

inhabit Kilimanjaro up to 6000 feet, are fairly tractable, and have a passionate love of trade, which with them is the great pacifier. They go absolutely naked, or if any clothing is worn in the way of ornament it rarely goes beyond leather capes for the shoulders. They all speak dialects belonging to the great Bantu group of languages. I have studied carefully several of them, and have, I believe, discovered some most interesting points in their construction likely to throw considerable light on the archaic forms of Bantu prefixes. I may add that, after a very happy sojourn in the lovely forest region of Tavcita at the foot of the mountain, I was compelled to return most reluctantly to the coast at the end of November owing to the exhaustion of my funds. I left Kilimanjaro with great regret, and on my homeward journey my thoughts were persistently directed to my whilom African home, rather than to an unwilling and too early return to civilisation. My collections have safely reached this country, and will, I hope, be sufficient to indicate the true character and relationships of the fauna and flora of Kilimanjaro."

THE death is announced at Lübeck of Dr. Robert Avé-Lallemant, at one time a well-known traveller in South America. He became surgeon to the Novara expedition, which, however, he left at Rio, in order to devote himself to exploration in Brazil. In 1858 he went to Rio Grande do Sul, where he commenced his journey into Southern Brazil, during which he visited Bonpland, a few months before his death, in his lonely ranche in Paraguay. He crossed the Uruguay Allegrette, San Gabriel, and Cacupava to the Jacuy. From San José he went along the coast to Laguna, visited the sources of the Uruguay, and returned to San José through forests still unknown to travellers. This journey lasted about a year, and soon after his return he again set out to travel through the northern provinces. Landing at Bahia, he followed the coast to the Mucury river. Here he discovered the shocking condition of some of the German colonies. Thence he went to Pernambuco, and ascended the Amazon to Tabatinga, on the Peruvian frontier. On these journeys he published two large works ("Reise durch Süd Brasilien, 1859," and a similar work on North Brazil), and numerous smaller ones. They give no new geographical discoveries or exact measurements, or the results of scientific investigation, but they contain valuable information respecting the country, the fauna and flora, and condition of the people. The later years of his life were spent in medical practice in his native city.

ACCORDING to *L'Exploration*, the Argentine authorities are sending an expedition to the Chaco. It consists of 200 men, divided into three columns, operating from different points, but meeting at Cangayé, a centre almost equally distant from Salta and Paraguay. The object is both military and scientific. It is desired to secure the possession of this vast territory to the Argentine Republic against the Indians, who are again masters there. Six topographical commissions are attached to the expedition in order to study the country, prepare maps, and also, it is said, to investigate the possibility of a railway as far as Oran, in the province of Salta. The investigation of the rivers, for which the gunboat *Pilcomayo* is sent, has been delayed by the low state of the water, but recent rains will now enable that work to be proceeded with. If the result should be the demonstration of the suitability of the *Pilcomayo* to navigation, not only will a great service be rendered to topographical science, but by assuring communications between Bolivia and the Rio Paraguay, a great economical revolution will, it is expected, be produced in these regions.

#### EXPERIMENTS SUITABLE FOR ILLUSTRATING ELEMENTARY INSTRUCTION IN CHEMISTRY

PROFESSORS SIR H. E. ROSCOE and W. J. Russell, by direction of the Lords of the Committee of Council on Education, have recently prepared, for the assistance of teachers of science schools and classes, an outline of experiments in chemistry. As this subject is now under discussion, we are glad to be able to give the outline *in extenso* in NATURE.

The notes have been prepared as some guide to the teachers as to the general character of the course of instruction expected in the elementary stage; they include instruction that should on no account be omitted, but must be considered rather as suggestive than exhaustive.

#### I.—Combustion and Chemical Combination

1. Burn a taper in a clean glass bottle. Show the presence of a colourless gas, differing in properties from common air by yielding a turbidity with lime-water.
2. Hold a bright glass over a burning candle and show the formation of water.  
Explain what is meant by chemical change, and state that chemistry is an experimental science.
3. Make similar experiments with a petroleum or paraffin lamp.
4. Show that coal-gas also yields the same products by passing the products of combustion through lime-water and by collecting the water.
5. Explain the difference between mechanical mixture and chemical combination; and illustrate by a mixture of finely-divided copper and flour of sulphur, and the effect of heat upon the same.
6. Experiment to show that chemical change consists of a change in the properties of matter and that no loss of matter takes place. Suspend lamp chimney, partly filled with lumps of caustic soda, from the arm of a balance. Place short piece of candle in the lower part of the glass and counterbalance. Light the candle. Explain the increase in weight.
7. Heat is evolved when chemical combination takes place. Pour water on to quicklime. Refer also to experiments 1 and 3.
8. Combustibles and supporters of combustion. The purely relative character of these terms. Ordinary combustion the union of atmospheric oxygen with a body termed the combustible, or with one or more of its constituents, heat being developed, as in all cases where two or more bodies combine. Illustrate by showing that air will burn in coal-gas just as well as coal-gas will burn in air.

#### II.—Air

1. Existence of atmosphere, felt in winds.
2. Weight of air shown by means of a flask exhausted by the air-pump.
3. Burn phosphorus in air.
4. Burn phosphorus in confined volume of air and show diminution in bulk.
5. Show that some diminution takes place slowly when a stick of phosphorus is exposed to air at ordinary temperatures.
6. Test residual gas (N) with a burning taper.
7. Show that phosphorus burnt in air increases in weight.
8. Allow iron borings moistened with sal ammoniac to rust in a confined volume of air and introduce burning taper into residual gas (N).
9. Show that iron filings, suspended by a magnet hanging on one scale of a balance, increase in weight on heating.
10. Strongly heat the red substance which may be formed by gently heating mercury in the air. Collect and test the gas (O) with a glowing splinter of wood.
11. Add the gas thus obtained to the residue obtained in experiment 4 or 8 so as to make up the original volume of air, and show that a taper burns in this mixture as in common air.
12. Refer to numbers giving exact analysis of air, calling especial attention to the fact that it varies slightly in composition.

Also explain that no obvious change, such as increase of temperature or alteration of bulk, occurs when oxygen and nitrogen are mixed. Also that air has the properties of a mixture, and that when water is shaken up with air a portion of that air dissolves, the residue being found to contain relatively less oxygen than the original air, whilst the dissolved portion contains relatively more oxygen, and that this could not be the case if the air were a compound. Consequently it is a mixture and not a chemical compound.

13. It is important that these experiments should be made and their explanation given so as to teach the student how the composition of air is ascertained by experiment, and in a similar manner how oxygen was discovered by Priestley, and how the composition of the air and the part which oxygen plays in the phenomena of combustion were experimentally demonstrated by Lavoisier.

#### III.—Effects of Animal and Vegetable Life upon the Atmosphere

1. Show that by drawing air into the lungs through lime-water a very faint, if any, precipitate is produced; but that on expiring air from the lungs through another portion of lime-water a copious precipitate is soon formed.

2. Show the production of carbon dioxide by the oxidation of ordinary articles of food, as by heating small quantities of the dried substance, such as sugar, bread, or meat, with copper oxide.

3. Show that carbon dioxide exists in the air by pouring clear lime-water into a shallow vessel exposed to air, and explain that this small quantity of carbon dioxide serves as the main food of the plants that grow on the earth.

4. Expel air from water by boiling, and explain how fish and aquatic plants are thus provided with oxygen and carbonic acid.

5. Explain that plants eliminate and animals require oxygen. That animals take in oxygen from the air, and give out carbonic acid. That plants possess the power under the influence of light of assimilating carbon from carbon dioxide and liberating the oxygen. Explain that thus the balance of oxygen and carbon dioxide in the atmosphere is maintained.

6. Illustrate the action of plants by the formation of bubbles of oxygen when a fresh plant is exposed to the action of light in water containing carbonic acid in solution.

#### IV.—Water

1. Illustrate the three states of matter, the solid, the liquid, and the gaseous, with ice, water, and steam, and point out that the difference is caused by increase or diminution in the amount of heat present.

2. Composition of water. Decompose water by the electric current. Collect the two gases separately in a voltmeter, and exhibit their properties.

3. Show formation of water by explosion of a mixture of hydrogen (two volumes) and oxygen (one volume) in a soda-water bottle.

4. Explode soap-bubbles inflated by a mixture of hydrogen and oxygen in the above proportions.

5. Throw potassium or sodium into water, and collect the hydrogen.

6. Pass steam over red-hot iron, collect the gas and show that it is hydrogen.

7. Show that the same gas may be obtained by dissolving zinc clippings or iron turnings in dilute sulphuric acid.

8. Demonstrate the properties of hydrogen :

(a) Its combustibility.

(b) Its lightness.

(c) That a candle will not burn in it.

(d) That water is formed when it burns in air.

9. Composition of water. Pass oxygen over red-hot copper, and show by weighing before and after that the weight increases.

10. Pass hydrogen over the copper oxide thus produced, heating gently. Collect the water, and show that the copper oxide has been entirely reduced, the tube weighing the same as before passing the oxygen through it.

11. Determine the composition of water by weight by passing dry hydrogen over half an ounce of copper oxide, and collecting the water in a weighed chloride of calcium tube. Show approximately that water contains two parts by weight of hydrogen to sixteen parts by weight of oxygen.

12. Note the first law of chemical combination : that chemical compounds, such as water, always contain their components in the same unvarying proportions.

13. Contrast the properties of water with those of its constituents on the one hand, and the properties of air with those of its constituents on the other.

14. Call attention to air and water as illustrations of the difference between a mixture and a compound, and quote oxygen, nitrogen, and hydrogen as examples of elementary bodies.

15. Separation of impurities from water by filtration and distillation. Preparation of fresh water from salt water.

16. Experiments illustrating solution and crystallisation. Soluble substances, as sugar, washing soda, alum; slightly soluble substances, as gypsum or plaster of Paris; insoluble substances, as chalk, flint, and sand.

17. Crystallise carbonate of soda, and sulphate of copper.

#### V.—Oxygen and Ozone

1. Prepare oxygen by heating

(a) Oxide of mercury.

(b) Potassium chlorate.

(c) Mixture of potassium chlorate, and either manganese dioxide, copper oxide, or ferric oxide.

2. Show the re-ignition of a splinter of red-hot wood and glowing wick of taper.

3. Burn charcoal in oxygen, and show the formation of carbon dioxide.

4. Burn phosphorus simultaneously in air and in oxygen.

5. Burn watch-spring in oxygen.

6. Show that iron does not rust in dry oxygen.

7. *Ozone*.—Describe and demonstrate the formation of ozone by submitting oxygen to the silent electric discharge.

8. Describe and demonstrate the properties of ozone which distinguish it from ordinary oxygen, such as its action on metallic mercury, on indigo solution, or on potassium iodide and starch. Also its change to ordinary oxygen when passed through a heated glass tube.

9. Explain the difference in density between oxygen and ozone.

#### VI.—Combining Weights; Names and Symbols of the Elements; Chemical Calculations, &c.

1. Exhibit list of the elements, distinguishing (by means of the type) the non-metals from the metals; and, again, the more commonly occurring metals from those which are rarer.

2. Describe the occurrence of these elements in the air, in the sea, and in the solid crust of the earth.

3. Write up the results of the quantitative analysis of potassium chlorate. Explain that this is the result of experiment, and demonstrate the fact that, when heated, an unalterable weight of oxygen is given off and a given unalterable weight of potassium chloride remains behind.

4. Dissolve a crystal of pure chlorate of potassium, and the residue of chloride from heating chlorate, in two separate glasses, and show the difference in the reaction with silver chloride.

5. Explain the meaning of the term chemical symbol, and chemical formula of the salt, referring afterwards to the combining weights of the elements.

6. Explain the mode of determining the formula from the percentage composition.

7. Method of calculating the quantity of oxygen from potassium chlorate (and from manganese dioxide).

#### VII.—Acids, Bases, and Salts

1. Burn sodium in oxygen; dissolve the product in water; give the formula of the oxide. Express the action of water upon it by an equation.

2. Act on water with sodium, and collect the hydrogen. Explain by equation that the same substance, sodium hydrate or hydroxide, or caustic soda, is formed, as in experiment 1.

3. Burn sulphur in a current of oxygen, and show the product fumes slightly in the air. Explain that it is a mixture of sulphur dioxide and trioxide. Pass the gas thus obtained into water.

4. Add litmus solution to the solutions obtained in experiments 2 and 3, and show that on adding the one solution to the other the colour is changed, or a point is reached where a further addition of the one has no effect, whereas a minute addition of the other at once changes the colour. Explain the action by an equation.

5. Explain that the compound formed from the sodium oxide and water is termed an alkali, or alkaline or basic hydroxide, and the oxide from which it is formed an alkaline or basic oxide; that the compound formed from the sulphur dioxide and water is termed an acid hydroxide or acid, and the original oxide an acid forming oxide or anhydride.

6. Explain that sodium hydroxide and sulphurous acid may be taken as representative of the two classes into which hydroxides are divided.

7. Explain that by the action of the one upon the other a salt is formed. Exhibit a white crystalline salt, e.g. sodium sulphate.

#### VIII.—Hydrogen

1. Prepare hydrogen by the action of dilute sulphuric acid on zinc.

2. Show that it is not obtained by the use of pure zinc (amalgamated zinc is best used), and illustrate the effect of impurity by adding a drop or two of a lead or copper salt.

3. Prepare hydrogen by dissolving zinc or aluminium in sodium hydroxide.

4. Point out that whereas sodium displaces hydrogen from water at ordinary temperature, and that iron does so at a red heat, copper is without any action at any temperature.

5. Give equations for the various methods here indicated for obtaining hydrogen.

6. Explain fully in detail the methods of chemical calculation, and make the pupils thoroughly understand the methods of calculating quantities.

7. Demonstrate the physical properties of hydrogen, especially its lightness and diffusibility.

8. Compare the heating powers of jet of hydrogen burning in air and in oxygen. Explain the difference.

9. Describe and (if possible) demonstrate the construction and use of the oxy-hydrogen blowpipe.

10. Explain what is meant by heat of combustion, and define the term "heat-unit." Show for this purpose side by side 18 grammes of water and the quantity of water which would be raised 1° C. in temperature by the heat developed in the formation of this quantity of water from its elements.

11. Point out that hydrogen is a powerful reducing agent, illustrating this by the reduction of oxide of iron.

12. Show that nascent hydrogen, or hydrogen at the moment of its liberation from its compounds, frequently produces effects that hydrogen in the free state does not. Bubble hydrogen through ferric chloride solution and show that no discoloration takes place. Place it in contact with zinc and dilute sulphuric acid and the colour disappears.

13. Explain the term nascent as applied to hydrogen and other gas at the moment of its liberation from one of its compounds, and distinguish between the atom of nascent hydrogen and the molecule of free hydrogen.

#### IX.—Hydrochloric Acid and Chlorine

1. Explain with equation and show the action of sulphuric acid on common salt. Collect the escaping gas by downward displacement and show its solubility in water.

2. Hold piece of paper dipped in ammonia solution in the gas.

3. Saturate water with the gas, noting that its volume increases and that considerable heat is developed.

4. Exhibit the effects produced by adding the solution to litmus and to silver nitrate solution.

5. Show that it has no action on indigo, or on a mixture of potassium iodide and starch solution:

6. Pass the gas over red-hot iron and show the production of hydrogen.

7. *Chlorine*.—Heat oxide of manganese with the solution of hydrochloric acid obtained in experiment 3, and collect several jars of the escaping chlorine by downward displacement. Give the equation.

8. Pass some of the gas into water. Exhibit the yellow colour of the solution and show that it precipitates silver nitrate and bleaches litmus and indigo.

9. Burn a jet of hydrogen in chlorine. Show the disappearance of the yellow-coloured gas.

10. Moisten some paper with a few drops of turpentine and throw it into a jar of chlorine. Point out the formation of hydrochloric acid and the deposition of carbon.

11. Explode a mixture of equal volumes of hydrogen and chlorine.

12. Point out how these experiments show that the gas produced in experiment 1 is a compound of chlorine and hydrogen. Give the symbol and atomic weight of chlorine, and state the composition of hydrochloric acid gas by weight and volume.

13. Explain the production of chlorine from common salt, sulphuric acid, and manganese dioxide. Give equations, and instruct the students in the calculations of quantities.

14. Show the combustion in chlorine, of phosphorus, antimony, and copper, and demonstrate its power to displace bromine and iodine from their compounds with metals.

15. Electrolysis of hydrochloric acid solution, and explain the fact of the evolution of equal volumes of its constituent gases.

16. Explain the bleaching action of chlorine as being due to the readiness with which it combines with hydrogen and that it thus acts as an oxidising agent. In illustration of this, show that a piece of dry turkey red cloth when placed in dry chlorine is not bleached.

#### X.—Nitrogen and Ammonia

1. The production of nitrogen from the air and the examination of its properties may here be repeated.

2. Describe and (if possible) demonstrate the production of ammonia by passing sparks from an induction coil or electric machine through a mixture of nitrogen and hydrogen. Explain that the reaction is not complete unless the ammonia is with-

drawn as it is formed, owing to the fact that ammonia is readily decomposed by heat.

3. Prepare ammonia by heating an ammoniacal salt with slaked lime. Collect by upward displacement and over mercury, and show extreme solubility in water.

4. Demonstrate and explain its combination with hydrochloric acid, and show the volatility of sal ammoniac.

5. Show that the aqueous solution of ammonia behaves in the same way as a solution of sodium hydroxide, turning red litmus blue, neutralising acids, and forming precipitates in solutions of metals (copper, iron, and zinc salts, for example) of the same composition as those produced by sodium hydroxide. Explain that on this account it is considered that the ammonia solution contains ammonium hydroxide.

6. Pass dry ammonia gas over red-hot copper oxide and show the production of water and metallic copper.

7. Pass air and ammonia gas simultaneously over red-hot copper as a method of preparing nitrogen.

#### XI.—Nitric Acid and the Oxides of Nitrogen

1. Explain on the blackboard the composition by weight of the five distinct oxides of nitrogen as illustrative of the law of chemical combination in multiple proportions, and as a deduction from this, explain Dalton's atomic theory and state clearly what is meant by an atom. Demonstrate with a series of blocks labelled with the symbols of the different elements how this explains the observed facts of combination in multiple proportions.

2. Make clear to the student the difference between atom and molecule, and explain atomic weight and molecular weight of (1) hydrogen; (2) oxygen, ozone; (3) chlorine; and then of compounds such as (4) hydrochloric acid; (5) water; (6) ammonia.

3. Describe and (if possible) demonstrate the formation of the red fumes of nitric peroxide on passing an electric spark through air.

4. Preparation of nitric acid from nitre and sulphuric acid. Explain the reaction by an equation.

5. Calculation of quantities to be carefully gone into.

6. Exhibit nitre, nitrate of soda, sulphate and bisulphate of potash, and sulphate and bisulphate of soda.

7. Show the oxidising action of nitric acid by dropping it on to some red-hot charcoal.

8. Oxidising action of nitric acid on metallic tin and metallic copper.

8A. Deflagrate mixture of nitre and charcoal.

9. Show the decomposition of nitric acid when heated by dropping it into the bowl of a clay tobacco pipe, the stem of which is strongly heated, collecting the gas over water and testing with a flaming splinter of wood.

10. Heat potassium nitrate and collect the gas (O).

11. Prepare nitric oxide from residue in experiment 10 by treating with dilute sulphuric acid. Explain decomposition of nitrous acid into nitric oxide and nitric acid.

12. Prepare nitric oxide by action of nitric acid on copper turnings. Collect the gas. Explain the reaction.

13. Exhibit the direct combination of nitric oxide with oxygen. Note the formation of red fumes of nitrogen peroxide and their immediate absorption by water.

14. Show that flame of a taper is extinguished in nitric oxide, and that feebly burning phosphorus is also extinguished, but that brightly burning phosphorus continues to burn, and with greater brilliance than in ordinary air. Explain this.

15. Preparation of nitrous oxide. Neutralise nitric acid with ammonia. Evaporate the solution and obtain the solid salt. Show the preparation of nitrous oxide with this residue. Collect the gas over warm water. Give equation. Explain that nitrous oxide is readily soluble in cold water.

16. Show that like oxygen, nitrous oxide supports the combustion of a taper, and explain that this is caused by the decomposition of the gas, and the union of the constituents of the taper with the oxygen of the nitrous oxide, and liberation of the nitrogen.

17. Also show that phosphorus and strongly ignited sulphur burn in the gas, but that feebly ignited sulphur is extinguished. Explain this.

18. Point out the distinction between nitrous oxide and oxygen: (1) the solubility of nitrous oxide in cold water, (2) the production of nitrogen when bodies burn in it, (3) the fact that nitric oxide does not produce with it red fumes, as is the case with oxygen.

19. Prepare nitrogen from ammonium nitrite (*i.e.* a mixture of potassium nitrite and ammonium chloride).

20. Explain how, in the above experiments, the gradual de-oxidation of nitric acid yields the several oxides of nitrogen, and lastly, nitrogen itself.

#### XII.—Sulphur

1. Exhibit the different forms of sulphur: flour of sulphur, brimstone or stick sulphur, and crystallised native sulphur.

2. Dissolve sulphur in bisulphide of carbon, and obtain crystals by spontaneous evaporation. Indicate the identity of this form with the naturally occurring crystals, and its difference from that obtained by fusing sulphur and allowing the mass to cool.

3. Explain what is meant by allotropic modification, and point out how the one form of crystal passes into the other.

4. Show the effect of heat upon sulphur melted in a flask. Contrast the brittle mass derived from cooling the sulphur after heating slightly above its melting-point by pouring into cold water, with the plastic mass obtained when cooled in the same way from a high temperature. Point out the changes which occur as the temperature rises, and exhibit the red vapour of sulphur.

5. Show combustion in sulphur vapour. Insert a coil of copper wire into the sulphur vapour, and show that combination occurs.

6. Distil sulphur in a small retort.

7. Pass hydrogen through boiling sulphur, and demonstrate the formation of hydrogen sulphide by its blackening action on lead paper.

8. Exhibit ferrous sulphide and galena (lead sulphide). Prepare hydrogen sulphide (sulphuretted hydrogen) from the former by the action of dilute sulphuric acid. Collect by displacement and prepare a solution of the gas in water.

9. Show the combustible nature of hydrogen sulphide by burning a jar of the gas, and point out the deposition of sulphur due to incomplete combustion. Demonstrate and explain the decomposition of hydrogen sulphide by chlorine, and show the deposition of sulphur when its solution is allowed to stand exposed to the air and light.

10. Demonstrate the value of hydrogen sulphide as a means of separating the metals into groups, by adding the solution or passing the gas into solutions of the various metals, as, for example, arsenious acid, copper sulphate, lead nitrate, antimony chloride, zinc sulphate, ferrous sulphate, and magnesium sulphate.

Write down the equations in each case.

11. Prepare sulphur dioxide by heating copper with sulphuric acid and collect the gas.

12. Illustrate the condensation of a gas into a liquid by passing sulphur dioxide into a glass tube surrounded by a freezing mixture of ice and salt.

13. Pass the gas into water and demonstrate the acid properties of the solution.

14. Prepare sulphur trioxide from fuming Nordhausen sulphuric acid. Add it to water and compare its behaviour with that of the dioxide under similar circumstances.

15. Describe the formation in the above experiment of sulphuric acid, explain the properties of oil of vitriol, demonstrating its affinity for water as exhibited by the great heat evolved when the two liquids are mixed.

16. Explain the barium chloride test for sulphuric acid.

17. Add barium chloride to a solution of sulphurous acid, and then nitric acid.

18. Explain that in consequence of the readiness with which sulphurous acid takes up oxygen it acts as a bleaching agent and as a powerful reducing agent.

#### XIII.—Carbon

1. Show the presence of carbon (charcoal) in wood by carbonising a splinter of wood in a test-tube; and in white sugar by pouring strong sulphuric acid on to a syrupy solution.

2. Describe the properties and modes of occurrence of the three allotropic modifications of carbon: (*a*) the amorphous form (lamp-black and charcoal), and the two crystalline forms, (*b*) graphite, and (*c*) diamond. Describe the octahedral forms of the crystal of diamond and show glass or wood models.

3. Explain that the same weight of each of these substances when burnt gives the same weight of the same product (carbon dioxide).

4. Calculate the weight of carbon dioxide obtained from a given weight of any one of these forms.

5. Prepare carbon dioxide by treating chalk or carbonate of soda (washing soda) with an acid. Prove that the gas thus obtained really obtains carbon by heating a pellet of potassium in the dry gas contained in a small flask.

6. Demonstrate the high specific gravity of carbon dioxide by pouring it from one vessel to another, and showing that it extinguishes a taper.

7. Pass carbon dioxide over red-hot carbon in an iron tube, and show that it loses a part of its oxygen and is converted into carbon monoxide, a combustible gas, which, on combustion, again yields carbon dioxide. Collect the carbon monoxide over water containing caustic soda, and show that the gas does not render lime-water turbid. Then burn it, and show that the residual gas does possess this power.

8. Pass carbon monoxide over red-hot copper oxide to show the formation of carbon dioxide, and explain the use of carbon monoxide as a reducing agent in metallurgical operations.

9. Explain the changes which take place in an ordinary coal fire. Mention the poisonous nature of the carbon monoxide, and state that it is formed in cases of incomplete combustion from insufficient supply of oxygen.

10. Mention heat of combustion of carbon, and of carbon monoxide, and explain the value of the latter as a fuel.

11. Explain the reaction which takes place when carbon dioxide is passed into caustic soda and into lime-water, and explain the formation of a soluble carbonate in the first, and an insoluble carbonate in the second case.

#### CHARACTERISTICS OF THE NORTH AMERICAN FLORA<sup>1</sup>

WIEN the British Association, with much painstaking, honours and gratifies the cultivators of science on this side of the ocean by meeting on American soil, it is but seemly that a Corresponding Member for the third of a century should endeavour to manifest his interest in the occasion and to render some service, if he can, to his fellow-naturalists in Section D. I would attempt to do so by pointing out, in a general way, some of the characteristic features of the vegetation of the country which they have come to visit,—a country of “magnificent distances,” but of which some vistas may be had by those who can use the facilities which are offered for enjoying them. Even to those who cannot command the time for distant excursions, and to some who may know little or nothing of botany, the sketch which I offer may not be altogether uninteresting. But I naturally address myself to the botanists of the Association, to those who, having crossed the wide Atlantic, are now invited to proceed westward over an almost equal breadth of land; some, indeed, have already journeyed to the Pacific coast, and have returned; and not a few, it is hoped, may accept the invitation to Philadelphia, where a warm welcome awaits them—warmth of hospitality, rather than of summer temperature, let us hope; but Philadelphia is proverbial for both. There opportunities may be afforded for a passing acquaintance with the botany of the Atlantic border of the United States, in company with the botanists of the American Association, who are expected to muster in full force.

What may be asked of me, then, is to portray certain outlines of the vegetation of the United States and the Canadian Dominion, as contrasted with that of Europe; perhaps also to touch upon the causes or anterior conditions to which much of the actual differences between the two floras may be ascribed. For indeed, however interesting or curious the facts of the case may be in themselves, they become far more instructive when we attain to some clear conception of the dependent relation of the present vegetation to a preceding state of things, out of which it has come.

As to the Atlantic border on which we stand, probably the first impression made upon the botanist or other observer coming from Great Britain to New England or Canadian shores, will be the similarity of what he here finds with what he left behind. Among the trees the White Birch and the Chestnut will be identified, if not as exactly the same, yet with only slight differences—differences which may be said to be no more essential or profound than those in accent and intonation between the British

<sup>1</sup> An Address to the Botanists of the British Association for the Advancement of Science; read at Montreal to the Biological Section, August 29, 1884, by Prof. Asa Gray.