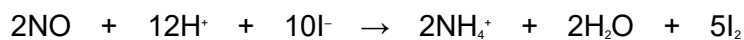


**Q1.(a)** The following is an equation for a redox reaction.



(i) Define *oxidation* in terms of electrons.

.....

(ii) Deduce the oxidation state of nitrogen in NO and of nitrogen in NH<sub>4</sub><sup>+</sup>

*Oxidation state of nitrogen in NO* .....

*Oxidation state of nitrogen in NH<sub>4</sub><sup>+</sup>* .....

(iii) Identify the species formed by oxidation in this reaction.....

**(4)**

(b) When chlorine gas is bubbled into an aqueous solution of sulphur dioxide, hydrogen ions, sulphate ions and chloride ions are formed.

(i) Write a half-equation for the formation of chloride ions from chlorine.

.....

(ii) Write a half-equation for the formation of hydrogen ions and sulphate ions from sulphur dioxide and water.

.....

(iii) Hence, deduce an overall equation for the reaction which occurs when chlorine is bubbled into aqueous sulphur dioxide.

.....

**(3)**  
**(Total 7 marks)**

Q2.

Summarised directions for recording responses to multiple completion questions			
<b>A</b> (i), (ii) and (iii) only	<b>B</b> (i) and (iii) only	<b>C</b> (ii) and (iv) only	<b>D</b> (iv) alone

In which of the following conversions is the copper reduced?

- (i)  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} \rightarrow [\text{CuCl}_4]^{2-}$
- (ii)  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} \rightarrow \text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2$
- (iii)  $\text{Cu} \rightarrow \text{CuCl}_2$
- (iv)  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} \rightarrow \text{CuCl}$

(Total 1 mark)

Q3. Which one of the following contains the metal with the lowest oxidation state?

- A  $\text{CrO}_2\text{F}_2$
- B  $[\text{Cr}_2\text{O}_7]^{2-}$
- C  $[\text{MnCl}_6]^{2-}$
- D  $[\text{Mn}(\text{CN})_6]^{3-}$

(Total 1 mark)

- Q4. (a) Samples of solid sodium fluoride, sodium chloride, sodium bromide and sodium iodide are each warmed separately with concentrated sulphuric acid. All four compounds react with concentrated sulphuric acid but only two can reduce it.
- (i) Identify the **two** halides which do **not** reduce concentrated sulphuric acid. Write an equation for the reaction which does occur with **one** of these two halides.

(ii) Identify the **two** halides which reduce concentrated sulphuric acid to sulphur dioxide. Using half-equations for the oxidation and reduction processes, deduce an overall equation for the formation of sulphur dioxide when concentrated sulphuric acid reacts with **one** of these halides.

(iii) In addition to sulphur dioxide, two further reduction products are formed when one of these two halides reacts with concentrated sulphuric acid. Identify the two reduction products and write a half-equation to show the formation of **one** of them from concentrated sulphuric acid.

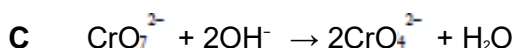
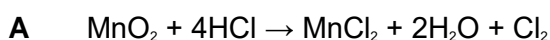
(9)

(b) How would you distinguish between separate solutions of sodium chloride, sodium bromide and sodium iodide using solutions of silver nitrate and ammonia?

(6)

(Total 15 marks)

**Q5.** In which one of the following reactions does the metal species undergo reduction?



(Total 1 mark)

**Q6.** The compound lithium tetrahydridoaluminate(III),  $\text{LiAlH}_4$ , is a useful reducing agent. It behaves in a similar fashion to  $\text{NaBH}_4$ . Carbonyl compounds and carboxylic acids are reduced to alcohols. However,  $\text{LiAlH}_4$  also reduces water in a violent reaction so that it must be used in an organic solvent.

Which one of the following concerning the violent reaction between  $\text{LiAlH}_4$  and water is **false**?

**A** A gas is produced.

- B The activation energy for the reaction is relatively high.
- C The reaction has a negative free-energy change.
- D Aqueous lithium ions are formed.

(Total 1 mark)

Q7. Which one of the following is the electronic configuration of the strongest reducing agent?

- A  $1s^2 2s^2 2p^5$
- B  $1s^2 2s^2 2p^6 3s^2$
- C  $1s^2 2s^2 2p^6 3s^2 3p^5$
- D  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

(Total 1 mark)

Q8. Which one of the following is a redox reaction?

- A  $2\text{CrO}_4^{2-} + 2\text{H}^+ \rightarrow \text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O}$
- B  $3\text{Cl}_2 + 6\text{OH}^- \rightarrow 5\text{Cl}^- + \text{ClO}_3^- + 3\text{H}_2\text{O}$
- C  $\text{HNO}_3 + 2\text{H}_2\text{SO}_4 \rightarrow \text{NO}_2^+ + \text{H}_3\text{O}^+ + 2\text{HSO}_4^-$
- D  $\text{CaCO}_3 + \text{SiO}_2 \rightarrow \text{CaSiO}_3 + \text{CO}_2$

(Total 1 mark)

Q9. (a) In terms of electron transfer, what does the reducing agent do in a redox reaction?

.....

(1)

(b) What is the oxidation state of an atom in an uncombined element?

.....

(1)

(c) Deduce the oxidation state of nitrogen in each of the following compounds.

(i)  $\text{NCl}_3$  .....

(ii)  $\text{Mg}_3\text{N}_2$  .....

(iii)  $\text{NH}_2\text{OH}$  .....

(3)

(d) Lead(IV) oxide,  $\text{PbO}_2$ , reacts with concentrated hydrochloric acid to produce chlorine, lead(II) ions,  $\text{Pb}^{2+}$ , and water.

(i) Write a half-equation for the formation of  $\text{Pb}^{2+}$  and water from  $\text{PbO}_2$  in the presence of  $\text{H}^+$  ions.

.....

(ii) Write a half-equation for the formation of chlorine from chloride ions.

.....

(iii) Hence deduce an equation for the reaction which occurs when concentrated hydrochloric acid is added to lead(IV) oxide,  $\text{PbO}_2$

.....

(3)  
(Total 8 marks)

**Q10.** (a) Concentrated sulphuric acid can be reduced by some solid sodium halides to  $\text{H}_2\text{S}$

(i) Give the oxidation state of sulphur in  $\text{H}_2\text{S}$

.....

- (ii) Give **one** solid sodium halide which will reduce concentrated sulphuric acid, forming  $\text{H}_2\text{S}$

.....

- (iii) State **one** way in which the presence of  $\text{H}_2\text{S}$  could be recognised.

.....

- (iv) Write a half-equation for the formation of  $\text{H}_2\text{S}$  from sulphuric acid.

.....

(4)

- (b) A different solid sodium halide reacts with concentrated sulphuric acid without reduction forming a halogen-containing product **X**.

- (i) Suggest an identity for **X**.

.....

- (ii) Identify the solid sodium halide which produces **X**.

.....

- (iii) State the role of sulphuric acid in the formation of **X**.

.....

- (iv) Write an equation for the reaction with concentrated sulphuric acid in which **X**

is formed.

.....

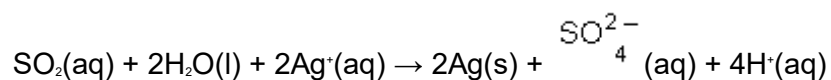
(4)  
(Total 8 marks)

**Q11.** (a) In terms of electrons, what happens to an oxidising agent during a redox reaction?

.....

(1)

(b) Consider the following redox reaction.



(i) Identify the oxidising agent and the reducing agent in this reaction.

*Oxidising agent* .....

*Reducing agent* .....

(ii) Write a half-equation to show how sulphur dioxide is converted into sulphate ions in aqueous solution.

.....

(3)

(c)  $\text{Fe}^{2+}$  ions are oxidised to  $\text{Fe}^{3+}$  ions by  $\text{ClO}_3^-$  ions in acidic conditions. The  $\text{ClO}_3^-$  ions are reduced to  $\text{Cl}^-$  ions.

(i) Write a half-equation for the oxidation of  $\text{Fe}^{2+}$  ions in this reaction.

.....

(ii) Deduce the oxidation state of chlorine in  $\text{ClO}_3^-$  ions.

.....

(iii) Write a half-equation for the reduction of  $\text{ClO}_3^-$  ions to  $\text{Cl}^-$  ions in acidic conditions.

.....

(iv) Hence, write an overall equation for the reaction.

.....

(4)

(d) Write an equation to show how sulphur is removed from impure iron obtained from the Blast Furnace. Identify the oxidising agent in this reaction.

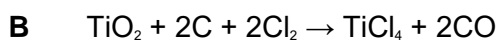
*Equation* .....

*Oxidising agent* .....

(2)

(Total 10 marks)

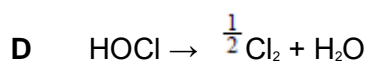
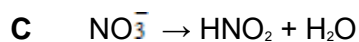
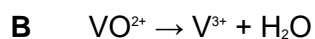
**Q12.** Which equation does **not** involve the reduction of a transition metal compound?



(Total 1 mark)

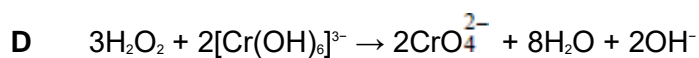
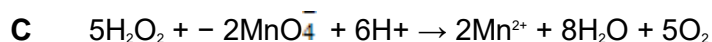
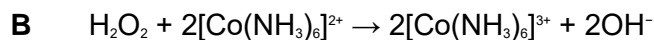
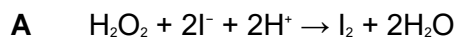


**Q13.** In which one of the following reactions do two H ions and one electron have to be added to the left-hand side in order to balance the equation?



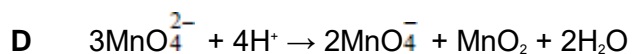
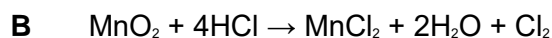
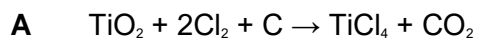
(Total 1 mark)

**Q14.** In which one of the following reactions is  $\text{H}_2\text{O}_2$  behaving as a reducing agent?



(Total 1 mark)

**Q15.** Which one of the following is **not** a redox reaction?



(Total 1 mark)