

Chemical reactions

30 questions: 15 multiple choice, 15 structured.

1 Core Physical and chemical changes [1]

Which change is a chemical change?

- A rusting of an iron nail
- B melting of candle wax
- C dissolving of sugar in water
- D evaporation of ethanol

2 Core Rate of reaction [1]

Marble chips react with excess dilute hydrochloric acid to produce carbon dioxide gas. The experiment is repeated at a higher temperature, with all other conditions kept the same. What happens to the rate of the reaction?

- A It increases
- B It decreases
- C It stays the same
- D It increases at first, then decreases to zero

3 Core Rate of reaction [1]

Which statement about a catalyst is correct?

- A A catalyst is used up during the reaction it speeds up
- B A catalyst increases the rate of a reaction and is chemically unchanged at the end of it
- C A catalyst decreases the rate of a reaction
- D A catalyst changes the products formed by a reaction

4**Core**

Rate of reaction

[1]

A student investigates the reaction between calcium carbonate lumps and excess dilute hydrochloric acid, which produces carbon dioxide gas. Which apparatus set-up allows the volume of gas produced to be measured directly at regular time intervals?

- A a thermometer placed in the reaction mixture
 - B a gas syringe connected to the reaction flask
 - C a balance placed under the open reaction flask
 - D a pH probe placed in the reaction mixture
-

5**Supplement**

Rate of reaction

[1]

According to collision theory, how does a catalyst increase the rate of a reaction?

- A It increases the number of reactant particles per unit volume
 - B It increases the average kinetic energy of the reactant particles
 - C It provides an alternative reaction pathway with a lower activation energy
 - D It increases the pressure of the reacting system
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A student reacts excess small marble chips (calcium carbonate) with dilute hydrochloric acid in a conical flask plugged with cotton wool, standing on a balance. The flask and contents are weighed every 30 seconds as carbon dioxide gas escapes. The table shows the results.

Time / s	0	30	60	90	120	150	180
Total mass lost / g	0.00	0.32	0.56	0.72	0.82	0.88	0.88

- (a) State two variables that should be kept constant during this experiment for it to be a fair test.

[2]

- (b) Calculate the mean rate of reaction, in g/s, over the first 60 seconds.

[2]

- (c) Describe how the rate of the reaction changes between 0 s and 180 s, and explain what the results show has happened to the reaction by 150 s.

[2]

Dilute hydrochloric acid reacts with small pieces of magnesium ribbon.

- (a) Using collision theory, explain why increasing the concentration of the hydrochloric acid increases the rate of this reaction.

[3]

- (b) Using collision theory, explain why increasing the temperature of the hydrochloric acid increases the rate of this reaction.

[3]

8**Supplement**

Rate of reaction

[5]

A teacher wants to compare two methods of investigating the rate of reaction between marble chips and dilute hydrochloric acid: Method 1 measures the loss in mass of the reaction flask over time using a balance; Method 2 measures the volume of gas collected in a gas syringe over time.

- (a) State one piece of data that both methods can be used to calculate. [1]

- (b) Evaluate Method 1, compared with Method 2, for this particular reaction. [2]

- (c) Suggest one improvement that could be made to Method 1 to reduce error in the results. [2]

9**Core**

Reversible reactions and equilibrium

[1]

Which symbol shows that a reaction is reversible?

- A $\rightleftharpoons$
B $\rightarrow$
C $=$
D $\pm$

10 **Core** Reversible reactions and equilibrium

[1]

White anhydrous copper(II) sulfate is used to test for the presence of water. What colour does it turn when water is added?

- A pink
 - B yellow
 - C blue
 - D it stays white
-

11 **Supplement** Reversible reactions and equilibrium

[1]

Which equation correctly represents the reaction taking place in the Haber process?

- A $\text{N}_2(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons \text{NH}_3(\text{g})$
 - B $2\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
 - C $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
 - D $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
-

12 **Supplement** Reversible reactions and equilibrium

[1]

What are the typical conditions used in the Haber process?

- A 450 °C, 200 kPa, vanadium(V) oxide catalyst
 - B 450 °C, 20 000 kPa, iron catalyst
 - C 200 °C, 20 000 kPa, platinum catalyst
 - D 450 °C, 20 000 kPa, nickel catalyst
-

13 **Supplement** Reversible reactions and equilibrium

[1]

In the Contact process, which is a typical source of the sulfur dioxide used?

- A cracking crude oil fractions
- B fractional distillation of liquid air
- C electrolysis of concentrated sodium chloride solution
- D burning sulfur or roasting sulfide ores

Nitrogen and hydrogen react in a closed container: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$, $\Delta H = -92 \text{ kJ/mol}$ (the forward reaction is exothermic).

- (a) State the two conditions that show a reversible reaction in a closed system has reached equilibrium. [2]

- (b) Predict and explain the effect of increasing the pressure on the position of this equilibrium. [2]

- (c) Predict and explain the effect of increasing the temperature on the position of this equilibrium. [2]

- (d) State the effect of adding a catalyst on the position of this equilibrium. [1]

The Haber process is used industrially to manufacture ammonia.

- (a) Write the balanced symbol equation, including state symbols, for the Haber process. [2]

- (b) State the raw material source of the hydrogen and the raw material source of the nitrogen used in the process. [2]

- (c) State the typical temperature and pressure used in the Haber process, and name the catalyst used. [2]

The Contact process is used industrially to manufacture sulfur trioxide, which is later converted into sulfuric acid.

- (a) Write the balanced symbol equation, including state symbols, for the conversion of sulfur dioxide to sulfur trioxide. [2]

- (b) State a source of the sulfur dioxide and the source of the oxygen used in the process. [2]

- (c) State the typical temperature and pressure used in this stage of the Contact process, and name the catalyst used. [2]

The forward reaction in the Haber process is exothermic, and produces fewer gas molecules than it uses. Industrially, a temperature of 450 °C and a pressure of 20 000 kPa are used, rather than a much lower temperature or a much higher pressure.

- (a) Explain, in terms of rate of reaction and position of equilibrium, why a compromise temperature of 450 °C is used rather than a much lower temperature.

[3]

- (b) Explain, in terms of position of equilibrium and cost/safety, why a pressure of 20 000 kPa is used rather than a much higher pressure.

[3]

Blue anhydrous cobalt(II) chloride paper turns pink when water is added to it, and the pink paper turns back to blue on heating. This can be summarised as a reversible reaction:

hydrated cobalt(II) chloride (pink) $\rightleftharpoons$ anhydrous cobalt(II) chloride (blue) + water

- (a) State what is meant by describing this reaction as reversible. [2]

- (b) Predict and explain what you would observe if water is added to a sample of the blue anhydrous solid. [2]

- (c) Predict and explain what you would observe if the pink hydrated solid is heated strongly. [2]

19**Core**

Redox

[1]

What is the oxidation number of iron in iron(III) oxide, Fe_2O_3 ?

- A +2
 - B +6
 - C -3
 - D +3
-

20**Core**

Redox

[1]

In the reaction $\text{CuO(s)} + \text{H}_2\text{(g)} \rightarrow \text{Cu(s)} + \text{H}_2\text{O(l)}$, which statement is correct?

- A CuO is reduced because it loses oxygen
 - B CuO is oxidised because it loses oxygen
 - C H_2 is reduced because it gains oxygen
 - D H_2 is reduced because it loses oxygen
-

21**Core**

Redox

[1]

In the reaction $\text{Mg(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{MgSO}_4\text{(aq)} + \text{Cu(s)}$, which species is oxidised?

- A Cu^{2+}
 - B SO_4^{2-}
 - C Cu
 - D Mg
-

22**Supplement**

Redox

[1]

What is the oxidation number of nitrogen in the nitrate ion, NO_3^- ?

- A +3
- B -3
- C +5
- D +6

23**Supplement**

Redox

[1]

Acidified potassium manganate(VII) solution is added to a colourless aqueous solution of potassium iodide. Which colour change is observed?

- A colourless to purple
 - B purple to (almost) colourless, with a brown colour developing in the solution
 - C orange to green
 - D no colour change occurs
-

24**Core**

Redox

[4]

Iron(III) oxide reacts with carbon monoxide in a blast furnace: $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{l}) + 3\text{CO}_2(\text{g})$

- (a) Identify the substance that is reduced in this reaction, giving a reason based on gain or loss of oxygen. [2]

- (b) Identify the substance that is oxidised in this reaction, giving a reason based on gain or loss of oxygen. [1]

- (c) Explain why this reaction is described as a redox reaction. [1]

Iron forms two common oxides, FeO and Fe₂O₃. Copper forms two common oxides, Cu₂O and CuO. Give the full name of each oxide below, using a Roman numeral to show the oxidation number of the metal.

(a) FeO [1]

(b) Fe₂O₃ [1]

(c) Cu₂O [1]

(d) CuO [1]

26**Supplement**

Redox

[5]

Zinc metal is added to aqueous copper(II) sulfate: $\text{Zn(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu(s)}$

- (a) Define oxidation in terms of electron transfer.

[1]

- (b) Write an ionic half-equation, including state symbols, for the change happening to the zinc.

[2]

- (c) State, with a reason based on electron transfer, whether the copper(II) ion is oxidised or reduced.

[2]

Use the rules for oxidation numbers to answer the following.

- (a) State the oxidation number of nitrogen in the ammonium ion, NH_4^+ . [1]

- (b) State the oxidation number of chromium in the dichromate ion, $\text{Cr}_2\text{O}_7^{2-}$. [2]

- (c) State the oxidation number of sulfur in the sulfite ion, SO_3^{2-} . [2]

- (d) State the oxidation number of manganese in the manganate(VII) ion, MnO_4^- . [1]

Acidified aqueous potassium manganate(VII) is purple. It is added to an excess of colourless aqueous potassium iodide, and the manganate(VII) ions are converted to pale pink/colourless manganese(II) ions while the iodide ions are converted to brown aqueous iodine.

- (a) State the colour change observed in this reaction. [1]

- (b) Define an oxidising agent, and identify the oxidising agent in this reaction. [2]

- (c) Define a reducing agent, and identify the reducing agent in this reaction. [2]

- (d) State whether the manganate(VII) ion is oxidised or reduced, giving a reason in terms of oxidation number. [2]

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Supplement

Redox

[6]

In the blast furnace, iron(III) oxide reacts with carbon monoxide: $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{l}) + 3\text{CO}_2(\text{g})$

(a) Define an oxidising agent and a reducing agent.

[2]

(b) Identify the oxidising agent and the reducing agent in this reaction, giving a reason for each.

[4]

Aqueous iron(II) sulfate reacts with chlorine gas: $2\text{Fe}^{2+}(\text{aq}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{Fe}^{3+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq})$

- (a) State the oxidation number of iron before and after this reaction. [2]

- (b) State the oxidation number of chlorine before and after this reaction. [2]

- (c) Identify which species is oxidised and which is reduced, using the oxidation number changes from (a) and (b). [2]

- (d) Write separate ionic half-equations for the oxidation process and the reduction process taking place. [2]
