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Checkups and follow-ups

CHAPTER 4 ANSWER KEY

ST
Questions 1–7, 17, 18, 20–23, C and E

Changes in matter

Checkup

1 WHAT ARE CHANGES IN MATTER? (p. 108)

1. Does each of the following phenomena describe a physical change, a chemical change or a nuclear transformation? Explain your answers.

a) a puddle of water evaporating in the sun

A physical change, because it is a change in state.

b) propane gas burning in a barbecue

A chemical change, because it is a combustion reaction.

c) a wooden plank being sawn in half

A physical change, because it is a change in form.

d) lead turning into gold

A nuclear transformation, because atomic nuclei are rearranged.

2 CHEMICAL CHANGES (pp. 109–124)

2. For each of the situations in the following photos, name at least one sign that a chemical change is occurring.

A

A change in colour

B

The release of a gas

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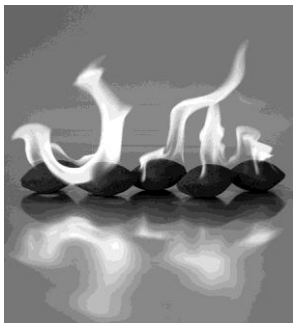
C

The formation of a precipitate or a change in colour

D



The emission of heat or light

3. Represent each of the following reactions with a chemical equation. Specify the physical state of each substance.

a) A solid zinc atom reacts with two molecules of a solution of hydrochloric acid (HCl), to form one molecule of zinc chloride ($ZnCl_2$) in solution and one molecule of hydrogen gas.

$Zn_{(s)} + 2\ HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

b) Two atoms of solid sodium react with two molecules of liquid water to form two molecules of sodium hydroxide (NaOH) in solution and one molecule of hydrogen gas.

$2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ NaOH_{(aq)} + H_{2(g)}$

c) The reaction of one molecule of propane gas (C_3H_8) with five molecules of oxygen gas produces three molecules of carbon dioxide gas and four molecules of water vapour.

$C_3H_{8(g)} + 5\ O_{2(g)} \rightarrow 3\ CO_{2(g)} + 4\ H_2O_{(g)}$

d) When two molecules of sodium chloride (NaCl) in solution are mixed with one molecule of barium nitrate ($Ba(NO_3)_2$) in solution, two molecules of sodium nitrate ($NaNO_3$) in solution are formed, as well as one molecule of barium chloride ($BaCl_2$) in the form of a solid precipitate.

$2\ NaCl_{(aq)} + Ba(NO_3)_{2(aq)} \rightarrow 2\ NaNO_{3(aq)} + BaCl_{2(s)}$

4. The equation for the synthesis of water is: $2\ H_{2(g)} + O_{2(g)} \rightarrow 2\ H_2O_{(l)}$. If 2 g of hydrogen are made to react with 16 g of oxygen, what is the mass of the resulting water? Show your calculations.

According to the law of conservation of mass, the total mass of the reactants is equal to the total mass of the products, therefore:
16 g of oxygen + 2 g of hydrogen = 18 g of water

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5. When magnesium is made to react with hydrochloric acid, hydrogen gas is released. If the reaction occurs in an open beaker, what will happen to the mass of the beaker's contents? Explain your answer.

The mass will decrease because the hydrogen gas will escape from the beaker.

6. Is each of the following equations balanced or not? Explain your answers.

a) $NA + O_2 \rightarrow Na_2O_2$ *No*

Before the chemical reaction		After the chemical reaction	
Reactants	**Numbers of atoms**	**Product**	**Numbers of atoms**
Na + O_2	*1 Na atom* *2 O atoms*	*Na_2O_2*	*2 Na atoms* *2 O atoms*

b) $C + O_2 \rightarrow CO_2$ *Yes*

Before the chemical reaction		After the chemical reaction	
Reactants	**Numbers of atoms**	**Product**	**Numbers of atoms**
C + O_2	*1 C atom* *2 O atoms*	*CO_2*	*1 C atom* *2 O atoms*

c) $2\ C_2H_2 + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O$ *Yes*

Before the chemical reaction		After the chemical reaction	
Reactants	**Numbers of atoms**	**Products**	**Numbers of atoms**
2 C_2H_2 + 5 O_2	*4 C atoms* *4 H atoms* *10 O atoms*	*4 CO_2 + 2 H_2O*	*4 C atoms* *4 H atoms* *10 O atoms*

d) $CH_4 + 2\ Cl_2 \rightarrow CCl_4 + 4\ HCl$ *No*

Before the chemical reaction		After the chemical reaction	
Reactants	**Numbers of atoms**	**Products**	**Numbers of atoms**
CH_4 + 2 Cl_2	*1 C atom* *4 H atoms* *4 Cl atoms*	*CCl_4 + 4 HCl*	*1 C atom* *4 H atoms* *5 Cl atoms*

7. Balance each of the following equations.

a) $Mg + O_2 \rightarrow MgO$ *2 Mg + O_2 → 2 MgO*

Mg + O_2	→	MgO
Mg *O_2* *Mg*	~~*Mg*~~ ~~*O*~~ ~~*Mg*~~ ~~*O*~~	*MgO* *MgO*
2 Mg + O_2		*2 MgO*

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b) $Fe + O_2 \rightarrow Fe_2O_3$ *$4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$*

$Fe + O_2$		**$\rightarrow$**			**Fe_2O_3**
Fe	*O_2*	~~*Fe*~~	~~*O*~~	~~*O*~~	*Fe_2O_3*
Fe	*O_2*	~~*Fe*~~	~~*O*~~	~~*O*~~	*Fe_2O_3*
Fe	*O_2*	~~*Fe*~~	~~*O*~~	~~*O*~~	
Fe		~~*Fe*~~			
$4\ Fe + 3\ O_2$					*$2\ Fe_2O_3$*

c) $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$ *$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$*

$C_3H_8 + O_2$		**$\rightarrow$**					**$CO_2 + H_2O$**	
C_3H_8	*O_2*	~~*C*~~	~~*H*~~	~~*H*~~	~~*O*~~	~~*O*~~	*CO_2*	*H_2O*
	O_2	~~*C*~~	~~*H*~~	~~*H*~~	~~*O*~~	~~*O*~~	*CO_2*	*H_2O*
	O_2	~~*C*~~	~~*H*~~	~~*H*~~	~~*O*~~	~~*O*~~	*CO_2*	*H_2O*
	O_2		~~*H*~~	~~*H*~~	~~*O*~~	~~*O*~~		*H_2O*
	O_2				~~*O*~~	~~*O*~~		
$C_3H_8 + 5\ O_2$							*$3\ CO_2 + 4\ H_2O$*	

d) $KOH + H_2SO_4 \rightarrow K_2SO_4 + H_2O$ *$2\ KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\ H_2O$*

$KOH + H_2SO_4$		**$\rightarrow$**				**$K_2SO_4 + H_2O$**
KOH	*H_2SO_4*	~~*K*~~	~~*O*~~	~~*H*~~	~~*S*~~	*$K_2SO_4 + 2\ H_2O$*
KOH		~~*K*~~	~~*O*~~	~~*H*~~		
			~~*O*~~	~~*H*~~		
			~~*O*~~	~~*H*~~		
			~~*O*~~			
			~~*O*~~			
$2\ KOH + H_2SO_4$						*$K_2SO_4 + 2\ H_2O$*

⇒ **Questions 8 to 16 are not intended for students in the ST program.**

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17. When solutions of hydrochloric acid (HCl) and potassium hydroxide (KOH) are mixed, the substances react with each other.

a) What type of chemical reaction is involved?

An acid-base neutralization reaction

b) Write the chemical equation for this reaction.

$HCl_{(aq)} + KOH_{(aq)} \rightarrow KCl_{(aq)} + H_2O_{(l)}$

or $H^+_{(aq)} + Cl^-_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightarrow K^+_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)}$

18. In an acid-base neutralization reaction, what happens to the pH of the acid solution? Explain your answer.

The pH increases. The pH of an acid is less than 7, and the pH of the solution resulting from a complete acid-base neutralization reaction is 7.

⇒ **Question 19 is not intended for students in the ST program.**

20. To learn how to control fires, firefighters have to study the three necessary conditions for a fire to start. What are these conditions?

There must be an oxidizing agent and fuel, and the fuel must reach its ignition temperature.

21. What is the difference between an oxidizing agent and a fuel? Give an example of each.

An oxidizing agent causes combustion. Answers will vary. Example: oxygen.

A fuel undergoes combustion. Answers will vary. Example: wood.

22. Does each of the following statements refer to rapid combustion, spontaneous combustion or slow combustion?

a) A fire starts because of a gasoline-soaked rag.

Spontaneous combustion

b) Iron rusts easily in damp environments.

Slow combustion

c) A campfire draws people together with its light and warmth.

Rapid combustion

d) Many varieties of fruit rot quickly when cut and left in the open air.

Slow combustion

23. What distinguishes photosynthesis from cellular respiration? Name at least five differences.

Answers will vary. Examples:

Cellular respiration	Photosynthesis
Releases energy.	*Absorbs energy.*
Produces carbon dioxide.	*Converts carbon dioxide.*
Converts oxygen.	*Produces oxygen.*
Converts glucose.	*Produces glucose.*
Takes place in plants and animals.	*Takes place only in plants.*
Converts chemical energy into thermal energy and mechanical energy.	*Converts solar energy into chemical energy.*

3 NUCLEAR TRANSFORMATIONS (pp. 124–131)

⇒ **The questions in this section are not intended for students in the ST program.**

REVIEW QUESTIONS

⇒ **Questions A, B and D are not intended for students in the ST program.**

C. Dwindling oil reserves and climate change are spurring scientists to find alternative methods of fuelling cars. One method is to use metal powder. For example, zinc reacts with oxygen gas to produce solid zinc oxide (ZnO), releasing a large amount of energy in the process. Preliminary results for this method look promising.

a) Write a balanced equation for this reaction.

$2\ Zn_{(s)} + O_{2(g)} \rightarrow 2\ ZnO_{(s)}$

b) What type of chemical change is involved?

Oxidation or combustion

c) Normally, when a metal reacts with oxygen, the energy released is barely noticeable. Explain your answer.

Normally, the reaction is one of slow combustion, so it occurs over a long period of time. The energy released is barely noticeable because it disperses gradually into the environment.

d) Researchers believe that using metal powder to fuel cars would be less harmful to the environment than burning gasoline. Explain your answer.

Unlike gasoline, the combustion of metal powder does not produce carbon dioxide, a greenhouse gas.

E. Prepare your own summary of Chapter 4 by building a concept map.

See the Concept maps *section in Guide B.*

Follow-up

1. Why is it difficult to protect people from the radiation given off by radioactive elements? Why is this radiation harmful to human health?

Some radiation, such as gamma rays, is stopped only by high-density materials, like concrete or lead, so it passes easily through the human body. Radiation can be harmful to health because of its ability to alter a cell's DNA, which can lead to the development of cancer cells.

2. Cesium-137 has a half-life of about 30 years. Is it normal that after more than 20 years, levels of radioactivity in the ground near Chernobyl are still very high? Explain your answer.

Yes, because a half-life of 30 years means that it takes 30 years for half of the amount of cesium to decay. Therefore, after 20 years, more than half of the cesium still remains in the ground.