Reversible reactions

Question Paper 1

Level	IGCSE
Subject	Chemistry (0620/0971)
Exam Board	Cambridge International Examinations (CIE)
Topic	Chemical reactions
Sub-Topic	Reversible reactions
Booklet	Question Paper 1

Time Allowed: **38 minutes**

Score: **/31**

Percentage: **/100**

Grade Boundaries:

9	8	7	6	5	4	3	2	1
>85%	75%	68%	60%	53%	48%	40%	33%	<25%

1 When blue copper(II) sulfate is heated, a white solid and water are formed.

The white solid turns blue and gives out heat when water is added to it.

Which terms describe the blue copper(II) sulfate and the reactions?

	the blue copper(II) sulfate is	reaction
A	a mixture	can be reversed
B	a mixture	cannot be reversed
C	hydrated	can be reversed
D	hydrated	cannot be reversed

2 The equation shows a reaction that is reversed by changing the conditions.

$$CuSO_4.5H_2O \xrightarrow{\text{forward reaction}} CuSO_4 + 5H_2O$$

How can the forward reaction be reversed?

	by adding water	by heating
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

3 When pink cobalt(II) sulfate crystals are heated, they form steam and a blue solid.

When water is added to the blue solid, it turns pink and becomes hot.

Which terms describe the pink cobalt(II) sulfate crystals and the reactions?

	pink cobalt sulfate	reactions
A	aqueous	irreversible
B	aqueous	reversible
C	hydrated	irreversible
D	hydrated	reversible

4 The sign ⇌ is used in some equations to show that a reaction is reversible.

Two incomplete equations are given.

	reactants	products
P	$CoCl_2 + 2H_2O$	$CoCl_2.2H_2O$
Q	$C + O_2$	CO_2

For which of these reactions can a ⇌ sign be correctly used to complete the equation?

	P	Q
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

5 The equation for the effect of heat on hydrated sodium carbonate is as shown.

$$Na_2CO_3.10H_2O(s) \rightleftharpoons Na_2CO_3(s) + 10H_2O(g)$$

Statements made by four students about the reaction are given.

P Anhydrous sodium carbonate is formed.

Q Steam is formed.

R There is a colour change from blue to white.

S The reaction is reversible.

Which students' statements are correct?

A P, Q and R only

B P, Q and S only

C Q, R and S only

D P, Q, R and S

6 When green iron(II) sulfate is heated, it turns white and a colourless liquid is produced. When the liquid is put back into the white solid it changes back to green.

What type of reaction takes place and what is the name of the liquid?

	type of reaction	name of liquid
A	redox	sulfuric acid
B	redox	water
C	reversible	sulfuric acid
D	reversible	water

7 The equation shows the formation of anhydrous copper(II) sulfate from hydrated copper(II) sulfate.

$$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$$

Statements 1, 2 and 3 refer to this reaction.

1 Hydrated copper(II) sulfate is reduced to anhydrous copper(II) sulfate.

2 The (II) in the name copper(II) sulfate refers to the oxidation state of the metal.

3 The reaction is reversible.

Which statements are correct?

A 1 only **B** 1 and 2 **C** 2 and 3 **D** 3 only

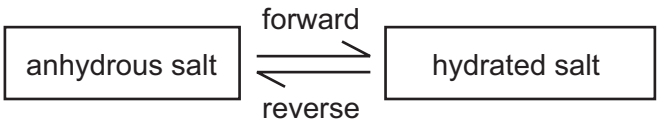
8 Heating pink cobalt(II) chloride crystals forms a blue solid and steam.

The blue solid turns pink when water is added.

Which terms describe the pink cobalt(II) chloride and the reaction?

	pink cobalt(II) chloride is	the reaction is reversible
A	anhydrous	yes
B	anhydrous	no
C	hydrated	yes
D	hydrated	no

9 The diagram shows the change from an anhydrous salt to its hydrated form.



Which statement is correct?

A forward reaction requires heat and water

B forward reaction requires water only

C reverse reaction requires heat and water

D reverse reaction requires water only

10 Which reaction is **not** a reversible reaction?

A combustion of alkanes

B hydration of anhydrous copper(II) sulfate

C melting lead(II) bromide

D thermal decomposition of hydrated cobalt(II) chloride

11 Which reaction is reversible?

A $Cu + ZnSO_4 \rightarrow CuSO_4 + Zn$

B $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

C $CuO + H_2 \rightarrow Cu + H_2O$

D $CuSO_4.5H_2O \rightarrow CuSO_4 + 5H_2O$

12 Steam reacts with carbon in an endothermic reaction.

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$$

Which conditions of temperature and pressure would give the largest yield of hydrogen?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

13 Methanol is made by reacting carbon monoxide with hydrogen.

The reaction is exothermic and is a chemical equilibrium.

The equation for the reaction is shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Which changes in temperature and pressure increase the yield of methanol?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

14 Ammonia is manufactured by a reversible reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

What is the effect of increasing the pressure on the percentage yield and rate of formation of ammonia?

	percentage yield	rate of formation
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

15 Methanol is manufactured by reacting carbon monoxide and hydrogen together in the presence of an aluminium oxide catalyst.

The equation for the reaction is shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The reaction is a reversible reaction.

The forward reaction is exothermic.

Which change in conditions increases the yield of methanol?

A decreasing the concentration of the carbon monoxide

B increasing the pressure

C increasing the rate of the reaction

D increasing the temperature

16 Two reactions involving water are shown.

X anhydrous cobalt(II) chloride + water → hydrated cobalt(II) chloride

Y iron + oxygen + water → rust

Which reactions are reversible by heating?

	X	Y
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

17 A reversible reaction is shown.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H = -58\,kJ/mol$$

Which statement about an equilibrium mixture of NO_2 and N_2O_4 is correct?

A If the pressure is decreased the amount of N_2O_4 increases.

B If the temperature is increased the amount of N_2O_4 increases.

C The rates of formation and decomposition of N_2O_4 are not the same.

D The decomposition of N_2O_4 is an endothermic reaction.

18 Dinitrogen tetroxide, N_2O_4, breaks down into nitrogen dioxide, NO_2.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The reaction is reversible and endothermic.

Which conditions will give the largest yield of nitrogen dioxide, NO_2?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

19 When pink cobalt(II) chloride crystals are heated they form steam and a blue solid.

When water is added to the blue solid, it turns pink and becomes hot.

Which terms describe the pink cobalt(II) chloride crystals and the reactions?

	pink cobalt(II) chloride	reactions
A	aqueous	irreversible
B	anhydrous	reversible
C	hydrated	irreversible
D	hydrated	reversible

20 When blue copper(II) sulfate is heated, a white solid and water are formed.

The white solid turns blue and gives out heat when water is added to it.

Which terms describe the blue copper(II) sulfate and the reactions?

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21 Methane reacts with steam to produce hydrogen and carbon monoxide.

The equation for the reaction is shown.

$$CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g)$$

The reaction is reversible. The forward reaction is endothermic.

Which changes in temperature and pressure increase the equilibrium yield of carbon monoxide?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

22 The formation of sulfur trioxide from sulfur dioxide is a reversible reaction.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which changes would increase the equilibrium yield of SO_3?

1 increasing the pressure

2 lowering the temperature

3 decreasing the concentration of oxygen

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 and 3 only

23 The following reaction has reached equilibrium in a closed system.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which row shows the effect of increasing the pressure on the equilibrium mixture?

	reaction rate	amount of SO_2	amount of SO_3
A	increases	decreases	increases
B	increases	increases	decreases
C	unchanged	decreases	increases
D	unchanged	increases	decreases

24 The Haber process for making ammonia is carried out at a temperature of 450 °C and a pressure of 200 atmospheres in the presence of a catalyst.

Which statement is **not** correct?

A Lowering the pressure increases the rate at which ammonia is produced.

B Lowering the temperature slows down the rate at which ammonia is produced.

C Maintaining a very high pressure is very difficult and needs expensive equipment.

D The reaction is a reversible reaction which can proceed forwards and backwards.

25 Which row correctly matches the experiment and observations to the identity of the underlined substance?

	experiment and observations	identity of the underlined substance
A	Blue crystals are heated. The crystals turn white and steam is given off.	hydrated cobalt(II) chloride
B	Pink crystals are heated. The crystals turn blue and steam is given off.	anhydrous cobalt(II) chloride
C	Water is added to a blue solid. The blue solid turns pink.	hydrated copper(II) sulfate
D	Water is added to a white solid. The white solid turns blue.	anhydrous copper(II) sulfate

26 Nitrogen, hydrogen and ammonia gases are placed inside a container. The container is then sealed. After some time, an equilibrium forms.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Which statement describes the equilibrium in this container?

A The amount of ammonia remains constant from the moment the container is sealed.

B The amounts of ammonia, nitrogen and hydrogen in the container are always equal.

C The rate of formation of ammonia is equal to the rate of decomposition of ammonia.

D The rate of formation of ammonia is faster than the rate of decomposition of ammonia.

27 The reaction used to manufacture ammonia from nitrogen and hydrogen is reversible.

An equilibrium can be established between ammonia, nitrogen and hydrogen.

Which statement describes the equilibrium?

A Both the forward reaction and the backward reaction have the same rate.

B The rate of the backward reaction is greater than the rate of the forward reaction.

C The rate of the forward reaction is greater than the rate of the backward reaction.

D The forward and backward reactions have both stopped.

28 Hydrogen is produced when methane reacts with steam.

The equation for the reaction is shown.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The forward reaction is endothermic.

Which conditions produce the highest yield of hydrogen?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

29 The equation for the effect of heat on hydrated sodium carbonate is as shown.

$$Na_2CO_3.10H_2O(s) \rightleftharpoons Na_2CO_3(s) + 10H_2O(g)$$

Statements made by four students about the reaction are given.

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Q Steam is formed.

R There is a colour change from blue to white.

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Which students' statements are correct?

A P, Q and R only

B P, Q and S only

C Q, R and S only

D P, Q, R and S

30 The equation for the reversible reaction between hydrogen and iodine to form hydrogen iodide is shown.

The colours of the reactants and products are shown.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

colourless purple colourless

The forward reaction is exothermic.

Which statement is correct?

A An increase in pressure has no effect on the equilibrium position.

B The purple colour fades when the reaction mixture is heated.

C When equilibrium is reached, both forward and reverse reactions stop.

D When more hydrogen gas is added, the purple colour increases.

31 Ammonia is formed by a reversible reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which changes in conditions would increase the yield of ammonia?

	increase in pressure	increase in temperature
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗