Activity: Structure of the Atomic Nucleus



Watch the animation.

Then answer the questions.

Part A

What is the atomic number of an atom that has 6 protons, 6 neutrons, and 6 electrons?

ANSWER:

- -1
- 18
- 6
- 0
- 12

Part B

Which of these refers to atoms with the same atomic number but different atomic masses?

ANSWER:

- These atoms are different elements.
- These atoms have different numbers of electrons.
- These atoms are isotopes.
- These atoms have different numbers of protons.
- These atoms are isomers.

Part C

Fluorine's atomic number is 9 and its atomic mass is 19. How many neutrons does fluorine have?

ANSWER:

- 10
- 28
- 9
- 19
- 81

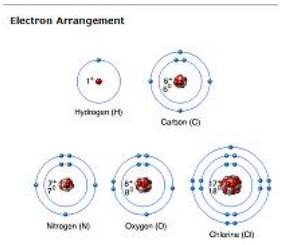
Part D

An uncharged atom of boron has an atomic number of 5 and an atomic mass of 11. How many protons does boron have?

ANSWER:

- 0
- 16
- 6
- 11
- 5

Activity: Electron Arrangement



Watch the animation.

Then answer the questions.

Part A

The innermost electron shell of an atom can hold up to _____ electrons.

ANSWER:

- 18
- 1
- 8
- 2
- 32

Part B

Which of these relationships is true of an uncharged atom?

ANSWER:

- The number of protons is equal to the number of electrons.
- The atomic mass is equal to the atomic number.
- The number of electrons is equal to the number of neutrons.
- The number of neutrons is equal to the number of protons.
- The atomic mass is equal to the number of electrons.

Part C

What determines the types of chemical reactions that an atom participates in?

ANSWER:

- the number of electrons in the outermost electron shell
- the number of protons it contains
- the number of electrons in the innermost electron shell
- its atomic mass
- its atomic number

Misconception Question 6

Part A

What does the term **electron orbital** describe?

ANSWER:

- An electron orbital describes the orbit of an electron around the nucleus.
- An electron orbital describes the exact distance of an electron from the nucleus.
- An electron orbital describes a three-dimensional space where an electron can be found 90% of the time.

Misconception Question 8

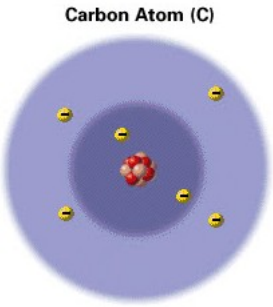
Part A

Which statement about relative potential energy of electrons is correct?

ANSWER:

- An electron in the *2 p* orbital of the second electron shell has more potential energy than an electron in the *2 s* orbital of the second electron shell.
- An electron in the *3 p* orbital of the third electron shell has more potential energy than an electron in the *2 p* orbital of the second electron shell.
- An electron in the *2 p* orbital of the second electron shell has more potential energy than an electron in the *3 p* orbital of the third electron shell.

Chemistry Review - Atoms & Molecules: Atomic Structure



Review the Atomic Structure tutorial.

Then answer the questions.

Part A

The mass number of an atom is 15, and its atomic number is 7. The atom probably has...

ANSWER:

- at least 15 electrons.
- 8 neutrons in the nucleus.
- about as much mass in electrons as in protons.
- 7 units of negative charge in the nucleus.
- 7 electrons in the nucleus.

Part B

Which statement is true of atoms?

ANSWER:

- Most of an atom's volume is filled with matter.
- Protons repel electrons.
- Electrons determine the atom's size.
- Protons attract other protons.
- All of the above.

Part C

Dr. Jones says an atom has 3 electrons in the first shell and four electrons in the second shell. Someone should tell Dr. Jones that ...

ANSWER:

- the first shell shouldn't have 3 electrons.
- no shell can hold more than 2 electrons.
- the first shell must fill before the second shell can have electrons.
- the second shell should have 8 electrons.
- the second shell can't have 4 electrons.

Part D

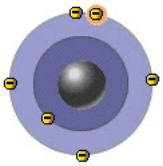
Which statement is true of the energy levels of electrons in shells?

ANSWER:

- The valence shell has higher energy than other occupied shells.
- Electrons must lose energy to move from the first to the second shell.
- All the electrons in an atom have similar amounts of energy.
- All of the above.
- None of the above.

Part E

Which statement is true of the atom shown in the diagram?



ANSWER:

- An electron will move from the outer to the inner shell.
- The atom is in the excited state.
- The atom has more than one valence electron.
- All of the above.
- None of the above.

Part F

Two atoms always represent the same element if they have ...

ANSWER:

- the same number of particles in the nucleus.
- the same number of protons.
- the same mass number.
- the same number of shells.
- the same number of electrons.

Part G

An atom has 6 electrons, 6 protons, and 6 neutrons. You can tell that this atom belongs to the element _____ because _____.

ANSWER:

- N; it has 6 electrons.
- C; it has 6 protons.
- N; it has 6 protons.
- C; it has 6 electrons.
- O; its mass number is 12.

Part H

An atom has 8 protons, 8 neutrons, and 8 electrons. Another isotope of the same element might have ...

ANSWER:

- 7 electrons.
- mass number 16, atomic number 7.
- 9 protons.
- 10 neutrons.
- All of the above.

Part I

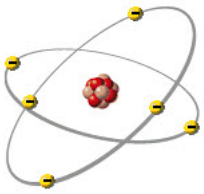
Radioactive decay is likely to occur when ...

ANSWER:

- atoms collide with one another.
- protons break into neutrons and electrons.
- an atom has too many electrons.
- an electron hits the nucleus.
- an atom has too many neutrons.

Part J

Which model most accurately represents the current view of the structure of the atom?



Planetary Model

Probability Model

ANSWER:

- Planetary model
- Probability model

Part K

Chemists assign atoms to chemical elements by counting their _____.

ANSWER:

- isotopes
- electrons
- protons
- neutrons

Chapter 2 Question 1

Part A

Compared with $^{31}\mathrm{P}$, the radioactive isotope $^{32}\mathrm{P}$ has

ANSWER:

- one more proton.
- one more electron.
- a different atomic number.
- one more neutron.

Chapter 2 Question 3

Part A

The reactivity of an atom arises from

ANSWER:

- the existence of unpaired electrons in the valence shell.
- the average distance of the outermost electron shell from the nucleus.
- the sum of the potential energies of all the electron shells.
- the potential energy of the valence shell.

Chapter 2 Question 6

Part A

We can represent atoms by listing the number of protons, neutrons, and electrons—for example, $2\mathrm{p}^{+}, 2\mathrm{n}^{0}, 2\mathrm{e}^{-}$ for helium. Which of the following represents the $^{18}\mathrm{O}$ isotope of oxygen?

ANSWER:

- $10\mathrm{p}^{+}, 8\mathrm{n}^{0}, 9\mathrm{e}^{-}$
- $8\mathrm{p}^{+}, 10\mathrm{n}^{0}, 8\mathrm{e}^{-}$
- $9\mathrm{p}^{+}, 9\mathrm{n}^{0}, 9\mathrm{e}^{-}$
- $7\mathrm{p}^{+}, 2\mathrm{n}^{0}, 9\mathrm{e}^{-}$

Chapter 2 Pre-Test Question 3

Part A

Which of the following subatomic particles always has a positive charge? See Concept 2.2 (Page)

You did not open hints for this part.

ANSWER:

- neutron
- atom
- proton
- electron
- element

Chapter 2 Pre-Test Question 5

Part A

The atoms of different phosphorus isotopes _____. See Concept 2.2 (Page)

You did not open hints for this part.

ANSWER:

- have different atomic numbers
- react differently with other atoms
- have different numbers of electrons
- have different numbers of protons
- have different numbers of neutrons

Chapter 2 Pre-Test Question 1

Part A

A substance that cannot be broken down into other substances by ordinary chemical procedures is a(n) _____.

You did not open hints for this part.

ANSWER:

- compound
- isotope
- proton
- molecule
- element

Chapter 2 Pre-Test Question 4

Part A

Changing the number of _____ would change an atom into an atom of a different element.

You did not open hints for this part.

ANSWER:

- bonds formed by an atom
- particles in the nucleus of an atom
- protons in an atom
- neutrons in an atom
- electrons circling the nucleus of an atom

Chapter 2 Question 6

Part A

Which of the following is true of oxygen that has 8 protons, 8 neutrons, and 8 electrons?

ANSWER:

- It has a mass number of 8.
- It has an atomic number of 8.
- It has atomic number of 16.
- It has a charge of +8.

Chapter 2 Question 7

Part A

How many electrons are present in a H- and H+ ion respectively?

ANSWER:

- 2,0
- 0,2
- 1,2
- 2,1

Chapter 2 Question 9

Part A

18
Ar
39.948

How many electrons are present in the neutral atom represented in the Periodic Table block in the figure?

ANSWER:

- 40
- 22
- 18
- 19

Chapter 2 Question 5

Part A

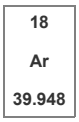
Atoms have no electric charge because they have _____.

ANSWER:

- an equal number of protons and neutrons
- an equal number of protons and electrons
- an equal number of charged and uncharged subatomic particles
- uncharged neutrons in their nuclei

Chapter 2 Question 8

Part A



What is the atomic number of the neutral atom represented by the Periodic Table block in the figure?

ANSWER:

- 19
- 18
- 39
- 22

Chapter 2 Question 25

Part A

To find out the number of neutrons in an atom, we need to know the following.

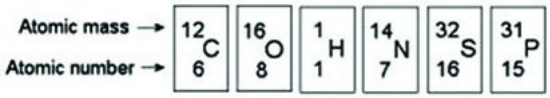
ANSWER:

- mass and atomic number
- mass number
- electron number
- atomic number

Chapter 2 Question 22

Part A

Refer to the following figure to answer the questions below.



How many electrons will a single atom of nitrogen with no charge and no bonds have in its valence shell?

ANSWER:

- 7
- 2
- 14
- 5

Chapter 2 Question 29

Part A

Based on electron configuration, which of the elements would exhibit a chemical behavior similar to oxygen?

ANSWER:

- sulfur
- nitrogen
- carbon
- phosphorus

Chapter 2 Question 26

Part A

Under which of the following conditions will an atom be the most stable?

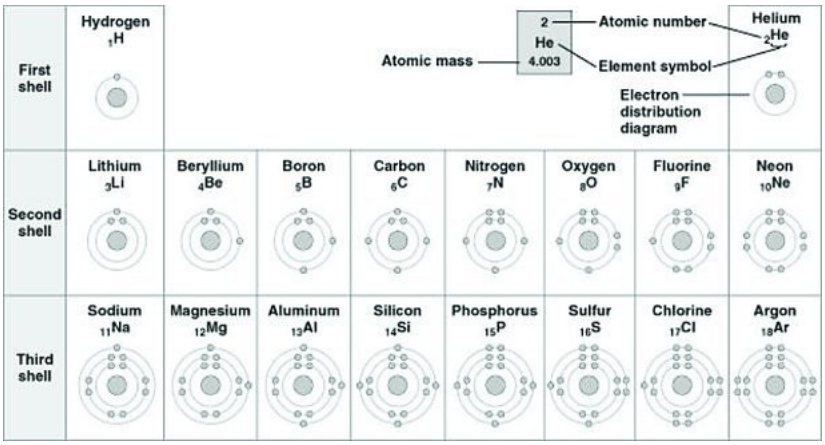
ANSWER:

- when all of the electron orbitals in the valence shell are filled
- when they have the maximum number of unpaired electrons
- when all electrons are paired
- when they have the fewest possible valence electrons

Chapter 2 Question 20

Part A

Refer to the following figure (first three rows of the periodic table) to answer the questions below.



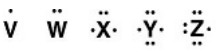
Which pair of elements is most likely to react if bought together?

ANSWER:

- hydrogen and lithium
- hydrogen and argon
- sodium and chlorine
- nitrogen and oxygen

Chapter 2 Question 28

Part A



In the above diagram, what kind of bond is most likely to form between V and Z?

ANSWER:

- hydrogen
- covalent
- van der Waals
- ionic

Chapter 2 Question 10

Part A

18
Ar
39.948

How many electrons are present in the +2 ionic form of the atom in the Periodic Table block shown in the figure?

ANSWER:

- 18
- 42
- 16
- 40

Chapter 2 Question 16

Part A

The atomic number of nitrogen is 7. Which of the following explains the greater mass number of nitrogen-15 compared to nitrogen-14? Nitrogen-15 contains _____.

ANSWER:

- 8 protons and nitrogen 14 contains 7 protons
- 7 neutrons and nitrogen-14 contains 8 neutrons
- 15 protons and nitrogen-14 contains 14 protons
- 8 neutrons and nitrogen-14 contains 7 neutrons

Chapter 2 Question 23

Part A

Oxygen has an atomic number of 8 and, most commonly, a mass number of 16. Thus, what is the atomic mass of an oxygen atom?

ANSWER:

- approximately 8 daltons
- approximately 16 grams
- approximately 8 grams
- approximately 16 daltons

Chapter 2 Question 24

Part A

Elements ^{72}Zn, ^{75}As, and ^{74}Ge have the same number of _____.

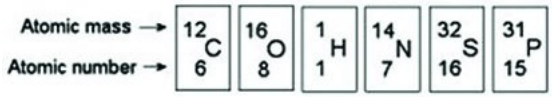
ANSWER:

- protons
- protons and electrons
- neutrons
- neutrons and electrons

Chapter 2 Question 21

Part A

Refer to the following figure to answer the questions below.



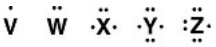
How many electrons are present in a Phosphorus 2+ atom?

ANSWER:

- 12
- 19
- 34
- 13

Chapter 2 Question 27

Part A



Which pair of elements in the diagram is most likely to form a ionic bond?

ANSWER:

- W and Z
- V and Y
- V and X
- V and Z

Chapter 2 Question 13

Part A

Which of the following atoms has the smallest number of neutrons?

ANSWER:

- carbon-14
- oxygen-16
- neon-20
- nitrogen-14

Chapter 2 Question 14

Part A

Molybdenum has an atomic number of 42. Several common isotopes exist, with mass numbers from 92-100. Based on this information, which of the following is also true of molybdenum?

ANSWER:

- Molybdenum atoms can have between 50 and 58 electrons.
- Isotopes of molybdenum have different numbers of electrons.
- Molybdenum atoms can have between 50 and 58 neutrons.
- Molybdenum atoms can have between 50 and 58 protons.

Chapter 2 Question 15

Part A

An ion that consists of 7 protons, 6 neutrons, and 11 electrons has a net charge of _____.

ANSWER:

- 4+
- 5-
- 5+
- 4-

Chapter 2 Question 11

Part A

Which of the following best explain why argon, which is a noble gas, does not react with other elements. Noble gases _____.

ANSWER:

- have completely paired up and stable electron shells
- have very small atoms
- are not found in abundance on our planet
- have a high positive charge that repels most elements

Chapter 2 Question 12

Part A

An ion with six protons, seven neutrons, and a charge of 2+ has an atomic number of _____.

ANSWER:

- seven
- four
- six
- five

Chapter 2 Question 17

Part A

Which of the following has the smallest total mass?

ANSWER:

- two electrons
- 1 neutron plus 1 proton
- two neutrons
- 1 electron plus 1 neutron

Chapter 2 Question 18

Part A

A neutral atom has 2, 8, 8 electrons in its first, second, and third energy levels. This information _____.

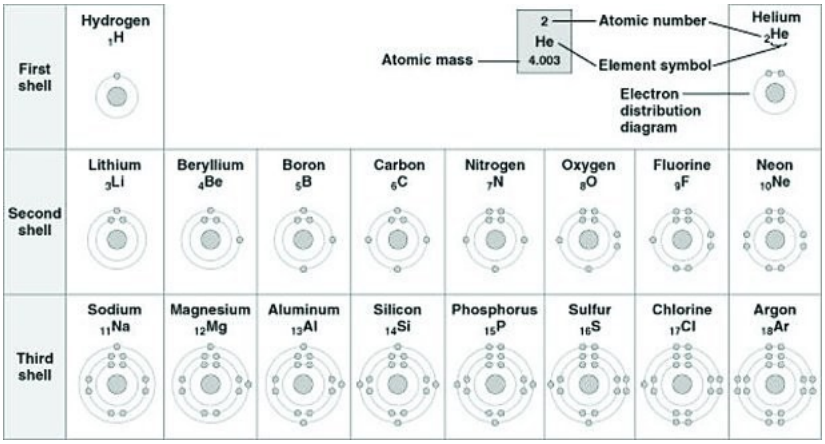
ANSWER:

- does not tell us about the chemical properties of the element
- does not tell us about the size of the element
- does not tell us about the atomic mass of the element
- does not tell us about the atomic number of the element

Chapter 2 Question 19

Part A

Refer to the following figure (first three rows of the periodic table) to answer the questions below.



What element does not react with other elements?

ANSWER:

- oxygen
- hydrogen
- silicon
- helium

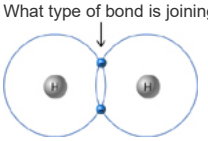
Activity: Covalent Bonds

Covalent Bonds

Watch the animation and answer the questions.

Part A

What type of bond is joining the two hydrogen atoms?



ANSWER:

- covalent
- ionic
- hydrophilic
- hydrophobic
- hydrogen

Part B

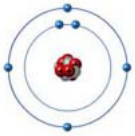
A(n) _____ refers to two or more atoms held together by covalent bonds.

ANSWER:

- molecule
- isotope
- ion
- shell
- community

Part C

This atom can form up to _____ single covalent bond(s).

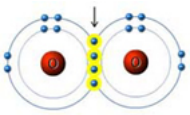


ANSWER:

- 0
- 2
- 4
- 1
- 3

Part D

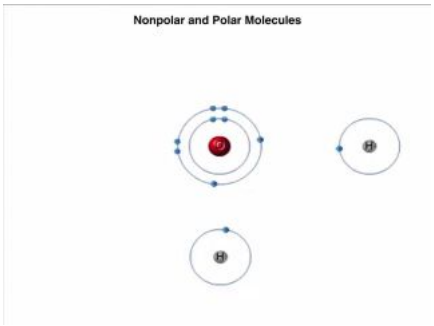
A(n) _____ bond joins these two oxygen atoms.



ANSWER:

- double covalent
- ionic
- single covalent
- hydrogen
- quadruple covalent

Activity: Nonpolar and Polar Molecules

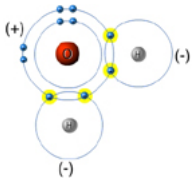


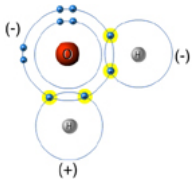
Watch the animation and answer the questions.

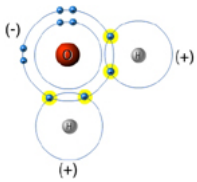
Part A

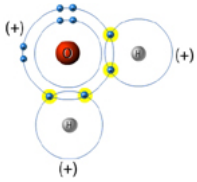
Which of these figures correctly illustrates the nature of the bonding of H_2O?

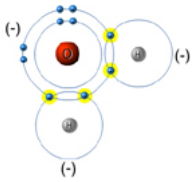
ANSWER:





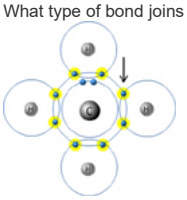






Part B

What type of bond joins the carbon atom to each of the hydrogen atoms?



ANSWER:

- polar covalent
- hydrogen
- single (nonpolar) covalent
- ionic
- double (nonpolar) covalent

Activity: Ionic Bonds

Ionic Bonds

Launch the Ionic Bonds Activity and answer the questions.

Part A

Atoms with the same number of protons but with different electrical charges _____.

ANSWER:

- are different ions
- have different atomic numbers
- have different numbers of neutrons
- have different atomic masses
- are different isotopes

Part B

In salt, what is the nature of the bond between sodium and chlorine?

ANSWER:

- hydrogen
- ionic
- nonpolar covalent
- hydrophobic
- polar covalent

Part C

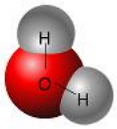
An ionic bond involves _____.

ANSWER:

- the unequal sharing of an electron pair
- water avoidance
- an attraction between ions of opposite charge
- no atoms other than sodium and chlorine
- the sharing of a single pair of electrons

Activity: Hydrogen Bonds

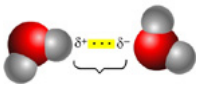
Hydrogen Bonds



Launch the Hydrogen Bonds Activity and answer the questions.

Part A

The brackets are indicating a(n) _____ bond.



ANSWER:

- ionic
- single (nonpolar) covalent
- polar covalent
- hydrogen
- hydrophobic

Part B

What name is given to the bond between water molecules?

ANSWER:

- ionic
- polar covalent
- single (nonpolar) covalent
- hydrophobic
- hydrogen

Misconception Question 9

Part A

Which of the following bonds can form between atoms of equal electronegativity?

ANSWER:

- Van der Waals interactions can form between atoms of equal electronegativity.
- Ionic bonds can form between atoms of equal electronegativity.
- Hydrogen bonds can form between atoms of equal electronegativity.

Misconception Question 10

Part A

Which statement about weak bonds is correct?

ANSWER:

- Weak chemical bonds form only between atoms of similar electronegativity.
- Weak bonds are less important to living things than strong covalent bonds.
- Weak bonds are transient and easily reversible.

Misconception Question 7

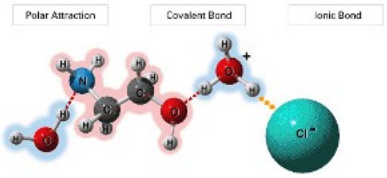
Part A

What happens when two atoms form a chemical bond?

ANSWER:

- A chemical bond forms when two atoms transfer or share protons to achieve a stable nucleus.
- Two atoms fuse together to form a chemical bond.
- A chemical bond forms when two atoms transfer or share outer electrons to complete their outer shells.

Chemistry Review - Atoms & Molecules: Kinds of Bonds



Review the Kinds of Bonds tutorial.

Then answer the question.

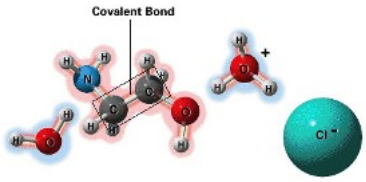
Part A

A phrase that applies to covalent bonding and not other kinds of bonds is ...

ANSWER:

- paired electrons.
- electron-sharing.
- charge attraction.
- great strength.
- All of the above.

Chemistry Review - Atoms & Molecules: Covalent Bonds



Review the Covalent Bonds tutorial.

Then answer the questions.

Part A

Covalent bonds hold atoms together because they ...

ANSWER:

- (a) fill shells without giving atoms much charge.
- (b) bring electrons closer to protons.
- (c) use forces between nuclei as well as forces between electrons.
- do all of the above.
- do both (a) and (b).

Part B

In molecules, C, H, O, and N atoms usually make __, __, __, and __ bonds respectively.

ANSWER:

- 2, 1, 3, 4
- 3, 2, 4, 2
- 4, 1, 2, 3
- 3, 2, 1, 4
- 4, 1, 3, 2

Part C

An atom's atomic number is 7. Its valence is most likely ...

ANSWER:

- 1
- 5
- 3
- 2
- 7

Part D

By making two covalent bonds, an O atom (with 8 protons) fills its valence shell. Why does the atom's charge stay close to zero?

ANSWER:

- The valence shell has 6 electrons.
- Shared electrons aren't always near oxygen.
- The atom lost electrons from other shells.
- The charge isn't near zero; it's -2.
- The atom has 8 electrons.

Part E

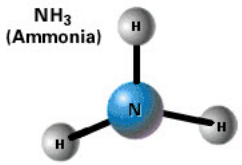
In a double covalent bond, a carbon atom shares ...

ANSWER:

- electrons in two orbitals.
- both valence and nonvalence electrons.
- two electrons.
- electrons in two of its shells.
- None of the above.

Part F

The ammonia molecule in the diagram has the observed bond orientation because ...

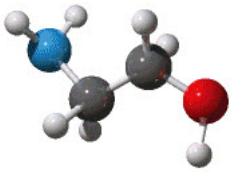


ANSWER:

- N has four pairs of electrons in the valence shell.
- electrons repel one another.
- N has 7 protons in its nucleus.
- All of the above.
- None of the above.

Part G

Without making or breaking bonds, the pictured molecule can change its shape because ...



ANSWER:

- rotation can occur around single bonds.
- proximity of other atoms alters bond angles.
- electrons can move from one bond to another.
- some atoms make longer bonds than others.
- None of the above.

Part H

Two C atoms form a double bond. Each C is bound to two H atoms. Which statement is true?

ANSWER:

- All the atoms lie in a plane.
- The bonds orient in a tetrahedral fashion.
- The groups rotate around the C=C bond.
- The bonds orient like tripods or pyramids.
- All the atoms lie in a line.

Part I

Partial charges occur when ...

ANSWER:

- (a) a covalent bond links atoms of two kinds.
- (b) atoms share electrons unequally.
- (c) two ions are close together.
- any of the above occur.
- both (a) and (b).

Part J

To fill the valence shell, an electrically neutral, unbonded atom with atomic number 8 must add ...

ANSWER:

- 3 electrons.
- 1 electron.
- 2 electrons.
- 8 electrons.
- Can't tell without knowing which element it is.

Part K

Which answer helps to explain why carbon atoms tend to make 4 covalent bonds?

ANSWER:

- The carbon nucleus has 4 protons.
- The first electron shell has 4 orbitals.
- The valence shell needs 8 electrons.
- All of the above.
- None of the above; carbon makes 3 covalent bonds.

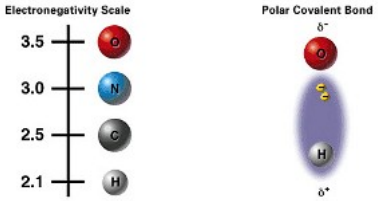
Part L

An electrically neutral molecule has the formula $C_3H_4O_2N$. If the carbon atoms form the usual number of bonds, how many covalent bonds will each hydrogen atom have with other atoms in the molecule?

ANSWER:

- 2
- 3
- 1
- 5
- 4

Chemistry Review - Atoms & Molecules: Electronegativity



Review the Electronegativity tutorial.

Then answer the questions.

Part A

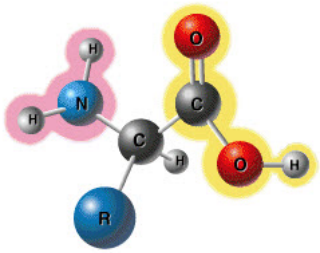
Which answer correctly ranks the atoms in terms of decreasing electronegativity (the highest electronegativity first)?

ANSWER:

- N, O, C, H
- N, O, H, C
- O, N, H, C
- O, N, C, H
- C, H, O, N

Part B

Which atom in the pictured molecule will have the strongest partial positive charge?



ANSWER:

- The H that's bound to O.
- The C that's bound to N.
- The N atom.
- The O atom that's in C=O.
- The C that's in C=O.

Part C

Dr. Haxton says the O-O bond is polar and the C-C bond is nonpolar. A good student would say ...

ANSWER:

- No, both bonds are highly polar.
- Wrong again, Ralph. Both bonds are nonpolar.
- No way. C is more electronegative than O.
- Right! O is electronegative, so O_2 is polar.
- Yes. O attracts electrons more strongly than C.

Part D

Use your knowledge of electronegativity to pick out the most polar bond in the list below.

ANSWER:

- O-N
- O-C
- C-H
- N-H
- O-H

Part E

If you want a molecule that is highly polar, look for one that contains:

ANSWER:

- C-S
- H-N
- O-N
- S-H
- C-H

Chapter 2 Question 4

Part A

Which statement is true of all atoms that are anions?

ANSWER:

- The atom has more neutrons than protons.
- The atom has fewer protons than does a neutral atom of the same element.
- The atom has more electrons than protons.
- The atom has more protons than electrons.

Chapter 2 Question 7

Part A

The atomic number of sulfur is 16. Sulfur combines with hydrogen by covalent bonding to form a compound, hydrogen sulfide. Based on the number of valence electrons in a sulfur atom, predict the molecular formula of the compound.

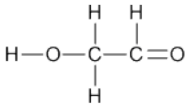
ANSWER:

- HS_2
- HS
- H_4S
- H_2S

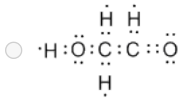
Chapter 2 Question 9

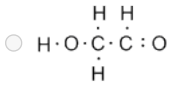
Part A

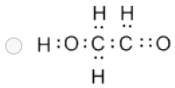
Choose Lewis dot structure for the hypothetical molecule shown below, using the correct number of valence electrons for each atom.

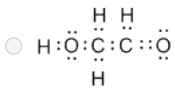


ANSWER:



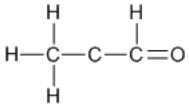




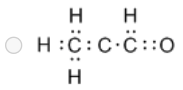


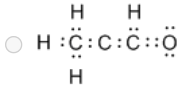
Part B

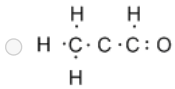
Choose Lewis dot structure for the hypothetical molecule shown below, using the correct number of valence electrons for each atom.

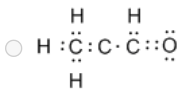


ANSWER:





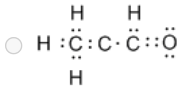


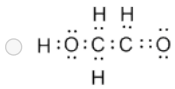


Part C

Determine which molecule makes sense because each atom has a complete valence shell and each bond has the correct number of electrons.

ANSWER:





Part D

Explain what makes the other molecule nonsensical, considering the number of bonds each type of atom can make.

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

three
one
outermost
covalent
ionic
four
two
inner
metallic

Electron sharing can be depicted by a Lewis dot structure, in which element symbols are surrounded by dots that represent the valence electrons (electrons in the [ ] shell). A [ ] bond is the sharing of a pair of valence electrons by [ ] atoms. Hydrogen has [ ] valence electron(s) in the first shell, but the capacity of the shell is [ ] electron(s). When a hydrogen atom comes close enough to a carbon atom for their orbitals to overlap, they can share their electrons. The hydrogen atom is now associated with [ ] electron(s) and a [ ] bond is formed. As a result, one of the structures does not make sense because hydrogen has only [ ] valence electron(s) to share, so it cannot form bonds with two atoms.

Chapter 2 Pre-Test Question 6

Part A

The type of bonding and the number of covalent bonds an atom can form with other atoms is determined by _____.

You did not open hints for this part.

ANSWER:

- the size of the atom: smaller atoms are chemically more reactive
- the number of unpaired electrons in the valence shell
- the number of protons
- the number of neutrons
- the nucleus

Chapter 2 Pre-Test Question 7

Part A

A carbon atom and a hydrogen atom form what type of bond in a molecule?

You did not open hints for this part.

ANSWER:

- hydrogen bond
- ionic bond
- Van der Waals interaction
- polar covalent bond
- nonpolar covalent bond

Chapter 2 Pre-Test Question 8

Part A

An ionic bond is formed when _____.

You did not open hints for this part.

ANSWER:

- one atom transfers an electron to another atom
- both atoms are nonpolar
- both atoms are equally attractive to electrons
- atoms are subjected to radioactive isotopes
- both atoms are electrically neutral

Chapter 2 Pre-Test Question 9

Part A

Hydrogen bonding is most often seen _____.

You did not open hints for this part.

ANSWER:

- **when the** molecule's three-dimensional shape is tetrahedral
- when multiple carbon atoms are present
- when the bonds within the molecule are nonpolar covalent bonds
- if the molecule consists of three or fewer atoms
- when hydrogen is covalently bonded to an electronegative atom

Chapter 2 Question 34

Part A

In the following structure where A and B represent two different elements, the valency of A is _____ and B is _____.

ANSWER:

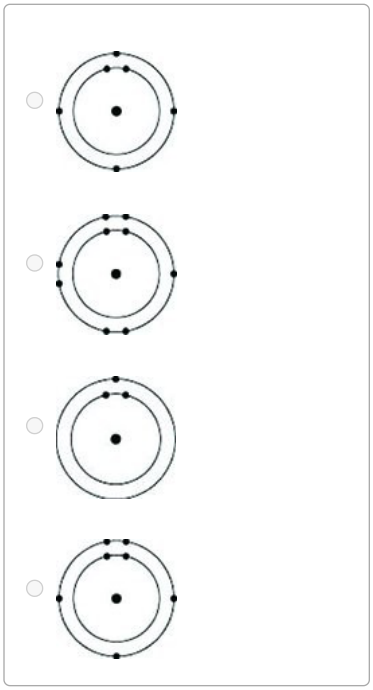
- eight; eight
- three; five
- one; three
- one; five

Chapter 2 Question 32

Part A

Which of the following models represents an atom that is most likely to form an anion with a charge of -1?

ANSWER:



Chapter 2 Question 30

Part A

A salamander relies on hydrogen bonding to stick to various surfaces. Therefore, a salamander would have the greatest difficulty clinging to a _____.

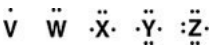
ANSWER:

- surface of mostly carbon-nitrogen bonds
- surface of mostly carbon-oxygen bonds
- surface of hydrocarbons
- slightly damp surface

Chapter 2 Question 31

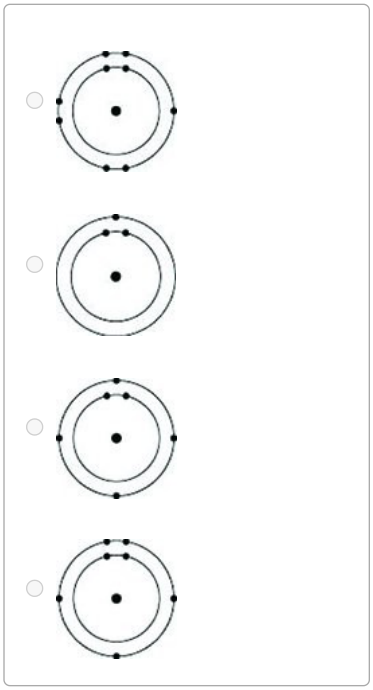
Part A

Use the following figure to answer the following question.



Which of the following models represents an atom that is most likely to form a cation with a charge of +1?

ANSWER:



Chapter 2 Question 38

Part A

Which of the following types of bond is broken when water evaporates?

ANSWER:

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

Chapter 2 Question 39

Part A

Van der Waals interactions may result under which of the following conditions?

ANSWER:

- molecules held by ionic bonds react with water
- electrons are not symmetrically distributed in a molecule
- a hydrogen atom loses an electron
- two polar covalent bonds react

Chapter 2 Question 35

Part A

A covalent bond is likely to be polar under which of the following conditions?

ANSWER:

- carbon is one of the two atoms sharing electrons
- one of the atoms sharing electrons is more electronegative than the other atom
- the two atoms sharing electrons are of the same elements
- the two atoms sharing electrons are equally electronegative

Chapter 2 Question 36

Part A

The atomic number of chlorine is 17. The atomic number of magnesium is 12. Given this information, what is the formula for magnesium chloride?

ANSWER:

- $MgCl_3$
- $MgCl$
- Mg_2Cl
- $MgCl_2$

Chapter 2 Question 37

Part A

How many electron pairs are shared between carbon atoms in a molecule that has the formula C_2H_4?

ANSWER:

- one
- two
- three
- four

Chapter 2 Question 33

Part A

Nitrogen (N) is more electronegative than hydrogen (H). Which of the following is a correct statement about the atoms in ammonia (NH_3)?

ANSWER:

- Ammonia has an overall positive charge.
- Each hydrogen atom has a partial positive charge; the nitrogen atom has a partial negative charge.
- The nitrogen atom has a partial positive charge; each hydrogen atom has a partial negative charge.
- Ammonia has an overall negative charge.

Chapter 2 Question 45

Part A

Elements found in the first two columns of the periodic table contain outer electron shells that are _____; these elements tend to form _____ in solution.

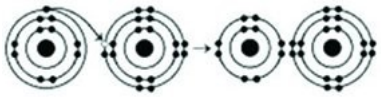
ANSWER:

- almost empty; anions
- almost full; anions
- almost empty; cations
- almost full; cations

Chapter 2 Question 40

Part A

Refer to the following figure to answer the questions below.



Considering that the reactants have no charge, what are the products of the reaction shown above?

ANSWER:

- a cation with a net charge of +1 and an anion with a net charge of +1
- a cation with a net charge of -1 and an anion with a net charge of -1
- a cation with a net charge of -1 and an anion with a net charge of +1
- a cation with a net charge of +1 and an anion with a net charge of -1

Chapter 2 Question 46

Part A

An atom has four electrons in its valence shell. What types of covalent bonds is it capable of forming?

ANSWER:

- single bonds only
- single, double, or triple
- double bonds only
- single and double only

Chapter 2 Question 42

Part A

Which of the following factors contribute to the tetrahedral shape of the above molecule?

ANSWER:

- the shape of the two *p* orbitals in the carbon atom
- the shape of the one *s* orbital in the carbon atom
- the shape of the sp^3 hybrid orbitals of the electrons shared between the carbon and hydrogen atoms
- hydrogen bonding configurations between the carbon and hydrogen atoms

Chapter 2 Question 44

Part A

If an atom has a charge of +1, which of the following must be true?

ANSWER:

- It has one more electron than it does protons.
- It has one more proton than it does electrons.
- It has two more protons than neutrons.
- It has the same number of protons as electrons.

Chapter 2 Question 47

Part A

Which one of the following describes the correct trends in electronegativity in the periodic table?

ANSWER:

- increases across a period and decreases down a group
- increases across a period and increases down a group
- decreases across a period and decreases down a group
- decreases across a period and increases down a group

Chapter 2 Question 48

Part A

Nitrogen (N) normally forms three covalent bonds with a valence of five. However, ammonium has four covalent bonds, each to a different hydrogen (H) atom (H has a valence of one). What do you predict to be the charge on ammonium?

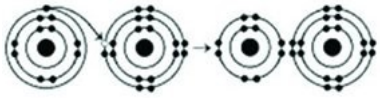
ANSWER:

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

Chapter 2 Question 41

Part A

Refer to the following figure to answer the questions below.



What is the atomic number of the cation formed in the reaction in the illustration?

ANSWER:

- 16
- 11
- 8
- 10

Chapter 2 Question 43

Part A

How many electrons participate in a triple covalent bond?

ANSWER:

- 12
- 3
- 6
- 9

Chapter 2 Question 49

Part A

Which of the following types of representation would work best to indicate the type and number of atoms in a molecule?

ANSWER:

- structural formula
- molecular formula
- space-filling model
- ball-and-stick model

Chapter 2 Question 50

Part A

How is a single covalent bond formed?

ANSWER:

- two atoms share two electrons
- two atoms share one electron
- one atom loses a pair of electrons to the other
- two atoms share two pairs of electrons

Chapter 2 Question 5

Part A

Which of the following statements correctly describes any chemical reaction that has reached equilibrium?

ANSWER:

- The rates of the forward and reverse reactions are equal.
- The concentrations of products and reactants are equal.
- Both forward and reverse reactions have halted.
- The reaction is now irreversible.

Chapter 2 Question 8

Part A

What coefficients must be placed in the following blanks so that all atoms are accounted for in the products?

$\mathrm{C_6H_{12}O_6} \rightarrow \_\_\_\_\mathrm{C_2H_6O} + \_\_\_\_\mathrm{CO_2}$

ANSWER:

- 1; 3
- 2; 2
- 3; 1
- 2; 1

Chapter 2 Pre-Test Question 10

Part A

Chemical equilibrium is reached when _____. See Concept 2.4 (Page)

You did not open hints for this part.

ANSWER:

- the forward and reverse reactions occur at the same rate so that the concentrations of reactants and products remain the same
- matter is conserved
- all of the reactants are converted to products
- the rate at which matter is destroyed and the rate at which it is created offset each other
- the reverse reaction begins to occur

Chapter 2 Question 11

SCIENTIFIC INQUIRY

Female luna moths (*Actias luna*) attract males by emitting chemical signals that spread through the air. A male hundreds of meters away can detect these molecules and fly toward their source. The sensory organs responsible for this behavior are the comblike antennae. Each filament of an antenna is equipped with thousands of receptor cells that detect the sex attractant.

Part A

Based on what you learned, complete a hypothesis to account for the ability of the male moth to detect a specific molecule in the presence of many other molecules in the air.

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

cell-surface
male
shape
size
female
sex attractant

Receptor cells on the filaments of the [ ] luna moth's antennae contain [ ] molecules that are complementary in [ ] to [ ] molecules (pheromones) produced by the [ ] luna moth.

Part B

What predictions does this hypothesis make?

Select the *three* correct statements.

ANSWER:

- If it is possible to synthesize molecules that are very similar in shape to luna moth pheromones, these molecules will also attract male luna moths.
- Luna moth pheromones will bind to specific sites on the cells of the filaments of the male's antennae.
- Chemical or temperature treatments that modify the volatility of luna moth pheromones will reduce the attractiveness of these molecules to male luna moths.
- Chemical or temperature treatments that modify the molecular shape of luna moth pheromones will reduce the attractiveness of these molecules to male luna moths.
- Luna moth pheromones will modify the molecular shape of the cell-surface molecules of the filaments of the male's antennae.

Part C

Choose treatments of an experiment to test the following prediction:

Chemical or temperature treatments that modify the molecular shape of luna moth pheromones will reduce the attractiveness of these molecules to male luna moths.

Select the *two* correct statements.

ANSWER:

- [ ] Unaltered pheromones would be released near female luna moths, and the response of the moths would be noted.
- [ ] A mix of unaltered and modified pheromones would be released near male luna moths, and the response of the moths would be noted separately for unaltered and modified pheromones.
- [ ] Unaltered pheromones would be released near male luna moths, and the response of the moths would be noted.
- [ ] Modified pheromones would be released near male luna moths, and the response of the moths would be noted.
- [ ] A mix of unaltered and modified pheromones would be released near female and male luna moths, and the response of the moths would be noted separately.

Chapter 2 Question 12

Part A

While waiting at an airport, Neil Campbell once overheard this claim: "It's paranoid and ignorant to worry about industry or agriculture contaminating the environment with their chemical wastes. After all, this stuff is just made of the same atoms that were already present in our environment." Drawing on your knowledge of electron distribution, bonding, and emergent properties, complete a short essay countering this argument.

Match the words in the left column to the appropriate blanks in the sentences on the right.

ANSWER:

Reset Help

electron distribution
valence electrons
electrons
atoms
charge distribution
molecules
harm living organisms
interact with other molecules
electron shells
basic atoms

The [ ] of each element have a characteristic number of [ ] arranged in [ ]. The number of [ ] determines what types of bonds or ions the atoms may form, so the chemical reactivity of an atom arises from its [ ]. The properties of compounds emerge from the arrangement of their constituent atoms and of the bonds between them.

Thus, a wide variety of [ ] with very different chemical properties can be made from the same [ ]. Each molecule has a distinctive size, shape, and [ ], which determine its highly specific ability to [ ].

Compounds in chemical wastes may contaminate the environment if their atoms are combined in new arrangements that [ ].

Chapter 2 Question 13

Part A

Bombardier beetles can spray a boiling hot liquid that contains irritating chemicals, which is used as a defense mechanism against its enemies. The beetles store two sets of chemicals separately in their glands.

Using what you learned about chemistry, choose a possible explanation for why the beetle is not harmed by the chemicals it stores.

ANSWER:

- ( ) The two chemicals are harmless when stored separately.
- ( ) The two chemicals are harmless as long as their temperature is lower than 40 degrees Celsius.
- ( ) The two chemicals are harmless until the third component is added.
- ( ) The two chemicals are stored in special chambers that protect the beetles' internal organs.

Part B

What causes the explosive discharge?

ANSWER:

- When the beetle is threatened, the glands contract to develop additional pressure inside cavities where the two chemicals are stored. Under pressure, the chemicals become hot and are sprayed.
- When the beetle is threatened, structures in its body heat the two chemicals. The glands produce pressure to spray the boiling liquid with irritating chemicals.
- When the beetle is threatened, structures in its body allow the two chemicals to combine inside a specialized "mixing chamber." The resulting chemical reaction produces irritating chemicals, and the glands produce pressure for an explosive discharge.
- When the beetle is threatened, structures in its body allow the two chemicals to combine inside a specialized "mixing chamber." The resulting chemical reaction produces irritating chemicals along with intense heat and an audible pop.

Chapter 2 Question 52

Part A

Refer to the following figure to answer the questions below.

$3H_2 + N_2 \leftrightarrow 2NH_3$

Which of the following factors will increase the rate of reaction in the forward direction?

ANSWER:

- addition of hydrogen
- addition of nitrogen
- addition of ammonia
- addition of both nitrogen and hydrogen

Chapter 2 Question 53

Part A

Which of the following correctly describes *chemical equilibrium*?

ANSWER:

- Concentrations of products are higher than the concentrations of the reactants.
- Forward and reverse reactions continue with no net effect on the concentrations of the reactants and products.
- There are equal concentrations of reactants and products, and the reactions have stopped.
- There are equal concentrations of products and reactants while forward and reverse reactions continue.

Chapter 2 Question 51

Part A

Refer to the following figure to answer the questions below.

$3H_2 + N_2 \leftrightarrow 2NH_3$

Which of the following is true for the above reaction?

ANSWER:

- only the forward or reverse reactions can occur at one time
- hydrogen and nitrogen are the reactants of the reverse reaction
- ammonia is being formed and decomposed simultaneously
- the reaction is nonreversible