# Chemical reactions – 2022J O Level 5070

**1.** June/2022/Paper_11/No.20

Sulfur dioxide reacts with oxygen in the air.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -196\,kJ/mol$$

The reaction is very slow if no catalyst is present.

Which statement explains this?

**A** Air contains only 21% oxygen so there is not enough oxygen for all the sulfur dioxide to react.

**B** Only a small proportion of the sulfur dioxide and oxygen molecules have enough energy to react, even at high temperatures.

**C** The reaction is exothermic and so at high temperatures the equilibrium shifts to the left.

**D** The reaction is reversible and so products turn back to reactants; this happens more quickly at high temperatures.

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**2.** June/2022/Paper_11/No.21

Which statement is correct?

**A** An enzyme is a biological catalyst that decreases the activation energy of a reaction.

**B** An enzyme is a biological catalyst that increases the activation energy of a reaction.

**C** An enzyme is a compound of a transition element that decreases the activation energy of a reaction.

**D** An enzyme is a compound of a transition element that increases the activation energy of a reaction.

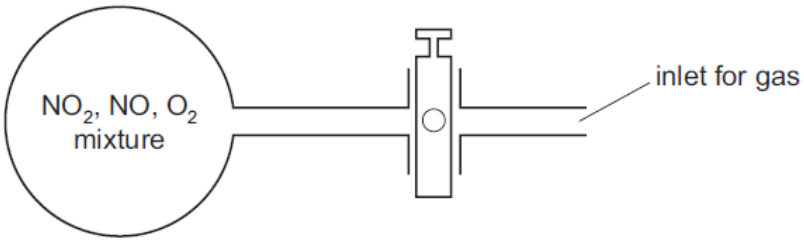
**3.** June/2022/Paper_11/No.22

Nitrogen dioxide, $NO_2$, is a dark brown gas that decomposes as shown in the equation.

$$2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$$

dark brown colourless

The diagram shows a glass flask containing a mixture of the three gases. The mixture is pale brown.




More oxygen is forced into the flask.

Which colour change is seen in the mixture?

**A** It becomes a darker brown.

**B** It becomes a paler brown.

**C** It turns colourless.

**D** There is no change.

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**4.** June/2022/Paper_11/No.23

Concentrated hydrochloric acid is oxidised by manganese(IV) oxide, $MnO_2$.

What are two products of this reaction?

**A** $Mn^{2+}$ and $Cl^-$

**B** $Mn^{2+}$ and $Cl_2$

**C** $Mn^{6+}$ and $Cl^-$

**D** $Mn^{6+}$ and $Cl_2$

**5.** June/2022/Paper_11/No.24

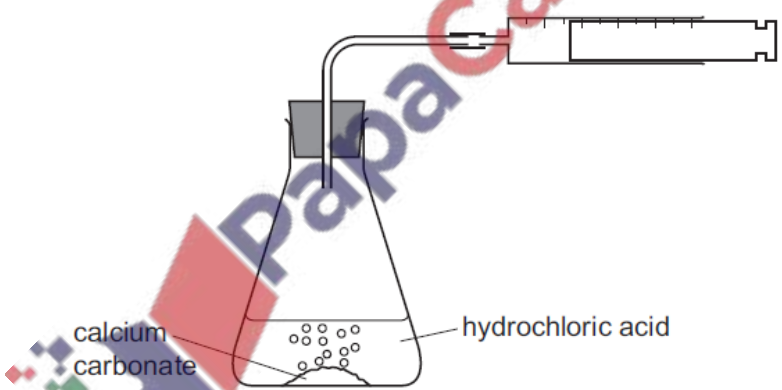
The table gives some information about four redox reactions.

Which row gives correct information about what is oxidised and the evidence that this is oxidation?

| | equation | what is oxidised in the reaction | evidence for this oxidation |
|---|---|---|---|
| **A** | $CuO(s) + C(s) \rightleftharpoons CO(g) + Cu(s)$ | copper | copper oxide has given oxygen to carbon |
| **B** | $Na(s) + \frac{1}{2}Cl_2(g) \rightleftharpoons NaCl(s)$ | sodium | sodium has lost an electron |
| **C** | $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ | nitrogen | nitrogen has gained hydrogen |
| **D** | $Zn(NO_3)_2(aq) + Mg(s) \rightleftharpoons Mg(NO_3)_2(aq) + Zn(s)$ | zinc | zinc has gained two electrons |

**6.** June/2022/Paper_12/No.1

A student investigates the rate of reaction between calcium carbonate and hydrochloric acid.




The volume of gas in the syringe is recorded after one minute.

The experiment is repeated using different concentrations of hydrochloric acid.

Which additional pieces of apparatus are essential for the investigation?

1 balance

2 measuring cylinder

3 stop-clock

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

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**7.** June/2022/Paper_12/No.12

Aqueous silver nitrate, $AgNO_3$, reacts with aqueous potassium chromate(VI), $K_2CrO_4$, to give a yellow precipitate.

What is the ionic equation for this reaction?

**A** $2AgNO_3(aq) + K_2CrO_4(aq) \rightarrow Ag_2CrO_4(s) + 2KNO_3(aq)$

**B** $2Ag^+(aq) + 2NO_3^-(aq) + 2K^+(aq) + CrO_4^{2-}(aq) \rightarrow Ag_2CrO_4(s) + 2NO_3^-(aq) + 2K^+(aq)$

**C** $2Ag^+(aq) + CrO_4^{2-}(aq) \rightarrow Ag_2CrO_4(s)$

**D** $Ag^+(aq) + CrO_4^-(aq) \rightarrow AgCrO_4(s)$

**8.** June/2022/Paper_12/No.20

Bromate, bromide and hydrogen ions react according to the equation shown.

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

Some apparatus for measuring how the rate of this reaction varies over time is suggested.

1 gas syringe

2 balance

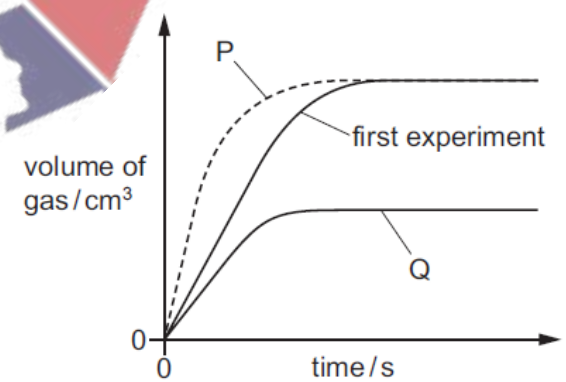
3 pH meter

Which apparatus is suitable to measure the rate of this reaction?

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

**9.** June/2022/Paper_12/No.21

25 $cm^3$ of 1.0 $mol/dm^3$ hydrochloric acid reacts with 10 g of a solid to produce a gas. The solid is in excess. The graph labelled first experiment shows the volume of gas produced over time. Graphs P and Q show the volume of gas produced under different conditions.




Which changes in conditions produce graphs P and Q, if all other conditions are kept the same?

**A** P uses a catalyst and Q has a lower temperature.

**B** P uses 25 $cm^3$ of more concentrated acid and Q uses smaller pieces of solid.

**C** P uses a higher temperature and Q uses 25 $cm^3$ of more dilute acid.

**D** P uses smaller pieces of solid and Q uses larger pieces of solid.

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**10.** June/2022/Paper_12/No.22

Nitrogen dioxide, $NO_2$, is a dark brown gas that decomposes as shown in the equation.

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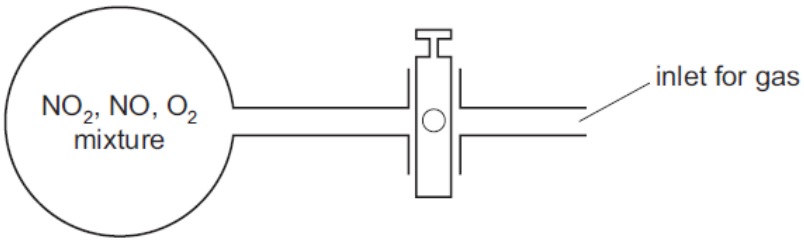


More oxygen is forced into the flask.

Which colour change is seen in the mixture?

**A** It becomes a darker brown.

**B** It becomes a paler brown.

**C** It turns colourless.

**D** There is no change.

**11.** June/2022/Paper_12/No.23

What is an observation of an oxidation process?

**A** blue copper sulfate crystals turning to white powder when heated

**B** copper being deposited on the cathode during electrolysis

**C** green gas being produced at the anode when sodium chloride is electrolysed

**D** white precipitate forming when aqueous silver ions react with aqueous chloride ions

**12.** June/2022/Paper_12/No.24

An excess of aqueous iodide ions is added to acidified aqueous potassium manganate(VII).

Which row is correct?

| | iodide ions | colour of final solution |
|---|---|---|
| **A** | oxidised | colourless |
| **B** | oxidised | brown |
| **C** | reduced | colourless |
| **D** | reduced | brown |

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**13.** June/2022/Paper_12/No.25

When ammonia gas is dissolved in water a reversible reaction takes place.

$$NH_3(g) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

Which statements are correct?

1 Ammonia is an alkali because it produces hydroxide ions in solution.

2 The pH of this solution is 7.

3 Adding hydroxide ions to the mixture at equilibrium produces more ammonia.

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

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**14.** June/2022/Paper_21/No.5(a)

Iron reacts with steam and with dilute sulfuric acid.

**(a)** The reaction between iron and steam is reversible.

The forward reaction is exothermic.

$$3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$$

An equilibrium mixture is formed when the reversible reaction happens in a closed system.

**(i)** Predict what happens to the amount of hydrogen in the equilibrium mixture if the temperature is increased and the pressure remains constant.

Explain your answer.

prediction .....

explanation .....

.....

.....

[2]

**(ii)** Predict what happens to the amount of hydrogen in the equilibrium mixture if the pressure is increased and the temperature remains constant.

Explain your answer.

prediction .....

explanation .....

.....

.....

[2]

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**15.** June/2022/Paper_21/No.6

Carbon monoxide and nitrogen monoxide are pollutants formed in a car engine.

**(a)** Describe how nitrogen monoxide is formed in a car engine.

.....

..... [1]

**(b)** Carbon monoxide reacts with nitrogen monoxide as shown in the equation.

$$2CO + 2NO \longrightarrow 2CO_2 + N_2$$

This reaction is extremely slow at room temperature but is much faster in the presence of a catalyst in a catalytic converter.

**(i)** Explain why this reaction involves **both** oxidation and reduction.

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..... [2]

**(ii)** The reaction between carbon monoxide and nitrogen monoxide is exothermic.

Explain, using ideas about bond breaking and bond forming, why the reaction is exothermic.

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..... [2]

**(iii)** Explain, using ideas about particles, why increasing the temperature increases the rate of the reaction between carbon monoxide and nitrogen monoxide.

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..... [2]

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**(iv)** Explain why a catalyst increases the rate of the reaction between carbon monoxide and nitrogen monoxide.

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..... [1]

**(v)** Explain, using ideas about particles, why the catalyst in a catalytic converter needs to have a large surface area.

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..... [2]

[Total: 10]

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**16.** June/2022/Paper_22/No.7

Carbon dioxide and sulfur dioxide are pollutants formed at power stations that burn fossil fuels such as coal.

**(a)** State one environmental problem caused by producing carbon dioxide as an atmospheric pollutant.

..... [1]

**(b)** State one environmental problem caused by producing sulfur dioxide as an atmospheric pollutant.

..... [1]

**(c)** Sulfur dioxide produced at power stations can be removed by a process called flue gas desulfurisation.

In flue gas desulfurisation, sulfur dioxide reacts with calcium carbonate.

$$CaCO_3(s) + SO_2(g) \rightarrow CaSO_3(s) + CO_2(g)$$

The reaction needs to be fast to remove as much sulfur dioxide as possible.

**(i)** Explain, using ideas about particles, why the calcium carbonate needs to be a powder instead of a single solid lump.

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..... [2]

**(ii)** Explain, using ideas about particles, why decreasing the temperature decreases the rate of the reaction between calcium carbonate and sulfur dioxide.

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..... [2]

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**(d)** Sulfur dioxide reacts with oxygen as shown.

$$2SO_2 + O_2 \rightarrow 2SO_3$$

**(i)** Explain why sulfur dioxide is oxidised in this reaction.

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..... [1]

**(ii)** Explain, using ideas about bond breaking and bond forming, why the reaction is exothermic.

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..... [2]

**(iii)** Explain why the addition of a catalyst increases the rate of this reaction.

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..... [1]

[Total: 10]

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