CK-12 Chemistry Concepts - Intermediate
Answer Key

Chapter 4: Atomic Structure

4.1 Democritus' Idea of the Atom

Review

Questions

1. How did the ancient Greek philosophers spend their time?
2. What approach did they not have for studying nature?
3. Who was the most influential philosopher of that time?
4. What was the major contribution Democritus made to the thinking of his day?
5. List characteristics of atoms according to Democritus.

Answers

1. Debate and discussion
2. Observe nature and experiment.
3. Aristotle.
4. The idea of the atom.
5. Unchangeable, indestructible, always existed.

4.2 Law of Conservation of Mass

Review

Questions

1. The Law of Conservation of Mass states that, during a chemical reaction, the total _____ of the products must be equal to the total _____ of the reactants.
2. Describe an example of the law of conservation of mass.

Answers

1. mass, mass
2. A specific amount of water would have the same mass even if you turned it from a liquid to a solid or a gas.

4.3 Law of Multiple Proportions

Review

Questions

1. State the law of multiple proportions.
2. In carbon dioxide (CO_2), how many grams of oxygen (O) would there be if there are 24 grams of carbon (C)?
3. How many grams of carbon (C) would be present in carbon monoxide (CO) that contains 2.666 grams of oxygen (O)?

Answers

1. When two elements combine with each other to form two or more compounds, the ratios of the masses of one element that combines with a fixed mass of the other are simple whole numbers.
2. 24 × 2.666 = **63.984 g**
3. 2.666 ÷ 1.333 = **2 g**

4.4 Law of Definite Proportions

Review

Questions

1. State the law of definite proportions.
2. Will the composition of water vary depending on its source?
3. Why is this law important?

Answers

1. A given chemical compound always contains the same elements in the same proportions by mass.
2. No.
3. So we can make reliable predictions about how much materials and what kind will be produced in a given process.

Explore More

Watch the video (link below) and answer the questions:

http://www.youtube.com/watch?v=nvTB2cMbWU8

1. How many hydrogen atoms are there in a molecule of water?
2. How many oxygen atoms are there in a molecule of water?

3. What is the mass ratio of hydrogen to oxygen in a molecule of water?
4. Will the mass ratio of hydrogen to oxygen change depending on the size of the sample? For example, if the sample size was 10 L or 10,000 L.

Answers

1. two
2. one
3. 1 g H to 8 g O
4. 1
5. No. Regardless of the sample size, the mass of oxygen in the water sample will be 8 times that of hydrogen.

4.5 Mass Ratio Calculation

Review

Questions

1. What does the mass ratio tell us?
2. In the compound CH_4, what is the carbon to hydrogen mass ratio?
3. In the compound ethane (C_2H_6). What is the mass ratio of carbon per gram of hydrogen?

Answers

1. The mass of an element that is found in combination with another element.
2. For CH_4 the mass ratio is

   Mass from carbon: 1 C × 12 g = 12 g C

   Mass from hydrogen: 4 H × 1 g = 4 g H

   Mass Ratio: $\frac{12\ g\ C}{4\ g\ H} = \frac{3\ g\ C}{1\ g\ H}$

3. For C_2H_6 the mass ratio is

   Mass from carbon: 2 C × 12 g = 24 g C

   Mass from hydrogen: 6 H × 1 g = 6 g H

   Mass Ratio: $\frac{24\ g\ C}{6\ g\ H} = \frac{4\ g\ C}{1\ g\ H}$

4.6 Dalton's Atomic Theory

Review

Questions

1. Did Dalton believe that atoms could be created or destroyed?
2. According to Dalton's theory, all atoms of the same _____ are identical in size, mass, and other properties.
3. What parts of the theory are not considered valid any more?

Answers

1. No
2. Elements
3. The second and third points.

4.7 Atom

Review

Questions

1. What is an atom?
2. Which of the following statement(s) are true about the atoms of any element?
    a. The number of protons in an atom of an element is unique to each element.
    b. A proton in an atom of one element is different from a proton in an atom of another element.
    c. The number of protons in an atom of an element is the same for all elements.
    d. The radius of an atom changes depending on the element.
3. Explain why atoms are always neutral in charge.

Answers

1. An atom is the smallest particle of an element that still has the element's properties.
2. A and D
3. Atoms always contain the same number of protons (positive particles) and electrons (negative particles), making their overall charge neutral.

4.8 Electron

Review

Questions

1. What subatomic particle creates electric power, and how does it do it?
2. Whose work did Thomson repeat and revise?
3. What experiment did Thomson perform that showed cathode rays to be particles?
4. How did he show that these particles had a charge on them?
5. Did the cathode ray have positive or negative charge?

Answers

1. Electrons are the subatomic particle responsible for electrical power. Electric power is created when electrons flow through wires which creates an electrical current.
2. Sir William Crookes.
3. Thompson placed a rail between the anode and cathode inside the cathode ray tube. He then attached a paddle wheel capable of rotating along the rail.When he turned on the cathode ray tube, the wheel rotated from the cathode towards the anode. Thus, demonstrating that the cathode rays had mass.
4. When Thomson applied a magnetic field to the cathode rays, the rays deflected away from the negatively charged magnet and towards the positively charged magnet.
5. Negative, the rays would deflect away from negatively charged metal plates and towards positively charged metal plates.

4.9 Proton

Review

Questions

1. Why is it easy to describe things we can see?
2. Why did researchers believe that the particle left after electrons were emitted as cathode rays had to be positive?
3. Atoms, which are always neutral in electric charge, contain electrons as well as protons and neutrons. An electron has an electrical charge of -1. If an atom has three electrons, infer how many protons it has.
4. How many electrons does it take to equal the mass of one proton?

Answers

1. It is easier to describe things that we cannot see than things we can see because we have a common language (size, color, construction) and a basic idea of what it is (a car, not a house or a tree) by which we can describe them.

2. Researched predicted that the particles left were left becauses atoms had no overall electrical charge meaning that they had to have equal numbers of positive and negative charges.
3. If the atom has 3 electrons it has 3 (-1) charges and since the atom is neutral it must have 3 (1+) charge to balance it. Therefore there are 3 protons in the atom.
4. 1840 electrons

4.10 Neutron

Review

Questions

1. How did Rutherford try to explain the differences between the number of protons in the nucleus and the atomic weight?
2. What did German researchers find when they bombarded beryllium with alpha particles?
3. What did Chadwick determine about these new particle (observed by the German scientist and the Curies)?

Answers

1. Rutherford thought that difference in the differences between the number of protons in the nucleus and the atomic weight was due to an "extra" particles. He predicted that the ‘extra’ particle was a combination of protons and electrons, so they would have a mass very similar to a proton, but would be electrically neutral since the positive charge of the proton and the negative charge of the electron would cancel each other out.
2. The German researchers bombarded the beryllium atoms with alpha particles (helium nuclei containing two protons and two neutrons with a charge of +2). This produced particles had both a strong penetrating power and were neutral because they were not attracted to a field.
3. Chadwick discovered that the particles observed by the German researchers and the Curies had the same mass as a proton.

4.11 Cathode Ray Tube

Review

Questions

1. Who developed the first cathode ray tube?
2. What improvement did Crookes make to the cathode ray tube?
3. How did Crookes show there were particles being emitted?
4. What did Karl Ferdinand Braun invent?

5. What did Wilhelm Roentgen invent?

Answers

1. Heinrich Geissler
2. Better vacuum inside the tube.
3. He put an object between the cathode and the other end of the tube and showed that the object blocked cathode rays.
4. The oscilloscope.
5. X-ray machine.

4.12 Oil Drop Experiment

Review

Questions

1. How did Millikan learn physics in college?
2. What did Millikan use to pick up static charge?
3. Where did the oil drops go to be measured?

Answers

1. He taught himself physics as there was nobody on the faculty that could teach him.
2. Oil drops.
3. Between two charged plates.

4.13 Plum Pudding Atomic Model

Review

Questions

1. What is a model?
2. Why are models useful in science?
3. In Thomson's model of the atom, where were the electrons?
4. What was the positive charge in this model?
1. What kept the electrons in the atom?
2. Whose model replaced Thomson's?
3. What awards did Thomson receive?

Answers

1. A model gives an idea of what the real thing is.
2. They help us understand basic structures.
3. Embedded throughout the positive sphere.
4. The “dough.”
5. The positive charge.
6. Rutherford.
7. Nobel Prize in Physics (1906), a knighthood (1908).

4.14 Gold Foil Experiment

Review

Questions

1. What is an alpha particle?
2. What did Rutherford observe from shooting thousands and thousands of alpha particles at a thin piece of gold foil?
3. How did Rutherford explain the observation that most alpha particles went straight through the gold foil?
4. What did he say about the particles that were deflected?
5. Describe Rutherford’s nuclear model.

Answers

1. A helium nucleus.
2. Almost all the alpha particles when through little to no deflection from the gold foil. About 1 in every 8000 alpha particles either bounced of the alpha particle at a very large angle or bounced directly back at the source.
3. The rare cases of alpha particles being deflection meant a positive charge and mass was concentrated in a very small space inside the atom.
4. Most of the alpha particles went through, so most of the atom was empty space.
5. Rutherford’s model of the atom had a small, dense, positive nucleus comprising nearly all of the mass of the atom. The electrons are distributed around the nucleus and occupy most of the volume of the atom.

4.15 Atomic Nucleus

Review

Questions

1. How did Rutherford change our thinking about atomic structure?

2. What is our current picture of the atom?
3. Why is the presence of positively charged protons a problem with current models of the atom?
4. How do we explain why the nucleus does not fall apart?

Answers

1. Rutherford showed that atoms had a small, solid core surrounded by a great deal of empty space.
2. A dense nucleus made up of protons and neutrons surrounded by electrons.
3. Positively charged particles repel each other so a nucleus containing only positive particles should push itself apart.
4. A force exists that is stronger than the repulsion between like charges when particles are extremely close together (Strong Nuclear Force).

4.16 Atomic Number

Review

Questions

1. What is the atomic number of an atom? Why is this number important?
2. Using a periodic table, what is the atomic number of helium have
3. How many protons are in the following elements:
    a. Ne
    b. Ca
    c. Pt
4. Write the symbol for the element with the following atomic number:
    a. 18
    b. 41
    c. 82
    d. 12

Answers

1. The number of protons. It is unique for each element
2. 2 protons
3. (a) 10 (b) 20 (c) 78
4. (a) Ar (b) Nb (c) Pb (d) Mg

4.17 Mass Number

Review

Questions

1. Who first determined atomic weights for elements?
2. What were the original atomic weights based on?
3. Why were calculations based on numbers of protons not valid for determining atomic weights?
4. A tin atom has an atomic number of 50 and a mass number of 118. How many neutrons are present in this atom?
5. What is the mass number of a cobalt atom that has 27 protons and 30 neutrons?

Answers

1. John Dalton.
2. Comparison to hydrogen, which has an atomic weight of one.
3. The weight of the neutrons was not included.
4. 68
5. 57

4.18 Isotope

Review

Questions

1. What are isotopes?
2. Why do different isotopes of an element generally have the same physical and chemical properties?
3. How would the nucleus of the hydrogen-1 and hydrogen-2 differ?
4. Relate the concepts of isotope and mass number.
5. All oxygen atoms have eight protons, and most have eight neutrons as well. What is the mass number of an oxygen isotope that has nine neutrons? What is the name of this isotope?
6. An isotope of yttrium has 39 protons and 59 neutrons. What is the mass number of that isotope?
7. An isotope with a mass number of 193 has 116 neutrons. What is the atomic number of this isotope?
8. An isotope of barium (atomic number 56) has a mass of 138. How many neutrons are in the nucleus of this isotope?

Answers

1. Atoms with the same atomic number (number of protons), but different mass numbers because the number of neutrons differs.

2. Because they have the same number of protons and electrons.
3. Hydrogen-1 has one proton in the nucleus and no neutrons, hydrogen-2 has one proton and one neutron in the nucleus.
4. The mass number is the sum of its protons and neutrons, because an element always has the same number of protons, the mass can indicate how many neutrons are in an isotope.
5. 17, this is called oxygen-17
6. mass number is 98
7. atomic number is 77
8. 82 neutrons

4.19 Atomic Mass Unit

Review

Questions

1. What instrument is used to measure the mass of atoms?
2. How much does a single oxygen-16 atom weigh in grams?
3. What is the reference standard for atomic mass units?
4. How is an atomic mass unit defined?
5. Why are the numbers for atomic mass of individual atoms not whole numbers?

Answers

1. mass spectrometer
2. 2.66×10^{-23} g.
3. carbon-12
4. a mass equal to one twelfth the mass of an atom of carbon-12
5. The atomic mass of individual atoms are not whole numbers because an atom's mass is affected very slightly by the interactions of the various particles within the nucleus, and the small mass of the electron is taken into account.

4.20 Calculating Atomic Mass

Review

Questions

1. Define atomic mass.
2. What information do you need to calculate atomic mass for an element?
3. Calculate the atomic mass for carbon using the following data:

isotope	atomic mass	percent abundance
carbon-12	12.000000	98.90
carbon-13	13.003355	1.10

Answers

1. The atomic mass of an element is the weighted average of the atomic masses of the naturally occurring isotopes of that element
2. The percent abundance of each isotope.
3. (12.000000) (0.9890) + (13.003355) (0.0110) = 12.01 amu