

SOLUTIONS TO THE MODULE #13 STUDY GUIDE

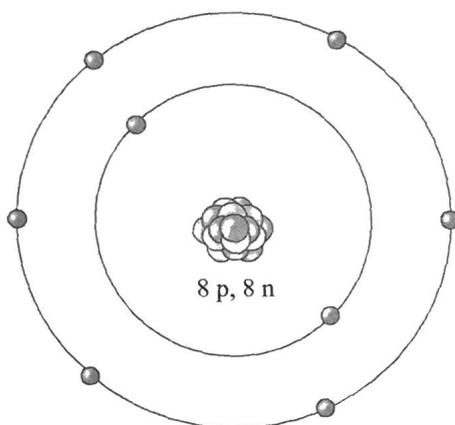
1. a. Model – A schematic description of a system that accounts for its known properties
 - b. Nucleus – The center of an atom, containing the protons and neutrons
 - c. Atomic number – The number of protons in an atom
 - d. Mass number – The sum of the numbers of neutrons and protons in the nucleus of an atom
 - e. Isotopes – Atoms with the same number of protons but different numbers of neutrons
 - f. Element – A collection of atoms that all have the same number of protons
 - g. Radioactive isotope – An atom with a nucleus that is not stable
 - h. Half-life – The time it takes for half of the original sample of a radioactive isotope to decay
2. The three constituents of the atom are the proton, neutron and electron. The electrons are significantly less massive than the other two, and the neutron is just slightly more massive than the proton. Thus, the order is electron, proton, neutron.
 3. The nuclear force holds the protons and neutrons in the nucleus. This force is caused by the exchange of pions between protons and/or neutrons. The student could also call it the strong force, since the nuclear force is just another manifestation of the strong force.
 4. The electromagnetic force (or electroweak force) holds the electrons in orbit. They stay in orbit because they are attracted to the oppositely charged protons.
 5. An atom is mostly empty space.
 6. The atomic number is defined as the number of protons in an atom. Atoms have the same number of electrons as they have protons. Thus, this atom has 34 electrons and 34 protons. In order to get the symbol, we just look at the chart. The chart tells us that atoms with atomic number of 34 are symbolized with Se.
 7. a. Since the chemical symbol is Ne, we can use the chart to learn that the atom has 10 protons. This tells us there are also 10 electrons. The mass number is the sum of protons and neutrons in the nucleus. Thus, there are also 10 neutrons.
 - b. Since the chemical symbol is Fe, we can use the chart to learn that the atom has 26 protons. This tells us there are also 26 electrons. The mass number is the sum of protons and neutrons in the nucleus. Thus, there are 30 neutrons.
 - c. Since the chemical symbol is La, we can use the chart to learn that the atom has 57 protons. This tells us there are also 57 electrons. The mass number is the sum of protons and neutrons in the nucleus. Thus, there are 82 neutrons.

d. Since the chemical symbol is Mg, we can use the chart to learn that the atom has 12 protons. This tells us there are also 12 electrons. The mass number is the sum of protons and neutrons in the nucleus. Thus, there are 12 neutrons.

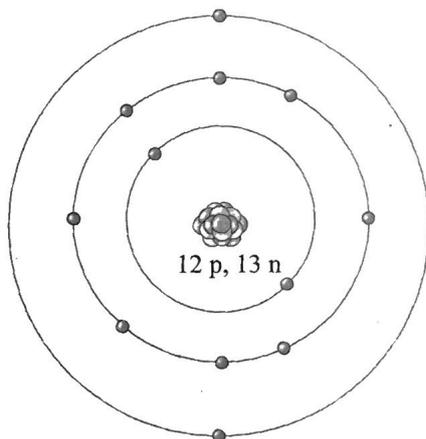
8. In order to be isotopes, the two atoms must have the same number of protons. Thus, the second atom also has 18 protons.

9. Isotopes must all have the same number of protons but different numbers of neutrons. Since the chemical symbol tells you how many protons that an atom has, in the end, only atoms with the same chemical symbol can be isotopes. In order to be isotopes, then, the atoms must have the same chemical symbol but different mass numbers. Thus, ^{112}Sn , ^{124}Sn , and ^{120}Sn are isotopes.

10. All atoms symbolized with “O” have 8 protons according to the chart. This also means there are 8 electrons. Two of them can go into the first Bohr orbit, but we will have to put the remaining 6 in the second Bohr orbit. That’s fine, because the second Bohr orbit can hold up to 8 electrons. The mass number indicates that there are also 8 neutrons:



11. All atoms symbolized with “Mg” have 12 protons according to the chart. This also means there are 12 electrons. Two of them can go into the first Bohr orbit, and 8 can go in the second Bohr orbit. We will have to put the remaining 2 in the third Bohr orbit. That’s fine, because the third Bohr orbit can hold up to 18 electrons. The mass number indicates that there are 13 neutrons:



12. All uranium atoms, regardless of their mass number, have 92 protons and 92 electrons. That's what the periodic chart tells us for any element symbolized with "U." The first 2 electrons will go in the first Bohr orbit. The next 8 will go in the second Bohr orbit. The next 18 will go in the third Bohr orbit, and the next 32 will go in the fourth Bohr orbit. That makes 60 electrons. The remaining 32 will all fit in the fifth Bohr orbit because it can hold up to 50 electrons. Thus, the largest Bohr orbit is the fifth one, and there are 32 electrons in it.
13. The strong nuclear force is governed by the exchange of pions. Since pions have a very short lifetime, the strong nuclear force can only act over very tiny distances.
14. a. ^{98}Tc has 43 protons according to the chart. This means there must be 55 neutrons. In beta decay, a neutron turns into a proton. This will result in an atom with 44 protons and 54 neutrons, or ^{98}Ru .
- b. ^{125}I has 53 protons according to the chart. This means there must be 72 neutrons. In beta decay, a neutron turns into a proton. This will result in an atom with 54 protons and 71 neutrons, or ^{125}Xe .
15. a. ^{212}Bi has 83 protons according to the chart. This means there must be 129 neutrons. In alpha decay, the nucleus loses 2 protons and 2 neutrons. This will result in an atom with 81 protons and 127 neutrons, or ^{208}Tl .
- b. ^{224}Ra has 88 protons according to the chart. This means there must be 136 neutrons. In alpha decay, the nucleus loses 2 protons and 2 neutrons. This will result in an atom with 86 protons and 134 neutrons, or ^{220}Rn .
16. Only gamma decay does not affect the number of neutrons and protons in a radioactive isotope.
17. In 1,600 years, the 10 grams will be cut in half to 5 grams. In the next 1,600 years, those 5 grams will be cut in half to 2.5 grams. That's a total of 3,200 years, so the answer is 2.5 grams.
18. In one hour, the ^{11}C will have passed through three half-lives. During the first half-life, the 1 gram sample will be reduced to 0.5 grams. During the next half-life, those 0.5 grams will be reduced to 0.25 grams. In the final half-life, those 0.25 grams will be reduced to 0.125 grams.
19. Radioactive dating is usually unreliable because assumptions must be made as to the original condition of the object. These assumptions are usually erroneous.
20. Alpha particles pass through the least amount of matter before stopping, beta particles are next, and gamma rays pass through the most matter before stopping.