Chemistry Chapter 3
Questions on Pages 92-94
2 points

Name: _____

Date: _____ Hour: _____

Read the passage on the back of this worksheet taken from pages 92-94 of *Conceptual Chemistry* (Pearson Prentice-Hall, 2007) and answer the following questions:

1. What do we call positively charged subatomic particles? _____
2. Which has more mass, a proton or an electron? _____
3. Which has more electric charge, a proton or an electron? _____
4. The number of protons in the nucleus of the atom is equal to _____

   _____
5. An electrically balanced oxygen atom has _____ protons and _____ electrons.
6. What is an atomic number? _____

   _____
7. In what order does the modern periodic table list elements? _____

   _____
8. Besides the proton, what other particle is in the nucleus? _____
9. What is one way a neutron is similar to a proton? _____
10. What is one way a neutron is different from a proton? _____
11. How did a neutron get its name? _____
12. What does the term nucleon mean? _____

    _____
13. For any element, there is no set number of _____.
14. How many neutrons does an iron atom have? _____
15. What are isotopes? _____

    _____
16. Are iron-56 and colbalt-56 isotopes? _____
17. What is a mass number? _____

    _____
18. What is the mass number of iron-55? _____
19. What is the formula for calculating the total number of neutrons?

20. Isotopes of an element differ by _____, not by _____.

3.6 The Atomic Nucleus Is Made of Protons and Neutrons

The positive charge of any atomic nucleus was found to be equal in magnitude to the combined negative charge of all the electrons in the atom. It was thus reasoned, and then experimentally confirmed, that positively charged subatomic particles make up the nucleus. Today we call these positively charged particles **protons**. The proton is nearly 2000 times more massive than the electron. The electric charge on the proton is numerically equal to the electric charge on the electron, but, as just mentioned, the charge on the proton is positive. Thus each electron has an electric charge of -1.60×10^{-19} coulomb, and each proton has an electric charge of $+1.60 \times 10^{-19}$ coulomb. The number of protons in the nucleus of any atom is equal to the number of electrons whirling about the nucleus, and so the positive charge and negative charge cancel each other, which means the atom is electrically balanced. For example, an electrically balanced oxygen atom has eight electrons and eight protons.

Scientists have agreed to identify elements by **atomic number**, which is the number of protons each atom of a given element contains. The modern periodic table lists the elements in order of increasing atomic number. Hydrogen, with one proton per atom, has atomic number 1; helium, with two protons per atom, has atomic number 2; and so on.

CONCEPT CHECK

How many protons are there in an iron atom, Fe (atomic number 26)?

Was this your answer? The atomic number of an atom and its number of protons are the same. Thus, there are 26 protons in an iron atom. Another way to put this is that all atoms that contain 26 protons are, by definition, iron atoms.

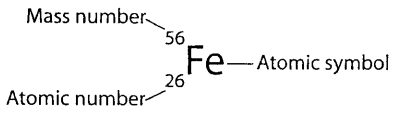
If we compare the electric charges and masses of different atoms, we see that the atomic nucleus must be made up of more than just protons. Helium, for example, has twice the electric charge of hydrogen but *four* times the mass. The added mass is due to another subatomic particle found in the nucleus, the **neutron**, which was first detected in 1932 by the British physicist James Chadwick (1891–1974). The neutron has about the same mass as the proton, but it has no electric charge. Any object that has no net electric charge is said to be *electrically neutral*, and that is how the neutron got its name. We discuss the important role that neutrons play in holding the atomic nucleus together in the following chapter.

Both protons and neutrons are called **nucleons**, a term that denotes their location in the atomic nucleus. Table 3.1 summarizes the basic facts about our three subatomic particles.

For any element, there is no set number of neutrons in the nucleus. For example, most hydrogen atoms (atomic number 1) have no neutrons. A small percentage, however, have one neutron, and a smaller percentage have two neutrons. Similarly, most iron atoms (atomic number 26) have 30 neutrons, but a small percentage have 29 neutrons. Atoms of the same element that contain different numbers of neutrons are **isotopes** of one another.

We identify isotopes by their **mass number**, which is the total number of protons and neutrons (in other words, the number of nucleons) in the nucleus. As Figure 3.20 shows, a hydrogen isotope with only one proton is called hydrogen-1, where 1 is the mass number. A hydrogen isotope with one proton and one neutron is therefore hydrogen-2, and a hydrogen isotope with one proton and two neutrons is hydrogen-3. Similarly, an iron isotope with 26 protons and 30 neutrons is called iron-56, and one with only 29 neutrons is iron-55.

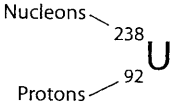
An alternative method of indicating isotopes is to write the mass number as a superscript and the atomic number as a subscript to the left of the atomic symbol. For example, an iron isotope with a mass number of 56 and atomic number of 26 is written



The total number of neutrons in an isotope can be calculated by subtracting its atomic number from its mass number:

$$\begin{array}{l} \text{mass number} \\ -\ \text{atomic number} \\ \hline \text{number of neutrons} \end{array}$$

For example, uranium-238 has 238 nucleons. The atomic number of uranium is 92, which tells us that 92 of these 238 nucleons are protons. The remaining 146 nucleons must be neutrons:



$$\begin{array}{l} 238 \text{ proton and neutrons} \\ -\ 92 \text{ protons} \\ \hline 146 \text{ neutrons} \end{array}$$

Atoms interact with one another electrically. Therefore, the way any atom behaves in the presence of other atoms is determined largely by the charged particles it contains, especially its electrons. Isotopes of an element differ only by mass, not by electric charge.