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Chemistry

Unit AS1: Practical Manual

Questions Solutions

Practical 1.1

Determine the formula of a hydrated compound by weighing and heating a hydrated salt to constant mass (spec ref: 1.1.7)

1. Incorrect mass measurement/loss of salt during transfer/some water of crystallisation remains/decomposition of the salt.

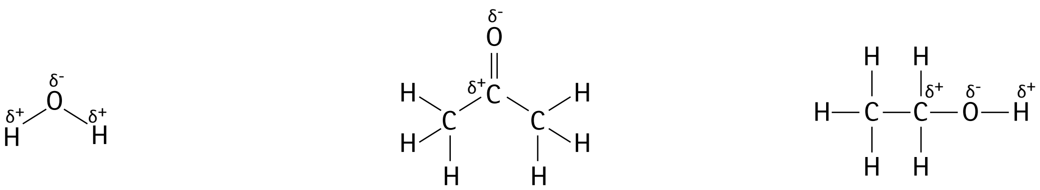
Practical 2.1

Use the deflection of a stream of liquid from a burette to indicate polarity or lack of polarity within a molecule (spec ref: 1.3.9)

1. Water, propanone and ethanol.

2. Water was observed to deflect the most.

3.



4. Carbon tetrachloride has a tetrahedral shape, which is symmetrical so the dipoles cancel.

Practical 3.1

Carry out tests of electrical conductivity on solids and liquids and aqueous solutions of ionic and covalent substances (spec ref: 1.5.2)

1. Sodium chloride: When solid, the ions are held in fixed positions and cannot move and carry charge. When molten, or in aqueous solution, the ions can move and carry charge.
   Sucrose: There are no free electrons or ions which can move and carry charge. The atoms in sucrose are held together by strong covalent bonds.

Practical 4.1

Determine the solubility of chlorine and iodine in aqueous and non-aqueous solvents (spec ref: 1.8.2)

1. Add a few drops of water to each test tube. In each case, the bottom layer will increase in volume.

Practical 4.2

Produce a reactivity order of the halogens using the displacement reactions of halogens with other halide ions in solution (spec ref: 1.8.5)

1.
   $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$
   $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$
   $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$

2. For example, in the reaction:
   $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$
   Cl changes oxidation state from 0 to -1 (reduction)
   Br changes oxidation state from -1 to 0 (oxidation)
   Since both reduction and oxidation are occurring in the same reaction, it can be classified as a redox reaction.

Practical 4.3

Carry out the reactions of the halides with concentrated sulfuric and phosphoric acids and perform chemical tests for the products (spec ref: 1.8.6)

1. With potassium chloride, only misty/steamy fumes (of HCl) are observed as the chloride ion is not a strong enough reducing agent to reduce concentrated sulfuric acid.

   With potassium bromide, misty/steamy fumes (of HBr) are observed. In addition, red-brown vapour (bromine) is observed as the bromide ion can reduce the concentrated sulfuric acid (to sulfur dioxide).

   With potassium iodide, misty/steamy fumes (of HI) are observed. The iodide ion is a stronger reducing agent than the bromide ion so, in addition to the appearance of violet/purple vapour and a grey-black solid appearing on the sides of the test tube (iodine), the smell of rotten eggs (H_2S) and a yellow solid (S) is observed.

2.
$KCl + H_2SO_4 \rightarrow KHSO_4 + HCl$
$KBr + H_2SO_4 \rightarrow KHSO_4 + HBr$
$KI + H_2SO_4 \rightarrow KHSO_4 + HI$
In each case, no species is changing oxidation state so the reactions are not classed as redox reactions.

3.
$SO_4^{2-} + 4H^+ + 2Br^- \rightarrow SO_2 + Br_2 + 2H_2O$
$SO_4^{2-} + 4H^+ + 2I^- \rightarrow SO_2 + I_2 + 2H_2O$
$SO_4^{2-} + 8H^+ + 6Br^- \rightarrow S + 3I_2 + 4H_2O$
$SO_4^{2-} + 10H^+ + 8I^- \rightarrow H_2S + 4I_2 + 4H_2O$
In the case of bromide, concentrated sulfuric acid is reduced to sulfur dioxide; the oxidation state of sulfur is reduced from +6 to +4.

In the case of iodide, concentrated sulfuric acid is reduced to sulfur dioxide, sulfur and hydrogen sulfide; the oxidation state of sulfur is reduced from +6 in concentrated sulfuric acid to +4 in sulfur dioxide, 0 in sulfur and -2 in hydrogen sulfide.

Iodide reduces concentrated sulfuric acid to sulfur-containing species with lower oxidation states than bromide can, therefore iodide is a stronger reducing agent than bromide.

4.
$NaCl + H_3PO_4 \rightarrow NaH_2PO_4 + HCl$
$NaBr + H_3PO_4 \rightarrow NaH_2PO_4 + HBr$
$NaI + H_3PO_4 \rightarrow NaH_2PO_4 + HI$
In each case, no species is changing oxidation state so the reactions are not classed as redox reactions.

5. Concentrated phosphoric acid cannot oxidise halide ions.

Practical 5.1

Prepare solutions of known concentration (spec ref: 1.9.8)

1. Percentage error = (2 × 0.1/12.5) × 100 = 1.6%

2. Inverting the flask ensures the solution is thoroughly mixed.

Practical 5.3

Prepare solutions of known concentration (spec ref: 1.9.8)

1. Apparatus (beaker, stirring rod, funnel) rinsed with deionised water and washings transferred into flask.

Practical 6.1

Carry out an acid-base titration to determine the concentration of acid/base, the degree of hydration in a hydrated metal carbonate and the percentage of ethanoic acid in vinegar (spec ref: 1.9.2)

1. Assuming a mean titre value of 25.0 cm^3, percentage error = (2 × 0.05/25.0) × 100 = 0.4%.

Practical 7.1

Use chemical tests listed in 'Qualitative tests' to identify unknown substances (spec ref: 1.10)

1.
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$
$Mg + 2HCl \rightarrow 2MgCl_2 + H_2$
$2H_2O_2 \rightarrow 2H_2O + O_2$

2.
$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$
$2H_2 + O_2 \rightarrow 2H_2O$
$Cl_2 + H_2O \rightarrow HCl + HClO$
$NH_3 + HCl \rightarrow NH_4Cl$

3. Nichrome wire has a high melting point and does not interfere with the observed colour of a salt in the flame.
Concentrated hydrochloric acid cleans the wire and allows the solid sample to stick to the wire.

4.
$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$
$AgNO_3(aq) + KBr(aq) \rightarrow AgBr(s) + KNO_3(aq)$
$AgNO_3(aq) + KI(aq) \rightarrow AgI(s) + KNO_3(aq)$

5.
$Ag^{+}(aq) + Cl^{-}(aq) \rightarrow AgCl(s)$
$Ag^{+}(aq) + Br^{-}(aq) \rightarrow AgBr(s)$
$Ag^{+}(aq) + I^{-}(aq) \rightarrow AgI(s)$

6.
$Ba^{2+}(aq) + SO_4^{2-} \rightarrow BaSO_4(s)$

7.
$NaHCO_3(aq) + HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(l) + CO_2(g)$

8.
$NH_4Cl(aq) + NaOH(aq) \rightarrow NH_3 + NaCl + H_2O$