

Explain how **fractional distillation** can be used to **separate** a **mixture**.

1

**Fractional distillation** is used to **separate components** with different **boiling points** from a **mixture**. The **mixture** is heated gradually and each **component** is collected when it **boils**.

1

If an **element** has different **isotopes**, what does this mean?

2

Each **isotope** of an **element** has the same number of **protons** but a different number of **neutrons** in each **atom**.

2

Complete the gaps in the sentences.  
The centre of the **Periodic Table** between Groups 2 and 3 contains **elements** known as the ... ..  
**Atoms** of these **elements** form ... with different **charges**.  
The **compounds** formed by these **elements** are ... .  
They can be used as ... to speed up **chemical reactions**.

3

The centre of the **Periodic Table** between Groups 2 and 3 contains **elements** known as the **transition metals**.  
**Atoms** of these **elements** form **ions** with different **charges**.  
The **compounds** formed by these **elements** are **coloured**.  
They can be used as **catalysts** to speed up **chemical reactions**.

3

Complete the table.

State of substance	State symbol
<b>solid</b>	( ... )
...	(l)
...	(g)
( ... ) dissolved in water	( ... )

4

State of substance	State symbol
<b>solid</b>	(s)
<b>liquid</b>	(l)
<b>gas</b>	(g)
<b>(aqueous)</b> dissolved in water	(aq)

4

Describe what happens to a **metal atom** and a **non-metal atom** when an **ionic bond** forms between them.

5

The **metal atoms** lose **electrons** to become **positively charged ions**. The **electrons** are transferred to the **non-metal atoms**, which **gain electrons** to become **negatively charged ions**.

5

## Metals

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What properties of **metals** make them useful structural materials?

6

## Metals

**Metals** contain **metallic bonds**, which are very strong. Most metals have high **melting** and **boiling points**.

6

## Covalent Compounds

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Describe what happens when one chlorine **atom** forms a **bond** with another chlorine **atom**.

7

## Covalent Compounds

An **electron** from each **atom** is **shared** so that each **atom** has a **complete outer shell** of **electrons**.

7

## Special Materials

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Explain why most **polymers** are **solid** at room temperature.

8

## Special Materials

The **atoms** within **polymer molecules** are held together by strong **covalent bonds**. The **intermolecular forces** between the large **polymer molecules** are also quite **strong**.

8

## Conservation of Mass

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Why do chemical **symbol equations** always need to be balanced?

9

## Conservation of Mass

**Mass** is **conserved**. In a chemical reaction, no **atoms** are **made** or **lost**.

9

## Amount of Substance

HT

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

- A. Three **moles** of potassium **atoms** contain a total of just over  $18 \times 10^{23}$  **atoms**
- B. Sodium has a lower **relative atomic mass** than potassium, so three **moles** of sodium atoms contain fewer than  $18 \times 10^{23}$  **atoms**

10

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## Amount of Substance

HT

A is true: one **mole** is  $6.02 \times 10^{23}$  **atoms**, so  $3 \times 6.02 \times 10^{23} = 18.06 \times 10^{23}$  atoms

B is false: one **mole** of any **element** always contains  $6.02 \times 10^{23}$  **atoms**

10

What is the **concentration** of  $0.5 \text{ dm}^3$  **solution** containing **1.5 moles** of hydrochloric acid?

11

**Concentration**

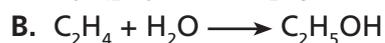
$$= \frac{\text{amount of substance}}{\text{volume}}$$

$$= \frac{1.5 \text{ mol}}{0.5 \text{ dm}^3}$$

$$= 3 \text{ mol/dm}^3$$

11

The following **reaction equations** show two different ways in which we can produce **ethanol**.



Which **reaction**, A or B, has an atom economy of 100%? How do you know this?

12

**Reaction B**, because all the **reactant atoms** end up in the desired **product (ethanol)**.

12

Use these words to complete the sentences that follow. (Use each word once only.)

**together loses gains**

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

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

**Oxidation** and **reduction** always occur ... .

13

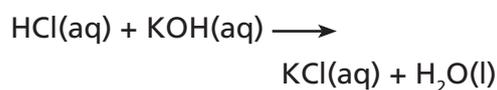
In **oxidation** reactions, a substance often **gains oxygen**.

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

**Oxidation** and **reduction** always occur **together**.

13

Why is the following reaction called a **neutralisation** reaction?



14

Hydrochloric **acid** (HCl) **neutralises** the **alkali** potassium hydroxide (KOH). The **solution** that remains has a **pH** of 7, meaning that it is **neutral**.

14

Explain why **electrolysis** is an expensive way of **extracting metals** from their **ores**.

15

**Electrolysis** requires a lot of **heat** and **electrical energy**.

15

What is the difference between **endothermic** and **exothermic** reactions?

16

**Endothermic** reactions **take in energy** from the surroundings and cause a **temperature drop**. **Exothermic** reactions **give out energy** to the surroundings and cause a **temperature rise**.

16

If a **reaction** is **endothermic**, what does this tell us about the **energy** needed to break and make **bonds** in the **reaction**?

17

An **endothermic reaction** takes in **energy** from the **surroundings**. This means that the **energy** needed to **break bonds** is greater than the **energy given out** by the making of bonds.

17

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

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

Choose the correct phrase from this list to complete the sentence that follows.

**much less than**  
**exactly the same as**  
**much more than**

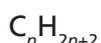
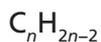
When a **reversible reaction** takes place in a **closed system**, an **equilibrium** is achieved when the rate of the **backward reaction** is ... the rate of the **forward reaction**.

19

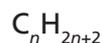
When a **reversible reaction** takes place in a **closed system**, an **equilibrium** is achieved when the **rate** of the **backward reaction** is **exactly the same** as the rate of the **forward reaction**.

19

Choose the correct **general formula** for **alkanes** from the following list.



20



20

Which of the following substances are alkenes?

- CH<sub>4</sub>  
C<sub>2</sub>H<sub>4</sub>  
C<sub>3</sub>H<sub>8</sub>  
C<sub>4</sub>H<sub>8</sub>

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C<sub>2</sub>H<sub>4</sub> and C<sub>4</sub>H<sub>8</sub> are both **alkenes**, because they follow the **general formula** C<sub>n</sub>H<sub>2n</sub>

21

The substance with the formula CH<sub>3</sub>COOH is known as **ethanoic acid**. This substance is commonly found in **vinegar**.

What is the **functional group** of ethanoic acid? What would you predict about the **pH** of vinegar?

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The **functional group** of ethanoic acid is the **carboxyl** or **-COOH** group. Vinegar has a **pH** of less than 7 (it is **acidic**).

22

Use the list of words to complete the sentences that follow. (You may need to use each word once, more than once or not at all.)

**alkenes alkanes polymers monomers isomers saturated unsaturated addition subtraction**

**Hydrocarbons** called ... are useful for making ... because they are ...

Many ... join together in a **reaction** called ... **polymerisation**.

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23

**Hydrocarbons** called **alkenes** are useful for making **polymers** because they are **unsaturated**. Many **monomers** join together in a **reaction** called **addition polymerisation**.

23

Complete the following table that describes tests for different gases.

Gas	Test for gas
...	Turns limewater cloudy
Hydrogen	...
Oxygen	...
...	Turns damp indicator paper white

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Gas	Test for gas
<b>Carbon dioxide</b>	Turns limewater cloudy
Hydrogen	<b>Burns with a squeaky pop</b>
Oxygen	<b>Relights a glowing splint</b>
<b>Chlorine</b>	Turns damp indicator paper white

24

When **calcium carbonate** is reacted with **hydrochloric acid**, **calcium chloride** is formed along with a **colourless gas** and a **colourless liquid**.

Name the gas and liquid. Which **test** could be used to identify the gas?

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The gas is **carbon dioxide**. The liquid is **water**. Carbon dioxide **turns limewater milky**.

25

Describe the effects that the evolution of **plants** had on the Earth's **atmosphere**.

26

**Plants** use carbon dioxide and water to produce oxygen in the reaction called **photosynthesis**. As more plants evolved, the amount of oxygen in the **atmosphere** increased. Eventually the levels of oxygen were enough for land-based **animals** that breathed oxygen from the air to evolve.

26

What is the **carbon footprint**?

27

The **carbon footprint** of a product, service or event is the **total** amount of **carbon dioxide** and other **greenhouse gases** that are **emitted** over its **full life cycle**.

27

Why can't we release our **waste water** directly into the **environment**?

28

**Waste water** can contain **toxic chemicals**, harmful **microorganisms** and other **organic matter**. All these things can cause **pollution** and affect **plants** and **animals**, including humans.

28

What is the purpose of a **life cycle assessment**?

29

A **life cycle assessment** provides a way of comparing different products to see which cause **least damage** to the **environment**, over their whole lifetime.

29

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

30

The Haber process involves an **equilibrium reaction** that is **exothermic**. A **moderate temperature** is used to give a **balance** between a **fast rate** but **low yield** of ammonia, and a **slow rate** but **high yield**. A **high pressure** produces a **high yield**. An **iron catalyst** increases the **rate** of reaction.

30