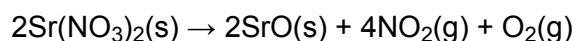


# F321: Atoms, Bonds and Groups

## Redox

39 Marks

1. The element strontium forms a nitrate,  $\text{Sr}(\text{NO}_3)_2$ , which decomposes on heating as shown below.

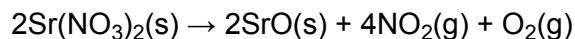


- (i) Using oxidation numbers, explain why the reaction involves both oxidation and reduction.

.....  
.....  
.....  
.....

[3]

- (ii) A student heats 5.29 g of  $\text{Sr}(\text{NO}_3)_2$  and collects the gas at room temperature and pressure, RTP.



Calculate the volume of gas, in  $\text{dm}^3$ , obtained by the student at RTP.

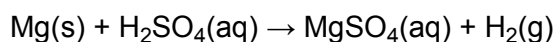
Molar mass of  $\text{Sr}(\text{NO}_3)_2 = 211.6 \text{ g mol}^{-1}$ .

answer = .....  $\text{dm}^3$

[3]

[Total 6 marks]

2. The reaction between magnesium and sulfuric acid is a redox reaction.



(i) Use oxidation numbers to identify which element has been oxidised.

Explain your answer.

element oxidised .....

explanation .....

.....

[2]

(ii) Describe what you would **see** when magnesium reacts with an excess of sulfuric acid.

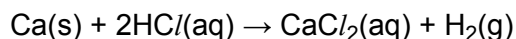
.....

.....

[2]

[Total 4 marks]

3. A student prepared an aqueous solution of calcium chloride by reacting calcium with hydrochloric acid.



(i) Using oxidation numbers, show that this is a redox reaction.

.....

.....

.....

.....

.....

[2]

- (ii) The student had added the exact amount of calcium required to react with the hydrochloric acid used. After carrying out the experiment, the student accidentally added some more calcium. The student was surprised that the extra calcium still reacted.

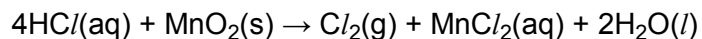
Explain this observation. Include an equation in your answer.

.....  
.....  
.....  
.....  
.....  
.....

[2]

[Total 4 marks]

4. Chlorine can be prepared by reacting concentrated hydrochloric acid with manganese(IV) oxide.



- (a) A student reacted 50.0 cm<sup>3</sup> of 12.0 mol dm<sup>-3</sup> hydrochloric acid with an excess of manganese(IV) oxide.

- (i) Calculate how many moles of HCl were reacted.

answer = ..... mol

[1]

- ii) Calculate the volume of  $Cl_2(g)$  produced, in  $dm^3$ .  
Under the experimental conditions, one mole of  $Cl_2(g)$  occupies  $24.0 dm^3$ .

answer = .....  $dm^3$

[2]

- (b) In this reaction, chlorine is oxidised.

Use oxidation numbers to determine what is reduced.

.....  
.....  
.....  
.....

[2]

[Total 5 marks]

5. Barium reacts with water in a redox reaction.



- (i) Explain, in terms of electrons, what is meant by oxidation.

.....

[1]

- (ii) Which element has been oxidised in this reaction? Deduce the change in its oxidation number.

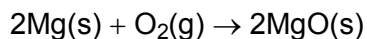
element .....

oxidation number changes from ..... to.....

[2]

[Total 3 marks]

6. Magnesium reacts with oxygen to form magnesium oxide.



(i) Use oxidation numbers to show that oxygen has been reduced in its reaction with magnesium.

.....  
.....  
.....

[2]

(ii) Draw a 'dot-and-cross' diagram to show the arrangement of electrons in magnesium oxide. Show outer electron shells only and include any charges.

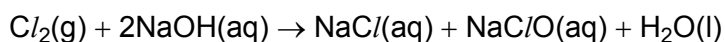
[2]

[Total 4 marks]

7. A student carried out two experiments using chlorine gas,  $\text{Cl}_2\text{(g)}$ .

(a) In the first experiment, the student bubbled chlorine through  $120\text{ cm}^3$  of an aqueous solution of  $0.275\text{ mol dm}^{-3}$  sodium hydroxide,  $\text{NaOH(aq)}$ .

The equation for this reaction is shown below.



Under the reaction conditions, 1 mole of  $\text{Cl}_2\text{(g)}$  occupies  $24.0\text{ dm}^3$ .

(i) What is meant by the term *the mole*?

.....  
.....  
.....

[1]

(ii) How many moles of NaOH were in the 120 cm<sup>3</sup> volume of NaOH(aq)?

answer ..... mol

[1]

(iii) Calculate the volume of Cl<sub>2</sub>(g) that was needed to react with the NaOH(aq) used.

answer .....

[2]

(iv) What is a common use for the solution that the student prepared?

.....

[1]

(b) In the second experiment, the student repeated the procedure in (a) but with hot concentrated sodium hydroxide. A different reaction took place in which sodium chlorate (V) was formed instead of NaClO.

Suggest the formula of sodium chlorate (V).

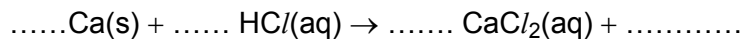
.....

[1]

[Total 6 marks]

8. A student prepared an aqueous solution of calcium chloride by reacting calcium with hydrochloric acid. Calcium chloride contains Ca<sup>2+</sup> and Cl<sup>-</sup> ions.

(a) Complete and balance the following equation for this reaction.



[2]

(b) This is a redox reaction.  
Use oxidation states to show that calcium has been oxidised.

.....

.....

.....

[2]

[Total 4 marks]

9. The Group 2 element radium, Ra, is used in medicine for the treatment of cancer. Radium was discovered in 1898 by Pierre and Marie Curie by extracting radium chloride from its main ore pitchblende.

(a) Predict the formula of radium chloride.

.....

[1]

(b) Pierre and Marie Curie extracted radium from radium chloride by reduction. Explain what is meant by *reduction*, using this reaction as an example.

.....

.....

[2]

[Total 3 marks]