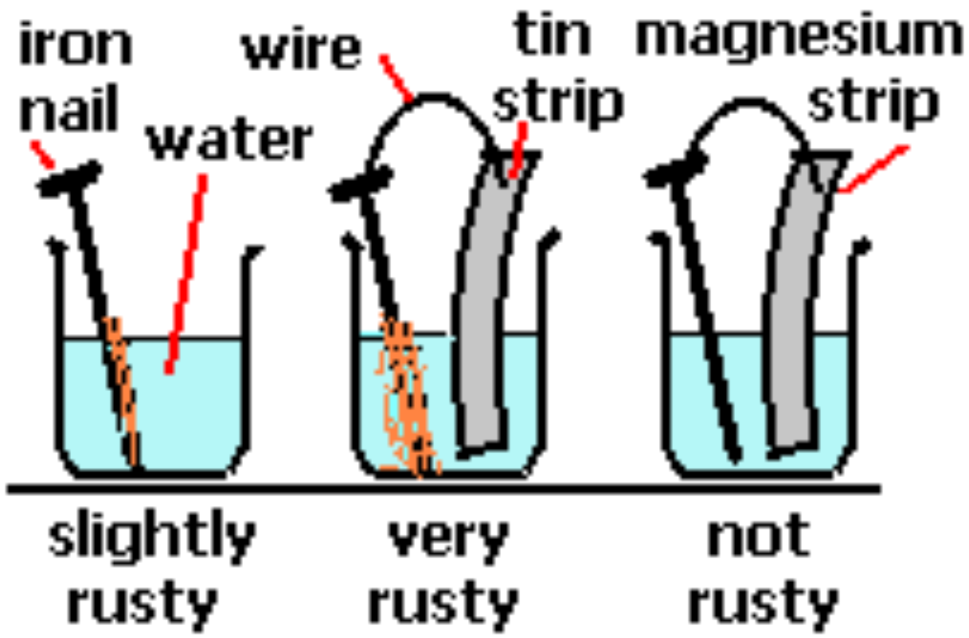
Batteries

First, a review of Redox Reactions

OIL RIG

oxidation is loss   reduction is gain



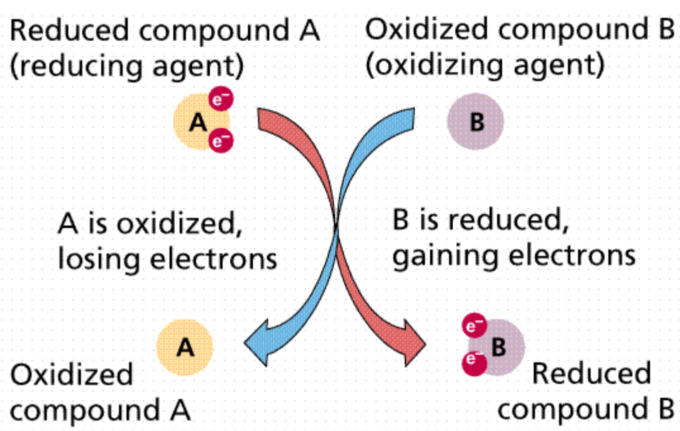


TABLE 2-11 The Galvanic Scale

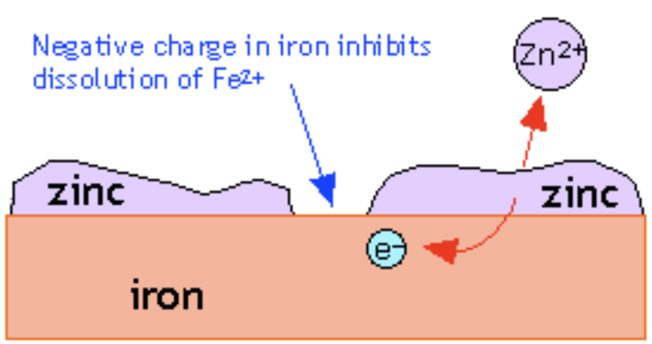
Most anodic or active (likely to corrode)	Zinc
	Aluminum
	Galvanized steel
	Mild steel, cast iron
	Lead
	Tin
	Brass, bronze
	Copper
	Silver solder
	Stainless steel (passive)*
	Silver
Most cathodic or passive (protected from corrosion)	Graphite
	Gold

*Most stainless steel used in light construction is passive, typically Type 304. Type 316 is recommended for exposure to salts or saltwater.

Note: Avoid placing dissimilar metals in direct contact unless they are close together on the galvanic scale.

Sacrificial Anodes (Zinc)

Same principle of Galvanised Nails



Sacrificial coating

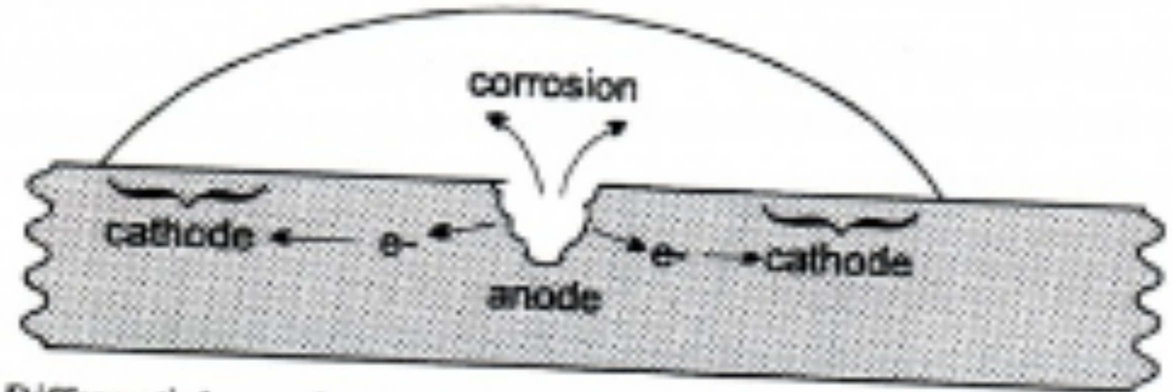
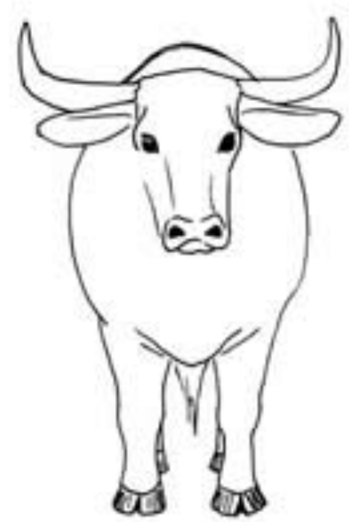


Fig 8.8 Differential aeration beneath a droplet of water

Thus much pitting corrosion in metals is caused by this phenomenon - the concentration of oxygen dissolved from the air varies in different parts, and in particular varies with the depth in a liquid. This may also be observed by placing a metal vertically in an electrolyte.

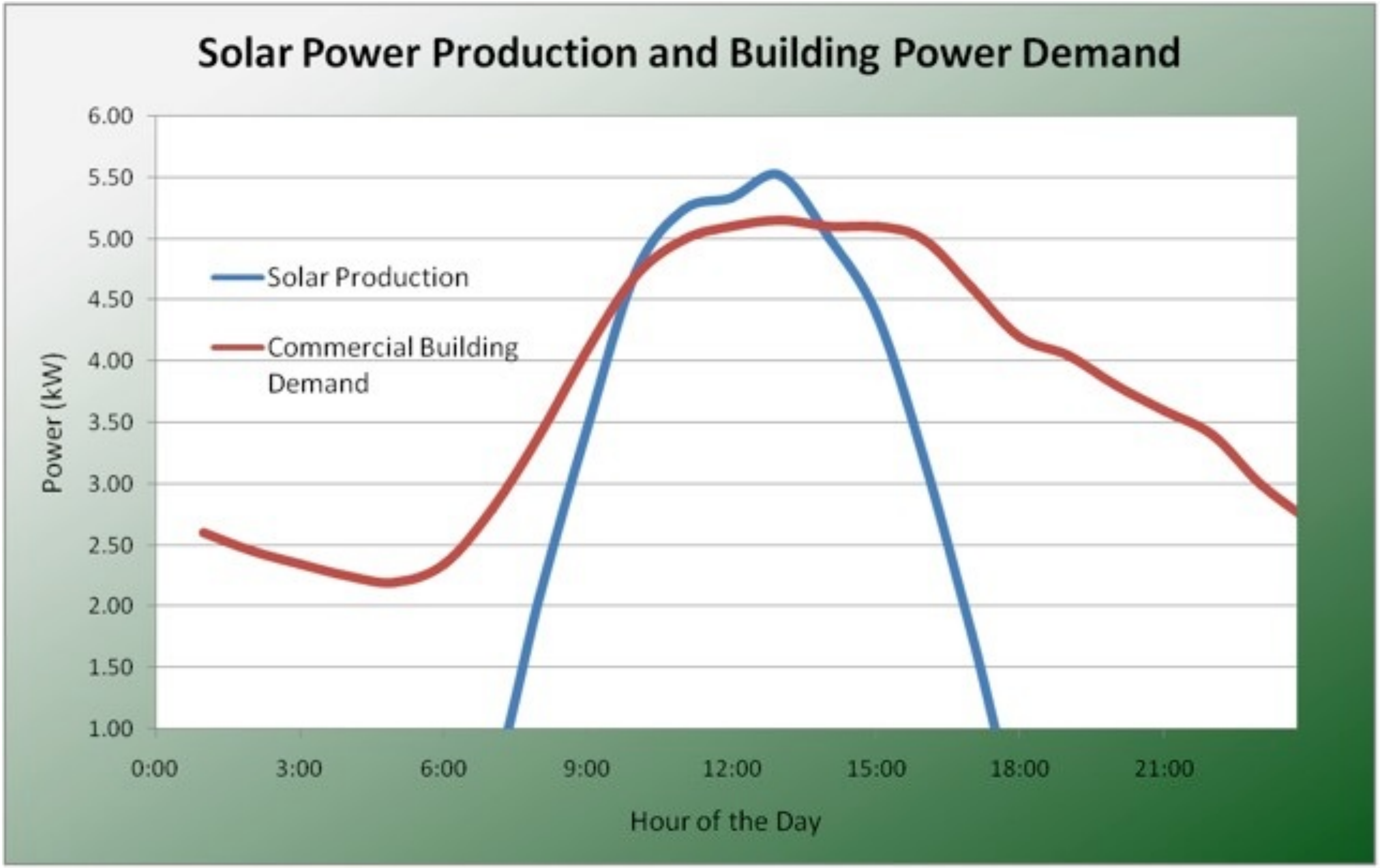
Mnemonic (memory aid) for anode and cathode:

Red Cat
Reduction = Cathode

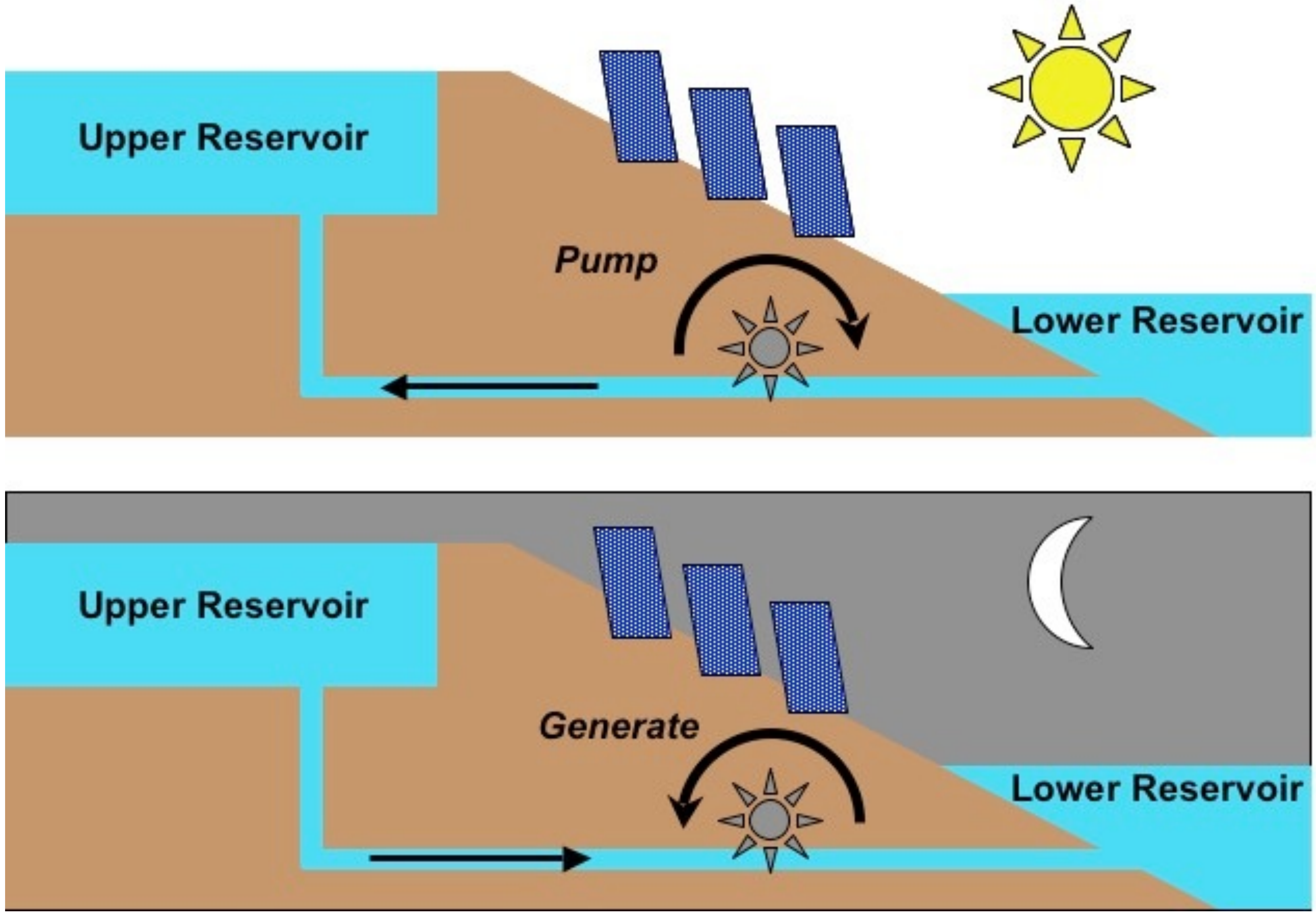


An Ox
Anode = Oxidation

Plenty of solar energy, but how to store it?



Large scale energy storage



X PRIZE FOUNDATION

Battery X PRIZE

The best batteries currently offer energy storage densities of 100s of Wh/kg, more than two orders of magnitude below that of liquid fuels. With breakthroughs in higher energy density, lightweight batteries will enable a revolution in electric aircraft, surface vehicles, and robotic applications.

$1,000,000

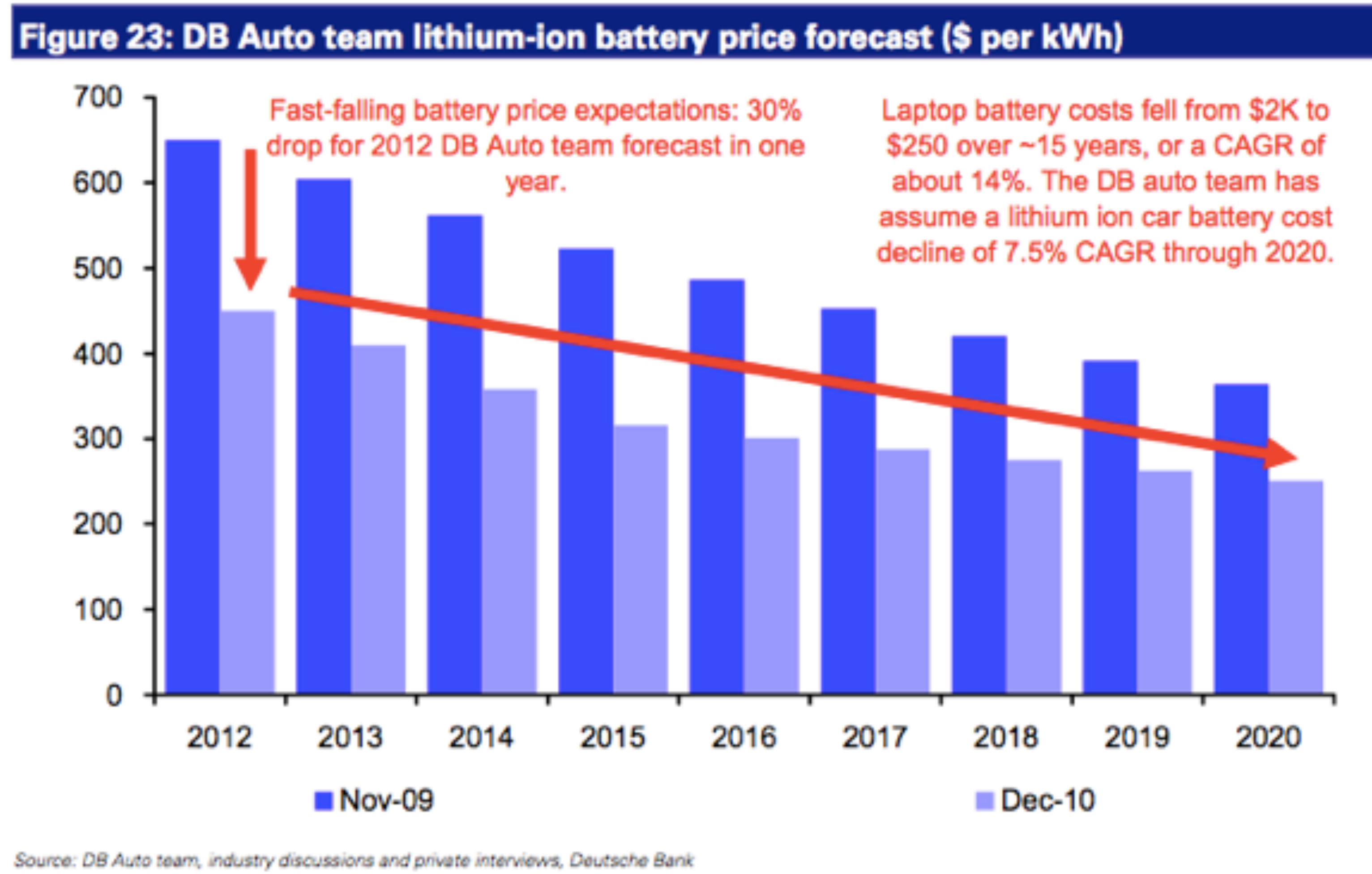
iPhone Battery (lithium ion)

The battery is constructed as:

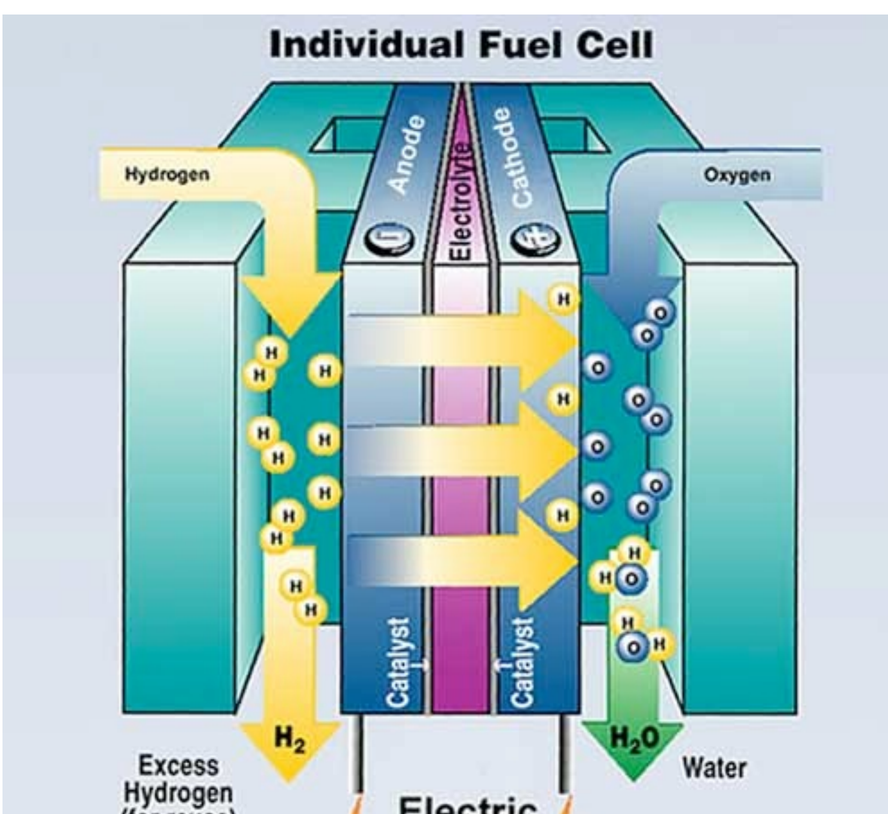
- **positive electrode**: $LiCoO_2$ or $LiMn_2O_4$
- **Separator**: Conducting polymer electrolyte (e.g., polyethyleneoxide, PEO)
- **negative electrode**: Li or carbon-Li intercalation compound

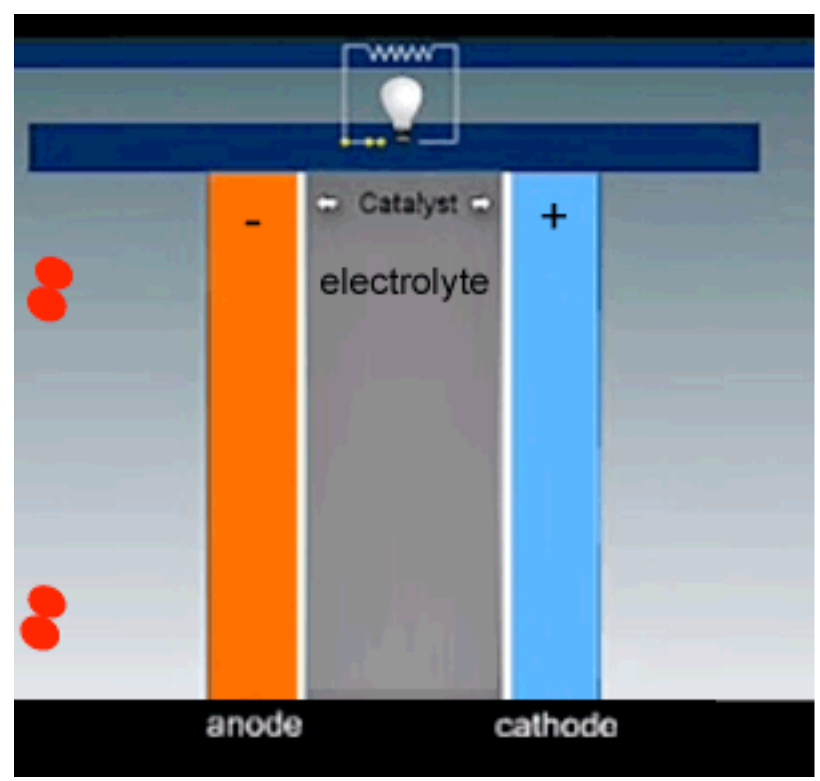
Typical reaction:

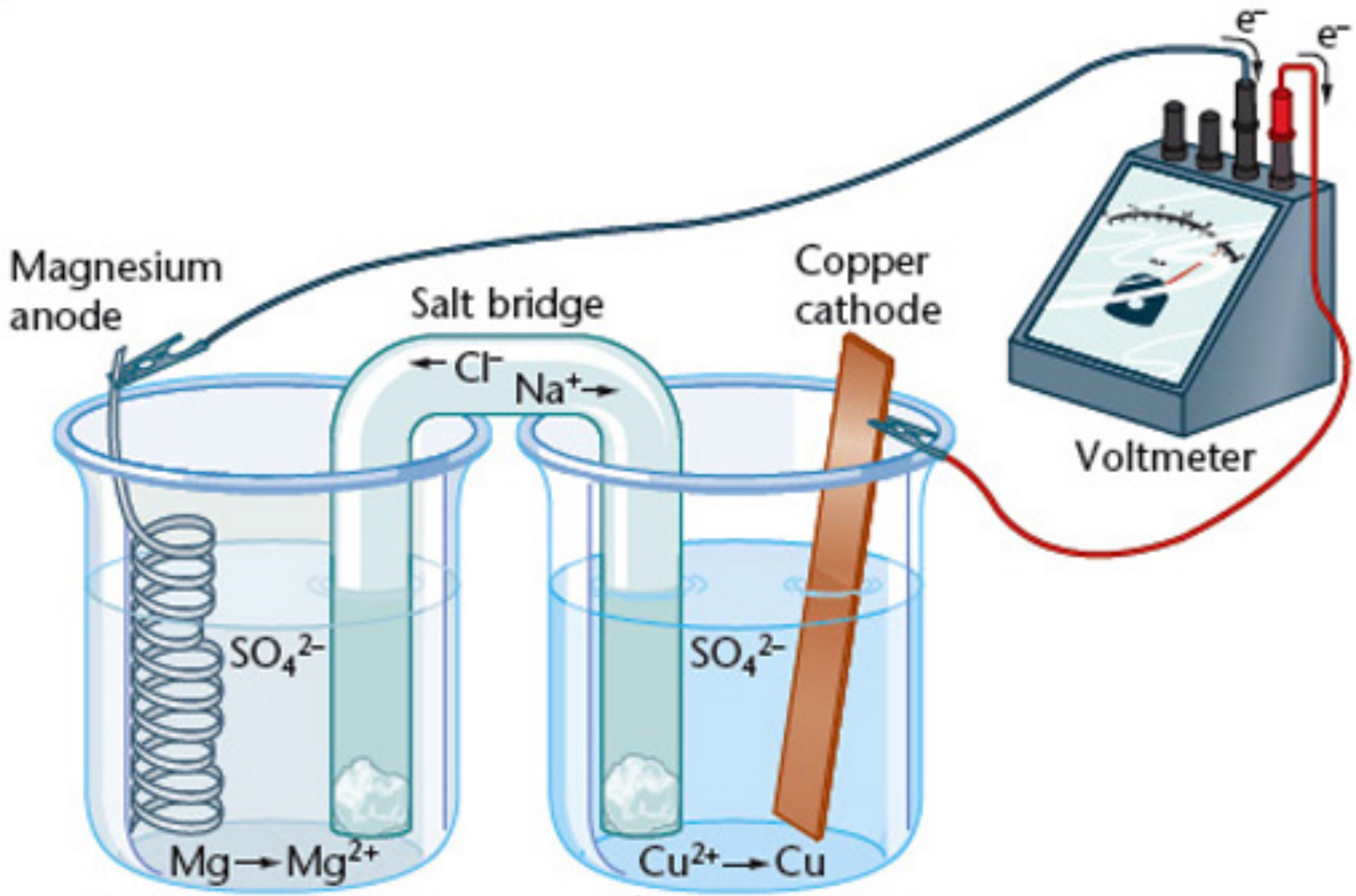
- Negative electrode: carbon–Li_x → $C + xLi^+ + xe^-$
- Separator: Li+ conduction
- Positive electrode: $Li_{1-x}CoO_2 + xLi^+ + xe^- \rightarrow LiCoO_2$



Fuel Cells





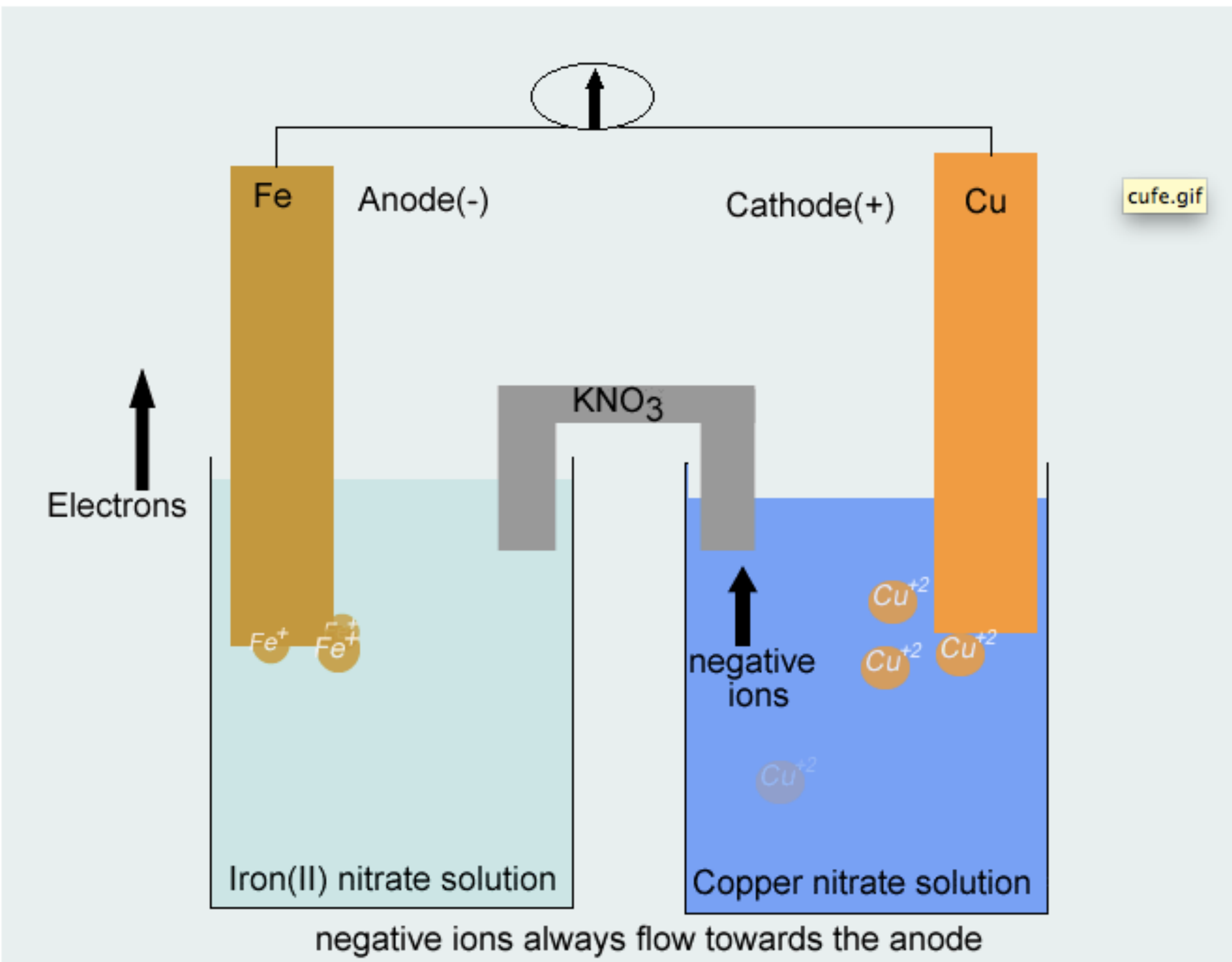


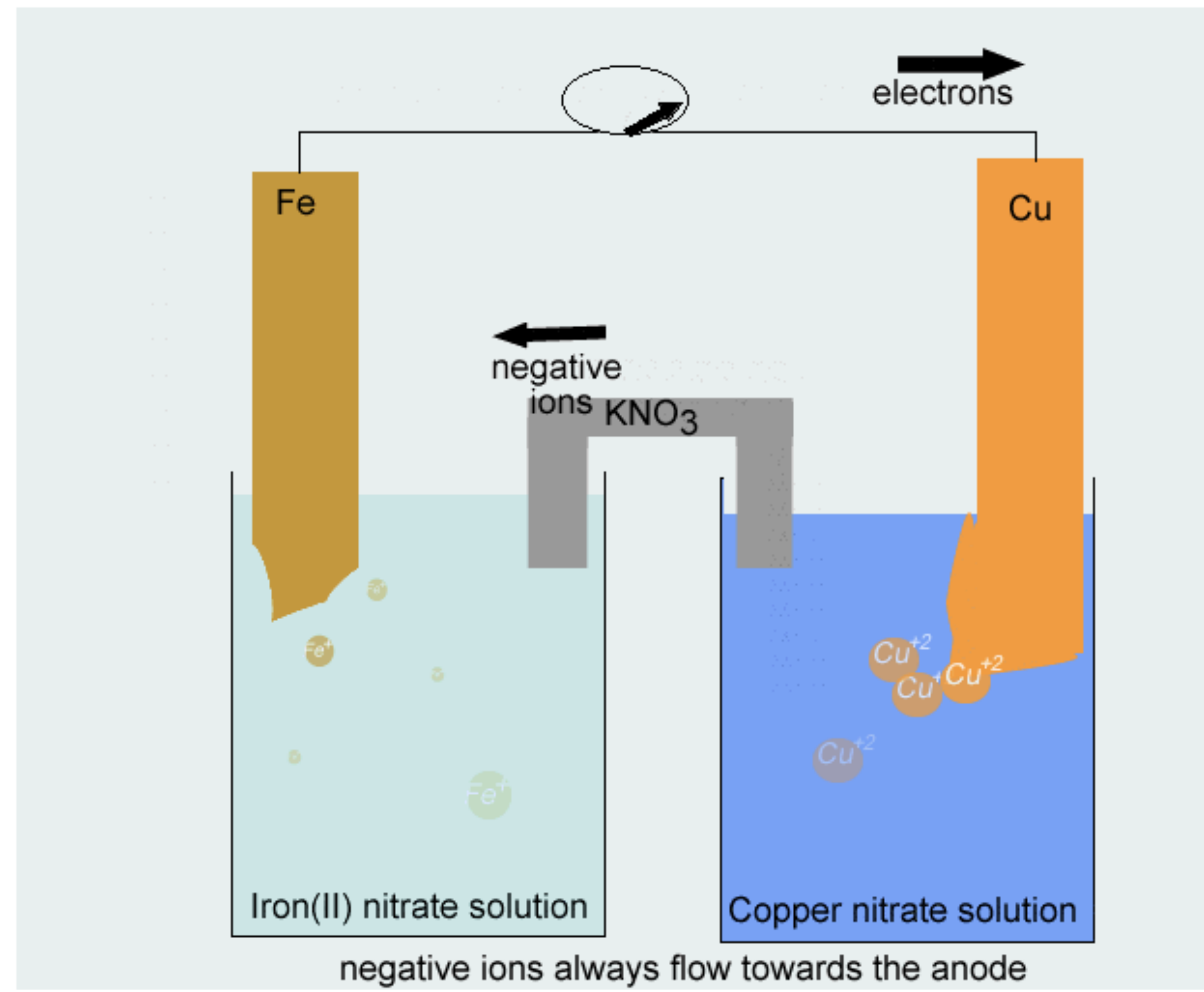
$Mg \longrightarrow Mg^{2+} + 2e^-$

Oxidation

$Cu^{2+} + 2e^- \longrightarrow Cu$

Reduction


Fe
Anode(-)
Cathode(+)
Cu
cufe.gif
KNO3
Electrons
negative ions
Iron(II) nitrate solution
Copper nitrate solution
negative ions always flow towards the anode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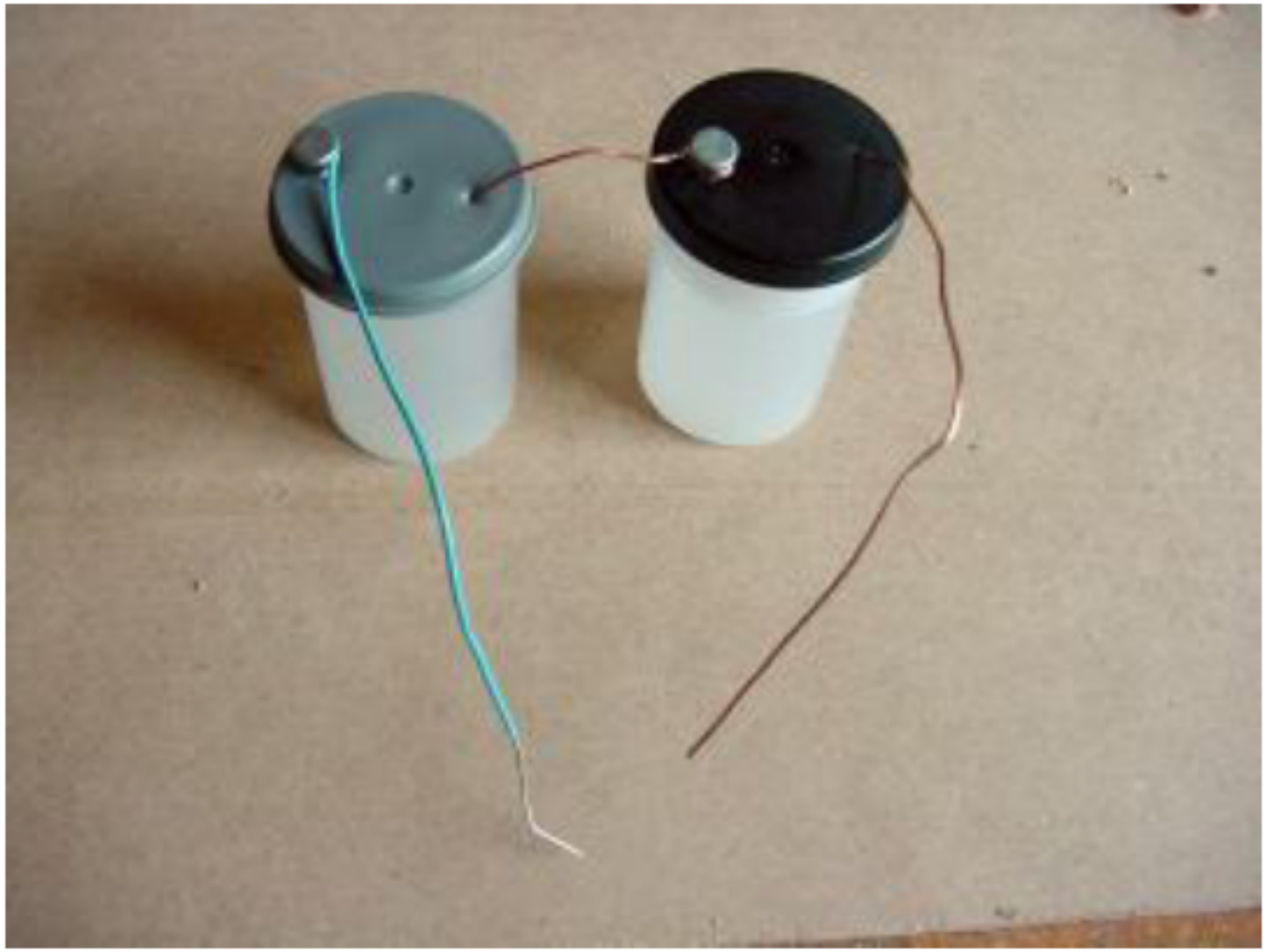
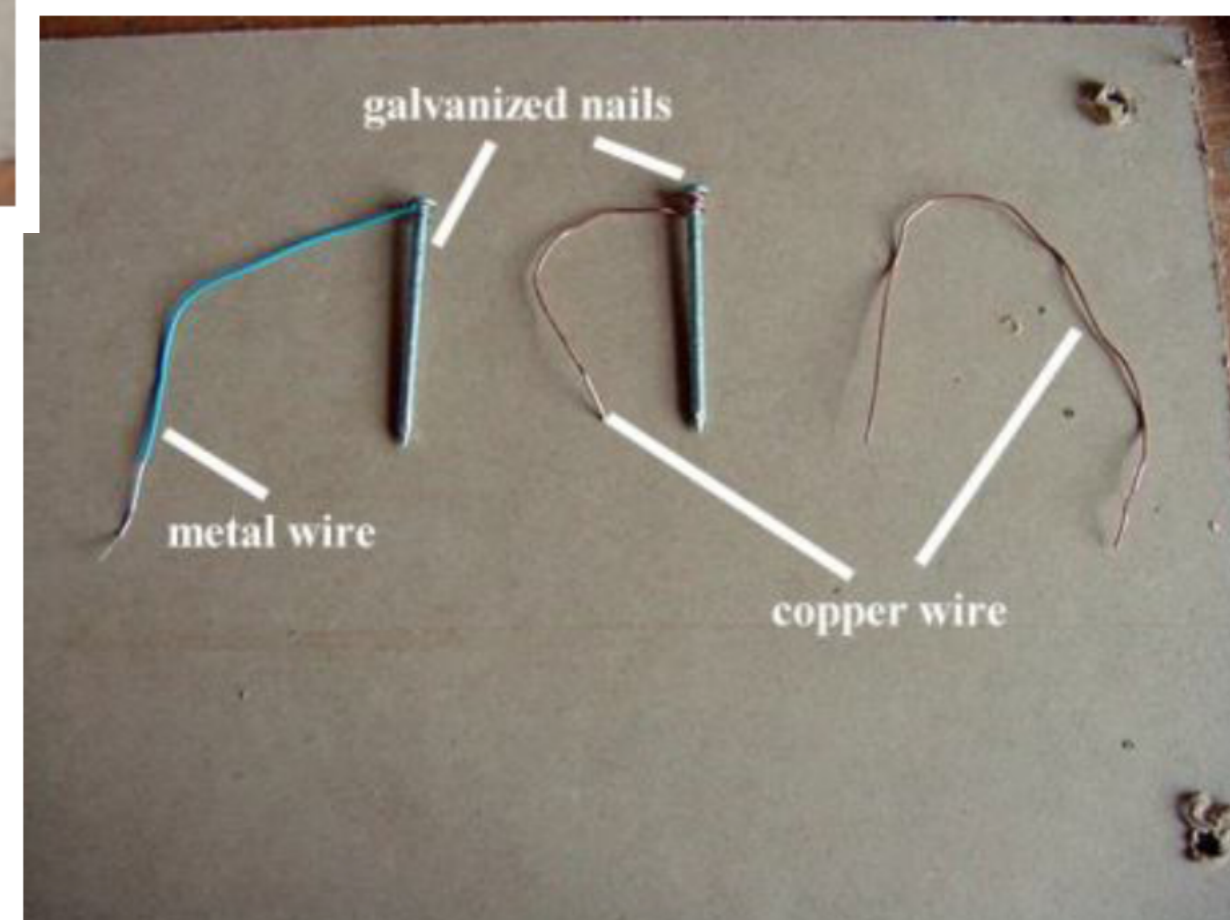
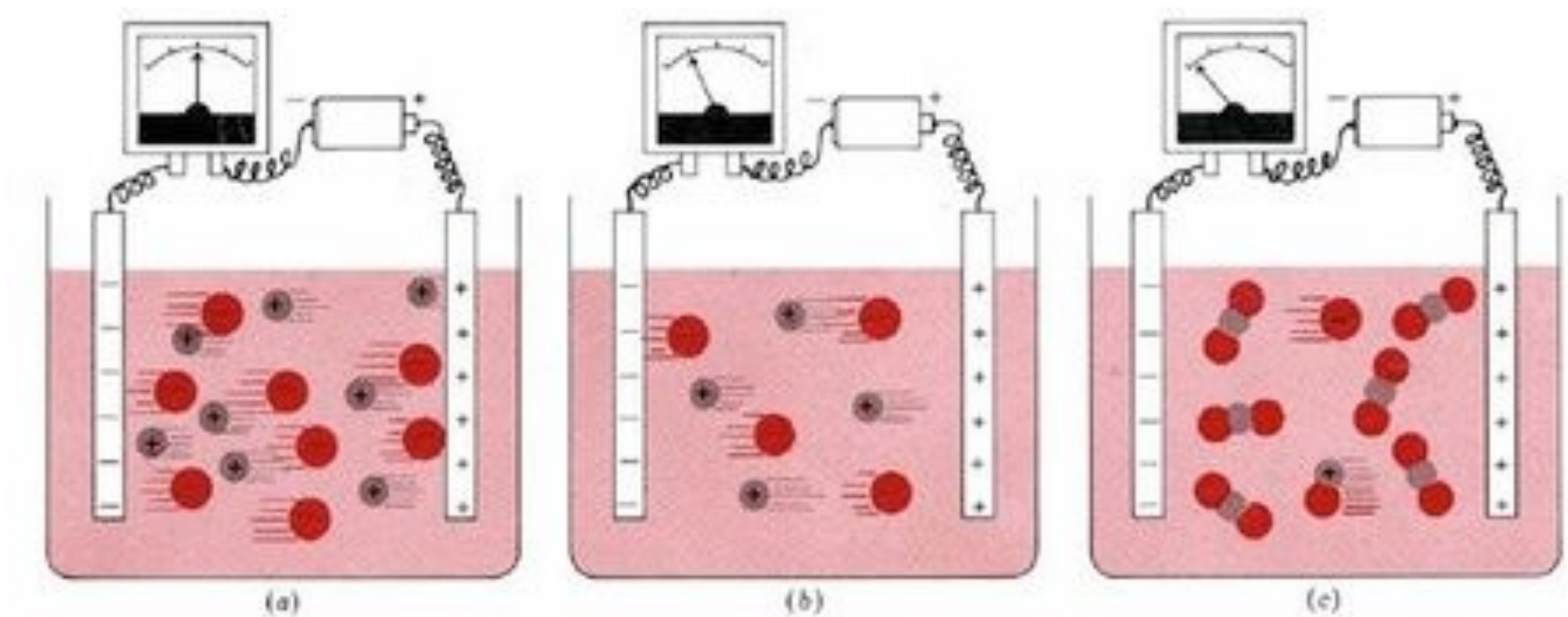
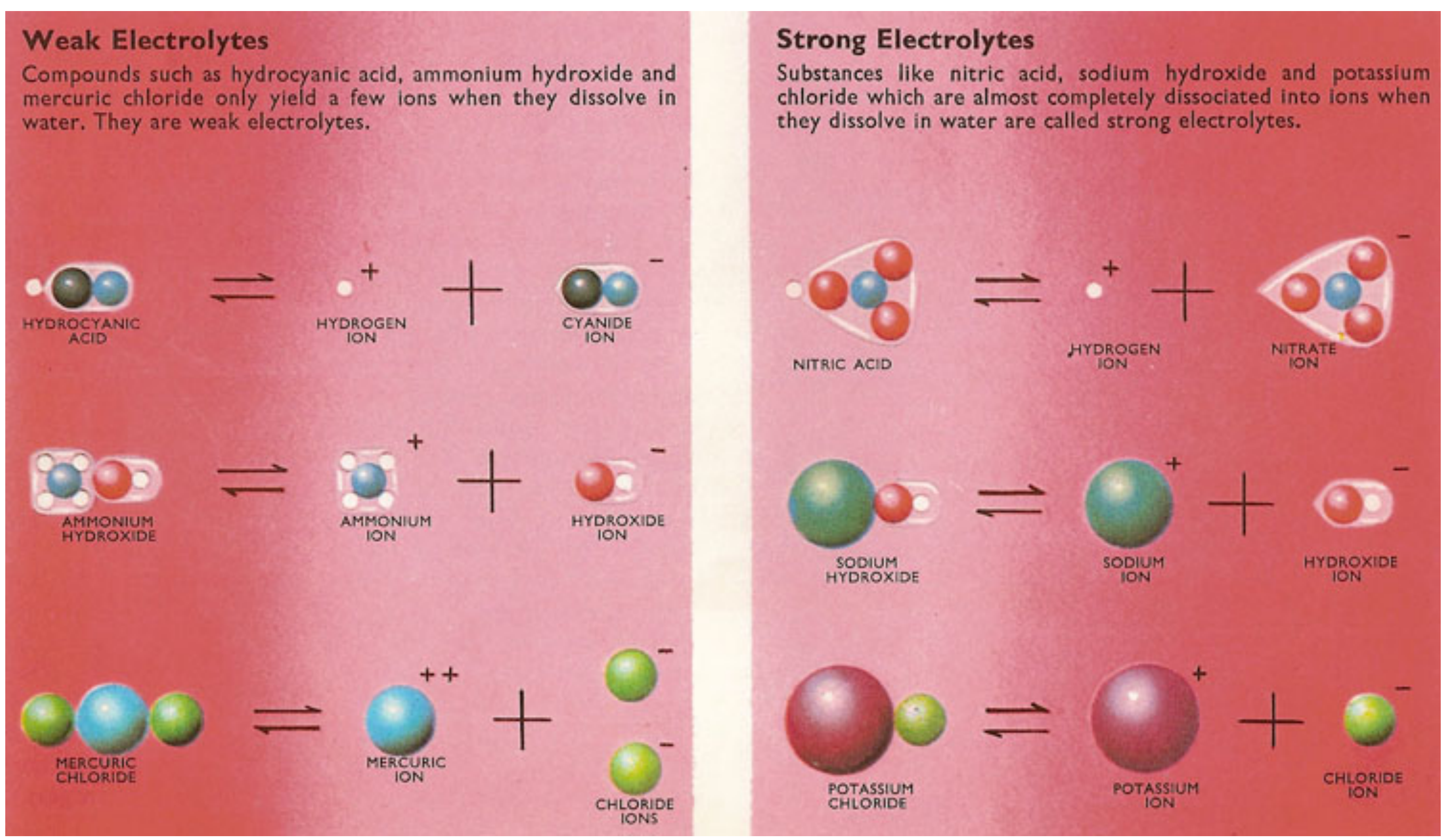



galvanized nails
metal wire
copper wire

Electrolyte between anode and cathode to allow current flow





We will use lemon juice, vinegar, and other "safe" electrolytes for this experiment

Materials

copper foil (available in craft stores)
aluminum foil (from the supermarket)
facial tissue (Kleenex)
multimeter or voltmeter
disposable plate (to work on)
dish soap or lemon juice

1. Cut a piece of copper foil about 1 inch by 2 inches.
2. Separate the tissue into layers. Cut a piece about 1 inch by 3 inches.
3. Cut a piece of aluminum foil about 2 inches square.
4. Layer the materials so that the aluminum foil is on the bottom, the tissue is in the middle, and the copper is on top. Fold the aluminum foil so that the edges wrap around the tissue and copper foil as shown above. This is your battery.
5. Place the battery on a plate. Soak the paper with either dish soap or lemon juice. (We tried one of each.)
6. With your voltmeter, measure the voltage generated by placing one terminal on the copper and one on the aluminum. We got up to half a volt of electricity from our primitive Galvanic cell batteries.

Method Two: Copper and Zinc Wire Battery

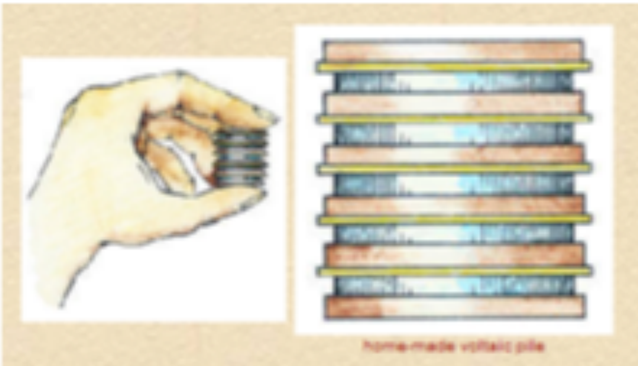
Materials
2 inch long piece of zinc-plated steel wire ("galvanized" picture-hanging wire works well)
4 inch long piece of uncoated copper wire, as thin as possible
a layer of Kleenex (see above)
disposable plate
lemon juice or dish soap

1. Cut a piece of tissue about 1 1/2 inches long and 1/2 inch wide.
2. Wrap the tissue layer around the steel wire, leaving the ends uncovered.
3. Coil the copper wire around the tissue, being sure not to touch the steel wire inside. Make the coils as close together as possible without overlapping.
4. Soak the paper in lemon juice or soap as above and measure the voltage!

The Instructables page has directions for several variations, which include making several batteries and attaching them in series to light an LED, and flower and animal "sculptures" which use lemon juice to light up attached LEDs using the same techniques. One variation which we tried but did not (yet) get to work was to make tiny batteries from coils of wire inside lemon juice-filled drinking straws sealed with hot glue. Although the cells we made looked right, we could measure no voltage from them. We'll write an update post when we've got a few more designs to show off!


Sinometer
2.079
M320
AUTO-RANGE
DMM
HOLD
SELECT
Hz
OFF
600V 400mA MAX
IEC
1010

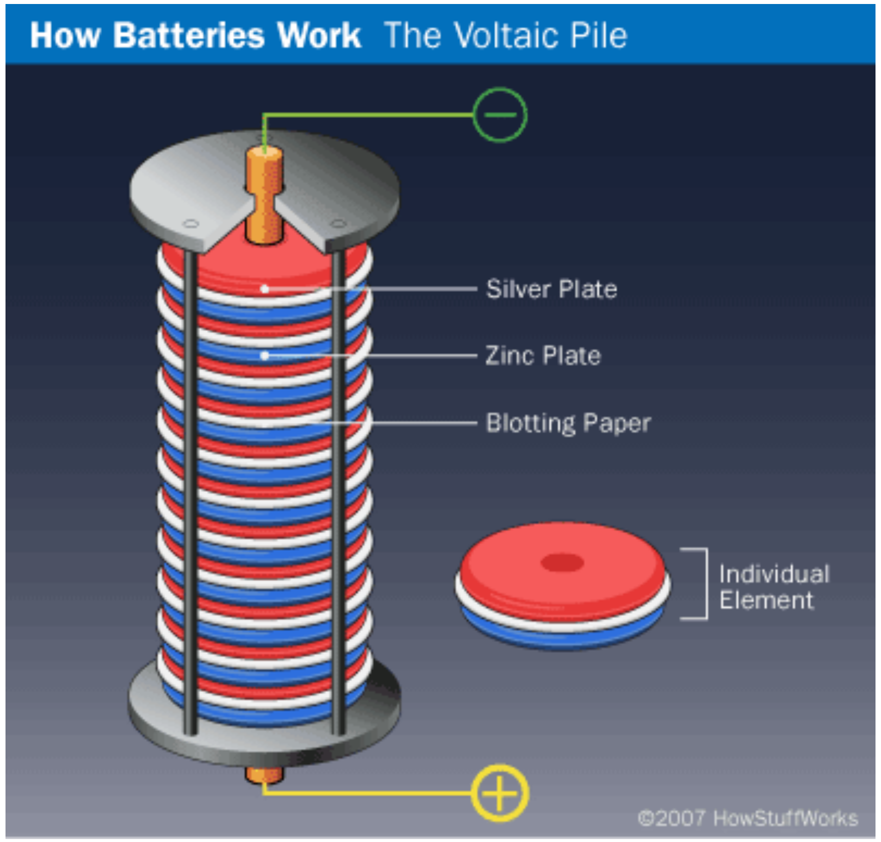
MAKE YOUR OWN PILE You can create your own voltaic pile using 2p and 10p coins and some paper towel the same size as the coins and soaked in lemon juice (or water that has had as much table salt dissolved in it as possible - what's called a 'saturated' solution). The paper discs need to be the same size as the 10p coins so that they don't overlap and short-circuit. Build up your pile by placing a 2p coin, a 10p coin and then a disc of wet paper towel in sequence. The lemon juice (or salt solution) is there to act as a conductor, to help the electrons travel between the different metals.

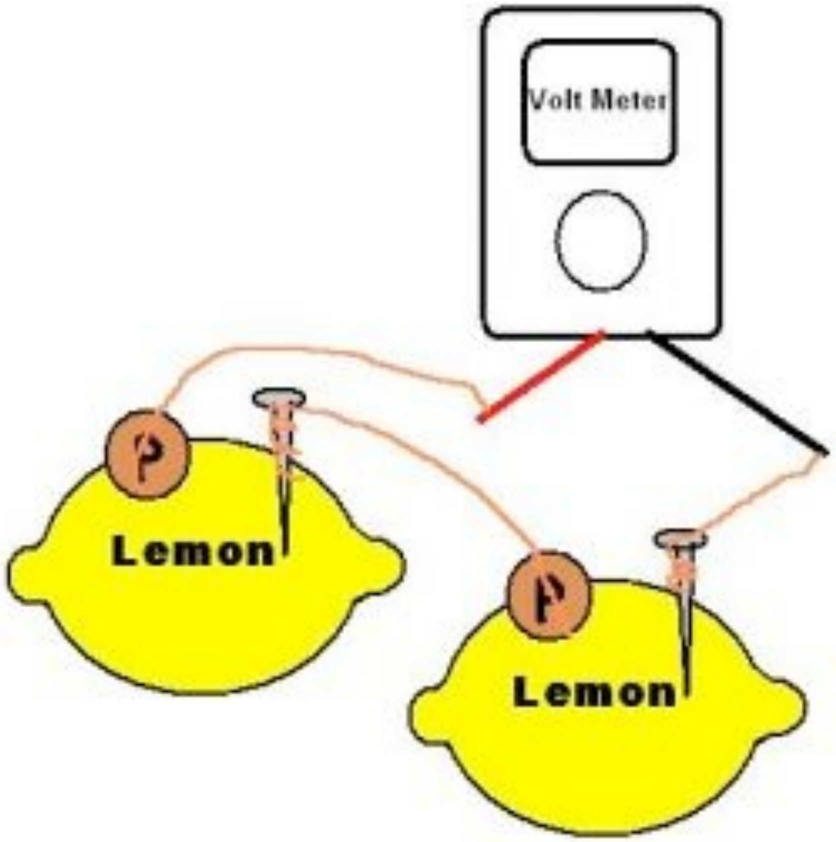


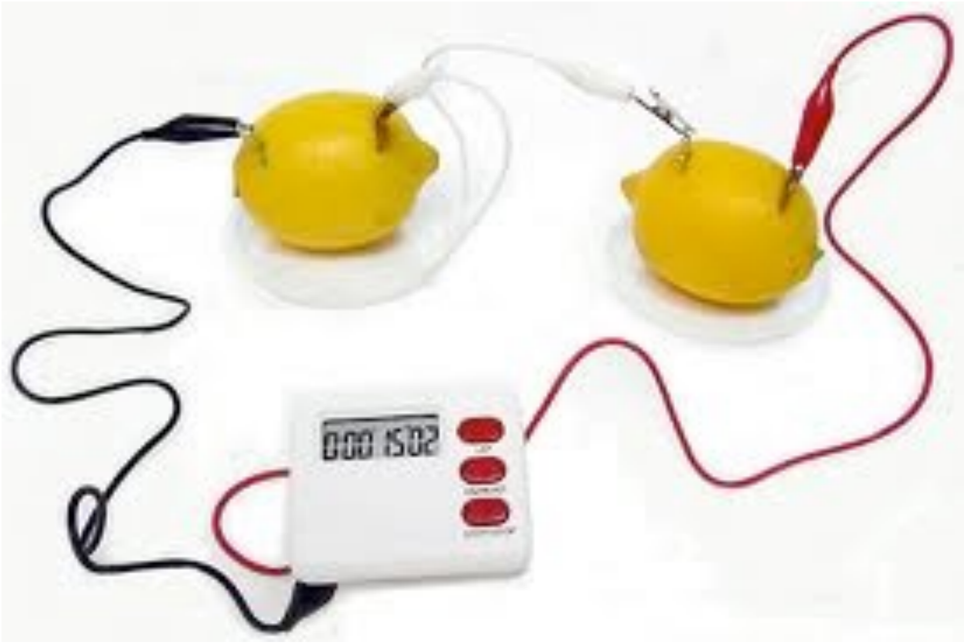
Note: English terms, try penny and nickel for 2p and 10p

Repeat the 2p coin/10p coin/wet paper sequence at least ten times. If you have a multimeter, you should be able to measure the voltage. You can construct a pile using any two different metals. You'll find that different combinations of metals will produce slightly different voltages, though you won't be able to feel the difference

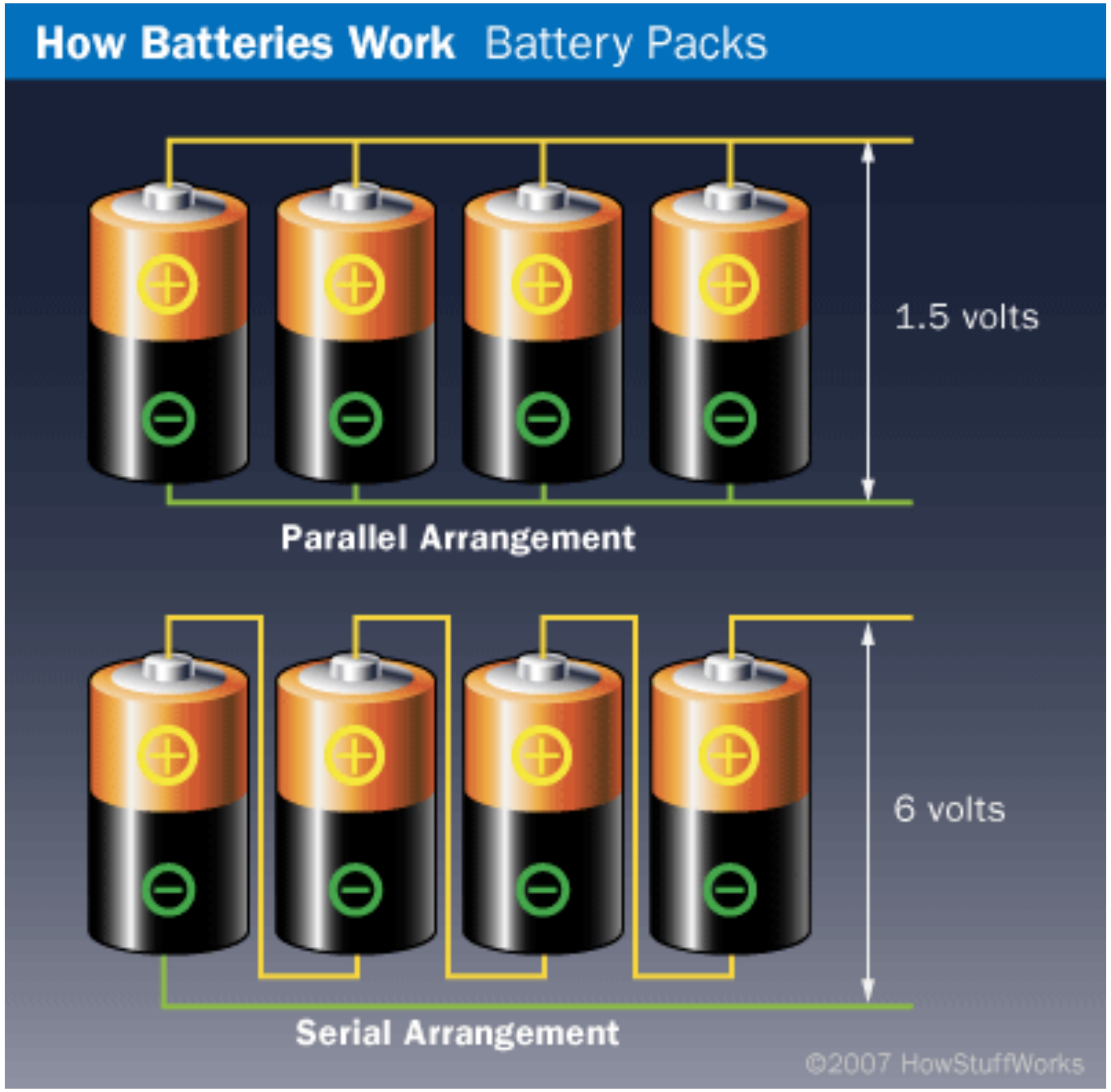
http://www.open2.net/science/roughscience/library/batteries.htm

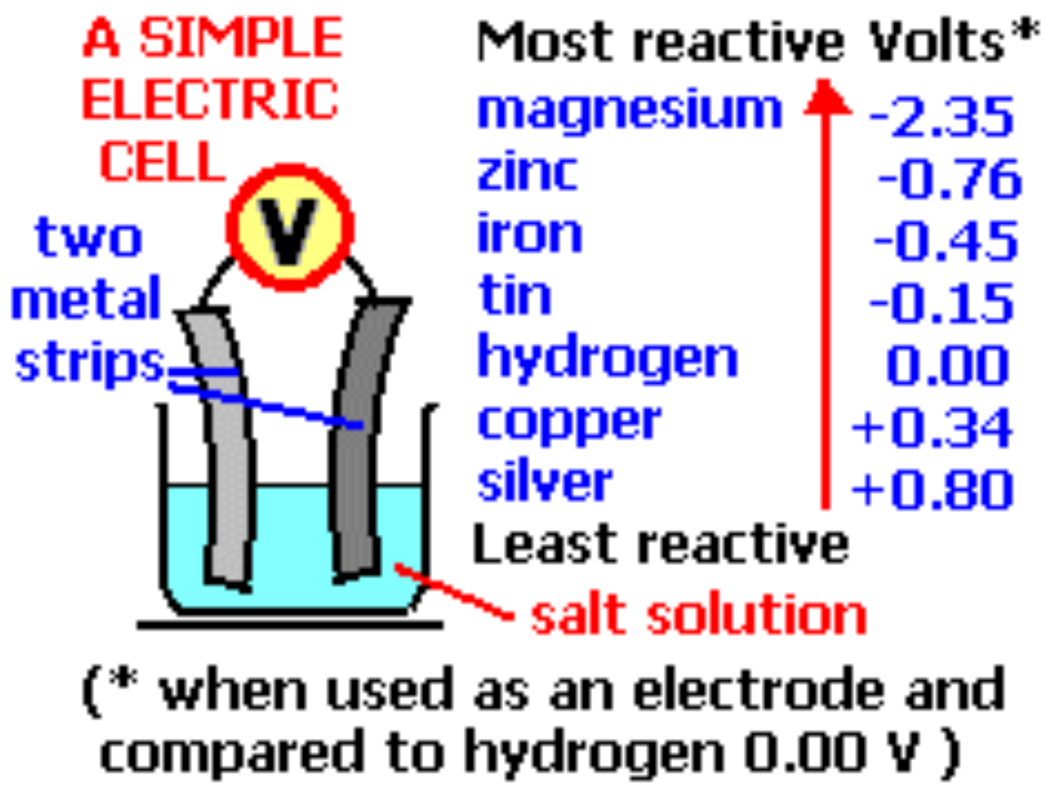



Volt Meter
Lemon
Lemon



A few things to know….





	Redox table - list of reduction potentials measured under standard conditions (25°C, 1 atmosphere pressure, 1 mol/L solution)		
OXIDISING AGENTS (Oxidants) Weakest oxidising agents	$Li^+ + e^- \rightleftharpoons Li(s)$	-3.04 V	**REDUCING AGENTS (Reductants)** Strongest reducing agents
	$K^+ + e^- \rightleftharpoons K(s)$	-2.92 V	
	$Ba^{2+} + 2e^- \rightleftharpoons Ba(s)$	-2.90 V	
	$Ca^{2+} + 2e^- \rightleftharpoons Ca(s)$	-2.87 V	
	$Na^+ + e^- \rightleftharpoons Na(s)$	-2.71 V	
	$Mg^{2+} + 2e^- \rightleftharpoons Mg(s)$	-2.36 V	
	$Al^{3+} + 3e^- \rightleftharpoons Al(s)$	-1.66 V	
	$Zn^{2+} + 2e^- \rightleftharpoons Zn(s)$	-0.76 V	
	$Fe^{2+} + 2e^- \rightleftharpoons Fe(s)$	-0.41 V	
Strength of oxidising agents increases down table	$Sn^{2+} + 2e^- \rightleftharpoons Sn(s)$	-0.14 V	Strength of reducing agents decreases down table
	$Pb^{2+} + 2e^- \rightleftharpoons Pb(s)$	-0.13 V	
	$Fe^{3+} + 3e^- \rightleftharpoons Fe(s$	-0.02 V	
	$H^+ + e^- \rightleftharpoons 1/2H_2(g)$	0.00 V	
	$SO_4^{2-} + 2e^- + 4H^+ \rightleftharpoons SO_2(g) + 2H_2O$	0.21 V	
	$Cu^{2+} + 2e^- \rightleftharpoons Cu(s)$	0.34 V	
	$1/2I_2(s) + e^- \rightleftharpoons I^-$	0.54 V	
	$1/2I_2(aq) + e^- \rightleftharpoons I^-$	0.62 V	
	$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	0.77 V	
Strongest oxidising agents	$Ag^+ + e^- \rightleftharpoons Ag(s)$	0.80 V	Weakest reducing agents
	$1/2O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O$	1.23 V	
	$1/2Cl_2(g) + e^- \rightleftharpoons Cl^-$	1.36 V	
	$MnO_4^- + 5e^- + 8H^+ \rightleftharpoons Mn^{2+} + 4H_2O$	1.51V	
	$1/2 F_2(g) + e^- \rightleftharpoons F^-$	2.87 V	
	The higher the reduction potential, (e.g. F_2), the more easily the substance is reduced (and thus the greater its oxidising power).		

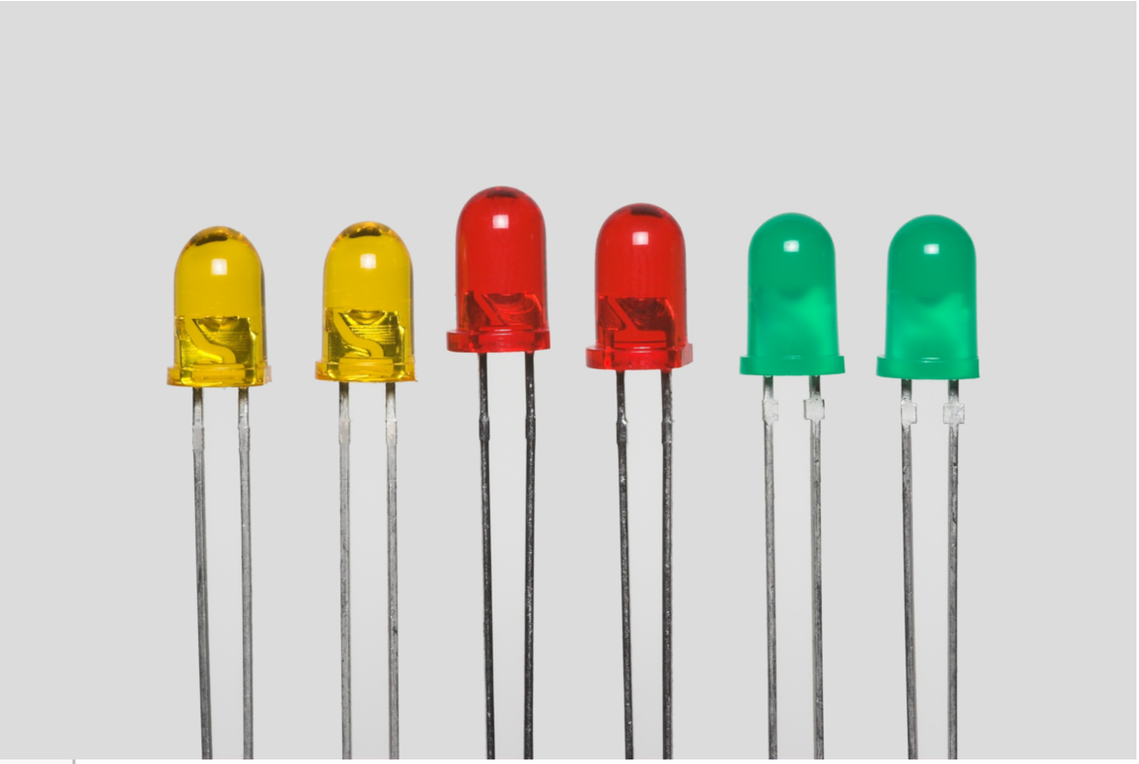
Quiz:

Iron-Zinc: which will reduce, and which will oxidise?

Iron-Tin: which will reduce, and which will oxidise?

LEDs

Color	Wavelength [nm]	Voltage drop [ΔV]	Semiconductor material
Infrared	$\lambda > 760$	$\Delta V < 1.63$	Gallium arsenide (GaAs) Aluminium gallium arsenide (AlGaAs)
Red	$610 < \lambda < 760$	$1.63 < \Delta V < 2.03$	Aluminium gallium arsenide (AlGaAs) Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium(III) phosphide (GaP)
Orange	$590 < \lambda < 610$	$2.03 < \Delta V < 2.10$	Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium(III) phosphide (GaP)
Yellow	$570 < \lambda < 590$	$2.10 < \Delta V < 2.18$	Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium(III) phosphide (GaP)
Green	$500 < \lambda < 570$	1.9[54] $< \Delta V < 4.0$	Indium gallium nitride (InGaN) / Gallium(III) nitride (GaN) Gallium(III) phosphide (GaP) Aluminium gallium indium phosphide (AlGaInP) Aluminium gallium phosphide (AlGaP)
Blue	$450 < \lambda < 500$	$2.48 < \Delta V < 3.7$	Zinc selenide (ZnSe) Indium gallium nitride (InGaN) Silicon carbide (SiC) as substrate Silicon (Si) as substrate – (under development)
Violet	$400 < \lambda < 450$	$2.76 < \Delta V < 4.0$	Indium gallium nitride (InGaN)
Purple	multiple types	$2.48 < \Delta V < 3.7$	Dual blue/red LEDs, blue with red phosphor, or white with purple plastic
Ultraviolet	$\lambda < 400$	$3.1 < \Delta V < 4.4$	Diamond (235 nm)[55] Boron nitride (215 nm)[56][57] Aluminium nitride (AlN) (210 nm)[58] Aluminium gallium nitride (AlGaN) Aluminium gallium indium nitride (AlGaInN) – (down to 210 nm)[59]
Pink	multiple types	$\Delta V \sim 3.3$[60]	Blue with one or two phosphor layers: yellow with red, orange or pink phosphor added afterwards, or white with pink pigment or dye. [61]
White	Broad spectrum	$\Delta V = 3.5$	Blue/UV diode with yellow phosphor



LEDs are diodes, thus the current has to flow in a one direction only.

LESSON PLAN - Science M-Tues.

precipitate experiment → PbI_2 /

Lay out as a challenge - here's the brief - 2 chemicals, observe and hypothesise what is happening. Conclude - tell honestly what you can conclude. If you can't conclude anything, then explicitly say, something like
"Based on the observations cited above, I cannot conclude on any aspect of a chemical reaction of H_2O and NaCl"
Better, though, would be something like
"Based on the observation of the salt particles dissolving in the water, I conclude that the ionic bond between sodium and chlorine is broken by the water molecules." etc.

Show powerpoint of experiment, tell them also it is on one-note!

<u>By end of Period, hand in:</u>

<u>Report</u>
Aim
Hypothesis
(no materials for this one)
Method (one sentence)
Observations - the more the better
<u>Conclusion</u> → what's happening??

→ Also Electroplating — w/ Battery.

TUESDAY: Double Period - Batteries
do battery contest - <u>closest to 2V</u> ←
- paper plates + lemon juice
- aluminum foil   show paper plate + also lemons -

colors

LESSON PLAN - Science Prac

transfer of electrons

1) Begin w/ chemical equation

BATTERIES

- [Reduction - gain of e^-
  oxidation - loss of e^-

vs Acid Base

RedOX

oxidation
$H_2 \rightarrow 2H^+ + 2e^-$
reduction
$2e^- + F_2 \rightarrow 2F^-$

chemical reaction
sharing of electrons - orbitals

\+ / -
CATHODE / ANNODE
reduction / oxidation

PH

- [~~Battery~~ rust w/ sacrificial block]

oxidation
$Zn \rightarrow Zn^{2+} + 2e^-$ loses
copper ion → reduced
$Cu^{2+} \rightarrow Cu$ gains

salt bridge

Leds
1.6 V
1 MA

Patato

H_3PO_4 - acid

~~Zn~~ copper
$2H^+ + 2e^- \rightarrow H_2$ gas

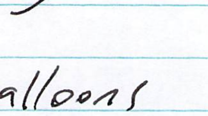
zinc
$Zn \rightarrow Zn^{++} + 2e^-$

Materials

- Voltmeter

current (amps)
measure of electrons (stream)

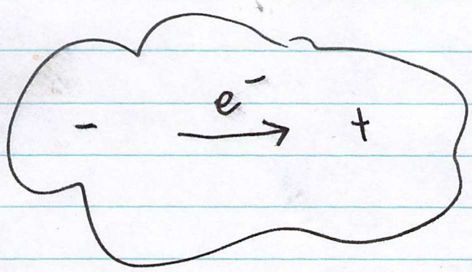
voltage V



- Alka Seltzer in balloon
  weight of alkaseltzer
  weight of watter
  balloon

PV = nRT

Endo / Exo - thermic



McGiver Battery

Balloons
alkaseltzer
measure - diameter of ballon

LESSON PLAN   Role call

REDOX Reactions

- we've actually been doing them all along

chemical compounds (molecules) SHARE electrons.

$NaCl \rightarrow Na^+ + Cl^-$

Redox = Reduction / Oxidation generally come in pairs

- Reduction - originally Reducing ore

2000° $MgO(s) + C(s) \rightarrow Mg(s) + CO(g)$

- Oxidation - substances combing w/ O_2 (burning)

$Mg(s) + O_2(g) \rightarrow 2\,MgO$

Electron sharing $Mg^{2+}\ O^{2-}$

EXPERIMENT

$AgNO_3 + Cu$

work out equation

anode $Cu \rightarrow Cu^{2+} + 2e^-$ oxidized (An Ox)

cathode $Ag^+ + e^- \rightarrow Ag(s)$ reduced (Red cat)

· How to get electricity?

TASK - Design experiment.

$Fe \rightarrow FeO_3$ (rust mostly)

$Fe \rightarrow Fe^{2+} + 2e^-$ oxidation

$Fe^{2+} + O_2 \rightarrow 2\,Fe^{3+}$

Nobility of Metals

Clean up -

LESSON PLAN – Science

1) Redox Reactions

- Battery ppt (?)
- Silver Nitrate – copper example
  [electrode potential]

9:05 – check w/ Sara

Forgiveness as middle path
bitter
→ forgive
ignore (doesnt exist

Next lesson

Equipment

2M Hydrochloric Acid

- (~~Magnesium~~ Copper sulfate)
- SALT BRIDGE — [1M sodium chloride] + tubing cotton

[tin lead iron nickel aluminium zinc] copper – magnesium] (metal strips)

sodium chloride
– Magnesium sulfate — aluminium or zinc sulfate)
- copper sulfate.

last lesson → Review of nail

SCI 4 P 2 — sci 3 Tues ✓ Wed ✓
(did not do yellow / mixture experiment)

LESSON PLAN Battery Redox

—Questions—

Attendance + Assignment [experiment]

(*) Presentation

— Redox Reactions —

[Review - we looked at silver nitrate + did nails]

Experiment

SET UP

- Volt meters
- X-acto knives
- metals
- Steel wool

[Mention
$300 million prize once proposed for better battery]

Report [Design Battery and explain in terms of Redox]
— include info on Rusting prac —

{Take apart Battery
Zinc - Mn}

[
- Sketch of test (verbal outline of)
- Graph
- Any special notes/observation
]

Mention
- Voltmeter - how to use
-

SHOW REPORT
- sci 3 -

Immediately
- set up. Elmo.

Example

$Fe + CuSO_4 \rightarrow \_\_ + Cu$

7 Metals — 21 exps

- Copper
- Lead
- Tin
- Iron
- Zinc
- Alum.
- Magnesium

~~Copper~~	6	4
~~Zinc~~	5	3
~~Alum.~~	4	2
~~Tin~~	3	1
~~Mg~~	2	
~~Lead~~	1	
~~Iron~~		

___/___/___

SC14

Attendance

[Presentation on Screen]

- Review: • Silver Nitrate + Cu
  - Nail – Rusting
    - color of rust
    - other things oxidized – different colors
  - Lemon experiment
    - different voltages

why lemon? HCl, salt solution potato H_3PO_4 acid

video of salt dissolving

show valence chart

- Hand out Prac Report. w/ Rubric
  - do step by step Silver nitrate
  - also: $Fe + CuSO_4 \rightarrow \_\_ + Cu$
  - (*) NOTATION e^-
- Today – finish up Nails – OBSERVE and discern chemical reactions in terms of what metal is oxidizing – [HALF Reaction OK]

Prac Report due Monday.

Double Period next week – build battery.

- [Might have a one-day experiment & report] @ Monday.

$$2AgNO_3(aq) + Cu \longrightarrow Cu(NO_3)_2 + 2Ag$$

$$2Ag^+ + 2e^- \longrightarrow 2Ag$$

$$Cu \longrightarrow Cu^{2+} + 2e^-$$

e^-

FRIDAY
SCI 4

WED P4

Have done:
- yellow mix
- ~~N~~ Nails
- Lemon

~~SCI 3~~ – Redox SCI 3

[Remind – doing great – I'm impressed w/ scientific methods –]

BUSINESS
Attendance

(★) Homework: Double Replacement (yellow mixture)
(Need from all but 4)

Review Redox – [not enough time]
We were going to design a battery, and perhaps we'll get a chance at end of term, but for now we need to finish up Redox Prac Write-up.

[Review Presentation] ←

So – examine nails
explain chemically what is happening.

DIARIES
Write up – Due May 24, P6

- TITLE → Redox Reactions ←   [2-part]
- AIM → to study Redox reactions
- Hypothesis – of nail rusting
- Materials (nail)
- Method (nail)
- Observations
- Chemical Reactions – of each test tube
- Discussion

AND

- Chart of Reduction Pote[…] […]V
  → which combination of ma[…]
  → Chemical reaction of h[…] […]s
    → As TWO HALF

H

- PRESENTATION ←
  [FOR class – step by step.
  Review Silver nitride
  draw picture
  Paper out – in silence
  Question 1]
- notation half reaction e^-
- valence ~~printout~~ –

[WORK THROUGH SILVER NITRATE.]

Precipitate
observations & inferences -

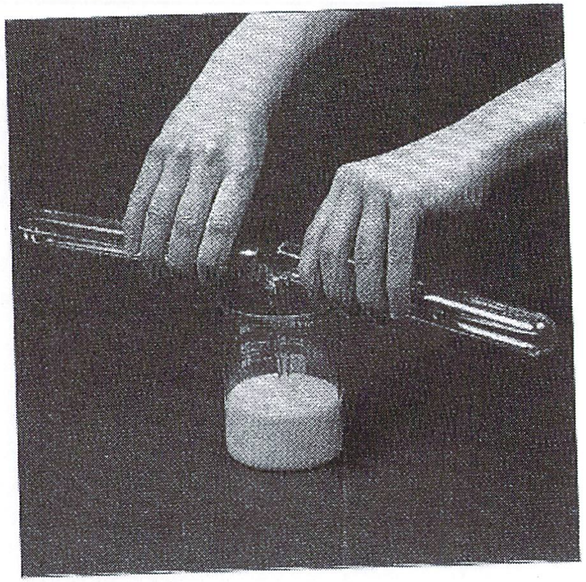


FIGURE 1.18 The reaction between potassium iodide and lead nitrate is a spectacular example of a double replacement reaction.

Double replacement reactions

Sometimes when two compounds react they totally swap ions. Two new compounds are formed. Instead of one element or group of elements being replaced, two lots are replaced. This is called a **double replacement reaction**.

You observed this type of reaction in Experiment 1.5, part A, the reaction between potassium iodide and lead nitrate. It is called 'swapping ions' because it is a double replacement reaction:

potassium iodide + lead nitrate → potassium nitrate + lead iodide

$$2KI(aq) + Pb(NO_3)_2(aq) \rightarrow 2KNO_3(aq) + PbI_2(s)$$

In this experiment, an insoluble salt (PbI_2) was formed and appeared as a solid that settled out of solution. The insoluble lead iodide is known as a **precipitate**. Reactions that have precipitates as their products are known as precipitation reactions.

CHEMICAL
REACTIONS
LESSON PLAN

30 Copies of
Handout

- Begin w/ Presentation
- Read over experiment
- Remind them that one-page report will be due
- Let 'em at it.
  Remind observations
- Have 5 minute QUIET READING TIME - WORK IN GROUPS OF THREE

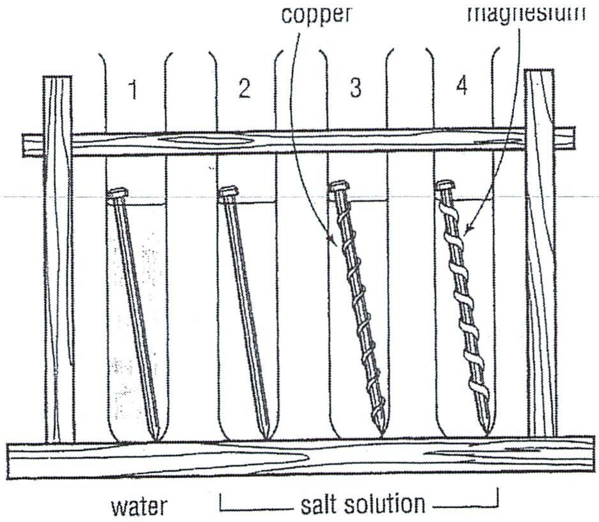
Redox Report for SCI3--Due Thursday, May 17, Period 6.

- Title: Redox reactions
- Aim: To study Redox Reactions
- Define: Redox Reaction--provide an example with:

--A balanced chemical equation (you can use the Silver Nitrate and Copper example)
--Derive the two half equations (e.g. $Cu \rightarrow Cu^{2+} + 2e^-$ is one "half equation").
--Identify which element is being reduced, and which one is oxidised.
(Recall OIL RIG--> Oxidation Is Loss of electrons, Reduction Is Gain of electrons)

The following apply only to the Nail Experiment and need to be included in your report:

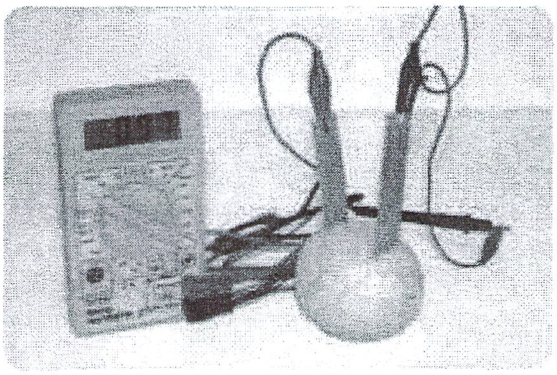
- Hypothesis
- Materials
- Method
- Observations
- Chemical Reactions taking place within each test tube.
- Discussion/Conclusion



ALSO INCLUDE IN YOUR REPORT:

- A chart of the measured voltaic potentials of ALL the metal combinations we tested with the lemons.

- Which combination of metals provided the highest voltage? Write the two half equations for these two metals, and again, decide which metal is being oxidised, and which one is being reduced.



- What do you think would happen to each metal if you hooked up the lemon battery to a lightbulb for a long time?

Thanks!
Mr. Middendorf and Ms. Balfe

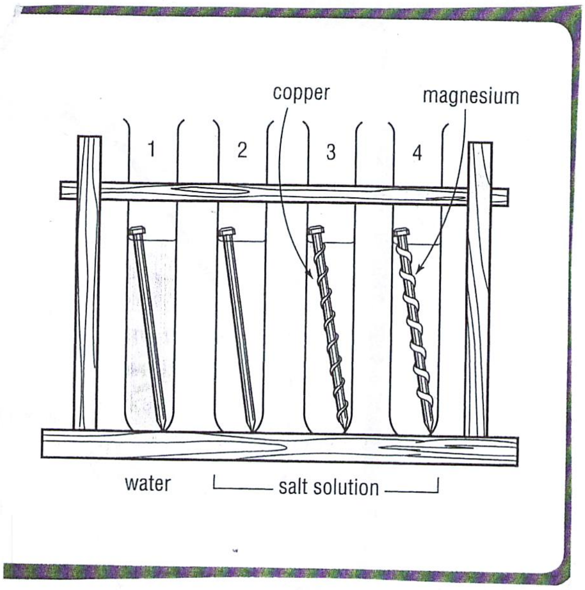
P.S. PLEASE REFERENCE ALL INTERNET SOURCES.

Prac 1 –Redox reactions and electrochemistry

Materials
4 Nails
4 Test tubes
Copper wire
Magnesium wire strip
Salt solution

In this prac, we want to investigate factors that affect the rusting (or lack thereof) of an iron nail.

Design an experiment which investigates the rusting of iron.



AIM
Hypothesis
Materials
Method
Measurements /Observation
Discussion /Conclusion

Rubric--Chemical Reactions Prac

Criteria	Excellent	Proficient	Pass
Cognitive Skills	Student balances chemical reaction, noting the ion "swap", and provides an insightful discussion/conclusion which theorises on the nature of the reaction based on actual observations combined with prior chemistry knowledge.	Student balances chemical reaction, noting the ion "swap" and answers three discussion questions.	Student balances chemical reaction.
Procedural Skills	Student records observations, providing detail and context of experiment, and makes running notes of possible hypotheses.	Student records observations, providing detail and context of experiment.	Student records observations.
Interpersonal Skills	The student actively promotes effective group interaction and initiates group tasks.	Student cooperates with group and participates in group tasks.	Student works with group to complete experiment.

 Name______________________________

More chemical reactions

experiment 1.5

Aim

To observe some chemical reactions and write their balanced chemical equations.

Part A Swapping ions

Materials

- lead nitrate solution $Pb(NO_3)_2$
- potassium iodide solution KI
- 3 test-tubes

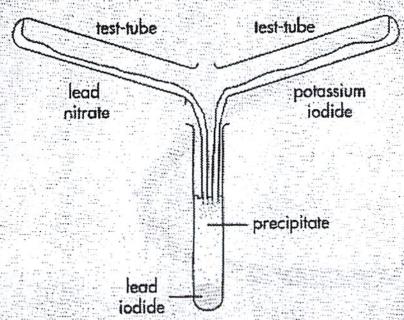


FIGURE 1.13 A precipitate is formed in this reaction.

Safety

Lead compounds are poisonous. Handle them with care, and wash your hands thoroughly after using them.

Method

1. Pour about 2 cm depth of lead nitrate into one test-tube and about 2 cm depth of potassium iodide into the other.
2. Pour the contents of the test-tubes into a third test-tube.
3. Allow the mixture to settle.
4. Record your observations.

Discussion

In this reaction, the ions of the two substances swap over and one of the new substances is a solid. This solid also contains lead ions.

1. Write a word equation for this reaction showing how the ions swap.
2. What product remains dissolved in the clear solution? How could you obtain a solid product from this solution?
3. Write a balanced chemical equation for this reaction.

Observations:
Balanced Chemical Equation:
Discussion/Conclusion:

Rubric--Chemical Reactions Prac			
Criteria	**Excellent**	**Proficient**	**Pass**
Cognitive Skills	Student balances chemical reaction, noting the ion "swap", and provides an insightful discussion/conclusion which theorises on the nature of the reaction based on actual observations combined with prior chemistry knowledge.	Student balances chemical reaction, noting the ion "swap" and answers three discussion questions.	Student balances chemical reaction.
Procedural Skills	Student records observations, providing detail and context of experiment, and makes running notes of possible hypotheses.	Student records observations, providing detail and context of experiment.	Student records observations.
Interpersonal Skills	The student actively promotes effective group interaction and initiates group tasks.	Student cooperates with group and participates in group tasks.	Student works with group to complete experiment.

Homework for Chemical Reactions Prac **NAME**______________________

PART 1:

Balance the following equations:

1) ___ $NaNO_3$ + ___ PbO → ___ $Pb(NO_3)_2$ + ___ Na_2O

2) ___ AgI + ___ $Fe_2(CO_3)_3$ → ___ FeI_3 + ___ Ag_2CO_3

3) ___ $C_2H_4O_2$ + ___ O_2 → ___ CO_2 + ___ H_2O

4) ___ $ZnSO_4$ + ___ Li_2CO_3 → ___ $ZnCO_3$ + ___ Li_2SO_4

5) ___ V_2O_5 + ___ CaS → ___ CaO + ___ V_2S_5

6) ___ $Mn(NO_2)_2$ + ___ $BeCl_2$ → ___ $Be(NO_2)_2$ + ___ $MnCl_2$

7) ___ $AgBr$ + ___ $GaPO_4$ → ___ Ag_3PO_4 + ___ $GaBr_3$

8) ___ H_2SO_4 + ___ $B(OH)_3$ → ___ $B_2(SO_4)_3$ + ___ H_2O

9) ___ S_8 + ___ O_2 → ___ SO_2

10) ___ Fe + ___ $AgNO_3$ → ___ $Fe(NO_3)_2$ + ___ Ag

PART 2:

Write up the chemical reactions experiment (lead nitrate and potassium iodide) in a neatly presented one-page report and include:

- Title of Experiment
- Aim
- Materials (with sketch)
- Method
- Observations
- Chemical Reaction--the balanced chemical equation.
- Discussion (explain how you could obtain a solid product when combining lead nitrate and potassium iodide).

TABLE 1.5 BALANCING A CHEMICAL EQUATION.

	Reactants		Products		
Word equation	water	→	hydrogen	+	oxygen
Chemical formulae	H_2O	→	H_2	+	O_2
Use numbers in front of formulae to balance atoms	$2H_2O$	→	$2H_2$	+	O_2
Checking	4 × H, 2 × O		4 × H, 2 × O		
Balanced equation	$2H_2O(l)$	→	$2H_2(g)$	+	$O_2(g)$

More chemical reactions

experiment 1.5

Aim

To observe some chemical reactions and write their balanced chemical equations.

Part A Swapping ions

Materials

- lead nitrate solution $Pb(NO_3)_2$
- potassium iodide solution KI
- 3 test-tubes

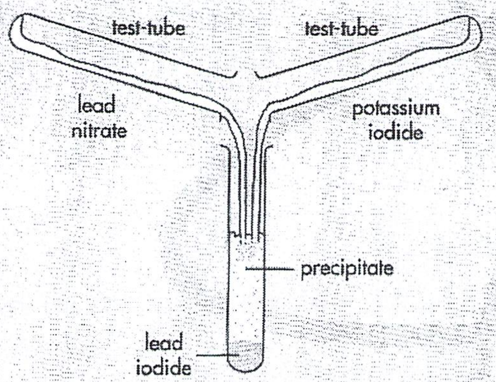


FIGURE 1.13 A precipitate is formed in this reaction.

Safety

Lead compounds are poisonous. Handle them with care, and wash your hands thoroughly after using them.

Method

1 Pour about 2 cm depth of lead nitrate into one test-tube and about 2 cm depth of potassium iodide into the other.
2 Pour the contents of the test-tubes into a third test-tube.
3 Allow the mixture to settle.
4 Record your observations.

Discussion

In this reaction, the ions of the two substances swap over and one of the new substances is a solid. This solid also contains lead ions.

1 Write a word equation for this reaction showing how the ions swap.
2 What product remains dissolved in the clear solution? How could you obtain a solid product from this solution?
3 Write a balanced chemical equation for this reaction.

ICT Resources
Explore Learning Gizmos
Phet

DO EXPERIMENTS
$Mg + O_2 \rightarrow MgO$
$Na + H_2O \rightarrow NaOH + H_2$

Education

Balancing Chemical Equations –

Balancing Equations Worksheet

Balance the following equations:

1. Limestone ($CaCO_3$), a common Ohio mineral, can be heated to produce calcium oxide.

   $CaCO_3 \rightarrow CaO + CO_2$

2. Joseph Priestley discovered oxygen in 1774. He heated mercury (II) oxide to form mercury and oxygen.

   $HgO \rightarrow Hg + O_2$

3. Ammonia is an important compound used to make fertilizers. It is produced by reacting nitrogen and hydrogen.

   $N_2 + H_2 \rightarrow NH_3$

4. Photosynthesis is a reaction by which plants convert carbon dioxide and water into sugar.

   $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$

5. Combustion of gasoline in an automobile engine not only produces carbon dioxide and water but also energy.

   $C_8H_{18} + O_2 \rightarrow CO_2 + H_2O$

6. Marble (calcium carbonate) reacts with sulfuric acid (one possible acid in acid rain).

   $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$

7. Iron reacts with oxygen in the air to form rust (Fe_2O_3).

   $Fe + O_2 \rightarrow Fe_2O_3$

8. Magnesium hydroxide (one ingredient in a popular antacid) is used to neutralize stomach acid.

   $Mg(OH)_2 + HCl \rightarrow MgCl_2 + H_2O$

9. Silver nitrate and sodium bromide are used to make silver bromide (a sun-sensitive substance useful in photographic processes).

   $AgNO_3 + NaBr \rightarrow AgBr + NaNO_3$

SCIENCE

Gr 10 Sci 3

Fri - P2 - start rusting chemical combo. —

GYC (~~Mon - P2 - go over " check~~

Mon P5 - Exam - exp 1+2

M1 Tues P2 - ~~rusting - comp lek + write up~~ Exam - exp3

Tues P5 - rusting + begin write up

Wed P4 - ?? exam, write, prac
equations
balancing

Thur P6 - finish rusting prac + write up //

Fri P2 - hand in rusting prac - for marking //

Gr 10 Sci 4

GYC (Mon - P6 - set up rusting

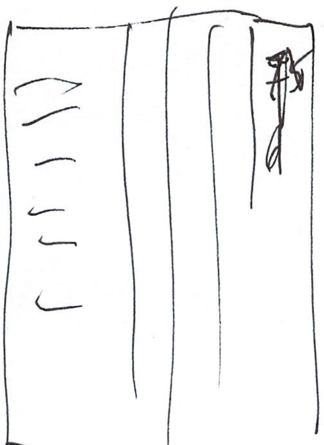
Tues - P1 - exam exp 1+2

Wed - P3 - rusting

Fri P2 - exp 3

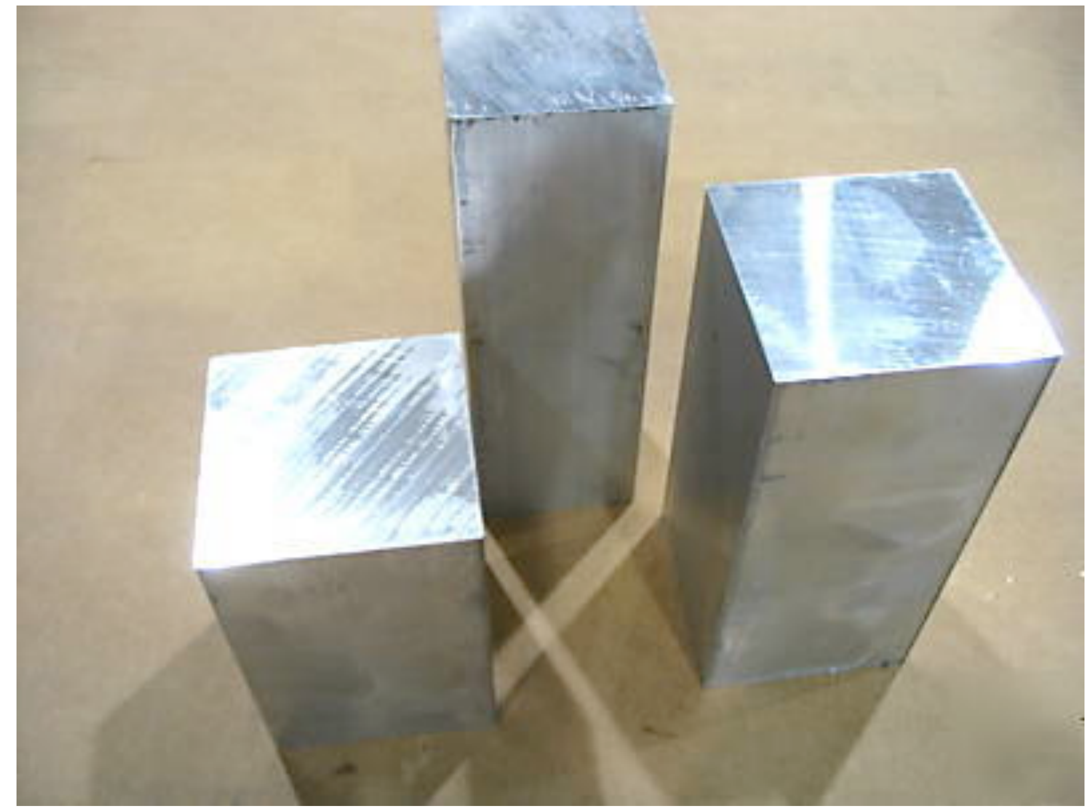
Mon P1 - rusting + begin write up

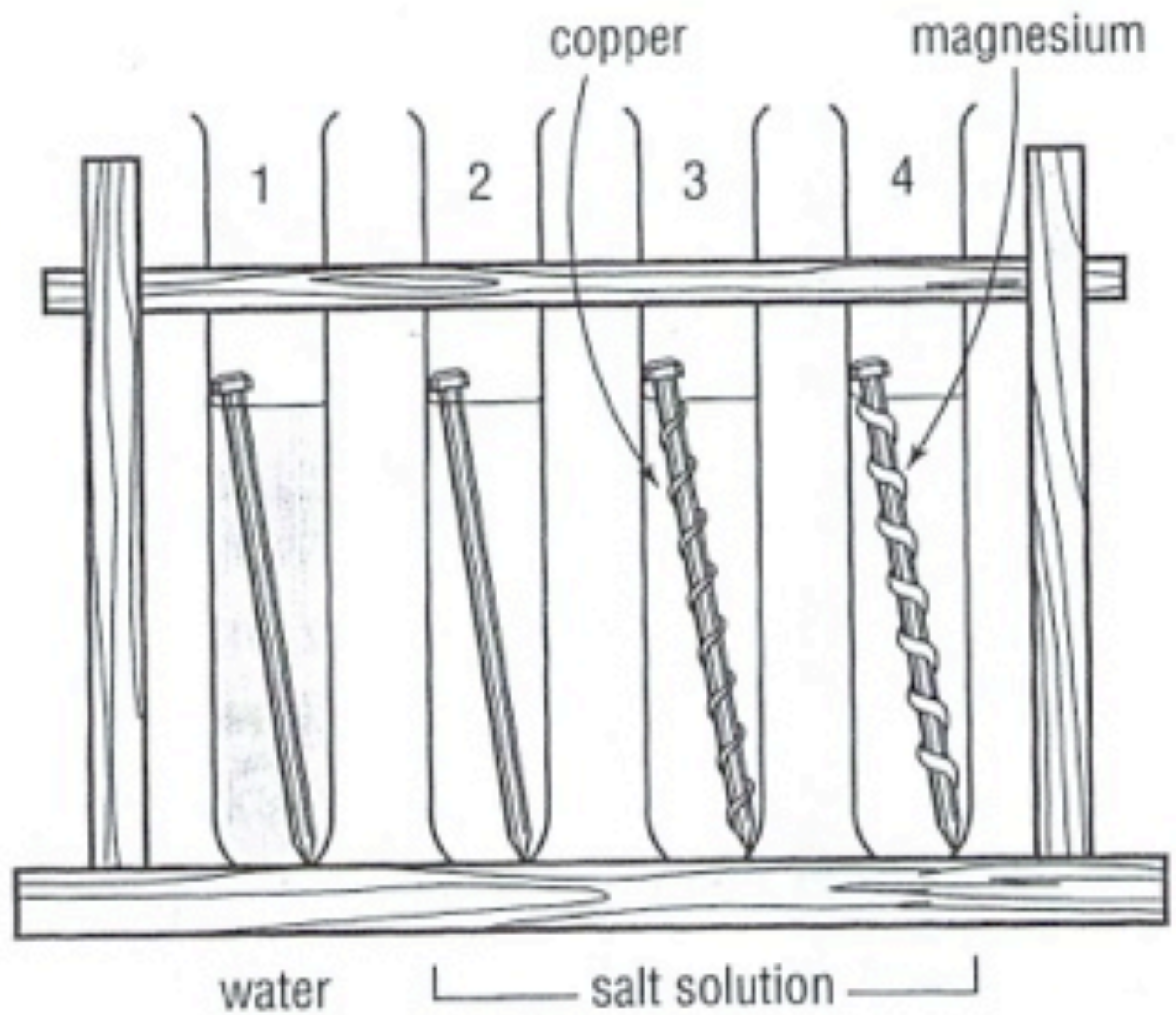
Thes P1+2 - finish rusting, write up
+ equation + balancing



Electro-Chemistry and Redox Reactions

The ores of aluminium is called bauxite. Bauxite is a composition of aluminium oxide, (Al_2O_3).




copper
magnesium
1
2
3
4
water
salt solution

Silver Nitrate ($AgNO_3$) and Copper (Cu)

$$Cu(s) + 2AgNO3\ (aq) \rightarrow Cu(NO3)2\ (aq) + 2\ Ag(s)$$

$$Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$$

Half Reactions:

$Cu \rightarrow Cu^{2+} + 2e^{-}$ Oxidation

$2e^{-} + 2Ag^{+} \rightarrow 2Ag$ Reduction

$$Cu(s) + 2AgNO3\ (aq) \rightarrow Cu(NO3)2\ (aq) + 2\ Ag(s)$$

Half Reactions:

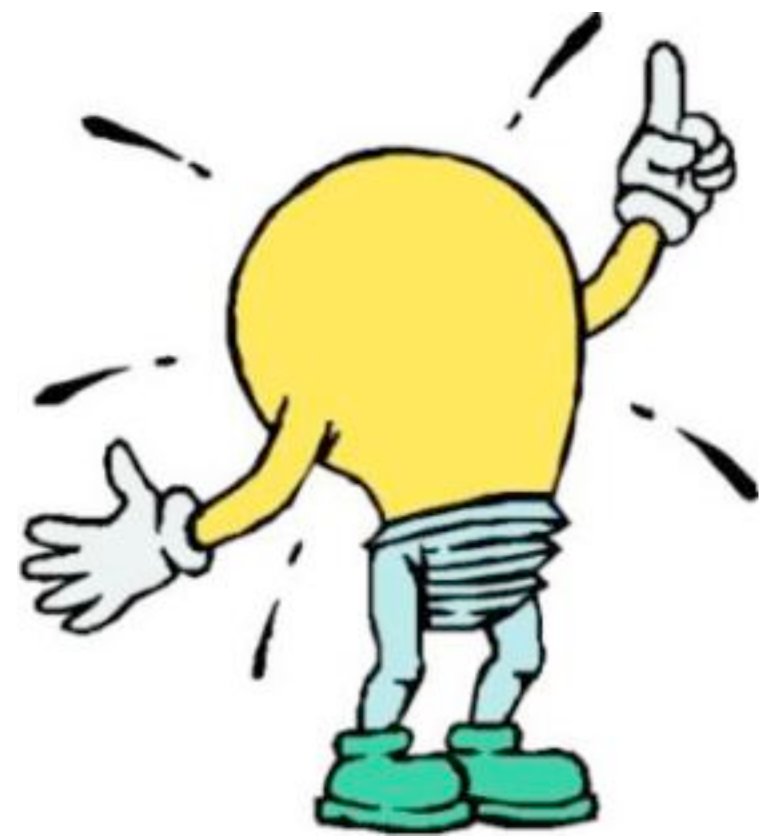
$Cu \rightarrow Cu^{2+} + 2e^-$ Oxidation

$2e^- + 2Ag^+ \rightarrow 2Ag$ Reduction

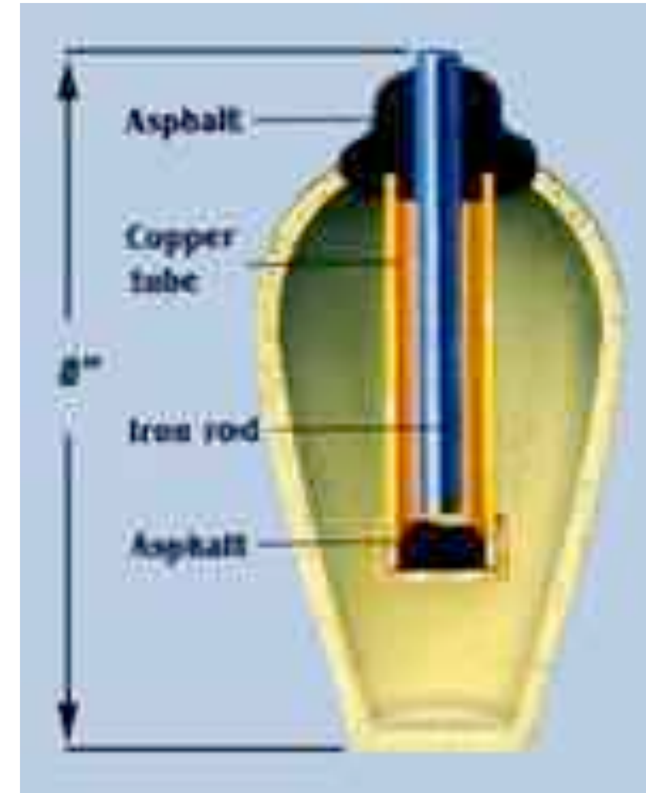
OIL RIG

oxidation is loss reduction is gain

How can we use the electrons in a Redox reaction to create electricity?



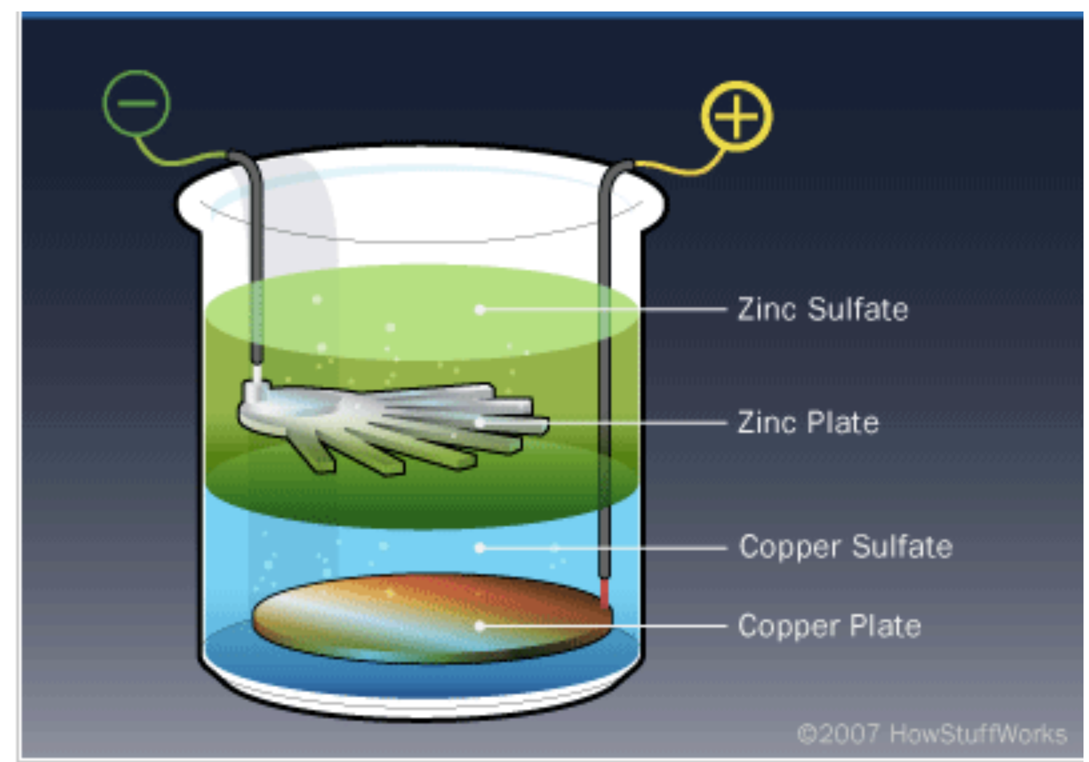
Baghdad Battery ~2000 years old



$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

$$Cu^{2+} + 2\,e^{-} \rightleftharpoons Cu\text{: } E^{0} = +0.34\text{ V}$$

$$Zn^{2+} + 2\,e^{-} \rightleftharpoons Zn\text{: } E^{0} = -0.76\text{ V}$$



Half Reactions Potentials

	Redox table - list of **reduction potentials** measured under **standard conditions** (25°C, 1 atmosphere pressure, 1 mol/L solution)		
OXIDISING AGENTS **(Oxidants)** Weakest oxidising agents	$Li^+ + e^- \rightleftharpoons Li(s)$	-3.04 V	**REDUCING AGENTS** **(Reductants)** Strongest reducing agents
	$K^+ + e^- \rightleftharpoons K(s)$	-2.92 V	
	$Ba^{2+} + 2e^- \rightleftharpoons Ba(s)$	-2.90 V	
	$Ca^{2+} + 2e^- \rightleftharpoons Ca(s)$	-2.87 V	
	$Na^+ + e^- \rightleftharpoons Na(s)$	-2.71 V	
	$Mg^{2+} + 2e^- \rightleftharpoons Mg(s)$	-2.36 V	
	$Al^{3+} + 3e^- \rightleftharpoons Al(s)$	-1.66 V	
	$Zn^{2+} + 2e^- \rightleftharpoons Zn(s)$	-0.76 V	
	$Fe^{2+} + 2e^- \rightleftharpoons Fe(s)$	-0.41 V	
Strength of oxidising agents increases down table	$Sn^{2+} + 2e^- \rightleftharpoons Sn(s)$	-0.14 V	Strength of reducing agents decreases down table
	$Pb^{2+} + 2e^- \rightleftharpoons Pb(s)$	-0.13 V	
	$Fe^{3+} + 3e^- \rightleftharpoons Fe(s$	-0.02 V	
	$H^+ + e^- \rightleftharpoons 1/2H_2(g)$	0.00 V	
	$SO_4{}^{2-} + 2e^- + 4H^+ \rightleftharpoons SO_2(g) + 2H_2O$	0.21 V	
	$Cu^{2+} + 2e^- \rightleftharpoons Cu(s)$	0.34 V	
	$1/2I_2(s) + e^- \rightleftharpoons I^-$	0.54 V	
	$1/2I_2(aq) + e^- \rightleftharpoons I^-$	0.62 V	
	$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	0.77 V	
Strongest oxidising agents	$Ag^+ + e^- \rightleftharpoons Ag(s)$	0.80 V	Weakest reducing agents
	$1/2O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O$	1.23 V	
	$1/2Cl_2(g) + e^- \rightleftharpoons Cl^-$	1.36 V	
	$MnO_4{}^- + 5e^- + 8H^+ \rightleftharpoons Mn^{2+} + 4H_2O$	1.51V	
	$1/2\ F_2(g) + e^- \rightleftharpoons F^-$	2.87 V	
	The higher the reduction potential, (e.g. F_2), the more easily the substance is reduced (and thus the greater its oxidising power).		

Today: experiment to find electrode potentials between different metals.

Tips:
-Roll and squeeze the lemon on a bench top to loosen the juices inside - but don't squeeze too hard.
--cut slit in lemon with x-acto knife for tight fit of electrodes.
--sand electrodes with steel wool or sandpaper.

Create chart!

Electrode	Mg	Al	Zn	Fe	Ni	Sn	Pb	Cu
Mg		___.___V	___.___V	___.___V	___.___V	___.___V	___.___V	___.___V
Al	___.___V		___.___V	___.___V	___.___V	___.___V	___.___V	___.___V
Zn	___.___V	___.___V		___.___V	___.___V	___.___V	___.___V	___.___V
Fe	___.___V	___.___V	___.___V		___.___V	___.___V	___.___V	___.___V
Ni	___.___V	___.___V	___.___V	___.___V		___.___V	___.___V	___.___V
Sn	___.___V	___.___V	___.___V	___.___V	___.___V		___.___V	___.___V
Pb	___.___V	___.___V	___.___V	___.___V	___.___V	___.___V		___.___V
Cu	___.___V	___.___V	___.___V	___.___V	___.___V	___.___V	___.___V	

Rubric for Redox Report SHC Year 10 SCI3 and SCI4 Name____________

Criteria	Exceptional	Proficient	Pass
Demonstrate knowledge of Redox Reactions	Student can provide an example of a redox reaction, identifying the corresponding half reaction equations as reduction or oxidation, explain a redox reaction in terms of electron transfer, AND hypothesise that an element can be either reduced or oxidised, depending on the chemical environment.	Student can provide an example of a redox reaction, identifying the corresponding half reaction equations as reduction or oxidation, AND explain a redox reaction in terms of electron transfer.	Student can provide an example of a redox reaction, identifying the corresponding half reaction equations as either reduction or oxidation.
Develop, interpret and evaluate chemistry experiments	Student can design and document a scientific experiment, record insightful observations of the experiment, AND correctly identify chemical reactions based on the observations.	Student can design and document a scientific experiment, AND record insightful observations of the experiment.	Student can design and properly document a scientific experiment.
Collect, process, and communicate scientific information	Student can provide a readable report with all the required components (Title, Aim, Hypothesis, Materials, Method, Observations, Discussion/ Conclusion), organise the report in a clear and logical sequence, AND provide relevant additional information from properly referenced sources.	Student can provide a readable report with all the required components (Title, Aim, Hypothesis, Materials, Method, Observations, Discussion/Conclusion), AND organise the report in a clear and logical sequence.	Student can provide a readable report with all the required components (Title, Aim, Hypothesis, Materials, Method, Observations, Discussion/ Conclusion).

Rubric for Redox Report SHC Year 10 SCI3 and SCI4 Name____________