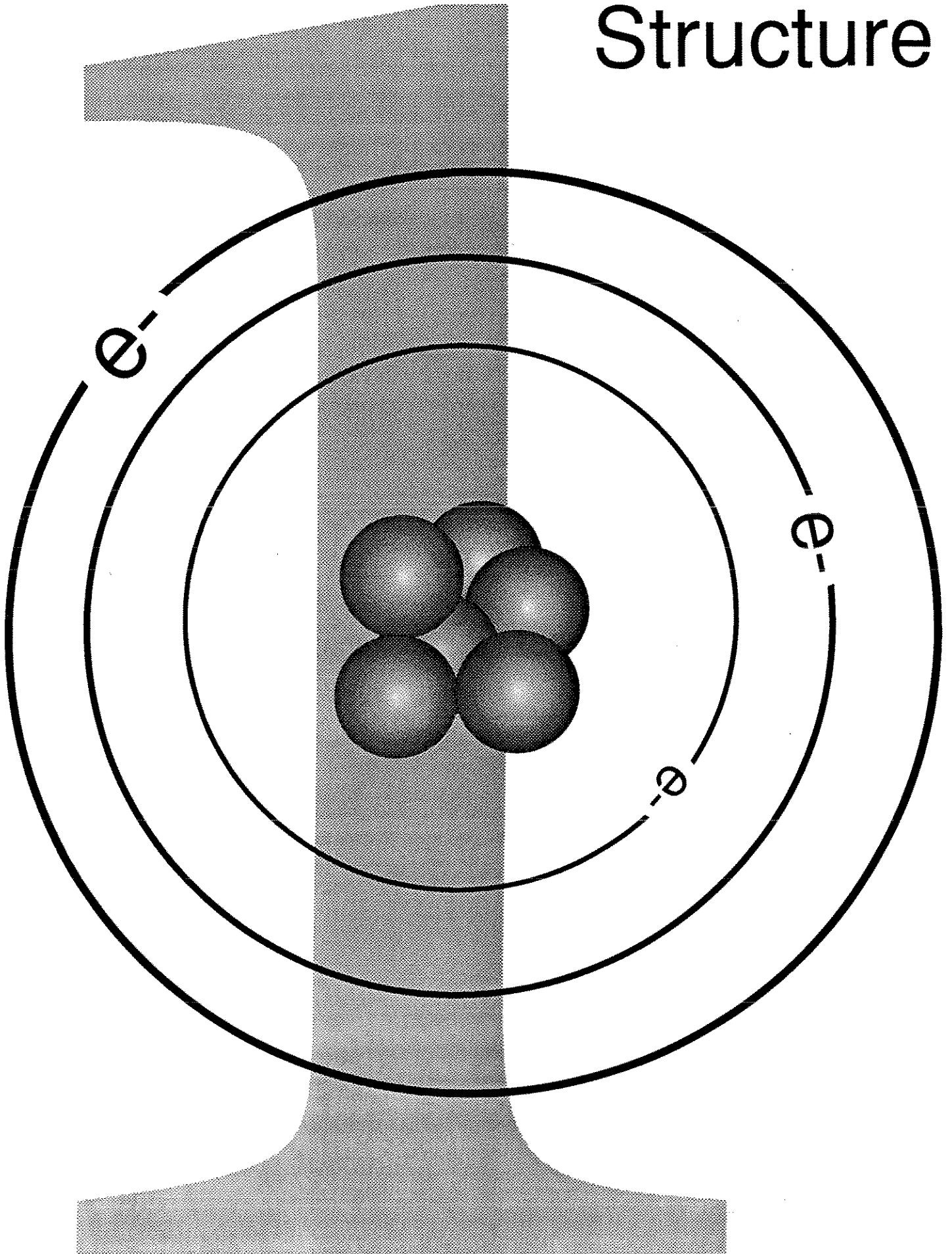


# Atomic Structure

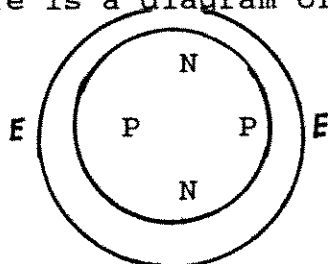


## ATOMIC STRUCTURE

1. Atoms are made up of several components. Collectively these components are called the elementary particles.

We will be discussing the three major elementary particles; protons, neutrons, and electrons.

Here is a diagram of an atom:



Proton P

Neutron N

Electron E

The protons P and neutrons N are packed together in center called the \_\_\_\_\_

The outer part of the atom consists of the particles that orbit the nucleus. These particles are called \_\_\_\_\_

Nucleus: electrons

2. We can visualize this atomic model as a miniature solar system. In the solar system, the planets orbit the sun. In the atom, the \_\_\_\_\_ orbit a nucleus that is composed of two types of particles: \_\_\_\_\_ and \_\_\_\_\_

electrons; protons and neutrons (either order)

3. Gravitational attraction keeps the planets in orbit around the sun. In the atom, it is electrical attraction that keeps the \_\_\_\_\_ orbiting the \_\_\_\_\_

electrons; nucleus

4. The electron has a negative electrical charge. Remember that like electrical charges repel each other, and unlike charges attract.

Indicate whether the following pairs of charges would attract or repel each other. (Check the correct word for each pair.)

a. + +	b. - +	c. - -	d. + -
<input type="checkbox"/> repel	<input type="checkbox"/> repel	<input type="checkbox"/> repel	<input type="checkbox"/> repel
<input type="checkbox"/> attract	<input type="checkbox"/> attract	<input type="checkbox"/> attract	<input type="checkbox"/> attract

a. repel; b. attract; c. repel; d. attract

5. The nucleus must attract the negatively charged electrons to keep them in orbit. Therefore the overall charge of the nucleus must be (negative/positive) \_\_\_\_\_

positive

6. The neutron was named for its electrical characteristics. It has no electrical charge; it is neutral.

This means that the positive charge of the nucleus must be due to the second type of particle it contains. This second type of particle is the \_\_\_\_\_

If the electron has a charge of -1, then the proton would have a charge of (check one)

-1       +1       +/-1

proton; +1

7. So far, then, we have this picture of atomic structure

(a) An atom consists of an inner part, or \_\_\_\_\_  
\_\_\_\_\_ that is made up of \_\_\_\_\_  
and \_\_\_\_\_

(b) The electron has a charge of \_\_\_\_\_  
(c) The charge on the proton is \_\_\_\_\_  
(d) The neutron has a charge of \_\_\_\_\_

(a) nucleus, protons and neutrons; (b)-1; (c)+1; (d)0

8. One proton with its charge of +1 will just balance the charge of -1 of an electron.

An atom with one proton in its nucleus and one electron orbiting that nucleus would therefore have an overall charge of (+1, -1, 0)

---

0

9. Normally, atoms are electrically neutral. This means that a normal atom will contain: (check the correct box)

- (a) more protons than electrons
- (b) more electrons than protons
- (c) an equal number of protons and electrons

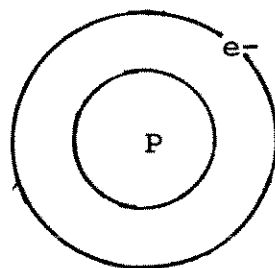
(c) an equal number of protons and electrons

10. An atom with 12 protons in the nucleus would normally have how many electrons around the nucleus? \_\_\_\_\_

12

11. The atom with the simplest atomic structure is hydrogen. The nucleus of the hydrogen atom consists of one \_\_\_\_\_

\_\_\_\_\_ The outer part of the atom contains one \_\_\_\_\_

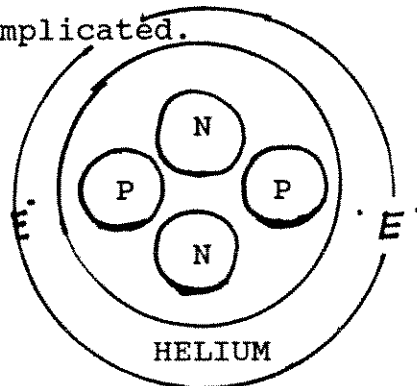


HYDROGEN

proton; electron

12. The helium atom is a little more complicated.

It contains (how many?)  
\_\_\_\_\_ neutrons;  
\_\_\_\_\_ protons; and  
\_\_\_\_\_ electrons



two; two; two

13. There are approximately 100 known elements. Each element has two numbers associated with it—numbers that give certain facts about the structure of its atoms.

The first number is the atomic number. This is the number of protons in the nucleus of the atom. Hydrogen, is the simplest atom, contains only one proton, so that the atomic number of hydrogen is \_\_\_\_\_

14. Uranium is the most complicated of the elements that occur naturally. A uranium atom contains 92 protons, 146 neutrons, and 92 electrons.

The atomic number of uranium is \_\_\_\_\_

92

15. An atom of carbon, atomic number 12, must have a nucleus containing \_\_\_\_\_ protons.

If the nucleus contains 12 protons, there must be how many electrons? \_\_\_\_\_

12; 12

16. Therefore, the atomic number of an element indicates the number of \_\_\_\_\_ in the nucleus of the atom and also the number of \_\_\_\_\_ that orbit the nucleus.

protons; electrons

17. The second number associated with each atom is the atomic weight. The atomic weight expresses the sum of the weights of the particles in the atom.

The proton weighs 1 atomic weight unit. The electron is considered to have zero atomic weight, or a weight of 0.

Thus, the hydrogen atom has an atomic weight of \_\_\_\_\_  
(if you don't know, see frame 11).

1

18. The helium atom has an atomic weight of 4.

(a) The 2 protons in the helium atom weigh a total of how many atomic weight units? \_\_\_\_\_

(b) The 2 electrons in the helium atom weigh a total of how many atomic weight units? \_\_\_\_\_

(c) Therefore, for the helium atom to have an atomic weight of 4, the 2 neutrons must weigh how many atomic weight units? \_\_\_\_\_

(d) If 2 neutrons weigh 2 atomic weight units, a neutron must have an atomic weight of \_\_\_\_\_.

(a) 2; (b) 0; (c) 2; (d) 1

19. Since the electrons, which have no weight, are located outside the nucleus, the entire weight of the atom can be considered to be located

- (a) in its electron orbits
- (b) in the nucleus
- (c) in the outer shells

(b) in the nucleus

20. The atomic number indicates the number of protons (each with atomic weight 1) inside the nucleus of an atom.

The atomic weight indicates the number of protons and neutrons (each with atomic weight 1) in the nucleus.

Therefore, the number of neutrons can be determined by subtracting the atomic number from the atomic weight.

The sodium atom has an atomic weight of 23 and an atomic number of 11. The number of neutrons in the nucleus of the sodium atom is \_\_\_\_\_

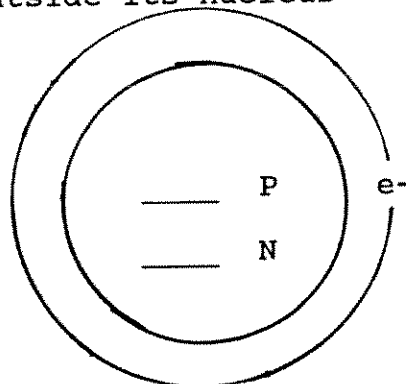
12

21. The carbon atom has an atomic number of 6 and an atomic weight of 12. The carbon atom contains (how many?):

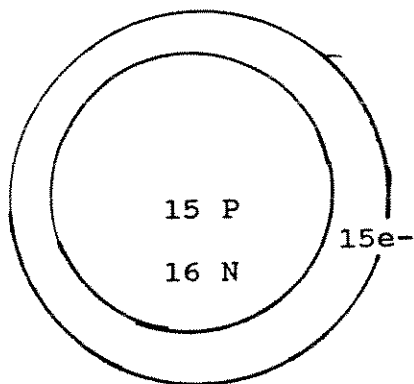
\_\_\_\_\_ protons in its nucleus  
 \_\_\_\_\_ neutrons in its nucleus  
 \_\_\_\_\_ electrons outside its nucleus

6;6;6

22. The element phosphorus has an atomic number of 15 and an atomic weight of 31. Indicate on the blank lines on the diagram the number of protons, neutrons, and electrons.

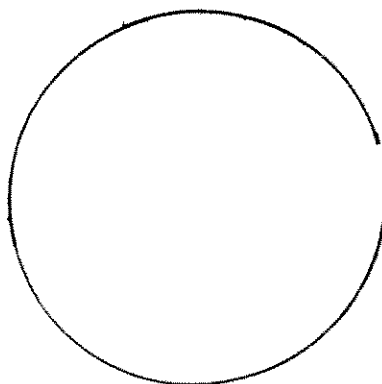


PHOSPHORUS

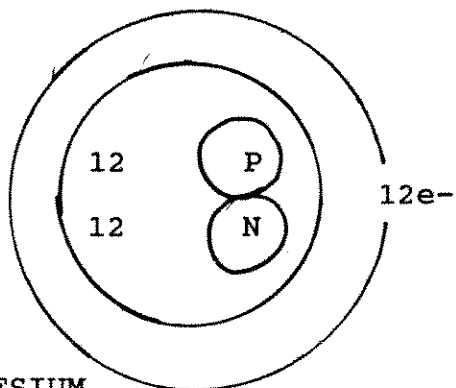


PHOSPHORUS

23. Diagram the structure of the magnesium atom, atomic number 12 and atomic weight 24.

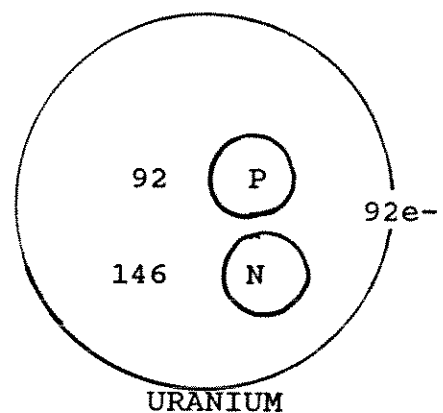


MAGNESIUM



MAGNESIUM

24. The uranium atom has the atomic structure shown here:



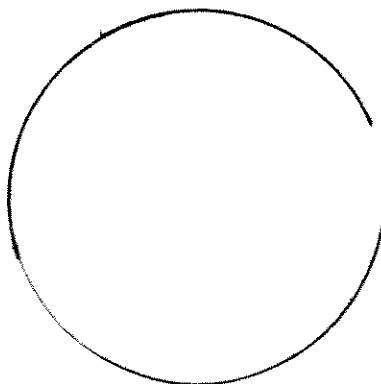
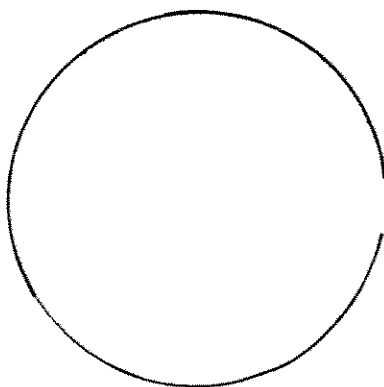
URANIUM

Therefore, the uranium atom has an atomic number of \_\_\_\_\_ and an atomic weight of \_\_\_\_\_.

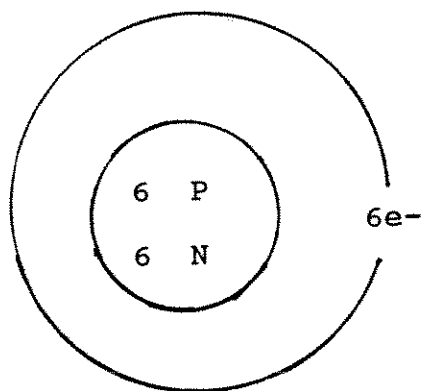
92, 238

### ISOTOPES

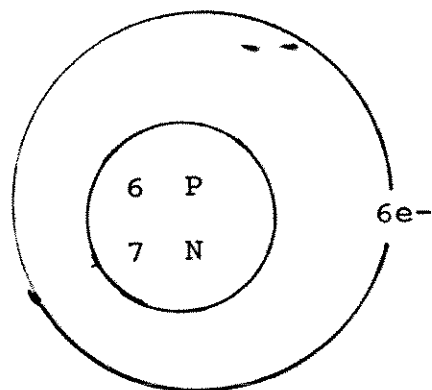
25. Draw the structure of a carbon atom, atomic number 6 and atomic weight 12. Now draw the structure of a carbon atom, atomic number 6 and atomic weight 13.





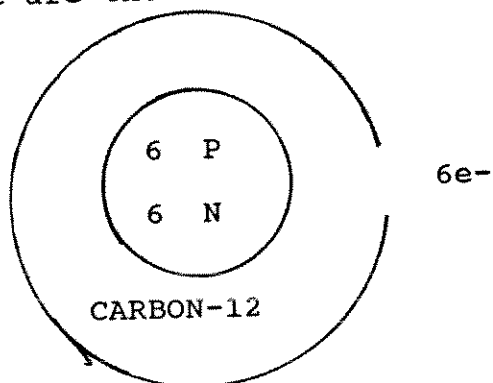


CARBON-12

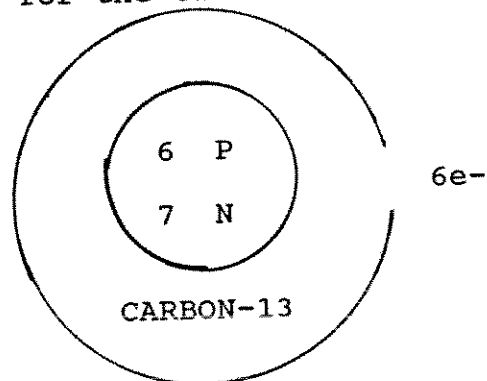


CARBON-13

26. Here are the structures you drew for the two carbon atoms:



CARBON-12



CARBON-13

- (a) These atoms have (check one)  
 the same atomic number  
 different atomic numbers
- (b) These atoms have  
 the same atomic weight  
 different atomic weights

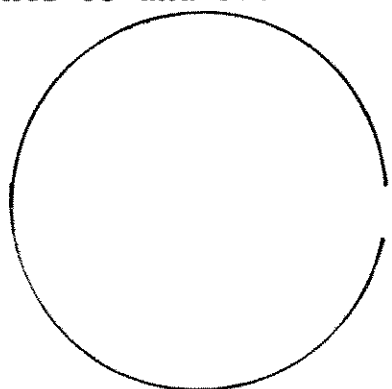
Such atoms are called isotopes.

(a) the same atomic number; (b) different atomic weights

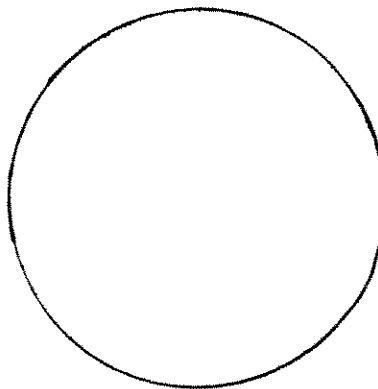
27. Isotopes, then, may be defined as atoms that have

- (a) the same atomic number and the same atomic weight  
 (b) different atomic numbers  
 (c) different atomic weights and the same atomic numbers
- (c) different atomic weights and the same atomic numbers

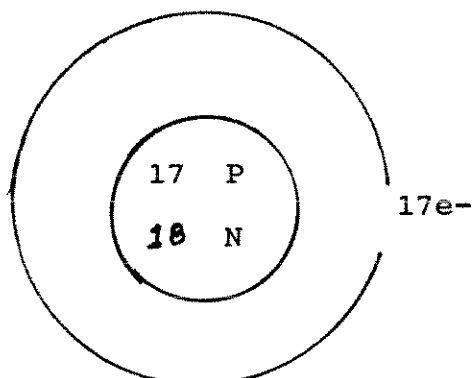
28. Draw the two isotopes of chlorine, atomic number 17 and atomic weights 35 and 37.



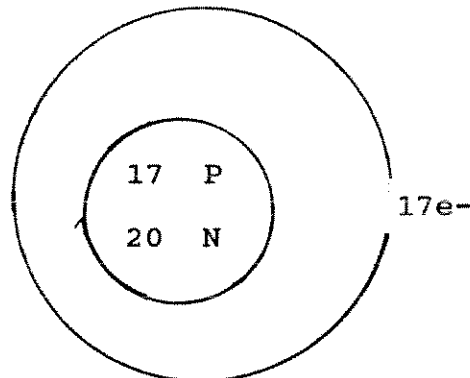
CHLORINE-35



CHLORINE-37

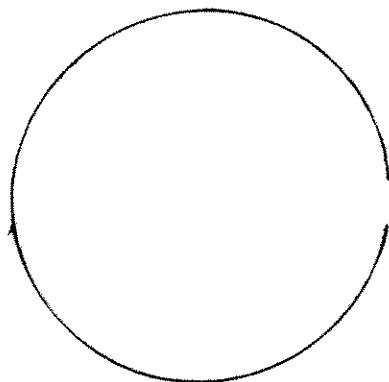


CHLORINE-35

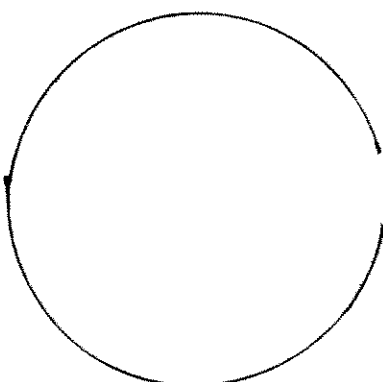


CHLORINE-37

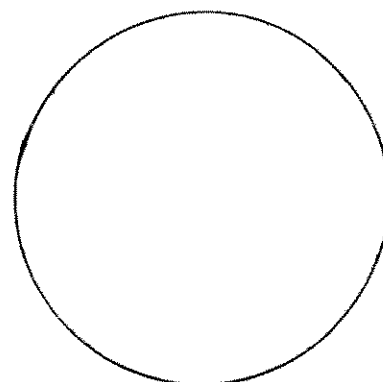
29. Draw the three isotopes of hydrogen, atomic number 1 and atomic weights 1, 2, and 3.



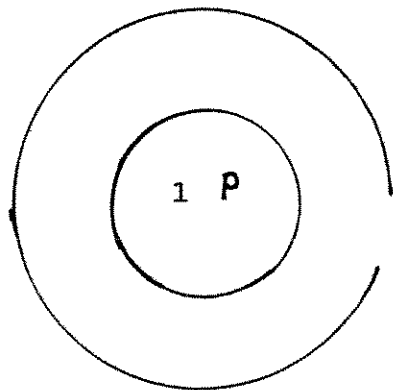
HYDROGEN-1



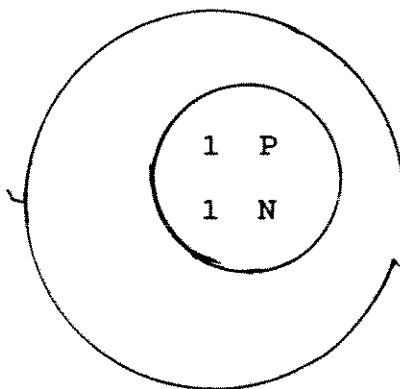
HYDROGEN-2



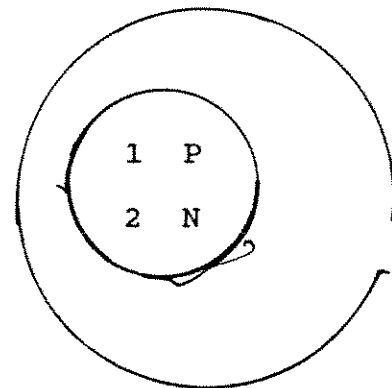
HYDROGEN-3



HYDROGEN-1



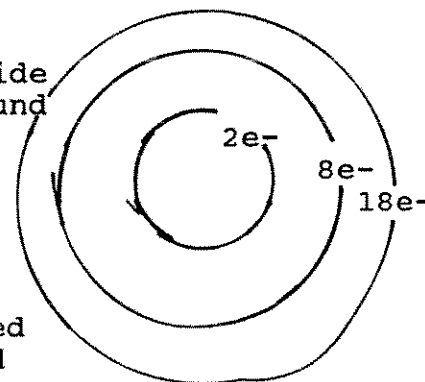
HYDROGEN-2



HYDROGEN-3

### ELECTRON SHELLS

30. The electrons, which are located outside the nucleus the atom, revolve around the nucleus in specific paths called shells.

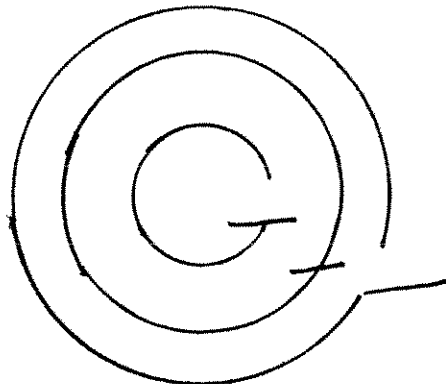


The shell nearest the nucleus is called the first shell. Then come the second shell, third shell, etc. The diagram indicates the maximum number of electrons possible in each shell.

- (a) the first shell can hold up to \_\_\_\_\_ electrons.  
 (b) the second shell can hold up to \_\_\_\_\_ electrons.  
 (c) the third shell can hold up to \_\_\_\_\_ electrons.

a) 2; (b) 8; (c) 18

31. Label the maximum number of electrons possible in each shell in the diagram.



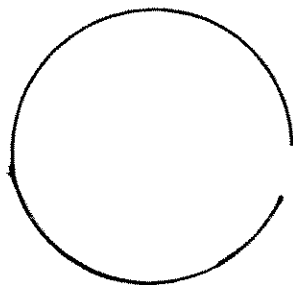
2 e<sup>-</sup> in the first shell; 8 e<sup>-</sup> in the second shell; 18 e<sup>-</sup> in the third shell.

32. The first shell must be filled with 2 electrons before electrons can go into the second shell.

The second shell must be filled with \_\_\_\_\_ electrons before electrons can go into the third shell.

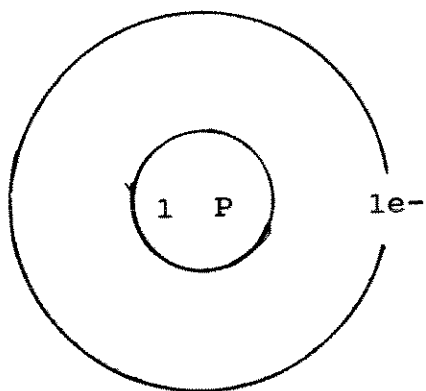
8

33. On the diagram, show the structure of the hydrogen atom, atomic number 1, atomic weight 1.



HYDROGEN

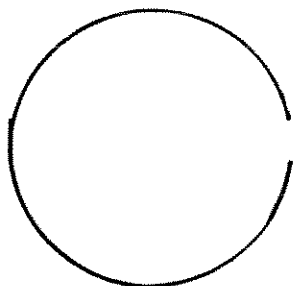
- (a) The number of protons in the hydrogen atom is \_\_\_\_\_  
(b) The number of neutrons is \_\_\_\_\_  
(c) The number of electrons is \_\_\_\_\_  
(d) The one electron in the hydrogen atom must go into which shell - (1st, 2nd, 3rd)? \_\_\_\_\_



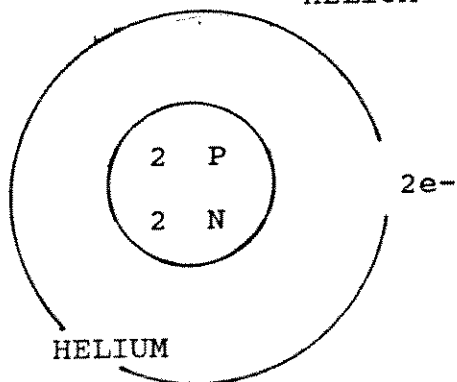
HYDROGEN

(a) 1; (b) 0; (c) 1; (d) 1st

34. In the space provided, draw the structure of the helium atom, atomic number 2 and atomic weight 4.



HELIUM



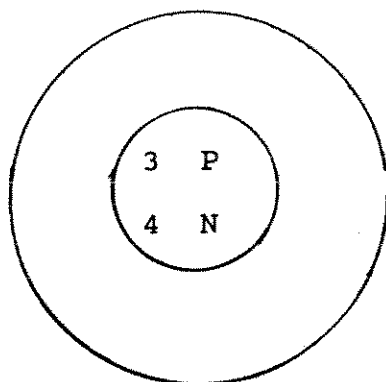
35. Now let's look at the structure for the lithium atom, atomic number 3 and atomic weight 7.

- (a) The number of protons in the lithium atom is \_\_\_\_\_  
 (b) The number of neutrons in the lithium atom is \_\_\_\_\_  
 (c) The number of electrons in the lithium atom is \_\_\_\_\_

(a) 3; (b) 4; (c) 3

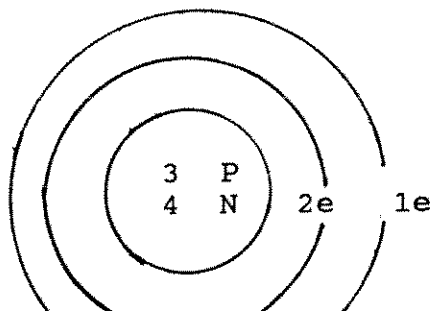
36. There are 3 electrons in the lithium atom. How many shells will lithium atom have? \_\_\_\_\_.  
 (If you aren't sure, check frame 32).

Complete the diagram of the lithium atom:



LITHIUM

2

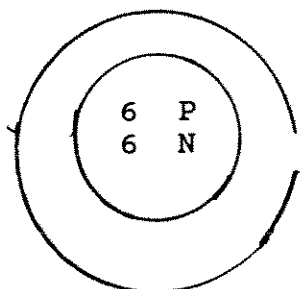


LITHIUM

37. The carbon atom has atomic number 6 and atomic weight 12.

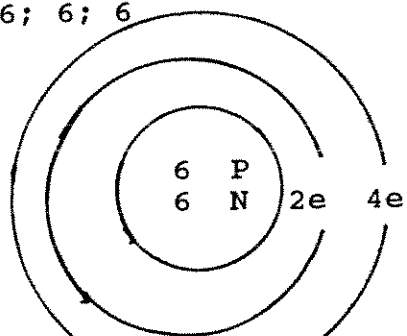
- The carbon atom contains \_\_\_\_\_ protons.  
 The carbon atom contains \_\_\_\_\_ neutrons.  
 The carbon atom contains \_\_\_\_\_ electrons.

Complete the structure of the carbon atom:



CARBON

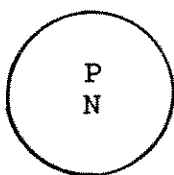
6; 6; 6



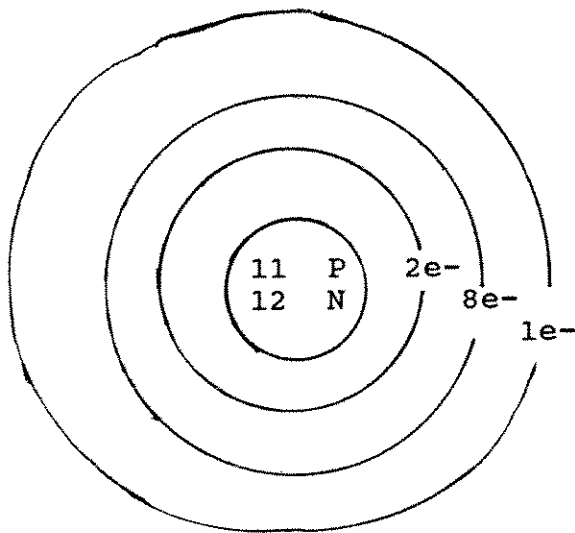
CARBON

38. (a) In the element sodium, atomic number 11, there are how many electrons? \_\_\_\_\_.
- (b) How many shells will the sodium atom have? \_\_\_\_\_.
- (c) How many electrons will each shell of the sodium atom have?
- 1st shell \_\_\_\_\_
- 2nd shell \_\_\_\_\_
- 3rd shell \_\_\_\_\_

Diagram the complete structure of the sodium atom, atomic number 11 and atomic weight 23.

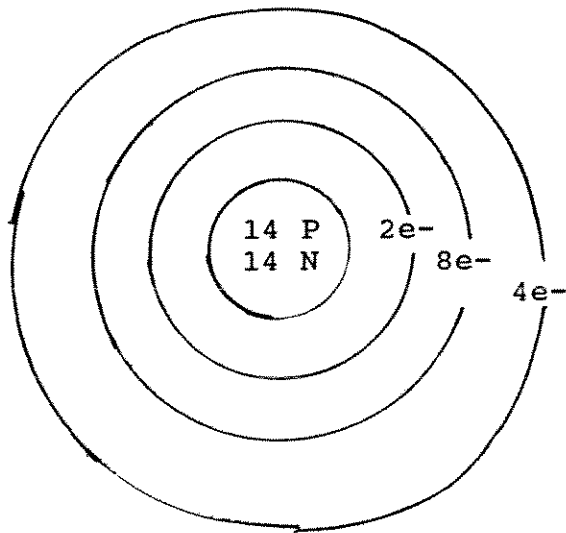


(a) 11; (b) 3; (c) 2, 8, 1



SODIUM

39. Diagram the structure of the silicon atom, atomic number 14, atomic weight 28.



SILICON

CHEMICAL SYMBOLS

40. Each of the approximately 100 elements has its own name and its own properties. The symbol for an element is usually an



abbreviation for its name. Frequently the abbreviation is merely the first letter of that name. The following table lists some of these elements.

ELEMENT	SYMBOL
Hydrogen	H
Carbon	C
Oxygen	O
Nitrogen	N
Phosphorus	P
Sulfur	S

41. What elements are present in the compound  $\text{CO}_2$  \_\_\_\_\_

\_\_\_\_\_

carbon and oxygen

42. What elements are present in ammonia,  $\text{NH}_3$ ? \_\_\_\_\_

\_\_\_\_\_

nitrogen and hydrogen

43. What elements are present in glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$ ? \_\_\_\_\_

\_\_\_\_\_

carbon, hydrogen, and oxygen.

44. What elements does the compound  $\text{C}_6\text{H}_7\text{NSO}_3$  contain? \_\_\_\_\_

\_\_\_\_\_

carbon, hydrogen, nitrogen, sulfur, and oxygen.

45. When the names of more than one element begin with the same letter, frequently the second letter of the name is added to the symbol.

Here are some of the elements whose symbols are the first two letters of their names. Write the symbols for each.

ELEMENT	SYMBOL
calcium	_____
bromine	_____
silicon	_____
barium	_____

Ca; Br; Si; Ba

46. The compound  $\text{CaBr}_2$  contains the elements \_\_\_\_\_  
and \_\_\_\_\_

calcium, bromine

47. The compound  $\text{BaO}_2$  contains the elements \_\_\_\_\_  
and \_\_\_\_\_

barium, oxygen

48. The compound  $\text{CaC}_2\text{O}_4$  contains the elements \_\_\_\_\_  
\_\_\_\_\_

calcium, carbon and oxygen

49. The compound sucrose contains 12 atoms of carbon, 22 atoms of hydrogen, and 11 atoms of oxygen. The formula of sucrose is

\_\_\_\_\_

$\text{C}_{12}\text{H}_{22}\text{O}_{11}$

50. The compound calcium sulfate contains 1 atom of calcium, 1 atom of sulfur, and 4 atoms of oxygen. The formula for calcium sulfate is \_\_\_\_\_

$\text{CaSO}_4$

51. There are several elements whose symbols are not derived from the first letter or first two letters of their English names. Here are some of these elements:

ELEMENTS	SYMBOL
chlorine	Cl
sodium	Na (from the Latin natrium)
magnesium	Mg
Potassium	K
zinc	Zn
iron	Fe (from the Latin ferrum)

Write the name of the element represented by each of the symbols below:

H _____	C _____
N _____	S _____
O _____	Si _____
Ca _____	Br _____

Hydrogen	Carbon
Nitrogen	Sulfur
Oxygen	Silicon
Calcium	Bromine

52. What elements are present in each of the following compounds?

- (a) KBr \_\_\_\_\_
- (b) CCl<sub>4</sub> \_\_\_\_\_
- (c) NaOH \_\_\_\_\_
- (d) MgCl<sub>2</sub> \_\_\_\_\_
- (e) NaNO<sub>3</sub> \_\_\_\_\_
- (f) K<sub>3</sub>FeC<sub>6</sub>N<sub>6</sub> \_\_\_\_\_

- (a) potassium and bromine; (b) carbon and chlorine;
- (c) sodium, oxygen, and hydrogen; (d) magnesium and chlorine;
- (e) sodium, nitrogen, and oxygen;
- (f) potassium, iron, carbon, and nitrogen.

53. One molecule of vitamin B12 contains:

- 63 atoms of carbon
- 90 atoms of hydrogen
- 14 atoms of oxygen
- 14 atoms of nitrogen
- 1 atom of phosphorus
- 1 atom of cobalt (Co)

The formula for vitamin B12 is \_\_\_\_\_

C<sub>63</sub>H<sub>90</sub>O<sub>14</sub>N<sub>14</sub>PCo

54. A molecule of biotin, one of the B vitamins, contains:

- 10 atoms of carbon
- 16 atoms of hydrogen
- 3 atoms of oxygen
- 2 atoms of nitrogen
- 1 atom of sulfur

The formula for biotin is \_\_\_\_\_

C<sub>10</sub>H<sub>16</sub>O<sub>3</sub>N<sub>2</sub>S

55. Heme, a constituent of hemoglobin, contains:

- 34 atoms of carbon
- 35 atoms of hydrogen
- 4 atoms of nitrogen
- 4 atoms of oxygen
- 1 atom of iron

The formula for heme is \_\_\_\_\_

C<sub>34</sub>H<sub>35</sub>N<sub>4</sub>O<sub>4</sub>Fe

56. Chlorophyll has the formula C<sub>55</sub>H<sub>68</sub>O<sub>5</sub>N<sub>4</sub>Mg. It contains the elements:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

carbon, hydrogen, oxygen, nitrogen, magnesium