55. Write out in words the meaning of the following equations;—

$KClO_3 = KCl + O_3$

$3MnO_2 = Mn_3O_4 + O_2$. N.B. compare Fe_3O_4; trimanganic tetroxide

$2H_2SO_4 = 2SO_2 + 2H_2O + O_2$

$2HgO = 2Hg + O_2$

$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$

$3Fe + 4H_2O = Fe_3O_4 + 4H_2$. N.B. triferric tetroxide.

56. In the formula $N_2CO_3 + 10H_2O$, what is the $10H_2O$ called?

57. In H_2SO_4 that is H_2O,SO_3 what is the H_2O called?

58. What is the province of organic chemistry?

59. What sort of substances have names ending in —yl as methyl, formyl, hydroxyl, sodoxyl, onproxyl?

60. Define oxyacid, hydracid, and sulphacid.

61. What is an anhydride? Name some and give their formulas.

62. What determines the basicity of an acid?

63. What determines whether a salt is normal or acid?

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20. There are three principal varieties of chemical changes or reactions, namely.

1. **Synthesis, or Composition,** the direct union of two elements, atoms uniting to form molecules. Example:— chlorine and hydrogen under the influence of light or of electricity combine directly, $H + Cl = HCl$.

Cases of pure synthesis seldom if ever happen in the strict sense. Almost every chemical process is attended both with the breaking up of molecules into atoms and the re-grouping of these atoms to form new molecules. This is true even of elementary substances like hydrogen and chlorine. We have used the *atomic formula* but the *molecular formula* $H_2 + Cl_2 = 2HCl$ probably expresses the real operation. Similarly free oxygen and free hydrogen combine to form water $2H_2 + O_2 = 2H_2O$. There may be cases in which the molecule consists of a single atom but they are rare. In general the term synthesis is employed to designate the change which takes place when the old molecules attach to themselves more material, and new molecules of greater weight result as when iron is burnt in oxygen, $Fe_3 + O_4 = Fe_3O_4$.

2. **Analysis,** or **Decomposition,** the separation of a compound into simpler compounds, or into its elements, the breaking up of molecules into atoms. Examples:—mercuric oxide by the application of heat is split up into its elements $2HgO = Hg_2 + O_2$. Similarly by a galvanic current $2H_2O = 2H_2 + O_2$, by heat potassic chlorate is decomposed $2KClO_3 = 2KCl + 3O_3$

3. **Metathesis, Replacement,** or **Substitution,** in which one ingredient of a compound substance is withdrawn and its place supplied by some other material, the atoms of one molecule changing places with the atoms of another molecule. It might be regarded as a combination of analysis and synthesis, and and is therefore frequently called *Double Decomposition.*

Examples :—metallic sodium immersed in water decomposes the water by replacing the hydrogen $2H_2O + Na_2 = 2NaHO + H_2$. Each atom of sodium displaces one atom of hydrogen from a molecule of water and forms caustic soda or sodic hydrate with the remaining atoms of the water molecule. The displaced hydrogen is liberated in the free state. Add a little hydrochloric acid to this caustic soda and water and common salt are produced, thus $NaHO + HCl = H_2O + NaCl$. The hydrogen of the acid and the metal of the alkali have replaced each other. Numerous examples will occur as we proceed.

21. There are two peculiar conditions under which chemical action will sometimes take place even when ordinary means fail to develop the chemical force. They are called *Catalysis* and the *Nascent State.*

It is sometimes found that the mere presence of another body which itself remains quite unchanged, is sufficient greatly to facilitate, or even to determine the combination of elements, or the separation of a compound. This influence is termed catalysis. Thus free oxygen gas and double its volume of free hydrogen gas diffused together in the same vessel form a mechanical mixture known as oxyhydrogen gas. Under ordinary conditions this gas may be kept for a long time without undergoing any chemical change. But when a piece of porous spongy platinum is introduced the gases combine to form water and the platinum becomes quite hot. Charcoal produces a similar effect on a mixture of oxygen and sulphuretted hydrogen, (H_2S). The gases combine with explosion, but the charcoal undergoes no change, nor does the platinum in the preceding example. In preparing oxygen from potassic chlorate ($KClO_3$), it has been found that the gas is given up at a much lower temperature if some black oxide of manganese, (manganic dioxide, MnO_2) be mixed with the chlorate. [N.B. See that the manganic oxide has not been adulterated with coal dust or the mixture will be explosive.] But the oxide itself remains unchanged. Even powdered glass or sand will have a similar effect in causing the chlorate to decompose at a lower temperature. This catalyctic influence is not well understood, but it is conjectured that in some instances at least the neutral substance acts as a carrier. Thus the MnO_2 may seize part of the oxygen of the $KClO_3$ and form MnO_3, this MnO_3 then decompose into $MnO_2 + O$ and the MnO_2 be ready to repeat the process. In other cases, as those of charcoal and platinum, the third substance acts by condensing the gases in its pores.

22. It is also observed that at the moment any substance is liberated from a chemical combination its affinity or power of entering into combination with other elements is greatly exalted. The substance is then said to be in the *Nascent State.* The increased energy of combination observed is probably owing to the separation of individual atoms which at first have not as yet united with each other to form molecules. Thus, nascent hydrogen would be represented by H while ordinary free hydrogen would be HH or H_2, for as previously stated the molecule of the element is believed to consist of at least two atoms.

A high temperature, the gaseous form, catalyctic influence, the nascent state and a strong current of electricity are powerful means of promoting chemical action, more especially when two or more of them are brought to bear simultaneously. Numerous cases occur which must be carefully noticed. Thus free oxygen and free hydrogen do not ordinarily combine, but if oxygen and hydrogen be brought together at the moment of their separation from some compounds they immediately unite to form water. The bleaching power of chlorine also depends on nascent oxygen.

23. After innumerable experiments and careful observation chemists have been able to sum up the essential points discovered with regard to chemical action under the five following statements commonly known as the Laws of Chemical Combination.

I. **The Law of Constant Constitution.** The same chemical substance contains the same elements.

II. **The Law of Fixed or Constant Proportion.** The elements of any substance are always combined in the same proportion by weight. These combining weights, chemical equivalents, or atomic weights are given in section 14.

III. **The Law of Multiple Proportions.** When one body combines with another in several proportions, the higher proportions are multiples of the lower.

IV. **The Law of Compound Proportion.** The combining proportion of any compound is the sum of the combining proportions of all its constituents.