most satisfactory result derived from the hypotheses described above. There is no reason to alter any hypothesis because of the difference in these figures, for the shape of the electron would have to be taken into account, a subject about which there is uncertainty.

In the following Table XII the single quantity m^2 is used as an abbreviation for $(m_A^2 + m_{A_1}^2)$. r is the distance between the atoms designated. In each instance the force of the second atom upon the first is the same as that of the first on the second.

CHAPTER X.

PARTICULAR EXAMPLES OF MOLECULES.

CH

Let us illustrate the use of Table XII by item No. 3, Carbon and Hydrogen. With the values previously found, namely

$$D = 5.15 \times 10^{-18}; \quad (D + H)_C = 10.30 \times 10^{-18}; \quad r = 1.63 \times 10^{-8},$$

Average $\cos\alpha = .6369$; $(3\cos^2\alpha - 1)/\cos\alpha = .339$; m_A^2 for $H = 3.34 \times 10^{-26}$, and $\frac{45}{8} = 5.625$, we find $m_C^2 = 22.1 \times 10^{-26}$, that is

$$m_A^2 + m_{A_1}^2 = 22.1 \times 10^{-26}. \tag{120}$$

Here m_A is the distance of those electrons in contact with the positive charges in the carbon atom from its equator, while $m_{A.}$ is the distance of the connecting electrons in the carbon atom, namely those not in contact with the positive charges. It is reasonable to suppose that the distance to those electrons in contact is the same as the distance we have already found for hydrogen in (119) above. In fact the positive charge is twice as great in contact with the electron in carbon as in hydrogen, which must bind it more firmly. Using the value of m_A^2 in (118), namely 3.34×10^{-26}, we find from (120)

$$m_{A_1}^2 = (22.1 - 3.34)\ 10^{-26} = 18.8 \times 10^{-26} \tag{121}$$

and

$$m_{A_1} = 4.33 \times 10^{-13} \text{ cm.} \quad \text{for H on C.} \tag{122}$$

* * *

HO

Following the same plan with item No. 4, Table XII, Oxygen and Hydrogen, we obtain

$$m_O^2 = m_A^2 + m_{A_1}^2 = 26.65 \times 10^{-26},$$

and $$m_{A_1}^2 = (26.65 - 3.34)\ 10^{-26}$$
$$= 23.3 \times 10^{-26}, \qquad (123)$$

whence $$m_{A_1} = 4.83 \times 10^{-13} \quad \text{for Oxygen in HO.} \qquad (124)$$

The distances between the atoms C and H and O and H are given in Figure 8.

By these two results it appears that the distance to the connecting electrons is greater, 4.83, in oxygen when united to one hydrogen than in carbon, 4.33, united to one hydrogen.

There is no means of knowing from the equations so far developed what these distances are in free atoms not united to other atoms. But it is safe to say the distance is more than 1.83×10^{-13} cm.

* * *

Carbon on Carbon.

Using item No. 8 in Table XII, namely

$$\underset{\text{C on C}}{F} = \frac{27e^2}{2k}[(D+H)_C^2 \cos\alpha\, r^{-4} - \tfrac{45}{8}(3\cos^2\alpha - 1)(m_A^2 + m_{A_1}^2)^2 r^{-6} \cdots], \qquad (125)$$

and equating to zero for equilibrium, putting $(3\cos^2\alpha - 1)/\cos\alpha = .339$ (see (107)), and $\frac{45}{8} = 5.625$, we have $(D+H)_C^2 r^2 = 5.625 \times .339\ (m_A^2 + m_{A_1}^2)_C^2 = 1.907(m_A^2 + m_{A_1}^2)^2$, and

$$(D+H)_C r = 1.382(m_A^2 + m_{A_1}^2)_C.$$

By (23) $(D+H)_C = 20.60 \times 10^{-18}$, and by Fig. 8 $r_{CC} = 2.96 \times 10^{-8}$ cm. Hence

$$(m_A^2 + m_{A_1}^2)_C = 44.1 \times 10^{-26} \qquad (126)$$

And putting $m_A^2 = 3.34 \times 10^{-26}$ as before (see (118)), we find

$$m_{A_1}^2 = 40.76 \times 10^{-26}, \quad \text{and} \quad m_{A_1} = 6.38 \times 10^{-13} \text{ cm.}, \qquad (127)$$

the distance to the connecting electrons from the equator in the carbon atom when united to another carbon atom. The distance between the two carbon atoms is given in Fig. 8.

* * *

Oxygen on Oxygen.

Using item No. 10, Table XII, namely

$$F_{OO} = 24\frac{e^2}{k}[(D+H)_O^2 \cos\alpha\, r^{-4} - \tfrac{45}{8}(3\cos^2\alpha - 1)(m_A^2 + m_{A_1}^2)^2 r^{-6} \cdots], \qquad (128)$$

upon equating to zero for equilibrium we have

$$(D+H)_O^2 r^2 = 5.625 \times .339(m_A^2 + m_{A_1}^2)_O^2$$
$$= 1.907(m_A^2 + m_{A_1}^2)_O^2 \qquad (129)$$

and $$(D+H)_O r = 1.382(m_A^2 + m_{A_1}^2)_O. \qquad (130)$$

By (116) $$(D+H)_O = 20.60 \times 10^{-18}.$$

By Fig. 8 $$r_{OO} = 3.59 \times 10^{-8},$$

hence $$(m_A^2 + m_{A_1}^2)_O = 53.5 \times 10^{-26}. \qquad (131)$$

Putting $m_A^2 = 3.34 \times 10^{-26}$ as before (see (26)), we find

$$m_{A_1}^2 = 50.2 \times 10^{-26}, \quad \text{and} \quad m_{A_1} = 7.08 \times 10^{-13} \text{ cm.}, \qquad (132)$$

as the distance to the connecting electrons from the equator in the oxygen atom when united to another oxygen atom. This greater distance compares with 6.38×10^{-13} cm. for Carbon on Carbon. The distance between the oxygen atoms is given in Fig. 8.

* * *

Molecules with More than Two H Atoms.

By adding a second hydrogen atom to one carbon atom to form CH_2, the distance between C and H remains the same as before, and for each H-atom added thereafter up to the limit of stability.

* * *

CH

When there is but one hydrogen atom attached to a carbon atom, the force upon the positive charge in carbon at the origin due to the