Y11 Chemistry

ACIDS AND BASES

The two theories that we will discuss are the ________________ Theory and the ________________________ Theory.

The Proton in Water: ____________________ Theory

Swedish chemist Arrhenius defined

- an acid as a substance that ionizes in water to give __________ ions, and
- a base as a substance that ionizes in water to give _____________ ions.

Hydrochloric acid, HCl , is a ____________ acid, and is very soluble in water. It ionizes into its component ions in the following manner:

$HCl(g) \rightarrow H^+(aq) + Cl^-(aq)$

The hydrogen ion interacts strongly with a lone pair of electrons on the oxygen of a water molecule. The resulting ion, H_3O^+ is called the _____________ ion.

The ___________ ion ______ , is a proton.

ACIDIC solutions are formed when an acid transfers a __________ to water.

The reaction of HCl with water can be written in either of the following ways:

$HCl(aq) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$

$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

The Brønsted-Lowry Concept of Acids and Bases

- _____________ are proton donors, and
- _____________ are proton acceptors.

In the example above, the HCl acts as a Brønsted Acid by _____________ a proton to water. Water in turn acts as a Brønsted Base by _____________ a proton from the HCl.

Water can act as an acid or a base. When it reacts with the HCl it acts as a base. In the example below it is acting as an __________, a proton ________.

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

Here, H_2O acts as a Brønsted acid by ___________ a proton to NH_3 which acts as a Brønsted base.

Using the Arrhenius definition, we say that the resulting solution is ______ because it contains OH^- ions, thus we say that the NH_3 molecule is basic (a _______________ acceptor).

All Arrhenius acids are also Brønsted acids.

All Arrhenius bases are also Brønsted bases.

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PROPERTIES OF ACIDS and BASES

Properties of aqueous solutions of **ACIDS**

1. turn litmus ________________
2. ________________ an electric current
3. ______________ taste
4. react with _____________________ forming ________________ gas
5. react with __________________________ to form carbon dioxide gas
6. react with ____________ and __________ to produce a salt and water

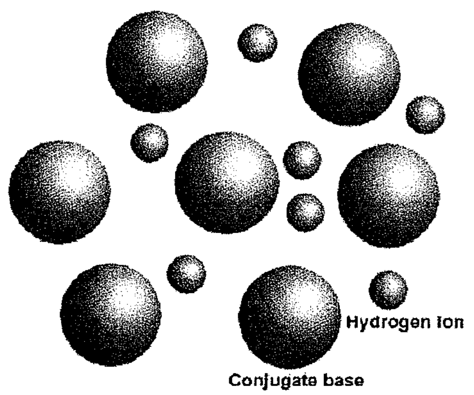
Properties of aqueous solutions of **BASES**

1. turn litmus ___________
2. ______________ an electric current
3. _____________ taste
4. react with the ____________ metals, aluminium, chromium and zinc forming hydrogen gas
5. react with ___________ to produce a __________ and __________

ACID & BASE STRENGTH

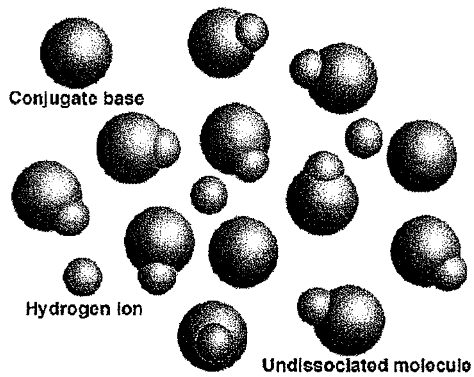
Acids and Bases as Equilibrium Reactions

Acids and bases are an important sub-section of ____________ reactions. The ____________ of strong acids and bases through reaction with water is assumed to go to completion (figure 1).



Strong acids are assumed to dissociate completely when in aqueous solution.

Figure 1



Weak acids dissociate only slightly in aqueous solution. The majority of molecules remain undissociated.

Figure 2

However, the majority of acids are ________ and only a fraction of the weak acid present in aqueous solution actually reacts with water. Most of the acid remains in its _______________ state.

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<u>Salts</u>

A salt is an ionic compound containing a cation other than ______________ and an anion other than _____________ / _________.
Eg.

In dilute aqueous solutions, salts are completely dissociated into ions.
Eg. $MgCl_{2\,(aq)} \rightarrow$ _______ + ________
Aqueous solutions of some salts like NaCl are neutral (pH = ___). Some aqueous solutions of salts are __________ (such as $AlCl_3$, pH < 7). Other solutions of salts are basic. An example is ______; the pH > 7.

<u>How can you predict whether an aqueous solution of a salt is acidic, basic or neutral?</u>
You need to know if the ions of the salt will react with ________. In other words, do any of the ions undergo _________________.
in Foundations shows which anions and cations will cause acidic and basic solutions.

PRAC Hydrolysis of Salts 2A.doc

Complete the pH of Salt Solutions PRACTICAL
Generalizations you can make from the results table:
1. Anions from strong acids do not ________________ and therefore produce neutral salts.

2. Cations from strong bases do not hydrolyse and therefore produce ____________ salts.

3. Basic anions are those that will react with ___________ to produce hydroxide ions.
Basic anions are derived from weak acids. Salts of these anions are called _______________.

4. Acidic anions are those that react with water to produce ___________ ions.
Acidic cations can be derived from weak bases and aquated metal cations.

Conjugate Acid-Base Pairs

Let's look at the reaction of NH_3 and H_2O again:

(1) $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

The reverse of this reaction is:

(2)

In this case, NH_4^+ acts as an acid which ____________ a proton to OH^- . OH^- acts as a __________.

An acid and a base that are related by the gain and loss of a proton are called a _____________ acid-base pair. For example, NH_4^+ is the _____________ _____________ of NH_3 , and NH_3 is the ___________ ___________ of NH_4^+.
Every acid has associated with it a ______________ base.
Likewise, every base has associated with it a ________________ acid.

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

$NH_3(aq)$	$H_2O(l)$	$NH_4^+(aq)$	$OH^-(aq)$		$NH_4^+(aq)$	$OH^-(aq)$	$NH_3(aq)$	$H_2O(l)$
base	acid	conj acid	conj base		acid	base	conj base	conj acid

For any reaction:
$HX + H_2O \rightarrow H_3O^+ + X^-$

If HX is a strong acid it will give up its proton _____________, this makes X^- a __________ base because it has less affinity for the proton. The forward reaction is favored, mainly __________ in solution.

If HX is a ___________ acid it will donate very few protons to the water, then X^- will have a high affinity for a __________, and X^- is a ___________ base than water. The reverse reaction is favored, mainly _____________ of HX in solution.

In summary,

- the stronger an acid the _________________ its conjugate base.
- the stronger a base the _________________ its conjugate acid.

Amphoteric metals, aluminium, chromium and zinc
Amphoteric metals react with both ___________ and __________ solutions. They react with metal ____________ solutions, such as sodium hydroxide, to form ____________ gas and with _________ solutions to form ______________ gas.

$2Al(s) + 2OH^-(aq) + 6H_2O(l)$ --->

$Al(OH)_3(s) + OH^-(aq)$ --->

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Answers:

Page 1

Arrhenius
Bronsted-Lowry
Arrhenius
Hydronium
Hydroxide
Strong
Hydronium/Hydrogen
Hydrogen
H^+
Proton
Acids
Bases
Donating
Receiving/accepting
Acid
Donor
Donating
Basic
Proton

Page 2

Red
Conducts
Sour
Metals
Hydrogen
Carbonates
Oxides
Hydroxides
Blue
Conducts
Bitter
Amphoteric
Acids
Salt
Water
chemical
ionisation
weak
molecular/original
pH
equilibrium
pH
concentration
pH
solvent (aka. H_2O)
pH
weaker

Page 3

H^+
OH^- or O^{2-}
Mg^{2+}
Cl^-
7
Acidic
$Ba(OH)_2$
Water
Ionization
Hydrolyse/React
Neutral
Water
Bases
Hydronium/H^+

Page 4

$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$
donates
base
conjugate
conjugate acid
conjugate base
conjugate
conjugate
easily/readily
weak
protons/hydronium ions
weak
proton
stronger
consists/molecules
weaker
strong
strong
weak

Y11 Chemistry

Conjugate Acid-Base Pairs

For the following equations identify (circle with a key) the acid - base conjugate pairs.

1. $CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$
2. $HSO_4^-{}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightleftharpoons SO_4^{2-}{}_{(aq)} + HCO_3^-{}_{(aq)}$
3. $H_3PO_{4(aq)} + 3NaOH_{(aq)} \rightarrow Na_3PO_{4(aq)} + 3H_2O_{(l)}$
4. $NH_{3(aq)} + HCl_{(aq)} \rightarrow NH_4Cl_{(aq)}$
5. $Na_2CO_{3(aq)} + H_2O_{(l)} \rightleftharpoons 2Na^+_{(aq)} + HCO_3^-{}_{(aq)} + OH^-_{(aq)}$
6. $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$
7. $OH^-_{(aq)} + HNO_{3(aq)} \rightarrow NO_3^-{}_{(aq)} + H_2O_{(l)}$
8. $OH^-_{(aq)} + HCO_3^-{}_{(aq)} \rightleftharpoons CO_3^{2-}{}_{(aq)} + H_2O_{(l)}$
9. $H^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons H_2O_{(l)}$
10. $H_2C_2O_{4(aq)} + NH_{3(aq)} \rightleftharpoons NH_4^+{}_{(aq)} + HC_2O_4^-{}_{(aq)}$

For the following complete the equation and then identify the conjugate acid base pairs.

11. $H_2S_{(aq)} + OH^-_{(aq)} \rightarrow$
12. $H_2PO_4^-{}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightleftharpoons$
13. $HClO_{(aq)} + NH_{3(aq)} \rightleftharpoons$
14. $HF_{(aq)} + O^{2-}{}_{(aq)} \rightleftharpoons$
15. $HNO_{3(aq)} + HCO_3^-{}_{(aq)} \rightarrow$
16. $HCl_{(aq)} + NaOH_{(aq)} \rightarrow$
17. $H_3O^+_{(aq)} + HSO_4^-{}_{(aq)} \rightleftharpoons$
18. $HCO_3^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons$
19. $HF_{(aq)} + NH_{3(aq)} \rightarrow$
20. $NH_4^+{}_{(aq)} + H_2O_{(l)} \rightarrow$

Y11 Chemistry

Conjugate Acid-Base Pairs- Answers

ACID → BASE **BASE → ACID**

$\underline{CH_3COOH_{(aq)}} + H_2O_{(l)} \rightleftharpoons \underline{CH_3COO^-_{(aq)}} + H_3O^+_{(aq)}$

$\underline{HSO_4^-{}_{(aq)}} + CO_3^{2-}{}_{(aq)} \rightleftharpoons \underline{SO_4^{2-}{}_{(aq)}} + HCO_3^-{}_{(aq)}$

$\underline{H_3PO_{4(aq)}} + 3OH^-_{(aq)} \rightarrow \underline{H_2PO_4^-{}_{(aq)}} + H_2O_{(l)}$

$NH_{3(aq)} + \underline{HCl_{(aq)}} \rightarrow NH_4^+ + \underline{Cl^-_{(aq)}}$

$CO_3^{2-}{}_{(aq)} + \underline{H_2O_{(l)}} \rightleftharpoons HCO_3^-{}_{(aq)} + \underline{OH^-_{(aq)}}$

$NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

$OH^-_{(aq)} + HNO_{3(aq)} \rightarrow NO_3^-{}_{(aq)} + H_2O_{(l)}$

$OH^-_{(aq)} + \underline{HCO_3^-{}_{(aq)}} \rightleftharpoons \underline{CO_3^{2-}{}_{(aq)}} + H_2O_{(l)}$

$\underline{H_3O^+_{(aq)}} + OH^-_{(aq)} \rightleftharpoons \underline{2H_2O_{(l)}}$

$\underline{H_2C_2O_{4(aq)}} + NH_{3(aq)} \rightleftharpoons NH_4^+{}_{(aq)} + \underline{HC_2O_4^-{}_{(aq)}}$

The pairs are highlighted as similar species below:

$\underline{H_2S_{(aq)}} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + \underline{HS^-_{(aq)}}$

$\underline{H_2PO_4^-{}_{(aq)}} + CO_3^{2-}{}_{(aq)} \rightleftharpoons \underline{HPO_4^{2-}} + HCO_3^-$

$\underline{HClO_{(aq)}} + NH_{3(aq)} \rightleftharpoons \underline{ClO^-_{(aq)}} + NH_4^+{}_{(aq)}$

$\underline{HF_{(aq)}} + O^{2-}{}_{(aq)} \rightleftharpoons \underline{F^-_{(aq)}} + OH^-_{(aq)}$

$\underline{HNO_{3(aq)}} + HCO_3^-{}_{(aq)} \rightarrow \underline{NO_3^-} + H_2CO_{3(aq)}$

$\underline{HCl_{(aq)}} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

$\underline{H_3O^+_{(aq)}} + HSO_4^-{}_{(aq)} \rightleftharpoons \underline{H_2O_{(l)}} + H_2SO_{4(aq)}$

$\underline{HCO^{3-}{}_{(aq)}} + H_2O_{(l)} \rightleftharpoons \underline{H_2CO_{3(aq)}} + OH^-_{(aq)}$

$\underline{HF_{(aq)}} + NH_{3(aq)} \rightarrow \underline{F^-_{(aq)}} + NH_4^+{}_{(aq)}$

$\underline{NH_4^+{}_{(aq)}} + H_2O_{(l)} \rightarrow \underline{NH_{3(aq)}} + H_3O^+_{(aq)}$

Amphoteric Substances

Base + Acid
With acid dissolve → salt + water (as for any metal hydroxide)

$Al(OH)_3(s) + H^+(aq) \rightarrow$

$Cr(OH)_3(s) + H^+(aq) \rightarrow$

$Zn(OH)_2(s) + H^+(aq) \rightarrow$

Amphoteric metals + Acids
With acids dissolve → salt + hydrogen gas (as for any reactive metal)

$Al(s) + H^+(aq) \rightarrow$

$Cr(s) + H^+(aq) \rightarrow$

$Zn(s) + H^+(aq) \rightarrow$

Metal Oxide + Acids
With acids dissolve → salt + water (as for any metal oxide)

$Al_2O_3(s) + H^+(aq) \rightarrow$

$Cr_2O_3(s) + H^+(aq) \rightarrow$

$ZnO(s) + H^+(aq) \rightarrow$

ANSWERS

$Al(OH)_3(s) + 3H^+(aq) \rightarrow Al^{3+}(aq) + 3H_2O(l)$
$Cr(OH)_3(s) + 3H^+(aq) \rightarrow Cr^{3+}(aq) + 3H_2O(l)$
$Zn(OH)_2(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + 2H_2O(l)$
$2Al(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2(g)$
$2Cr(s) + 6H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3H_2(g)$
$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$
$Al_2O_3(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2O(l)$
$Cr_2O_3(s) + 6H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3H_2O(l)$
$ZnO(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2O(l)$

Y11 Chemistry

REVISION:

MC SECTION

1. Which one of the following is **not** an acid-base reaction?

A $NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$

B $NH_4Cl_{(s)} + Ca(OH)_{2(s)} + heat \rightarrow NH_{3(g)} + CaCl_{2(aq)} + H_2O_{(l)}$

C $(NH_4)_2CO_{3(s)} + heat \rightarrow 2NH_{3(g)} + 2H_2O_{(g)} + CO_{2(g)}$

D $Ba(OH)_{2(s)} + 2NH_4SCN_{(s)} \rightarrow Ba^{2+}_{(aq)} + 2SCN^-_{(aq)} + 2H_2O_{(l)} + 2NH_{3(aq)}$

2. Which one of the following is a **conjugate acid-base pair**?

A HNO_3 and H_2O

B H_3O^+ and OH^-

C NH_3 and OH^-

D HNO_3 and NO_3^-

3. Which of the following correctly describes the ***difference between a strong acid and a weak acid***?

(a) All solutions of weak acids are poor conductors of electricity but solutions of strong acids are always good conductors of electricity.

(b) Concentrated solutions can only be prepared from strong acids.

(c) The degree of ionisation for strong acids is greater than for weak acids.

(d) Weak acids are less soluble than strong acids.

4. Which of the conjugate acid-base pairs is ***not*** correctly listed?

Acid	**Conjugate base**
(a) NH_3	NH_2^+
(b) SO_4^{2-}	HSO_4^-
(c) HCO_3^-	CO_3^{2-}
(d) HPO_4^{2-}	PO_4^{3-}

5. Water taken from a swimming pool had a pH of 9.5. Which of the following substances could be added to the pool water to bring the pH closer to 7?

(a) $Na_2CO_{3(s)}$

(b) $NaCl_{(s)}$

(c) $Na_3PO_{4(aq)}$

(d) $HCl_{(aq)}$

6. In which of the following equations is the ***underlined*** substance acting as an ***acid?***

(a) $\underline{C_6H_5COO^-}$ + $H_2SO_3 \rightarrow HSO_3^- + C_6H_5COOH$
(b) 2$\underline{Na}$ + $2H_2O \rightarrow 2Na^+ + 2OH^- + H_2$
(c) $\underline{HCO_3^-}$ + $H_2O \rightarrow H_2CO_3 + OH^-$
(d) $\underline{NH_4^+}$ + $OH^- \rightarrow NH_3 + H_2O$

7. The hydrogen carbonate ion, $HCO_3^-{}_{(aq)}$, may act as an acid or a base in aqueous solution. In which one of the equations below is it acting as an acid?
A $HCO_3^-{}_{(aq)} + H_2O_{(l)} \rightarrow H_2CO_{3(aq)} + OH^-{}_{(aq)}$
B $HCO_3^-{}_{(aq)} + H_3O^+{}_{(aq)} \rightarrow H_2CO_{3(aq)} + H_2O_{(l)}$
C $HCO_3^-{}_{(aq)} + H_2O_{(l)} \rightarrow CO_3^{2-}{}_{(aq)} + H_3O^+{}_{(aq)}$
D $HCO_3^-{}_{(aq)} + OH^-{}_{(aq)} \rightarrow H_2CO_{3(aq)} + O^{2-}{}_{(aq)}$

8. Acid ionisation or dissociation constants (K_a) provide information as to the extent to which an acid ionises / dissociates in aqueous solution. The larger the value the stronger the acid, the lower the weaker:

The table below shows acid dissociation constants, (K_a), for four acids, measured at 25°C.

ACID	FORMULA	DISSOCIATION CONSTANT (K_a)
Hydrofluoric acid	HF	7.2×10^{-4}
Hydrogensulfate ion	HSO_4^-	1.2×10^{-2}
Ethanoic acid	CH_3COOH	1.8×10^{-5}
Hypochlorous acid	HClO	3.5×10^{-8}

Which is the WEAKEST acid shown in the table above?
A, HF
B, HSO_4^-
C, CH_3COOH
D, HClO

ANSWERS

1	2	3	4	5	6	7	8
C	D	C	A	D	D	C	D

Y11 Chemistry

SHORT ANSWER

NET IONIC EQUATIONS AGAIN!

Write equations for any reactions that occur in the following situations. If no reaction occurs write "***no reaction***". In each case describe ***in full*** what you would observe, including any colours, odours, precipitates (give the colour), gases evolved (give the colour or describe as colourless).

Your equations should refer only to the actual species involved.
These species may be **ions** [for example; $Ag^{+}_{(aq)}$], **molecules** [for example; $NH_{3(g)}$, $NH_{3(aq)}$, $CH_3COOH_{(aq)}$] or **solids** [or precipitates for example; $BaSO_{4(s)}$, $Cu_{(s)}$, $Na_2CO_{3(s)}$].

1.

(a) Concentrated hydrochloric acid is poured onto solid Magnesium Carbonate.

EQUATION:

____

OBSERVATION:

____

(b) Nitric Acid poured onto a black solid copper oxide.

EQUATION:

____

OBSERVATION:

____

(c) A piece of Calcium metal is dropped into a Sulfuric Acid solution

EQUATION:

____

OBSERVATION:

____

(d) Solid zinc is added to 2.0 mol L^{-1} hydrochloric acid solution.

EQUATION:

____

OBSERVATION:

____

2.

a. Ammonia solution and acetic acid (ethanoic acid) are weak electrolytes and are not good conductors of electricity. But when you add them to each other the resulting solution has a high electrical conductivity. **Explain** this result.

____

____

____

[3 points!]

b. Give an explanation for each of the following observation. Solid lithium bromide, LiBr(s) is a ***non conductor of electricity*** and so too is liquid water $H_2O(l)$ yet the combination of LiBr(s) and $H_2O(l)$ produces a ***very good conducting mixture***.

____

____

____

[3 points!]

Y11 Chemistry

CALCULATIONS

TEE Chemistry-Acid & Base Calculations

1. Determine how many mL of 3.00 mol L^{-1} sodium hydroxide are required to neutralise 30.0 mL of 2.00 mol L^{-1} hydrochloric acid solution.

2. 2.00 g of sodium hydroxide was dissolved in water and the solution made up to 2.50×10^2mL. Determine:

i. the concentration of the solution
ii. the concentration of the solution in g L^{-1}
iii. the volume of 0.100 mol L^{-1} sulfuric acid required to neutralise 25.0 mL of the solution and
iv. the mass of pure sulfuric acid required for complete neutralisation.

3. A solution of crystalline oxalic acid ($H_2C_2O_4 . 2H_2O$), a diprotic acid, is prepared by dissolving 12.6 g of the acid in 4.00 L of water. 20.0 mL of this solution is required to completely neutralise 36.0 mL of a potassium hydroxide solution. Calculate the concentration in molL^{-1} and strength in g L^{-1} of the potassium hydroxide solution.

4. 0.700 g of an ammonium salt was dissolved in distilled water and then 25.0 mL of a 1.10 mol L^{-1} sodium hydroxide solution was added. The solution was boiled. All ammonia gas was expelled. After cooling it was found that 30.0 mL of 0.450 mol L^{-1} hydrochloric acid was required to neutralise the excess base. Determine the percentage of ammonia in the salt.

5. Determine the percentage purity of a sample of zinc if 0.325 g required 38.0 mL of 0.250 mol L^{-1} hydrochloric acid for a complete reaction.

6. 0.100 g of calcium carbonate was dissolved in 25.0 mL of hydrochloric acid solution, and it was found that 5.50 mL of sodium hydroxide solution were required to neutralise the excess acid. A second titration showed that 27.5 mL of sodium hydroxide

neutralised 25.0 mL of the hydrochloric acid solution. Determine the concentration of the sodium hydroxide and hydrochloric acid solutions.

7. (EXTENSION) In a method of volumetric determination of sulfate ion, the SO_4^{2-} ion is precipitated as $PbSO_4$ by the addition of Pb^{2+}. The $PbSO_4$ is then analysed for Pb and the number of moles of SO_4^{2-} ion is equal to the number of moles of Pb^{2+} in the precipitate.
The amount of lead is determined by titration using a compound symbolised as H_4Y. [This compound is actually called 1,2-diaminoethane-N,N,N',N'-tetraethanoic acid.]
A known amount of H_4Y is added to the precipitate, bringing it to solution.

$$PbSO_4(s) + H_4Y \rightarrow PbY^{2-}{}_{(aq)} + SO_4^{2-}{}_{(aq)} + 4\,H^+{}_{(aq)}$$

Then the amount of excess H_4Y is determined by titration with standard lead nitrate.

$$Pb^{2+} + H_4Y \rightarrow PbY^{2-}{}_{(aq)} + 4\,H^+$$

From this, the amount of Pb^{2+} in the $PbSO_4$, and hence the amount of SO_4^{2-} ion in the sample, can be calculated.
The following results were obtained for a sample of ground water analysed as above.

Volume of ground water sample: :	**10.00 L**
Volume of 0.1000 mol L^{-1} H_4Y added to the precipitate :	**25.00 mL**
Volume of 0.1000 mol L^{-1} $Pb(NO_3)_2$ required to titrate excess H_4Y:	**8.26 mL**

a. Calculate the total number of moles of H_4Y added, to the precipitate. [1 mark]

b. Calculate the number of moles of H_4Y in excess. [2 marks]

c. Calculate the number of moles of H_4Y that combined with the PbSO4.

[2 marks]

d. Calculate the concentration of the SO_4^{2-} ion in the ground water.

[3 marks]

Suggest a source of sulfate in the ground water resulting from agricultural activity.

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Answers:

1. 20.0 mL
2. 0.200 mol L^{-1}, 8.00 gL^{-1}, 25.0 mL, 0.245g
3. 0.028 mol L^{-1}, 1.56 gL^{-1}
4. 34.0%
5. 95.6%
6. 0.100 mol L^{-1},0.0900mol L^{-1}
7. ask me ☺

   (a) (b) (c) (d)