Detailed Scheme

Main themes

- Matter
- Energy
- Change
- Pattern
- Structure
- system

Matter and energy interact and constantly bring about change in both the matter (or matters involved) and its (their) surrounding. However, these changes are not random and haphazard; they are characterized by patterns, trends. In Chemistry, these patterns and trends in the changes are explained by the structure of the building blocks of matter, atoms and molecules, and the structure they produced in combinations. In studying and explaining the interaction of matter and energy thus, chemists isolate a select few or several matter and processes, which as a whole may constitute a system.

Inquiry based teaching

Start each unit with demonstrations of videos of processes and have them record observations. Get each one to come up with a question about the process that they would like to know the answer to. Place questions in a box for after the completion of the unit.

When the unit is completed, they could be asked to pick out their question and try to answer them as an assignment or discuss the answers together in the class.

Hubbard (2001) identifies three essential factors - risk, trust, and power - that helped her develop and change curriculum and methods in her classroom. To begin the process of change demands the teacher to take a risk with expected outcomes, but in order to engage students and make topics more relevant, the teacher must trust the students to choose significant and meaningful topics. This requires the teacher to relinquish some power as all-knowing director and subsume a co-learner position. These factors are important guiding principles for initiating immediate change in the classroom. However, in order for the change to be significant and lasting other factors have to be considered. (InquiryBasedScience.html)

Upon entering a science classroom, one should be able to observe an exciting learning environment in which students are wondering why and finding out. Students should be asking questions, resolving discrepancies, figuring out patterns, representing ideas, discussing information, and solving problems. This vision of science teaching is associated with the term inquiry. Science processes are also used to guide student learning. Such processess are: discrepant events, inductive activities (the learner first encounters the attributes and instances of an idea, then names and discusses the idea, experience-before-vocabulary approach to learning), deductive activities (opposite of the inductive approach; a concept or principle is defined and discussed using appropriate labels and terms, followed by experiences to illustrate the idea under study, vocabulary-before-experience model of learning in which lecture and discussion precede laboratory or field work), gathering information, problem solving (one type of problem-solving approach centering on problems that are relevant to students' lives where students raise questions, plan procedures, collect information, and form conclusions). (Inquiry based science teaching.pdf)

1. Measurement and Data Processing

1.1. Preamble

Introduce chemistry by showing introduction to chemistry slides. Use some of the materials from MYP chemistry introduction slides. However, touch upon the main themes above. And then come back to this on a regular basis at the beginning of each topic but with additional materials or elaboration on the materials that have already been covered. So this PowerPoint slide becomes bigger and bigger. And at the beginning of every topic, the slides are revisited.

Introductory lesson: master mind and what it can teach us about the Scientific Method and Chemistry. (See "Mathematics behind Mastermind" document.)

1.2. Units, Accuracy and Precision

Powerpoint Slides: Unit Accuracy & Precision

Worksheet:

Core units Accuracy & Precision – wkst

SI units and Prefixes (No worksheet of this name. prentice hall worksheet? 15/7/2011)

Quantitative and qualitative observations (properties) (No worksheet of this name. prentice hall worksheet? 15/7/2011)

Accuracy and Precision (No worksheet of this name. prentice hall worksheet? 15/7/2011)

1.3. Significant figures

Powerpoint Slides: Significant Figures

Worksheet: Core significant figures –wkst & qtns

1.4. Uncertainty

Powerpoint Slides: Uncertainty

Worksheet: Core uncertainty – wkst (Activity: Paper Clip length. Detailed in the worksheet.)

After completing the activity discuss the following:

- The components of a the act of making a measurement: the instrument, the person doing the measuring and the object being measured
- How do each of the components affect the final result, the measurement, the length of the paper clip?

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If time permits Lab: Accuracy and Precision of instruments

1.5. Nomenclature of inorganic compounds (Powerpoint Slides set: Nomenclature)

Powerpoint Slides: Formula & Nomenclature

Workheet: Not necessary, the PowerPoint slide has practice questions. Go through the slides with the students.

2. Atomic Structure and Quantitative Chemistry

2.1. Preamble: Review of the periodic table (Resources: Blank periodic table)

Start with a discussion of periodic table. Resource: blank periodic table.

Concepts to cover: Period, group, metal, metalloid, non-metal, alkali metals, alkaline earth metals, halogens, noble (inert gases), electronic structure (Bohr's model), electronic configuration, Bohr's model: the various terms associated with the structure: core shell, core electrons, valence shells, # of shells = period #, # of electrons in valence shell = group #, isotope, gaseous elements, solid elements, liquid elements, diatomic molecular elements, network covalent elements, atomic elements.

Where did all these elements come from?

Video: EDVD-04Chem P1 - Science in Focus - The Periodic Table.m4v.

Worksheet: Core atomic structure – Origin of matter - VDO wkst

2.2. Atomic Structure and Mass Spec

Resource: Powerpoint Slides: Atomic structure & mass spec

Worksheet: Core atomic str & mass spec - wkst

Other resources required: printouts of Chlorine ions, steel balls of different sizes, trolley plank, magnets, or hair dryer)

Describe operation and have them fill in/label the diagram.

Demonstrate mass spectrometer by using steel ball bearings of different sizes travelling down a acceleration ramp from physics lab and horse shoe magnets. Set it up and demonstrate the deflection of one ball bearing.

Guiding questions:

Why could the result be different for a different ball bearing? For example a bigger ball bearing?

What other variables might affect the path of the ball bearing?

OR

Role play travel through mass spectrometer using chlorine-35 and chlorine-37 paper ions. Start with each one going through the spectrometer pretending to be an ion with the magnetic field set at a fixed strength. They could develop the kind of memory trick used by the world memory champion as described in the BBC documentary Get Smart.

Then model a mass spectrometer albeit in slow motion.

Make piles of 10 ions. Then have them pretend to be 10 ions as the magnetic field changes from weak when both ions don't deflect at all to a strength that causes Cl-35 to deflect sufficiently to make it to the detector while Cl-37 still doesn't. Then strong enough for Cl-37 to make to the detector while Cl-35 deflects too much.

The only thing to remember is to make sure that the duration is the same. Count up the ions that make it to the detector and plot a bar graph.

2.3. Quantitative Chemistry: Mole, and Mole Calculations (2h)

Resource: Powerpoint Slides: Mole Concept

Worksheet: Core mole concept - wkst

Inter conversions between mole, mass and particles.

Mole Challenge: How many sugar cubes in a 50-mL beaker of sugar?

Give them a 150-ml beaker of sugar, ruler, black poster paper, graph paper, tweezers, scalpels and have balances available.

Guiding questions:

1. What is a graph paper use for and how can it be used here?

2. How is a ruler use and how can it be used here?

3. How is a balanced used and how can it be used here?

Challenge problem:

A Fermi question about the # of sand in a vial and then use that to estimate the number of sand grains in the Sahara.

Another Challenge: How many sand grains are there in the Sahara?

See "Sand in the Sahara – Challenge problem" for detailed instructions.

2.4. Quantitative Chemistry: Reaction Stoichiometry (3h + 1h)

Resources: Powerpoint Slides: Chemical Equation & Reaction Stoichiometry

Worksheet: Core chemical eqn & rxn stoichiometry - wkst

Writing and balancing equations

Interconversion between quantities of reactants and products.

2.5. Quantitative Chemistry: Mass Relationships (3 h)

Resource: Powerpoint Slides: Mass Relationships

Worksheet: Core mass relationships - wkst

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Demonstrate the conditionality of the quantities expressed in the equation for a reaction.

Introduce different concepts: limiting reagent and excess reagent. (Introduce experimental yield and theoretical yield after the activity.)

Have them perform the displacement reaction between copper(II) oxide and carbon. Activity (details appears in the worksheet).

- Mass ratio of $CuO:O_2:Cu=160:12:128$. (13.33:1:10.66)
- Total mass set at 2 g.

- Have them place hot test tube in a beaker of water and pick out lead using forceps and determine yield.
- Discuss all the concepts associated with mass relationship.

Challenge problems:

1. Gunpowder Challenge: How can I get the biggest bang out of a 10-g gunpowder mixture? Have them prepare their mixture, put it together and 'shoot' it, video record it and review. (See instruction sheet: gunpowder V3 - stoichiometry II – challenging problem.)

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2.6. Quantitative Chemistry: Formula (of compounds from mass information (mass to formula from elemental analysis data))

Resource: Powerpoint Powerpoint Slides: Formula

Worksheet: Core Chemical formula I – wkst & Core Chemical formula II – wkst

Activity 1.

- Have them perform the dehydration of copper sulfate pentahydrate to once again demonstrate the conditionality of the balanced chemical equation representing the dehydration of hydrated salt
- Have them measure a fixed amount of salt, predict the mass of anhydrous salt left behind, and then perform the dehydration and analyze the data

Activity 2.

Formula of copper oxide by reduction. (This time have them use copper(I) oxide since they would have already used copper(II) oxide in mass relationship activity.

- Give each pair different amounts of the compound and element.

Analysis

- Have them determine the formula using their individual data
- Have them determine a more accurate formula combining all the data

3. Quantitative Chemistry: Solution Stoichiometry and Reactions (2h)

3.1. Solution Stoichiometry

Resource: PowerPoint slides: Solution Stoichiometry

Worksheet: Core solution stoichiometry - wkst

i). Calculations of just molarity--Mass to concentration/concentration to mass of a substance

ii). Addition of solute to fixed amount of solvent

iii). Making/preparing solution of certain volume and concentration

Experiment: Preparation of NaCl solution.

iv). Dilution

v). Mass to concentration or to the concentration and mass of another substance

Experiment: Acid-base titration

3.2. Reactions

3.2.1. Chemical equations (0.5 h)

Combination reactions (metal with air, metal with another element), Precipitation (Ion-exchange reactions), Reactions involving Acids (rxn with alkali, metal oxides, carbonates, hydrogencarbonates, sulfites, hydrogensulfites), Redox Reactions (formation of ionic compounds – metal + another element; metal-acid rxn, displacement reaction of all variety)

3.2.2. Ion-exchange reactions (1h)

Resources: Power Point slides: Ion-exchange

Start with the discrepant event: Magical Crystals.

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Worksheet: Not required—reinforced through performance of reaction (see below).

Demonstrate some combination and combustion reactions and have them write both word and chemical equations, and predict products for the combination of other elements:

- Combination of zinc and sulfur
- Combination of alunimium and iodine
- Combination of sodium and oxygen
- Combustion of carbon and oxygen over potassium chlorate
- Combustion of magnesium

Experiment: Precipitation and Solubility of salts (worksheet to with the experiment has the same name).

3.2.3. Reactions involving Acids and bases (2h)

Resources: Power Point slides: Acid Base

Worksheet: Not needed. Just go through the slides and then move on to the conductivity tests.

Experiment: Conductivity of different solutions and classification of electrolytes (conductivity test – expt).

3.2.4. Redox Reactions (2h)

Start with discrepant event: “Green Volcano” (decomposition of ammonium chromate(VI)) and “Not so steely afterall” (reaction of steel wool with air in inverted measuring cylinder).

3.2.4.1. Redox reaction

Resources: Power Point slides: Redox

Worksheets:

- rxn your parents wish they had seen – wkst
- Core redox rxn oxidation # rules - wkst

Introduce redox reaction as another way of categorizing chemical reactions. Most reactions observed/studied can be classified under this category.

Introduce by going through all the variety of chemical reactions that they would have been introduced to by having them perform or demonstrating the following reactions:

(Worksheet: intro to redox rxn your parents wish they had seen – wkst)

Combination reaction: Have one of them perform the combination of iron and sulfur reaction in fume cupboard.

Decomposition reaction: Have one of them perform the decomposition of iron (III) nitrate

Demonstrate the following reactions:

- Precipitation of lead iodide in a measuring cylinder.
- Displacement reaction: aluminum powder + iron(III) oxide and aluminum powder + copper(II) oxide
- Oxidation of sugar by potassium permanganate: equal mass mixture initiated by adding several drops of water on it
- Oxidation of sugar by potassium chlorate: equal mass mixture initiated by adding a few drops of conc. Sulfuric acid
- Carbonate-acid reaction in a water bottle with a cork: sodium hydrogen carbonate + HCl
- Oxidation of charcoal on the surface of potassium chlorate in a boiling tube in the fume cupboard: powder charcoal on the surface of decomposing potassium chlorate
- Photochromatic lens with one exposed and the other covered with aluminum foil
- Test-tube of silver chloride precipitate produced by adding sodium chloride solution to silver nitrate solution.

Experiment: A Study of redox reactons - expt.

Have them confirm that they are indeed redox reaction by identifying the changes in oxidation numbers.

Balancing comes next (see below).

3.2.4.2. Redox reactions in acidic medium (2h)

Resources: Power Point slides: Balancing redox rxn in acid

Worksheet: Core balancing redox Reactions in Acidic medium – wkst

And then have them balance the redox reactions they say in the experiment.

(In 2007-09 session, was completed in Nov. 13, 2007.)

Redox reaction & Stoichiometry challenges:

- Sugar Daddy…with flare. Optimum mixture of sugar and potassium chlorate initiated by concentrated sulfuric acid. (see document "Sugar Daddy…with flare – Challenge problem" under Quantitative chemistry/challenge problem sheets.)

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4. Atomic Theory – Electronic structure (total 2h)

4.1. Preamble: Of light, atoms, electrons & electronic structure

PowerPoint slides:

- Nature of light
- Electronic structure

Video: Classroom video: Bohr's model of the atom

Worksheet: Core electronic structure - Bohr's model – DVD wkst

Applet: hydrogen line spectrum

Observe light given off by hydrogen and other discharge tubes using hand held spectroscope if available.

Movie clip: EDVD-04Chem. Electric City 14:00-17:15. Neon lights and different colors given off by different gases in discharge tubes.

Discussions of the different colors of noble gases in discharge tube (neon signs): 16:20-17:15.

Demo 1: emission of light by elements by burning methanol on samples of LiCl, NaCl, KCl, $CaCl_2$, $SrCl_2$ and $CuSO_4$.

Demo 2: Fireworks (charged with gunpowder mixture so that a match or filter paper dipped in saturated KNO_3 solution can be used as a fuse instead of Mg ribbon.

Other resources:

- Online simulation of emission spectra: http://phys.educ.ksu.edu/vqm/html/emission.html.
- Demonstrate different potential energy using a pulley and an objected tied to the end of a string.
- Move Clip: The big bang and evidence for expansion of the universe from emission spectra (EDVD-04S) 0:00-07:40; 13:40-17:15

4.2. AHL Evidence for main energy levels

PowerPoint: Ionization Energy & Atomic Str

Worksheet: AHL IE & Electronic Structure - wkst

4.3. AHL Modern Theory

Reading assignement: The Discover interview with Roger Penrose (published in Discover)

Clips from "What the bleep do we know?" and "What the bleep do we know down the rabbit hole quantum edition 1?"

Clip 1: 0:00:00-00:30:30 of What the Bleep Do We Know? (30 min)

Clip 2: 1:00:45-1:33:34 of What the Bleep Do We Know? Down the Rabbit Hole Quantum Edition part 1 (33 min)

Worksheet: what the bleep do we know – wkst

PowerPoint: Modern Theory

Worksheet: AHL modern theory – wkst

Demonstrate atomic orbitals using water filled balloons. Use long balloons to demonstrate p and d orbitals.

4.4. AHL Electronic Configuration

PowerPoint: Electronic Configuration

Worksheet: AHL Electronic Configuration – wkst

Arrow in a box diagram resource: Load periodictable.htm within the subdirectory "pertable" (under Applets & online simulation). The periodic table can be used to show arrow in the box diagram for the different elements.

Demonstrate atomic orbitals using water filled balloons. Use long balloons to demonstrate p and d orbitals.

4.5. AHL Evidence for sub-levels (moved from Periodicity—new syllabus lists this under atomic structure. 4/12/08).

PowerPoint: Evidence for Sub-levels

Worksheet: AHL Evidence for sub-levels – wkst

Reading assignment: What is everything made of? (Science Illustrated article)

Then go on to Video: The ATLAS experiment movie.mov

Worksheet: ATLAS movie biggest experiment ever – wkst

5. Periodicity (Part I) (total 5.75h)

5.1. The periodic table (0.75h) (Resource: Blank periodic table)

Concepts: s-block, p-block, d-block, f-block, electronic configuration and position in table, and balance of forces

After adding the terms and concepts to the table, discuss the term "Periodic."

After defining periodic, show EDVD-04Chem P1 - Science in Focus - The Periodic Table.m4v

Worksheet: Core periodicity – matter & periodic table – VDO wkst.

Next clip: Science_in_focus_rocks,grand, canyon, periodic table 0:48:00-1:06:00 (Dating game show parody—that between participants with characteristics of metals and non-metals.)

5.2. Periodicity of physical properties (2h)

Ionization energy, atomic radius, ionic radius, melting point, boiling point, electron affinity, electronegativity

Power Point Slides: Balance of Forces

Worksheets: Core balance of forces & definitions – wkst

Power Point Slides:

- IE and EA
- Physical Properties

Worksheets: Core physical properties – wkst

Use the following: IB Chemistry\ICT in Chemistry\From OCC\periodicity\elements.csv to get them to draw appropriate graphs and draw conclusions about the patterns in the physical properties of the elements.

Use: "Warwick Bailey's Periodicity Tutorial"? (See ICT in Chemistry from OCC/Periodicity)

Investigation 1: Thinking about Ionization energies (assign as homework?).

5.3. Core Chemical Properties (3h)

i) Properties of group I elements.

Power Point Slides: Chemical Props

Worksheets:

- Core chemical properties GP 1–wkst
- Core chemical properties GP 7 – wkst

Demonstrate reaction of sodium with water, and show videos of reactions of the other group 1 metals.

Unmasking Brainic Chemistry.

VHS Science Bank. Patterns of Reactivity. Group 1 Metals: 29:30-33:18 OR

EDVD-04Chem.The Periodic Table. Time 6:10 – 6:48, 12:24 – 13:35 and

EVD-05Chem. Chemicals from salt 2. Time 11:30-15:15 (reactions of group 1 metals with air and water)

VHS Science Bank. Patterns of Reactivity. Group 7 nonmetals: 33:18-37:55.

5.4. AHL Period 3 elements

PowerPoint Slides: AHL Periodicity I: Period 3 trend

Worksheet: None. (Lab based.)

Expt.: Periodicity Na to Ar - oxides and chlorides - expt.doc

Acidity and Basicity of oxide pattern: VHS Science Bank. Raw Materials. Oxygen and Oxides. 5:40-8:20.

COMPLETED REVISING THE NAME OF SLIDES, WORKSHEETS ETC UP TO HERE. 15/8/2011

6. Energetics (Part I) (total 8 h)

6.1. Enthalpy (3 + 1 h) (Resources: PowerPoint slides set I)

Start with discrepant event: Freezing mixture

(Ammonium thiocynate/chloride and hydrated barium hydroxide.)

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Ask Irada to put the chemical in the fridge and use cold water!!

Motion, kinetic energy and potential Energy:

Demonstrate using liquid nitrogen and dry ice.

Worksheet available: Liquid nitrogen and energy.

PowerPoint slide: Core Energetics I: Enthalpy

Accompanying worksheet: Core Enthalpy - wkst.

Activity (described in the enthalpy - wkst):

Take three 250-mL beakers. Fill three-quarters of two of them with tap water, and then the third one with ice water. Place one hand in icy cold water and the other in water at room temperature for several seconds. Now, move the hand in the icy water to the third beaker with water at room temperature.

6.2. Enthalpy change

PowerPoint slides: Core Energetics II: Enthalpy Change)

Worsksheet: Enthalpy change - wkst.

Look at a heating pack and a cooling pack.

Experiment: Determination of enthalpy of solution described in the worksheet.

6.3. Direct Enthalpy determination

PowerPoint slides: Core Energetics III: Direct Enthalpy Change Determination

Worsksheet: Enthalpy change direct determination - wkst.

Activity: Enthapy of solution (described in the worksheet).

Student struggle with understanding the distribution and loss of energy to different components of the system. Demonstrate this by using coins—the more variety of coins available the easier the demonstration. The demonstration could involve demonstrating the los of energy by letting the coins represent certain units of energy commensurate with their monetary values. Then model a chemical process and distribute the energy that is produced. And then try to account for the energy change.

Experiment: Enthalpy change of reaction – displacement reaction

Energetics challenge:

See document "Cold heat – getting the quantities right – challenging problem" under Energetics – Thermochemistry/challenging problem sheet.

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6.4. Indirect Enthalpy Calculation: Hess' Law (2 h)

PowerPoint Slides: Core and AHL Energetics IV: Indirect Enthalpy Calculations

Worksheets: Enthalpy change Indirect determination - wkst

Experiment: determination of the enthalpy change for water of crystallization of magnesium sulfate. OR

Enthalpy of formation of solid ammonium chloride.

Demonstration: Energetic stability. The decomposition of nitrogen triiodide.

Energetics, redox reaction and stoichiometry challenge: see "Sugar daddy…with a flare – challenging problem." Optimum mixture of sugar and potassium chlorate initiated by concentrated sulfuric acid. Have them take into account the energetics of the reaction as well.

7. Bonding (total 22 h)

Idea from July 13, 2011: Start with introduction to bonding slides which would contain a discussion of the fact that we have talked about the matter, energy, change and pattern. And then talk about structure. Talk about general structure and then relate structure to bonding. Introduce the topic by having them observe the following:

- The clip from what the bleep do we know where they talk about emotion and how it affect how water molecules crystallize in depending on the text taped outside
- Test the effect of charged rods on jet of water and hexane
- Microwave substances with polar and nonpolar molecules showing how polar molecules heat up but not nonpolar molecules
- Have them pinch each others' nose, close their eyes and guess the food being fed based on taste alone. And then have them remove fingers from their class mate and see if they can guess the food item still eye closed. Try different fruits.
- Fruits to try: orange and lemon (the smell of lemons is caused by a compound called S-limonene, which is chiral. Its non-identical mirror image, called R-limonene, smells of oranges), apple, nutrasweet (Aspartame is an amino acid derivative, chemically aspartyl-phenylalanine methyl ester), boiled potato, and a banana.
- Or have them eat banana with nose pinched describe taste and then going of the nose

Describe how all of those results have to do with chemical bonding.

7.1. Chemical Bond

With HL students, start with the M4 powerpoint slides which goes through the idea that atoms of elements other than the noble gases interact with each other so that they achieve a noble gas configuration of 2 or 8 electrons in the valence shell (referred to as a octet rule). However, point out that that is really not the case. There are many exceptions to that rule and not only that, noble gases also reaction with other elements and form compounds! That the real reason atoms combine with each other has to do with energy and entropy!

PowerPoint Slides: Core Bonding I: Chemical Bonds

Worksheet: Chemical Bond – wkst.

Video: Chemistry Core Curriculum. Chemical Bonding.

If they haven't had any introduction to covalent bonding, then use M4 covalent bonding.wkst and ionic bonding.wkst.

7.2. Covalent Bonding: Lewis Structure and Shape (1 h)

PowerPoint Slides: Core Bonding II: Lewis Str & Shape

Worksheet: lewis Structure and shape – wkst.

Video: Chemistry Core Curriculum. Chemical Bonding.

Have ball-and-stick models of period 2 hydrides.

Describes Lewis structure, resonance structure, octet rule and exceptions to the rule. Discusses Electronegativity, ionic bonding and covalent bonding as well. Then moves on to bond energy and reaction enthalpy.

7.3. AHL Covalent Bonding: 5 & 6 Charge centers

PowerPoint Slides: AHL Bonding I: 5 & 6 charge centers

Worksheet: AHL 5 & 6 charge centers – wkst.

Give them the opportunity to play with ball and stick models of the compounds and ions.

Experiment: Structure bonding and properties.

7.4. Quantum mechanical model of covalent bonding (2 h)

7.4.1. AHL Covalent Bonding: Valence Bond Theory

PowerPoint Slides: AHL Bonding II: Valence bond theory

Worksheet: AHL valence bond theory– wkst.

Give them the opportunity to model orbitals with water filled balloon.

7.4.2. AHL Covalent Bonding: Hybridization

PowerPoint Slides: AHL Bonding III: hybridization

Worksheet: AHL hybridization & shape – wkst.

Give them the opportunity to model orbitals with water filled balloon.

7.5. AHL Delocalization of electrons (2 h)

PowerPoint Slides: AHL Bonding IV: Delocalization

Worksheet: the deviants – wkst and AHL delocalization – wkst.

MPEG: Prgram Bucky Ball in Science_in_focus_2_nitrogen_cycle_buckyballs_cars_cats_&_chemists.mpeg

A good introduction to scientific research.

7.6. Core polarization of covalent bonds

7.6.1. Core Covalent Bonding

PowerPoint Slides: Core Bonding III: Polarization

Worksheet: polarization of covalent bond – wkst.

Demonstrate molecules with water filled balloons.

Demonstrate separation of charges using play dough/plasticine on organic models sticks (to demonstrate distribution of negative charge—electrons) and coins to demonstrate distribution of positive charges.

Use air pressure maps or contour maps to show how else the distribution can be represented.

Experiment: Bonding, structure and properties

Challenge problem:

- Precursor: Mythbuster episode Menthos & Coke (videos clips with 3 parts) and accompanying worksheet (Mythbusters meet chemistry – mentos & coke)
- Chemistry of Popcorn: What give the pop to the popcorn? In other words, what is the science behind corn that pop when microwaved? (See document "Chemistry of Pop corn – Challenge problem" under Bonding/Challenging problem sheets.

7.7. AHL Energetics of ionic bond formation, lattice enthalpy, factors that affect lattice enthalpy (2 h)

Start with a demonstration of the reaction between chlorine and sodium and iodine and sodium.

PowerPoint Slides: AHL Bonding V – Ionic Bond Energertics.ppt:

Worksheet: AHL Ionic Bond Energetics - wkst.

7.8. AHL Nature of real ionic bonds: Polarization ** Must cover after Ionic bond energetics as it requires knowledge of lattice enthalpies.**

PowerPoint Slides: AHL Bonding VI: Polarization

Worksheet: AHL Ionic Bond Polarization – wkst.

8. Intermolecular forces (1.5) (Resources: PowerPoint Slides)

van der Waals, dipole-dipole, hydrogen bond

Demonstrate the following discrepant event and ask them to explain it:

- **Error! Hyperlink reference not valid.**
- Pepper or talcum power on the surface of water in a wide container (trough) when finger dipped in the middle of the container nothing happens. But dip a finger soaked with a little bit of washing liquid, the pepper or talcum powder all migrate to the perimeter
- Display two shot glasses one over the other filled with water and the coin inside. Give them two shot glasses one over the other with water and coin and ask them to get the coin inside.
- Corky cork
- Un-freezing a freezing Mixture: Add salt to ice in a zip lock back and reduce temperature way down below 0.
- Bubbly Bubbles: bubble blower.
- Shrinking Liquid: 50 ml each of ethanol and water in a volumetric flask.
- Shy Peppers: Pepper on the surface of water.

Resources:

PowerPoint slides: Core Bonding IV: Intermolecular forces

Worksheet: core intermolecular forces – wkst

Challenge problem:

Explain the lowering of temperature of ice-water mixture when salt is added to it using energetics and bonding concepts.

8.1.1. Reasoning by analogy

Worksheet: critical thinking - reasoning by analogy - Water models - wkst

Resources: What the bleep do we know DVD and Water models.

9. State of Matter (5 h) (Resources: PowerPoint Slides)

Begin with demonstrations:

- Collapsing can
- Egg through the neck of conical flask
- Egg across a shot glass
- Boiling water under reduced pressure
- The dancing coin
- Video of liquid nitrogen experiments

9.1. Three states of matter: Empirical and theoretical models

9.2. Gaseous state

The worksheet adapted from MoLEGasLawManual.pdf needs some work. (25/2/2009)

i) Empirical derivation of ideal gas equation and its application

Can also show the applet: properties of gas.swf (found under Applets and Simulation in State of matter)

Applet available for the students to investigate the relationship between the three properties of gas:

http://intro.chem.okstate.edu/NSFCCLI/GasLaw/GLP.htm

Instructions, investigation and worksheet: MoLEGasLawManual.pdf - for use with applet.

Worksheet contains questions on Pressure-Volume and Pressure-Temperature invesigations. Have them also investigate Systems 1 & 2. Additionally, have them investigate Volume-number of moles.

Additional investigations:

- Pressure exerted by different gases when temperature, volume and moles are the same. Explain the result (which leads on to the next investigation)
- Velocity distribution of different gases under exactly the same temperature, pressure, volume and amount. Explain.
- Effect of temperature on the average speed and therefore average kinetic energy of the particles

ii) Kinetic molecular theory

Maxwell-Boltzmann distribution curve:

Software: GasPhaseBoltzmanDist.dcr (found under Applets & simulations)

Perform the following demonstrations after completing the two investigations.

- The funnel and the ball – present this as a challenge
- The leaping egg and ping pong ball – present this as a challenge. He same demonstration can be performed using shot glasses.
- Raw egg on in a tequila shot glass (egg must fit on the mouth) and challenge them to flip the egg upside down on the mouth. Demonstrate it by blowing on it. And also with practice get it to land sideways on the mouth.

Challenge problems:

- Demonstrate the burning out of candle inside a conical flask inverted on a bigger container with water, with the candle inside. Water should also rise up into the conical flask. (See document 'the burning issue of a candle inside an inverted container – challenge problem' under states of matter/challenge problem sheets.)

Brainstorm and identify questions about the demonstration they would like answers to.

10. Kinetics (total 10 h)(Resources: PowerPoint Slides)

10.1. Collision Theory and Factors (2 h)

Powerpoint slides: Core Kinetics I – Collision Theory and Factors

VDO Resources: 1. Science Bank 2 Chemistry. Reactions and Energy Changes. (Kinetics discussion after the discussion on energetics. Detailed discussions of catalysis.)

Viewtech Chemistry: Reaction Rates & Equilibrium.

Worksheet: Collision theory – demo observation sheet.

Demonstrate the following reactions:

- Hydrogen and oxygen mixture
- Sodium in water
- Steel wool in a gas jar left upside down in a trough
- Magnesium and sulfuric acid
- Zinc in copper sulfate
- Zinc and sulfuric acid with copper(II) sulfate catalyst
- Silver nitrate & sodium chloride solution
- Aluminum + copper oxide reaction on a hot mat
- Set up inverted gas jar in a trough of water with steel wool inside
- custard power demonstration
- Aluminum sheet on Bunsen burner
- Aluminum powder on Bunsen burner

Draw attention to the criteria for reaction.

And, point out that the topic will consider what affects rate/speed of reaction and how one goes about measuring and comparing speed different reactions are taking place at.

10.2. Rate of reaction (2 h)

Powerpoint slides: Core Kinetics II – Rate of Reaction

Worksheet: Core rate of reaction - wkst. (goes with the simulation: ..\applets & online simulation\reaction simulation\f4bl\ReactionRate.html)

Go over the idea of rate and how stoichiometry and rate of consumption of reactant and production of product are related by showing them the setup of experiments involving changes in

- Volume
- Mass
- Color
- pH
- conductivity

Experiments:

Expt: Effect of surface area on the speed of reaction (HCl $CaCO_3$).

Expt: Effect of concentration on speed of reaction (S2O32- and HCl).

Expt: Effect of catalyst on the rate of reaction.

Demonstrate the effect of catalysts on reactions and assign planning experiment studying an aspect of catalysis of a reaction:

- Copper sulfate on Zn and H2SO4
- MnO2 on and Br- H2O2 decomposition

10.3. AHL Rate Law (3 h)

PowerPoint Slides: AHL Kinetics I – Rate Law

Derivation of rate law from initial rate data using the applets:

Worksheet: AHL Rate Law – wkst

1st order: Applet: ..\applets & online simulatio\rsc_first_order\index.htm.

2nd Order: Applet: ..\applets & online simulation\rsc_second_order\index.htm.

Draw their attention to the characteristics of the [] vs time and [] vs rate graphs. Then have them predict graphs (both [] vs time and [] vs rate graphs) for zero order reaction.

Expt: kinetics of H_2O_2 & Iodide rxn - order of reaction

10.4. AHL Activation Energy (1 h)

PowerPoint Slides: AHL Kinetics I – Activation energy

Worksheet: AHL Activation energy – wkst (PDF document) (Needs revision 3/10/08.).

Rate and temperature

Expt: Effect of temperature on the speed of reaction.

Expt: measuring the activation energy for a reaction – practice Design

10.5. AHL Reaction Mechanism (1 h)

PowerPoint Slides: AHL Kinetics I – reaction mechanism

Worksheet: AHL Reaction Mechanism – wkst (Still needs revision 22/4/09.).

Design expt: Aspect of a catalyst.

Challenges

- Challenge: Hydrogen-oxygen rocket. (See "hydrogen-oxygen rocket – challenging problem" document under kinetics/challenging problem sheets.)
- The chemistry of explosion: study firecrackers and determine the what's and why's of it or hydrogen-oxygen mixture (see document 'the chemistry of explosions – challenging problem' under Kinetics/challenging problem sheets.)

11. Equilibrium (total 9)

11.1. Characteristics of a chemical equilibria (1 h)

PowerPoint Slides: Core Equlibrium I: Characteristics & Factors

Worksheet: core equilibrium characteristics & factors- wkst.doc
(http://mc2.cchem.berkeley.edu/Java/equilibrium/index.html)

Start with demonstrations:

Colorful Cobalt Equilibria, and Copper Complex equilibria (both under Demos & Simulation → Equilibria) and chromate(VI)-dichromate(VI) equilibria (discrepant event --> equilibria → Chromate-Dichromate Equilibrium).

Other demos:

Have a small vial with a small crystal of iodine inside completely sealed. Another vial with also a small iodine crystal but in the fume cupboard not sealed.

Set up demonstration of cobalt(II) chloride solution in hot water and ice cold water to show the effect of temperature on equilibrium.

Introduce and reinforce characteristics using the online applet. (See worksheet "core equilibrium characteristics & factors- wkst.doc".)

11.2. AHL Phase Equilibria (2 h)

Liquid/vapor, solid/liquid, solid/vapor

PowerPoint Slides: AHL Equilibrium I: Phase Eqm

Worksheet: AHL phase equilibrium - wkst.doc

11.3. Equilibrium position (4 h)

factors that affect equilibrium position

Expt: Effect of Concentration and Temperature on Equilibrium

11.4. Core Quantitative Equilibria: Equilibrium constant (2 h)

PowerPoint Slides: Core Equilibrium II: Quantitative Eqm

Worksheet: Core quantitative equilibrium - wkst.doc

11.5. AHL Quantitative Equilibria: Equilibrium constant (2 h)

PowerPoint Slides: AHL Equilibrium II: Quantitative Eqm

Worksheet: AHL quantitative equilibrium - wkst

Experiment: Equilibrium Constant (Vernier experiment 20). Need to modify the processing the data section.

11.6. Haber and Contact Process

PowerPoint Slides: Core Equilibrium III: Haber & Contact Process

Worksheet: Core Haber & Contact process - wkst

Expt: Factors that affect the flight time or distance covered by a film canister rocket using soda water and alka seltzer as fuel propellants.

Challenge problem:

- Explain the lowering of temperature of ice-water mixture when salt is added to it using energetic, bonding and equilibrium concepts.

12. Acid-Base Chemistry (total 15.5 h)

12.1. Core Characteristics/properties of Acids and bases (1 h)

Start with the demonstration of discrepant event: Magical beakers.

7 400-mL beakers with the following

- 1st beaker: approx. 300-mL of distilled water with a few drops of universal indicator solution (ideally should be the same color as the solution in beaker 7)
- 2nd beaker: drop of 0.1M HCl
- 3rd beaker: 2 drops of 0.1M HCl
- 4th beaker: 1 drop of 0.1M NaOH
- 5th beaker: 1 drop of 0.1M NaOH

- 6th beaker: 2 drops of 0.1M NaOH
- 7th beaker: approx. 100 mL of pH 7 buffer solution

Alternatively 6 beakers with the following (this worked well with M5B in Aug. 2009)

- 1st 800-mL beaker: approx. 450-mL of distilled water with a few drops of universal indicator solution (ideally should be green, the same color as the solution in beaker 7)
- 2nd 400-mL beaker: 3 drops of 0.1M HCl (Yellow)
- 3rd 400-mL beaker: 5 drops of 0.1M HCl (light pink)
- 4th 400-mL beaker: 7 drops of 0.1M NaOH (?)
- 5th 400-mL beaker: 1 drop of 1M & 3 drops of 0.1M NaOH (bluish green)
- 6th: approx. 100 mL of pH 7 buffer solution (green)

PowerPoint slides:

Core Acids and Bases I: Definitions

Core Acids and Bases II: pH

Worksheets:

Core definitions properties & pH I - VDO wkst (Classroom Video Education with vision series)

Core definitions properties & pH II – wkst

NO worksheet is required to accompany Core Acid and Bses: pH (questions in the slides suffice)

Experiment: Acids, bases and indicators.

12.2. AHL Lewis theory of acid-base and Periodicity (part II): Transition metals

PowerPoint Slides: AHL Periodicity II: d-block Elements

Worksheet: AHL d-block elements – wkst

Introduction:

Show all the characteristic properties of transition metals.

Colored salts and colored flames

Put out the following samples for the students to observe

- samples of d-block compounds
- samples of d-block compound solutions
- samples of main metal compounds
- samples of main metal compound solution

Go on to observe and discuss colors of copper(II) sulfate, copper(II) chloride and tetramine cupper(II) hydroxide solutions. They should be surprised to learn that though the color of copper salt solutions are due to the copper ions, the three are of different colors. (Why?)

Have sample of group 1 and 2 metal salts, their solutions and transition metal salts. Have them compare and contrast—no color, and colored.

Burn samples of group 1 & 2 salts in methanol to show that they do give out colored lights. And also some transition metals salts. But why is it that transition metal salts are normally colored why group 1 and 2 aren't and need to be burned?

Make and burn sparklers: wet one end of a splint and dab it with iron powder. Layer it with another transition metal salt and burn on a flame.

Demonstrate the following

- a colorful firework. Use sugar and potassium chlorate(VII) as the charge and initiate reaction with conc. Sulfuric acid.
- Encase it in a paper tube, bigger in diameter than a boiling tube because the last time a boiling tube was used, it didn't work.
- Ingredients for fireworks: strontium salt, barium salt, potassium salt, lithium salt and iron filings. Mix the salts and gunpowder except iron filing, which could be mixed with some copper salt.

Fireworks:

Why do fire crackers give out colored flames? Tell them that they will towards the end of the topic, create their own firework with particular specification: two distinct colors.

Catalytic properties

Set up four conical flasks with hydrogen peroxide solution. Add spatula of aluminum oxide to one, a spatula of manganese dioxide to another, a drop or two of potassium bromide, a drop or two of potassium iodide. Observation and explanation?

Demonstrate the following

- nucleation of carbon dioxide around mentos tablets in a carbonated water and discuss the mechanism of it and relate it to the process of catalysis by transition metals.
- catalytic behavior of copper sulfate on reaction between zinc and sulfuric acid.
- catalytic behavior of manganese dioxide and halide ions on decomposition of hydrogen peroxide.
- Catalytic behavior of manganese dioxide and iron(III) oxide on the decomposition of potassium chlorate(VII)
- Catalytic behavior of sulfuric acid on esterification reaction
- Burning sugar lump: Sugar is hard to burn with a match but will ignite easily when some cigarette ash is added to it. The ash acts as a catalyst in causing the sugar to burn. Source: Chemical Magic, p 44. (See original for how to demonstrate it as a show.)
- Reaction of aluminium powder with iodine powder initiated by a drop of water

Go to the field and observe two firecrackers.

Create sheet with questions related to behavior of gas and energetics. One where they are asked to explain the noise and propulsion. Also the charge and why it is needed.

Variable oxidation states

Demonstrate of variable oxidation states of transition metals and redox reaction. Transition metal & redox (under Demos & simulation/Redox).

Challenge Problem:

Transition metals and Fireworks (see "transition metals and fireworks – challenge problem" document) Make a firecracker that displays at least three distinct colors. They will need to research the different color flames that different elements produce. The charge will be sugar/KNO3 and gunpowder mixture. The color of this flame will be yellow. They need to work on two other colors and amounts.

Experiment: Copper complexes and their colors (the dependence of color of complex on the identity of the ligand. See transition metal ion & color, and copper complex equilibria)

VHS: Science Bank 3. Chemsitry. Patterns of Behavior, Transition metals approx. 24:20-30:00.

12.3. AHL pH Scale and equilibrium constant (1 h)

PowerPoint Slide: AHL Acids and Bases I: pH and Equilibrium Constant

Worksheet:

AHL Acids & bases: pH Scale

AHL Acids & Bases: Equilibrium Constant

12.4. AHL pHs of acids and bases

of strong monoprotic acid, weak monoprotic acids, strong and weak base

PowerPoint Slide: AHL Acids and Bases II: pH's

Worksheet:

AHL Acids and Bases: pH of acids and bases

Activity:

CalculatingpHUsingH-H.html (Shows pH of different acids and bases for any concentration chosen.)

12.5. pK_a's and pK_b's

PowerPoint Slide: AHL Acids and Bases III: pKs

Worksheet:

AHL pKa & pKb - wkst

12.6. Acid-base properties of salt solution (1 h) (AHL V: Acidity of salts)

PowerPoint Slide: AHL Acids and Bases IV: Acidity of Salts

Worksheet:

No worksheet. Experiment based.

Expt.: Hydrolysis of salts and acidity of metal ions

12.7. Buffers (1.5 h)

i) components
ii) pH determination
iii) buffering capacity
iv) preparation of buffers

PowerPoint Slide: AHL Acids and Bases V: Buffers

Worksheet:

AHL buffers – wkst

Expt: Buffers – expt.

Worksheet:

AHL pH of buffers - wkst

Activity:

BufferpH.html (found under activities and movies. Activity where one can change the concentrations of the components and observe the change in pH.)

Review acid-base reactions as a competition reaction.

Show what the competition results in (by looking at the equilibrium change) when a compound with

- an acidic hydrogen when dissolved in water produce hydrogen ions.
- a source of hydroxide ion dissolved in water produce hydroxide ions.
- ions which generate hydrogen ions (transition metal ions, ammonium ion) when reacted with water.
- ions which generate hydroxide ions (carbonate ion, ethanoate ion, fluoride ion, amine, conjugate base of a week acid in general).

Now, what happened, when we mix solutions of both

- a strong acid and a one containing its conjugate base? (HCl and NaCl)
- A weak acid and one containing its conjugate base? (ethanoic acid and sodium ethanoate/ hydrofluoric acid and potassium fluoride)
- A strong base and one containing its conjugate acid? (NaOH and water)
- A weak base and one containing its conjugate acid? (ammonia and ammonium chloride)

And, finally, what happens when we mix both a source o hydrogen ion and hydroxide ions?

- A strong acid and a strong base
- A strong acid and a weak base
- A weak acid and strong base
- A week acid and week base

12.8. Titration and indicators (2 h)

Strong acid-strong base, strong acid-weak base, weak acid-strong base, weak acid-weak base

PowerPoint Slide: AHL Acids and Bases VI: Titrations and indicators

Worksheet:

Prentice Hall acid-base titration – wkst

Expt: Vernier experiment “23 Titration Curves.” Use the video “expt 24 acid-base titration using vernier probe & computer.mov” for directions.)

Choice of indicator simulator: rsc_indicator (..Acid-base equilibria\Applets & online demos\rsc_indicator)

Final wrap up: show them the video of the magical beakers demonstration. Ask them to explain as fully as they can all the observed color changes.

Challenge problem:

- make a buffer solution of specific pH and determine its pH. pH should be one they can make using the weak acid and conjugate base or weak base and conjugate acid available in the lab. Determine the pH of the buffer. Determine deference in pH between the calculated pH and the experimental pH.

13. Core Oxidation and Reduction (total 9.5 h) & Option C: Chemical Industry & Technology

13.1. Core Redox reactions

Two demonstrations: disproportionation reaction of ammonium dichromate and reduction of dichromate by zinc powder.

PowerPoint Slide: Core Redox I: Reactivity

Worksheet: Core reactivity of metals - WKST.doc

Just have them conduct displacement reactions and deduce the reactivity series.

OR

Video on Reactivity Series

VHS Science Bank Chemistry. Patterns of Reactivity.

Starts with reactions of group 1 metals. Show that and ask them to describe the difference in reactivity in term of kinetics. (Then moves on to Group VII but omit that.)

It is followed up by Metals: Displacement reactions. 38:00-43:15.

Ask them to record observations and write equations, and order them according to reactivity.

Show videos of displacement reactions conducted here and in BMIS.

Then rewind back to raw materials where they talk about reactions of metal oxides with carbon and have them place carbon in the reactivity series.

And finally, ask them to identify oxidizing and reducing agents in the reactions. Then to rank them according to their ability to oxidize or reduce.

Need to create a worksheet to go with the video and one that reinforces the concepts of reactivity.

13.2. Option C: Core Chemistry, Industry and Technology: Iron

PowerPoint slides:

Core Chem. Industry & Tech I: Iron

Video: EDVD-05Chem. Iron and Steel

Worksheet: Core extraction of iron & steel making – vdo wkst.

13.3. Voltaic Cell (2 h)

PowerPoint Slide: Core Redox: Voltaic Cell

Worksheet: Core Voltaic Cell - wkst

Worksheet has details of experiment to be conducted.

Break open batteries and investigate components.

Use batteries.html (under Redox in chemistry videos and activites) to reinforce reactions and parts and show alkaline battery.mov.)

Design Experiment: Investigate an aspect of electrochemical cells (Brainstorm in the class and have them pick one factor. See 'Investigate an aspect of electrochemical cells-design' sheet for ideas.)

13.4. Core Chem Industry & Tech: Fuel Cells & Rechargeable Batteries

PowerPoint Slides: Core Chem Industry & Tech: Cells & Batteries

Worksheet: Prentice Hall Two common batteries

13.5. AHL Chem Industry & Tech: Silicon and photovoltaic cells

PowerPoint Slides: AHL Chem Industry & Tech III - Silicon & photovoltaics

Worksheet: AHL silicon & photovoltaics - wkst

13.6. Core Electrolysis

PowerPoint Slide: Core Redox: Electrolysis

Worksheet: Core Electrolysis – wkst

Activity: Appears on page 2 (step 9) of Electrolysis worksheet.)

Demonstrate electrolysis of molten salt by electrolyzing lead(II) bromide.

Electrolysis of Molten salt:

VHS Science Bank. Chemistry. Electrochemistry. Electrolysis of molten lead(II) bromide. (1st program)

Demonstrations

1. Set up Electrolytic cell consisting of copper sulfate electrolyte and copper strip electrodes.
2. Demonstrate the electrolysis of molten lead(II) bromide
3. VHS Science Bank. Chemistry. Electrochemistry. Electroplating. The third program (after lead(II) bromide electrolysis and NaCl solution electrolysis.

13.7. Option C: Core Chemistry, Industry and Technology: Aluminum

PowerPoint slides: Core Chem. Industry & Tech: Aluminum

Video: EDVD-05Chem. Aluminum

Worksheet: Core extraction of aluminum and Properties - VDO wkst

14. AHL Oxidation and Reduction (total 9.5 h) & AHL Option C: AHL Chemistry, Industry and Technology

14.1. Electrolysis[1] (2.5 + 2 h)

Concepts to be covered: Components of electrolytic cell, electrolysis of solution and molten salt, quantitative electrolysis

PowerPoint slides: AHL Redox I: Electrolysis

Worksheets:

AHL Electrolysis Introduction - wkst

AHL Electrolysis Discharge preference - wkst

Experiments as outlined in the Electrolysis discharge preference worksheet.

[1] Redox Spontaneity covered when covering Energetics II.

Could also show the Video of electrolysis of salt solution? VHS. Science Bank. Chemistry. Electrochemistry. Electrolysis of salt Solution: Follows electrolysis of lead(II) bromide. Video shows demonstration of the competition at the molecular level.

14.2. Option C. Chemistry, Industry and Technology: Chlor-Alkali industry

PowerPoint slides:

AHL Chemical Industries II: Chlor-alkali industry

Worksheet: AHL Chlor-alkali industry – VDO wkst.

Video: EVD-05Chem. Chlor-Alkali industry (alternative: Science_in_focus_1_metals_crude_oil_elements_chlor_alkali. Chlor-alkali Industry (1:00:00-1:15:00) Ends abruptly however.)

14.3. Standard Electrode potential

PowerPoint slides: AHL Redox II: Electrode Potential

Worksheet: AHL standard hydrogen electrode & cell potential – wkst

Quicktime movie to go with the worksheet: StandardReducPotentials.html (to look at standard hydrogen electrode potential) VoltaicZincHydrogenCell.html(to look at electrode potential).

(Both movies to be found under Redox reaction movies)

Materials to cover:

i) Origin of electrode potential

ii) Standard hydrogen electrode

iii) Measuring standard electrode potential— To Determine a Redox Series for some metal/metal ion half cells

iv) use of standard electrode potentials:

a) Calculating cell emf from tabulated electrode potential

b) Using cell emf to predict spontaneous reactions—Use ILPAC exercise 69 and Expt. 11 specimem results. [Cover under Thermodynamics – can be covered right here.]

14.4. Quantitative Electrolysis

PowerPoint slides: AHL Redox II: Electrode Potential

Worksheet: AHL Quantitative Electrolysis - wkst

Materials would have been covered by now. Ask them to read and complete questions that appear towards the end of the printout.

Planning experiment: Investigate the effect of a factor on the rate of deposition of a metal during electrolysis

14.5. Redox and Spontaneity

15. AHL Energetics (Thermodynamics)

15.1. Second Law of Thermodynamics

PowerPoint slides: AHL Thermodynamics: Second Law

Worksheet: No worksheets. Not necessary. (Assign as vacation work, like in October.)

15.2. Entropy

PowerPoint slides: AHL Thermodynamics: Entropy

Worksheet: AHL thermodynamics S & S change – wkst.

Demonstrate entropy using coins (to represent molecules) and play dough (to represent energy).

15.3. Gibbs Free Energy

PowerPoint slides: AHL Thermodynamics: S G & Spontaneity

Worksheet: AHL thermodynamics S G & spontaneity – wkst.

Demonstrate entropy using coins (to represent molecules) and play dough (to represent energy).

Demonstrate idea of free energy by using coins which can be made to represent either calories of food—Gibbs free energy being the energy available from food that which left over after that which is needed for internal functions is subtracted—or money—Gibbs free energy being the money that is available after all the bills and necessary expenses (such as food) etc. are paid for.

Spontaneous change then is in the direction of decreasing amount of calories available in the direction that reduces the available energy to spend. Increasing the amount of calories available is NOT spontaneous—must physically sit down and eat the food! The final calories available should then always be less than the initial, and therefore, in terms of available calories, the spontaneous change is in the direction of negative change in available energies.

Spontaneous change is in the direction of decreasing bank balance, in the direction that reduces the amount of disposable income. Increasing the bank balance is not spontaneous—requires a lot of energy and effort! Within a month, every day, the final bank bank balance will always be less than the initial bank balance, and therefore the change is in the direction of negative change in available funds!

15.4. Calculations

PowerPoint slides: AHL Thermodynamics: S & G Calculations

Worksheet: AHL Thermodynamics S & G calculations – wkst.

15.5. Redox Spontaneity

PowerPoint slides: AHL Redox: Redox Spontaneity

Worksheet: None; not necessary.

Use of standard electrode potentials: Using cell emf to predict spontaneous reactions—Expt: (ILPAC) testing predictions about redox reactions.

16. Core Organic Chemistry & Option C Chemical Industry and Technology

16.1. Core Hydrocarbons: Alkane, Alkenes, Functional groups and Isomerism & AHL Functional Groups

Assign as Summer break work.

PowerPoint slides:

Core Organic Chemistry I: Alkanes

Core Organic Chemistry II: Alkenes

Core Organic Chemistry III: Functional Groups

AHL Organic Chemistry I: Functional groups

Worksheets:

Core Nomenclature of hydrocarbons – wkst

(Additional worksheets available: naming formula & basic organic chem.pdf)

Start with nomenclature of alkanes and introduction to functional groups.

When actually going over the materials in class, start with a video/DVD that discusses the discovery of the oil and the principles involved in its separation and, if available, the chemistry of some of the components.

16.2. Core Organic Chemistry

Provide them with models of propane, butane, pentane and hexane and ask them to find other ways of arranging/bonding the atoms to one another. Provide them with extra models and have them make the models and write structural formula of the compounds formed. Then go one to discuss isomers.

Similarly with position and functional isomers, do the same. Provide them with some models and ask them to rearrange the atoms around to get different isomers.

PowerPoint slides:

Core Organic Chemistry IV: Isomerism

Worksheet: Need to create a worksheet to go with Isomerism

*** With HL students, cover AHL stereochemistry here***

Reinforcement worksheet:

Core & AHL Structures of org compds – wkst

16.3. Core Organic Reactions: Alkanes

Resources: Core Organic Chemistry V – Alkane Reactions

Worksheets: Core Alkane reactions - wkst

Experiment based. Experiment: Alkanes. (Chem in Context experiment.)

Cover Oil Industry here as it ties in well with cracking of alkanes. Option C Chem Industry and Tech Organic mechanism must be covered after Alkenes reaction as it involves looking at addition polymerization mechanism (though it is similar to alkane reaction).

16.3.1. Core Option C. Chem Industry Tech: Oil Industry

PowerPoint Slides:

Core Chem Industry & Tech III: Oil Industry

Core Chem Industry & Tech V: Catalysts

Worksheet: Core Oil industry cracking & Catalysts – DVD wkst

DVD's

1. EDVD-02S: Catalysts at Work. 0:00-10:00.

EDVD-02S: Principles of Refining: Part 2 Chemical Conversion

Additional video: Video/DVD: Oil as Raw Material (Science_in_focus_1_metals_crude_oil_elements_chlor_alkali.mpeg starts at the 19 minute mark)

16.4. Core Organic Reactions (Alkenes) & Core Chem Industry & Tech (Addition Polymers)

Core Organic Chemistry VI – Alkene Reactions

Core Chem Industry & Tech IV: Addition Polymers

Worksheets:

Core Alkene reactions – wkst

Core Organic & Chem Industry Addtion Polymers – VDO wkst (VHS: Boulton-Hawker Films Limited Addition Polymer)**.**

Experiment based. Check Chem in Context experiment on Alkene.

(Additional resources:

- VDO: ATLAS Movie. Worksheet: ATLAS movie resin – wkst if time permits.
- Royal Scientific Society Lecture. ***Need to review the video***)

Have them perform the following reactions:

- Addition reactions of margarine, butter and vegetable oil and if limonene is extracted also test for double bonds in limonene using bromine water.

16.4.1. AHL Option C. Chem Industry Tech: Organic Mechanism

PowerPoint Slides: AHL Chem Industry & Tech II: Polymer mechanism

Worksheet: Unnecessary. Cover it as another example of free-radical chain reaction.

16.5. Core Alcohols

PowerPoint Slides:

Core Organic Chemistry VII: Properties of alcohol

Worksheets: Core alcohol – wkst

Experiment: Chem in Context—Alcohols

Experiment: Fermentation of sugar.

17. AHL Organic Chemistry

17.1. AHL Properties of Functional Groups

PowerPoint Slides: AHL Organic Chemistry I: Functional groups

Worksheet: Not required. All that is required is basic introduction to the functional groups.

17.2. AHL Condensation Reactions & AHL Option C: Condensation Polymers

PowerPoint Slides:

AHL Organic Chemistry: III: Condensation Reactions

AHL Chem Industry & Tech I: Condensation Polymers

Worksheets:

- AHL condensation reactions – wkst
- AHL Condensation polymers – VDO wkst (to go with the 20-min Boulto-Hawker Video on Condensation Polymers.)

Additional stuff…

- Look at preparation of esters—only if time permits.
- Addendum to modifying conductive property of polymer by doping: doping of silicon, conductivity of graphite, conductivity of nanotubes and improvement in conductivity-same principle, conductivity of metal: conductive property is due to delocalized electrons. (Bring this up when looking at doping of polyethyne.)

Applications of polymer concepts: Natural polymer corn starch activity. Worksheet to go with it: Non-newtonian Behavior of Corn Starch – wkst.

Another resource: EDVD-1S – Royal Institute Christmas Lecture (the spider that built a suspension bridge) & Metals and Polymers.

17.3. Core & AHL Halogenoalkane

If only HL students, skip this and move on to AHL properties of Functional groups. Go over this material when covering AHL Halogenoalkane.

PowerPoint Slides:

Core Organic Chemistry VIII: Halogenoalkanes

Worksheets: Core halogenoalkane – wkst

For AHL Need to cover: nucleophilic substitution reaction; SN_1 and SN_2 mechanism and molecularity; rate dependence on type of halogenalkane

PowerPoint Slides:

AHL Organic Chemistry II: Halogenoalkanes

Worksheets: AHL halogenoalkane – wkst

Experiment: Chemistry in Context.

18. AHL Organic Chemistry

18.1. AHL Stereoisomerism

PowerPoint Slides: Core Organic Chemistry IV: isomerism

Worksheet: isomerism dichotomous key – wkst and AHL Stereoisomerism – wkst.

Movies: OpticalActivity.mov

Demo:

- Tell them that there are molecules in nature that have the same relationship as our two hand have to each other.
- Have them pinch each others' nose, close their eyes and guess the food being fed based on taste alone. And then have them remove fingers from their class mate and see if they can guess the food item still eye closed. Try different fruits.
- Fruits to try: orange and lemon (the smell of lemons is caused by a compound called S-limonene, which is chiral. Its non-identical mirror image, called R-limonene, smells of oranges), apple, nutrasweet (Aspartame is an amino acid derivative, chemically aspartyl-phenylalanine methyl ester), boiled potato, and a banana.
- carvone tastes of caraway seeds the other enantiomer tastes of spearmint
- ibuprofen (one is active the other isn't)
- Or have them eat banana with nose pinched describe taste and then going of the nose
  The study of optical isomers of limonene could be set up as a study. They could extract them, record observation (density relative to water), reaction with bromine water, and then look at the spectra. The spectra for the two would be exactly the same!!

  Spectra of limonene available in the L202 Spectra booklet.

  Lead on to stereochemistry discussion

- Ask them to demonstrate that two identical books are in fact identical. What tests can you perform and what would be the result if the books are indeed identical? The final one must be that they must be superimposable. Next questions: are the two hand identical, one a copy of the other by that criteria? No.

  D-limonene from orange peels:

  It can be extracted by boiling the orange peel with water, using a simple distillation apparatus. The mixture of limonene and water distils at a temperature which is 1 °C below the boiling point of water. The product given off can be collected in a beaker with some water so that the D-limonene floats on the water and can be smelled.

  It should be possible to extract L-limonene from lemon peels in the same way.

- Demonstrate behavior of polarizing filter by using polarizing filter on a camera.
- DNA fingerprinting: summary activity looking at polymerization of amino acids and stereoisomerism.

19. Option C: Chemistry in industry and technology

19.1. Core Liquid crystals

PowerPoint slides: Core Chem. Industry & Tech: Liquid Crystals

Worksheet and activity: Core & AHL Corn starch and liquid crystals – wkst.

(This activity can be extended to include a discussion and demonstration of liquid crystals, such as Kevlar. They could be asked to investigate how the properties of Oobleck changes with the amount of water added to the starch.)

Liquid crystals.

- Create worksheet where they perform the following activity: Have them add water to starch and prepare three samples. One with insufficient amount of water, just enough water and excess water. Ask them to analyze and attempt to explain why the difference is observed. Relate it to substances that have liquid crystals properties, more

specifically lyotropic ones, those that show liquid crystal properties at certain concentrations.

- Give them structure of Kevlar. Have then describe what might happen to Kevlar when acid is added to Kevlar. And the move on to thermotropic liquid crystals and analogous change accompanying temperature. The properties expected of molecules for a substance to behave as a liquid crystal.
- Then use soap solution as another example. Demonstrate liquid crystals by blowing soap bubbles.
- Provide structure of DNA and ask them under what conditions it might behave like a liquid crystal.

19.2. AHL Liquid crystals

PowerPoint slides: AHL Chem. Industry & Tech: Liquid Crystals

Worksheet and activity: Core & AHL Corn starch and liquid crystals – wkst.

Demonstrate the principle of liquid crystal display using the polarizers and a model of twisted nematic liquid crystal made using "toothpick ladders" like those used to model a DNA molecule. (Toothpick ladders consist of parallel toothpicks stuck together using scotch tape.) The difference being that one end of the toothpick, the same side for all toothpicks, should be colored, to indicate the polar end. To get a twisted geometry, all that needs to be done is to take the two end toothpicks and twist it!!

19.3. Core Nanotechnology

Additional resources:

For teachers

RSC Resource:

ICT in Chemistry/RSC resources/RSC video files/RSC Contemporary chem(D)/teach/teacher1.html#

This is the index page. Click on the appropriate topic to see the resources available.

For students:

ICT in Chemistry/RSC resources/RSC video files/RSC Contemporary chem (D)/student/s_index1.html

This is the index page. Click on Nanotechnology.

ICT in Chemistry: Check Inspirational Chemistry; it has worksheets on the topic.

20. Option A: Core Modern Analytical Chemistry

20.1. Mass Spec

PowerPoint slide: Core Analytical Chemistry III - Mass Spec.ppt

Worksheet: Core mass spectrometer - wkst.doc

20.2. Analytical Techniques

Demonstrate absorption, transmittance, and reflection using filters to convey these concepts.

Point out the colored pigments such as red or blue are not pure red or blue but rather a composite of some two or three colors. Color resource sheet.

Perform Sunset demonstration to reinforce the concepts of absorption, transmittance, diffraction and reflection.

Demonstrate emission of light energy from electronic transitions in atoms by demonstrating burning of different salts in methanol.

Demonstrate the emission spectrum using discharge tube.

Resources:

PowerPoint Slides: Core Analytical Chemistry I: Analytical techniques

Worksheet: Core Analytical techniques – wkst.

Demos:

- Demonstrate transmission and absorption of different colored lights coming from a white light source by filters.
- Demonstrate reflection of white and colored lights by colored surfaces and filtration by filters.
- Demonstrate emission of colored lights by burning salts in methanol.
  Demo 1: emission of light by elements by burning methanol on samples of LiCl, NaCl, KCl, $CaCl_2$ and $CuSO_4$.

Additional resources:

X-ray crystallography: ICT in Chemistry/RSC resources/RSC video files/RSC Coontemporary chem. (D)/student/crystal_intro.html#

PowerPoint Slides: AHL Analytical Chemistry I: UV-Vis Spectroscopy

Worksheet: None yet…just take it from periodicity…

20.3. Infrared spectroscopy

PowerPoint Slides: Core Analytical Chemistry II: IR Spec

Worksheet: Core IR Spec– wkst

Demonstrations of symmetric and asymmetric stretching and bending of -CH_2- group:

http://www.cem.msu.edu/~reusch/VirtTxtJml/Spectrpy/InfraRed/infrared.htm

20.4. NMR

PowerPoint Slides: Core Analytical Chemistry IV: Proton Nuclear Magnetic Resonance

Worksheet: Core NMR– wkst

PowerPoint Slides: AHL Analytical Chemistry II: Proton Nuclear Magnetic Resonance

Worksheet: AHL Analytical Chemistry: NMR.

20.5. Atomic Absorption Spectroscopy

PowerPoint Slides: Core Analytical Chemistry V: Atomic absorption spectroscopy

Worksheet: none yet.

20.6. Chromatography

PowerPoint Slides: Core Analytical Chemistry VI: Chromatography

Worksheet: none yet.