

Lab Reference Guide

Useful Information in a Handy
Form for the School Laboratory

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Cleaning Glassware

1. Add Alconox detergent to water. Stir into solution.
2. Soak glassware in solution, then clean using a brush or scouring pad.
3. Rinse well in tap or distilled water.

Sterilizing Glassware

1. **Using an oven:** Place in an oven and heat at 160-190°C (320-374°F) for at least one hour. Note that paper and cotton cloth at 175°C (about 350°F). If glassware is packed in metal containers for sterilizing, heat for at least two hours.
2. **Using an autoclave:** Place glassware in autoclave or pressure cooker. Close the lid. Make sure to open the safety valve to allow all the air to escape before closing. Regulate to 15 lbs. pressure. At this pressure, autoclave for 20 minutes.

Cleaning the Microscope

1. **The Eyepiece:** To remove dust, brush with a camel's hair brush. To remove grease film, use isopropyl alcohol on lens paper and then use a dry piece of lens paper to remove the isopropyl alcohol. To check, tip the eyepiece to reflect the light. If the eyepiece is to be removed from the tube for any length of time, plug the tube to prevent dust from collecting on the back surfaces of the objectives.
2. **The objectives:** Clean as above. To check, use a hand lens to examine the lenses.
3. **The mirror:** Clean the surface with distilled water on lens paper, then dry it with a clean piece of lens paper.

pH Defined

The concentration of hydrogen ions (power of hydrogen ion concentration) in solution when the concentration is expressed as gram-ionic weights per unit. The form used to express pH is the negative logarithm of this concentration. pH readings less than 7 are acids; those above 7 are alkalines.

Making a Buffering Solution

Buffers are compounds or pairs of compounds that have the chemical capacity to resist changes in pH. To prepare a standard phosphate buffer, follow one of the protocols.

To make a .067 M solution of Na_2HPO_4 , add 9.46 g per 1 L distilled water.

To make a .067 M solution of $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$, add 9.2 g per 1 L distilled water.

Dilute the solutions in the volumes listed below to 200 ml with distilled water to make the appropriate buffer.

Na_2HPO_4 (ml)	NaH_2PO_4 (ml)	pH
0.5	19.5	5.3
3.9	16.1	6.2
12.2	7.8	7.0
18.4	1.6	7.8
19.5	0.5	8.3

Preparing Molar and Normal Solutions

1. **Molar (M) Solutions** contain one gram molecular weight of dissolved substance in one liter of solution. The gram molecular weight of a substance is determined by calculating the total atomic weights in the molecule indicated by the chemical formula for that substance and then using that amount in grams.

To calculate the mass of a substance needed to make a solution at a certain molarity:

$$m = M \times M_r \times V \quad \text{where}$$

m	=	mass of substance in grams
M	=	molarity of solution
M _r	=	molecular weight of substance
V	=	volume of solution in liters

2. **Normal (N) Solutions** contain one gram equivalent weight of dissolved substance in one liter of solution. The gram equivalent weight is determined by calculating the molecular weight of the substance divided by the number of positive or negative ionic charges, and using that figure in grams. Thus the gram equivalent weight of HCl equals its gram molecular weight, but that of H₂SO₄ is ½ its gram molecular weight.

To calculate the mass of a substance needed to make a solution at a certain normality:

$$m = \frac{N \times M_r \times V}{\text{Valency}} \quad \text{where}$$

m	=	mass of substance in grams
N	=	normality of solution
M _r	=	molecular weight of substance
V	=	volume of solution in liters
Valency	=	number of hydrogen atoms (equivalent) which an atom could combine with or displace

DILUTION TABLE FOR LIQUIDS
Percentage Strength of Original Liquid

Percentage Strength of Liquid Required and Volumes of Original Liquid to be Taken	Percentage Strength of Original Liquid																		
	100	96	95	90	85	80	75	70	60	50	40	30	20	15	10	8	5	4	3
95	5	1																	
90	10	6	5																
85	15	11	10	5															
80	20	16	15	10	5														
75	25	21	20	15	10	5													
70	30	26	25	20	15	10	5												
60	40	36	35	30	25	20	15	10											
50	50	46	45	40	35	30	25	20	10										
40	60	56	55	50	45	40	35	30	20	10									
30	70	66	65	60	55	50	45	40	30	20	10								
20	80	76	75	70	65	60	55	50	40	30	20	10							
15	85	81	80	75	70	65	60	55	45	35	25	15	5						
10	90	86	85	80	75	70	65	60	50	40	30	20	10	5					
8	92	88	87	82	77	72	67	62	52	42	32	22	12	7	2				
5	95	91	90	85	80	75	70	65	55	45	35	25	15	10	5	3			
4	96	92	91	86	81	76	71	66	56	46	36	26	16	11	6	4	1		
3	97	93	92	87	82	77	72	67	57	47	37	27	17	12	7	5	2	1	
1	99	95	94	89	84	79	74	69	59	49	39	29	19	14	9	7	4	3	2

Volumes of diluent to be added

For example: To make a 70% ethanol solution from a 95% ethanol solution, take 70 ml of 95% ethanol and add 25 ml of distilled water.

*Note: When diluting acids, always pour the acid **INTO** the water slowly, tilting the container which holds the water at such an angle that the acid can run down the side and mix slowly with the water.*

Useful Reagents

Saline solution for invertebrates: Add 0.6 g NaCl to 100 ml H₂O.

Saline solution for frog tissue: Add 0.75 g NaCl to 100 ml H₂O.

Saline solution for mammalian tissue: Add 0.9 g of NaCl to 100 ml H₂O.

To discharge trichocysts of Paramecia: Use 1.0% aqueous solution of tannic acid.

To discharge to nematocysts of Hydra: Use 5.0% aqueous solution of NaCl.

Common Preservatives and Fixatives

Formalin in its concentrated form is formaldehyde gas dissolved in water to a 40% concentration. When preparing percentage solutions, treat formalin as 100% in calculating dilutions. It may be used in various strengths, depending on the size of the specimen, for anything plant or animal. A 10% solution will, however, satisfactorily preserve most specimens.

FAA (Formalin/Acetic acid/Alcohol) is used for preserving plant tissue:

Ethyl alcohol (85%).....	50 ml
Glacial acetic acid	2 ml
Formalin (40%)	10 ml
Water	40 ml

Bouin's Fixative:

Picric acid (saturated aqueous solution)	75 ml
Glacial acetic acid	5 ml
Formalin (40%)	25 ml

To avoid deterioration of the solution, it is best to add the picric acid just before you use it. However, the shelf life of the complete solution is six to eight months.

General Zoological Stain

Borax Carmine

To prepare a stock stain solution, add 1 g Borax Carmine to 100 ml distilled water. Boil for 1/2 hour. Cool, filter, and combine with 100 ml of 70% alcohol. Let stand for two days and filter.

To prepare a specimen for stain, you must first dehydrate the specimen using 30% and 50% alcohol. Prepare the stain by adding 20 ml of stock Borax Carmine stain (see above) to 80 ml of 70% alcohol. Overstain the tissue. Then place it in 70% acid alcohol made by adding 1 ml of concentrated HCl to 99 ml of 70% alcohol. The tissue must be checked periodically to get proper destaining. After the tissue has been destained, it must be dehydrated again using 85%, 90%, 95%, and absolute alcohol. Rinse in xylene and mount.

General Botanical Stain

Safranin O and Light Green SF Y

To prepare stock stain solutions:

Safranin O	1 g
50% alcohol	99 g
Light Green SF Yellowish	0.2 g
100% alcohol	50 ml
Clove oil	50 ml

To prepare a specimen for stain, you must first dehydrate the specimen in cellosolve for 2 minutes; then place it in Safranin (time will vary with tissue being stained). Move the tissue to cellosolve for one minute to remove the excess stain and then counterstain in Light Green for 2 minutes. Place the tissue in clove oil to remove the excess Light Green, run it quickly through xylene, and mount it in balsam.

CENTIGRADE TO FAHRENHEIT CONVERSION

(rounded to the nearest degree)

°C	°F	°C	°F	°C	°F	°C	°F
0	32	26	79	51	124	76	169
1	34	27	81	52	126	77	171
2	36	28	82	53	127	78	172
3	37	29	84	54	129	79	174
4	39	30	86	55	131	80	176
5	41	31	88	56	133	81	178
6	43	32	90	57	135	82	180
7	45	33	91	58	136	83	181
8	46	34	93	59	138	84	183
9	48	35	95	60	140	85	185
10	50	36	97	61	142	86	187
11	52	37	99	62	144	87	189
12	54	38	100	63	145	88	190
13	55	39	102	64	147	89	192
14	57	40	104	65	149	90	194
15	59	41	106	66	151	91	196
16	61	42	108	67	153	92	198
17	63	43	109	68	154	93	199
18	64	44	111	69	156	94	201
19	66	45	113	70	158	95	203
20	68	46	115	71	160	96	205
21	70	47	117	72	162	97	207
22	72	48	118	73	163	98	208
23	73	49	120	74	165	99	210
24	75	50	122	75	167	100	212
25	77						

TEMPERATURE CONVERSION FORMULAE

Fahrenheit to Centigrade: $C^{\circ} = \frac{5}{9} \times [F^{\circ} - 32]$

Centigrade to Fahrenheit: $F^{\circ} = \frac{9}{5} \times C^{\circ} + 32$

MOHS' SCALE OF HARDNESS

- | | |
|-------------|------------------------|
| 1. Talc | 6. Orthoclase feldspar |
| 2. Gypsum | 7. Quartz |
| 3. Calcite | 8. Topaz |
| 4. Fluorite | 9. Corundum |
| 5. Apatite | 10. Diamond |

WEIGHT, LENGTH, AND VOLUME CONVERSIONS

1 gram = .03527 ounces

1 kilogram = 2.205 pounds

1 ounce = 28.35 grams

1 pound = 453.6 grams

1 micron = $\frac{1}{1000}$ millimeter or $\frac{1}{25,400}$ inch

1,000 millimeters = 1 meter

1 centimeter = .3937 inches

1 meter = 3.281 feet or 39.37 inches

1 inch = 2.54 centimeters

1 foot = 30.48 centimeters

1 cubic centimeter = 1 milliliter (water at 4°C)

1,000 milliliters = 1 liter

1 liter = 1.056 U.S. liquid quarts

1 U.S. fluid ounce = 29.57 milliliters

1 teaspoon = 4.93 cubic centimeters

TABLE OF ATOMIC SYMBOLS, NUMBERS, AND WEIGHTS

Element	Symbol	Atomic Number	Atomic Weight	Element	Symbol	Atomic Number	Atomic Weight
Actinium	Ac	89	227.03	Mercury	Hg	80	200.59
Aluminum	Al	13	26.98	Molybdenum	Mo	42	95.94
Americium	Am	95	243.06	Neodymium	Nd	60	144.24
Antimony	Sb	51	121.76	Neon	Ne	10	20.183
Argon	Ar	18	39.944	Neptunium	Np	93	237.05
Arsenic	As	33	74.92	Nickel	Ni	28	58.69
Astatine	At	85	209.99	Niobium	Nb	41	92.91
Barium	Ba	56	137.33	Nitrogen	N	7	14.008
Berkelium	Bk	97	247.07	Nobelium	No	102	259.10
Beryllium	Be	4	9.013	Osmium	Os	76	190.23
Bismuth	Bi	83	208.98	Oxygen	O	8	16.0000
Boron	B	5	10.81	Palladium	Pd	46	106.42
Bromine	Br	35	79.90	Phosphorus	P	15	30.975
Cadmium	Cd	48	112.41	Platinum	Pt	78	195.08
Calcium	Ca	20	40.08	Plutonium	Pu	94	244.06
Californium	Cf	98	251.08	Polonium	Po	84	208.98
Carbon	C	6	12.011	Potassium	K	19	39.100
Cerium	Ce	58	140.12	Praseodymium	Pr	59	140.91
Cesium	Cs	55	132.91	Promethium	Pm	61	144.91
Chlorine	Cl	17	35.457	Protactinium	Pa	91	231.04
Chromium	Cr	24	52.00	Radium	Ra	88	226.03
Cobalt	Co	27	58.93	Radon	Rn	86	222.02
Copper	Cu	29	63.55	Rhenium	Re	75	186.21
Curium	Cm	96	247.07	Rhodium	Rh	45	102.91
Dysprosium	Dy	66	162.50	Rubidium	Rb	37	85.47
Einsteinium	Es	99	252.08	Ruthenium	Ru	44	101.07
Erbium	Er	68	167.26	Samarium	Sm	62	150.36
Europium	Eu	63	151.96	Scandium	Sc	21	44.96
Fermium	Fm	100	257.10	Selenium	Se	34	78.96
Fluorine	F	9	19.00	Silicon	Si	14	28.09
Francium	Fr	87	223.02	Silver	Ag	47	107.87
Gadolinium	Gd	64	157.25	Sodium	Na	11	22.991
Gallium	Ga	31	69.72	Strontium	Sr	38	87.62
Germanium	Ge	32	72.61	Sulfur	S	16	32.066
Gold	Au	79	196.97	Tantalum	Ta	73	180.95
Hafnium	Hf	72	178.49	Technetium	Tc	43	98.91
Helium	He	2	4.003	Tellurium	Te	52	127.60
Holmium	Ho	67	164.93	Terbium	Tb	65	158.93
Hydrogen	H	1	1.0080	Thallium	Tl	81	204.38
Indium	In	49	114.82	Thorium	Th	90	232.04
Iodine	I	53	126.90	Thulium	Tm	69	168.93
Iridium	Ir	77	192.22	Tin	Sn	50	118.71
Iron	Fe	26	55.85	Titanium	Ti	22	47.87
Krypton	Kr	36	83.80	Tungsten	W	74	183.84
Lanthanum	La	57	138.91	Uranium	U	92	238.03
Lawrencium	Lr	103	262.11	Vanadium	V	23	50.94
Lead	Pb	82	207.20	Xenon	Xe	54	131.29
Lithium	Li	3	6.940	Ytterbium	Yb	70	173.04
Lutetium	Lu	71	174.97	Yttrium	Y	39	88.91
Magnesium	Mg	12	24.31	Zinc	Zn	30	65.39
Manganese	Mn	25	54.94	Zirconium	Zr	40	91.22
Mendelevium	Md	101	258.10				

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