Cambridge Ordinary Level Notes
Chemistry 5070

Abrar Faiyaz Rahim, degrees pending

Contents

1 States of matter

1.1 Solids, liquids and gases

1.1.1. *State the distinguishing properties of solids, liquids and gases*

Matter comes in three forms. *Solid*, *liquid* and *gas*:

- *Solid*:

Figure 1: The Periodic Table of elements

2 The Periodic Table

2.1 Arrangement of elements

2.1.1. *Describe the Periodic Table as an arrangement of elements in periods and groups and in order of increasing proton number/atomic number*

The Periodic Table arranges all discovered elements by order of the number of their protons and the number of electron shells they have. In the table, the *columns are called groups and rows are called periods*.

2.1.2. *Describe the change from metallic to non-metallic character across a period*

Across a period, from left to right, metallic character of elements decreases.

2.1.3. *Describe the relationship between group number and the charge of the ions formed from elements in that group*

The Groups in the periodic table are labelled with the Roman numbers 1 through 8 (I through VIII). The Group numbers are identical to the number of valence electrons the members of the Group have, that is, members of Group n have n valence electrons.

For Group numbers less than four, it is easier for elements to lose their valence electrons than to gain more than five electrons. Hence, these elements form positive ions with the size of their charges identical to their group number.

For Group numbers above four, it is easier for elements to gain less than four electrons than lose the electrons they have in their valence shell. As a result, elements with group number n, where $n > 4$, the charges on their ions is $(n-8)$.

In the case of Group IV elements, it is equally easy to lose and gain the four valence electrons, so elements in this group can form ions with -4 and $+4$ charge.

2.1.4. *Explain similarities in the chemical properties of elements in the same group of the Periodic Table in terms of their electronic configuration*

Because all elements in the same Group have the same valence electrons, they tend to react similarly and hence have similar or identical chemical properties.

2.1.5. *Explain how the position of an element in the Periodic Table can be used to predict its properties*

For an element in the Periodic Table, its periodic position tells us about its metallic property and the group it is in tells us about its chemical and often, physical properties.

2.1.6. *Identify trends in groups, given information about the elements*

2.2 Group I properties

3 Chemistry of the environment

3.1 Water

3.1.1. *Describe chemical tests for the presence of water using anhydrous cobalt(II) chloride and anhydrous copper(II) sulfate*

Anhydrous copper(II) sulfate, $CuSO_4$, is white in colour. Upon addition of water, it turns blue, as hydrated copper(II) sulfate, $CuSO_4 \cdot 5H_2O$ forms. In other words, if anhydrous copper sulfate turns blue on addition of liquid being tested, the liquid contains water.

Anhydrous cobalt(II) chloride, $CoCl_2$, is blue. Upon addition of water it turns pink, as hydrated cobalt(II) chloride, $CoCl_2 \cdot 6H_2O$. In other words, if anhydrous cobalt chloride turns pink on addition of liquid being tested, the liquid contains water.

3.1.2. *Describe how to test for the purity of water using melting point and boiling point*

All substances have fixed melting and boiling points, which can be used to check for impurity. Impurities lower the melting point and raise the boiling point of a substance.

The melting point of water is 0 °C and its boiling point is 100 °C . Changes in these values for a sample show impurity.

3.1.3. *Explain that distilled water is used in practical chemistry rather than tap water because it contains fewer chemical impurities*

Chemical impurities in tap water may affect the outcomes of experiments, hence, in practical chemistry, distilled water is used.

3.1.4. *State that water from natural sources may contain substances, including:*

(a) dissolved oxygen

(b) metal compounds

(c) plastics

(d) sewage

(e) harmful microbes

(f) nitrates from fertilisers

(g) phosphates from fertilisers and detergents

3.1.5. *State that some of these substances are beneficial, including:*

(a) dissolved oxygen for aquatic life

(b) some metal compounds provide essential minerals for life

3.1.6. *State that some of these substances are potentially harmful, including:*

(a) some metal compounds are toxic

(b) some plastics harm aquatic life

(c) sewage contains harmful microbes which cause disease

(d) nitrates and phosphates lead to deoxygenation of water and damage to aquatic life

3.1.7. *Describe the treatment of the domestic water supply in terms of:*

(a) sedimentation and filtration to remove solids

(b) use of carbon to remove tastes and odours

(c) chlorination to kill microbes

3.2 Fertilisers

3.2.1. *State that ammonium salts and nitrates are used as fertilisers*

3.2.2. *Describe the use of NPK fertilisers to provide the elements nitrogen, phosphorus and potassium for improved plant growth*

3.3 Air quality and climate

3.3.1. *State the composition of clean, dry air as approximately 78% nitrogen,* N_2*, 21% oxygen,* O_2*, and the remainder as a mixture of noble gases and carbon dioxide,* CO_2

3.3.2. *State the source of each of these air pollutants:*

(a) carbon dioxide from the complete combustion of carbon-containing fuels

(b) carbon monoxide and particulates from the incomplete combustion of carbon-containing fuels

(c) methane from the decomposition of vegetation and waste gases from digestion in animals

(d) oxides of nitrogen from car engines

(e) sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds

3.3.3. *State the adverse effects of these air pollutants:*

(a) carbon dioxide: higher levels of carbon dioxide leading to increased global warming, which leads to climate change

(b) carbon monoxide: toxic gas

(c) particulates: increased risk of respiratory problems and cancer

(d) methane: higher levels of methane leading to increased global warming, which leads to climate change

(e) oxides of nitrogen: acid rain, photochemical smog and respiratory problems

(f) sulfur dioxide: acid rain

3.3.4. *Describe how the greenhouse gases carbon dioxide and methane cause global warming, limited to:*

(a) the absorption, reflection and emission of thermal energy

(b) reducing thermal energy loss to space

Methane and carbon dioxide are *greenhouse gases*. They are called such because they enhance the *greenhouse effect*.

[The greenhouse effect is where light sent by the Sun is absorbed by the Earth's atmosphere. This happens because when the light is reflected off of the Earth's surface, its wavelength increases, turning it into another form of light, *infrared light*, which is absorbed by certain gases.]

Greenhouse gases absorb the reflected rays of the Sun's light, reducing the amount of thermal energy emmited and reflected out to space. To an extent, this is helpful as this is responsible for keeping the almost constant temperature of the atmosphere. However, due to the increased amount of greenhouse gases in the atmosphere now, this is causing an *enhanced* greenhouse effect, which increase global temperatures further, causing *global warming*.

3.3.5. *State and explain strategies to reduce the effects of these environmental issues, limited to:*

(a) climate change: planting trees, reduction in livestock farming, decreasing use of fossil fuels, increasing use of hydrogen and renewable energy, e.g. wind, solar

(b) acid rain: use of catalytic converters in vehicles, reducing emissions of sulfur dioxide by using low- sulfur fuels and flue gas desulfurisation with calcium oxide

3.3.6. *Explain how oxides of nitrogen form in car engines and describe their removal by catalytic converters, e.g.* $2CO + 2NO \longrightarrow 2CO_2 + N_2$

Carbon monoxide and nitrogen oxide are two harmful gases produced and released by car engines. To reduce the extent of their damage, *catalytic converters* are used. In these catalytic converters, the reaction:

$$2CO + 2NO \longrightarrow 2CO_2 + N_2$$

takes place, converting the two dangerous gases to carbon dioxide and diatomic nitrogen.

3.3.7. *Describe photosynthesis as the reaction between carbon dioxide and water to produce glucose and oxygen in the presence of chlorophyll and using energy from light*

Photosynthesis is a chemical reaction performed by plants to produce glucose, which forms water as a byproduct. Glucose is required for respiration, another chemical reaction, that releases energy. It uses energy from light, trapped by *chlorophyll*, a pigment present in plants.

3.3.8. *State the word equation and symbol equation for photosynthesis*

The word and symbol equations for photosynthesis follow, in that order:

$$\text{carbon dioxide} + \text{water} \longrightarrow \text{glucose} + \text{oxygen}$$

$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$