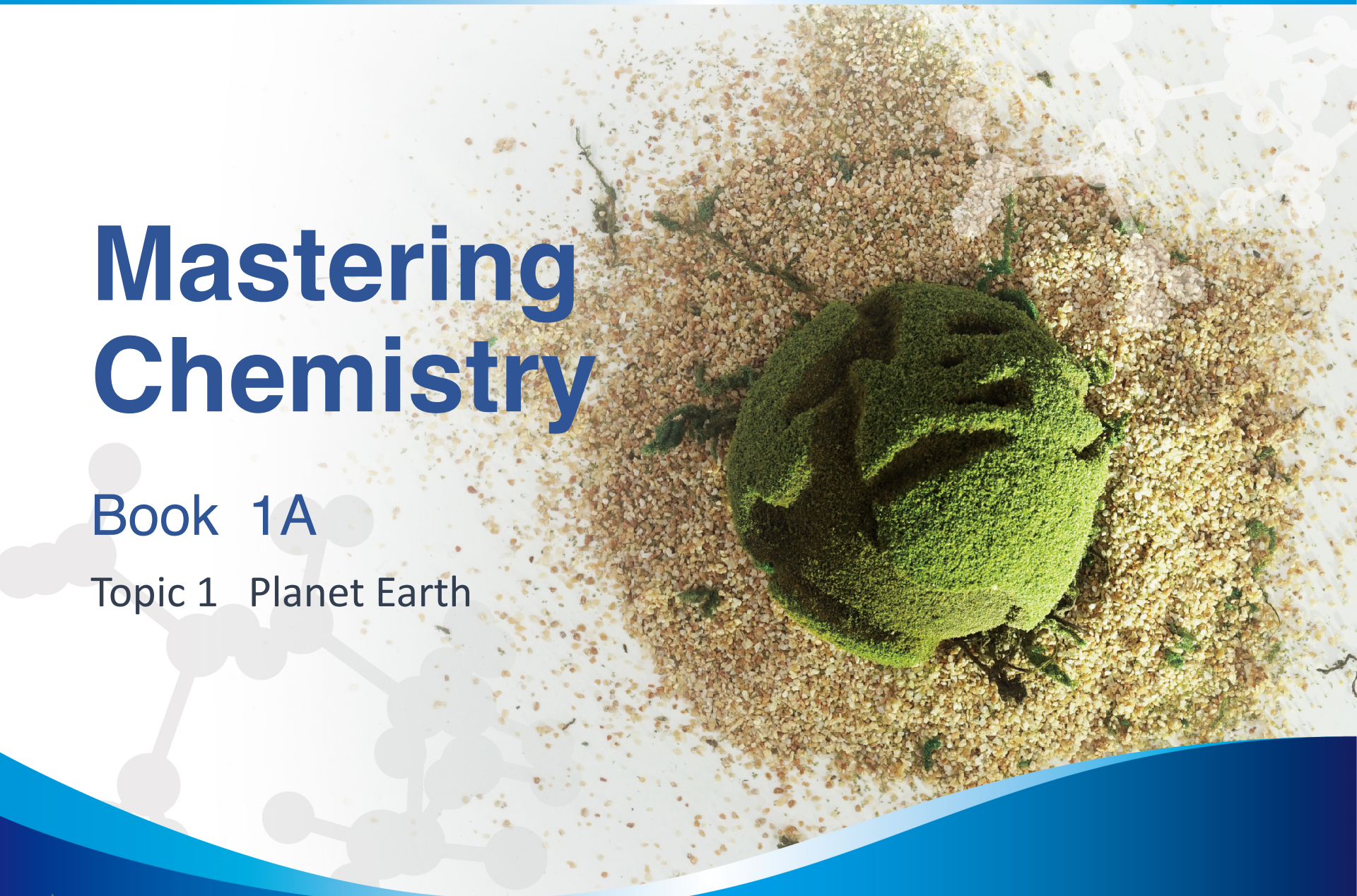
Mastering Chemistry

Book 1A

Topic 1 Planet Earth

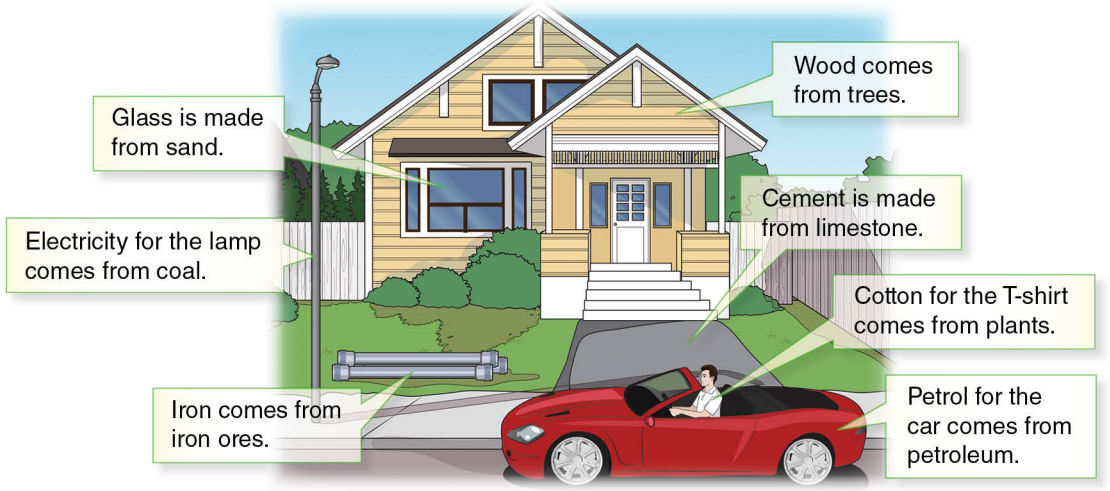


Content

Content

2.1 Earth's natural resources (p. 24)

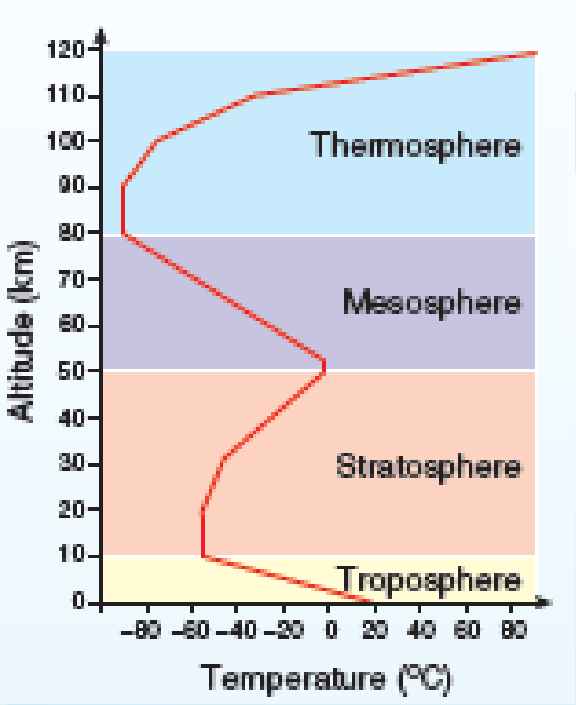
- **Natural resources (天然資源)** are useful materials that come from the Earth.
- Humans have found many ways to make use of the resources from the **atmosphere (大氣)**, the ocean and the **crust (地殼)** of the Earth to meet their needs.



Examples of products from natural resources

2.2 The Earth's atmosphere (p. 24)

- The atmosphere is divided into four layers — the troposphere, stratosphere, mesosphere and thermosphere. Humans live in the layer nearest the Earth.

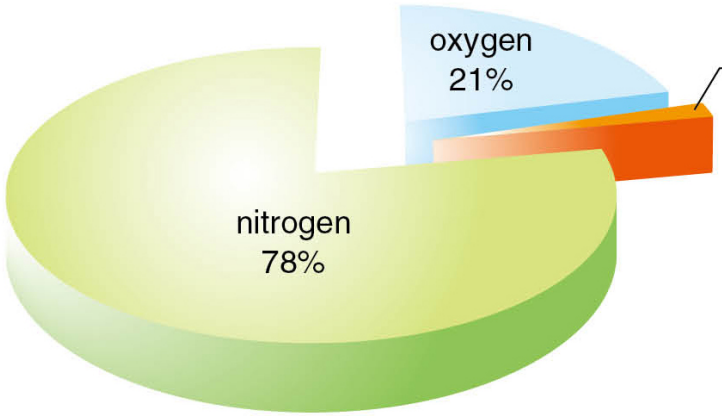


The layers of atmosphere defined by variations of temperature

2.2 The Earth's atmosphere (p. 25)

- Air consists mainly of two **elements (元素)**: 78% of nitrogen and 21% of oxygen.

Elements, compounds and mixtures Ref.



The rest (about 1%) is mainly *argon* (a *noble gas*)
+ 0.03–0.04% carbon dioxide
+ small amounts of other noble gases (*helium*, *neon*, *krypton*, and *xenon*)
+ varying amount of water vapour

Test for different gases

Composition of gases in air in the atmosphere

2.2 The Earth's atmosphere (p. 26)

An element is a pure substance that cannot be broken down into anything simpler by chemical methods.

Examples of elements

2.2 The Earth's atmosphere (p. 26)

A **compound (化合物)** is a pure substance that consists of two or more elements chemically joined together.

Example of compound – iron(II) sulphide

2.2 The Earth's atmosphere (p. 26)

A **mixture (混合物)** is made up of two or more substances (elements or compounds) that are not chemically joined together.

Example of mixture – iron + sulphur

2.3 Elements and compounds (p. 27)

- If a flame is put near the mixture of hydrogen and oxygen, a chemical reaction which produces the compound water takes place.
- This chemical reaction can be represent by the following **word equation (文字方程式)**:

hydrogen + oxygen ⟶ water

- In a word equation, you write the **reactant(s) (反應物)** on the left and the **product(s) (生成物)** on the right. The plus (+) sign means 'reacts with' and the arrow ( ) means 'to form'.

2.3 Elements and compounds (p. 28)

Compounds can be broken down (decomposed) into simpler substances. This can often be achieved by heating or using electricity.

- Passing direct electric current through molten aluminium oxide breaks it down into aluminium and oxygen.

$$\text{aluminium oxide} \xrightarrow{\text{direct electric current}} \text{aluminium + oxygen}$$

2.3 Elements and compounds (p. 28)

- The **constituent elements (成分元素)** and the uses of some common compounds:

Compound:	Sodium chloride (common salt)
Constituent elements:	sodium and chlorine
Common use:	flavouring

2.3 Elements and compounds (p. 28)

- The **constituent elements (成分元素)** and the uses of some common compounds:

Compound:	Sugar
Constituent elements:	carbon, hydrogen and oxygen
Common use:	flavouring

2.3 Elements and compounds (p. 28)

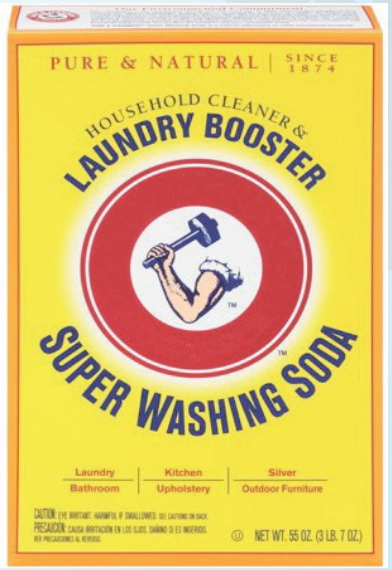
- The **constituent elements (成分元素)** and the uses of some common compounds:

Compound:	Calcium carbonate
Constituent elements:	calcium, carbon and oxygen
Common use:	for construction

2.3 Elements and compounds (p. 28)

- The **constituent elements (成分元素)** and the uses of some common compounds:

Compound:	Sodium carbonate
Constituent elements:	sodium, carbon and oxygen
Common use:	washing soda



2.3 Elements and compounds (p. 28)

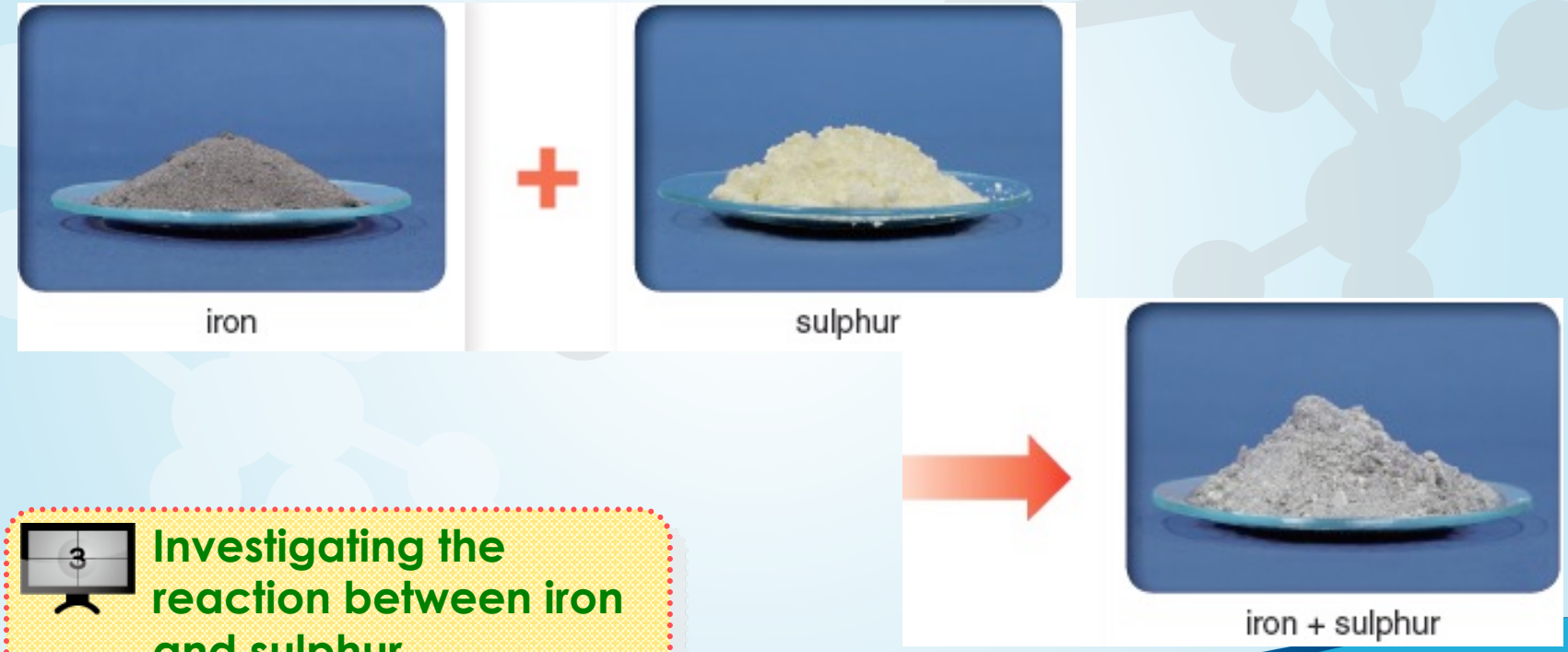
Practice 2.1

Classify each of the substances below as an element, a compound or a mixture.

Substance	Element / compound / mixture
Aluminium oxide	compound
Hydrogen	element
Ice cream	mixture
Pure water	compound
Sea water	mixture
Sulphur	element

2.4 Differences between a mixture and a compound (p. 29)

- Mix iron and sulphur without heating will obtain a mixture.



Investigating the reaction between iron and sulphur

2.4 Differences between a mixture and a compound (p. 29)

- Heat iron and sulphur together over a Bunsen flame. The compound, iron(II) sulphide is formed.

Heating iron and sulphur

Iron(II) sulphide

- The word equation for the reaction is:

$$\text{iron} + \text{sulphur} \xrightarrow{\text{heat}} \text{iron(II) sulphide}$$

2.4 Differences between a mixture and a compound (p. 30)

- Comparing the properties between mixture of iron and sulphur and iron(II) sulphide.

Property or test	Mixture of iron and sulphur	Iron(II) sulphide
Appearance	yellowish black powder	dark brown solid
Effect of a magnet	only iron powder attracted to it 	not attracted

Continued on next page

2.4 Differences between a mixture and a compound (p. 30)

- Comparing the properties between mixture of iron and sulphur and iron(II) sulphide.

Property or test	Mixture of iron and sulphur	Iron(II) sulphide
Effect of dilute hydrochloric acid	hydrogen gas is produced	a gas with a bad egg smell is produced

2.4 Differences between a mixture and a compound (p. 30)

- Main differences between a mixture and a compound:

	Mixture	Compound
1 Composition	Variable composition — you can vary the amount of each constituent in a mixture.	Definite composition — you cannot vary the amount of each element in a compound.
2 Energy change during formation	There is no or little energy change when a mixture is formed.	Energy is usually released or taken in when a compound is formed.
3 General properties	Each constituent in a mixture retains its own properties.	The properties are different from those of the elements in it.

Continued on next page

2.4 Differences between a mixture and a compound (p. 30)

- Main differences between a mixture and a compound:

	Mixture	Compound
4 Separating the constituents	The constituents may be separated quite easily by physical methods (e.g. evaporation).	The constituents can only be separated by chemical methods (e.g. heating).

2.5 Separating nitrogen and oxygen from air (p. 31)

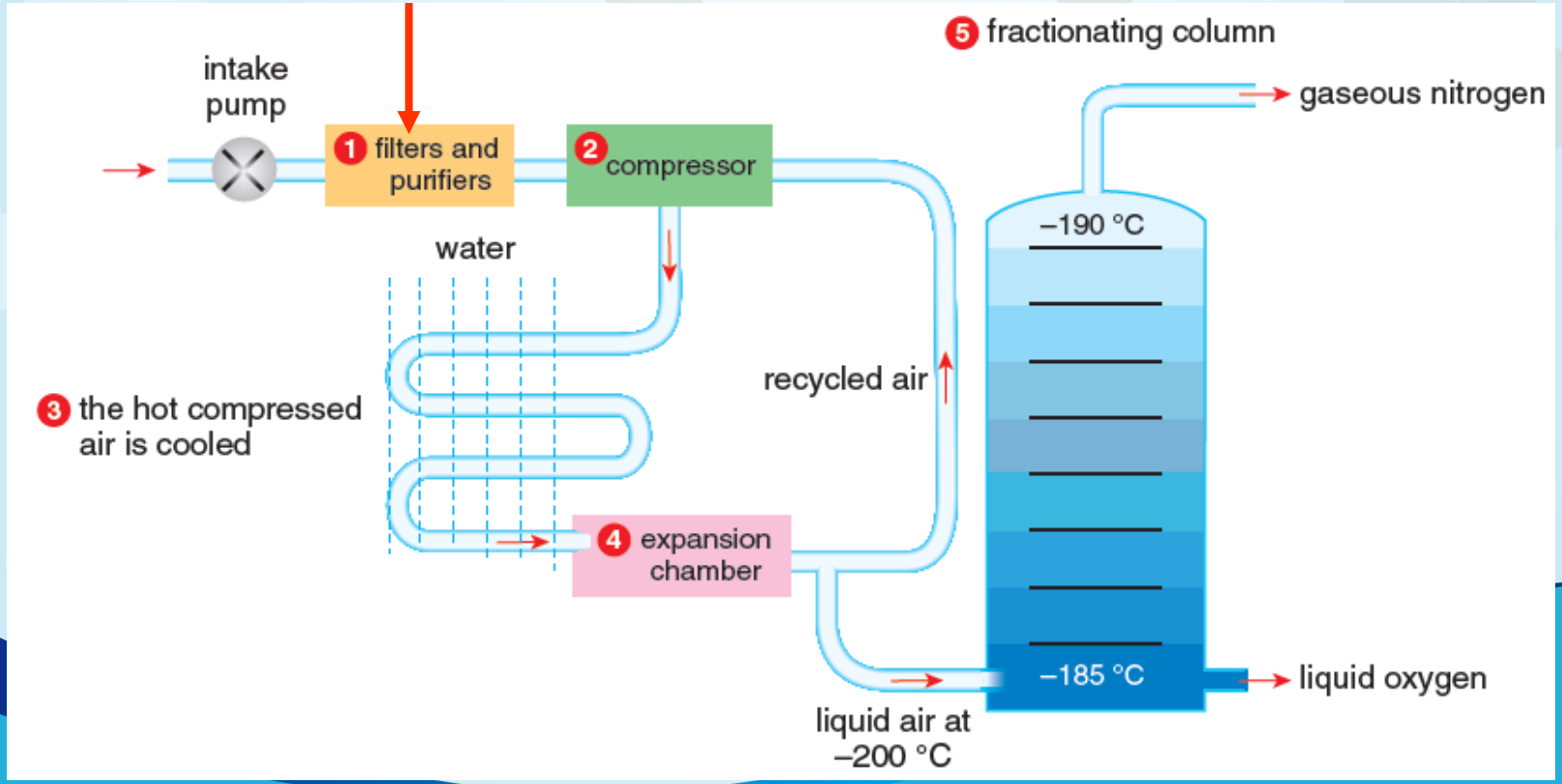
- The method used by industry to separate the mixture of gases in the air is **fractional distillation (分餾)** of liquid air.
- Fractional distillation depends on the fact that different components in the air have different boiling points.

Nitrogen and oxygen are separated from liquid air in this fractional distillation plant

2.5 Separating nitrogen and oxygen from air (p. 31)

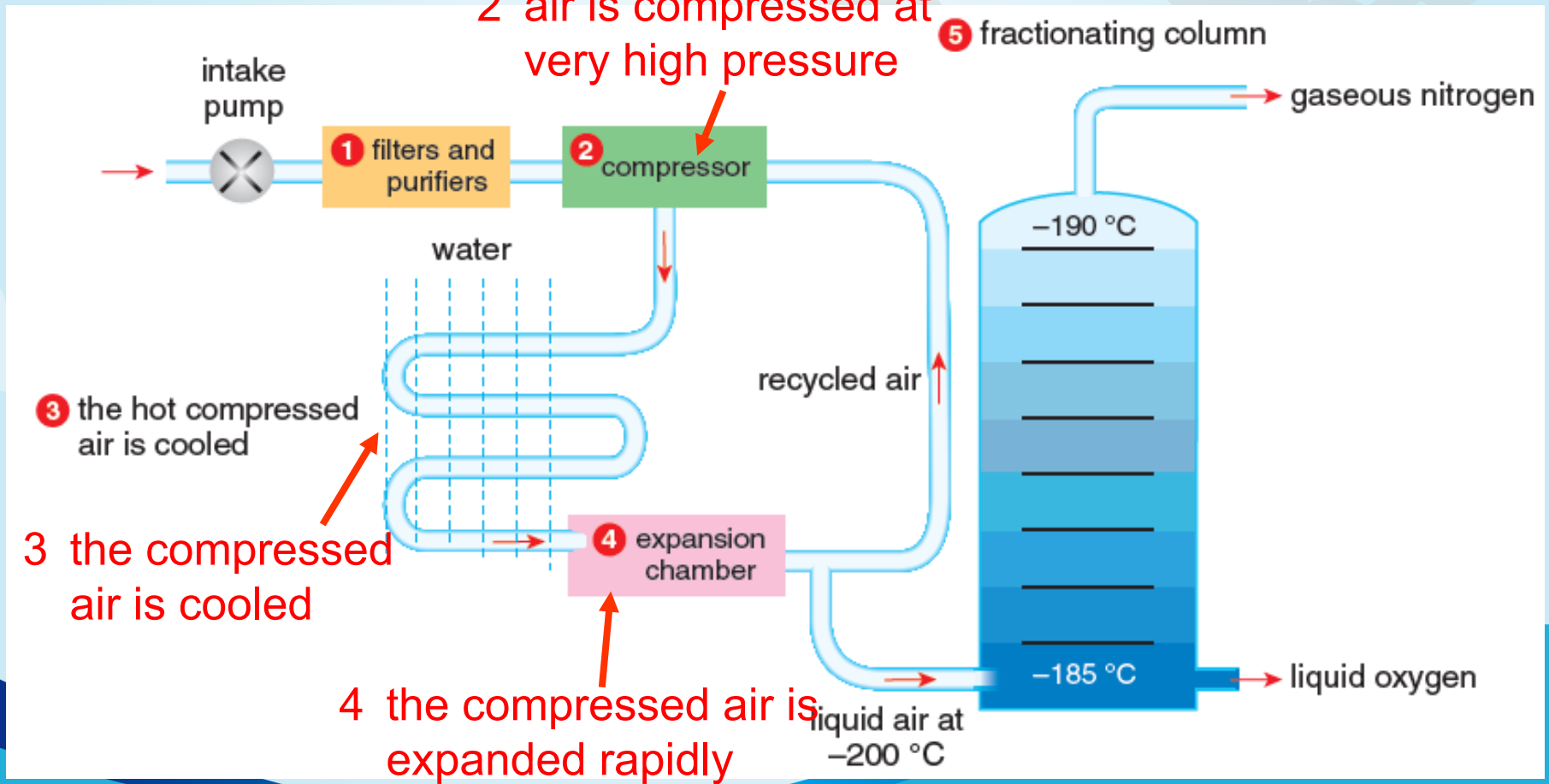
- There are 3 stages in the fractional distillation of liquid air.
- Stage A Purification *(step 1)*

1 purification



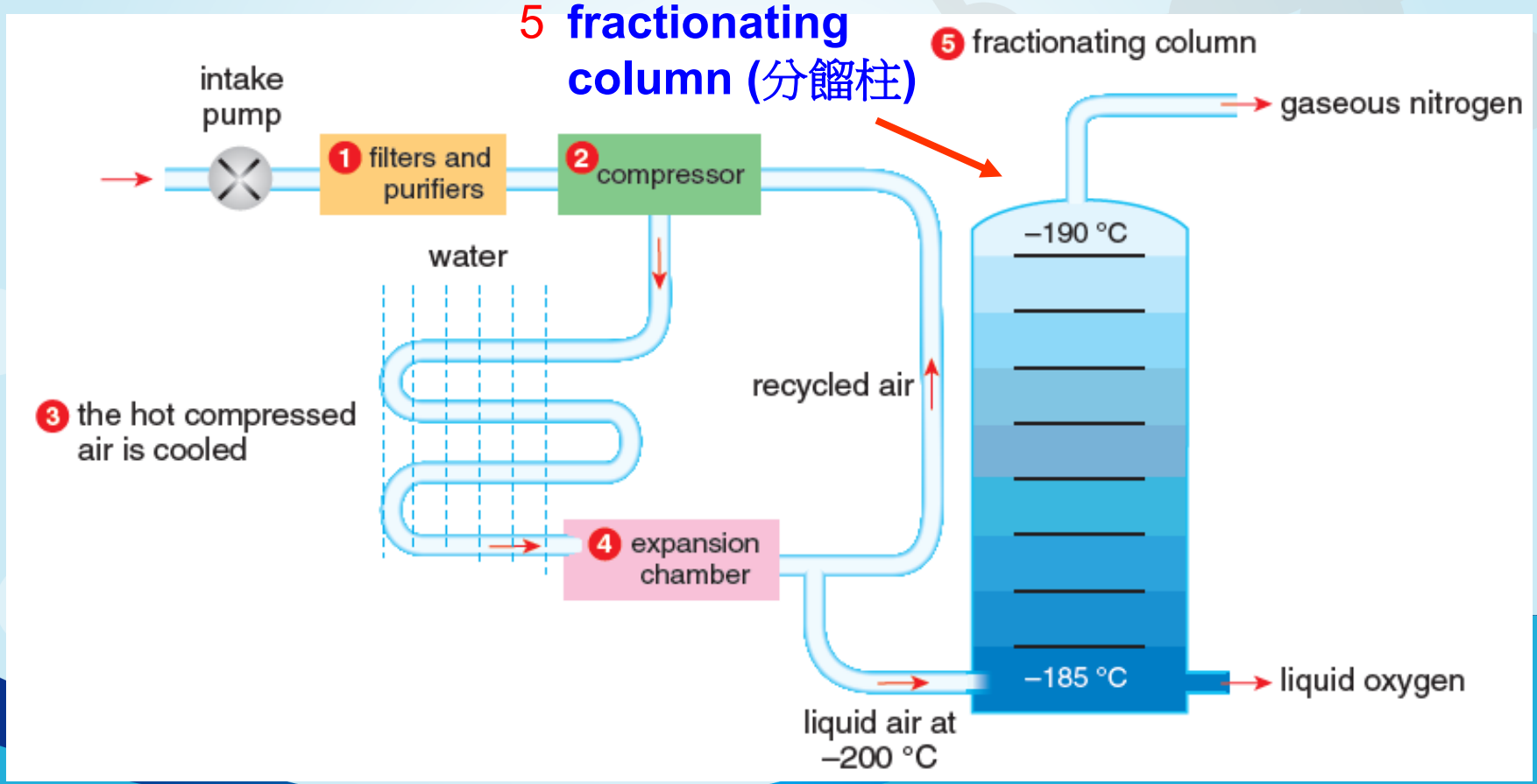
2.5 Separating nitrogen and oxygen from air (p. 31)

- Stage B Liquefaction of air *(steps 2-4)*



2.5 Separating nitrogen and oxygen from air (p. 31)

- Stage C Fractional distillation of liquid air *(step 5)*



2.6 Test for oxygen (p. 33)

- Oxygen supports. A simple test for oxygen is that it relights a **glowing splint (有餘燼的木條)**.

A glowing splint relights in oxygen

Key terms (p. 35)

natural resource	天然資源	reactant	反應物
atmosphere	大氣	product	生成物
crust	地殼	fractional distillation	分餾
element	元素	purification	淨化
compound	化合物	liquefaction	液化
mixture	混合物	fractionating column	分餾柱
word equation	文字方程式	glowing splint	有餘燼的木條

Summary (p. 36)

1 The approximate percentage composition of gases in air (in percent by volume) is as follow:

Gas in air	Approximate percentage (by volume)
Nitrogen	78%
Oxygen	21%
Other gases	about 1% (noble gases: mainly argon; carbon dioxide – 0.03%-0.04%; water vapour – varying amount)

Summary (p. 36)

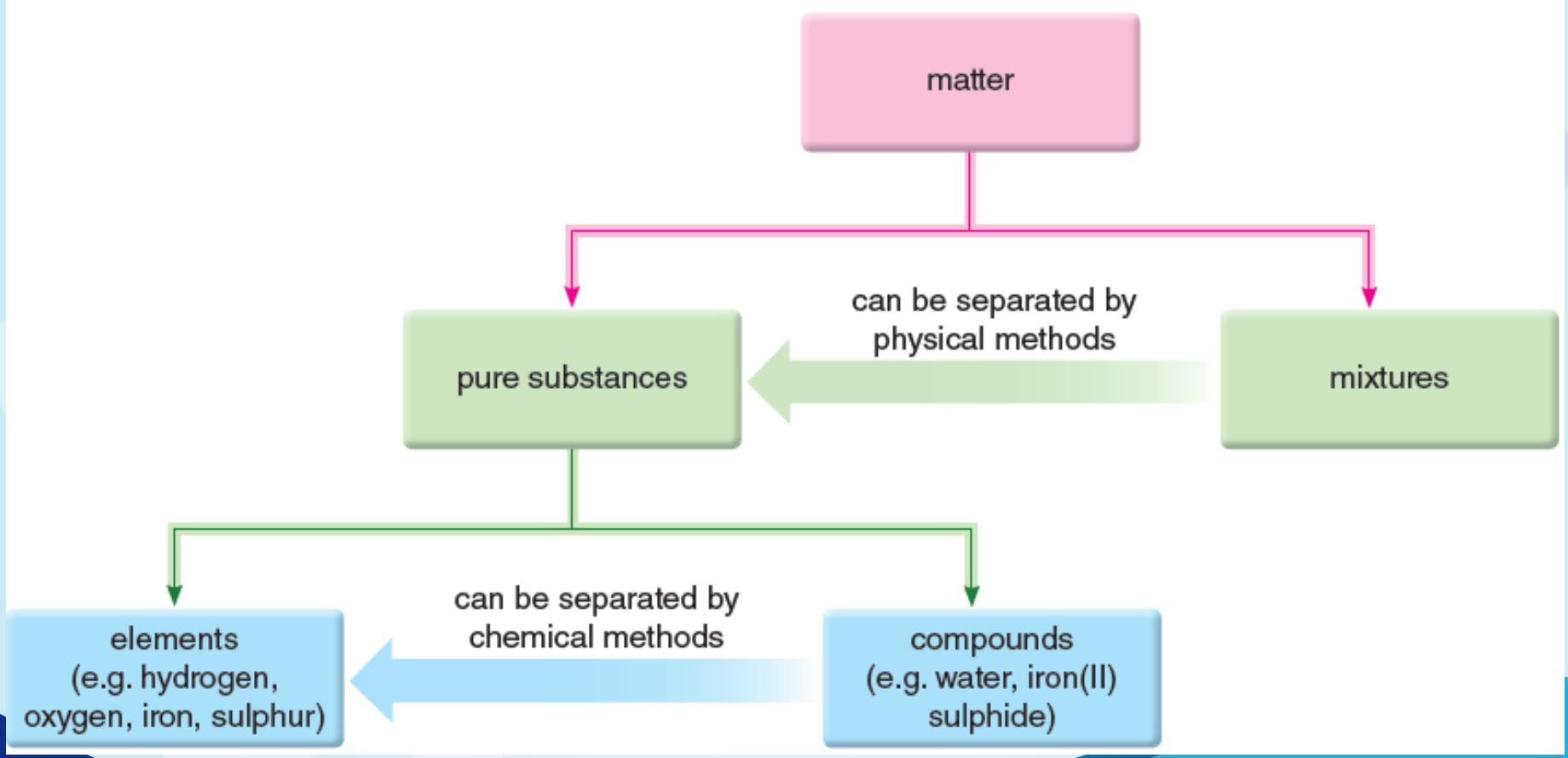
2 An element is a pure substance that cannot be broken down into anything simpler by chemical methods.

3 A compound is a pure substance that consists of two or more elements chemically joined together.

4 A mixture is made up of two or more substances (elements or compounds) that are not chemically joined together.

Summary (p. 36)

5 Classification of matter:



Summary (p. 36)

6 In industry, nitrogen and oxygen can be obtained from liquid air by fractional distillation.

7 A simple test of oxygen is that it can relight a glowing splint.

Unit Exercise (p. 37)

Note: Questions are rated according to ascending level of difficulty (from 1 to 5):

 question targeted at level 3 and above;

 question targeted at level 4 and above;

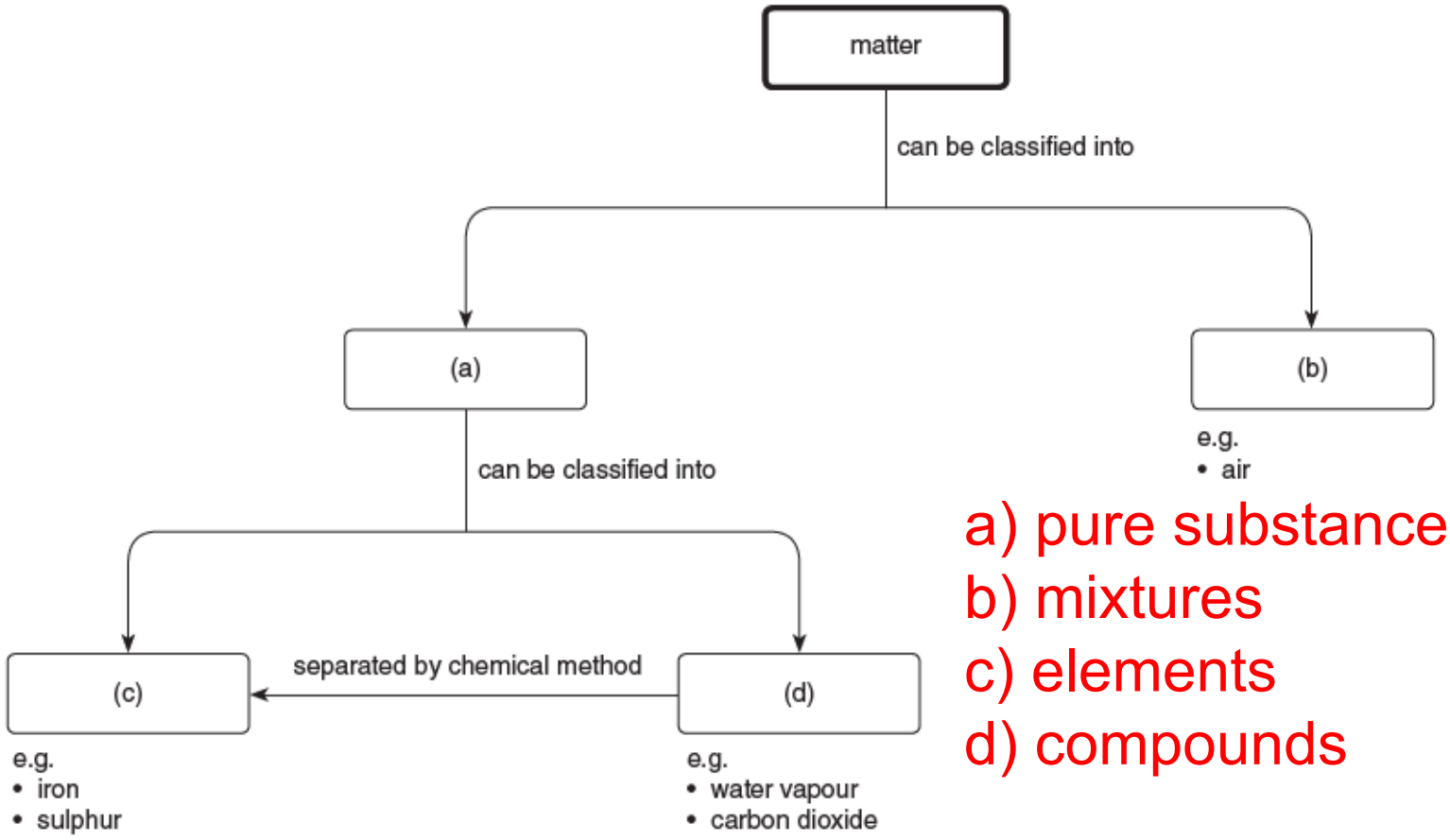
 question targeted at level 5.

‘ * ’ indicates 1 mark is given for effective communication.

Unit Exercise (p. 37)

Part I KNOWLEDGE AND UNDERSTANDING

1 Complete the following concept map.



a) pure substances
b) mixtures
c) elements
d) compounds

Unit Exercise (p. 38)

Part II MUTIPLE CHOICE QUESTIONS

Directions: Questions 2 and 3 are about some gases present in air.

2 Which is the most abundant gas in dry air?

A Argon
B Carbon dioxide
C Nitrogen
D Oxygen

Answer：C

(Edexcel IGCSE, Paper 2CR, Jun. 2016, 3(a))

Unit Exercise (p. 38)

Directions: Questions 2 and 3 are about some gases present in air.

3 Which gas makes up about 1% of dry air?

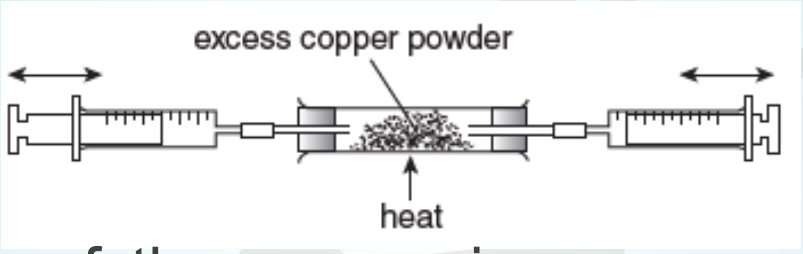
A Argon
B Carbon dioxide
C Nitrogen
D Oxygen

Answer：A

(Edexcel IGCSE, Paper 2CR, Jun. 2016, 3(b))

Unit Exercise (p. 38)

4 The set-up of an experiment is shown below. At room temperature, the system initially contains a sample of dry air.



Answer : C

The plungers of the gas syringes are moved to and fro until all the oxygen has reacted with the copper powder. The system is then allowed to cool to room temperature. The volume of gases at the end of the reaction is 152 cm^3. What is the starting volume of dry air?

A 168 cm^3
B 182 cm^3
C 192 cm^3
D 205 cm^3

Explanation:
Air contains 21% of oxygen. This means 79% of dry air remain at the end of the reaction.
Starting volume of dry air = (152 / 79 %) cm^3
= 192 cm^3

Unit Exercise (p. 38)

5 Rainwater is an example of a / an

A compound.
B element.
C mixture.
D pure substance.

Answer : C

Unit Exercise (p. 38)

6 The table below lists the properties of three unknown substances.

Substance	Appearance	Effect of passing electricity through the substance	Effect of heating the substance
X	colourless liquid	two colourless gases are formed	boils
Y	silvery solid	the solid conducts electricity	turns into a silvery liquid at high temperature
Z	Yellow solid	the solid does not conduct electricity	turns into a sticky yellowish orange liquid

Unit Exercise (p. 38)

6 (continued)
Which of the substances are likely to be elements?

A X and Y only
B X and Z only
C Y and Z only
D X, Y and Z

Answer : C

Explanation:
Substance X can be broken down into two gases. Thus, it is NOT an element.

Unit Exercise (p. 38)

7 Which of the following lists of substances consists only of mixtures?

A Dust, milk, honey, petroleum
B Ink, fizzy drink, soil, nitrogen
C Smoke, steel, blood, common salt
D Wine, paint, argon, fruit juice

Answer : A

Unit Exercise (p. 39)

8 A mixture of sulphur and iron filings needs to be separated. The solubilites of sulphur and iron filings in water and carbon disulphide are shown in the table below.

	Solubility in water	Solubility in carbon disulphides
Sulphur	×	✓
Iron filings	×	×

Unit Exercise (p. 39)

8 (continued)

What are possible methods of separating the sulphur and iron filings?

	Using water	Using carbon disulphide	Using a magnet
A	✓	✓	×
B	×	✓	✓
C	✓	×	✓
D	×	✓	×

(Cambridge IGCSE, 0620/11, Paper 1, Nov. 2012, 2)

Answer：B

Unit Exercise (p. 39)

9 Which of the following statements about a mixture is INCORRECT?

A Its composition is variable.
B There is usually a significant energy change when it is formed.
C Its constituents retain their own properties.
D Its constituents can be separated by physical methods.

Answer：B

Unit Exercise (p. 39)

10 Which is a use of oxygen?

A Filling balloons
B Filling light bulbs
C Food preservation
D Making steel

(Cambridge IGCSE, 0620/11, Paper 1, Jun. 2012, 29)

Answer：D

Unit Exercise (p. 39)

11 Which of the following are mixtures?

(1) Blood
(2) Petrol
(3) Tomato soup

A (1) and (2) only
B (1) and (3) only
C (2) and (3) only
D (1), (2) and (3)

Explanation:

(1) Blood is a mixture of a large number of substances, including red and white blood cells, and plasma.
(2) Petrol is a mixture of carbon compounds and performance additives.
(3) Tomato soup is a mixture of water and the components of tomatos.

Answer : D

Unit Exercise (p. 39)

12 Which of the following statements about a compound are correct?

(1) It is a pure substance.
(2) Its properties are similar to those of its constituents.
(3) It has a definite composition.

A (1) and (2) only
B (1) and (3) only
C (2) and (3) only
D (1), (2) and (3)

Answer：B

Unit Exercise (p. 39)

13 Which of the following statements about oxygen are correct?

(1) Oxygen is an element.
(2) Oxygen relights a glowing splint.
(3) The following hazard warning label is displayed on a cylinder of oxygen gas.

A (1) and (2) only
B (1) and (3) only
C (2) and (3) only
D (1), (2) and (3)

Explanation:
(3) Oxygen is NOT flammable.

Answer：A

Unit Exercise (p. 40)

Part III STRUCTURED QUESTIONS

14 The table shows some of the natural sources from which useful materials are obtained.
Complete the table by using the words below:
iron, nitrogen, oxygen, sodium chloride

Source	Useful materials	
Air	nitrogen (1)	oxygen (1)
Rocks	aluminium	iron (1)
Sea water	sodium chloride (1)	water

Unit Exercise (p. 40)

15 Classify each of the substances below as an element, a compound or a mixture.

a) Apple juice mixture (1)

b) Town gas mixture (1)

c) Oxygen element (1)

d) Magnesium chloride compound (1)

Unit Exercise (p. 40)

16 Air is a mixture of different gases.

a) Which gas makes up about 78% of air?

Nitrogen (1)

b) Only one gas in the mixture allows things to burn in it.

i) Identify this gas.

Oxygen (1)

ii) Suggest a test for this gas.

Place a glowing splint in the gas. (1) The splint relights. (1)

c) Name TWO compounds found in air.

Carbon dioxide (1)

Water (1)

Unit Exercise (p. 40)

17 The following box contains some information about chemical reactions. Read the information carefully and answer the questions that follow.

Chemical reactions involve converting reactants into products.

reactants ⟶ products

They are used in industry to produce new and useful materials from raw materials. Raw materials can be obtained from the Earth's crust, sea and air. Examples of raw materials include crude oil, nitrogen and metal ores. Useful products include fuels, plastics, medicines, metals and fertilisers.

Unit Exercise (p. 40)

17 (continued)

Use the information in the box above to help you answer parts (a)–(d).

a) State what happens during a chemical reaction.

Reactants are converted into products. (1)

b) State why chemical reactions are important in industry.

Produce new / useful materials. (1)

Unit Exercise (p. 41)

17 (continued)

c) Name a raw material obtained from

i) the earth's crust;

Crude oil / metal ores (1)

ii) the air.

Nitrogen (1)

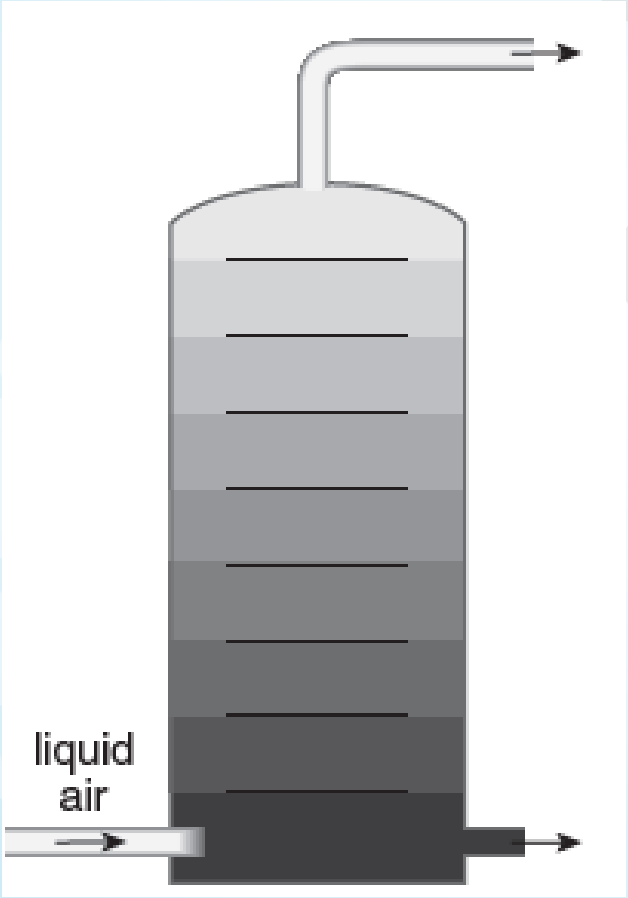
d) Name the raw material used to produce petrol.

Crude oil (1)

(WJEC GCSE (Foundation Tier), SUMMER-Chem. 1, 2012, 1)

Unit Exercise (p. 41)

18 The diagram below shows the equipment used to separate nitrogen and oxygen from liquid air.



Unit Exercise (p. 41)

18 (continued)

Complete the passage below.

The name of the method used is (a). Nitrogen and oxygen can be separated by this method because they have different (b).

The equipment shown is a (c). The temperature at the top of the equipment is (d) than the temperature at the bottom.

Liquid (e) boils at the bottom. The gas rises to the top, where it is collected.

a) fractional distillation (1)
b) boiling points (1)
c) fractionating column (1)
d) lower (1)
e) nitrogen (1)

Unit Exercise (p. 41)

19 Substances can be classified as: elements, mixtures, compounds

a) Define each of the following terms.

i) Element — An element is a pure substance that cannot be broken down into anything simpler by chemical methods. (1)

ii) Compound — A compound is a pure substance that consists of two or more elements chemically joined together. (1)

iii) Mixture — A mixture is made up of two or more substances (elements or compounds) that are not chemically joined together. (1)

b) Classify each of the following as either an element, compound or mixture.

i) Copper — Element (1)

ii) Steel — Mixture (1)

iii) Sugar — Compound (1)

Unit Exercise (p. 42)

20 Hydrogen reacts with oxygen to form a compound.

a) Suggest a test for oxygen. State also the expected observation. Place a glowing splint in oxygen. (1)
The splint relights. (1)

b) Draw a hazard warning label that should be displayed on a cylinder of oxygen.

c) Write the word equation for the reaction between hydrogen and oxygen.

hydrogen + oxygen ⟶ water (1)

Unit Exercise (p. 42)

21 Air is a mixture of gases and contains various pollutants. The gases are useful and can be separated by fractional distillation of liquid air. The table gives information about some of the gases in air.

Name of gas	Melting point (°C)	Boiling point (°C)
Helium	–272.2	–269.0
Oxygen	–219.0	–183.0
Nitrogen	–210.0	–195.9
Argon	–189.0	–185.9
Carbon dioxide	–78.5	–78.5 (carbon dioxide sublimes at –78.5 °C)
Water vapour	0.0	100.0

Unit Exercise (p. 42)

21 (continued)

To separate these gases,

- the air is filtered;
- water is removed first;
- carbon dioxide is then removed by absorption;
- the gases remaining are compressed and cooled to –200 °C.

a) The air is filtered before the gases are separated. Suggest why. To remove solid / dust particles. (1)

b) Water vapour and carbon dioxide are removed before the gases are compressed and cooled. Use the information in the table to suggest why.

b)
Because at –200 °C both water and carbon dioxide are solids. (1)
They would block the pipes. (1)

Unit Exercise (p. 42)

21 (continued)

c) After the water and carbon dioxide have been removed, which gas stays liquid over the greatest temperature range? Oxygen (1)

d) After the water and carbon dioxide have been removed, the four gases that are left are compressed and cooled to –200 °C. Helium (1)

i) Which gas does NOT liquefy?

ii) The three liquefied gases are then allowed to warm up. Give the order in which the three liquefied gases would vaporise.

1st nitrogen

2nd argon

3rd oxygen

(1)

(AQA GCSE (Higher Tier), Unit C1, Specimen paper, 2011, 8)

Unit Exercise (p. 43)

22 A student added a small piece of sodium metal to a beaker of water. The sodium moves about quickly on the surface of the water producing a hissing sound.

The word equation for the reaction that occurs is:

sodium + water → sodium hydroxide + hydrogen

a) What can you say about the density of sodium compared with water? Explain your answer.

b) A solution of sodium hydroxide is left at the end of the reaction. State whether each of the following is an element, a compound or a mixture.

i) Sodium Element (1)

ii) Water Compound (1)

iii) Sodium hydroxide Compound (1)

iv) Hydrogen Element (1)

v) Solution of sodium hydroxide Mixture (1)

a)

The density of sodium is lower than that of water. (1)

Sodium floats on the water surface. (1)

Unit Exercise (p. 43)

23 Nitrogen and oxygen are obtained from air by fractional distillation. Oxygen boils at –183 °C and nitrogen boils at –196 °C.

a) Which state must the air be in, before fractional distillation can be carried out?

In liquid state (1)

b) Very low temperatures are required for (a). How are these achieved?

The air is cooled and compressed, and then allowed to expand rapidly. The air becomes colder during the process. (1)

The process of compression followed by expansion is repeated until the air reaches –200 °C. (1)

Unit Exercise (p. 43)

23 (continued)

c) Explain how nitrogen and oxygen are separated.

Liquid air is pumped into the fractionating column. The column is warmer at the bottom than it is at the top. (1)

Nitrogen boils at the bottom and gaseous nitrogen rises to the top where it is piped off. Liquid oxygen is collected at the bottom of the column. (1)

Unit Exercise (p. 43)

*24 Suggest THREE differences between a mixture and a compound.

Any three of the following:

- The amount of each constituent in a mixture may vary. The amount of each element in a compound is fixed. (1)
- There is no or little energy change when a mixture is formed. Energy is usually released or taken in when a compound is formed. (1)
- Each constituent in a mixture retains its own properties. The properties of a compound are different from those of the elements in it. (1)
- The constituents of a mixture may be separated quite easily by physical methods. (1)
- The constituents of a compound can only be separated by chemical methods.

Communication mark (1)