O

14 Rate of Reactions

For each question, choose the most suitable option and write the letter (**A**, **B**, **C** or **D**) in the brackets provided.

Level 1

1. Which of the following does **not** describe what happens when a reaction mixture is immersed in an ice bath?

   A The proportion of particles colliding with energy greater than or equal to the activation energy decreases.

   B The rate of reaction does not change.

   C The reactant particles collide less frequently.

   D The reactant particles have less kinetic energy. ( )

2. Excess copper(II) carbonate and sulfuric acid are allowed to react in a conical flask. The mass of the conical flask is measured and plotted against time as shown in Figure 14.1.

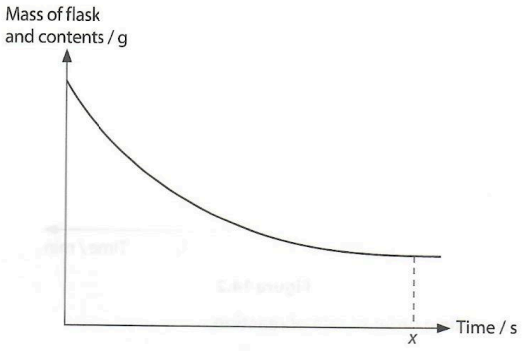

Figure 14.1

Which of the following statements about the graph is **true**?

A Copper(II) carbonate has been completely used up at *x* minutes.

B The rate of the reaction can be determined using the *y*-intercept of the graph.

C The rate of the reaction is the fastest at the beginning.

D The reaction is still occurring at *x* minutes. ( )

3. In order for a reaction to occur, _____.

   A the reactant particles must collide at high speeds

   B the reactant particles must collide more frequently

   C the reactant particles must collide with energy that is greater than or equal to the activation energy

   D the reactant particles must collide with energy that is less than the activation energy ( )

4. Which of the following reactions will **not** be affected by an increase in the surface area of reactant particles?

   A $BaCl_2(aq) + Na_2SO_4(aq) \longrightarrow BaSO_4(aq) + 2NaCl(aq)$

   B $CaCO_3(s) + 2HNO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + CO_2(g) + H_2O(l)$

   C $Cu(s) + 2AgNO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + 2Ag(s)$

   D $Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$ ( )

5. The rate of a particular reaction was measured and the data is shown in Figure 14.2.

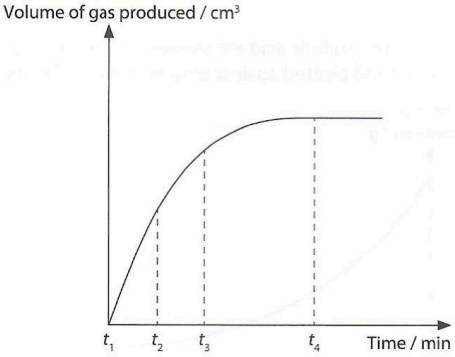

Figure 14.2

Arrange t_1 to t_4 in **ascending** order of rate of reaction.

A t_1, t_2, t_3, t_4

B t_1, t_3, t_4, t_2

C t_4, t_1, t_2, t_3

D t_4, t_3, t_2, t_1 ( )

Level 2

6. The decomposition of hydrogen peroxide is as shown.

$$2H_2O_2(aq) \longrightarrow O_2(g) + 2H_2O(l)$$

Which of the following will cause a **decrease** in the rate of decomposition?

A Adding water into the reaction mixture

B Decreasing the pressure of the reaction mixture

C Immersing the reaction mixture in a hot water bath

D Increasing the concentration of hydrogen peroxide ( )

7. A student wants to investigate the rate of reaction between calcium carbonate and nitric acid. Figure 14.3 shows some set-ups used to investigate the rate of reactions.

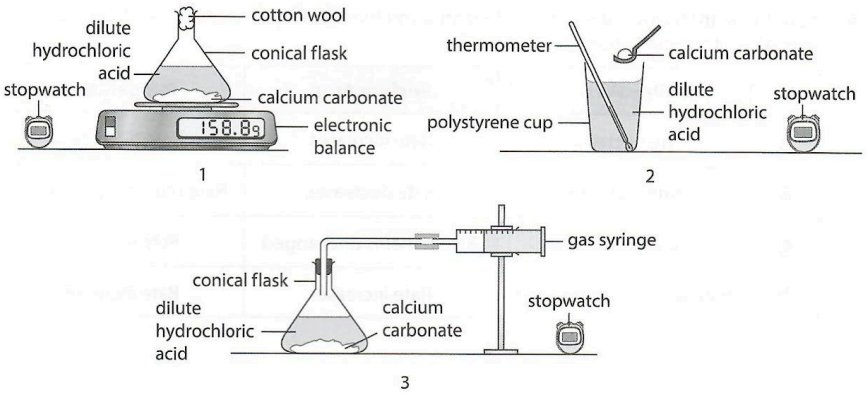

Figure 14.3

Which of the above set-up(s) can he use in his experiment?

A 1 only

B 1 and 3 only

C 2 and 3 only

D All of the above ( )

8. 15 g of zinc powder was added to 10 cm^3 of 1.0 mol/dm^3 nitric acid. The time taken to collect 20 cm^3 of hydrogen gas was measured.

   Which of the following change(s) can be made to ensure that the same volume of gas is collected in a **shorter** period of time?

   1 Use the same mass of magnesium instead of zinc.

   2 Use the same volume and concentration of hydrochloric acid instead of nitric acid.

   3 Use 2.0 mol/dm^3 nitric acid instead.

   A 1 only

   B 1 and 2 only

   C 1 and 3 only

   D 3 only ( )

9. How do the **increase** in pressure, surface area and temperature affect the rate of reaction of the formation of ammonia from its elements?

	Pressure	Surface Area	Temperature
A	Rate decreases	Rate increases	Rate decreases
B	Rate increases	Rate decreases	Rate remains unchanged
C	Rate increases	Rate remains unchanged	Rate increases
D	Rate remains unchanged	Rate increases	Rate increases

( )

Level 3

10. A student set up three experiments with different conditions as shown in Table 14.1.

$$2X + Y \longrightarrow 2Z$$

Table 14.1

Experiment	Concentration of X / mol/dm^3	Concentration of Y / mol/dm^3	Rate of Formation of Z / $moldm^{-3}s^{-1}$
1	0.100	0.100	0.0500
2	0.200	0.100	0.100
3	0.200	0.200	0.100

Which of the following statements is **correct**?

A The rate of reaction increases by four times when the concentration of **X** is doubled.

B The rate of reaction remains unchanged when the concentration of **X** is doubled.

C The rate of reaction doubles when the concentration of **Y** is doubled.

D The rate of reaction remains unchanged when the concentration of **Y** is doubled. ( )

11. Two experiments, **I** and **II**, are carried out according to Table 14.2.

Table 14.2

Experiment I	6 g of magnesium ribbon and 10 cm^3 of 1.0 mol/dm^3 H_2SO_4
Experiment II	6 g of magnesium ribbon and 10 cm^3 of 1.0 mol/dm^3 HNO_3

Which of the following measurements are the **same** in both experiments?

A The mass of magnesium leftover from the reaction

B The number of moles of acid used up in the reaction

C The rate of reaction

D The volume of gas produced ( )

12. The rate of a neutralisation reaction can be determined by monitoring the temperature of the reaction mixture over time.

A student set up an experiment to determine the effect of concentration on the rate of reaction. He used the same volume of hydrochloric acid and aqueous sodium hydroxide in his experiment. He monitored the temperature of the reaction mixture over time and plotted the data in Figure 14.4.

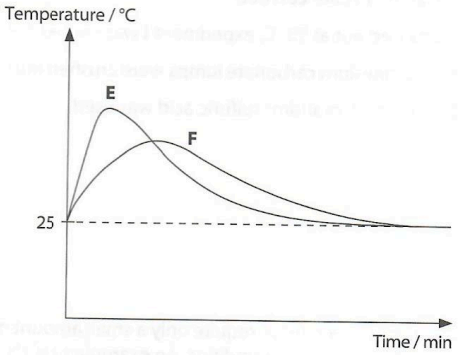

Figure 14.4

Which of the following is likely the concentration of the hydrochloric acid and aqueous sodium hydroxide used in the experiment?

	E		F	
	Hydrochloric Acid	**Sodium Hydroxide**	**Hydrochloric Acid**	**Sodium Hydroxide**
A	0.5 mol/dm^3	0.5 mol/dm^3	1.0 mol/dm^3	1.0 mol/dm^3
B	1.0 mol/dm^3	1.0 mol/dm^3	1.0 mol/dm^3	1.0 mol/dm^3
C	1.0 mol/dm^3	1.0 mol/dm^3	0.5 mol/dm^3	0.5 mol/dm^3
D	1.0 mol/dm^3	0.5 mol/dm^3	0.5 mol/dm^3	1.0 mol/dm^3

( )

13. Three experiments, **G**, **H** and **I**, involving excess magnesium carbonate and sulfuric acid were carried out. The mass of the reaction mixture was monitored over time and plotted in Figure 14.5. In experiment **I**, lumps of magnesium carbonate were reacted with 50 cm^3 of 1.0 mol/dm^3 sulfuric acid.

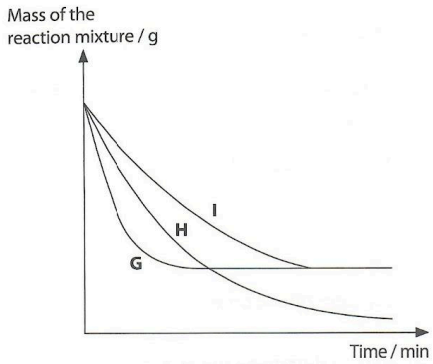

Figure 14.5

Which of the following statements are **correct**?

1 If experiment **G** was carried out at 50 °C, experiment **I** was carried out at 70 °C.

2 In experiment **G**, the magnesium carbonate lumps were crushed into a powder.

3 In experiment **H**, 50 cm^3 of 1.5 mol/dm^3 sulfuric acid was used.

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D All of the above ( )

14. Reactions that occur spontaneously tend to require only a small amount of energy. These reactions tend to release heat into the surroundings. An example of such reactions is the reaction of potassium with water.

Which of the following would indicate that reaction 1 is **more** spontaneous than reaction 2?

	Reaction 1		Reaction 2	
	Activation Energy	Type of Reaction	Activation Energy	Type of Reaction
A	High	Endothermic	Low	Exothermic
B	High	Exothermic	Low	Endothermic
C	Low	Endothermic	High	Exothermic
D	Low	Exothermic	High	Endothermic

( )

15. Two experiments were set up with the conditions listed in Table 14.3.

Table 14.3

Experiment I	20 cm^3 of 1.0 mol/dm^3 HCl and 10 g of powdered $FeCO_3$
Experiment II	20 cm^3 of 1.0 mol/dm^3 H_2SO_4 and 10 g of powdered $FeCO_3$

The volume of gas produced was measured and plotted against time.

Which two graphs in Figure 14.6 could be the graphs obtained for experiments **I** and **II** respectively?

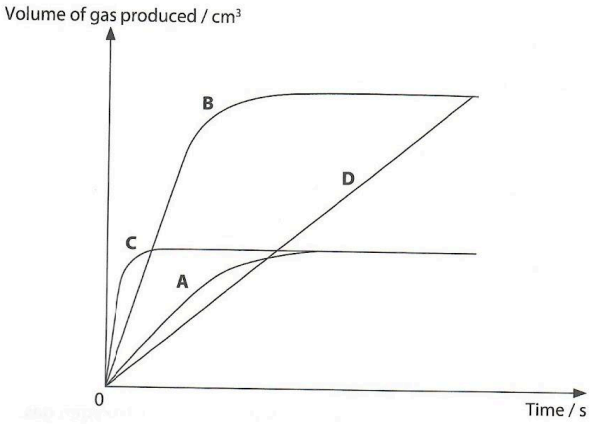

Figure 14.6

	Experiment I	Experiment II
A	Graph **A**	Graph **B**
B	Graph **A**	Graph **C**
C	Graph **C**	Graph **A**
D	Graph **D**	Graph **B**

( )