

F321: Atoms, Bonds and Groups

Acids

49 Marks

1. A student carries out experiments using acids, bases and salts.

Calcium nitrate, $\text{Ca}(\text{NO}_3)_2$, is an example of a salt.

The student prepares a solution of calcium nitrate by reacting dilute nitric acid, HNO_3 , with the base calcium hydroxide, $\text{Ca}(\text{OH})_2$.

- (i) Why is calcium nitrate an example of a salt?

.....
.....

[1]

- (ii) Write the equation for the reaction between dilute nitric acid and calcium hydroxide. Include state symbols.

.....

[2]

- (iii) Explain how the hydroxide ion in aqueous calcium hydroxide acts as a base when it neutralises dilute nitric acid.

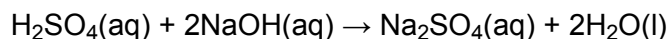
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[1]

[Total 4 marks]

2. (a) A student carries out a titration to find the concentration of some sulfuric acid.

The student finds that 25.00 cm³ of 0.0880 mol dm⁻³ aqueous sodium hydroxide, NaOH, is neutralised by 17.60 cm³ of dilute sulfuric acid, H₂SO₄.



- (i) Calculate the amount, in moles, of NaOH used.

answer = mol

[1]

- (ii) Determine the amount, in moles, of H₂SO₄ used.

answer = mol

[1]

- (iii) Calculate the concentration, in mol dm⁻³, of the sulfuric acid.

answer = mol dm⁻³

[1]

- (b) After carrying out the titration in (a), the student left the resulting solution to crystallise. White crystals were formed, with a formula of Na₂SO₄•x H₂O and a molar mass of 322.1 g mol⁻¹.

- (i) What term is given to the '•x H₂O' part of the formula?

.....

[1]

- (ii) Using the molar mass of the crystals, calculate the value of x.

answer =

[2]

[Total 6 marks]

3. Ammonium compounds such as ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, can be used as fertilisers.

(i) Write a balanced equation to show how ammonium sulfate could be formed by the reaction between aqueous ammonia and sulfuric acid.

.....

[1]

(ii) Ammonium sulfate is an example of a salt formed when an acid is neutralised by a base.

Explain what is meant by the term *salt*.

.....

.....

[1]

(iii) Why is ammonia acting as a base in this neutralisation?

.....

.....

[1]

(iv) What is the relative formula mass of $(\text{NH}_4)_2\text{SO}_4$?

Give your answer to **one** decimal place.

.....

[1]

[Total 4 marks]

4. Epsom salts can be used as bath salts to help relieve aches and pains.

Epsom salts are crystals of hydrated magnesium sulfate, $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$.

A sample of Epsom salts was heated to remove the water. 1.57 g of water was removed leaving behind 1.51 g of anhydrous MgSO_4 .

(i) Calculate the amount, in mol, of anhydrous MgSO_4 formed.

amount = mol

[2]

(ii) Calculate the amount, in mol, of H₂O removed.

amount = mol

[1]

(iii) Calculate the value of *x* in MgSO₄•*x*H₂O.

x =

[1]

[Total 4 marks]

5. Calcium oxide reacts with water and with nitric acid.

State the formula of the calcium compound formed when:

(i) calcium oxide reacts with water,

[1]

(ii) calcium oxide reacts with nitric acid.

[1]

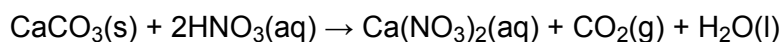
[Total 2 marks]

6. Calcium and its compounds, have properties typical of Group 2 in the Periodic Table.

Calcium carbonate, CaCO₃, reacts with acids such as nitric acid.

A student neutralised 2.68 g of CaCO₃ with 2.50 mol dm⁻³ nitric acid, HNO₃.

The equation for this reaction is shown below.



(i) Determine the amount, in mol, of CaCO₃ reacted.

amount = mol

[2]

- (ii) Calculate the volume, in cm^3 , of CO_2 produced at room temperature and pressure.

volume = cm^3

[1]

- (iii) Calculate the volume of 2.50 mol dm^{-3} HNO_3 needed to neutralise 2.68 g of CaCO_3 .

volume = cm^3

[2]

[Total 5 marks]

7. Old samples of magnesium oxide become contaminated with magnesium carbonate.

- (i) Suggest how this contamination takes place.

.....
.....

[1]

- (ii) A student added an excess of hydrochloric acid to an old sample of magnesium oxide that is contaminated with magnesium carbonate.

State **two** observations that the student would make.

.....
.....

[2]

- (iii) Explain, with the aid of equations, why the resulting solution contained only one dissolved compound of magnesium.

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

[3]

[Total 6 marks]

8. Both calcium carbonate, CaCO_3 , and calcium oxide, CaO , are white solids.

Dilute hydrochloric acid, HCl , can be used to identify whether a sample of white solid is CaCO_3 or CaO .

- (i) Write equations, including state symbols, for the reaction of HCl with CaCO_3 and the reaction of HCl with CaO .

.....
.....

[3]

- (ii) How would observation of the reactions with hydrochloric acid allow the identification of the white solid?

CaCO_3

.....

CaO

.....

[1]

[Total 4 marks]

9. A small amount of solid magnesium oxide, MgO , was reacted with excess dilute hydrochloric acid.

- (i) Define an acid.

.....

[1]

- (ii) Write a balanced equation for this reaction.

.....

[1]

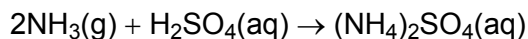
[Total 2 marks]

10. Chewing chalk has been used for many years to combat excess stomach acid and indigestion tablets often contain calcium carbonate, CaCO_3 . Suggest, with the aid of an equation, how these tablets work.

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

[Total 2 marks]

11. Ammonia reacts with sulphuric acid, as shown in the equation below.



- (i) Complete the statement below to describe how ammonia is behaving in this reaction.

Ammonia is behaving as a because

.....

[2]

- (ii) State **one** important use for the compound $(\text{NH}_4)_2\text{SO}_4$.

.....

[1]

- (iii) Apart from the manufacture of $(\text{NH}_4)_2\text{SO}_4$, state **one other** large-scale use of ammonia.

.....

[1]

[Total 4 marks]

12. Hydrogen iodide dissolves in water to give a solution of hydro-iodic acid, $\text{HI}(\text{aq})$. Its reactions are similar to those of hydrochloric acid, $\text{HCl}(\text{aq})$.

- (i) A length of magnesium ribbon is added to hydrochloric acid.

Describe what you would see in this reaction.

.....

.....

[1]

(ii) Write a balanced equation for this reaction.

.....

[2]

[Total 3 marks]

13. Hydrochloric acid is a strong acid.

What is meant by the term *acid*?

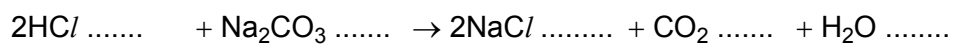
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[Total 1 mark]

14. Hydrochloric acid reacts with a solution of sodium carbonate.

(i) Write appropriate state symbols in the equation for this reaction shown below.



[1]

(ii) State what you would see to indicate that the reaction was taking place.

.....

[1]

[Total 2 marks]