Pd/C catalysis of H_2 & O_2

Fill clean, rinsed, empty 16 oz. pop bottles with two-parts H_2 gas and one-part O_2 gas via water displacement. Place a small amount (micro-spatula) of Pd-on-C (palladium on charcoal) into a cut-up pipette. Using an explosion shield, drop the Pd-filled pipette into the $H_2(g)/O_2(g)$ bottle. Ear protection is smart !

I always do this one with catalysis... I do an explosion with a burning stick (activation energy) followed by this Pd/C catalyzed method. The need for the addition of an activation energy can be circumvented ! Also a good tool to emphasize the spontaneous nature of the H_2 & O_2 reaction to produce water...

Dry Ice in Universal Indicator water

Dilute 30. mL of Universal Indicator to 3.0 liters in tap water. A tall cylinder or test tube is preferred. Add small pieces of dry ice. Some foaming/frothing may occur. Add small amounts of 6 M HCl and 6 M NaOH alternately.

Electrolysis of $SnCl_2(aq)$

Mix 10-20 grams of solid $SnCl_2$ into about 75 mL distilled water. Adding some 6 M $HCl(aq)$ may assist in the dissolution. Let this set undisturbed overnight. Decant or pipette off the clear liquid for the electrolysis. Support two pencil leads (graphite) into this saturated $SnCl_2(aq)$ solution. Applying a 9-volt batter to across the pencil leads should result in tin (sn) dendrites "growing" onto the (+) i.e. 'black wire' terminal pencil. A digital microscope is best for displaying this.

The $SnCl_2(aq)$ should be relatively fresh. A new 9-V battery is also nice, as are good electrical connections !

Of course the half-reaction of interest is simply : $Sn^{2+}(aq) + 2e^- \rightarrow Si(s)$

At the other electrode (anode) the dominant reaction is : $2H_2O(\ell) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

$Ca(C_2H_3O_2)_2(aq)$ & Ethanol Open Lattice

Prepare a saturated calcium acetate solution by dissolving 15 grams of the solid into ~50 mL of water. Pour this saturated solution into ~300 mL of ethanol. You might need to pour this goop back into another 600-mL beaker, as a little additional "agitation-of-pouring" helps set up the open lattice. Preferably with gloves over the sink, compress this goop until a snowball-type structure is formed.

Egg Osmosis

Soak 3 or 4 eggs in vinegar overnight or slightly longer. Gently rinse to remove last remnants of the calcium carbonate egg shell. Soak one membrane-exposed egg in pure water overnight. Soak one membrane-exposed egg in corn syrup & water (about 60 ml corn syrup to 40 mL warm water) overnight. Voila ! Gross !

The osmotic pressures are actually quite large, forcing water into the egg-membrane when soaking in pure water and water out of the egg when soaking in concentrated corn syrup water... Egg whites are about 88% water (10.5% proteins, 0.5% carbohydrates, 0.8% 'ash' and 0.2% lipids)

Brass Penny

Soak several very clean, new copper pennies in a bath of ~6 M NaOH(aq) along with a sprinkling of granular (~20 mesh) zinc. After about 24 hours, rinse thoroughly. Heat this penny gently in a mellow flame, turning back and forth constantly. This only takes a few seconds. Quench/cool the heated penny quickly in cool water.

My *"back-of-the-envelope"* calculations estimate the zinc layer on top of the copper penny to be several hundred zinc atoms thick (the zinc-coated penny weighs more than the original, fresh penny). The heat and subsequent rapid cooling anneal the zinc to the copper forming brass !

Condensing Air

Float several empty, dry, clean Pyrex test tubes in a tall open-mouth dewar of liquid nitrogen for about 20 minutes. Add small portions of $N_2(\ell)$ as needed from a styrofoam cup. After about 20 minutes, observe the "condensed air" that has accumulated in the previously empty test tubes. Test this liquid for paramagnetism.

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Whereas the Lewis structures of both N_2 { :N≡N: } and O_2 { :O=O: } both suggest no unpaired electrons, the paramagnetic behavior or O_2 certainly suggests otherwise. This experimental observation provides motivation for another, more complete model of bonding : molecular orbital theory

Oscillating Clock

- Flask A (2-liter) : 110. mL of 30% $H_2O_2(aq)$ diluted to ~300 mL
- Flask B (500-mL) : 13.0 grams $KIO_3(s)$ & ~4 mL 6 M $H_2SO_4(aq)$ into ~300 mL
- Flask C (500-mL) : 1.00 gram $MnSO_4$ & 4.68 grams Melonic Acid & 23 mL 0.4% starch solution (prepared with 0.4 grams soluble starch into 100 mL boiling water) into ~ 300 mL

Pour Flask B and Flask C into Flask A approximately simultaneously. Swirl once. Voila !

Shakhashiri, Bassam. "Chemical Demonstrations." Volume 2, Page 248

The mechanisms and kinetics of these reactions are very complex, and admittedly I often skirt around the details... but it sure does pique student interest & curiosity. Shakhashiri gives a detailed explanation.

Tollen's Test

Prepare your glass vessel with thorough rinses : Distilled water... concentrated nitric acid... distilled water... acetone... distilled water...

Prepare the silver-complexed solution : add concentrated ammonium hydroxide drop-wise to the $AgNO_3(aq)$ until cloudy and then drop-wise again until colorless. Add the KOH solution. Add ammonium hydroxide drop-wise again until colorless.

Add this silver-complexed solution to the empty, thoroughly-rinsed glass vessel. Add the dextrose solution. Firmly stopper the vessel and rotate gently for several minutes. Reaction completion may take 5-10 minutes. Flush the remaining products down the drain with plenty of water. Rinse the silvered glass vessel gently with distilled water. Allow this to dry overnight, preferably in a dark area.

Here are a couple of suggested reagent ratios...

Surface area does not scale linearly with volume, which presents a bit of a challenge...

Reagent	mass of solid / L solution	1-liter flask	250-mL flask
0.10 M $AgNO_3(aq)$	**17 g**	200 mL	100 mL
0.8 M KOH(aq)	**56 g**	106 mL	53 mL
0.25 M Dextrose(aq)	**45 g**	267 mL	134 mL

For larger glass containers like 1-L flasks, the container does not need to be "filled" with reagents - there will be quite a bit of "empty space" in the flask. For smaller containers like 250-mL flasks or even test tubes, the container should be about "full" of reactants. I've been quite successful with test tubes, as long as they are prepared with about 50% of their volume is used for the silver-complex solution and 50% of their volume is allowed for the dextrose solution.

Shakhashiri, Bassam. "Chemical Demonstrations." Volume 4, Page 240

I often do this one when talking about redox, as the sugar reduces the silver ion to pure silver... With small groups of students (AP classes?), I've had them make their own silver test tubes.