Particle Model and Atomic Structure

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The following **symbols** describe two different **substances**. Deduce all the information you can from these **symbols**.

$^{13}_{6}C$ $^{12}_{6}C$

1

Particle Model and Atomic Structure

The **substances** are **isotopes** of the same **element**, carbon. The **atomic number** of carbon is 6 and the **mass numbers** of the **isotopes** are 13 and 12. An **atom** of carbon-13 contains 6 **protons** and 7 **neutrons**. An **atom** of carbon-12 contains 6 **protons** and 6 **neutrons**.

1

Purity and Separating Mixtures

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Explain how the three different types of **chromatography** can be used to **separate** a **mixture**.

2

Purity and Separating Mixtures

Chromatography separates mixtures using a **stationary phase** and a **mobile phase**. **Paper chromatography** is used to **separate mixtures** of coloured **dyes** in solution. **Thin layer chromatography** uses a thin layer of an **inert solid** as the **stationary phase**. **Gas chromatography separates mixtures** of gases by passing them through a solid **stationary phase**.

2

Bonding

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Describe the two main types of chemical **bond** that can form between two different **elements**.

3

Bonding

An **ionic bond** is formed when one or more **electrons** are **donated** from an **atom** of one **element** to an **atom** of another **element**, so both **atoms** have full **outer electron shells**. The **atoms** form electrically charged **ions**.

A **covalent bond** is formed when two **atoms share electrons** to complete the **outer electron shells** of both **atoms**.

3

Models of Bonding

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Explain the differences between **simple molecules**, **polymers** and **metals**, referring to how they are formed and the **bonding** that takes place.

4

Models of Bonding

Simple molecules are formed when two or more **atoms share electrons** and form **covalent bonds**.

Polymers are formed when **repeated units** of smaller **molecules bond covalently** to form a **long chain**.

Metal atoms have outermost **electrons** that can move freely from one **metal atom** to another. They are held together by strong **metallic bonds**.

4

Properties of Materials

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Explain the difference between **intermolecular forces** and **intramolecular forces**.

5

Properties of Materials

Intermolecular forces are the forces between molecules.

Intramolecular forces are the forces between the **atoms** inside a **molecule**, such as **covalent bonds**.

5

Introducing Chemical Reactions

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Complete the table.

State of substance	State symbol
…	(s)
liquid	(…)
…	(g)
(…) dissolved in water	(…)

6

Introducing Chemical Reactions

State of substance	State symbol
solid	(s)
liquid	(l)
gas	(g)
(**aqueous**) dissolved in water	(aq)

6

Chemical Equations HT

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Simplify and balance the following **ionic equation**, which shows the reaction between copper sulfate and sodium hydroxide solutions to form solid copper hydroxide.

$Cu^{2+}(aq) + SO_4^{2-}(aq) + Na^+(aq) + OH^-(aq) \longrightarrow Cu(OH)_2(s) + Na^+(aq) + SO_4^{2-}(aq)$

7

Chemical Equations HT

$Cu^{2+}(aq) + 2OH^-(aq) \longrightarrow Cu(OH)_2(s)$

(The sodium and sulfate **ions** are **spectator ions** that do not change during the reaction, so they can be deleted from both sides.)

7

Moles and Mass HT

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Which of the following sentences are true and which are false?

A. Two **moles** of calcium **atoms** contain a total of just over 12×10^{23} **atoms**.

B. Carbon has a lower **relative atomic mass** than calcium, so two **moles** of carbon atoms contain fewer than 12×10^{23} **atoms**.

8

Moles and Mass HT

A is true: one **mole** is 6.022×10^{23} **atoms**, so $2 \times 6.022 \times 10^{23} = 12.044 \times 10^{23}$ atoms

B is false: one **mole** of any **element** always contains 6.022×10^{23} **atoms**

8

Energetics

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What is the **activation energy** of a reaction and why is it not the same as the total **energy given out** or **taken in** during the reaction?

9

Energetics

For most chemical reactions, energy is needed to **break chemical bonds** so the reaction can start. This is the **activation energy**. Any new bonds that form will cause some energy to be **given out**, so the **total energy** of the reaction is not the same as the **activation energy**.

9

Types of Chemical Reactions

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Use these words to complete the sentences that follow. (You do not need to use all the words.)

separately oxygen together reduction gains

In **oxidation** reactions, a substance often … oxygen.

In … reactions, a substance often loses … .

These two types of reaction always occur … .

10

Types of Chemical Reactions

In **oxidation** reactions, a substance often **gains** oxygen.

In **reduction** reactions, a substance often loses **oxygen**.

These two types of reaction always occur **together**.

10

pH, Acids and Neutralisation HT

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Explain the difference between a **strong acid** and a **weak acid**.

11

pH, Acids and Neutralisation HT

A **strong acid** easily forms H^+ **ions**, so the acids **fully ionise**.

A **weak acid** forms an **equilibrium** mixture, so that some of the **ions** formed can **recombine** into the original acid.

11

Electrolysis

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Use these words to complete the sentences that follow.

positive negative anode dissociate electrolyte cathode

In **electrolysis**, the solution containing the **ionic compound** is called the … .

In solution, the **ions** in the compound … .

The negative electrode is the … and attracts … **ions**.

The positive electrode is the … and attracts … **ions**.

12

Electrolysis

In **electrolysis**, the solution containing the **ionic compound** is called the **electrolyte**.

In solution, the **ions** in the compound **dissociate**.

The negative electrode is the **cathode** and attracts **positive ions**.

The positive electrode is the **anode** and attracts **negative ions**.

12

Predicting Chemical Reactions

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Explain the differences in **electron shells** between atoms of Group 1, Group 7 and Group 0 **elements** and suggest what happens to these **elements** in chemical reactions.

13

Predicting Chemical Reactions

Group 1 **elements** all have one **electron** in their **outer shell**. In a chemical reaction, they tend to **lose** this outer **electron** so that the 'new' **outer shell** is **complete**.

Group 7 **elements** all have seven **electrons** in their **outer shell**. They tend to **gain** one **electron** so the **outer shell** is **complete**.

Group 0 **elements** all have a **complete outer shell** of **electrons**. They are **unreactive**.

13

Identifying the Products of Chemical Reactions

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Complete the following table that describes tests for different gases.

Gas	Test for gas
Carbon dioxide	…
…	Burns with a squeaky pop
…	Relights a glowing splint
Chlorine	…
…	Turns damp red litmus paper blue

14

Identifying the Products of Chemical Reactions

Gas	Test for gas
Carbon dioxide	**Turns limewater cloudy**
Hydrogen	Burns with a squeaky pop
Oxygen	Relights a glowing splint
Chlorine	**Turns damp indicator paper white**
Ammonia	Turns damp red litmus paper blue

14

Ion Tests and Instrumental Methods of Analysis

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Complete the following table that describes flame tests for different metals.

Metal	Colour of flame
Sodium	…
…	Lilac
…	Blue-green
Calcium	…

15

Ion Tests and Instrumental Methods of Analysis

Metal	Colour of flame
Sodium	**Yellow**
Potassium	Lilac
Copper	Blue-green
Calcium	**Brick red**

15

Monitoring Chemical Reactions

Use these words to complete the sentences that follow.

indicator titration burette pipette

The method used to find out how much acid is needed to **neutralise** an alkali is called … .

The alkali is measured into a conical flask using a … .

The acid is added slowly using a device called a … .

An … is a substance that changes colour when the **pH** changes.

16

Monitoring Chemical Reactions

The method used to find out how much acid is needed to **neutralise** an alkali is called **titration**.

The alkali is measured into a conical flask using a **pipette**.

The acid is added slowly using a device called a **burette**.

An **indicator** is a substance that changes colour when the **pH** changes.

16

Calculating Yields and Atom Economy

Explain the difference between the **actual yield** and the **percentage yield** of a reaction. Include a **formula** in your answer.

17

Calculating Yields and Atom Economy

The **actual yield** is the amount of product actually produced in a reaction.

The **percentage** yield is calculated using the formula

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100.$$

17

Controlling Chemical Reactions

A sample of solid calcium carbonate is divided precisely into two equal masses. One half is a **single solid piece**, which is then reacted with an acid. The other half is **broken into small pieces** and reacted with a fresh sample of the same acid.

Which half will **react faster**, and why?

18

Controlling Chemical Reactions

The half that is broken into small pieces will **react** faster. This is because small pieces have a **large surface area** in relation to their **volume**. More **solid particles** are exposed to contact with **acid particles**, so there are more **collisions** and a faster **reaction**.

18

Catalysts and Activation Energy

What is a **catalyst**?

19

Catalysts and Activation Energy

A **catalyst** is a substance that **speeds up** the **rate** of a chemical reaction without being used up or changed in the reaction.

19

Equilibria HT

State **Le Chatelier's principle**.

20

Equilibria HT

Le Chatelier's principle: When the **conditions** of a system are **altered**, the **position** of the **equilibrium** changes to try and restore the **original conditions**.

20

Improving Processes and Products

How is carbon useful in the **extraction** of **metals**?

21

Improving Processes and Products

Most **metals** are found naturally as **minerals** (compounds). Carbon can **displace** less **reactive** metals from their mineral oxides. The carbon is heated with the metal oxide, and the pure metal is **extracted**.

21

The Haber Process HT

Explain the **conditions** used in practice in the **Haber process** to produce ammonia.

22

The Haber Process HT

The Haber process involves an **equilibrium reaction** that is **exothermic**. A **temperature** of 450 °C is used to produce a reaction that gives a good **yield** in a reasonable amount of time. A **high pressure** of 200 atmospheres increases the **yield**. An **iron catalyst** increases the **rate** of reaction.

22

Life Cycle Assessments, Recycling and Alloys

According to a **life cycle assessment**, what are the four stages in the life of a product?

23

Life Cycle Assessments, Recycling and Alloys

1 Obtaining **raw materials**.
2 **Manufacture** of the product.
3 **Use** of the product.
4 **Disposal** of the product when it is no longer useful.

23

Using Materials

Describe **two** ways in which iron can be prevented from **rusting** (**corrosion**).

24

Using Materials

A **physical barrier** can be placed between the iron and the water and air outside (e.g. the iron can be painted or coated).
Sacrificial protection involves attaching a piece of a **more reactive** metal (such as zinc) to the surface of the iron. This **more reactive** metal **corrodes** first.

24

Organic Chemistry

Match each **general formula** to the correct homologous series in the following table.

Alkanes	C_nH_{2n}
Alkenes	$C_nH_{2n+1}OH$
Alcohols	$C_nH_{2n+1}COOH$
Carboxylic acids	C_nH_{2n+2}

25

Organic Chemistry

Alkanes	C_nH_{2n+2}
Alkenes	C_nH_{2n}
Alcohols	$C_nH_{2n+1}OH$
Carboxylic acids	$C_nH_{2n+1}COOH$

25

Organic Compounds and Polymers

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Explain what happens to an **alcohol** when potassium manganate(VII) is added to it and heated.

26

Organic Compounds and Polymers

Potassium manganate(VII) is an **oxidising agent**. The **alcohol** is **oxidised** to form a **carboxylic acid**.

26

Crude Oil and Fuel Cells

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Describe the **conditions** needed for the reaction called **cracking**, and explain why this reaction is useful.

27

Crude Oil and Fuel Cells

Cracking requires a **catalyst**, **high temperature** and **high pressure**. **Cracking** breaks down some of the large molecules in **crude oil** to form smaller, more useful molecules.

27

Interpreting and Interacting with Earth's Systems

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Suggest **three** ways in which we could slow down **climate change**.

28

Interpreting and Interacting with Earth's Systems

Any **three** from:
Use less **fossil fuels**.
Develop and use **alternative energy sources**.
Improve **energy efficiency**/cut down on wasted energy.
Plant new forests that can change carbon dioxide into oxygen.
Reduce the amount of **waste** we produce, to cut down the amount of methane gas in the air.

28

Air Pollution, Potable Water and Fertilisers

Collins
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Why have many governments passed laws restricting the amounts of **particulates** that can be emitted?

29

Air Pollution, Potable Water and Fertilisers

Particulates in the air can cause lung problems and **respiratory** diseases. They can coat buildings and trees. Laws to restrict their emissions aim to improve air quality.

29