The Care and Keeping of a Science Lab

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Topics

General Information

Globally Harmonized System & SDS

Storage

Inventory

Chemical Disposal

A Culture of Safety

Solution Preparation

Lab Management

Get Ready!

Get Set!

It's Go Time!

Clean up!

All the Resources

Globally Harmonized System

A consistent set of standards for classifying and communicating hazards related to chemicals.

Labels Should Include

- Hazard pictograms
- Signal words “Danger” or “Warning”
- Hazard statements
- Product Name & Identifier
- Precautionary statements

A Few Common Suppliers

Safety Data Sheets

Information on

- Hazards
- Storage
- Disposal

Hands Down My Favorite Resource:

https://www.flinnsci.com/sds/

Storage Basics

- Everything needs a home.
- Sometimes a characteristic supersedes the family grouping.
  - flammable
  - poisonous

- Acids go in a lockable acid cabinet.
- Flammables go in a lockable flammable cabinet.
- Poisons go in a lockable poison cabinet.

Storage - Flinn Method Organics

O1: Organic acids, amino acids, acidic anhydrides, peracids

O2: alcohols, glycols, sugars, amines, amides, Imines, Imides

O3: Hydrocarbons, esters, aldehydes, oils

O4: ethers, ketones, halogenated hydrocarbons

O5: Epoxy compounds, isocyantes

O6: peroxides, hydroperoxides

O7: Sulfides, polysulfides, sulfoxides, nitriles

O8: Phenols, cresols

O9: dyes, stains, and indicators

OM: Miscellaneous

Storage - Flinn Method Inorganics

I1: Metals, hydrides

I2: Acetates, halides, iodides, sulfates, sulfites, thiosulfates, phosphates, halogens, oxalates, phthalates, oleates

I3: amides, nitrates (except NH_4NO_3), nitrites, azides

I4: hydroxides, oxides, silicates, carbonates, carbon

I5: Sulfides, selenides, phosphides, carbides, nitrides

I6: chlorates, bromates, iodates, chlorites, hypochlorites, perchlorates, perchloric acid, peroxides, hydrogen peroxide

I7: arsenates, cyanides, cyanates

I8: borates, chromates, manganates, permanganates, molybdates, vanadates

I9: acids, other than nitric (stored isolated)

I10: sulfur, phosphorus, arsenic, phosphorus pentoxide

IM: miscellaneous

Inventory

- Work with your administration to conduct an annual full inventory.
  - Request a district paid sub.
  - Do not do it on your own time.
- The first year, if it has been a while, you might need two or three days.

Inventory

- Deep clean when you do inventory!
- Vinegar spray, baking soda spray, air it out.
- Wipe down bottles.
- Replace damaged labels.
- Dispose of any hazardous materials (more on this later).

Inventory

- Get overly personal with your stockroom
- Master Inventory
  - digital for sharing with district, etc
  - print for quick use (sorted by chemical name)
  - Make your own spreadsheet or buy one

Inventory

	A	B	C	D	E	F	G	H	I
1	Chemical Name	Storage Room #	Storage Location	Supplier	Catalog #	Quantity (approx)	Size of Container	Notes/ Conditions	Need to Order
2			A						
3			P						
4			I1						
5			I2						
6			I3						
7			I4						
8			I5						
9			I6						
10			I7						
11			I8						
12			I9						
13			O1						
14			O2						
15			O3						
16			O4						
17			O5						
18			O6						
19			O7						
20			O8						
21			O9						
22			M/I						
23			M/O						

Inventory

	A	B	C	D	E	F	G	H
1	Chemical Name	Storage Room #	Storage Location	Vendor	Catalog #	Quantity (approx)	Size of Container	Notes/ Conditions
2	Acetamide	212	O2	Flinn	A0003		500 g	
3	Acetic acid (glacial)	212	A	Frey	64-19-7		500mL	
4	Acetic acid (glacial)	212	A	Flinn	A0006		2.5 L	
5	Acetic Anhydride	212	A	Flinn	A0008		500 mL	
6	Acetominophen	212	P	Flinn	A0309		25g	
7	Acetone	212	F	Flinn	A0081		20 L	
8	Acetylsalycilic Acid	212	P	Flinn	A0133		500 g	
9	Acetylsalycilic Acid	212	P	Wards	4 70300-076		100 g	
10	Adrenaline	212	P	wards	470300-088		1 g	
11	Agar nutrient 1 KG	212	M/O	Flinn	A0013		500 g	
12	Albumin	212	O2	Carolina	84-2252		500 g	
13	Aluminum Chloride	212	I2	Flinn	A0026		500 g	wet
14	Aluminum foil	212	I1	target			roll	all partial
15	Aluminum foil	212	I1	Flinn	A0019		rolls	on its own shelf near organics
16	Aluminum granules	212	I1	Flinn			500 g	
17	Aluminum nitrate	212	I3	Flinn	A0030		500g	
18	Aluminum potassium sulfate (Alum)	212	I2	Flinn	A0181		2 kg	
19	Aluminum Strips	212	I1	Flinn			10/pk	oxidized
20	Aluminum sulfate (practical)	212	I2	Flinn	A0036		500 g	
21	Ammonia	212	I4	grocery			1.5 L	
22	Ammonium acetate	212	I2	Flinn	A0040		500 g	very wet
23	Ammonium carbonate	212	I4	Flinn	A0043		500 g	
24	Ammonium chloride (lab)	212	I2	Flinn	A0046		2 kg	wet

Chemical Disposal

- Safe disposal is part of a safe chemical working environment.

- Make the stockroom part of the interview. Discuss procedures.

Chemical Disposal

- Know (or create) a chemical hygiene plan with the school or district.

- Work with admin and district to set up a regular (annual or biannual) hazardous pick up.

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Chemical Disposal

- Avoid using Ag, Cr, Ba, Cd, Pb, Hg

- Grow a LOVE / HATE relationship with 26.
  - LOVE 26A (trash can) and 26B (drain x 20 water)
  - HATE 26C - Hazardous Materials Collection

Go “Green”

Beyond Benign

Rehab the Lab

The “canning” section

A Culture of Safety

Safety Agreement & Quiz

Safety agreement on file

No safety quiz = no lab

Student Awareness

Keep a list of

- Students with contacts
- Students with allergies
- Students with medical issues

Review it before each lab.

Lab Behavior

- Explicit expectations
- Zero tolerance
- Clear consequences

- Get admin on board before school starts

Access

No student access to stockrooms or storerooms

Solution Preparation

Back of the Flinn catalog or the tabs at the bottom a Ward's Page.

https://www.flinnsci.com/flinn-freebies/digital-catalogs/flinn_sciencerefman_2021_v1_de_2/

https://www.wardsci.com/store/product/8887388/silver-nitrate

Solution Preparation

- Know the concentration and amount you need for the total number of lab groups.

$$? \text{ classes} \times \frac{? \text{ groups}}{\text{class}} \times \frac{? \text{ mL}}{\text{group}} = \text{volume needed}$$

- Over-estimate a little because they will mess up!

Solution Preparation

$$4 \text{ classes} \times \frac{8 \text{ groups}}{\text{class}} \times \frac{25 \text{ mL}}{\text{group}} = 800 \text{ mL}$$

Make a whole liter.

Solution Preparation

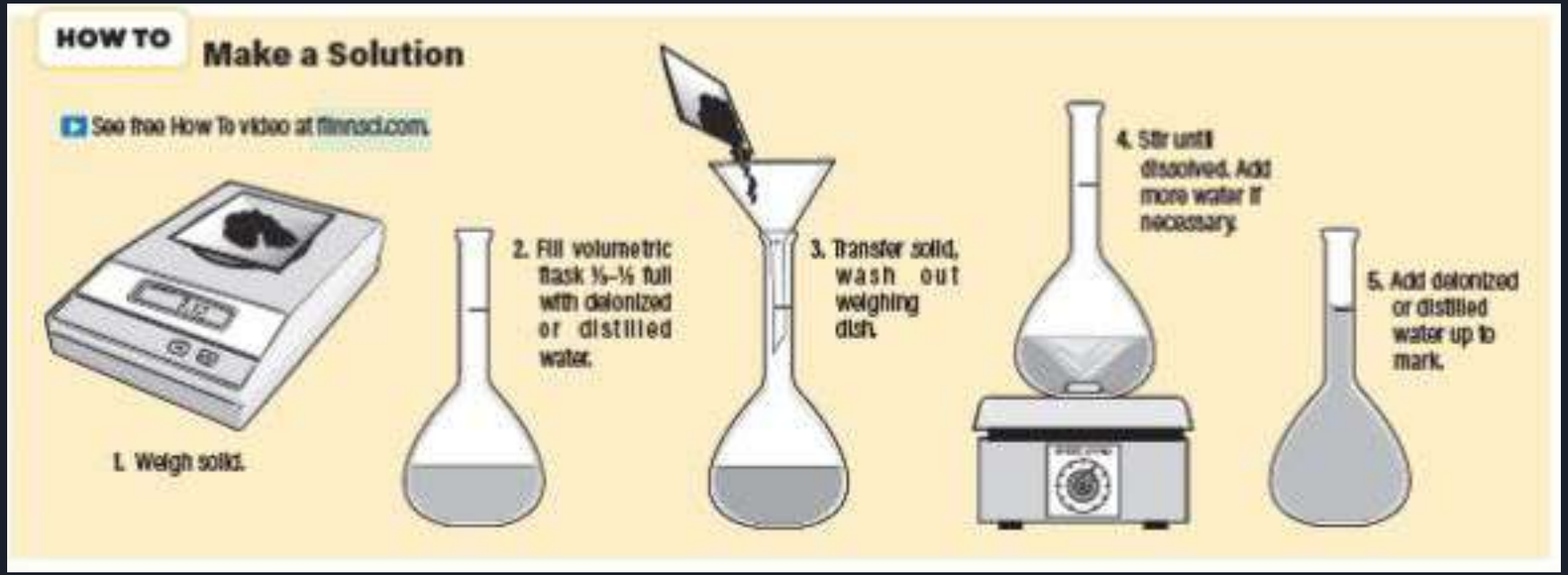
Once you know the volume you need, use this to find out the amount of solid you need.

Volume x concentration x molar mass = mass needed

$$L \times \frac{mol}{L} \times \frac{g}{mol}$$

Molar Mass is on the label, right under the name!

Flinn Resources for Solution Prep



Flinn Resources for Solution Prep

Preparation of Simple Inorganic Salt Solutions, continued

Name / Formula / F.W.	Concentration	g/L
Potassium chromate K_2CrO_4 194.21	1.0 M 0.5 M 0.1 M	194.2 g 97.1 g 19.4 g
Potassium dichromate $K_2Cr_2O_7$ 294.22	0.1 M	29.4 g
Potassium ferricyanide $K_3Fe(CN)_6$ 329.26	0.5 M 0.1 M	164.6 g 32.9 g
Potassium ferrocyanide $K_4Fe(CN)_6 \cdot 3H_2O$ 422.41	0.1 M	42.2 g
Potassium hydrogen phthalate $KHC_8H_4O_4$ 204.23	0.1 M	20.4 g

Name / Formula / F.W.	Concentration	g/L
Potassium phosphate, tribasic K_3PO_4 212.27	0.1 M	21.2 g
Potassium sulfate K_2SO_4 174.27	0.5 M 0.1 M	87.1 g 17.4 g
Potassium thiocyanate KSCN 97.18	1.0 M 0.5 M 0.1 M	97.2 g 48.6 g 9.7 g
Silver nitrate $AgNO_3$ 169.87	0.5 M 0.1 M	84.9 g 17.0 g
Sodium acetate $NaC_2H_3O_2 \cdot 3H_2O$ 136.08	1 M 0.5 M	136.1 g 68.0 g

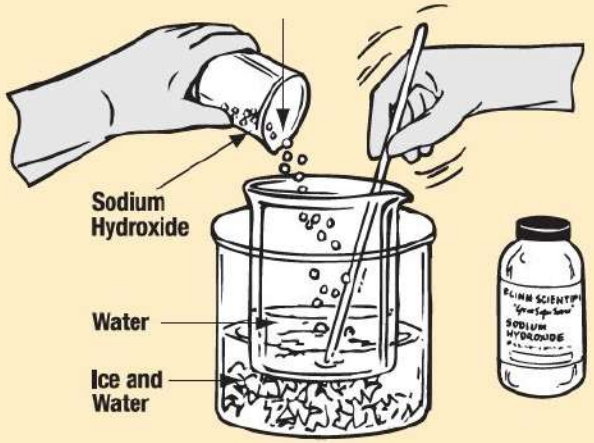
Flinn Resources for Solution Prep

Preparation of Acid Solutions

Name / Formula / F.W.	Concentration	Amount/Liter[§]
Acetic Acid*	6 M	345 mL
CH_3CO_2H	3 M	173
F.W. 60.05	1 M	58
99.7%, 17.4 M	0.5 M	29
sp. gr. 1.05	0.1 M	5.8
Hydrochloric Acid*	6 M	500 mL
HCl	3 M	250
F.W. 36.4	1 M	83
37.2%, 12.1 M	0.5 M	41
sp. gr. 1.19	0.1 M	8.3
Nitric Acid*	6 M	380 mL
HNO_3	3 M	190
F.W. 63.01	1 M	63
70.0%, 15.8 M	0.5 M	32
sp. gr. 1.42	0.1 M	6.3
Phosphoric Acid*	6 M	405 mL
H_3PO_4	3 M	203
F.W. 98.00	1 M	68
85.5%, 14.8 M	0.5 M	34
sp. gr. 1.70	0.1 M	6.8
Sulfuric Acid*	9 M	500 mL†
H_2SO_4	6 M	333†
F.W. 98.08	3 M	167†
96.0%, 18.0 M	1 M	56
sp. gr. 1.84	0.5 M	28
	0.1 M	5.6

Preparing Sodium Hydroxide Solution?

A great amount of heat is liberated when sodium hydroxide and water are mixed. The temperature of the solution may rise very rapidly. In fact, the temperature may rise so fast that the solution may boil and possibly spatter a hot, caustic solution. Immerse the flask or beaker in an ice-water bath to control the solution temperature. In addition, pay special attention to the condition of the beaker or flask, you use to prepare these solutions. If you use a glass vessel it must be borosilicate glass and it must be free of any scratches, chips or breaks. Inspect the vessel carefully before use. Add ingredients slowly with continuous stirring.



Flinn Resources for Solution Prep

Recipes for Biological, Histological and Chemical Solutions, continued

Nigrosin

Saturated: Dissolve 3 g of nigrosin (water soluble) in 100 mL of DI water. Stir and filter if necessary. *(biological stain for protozoa)*

Ninhydrin

Add 2.5 g of ninhydrin to 50 mL of n-butyl alcohol in a 600-mL beaker. Gently heat and stir the solution using a magnetic stirrer/hot plate in a fume hood until all the solid is dissolved. Dilute to 500 mL with n-butyl alcohol. Use extreme caution when heating n-butyl alcohol, extreme fire risk. *(test for proteins)*

Phenantholine

See Ferroin Solution, page 1320.

Phenolphthalein

1% alcoholic: Dissolve 1 g of phenolphthalein in 50 mL of 95% ethyl alcohol, then dilute to 100 mL with 95% ethyl alcohol. For a 0.5% solution, only use 0.5 g of phenolphthalein. *(pH indicator)*

Phenol Red

0.02% alcoholic: Dissolve 0.1 g of phenol red in 400 mL of 95% ethyl alcohol, then dilute to 500 mL with 95% ethyl alcohol. *(pH indicator)*

Get Ready!

Suggestions from Experienced Teachers

Lots of small labs, rather a few larger ones.

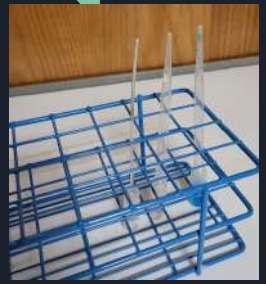
Start with “easy” labs and materials.

Don’t do something you are not comfortable with

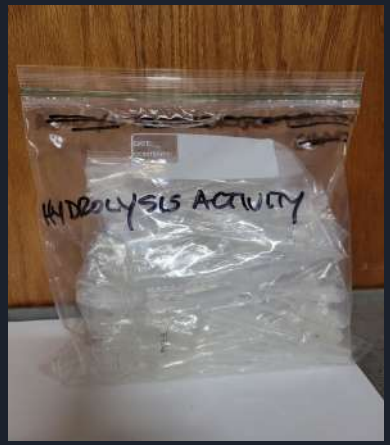
PRACTICE THE LAB BEFORE YOU GIVE IT TO KIDS!

Dropper Bottles

Beral Pipettes



Cassette Cases or Test Tube Racks are great for storage.



Store the whole lab together OR Make sets for the various chemicals to use for multiple labs.

Labelling!

Do it once!

Use tape as a protective cover

Ag^+	Ag^+	Ag^+	Ag^+
Ag^+	Ag^+	Ag^+	Ag^+
Co^{2+}	Co^{2+}	Co^{2+}	Co^{2+}
Co^{2+}	Co^{2+}	Co^{2+}	Co^{2+}
Cu^{2+}	Cu^{2+}	Cu^{2+}	Cu^{2+}
Cu^{2+}	Cu^{2+}	Cu^{2+}	Cu^{2+}
Fe^{3+}	Fe^{3+}	Fe^{3+}	Fe^{3+}
Fe^{3+}	Fe^{3+}	Fe^{3+}	Fe^{3+}
Cl^-	Cl^-	Cl^-	Cl^-
Cl^-	Cl^-	Cl^-	Cl^-
S^{2-}	S^{2-}	S^{2-}	S^{2-}
S^{2-}	S^{2-}	S^{2-}	S^{2-}
CO_3^{2-}	CO_3^{2-}	CO_3^{2-}	CO_3^{2-}
CO_3^{2-}	CO_3^{2-}	CO_3^{2-}	CO_3^{2-}
OH^-	OH^-	OH^-	OH^-
OH^-	OH^-	OH^-	OH^-

Lab “Kits” and “Sets”

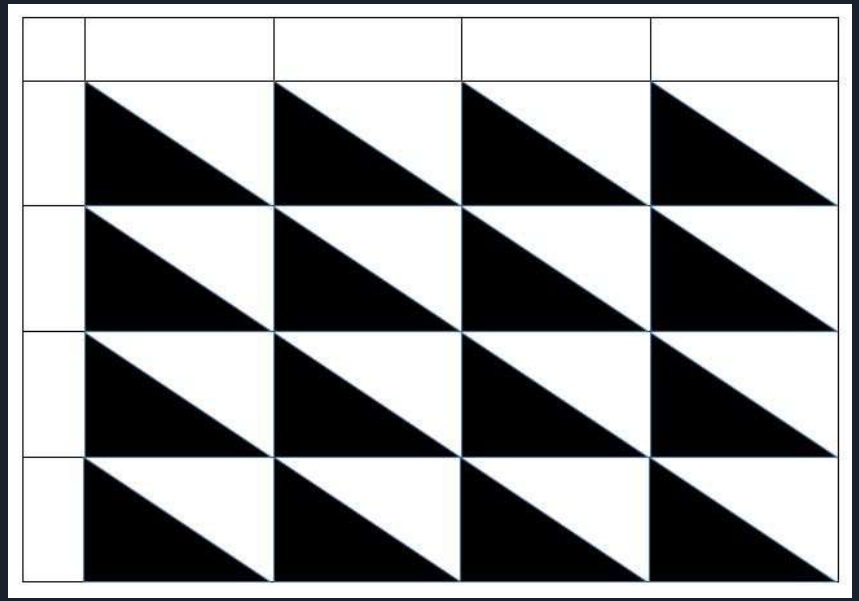
- Put together a full set of chemicals for each lab group.

- Create a drawer with glassware and basic equipment for each group.

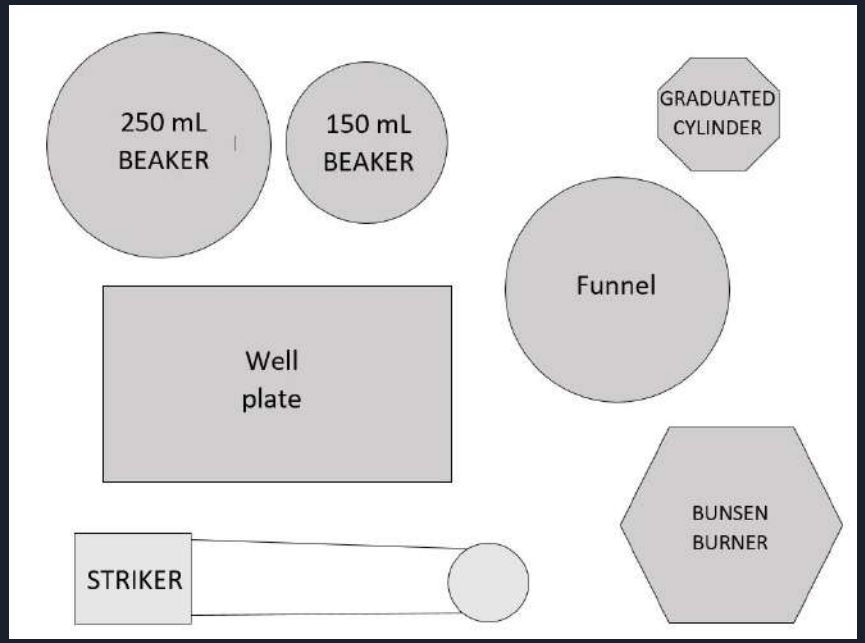
Permanent Kits

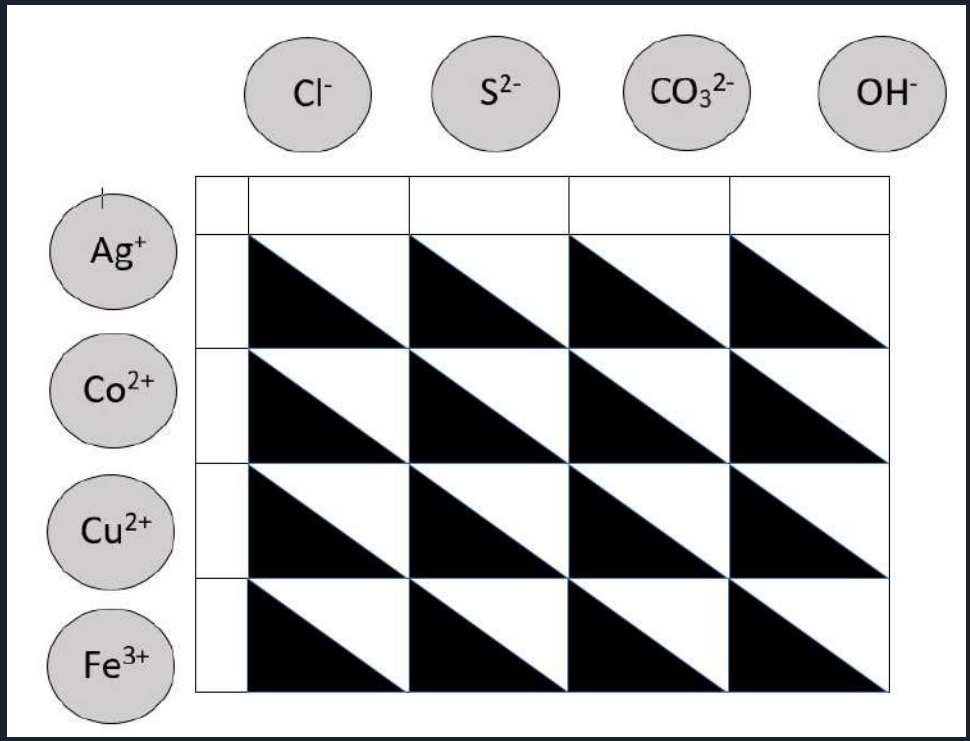
- Storing
- Station quantities of chemicals in bottles ready to hand out
  - Less than 50% stock concentrations
- Label bottles with chemical name, concentration, initials of who made it, and date
- Put a full GHS label for each chemical on the outside of the box.
- Tape a page protector to the top of the box that holds the list of chemicals and a copy of the student and teacher version of the lab.

Reaction Plates and Grids



Placemats


250 mL BEAKER
150 mL BEAKER
GRADUATED CYLINDER
Funnel
Well plate
BUNSEN BURNER
STRIKER


Cl^-
S^{2-}
CO_3^{2-}
OH^-
Ag^+
Co^{2+}
Cu^{2+}
Fe^{3+}

Get Set!

Timing

- Main pre-lab the day before
- Fast demo & safety overview day of lab
- Stop with 5-10 minutes left to clean up & restock

Explicit Instructions

- Reread (or read) the lab before starting.
- Keep their little paws off the goods until it is time to work.
- Fast demo the lab

Explicit Instructions

- Review specific safety issues (fire, hot glass looks like cold glass, corrosives)
- Pipettes stay tips up
- Write down everything you see, hear, or smell related to the experiment.

Expect the Unexpected

- ”Awareness, Acceptance, Action”
- Review the list of contacts, allergies, etc.
- Practice gas leaks, evacuations, fire drills during lab
- Have a person in each class who is in charge for specific items/jobs.

It’s Go Time!

Getting your Attention

“Tap Lights”
at each lab station
On = We Need Help!

Getting their Attention

CALL & RESPONSE

Clap once if you can hear me...

Clean Up!

5-10 minutes left?

Break it Down

Students can and should, wash dishes.

Break it Down

- Last class of the day groups pipettes or bottles by chemical.

- Refill easily or empty into a single container.

Resources

Resources - Basics

What is GHS?

https://www.ccohs.ca/oshanswers/chemicals/ghs.html

Linda Detwiler's Notes

https://docs.google.com/document/d/1E075_NhQKp-15m6uBSMC0DLc6YkLfyXAeZ4JAfM0aEQ/edit?usp=sharing

Resources - Storage

Flinn Shelf Patterns - Free

https://www.flinnsci.com/api/library/Download/993b9838c5f54c08b16785b4f9eef970

Flinn Storage Method Poster - Link to Order

https://www.flinnsci.com/flinn-chemical-storage-pattern-poster/ap6196/

Resources - Inventory

Basic Chemical Inventory Spreadsheet

https://docs.google.com/spreadsheets/d/1CojWUl0qwyT_2dEdSWqDxePFThoULQwcY9TsginZ-5E/edit?usp=sharing

Resources - Haz-Mat Disposal

Cactus Environmental - Dallas & Houston?

https://www.cactusenviro.com/

Hazardous Waste Experts

https://www.hazardouswasteexperts.com/texas/

The Cleaning Guys

https://www.cleaningguys.com/haz-non-haz-waste-services/

Resources - Going Green

Beyond Benign

https://www.beyondbenign.org/online-community-gctlc/

Rehab the Lab - Overview

https://www.hazwastehelp.org/educators/rehabthelab.aspx

Rehab the Lab - Least Toxic Labs

https://www.hazwastehelp.org/educators/chemlabs.aspx

Resources - Safety Agreements

Carolina Student Chemistry Lab Safety Agreement

https://www.carolina.com/teacher-resources/Document/student-chemistry-laboratory-safety-agreement/tr41708.tr

Flinn Student Lab Safety Agreement

https://www.flinnsci.com/api/library/download/80efae9513b548d6999c31d38ac36abe

Flinn Lab Safety Quiz

https://www.flinnsci.com/api/library/Download/27a18776135742dc848103f24b4dbb85

Resources - General Safety

AACT Safety Resources

https://teachchemistry.org/classroom-resources/safety

Resources - Safety Agreements

ACS Lab Safety Agreement

https://www.acs.org/content/dam/acsorg/education/students/highschool/chemistryclubs/chemclub-lab-safety-agreement.pdf

ACS Student Laboratory Code of Conduct

https://institute.acs.org/content/dam/pldp/center/lab-safety/publications/sample-lab-safety-guidelines-and-safety-acknowledgment-forms.docx

Resources - During Lab

Getting Your Attention

https://theardentteacher.com/2014/10/12/classroom-managemen/

Getting Their Attention

https://newteacheracademy.org/10-ways-to-get-your-students-attention-without-raising-your-voice/