Halide displacement reactions chemguide

Chemguide: SUPPORT CIE A-level ChemistryLearning outputs 9.4(d) and 9.4(e) These statements are about the reactions of hydrogen and halogens and the thermal stability of hydrogen halids. Before proceeding, you should find and read the statements in the copy of the curriculum. Expression 9.4(d) This is about reactions between halogens and hydrogen. Fluorine merges explosively with hydrogen to give hydrogen fluoride gas, even in cold and dark. Chlorine and hydrogen explode when exposed to sunlight or a flame to give hydrogen chloride gas. Alternatively, hydrogen can make them combine more peacefully if you light a jet and then lower it into a gas jar of chlorine. Hydrogen continues to burn and hydrogen chloride gas re-occurs. Put on a flame if bromine combines with a slight burst of vapor and hydrogen. Hydrogen bromide gas is formed. Iodine and hydrogen only partially combine even continuous heating. A balance is being established between hydrogen and iodine and hydrogen iodine gas. This shows the decrease in the reactivity of halogens as they descend to Group 7. Expression 9.4(e) This relates to the thermal stability of hydrogen halids. Hydrogen fluoride and hydrogen chloride are heat or very stable. If heated to a normal laboratory temperature, they will not be divided back into hydrogen, fluorine or chlorine. Hydrogen bromide heating is divided into hydrogen and bromine slightly, and hydrogen iodide divides to a greater extent. This lies in the strengths of hydrogen-halogen bonding. Using the bond energy values in the Data Booklet that you will have in the exam (and you will find towards the end of the curriculum): You will see that the bonds weaken as you descend into the Group. This is because halogen atoms are growing steadily, thereby longer in bond length, and the bond pair of electrons is moving further away from the halogen nucleus. The weaker the bond, the less heat energy you need to provide to break it. Go to section 9.4 Menu... To return to the list of learning outputs in Chapter 9.4, go to the CIE Main Menu... To return to the list of all CIE episodes, go to the Chemguide Main Menu . . . This will take you to the main section of Chemguide. © Jim Clark 2011 (modified August 2013) INORGANIC Part 9 Group 7/17 Halogens sub-index: 9.1 Introduction, trends & Group 7/17 data * 9.2 Halogen displacement reaction and reactivity trend * 9.3 Reactions of halogens with other elements * 9.4 Reactions between Halide salts and missing reaction. sulfuric acid * 9.5 Tests for halogens and halide ions * 9.6 Removal of halogens from natural sources * 9.7 Use of halogens and compounds * 9.8 Oxidation and Reduction – more about redox reactions of halogens * 9.9 Volume analysis – titrations containing halogens or halide ions * 9.10 Ozone, CFC and halogen organic chemistry connections * Chemical bonding in halogen compounds * 9.12 Various aspects of halogen chemistry Advanced Inorganic Chemistry Periodic Table Index * Part 1 Periodic Table history * Part 2 Electron configurations, spectroscopy, hydrogen spectrum, ionization energizes * Part 3 Term 1 poll H He * Part 4 Term 2 poll Li Ne * Part 5 Term 3 survey Na Ar * Part 6 Term 4 survey K K K And a group of important trends down * Part 7 s-block Groups 1/12 Alkali Metals/Alkali Soil Metals * Part 8 p-block Groups 3/13 to 0/18 * Part 9 Group 7/17 Halogens * Part 10 3d block elements & Transition Metal Series * Part 11 Group & Series data & Periodicity plots * All 11 Parts have their own sub-indexes near the top of pages 9.4 Heating halide salts effect with concentrated sulfuric acid salts if salts like sodium chloride , sodium bromide and sodium iodide conc. Heated with sulfuric acid, a simple pattern is not observed, each reaction gives different products regardless of the halogen element/compound that occurs. Similar results are achieved with potassium salts (swapping Na with just one K) and many other metal salts of halogens. Conc. Sulfuric acid is a viscous covalent liquid that can act as a mild oxidizing agent with mitigating agents. In any case, the metal ion is a spectator ion. When writing equations, it doesn't really matter to show the formation of sodium sulfate (Na2SO4) or sodium hydrogen sulfate (NaHSO4), I think the former is generally more appropriate. It has a 'theoretical summary' of what happens to scattered reactions and equations! (1) Sodium chloride displaces less volatile sulfuric acid than 'volatile' colorless hydrogen chloride gas and leaving a white residue of sodium hydrogen sulfate or sodium sulfate. NaCl(s) + H2SO4(l) ==> NaHSO4(s) + HCl(g) or 2NaCl(s) + H2SO4(l) ==> Na2SO4(s) + 2HCl(g) or Cl-(s) + H2SO4(l) ==> HSO4–(s) + HCl(g) contained changes in the non-oxidation state of the elements. Sodium fluoride will be released in a similar way i.e. hydrogen fluoride gas, HF. These are the 'displacement' reaction, note a redox reaction. However, hydrogen halids still form in bromides and iodine, while other more important redox reactions take places where halide ions oxidize to halogen and incomplete sulfuric acid decreases. These redox reactions are now described below. Note: Other chloride salts, such as potassium chloride, are used in the same way. Sodium fluoride or potassium fluoride salts behave the same way, and KF(s) + H2SO4(l) ==> KHSO4(s) + HF(g) Released hydrogen fluoride gas reacts with glass and erode it. (2) Sodium bromide With hot missing sulfuric acid, bromide ion in solid salts can act as a mitigating agent and sulfur acid sulfur dioxide (sulfur(IV) decreases oxidized bromide and bromide ion release. In addition to the orange-brown vapor of bromine, hydrogen bromide smoke and white sodium sulfate residue are formed. It's a redox reaction. 2NaBr(s) + 2H2SO4(l) ==> Na2SO4(s) + Br2(g) + SO2(g) + 2H2O(l) Half cell reactions are: (i) 2Br– ==> Br2 + 2e– (oxidation, 2 electron loss) (ii) H2SO4 + 2H+ + 2e- ==> SO2 + 2H2O (reduction, 2 electron gain) (i) balance in terms of electron/oxidation number change (ii) balance, i.e. ionic redox equation 2Br– + H2SO4 + 2HSO4 + ==> Br2 + SO2 + 2H2O Bromide ion, oxidation of bromide ion, half of the 'sulfate' actually remains unchanged, but sulfuric acid decreases the other molecule sulfur dioxide (sulfur dioxide, sulfur (IV) oxide. Redox analysis Bromine oxidation status varies from –1 in Br–to 0 in Br2 (oxidation, increase in oxidation). The oxidation status of sulfur varies from +6 in H2SO4 to +4 in SO2 (decrease in oxidation status, decrease). Reduce the number of sulfur oxidations suffers from 2 'units', hence for every 2 bromide ions, the number of oxidations per bromine atom increases by 1. NOTE: You can write the bromide oxidation reaction as if hydrogen bromide was first formed, then oxidized to broma and oxidized by concentrated sulfuric acid sulfur(IV) oxide (sulfur dioxide). NaBr(s) + H2SO4(l) ==> NaHSO4(s) + HBr(g) This explains why you also get hydrogen bromide fumes. Its a simple non-redox 'acid' displacement reaction. 2HBr(g) + H2SO4(l) ==> Br2(g) + SO2(g) + 2H2O(l) This is an effective alternative to general redox reaction. I don't know how much of the HBr survived oxidation. (3) Sodium iodide Hot conc. With sulfuric acid, iodide ion bromide in solid salts act as a stronger mitigating agent, and sulfuric acid is reduced to hydrogen sulfide gas and iodide ion is oxidized free of iodine. Iodine consists of purple vapor, the smell of hydrogen sulfide (rotten eggs!), hydrogen iodide fumes and a white sodium sulfate residue. Iodine will crystallize in the upper refrigerant parts of the test tube. It's a redox reaction. 8NaI(s) + 5H2SO4(l) ==> 4Na2SO4(s) + 4I2(g/s) + H2S(g) + 4H2O(l) Half cell reactions are: (i) 2I– ==> I2 + 2e– (oxidation, 2 electron loss) (ii) H2SO4 + 8H+ + 8e- ==> H2S + 4H2O (reduction, 8 electrons won) 4 x (i) balance (ii) in terms of electron/oxidation number change, i.e. ionic redox equation 8I- + H2SO4 + 8H+ ==> 4I2 + H2S + 4H2O Iodine ion is oxidized to iodine, 4/5 of 'Sulfate' remains unchanged, but the 5th molecule of sulfuric acid is reduced to hydrogen sulfate. Apart from the smell, hydrogen sulfide gives a black sedin with lead etanoate paper. Redox analysis Iodine oxidation status varies from I-1 to 0 in I2 (oxidation, in case of oxidation). The oxidation status of sulfur varies from +6 in H2SO4 to –2 in H2S (decrease in oxidation status, decrease). The number of sulfur oxidations suffers a decrease of 8 'units', hence for every 8 iodine ions, the number of oxidations per iodine atom increases by 1. NOTE: Hydrogen iodide first occurs and then iodine is oxidized and you can write an iodide oxidation reaction as if concentrated sulfuric acid has been reduced to hydrogen sulfide (hydrogen sulfide). NaI(s) + H2SO4(l) ==> NaHSO4(s) + HI(g) 8HI(g) + H2SO4(l) ==> 4I2(g/s) + H2S(g) + 4H2O(l) I don't know how much of HI survives oxidation? And I wonder if sulfur dioxide is also occurrent? As in the case of bromides. (4) As group 7 halogens descend, pay attention to the increasing mitigation, meaning that halide ion oxidizes more and more easily. This half-cell halogen/halide ion EfF2(aq)/F–(aq) = +2.87V > EfCl2(aq)/Cl–(aq) = +1.36V > EμBr2(aq)/Br –(aq) = +1.09V > EfI2(aq)/I–(aq) = +0.54V The more positive the half-cell potential, the stronger the oxidizing power (halogen) and the weaker the reduction power of the corresponding halide ion. Oxidizing power: F2 > Cl2 > Br2 > I2 Demoation power: I– > Br– > Cl– > F– 9.5 Halogen Test method test tests Test chemistry and chlorine gas Cl2 Sharp green gas. (i) Apply moist blue turnusol. (You can use red turnusol and see only the whitening effect.) (ii) A drop of silver nitrate at the end of a glass rod into the gas. (i) turnusol red and turn white. (ii) White sedie. (i) Non-metal is acid in aqueous solution and is a powerful oxidizing substance (ii) it creates a small amount of chloride ion in water, so it gives positive results for chloride testing. Brom Br2 (l or aq) Dark red liquid – orange-brown fumes, yellow-orange aqueous solution. Other common orange-brown gas nitrogen dioxide (i) shake with a liquid alkene. (ii) Mix with silver nitrate solution. (ii) Discolor. Look at the Alkene test. (ii) Silver bromide kremppt as in bromide test. (i) Colorless organic dibromo-compound >C=C< + Br2==> >CBr–CBr< (ii) Ag+(aq) + Br–(aq) ==> AgBr(s) Soluble bromide gives silver bromide sediment. Iodine (i) solid or (ii) solution Very dark solid (i) Gently heat the dark solid. (ii) Test the aqueous solution or solid with a starch solution. (i) Bright purple gives steam. (ii) Blue black color. (i) Iodine creates its own unique colored steam. (ii) Creates a blue-black complex with starch and is tested to detect starch with iodine solution in biology. Halide Ions Tests Test (i) silver nitrate is acidic with dilute nitric acid to prevent the precipitation of other non-halide silver salts. Halide ion Test test Observations Test chemistry and interpretations Fluoride Ion F– Fluoride and hydrogen fluoride gas are harmful, irritant and corroating substances. (i) Add dilute nitric acid and silver nitrate solution if the suspected fluoride dissolves. (ii) You can heat a solid fluoride with sulfur acid and hold smoke from a glass bar (ONLY!) with a drop of water at the end. (i) HAVE NO sedie! (ii) Look for engraving effects on the surface of the glass bar. (i) Silver fluoride, AgF, this test proves very little except that there is no chloride, bromide and iodide so it is moderately soluble! (ii) Hydrogen fluoride gas creates silica acid, silicon oxyfluoride, silicon fluoride produced by f– + H2SO4 ==> HSO4– + HF, which reacts with glass silica. The chemistry is messy and complex but the glass rod is clearly engraved. If the chloride ion contains sulfate ion in Cl-Solution, barium ions are tested with 1, filter off any barium sulfate sediation and then test for chloride ion. Silver sulfate is also ~ insoluble, so you could not distinguish between two sedie of silver sulfate and silver chloride (i) if chloride is soluble, add dilute nitric acid and silver nitrate solution. (ii) Insoluble salt, conc. Add sulfuric acid, test the gas for HCl after hot if necessary(iii) Add lead (II) nitrate solution. Not a very specific test - the test (i) is the best. (i) silver chloride white sediation soluble in dilute ammonia. (ii) Turn blue turnusol red and get bad fumes of hydrogen chloride to give a white sediation with silver nitrate solution. (iii) Lead(II) chloride consists of white ppt. (i) Ag+(aq) + Cl–(aq) ==> AgCl(s) Any soluble silver salt + soluble chloride gives white silver chloride sediment, this light darks. (ii) Cl–(s) + H2SO4(l) ==> HSO4–(s) + HCl(g) + Then Ag+(aq) + Cl–(aq) ==> AgCl(s) (iii) Pb2+(aq) + 2Cl–(aq) ==> PbCl2(s) Bromide ion- (i) Bromide brluble, add dilute nitric acid and silver nitrate solution. (ii) If insoluble salt, hot if necessary, minus. Add sulfuric acid. (iii) Add lead(II) nitrate solution. Not a very specific test - the test (i) is the best. (i) Silver bromide cream sediance is soluble only in concentrated ammonia. (ii) Orange vapor of bromine and sharp smoke of SO2 (iii) lead(II) a white ppt from bromide. Occurs. (i) Ag+(aq) + Br–(aq) ==> AgBr(s) Any soluble silver salt + any soluble bromide cream gives silver bromide precipitation. (ii) Bromide ion is oxidized into broma and sulfuric acid is reduced to sulfur dioxide. (Sulfur dioxide test – potassium dichromomate(VI) paper varies from orange to green) (iii) Pb2+(aq) + 2Br–(aq) ==> PbBr2(s) Iyodidi ion I– (i) Add dilute nitric acid and silver nitrate solution if iodine dissolves. (ii) Insoluble salt minus. if it can heat with sulfuric acid, (ii) purple iyot ve çok kokulu hidrojen sülfür. (iii) İyot çözünürse, kurşun(II) nitrat çözeltisi ekleyin. (i) Konsantre amonişte çözünmez gümüş iyodür sarı çökelti. (ii) mor buhar ve çürük yumurta kokusu!, (iii) sarı çökelti formları (iii) Kurşun sarı çökelti(II) iyodür. Çok kesin değil –Test (i) en iyi. (i) Ag+(aq) + I–(aq) ==> AgI(ler) , herhangi bir çözünür gümüş tuzu + herhangi bir çözünür iyodür ==> gümüş iyodür çökelti, (ii) iyodür iyonu iyota oksitlenir ve sülfürik asit 'çürük yumurta' kokulu hidrojen sülfüre indirgenir, (iii) çözünmez kurşun(II) iyodür oluşan Pb2+(aq) + 2I–(aq) ==> PbI2(ler) Amonyağ çözeltisinde AgX için çözünürlük eğilimi (AgF suda çözünür) AgCl >> AgBr >> AgI ÜST SAYFA LÜTFEN NOT KS4 Bilim GCSE/IGCSE/O Seviye GRUP 7 HALOJENS NOTLAR ayrı bir web sayfası Doc Brown's School Chemistry Web Sitesinde ne GELECEK? INORGANIC Part 9 Group 7/17 Halogens sub–index: 9.1 Introduction, trends & Group 7/17 data * 9.2 Halogen displacement reaction and reactivity trend * 9.3 Reactions of halogens with other elements * 9.4 Reaction between halide salts and conc. sulfuric acid * 9.5 Tests for halogens and halide ions * 9.6 Extraction of halogens from natural sources * 9.7 Uses of halogens & compounds * 9.8 Oxidation & Reduction – more on redox reactions of halogens & halide ions * 9.9 Volumetric analysis – titrations involving halogens or halide ions * 9.10 Ozone, CFC's and halogen organic chemistry links * 9.11 Chemical bonding in halogen compounds * 9.12 Miscellaneous aspects of halogen chemistry keywords phrases formula oxidation states balanced symbol equations: NaCl(s) + H2SO4(l) ==> NaHSO4(s) + HCl(g) 2NaCl(s) + H2SO4(l) ==> Na2SO4(s) + 2HCl(g) Cl–(s) + H2SO4(l) ==> HSO4–(s) + HCl(g) KF(s) + H2SO4(l) ==> KHSO4(s) + HF(g) 2NaBr(s) + 2H2SO4(l) ==> NaHSO4(s) + Br2(g) + SO2(g) + 2H2O(l) H2SO4 + 2H+ + 2e– ==> SO2 + 2H2O 2Br– + H2SO4 + 2H+ ==> Br2 + SO2 + 2H2O NaBr(s) + H2SO4(l) ==> NaHSO4(s) + HBr(g) 2HBr(g) + H2SO4(l) ==> Br2(g) + SO2(g) + 2H2O(l) 8NaI(s) + 5H2SO4(l) ==> 4Na2SO4(s) + 4I2(g/s) + H2S(g) + 4H2O(l) 8I– + H2SO4 + 8H+ ==> 4I2 + H2S + 4H2O NaI(s) + H2SO4(l) ==> NaHSO4(s) + HI(g) 8HI(g) + H2SO4(l) ==> 4I2(g/s) + H2S(g) + 4H2O(l) Doc Brown'ın Okul Kimya Web Sitesi TOP OF PAGE Web sitesi içeriği © Dr Phil Brown 2000+. 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