Chem 108: Lab

Week 6

Sign in: Roster @ front of lab

Pick up Papers & Handouts for
HYDRATES - Exp. 4
(Replacement Pages for Lab Manual's Pg. 29)

Exp. 3: Report Form pp. 5-8 & Post Lab Questions DUE Today

Classification of Matter and Chemical Change

- Complete Weighing & Check that Report is complete

Quantitative Data and Results

Mass of Plastic Vial and Unknown	
Mass of Plastic Vial	
Mass of Unknown*	
Mass of beaker, filter paper, and Material 1 – 1st weighing	
~~Mass of beaker, filter paper, and Material 1 – 2nd weighing~~	
~~Mass of beaker, filter paper, and Material 1 – 3rd weighing (if necessary)~~	
Mass of beaker	
Mass of filter paper	
Mass of Material 1*	
% Material 1 in Unknown*	%
Mass of Evaporating Dish, Watch Glass, and Material 2 – 1st weighing	
~~Mass of Evaporating Dish, Watch Glass, and Material 2 – 2nd weighing~~	
~~Mass of Evaporating Dish, Watch Glass, and Material 2 – 3rd weighing (if necessary)~~	
Mass of Evaporating Dish	
Mass of Watch Glass Cover	
Mass of Material 2*	
% Material 2 in Unknown*	%

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

Report Form pp. 5-8 & Post Lab Questions DUE Today

Exp. 3 – Classification of Matter and Chemical Change

- Report Forms: *One form for each lab partner are both to be turned in; stapled together. Neatest one on top.*
  - Check sig figs are correct and units included
  - Show example of each type of calculation
  - Answer questions legibly in complete sentences.

Individually complete on-line post-lab questions and submit:

http://www.chemconnections.org/general/chem108/Physical%20Properties.html

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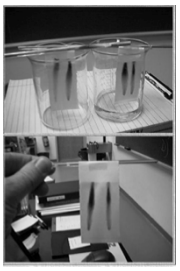
Classification of Matter

Part C

(Staple Paper Chromatogram to top page of Report)

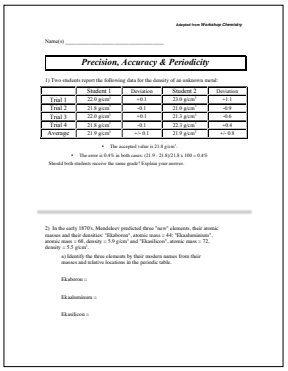


Turn in:
1 Worksheet
per Group of 4

(Last Week's Handout)

Due End of lab Today
1 Completed Worksheet
per Group
that includes everyone's name.
Circle the names of those who contributed

DUE Today



Adapted from Workshop Chemistry

Name(s) _____

Precision, Accuracy & Periodicity

1) Two students report the following data for the density of an unknown metal:

	Student 1	Deviation	Student 2	Deviation
Trial 1	22.0 g/cm³	+0.1	22.0 g/cm³	+1.1
Trial 2	21.8 g/cm³	-0.1	21.0 g/cm³	-0.9
Trial 3	22.0 g/cm³	+0.1	21.3 g/cm³	-0.6
Trial 4	21.8 g/cm³	-0.1	22.3 g/cm³	+0.4
Average	21.9 g/cm³	+/- 0.1	21.9 g/cm³	+/- 0.8

- The accepted value is 21.8 g/cm³.
- The error is 0.4% on both cases: (21.9 - 21.8)/21.8 x 100 = 0.4%

Should both students receive the same grade? Explain your answer.

2) In the early 1870's, Mendeleev predicted three "new" elements, their atomic masses and their densities: "Ekaboron", atomic mass = 44; "Ekaaluminium", atomic mass = 68, density = 5.9 g/cm³ and "Ekasilicon", atomic mass = 72, density = 5.5 g/cm³.

a) Identify the three elements by their modern names from their masses and relative locations in the periodic table.

Ekaboron =

Ekaaluminium =

Ekasilicon =

Experiment 4

Procedure: Lab Manual pp. 26-27

Hydrates

Background

It is common for salts (ionic compounds) to be hydrated; that is, to have specific amounts of water bonded to the ions in the salt. This water is called water of hydration or water of crystallization. Some examples of hydrated salts are: $CaCl_2 \cdot 2H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$, $MgCO_3 \cdot 3H_2O$, $Na_2SO_4 \cdot 10H_2O$. In the formula a dot precedes the number of moles of water per mole of anhydrous (without water) compound. The water molecules are usually not strongly held and often can be removed by heating.

$$BaCl_2 \cdot 2\,H_2O \xrightarrow{heat} BaCl_2 + 2H_2O$$

If a weighed hydrate sample is heated and then weighed again, the mass of water released can be determined and the percent water calculated. For example if a 10.00 g sample of a hydrate is found to have a mass of 8.53 g after heating, then the mass of water released can be calculated as follows:

$$10.00\ g - 8.53\ g = 1.47\ g$$

and the percent water is:

$$\frac{1.47\ g}{10.00\ g} = 14.7\ \%$$

This experiment is in two parts. In the first part you will verify that when a hydrate is heated, water is produced. The presence of water can be detected by using paper saturated with anhydrous cobalt (II) chloride. $CoCl_2$, which is blue, reacts with water to form red $CoCl_2 \cdot 6H_2O$.

Chemical Formulas and Unambiguous Names

http://www.chemconnections.org/general/chem108/Nomenclature.htm

- Molecular Formula:
- **Elements' Symbols** = atoms
- **Subscripts** = relative numbers of atoms
- How are compounds named?

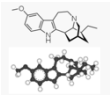
$CaCl_2$ CCl_4 NaOH $(NH_4)_2CO_3$

$C_{20}H_{26}N_2O$

(Ibogaine)

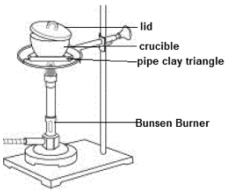
Tabernanthe iboga

One of > 152 million CAS carbon containing compounds



One unknown for you & your partner

(2 unknowns per group)



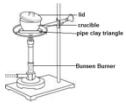
Determination of Percent Water in a Hydrate

Unknown number	
Mass, crucible + lid + hydrate sample	
Mass, crucible + lid	
Mass, hydrate sample*	
Mass, crucible + lid + anhydrous product (1st heating)	
Mass, crucible + lid + anhydrous product (2nd heating)	
Mass, crucible + lid + product (3rd heating if necessary)	
Mass, water lost*	
Percent water in hydrate*	

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

Hydrate *Handouts: Replacements for Page 29*

Using your unknown, complete the procedure, and accurately record all data on your individual Report Form.



Determination of Percent Water in a Hydrate

Unknown number	
Mass, crucible + lid + hydrate sample	
Mass, crucible + lid	
Mass, hydrate sample*	
Mass, crucible + lid + anhydrous product (1st heating)	
Mass, crucible + lid + anhydrous product (2nd heating)	
Mass, crucible + lid + product (3rd heating if necessary)	
Mass, water lost*	
Percent water in hydrate*	

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

Hydrate *Handouts*

1) Name the following hydrates:

$CoSO_4 \cdot 6\ H_2O$

$MgCl_2 \cdot 6\ H_2O$

$CuSO_4 \cdot 5\ H_2O$

2) Write formulas for the following hydrates:

Sodium dihydrogenphosphate nonahydrate

Potassium chromate tetrahydrate

Lead (II) acetate trihydrate

Report Form – Hydrates 29

Show completed pg. 29 data & questions (both pages except Post-Lab Question) on individual Reports to Dr. R. before leaving lab.

Hydrate

Page #29 Handout: (Separate Page from Data Table)

After completing the heating and data form for your unknown, calculate the % water in the following samples.
Show your calculations on your individual handout page to Dr. R. before leaving lab.

An "Epsom" salt sample (A) of 10.00 g was heated and re heated until it reached a "constant" mass of 5.70 g. What is the % water in the sample?

An "Epsom" salt sample (B) of 10.00 g was heated and re heated until it reached a "constant" mass of 4.88 g . What is the % water in the sample?

Hydrate

Page #29 Handout: (Separate Page from Data Table)

Post-Lab Question:

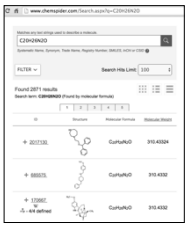
Spectroscopic satellite analysis of the composition of the moon was completed during the Clementine and subsequent NASA missions. The data indicates that water is present on the moon and there may be enough to allow human colonization. The water is tied up in rock (hydrates) and as ice. A notable hydrate for its high water content is Glauber's salt, sodium sulfate decahydrate. If a human were to require the equivalent of 2 liters of water per day, how many kilograms of Glauber's salt would need to be processed per month to meet one person's need. Assume a month is 30 days and that all of the water in the salt is recovered in the process. Glauber's Salt is 56% water by weight.

Include answer plus calculation on individual Lab Reports DUE Next Lab

Chemical Formulas and Unambiguous Names

- Molecular Formula:

$C_{20}H_{26}N_2O$



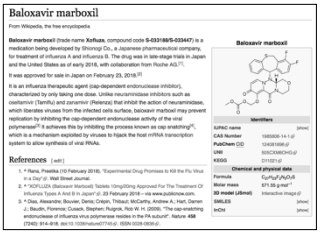
Search term: $C_{20}H_{26}N_2O$ produced 2871 results, ***where names were all different.***

Chemical Formulas and Naming Organic Molecules

https://pubchem.ncbi.nlm.nih.gov/compound/124081896

(((12aR)-12-{(11S)-7,8-Difluoro-6,11-dihydrodibenzo(b,E)thiepin-11-yl}-6,8-dioxo-3,4,6,8,12,12ahexahydro-1H-(1,4)oxazino(3,4-C)pyrido(2,1-F)(1,2,4)triazin-7-yl)oxy)methyl methyl carbonate

Carbonic acid, (((12aR)-12-{(11S)-7,8-difluoro-6,11-dihydrodibenzo(b,E)thiepin-11-yl}-3,4,6,8,12,12a-hexahydro-6,8-dioxo-1H-(1,4)oxazino(3,4-C)pyrido(2,1-F)(1,2,4)triazin-7-yl)oxy)methyl methyl ester



Nomenclature

- Nomenclature: the unambiguous naming of compounds/ molecules
- Governed by the IUPAC: *International Union of Pure and Applied Chemistry*
- International rules are updated periodically

https://www.iupac.org/fileadmin/user_upload/databases/Red_Book_2005.pdf

Organic and Inorganic compounds/ molecules have separate naming rules.

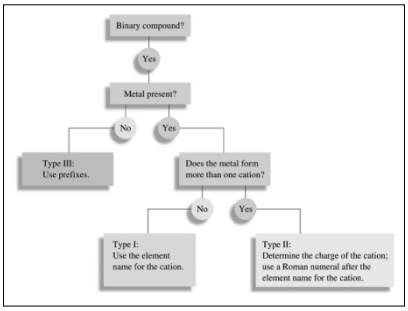
Chemical Formulas and Unambiguous Names

http://www.chemconnections.org/general/chem108/Nomenclature.htm

- Molecular Formula:
- **Elements' Symbols** = atoms
- **Subscripts** = relative numbers of atoms
- How are compounds named?

$CaCl_2$ CCl_4 NaOH $(NH_4)_2CO_3$

Naming Inorganic Compounds



https://chem.libretexts.org/Core/Inorganic_Chemistry/Chemical_Compounds/Nomenclature_of_Inorganic_Compounds

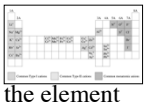
Ions

- Cation: A positive ion
  - Ca^{2+}
- Anion: A negative ion
  - Cl^-
- Ionic Bonding: Force of attraction between oppositely charged ions.
- Compounds & Formulas: $CaCl_2$

Naming Compounds

Binary Ionic Compounds (Type I)

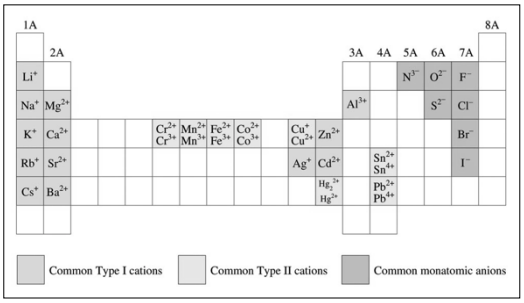
For example: $CaCl_2$



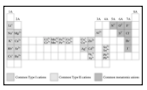
- Name cation first, then anion
- Monatomic cation = name of the element
  - Ca^{2+} = calcium ion
- Anion = root + -ide
  - Cl^- = chlor**ide**

$CaCl_2$ = calcium chloride

Common Cations and Anions



Naming Compounds
(continued)

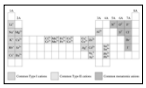


Binary Ionic Compounds (Type II):

- metal forms more than one cation: Pb^{2+} or possibly Pb^{4+} ? *Ambiguous?*
- option 1) use Roman numeral in name
  - If Pb^{2+} is the cation; eg. $PbCl_2$:
    - $PbCl_2$ = lead (II) chloride
- or 2) use name (latinized) + suffix: -ous (lower) or -ic (higher)

Plumbum Plumbous

Common Type II Cations



Common Type II

Ion	Systematic Name
Fe^{3+}	Iron(III)
Fe^{2+}	Iron(II)
Cu^{2+}	Copper(II)
Cu^{+}	Copper(I)
Co^{3+}	Cobalt(III)
Co^{2+}	Cobalt(II)
Sn^{4+}	Tin(IV)
Sn^{2+}	Tin(II)
Pb^{4+}	Lead(IV)
Pb^{2+}	Lead(II)
Hg^{2+}	Mercury(II)
Hg_2^{2+*}	Mercury(I)
Ag^{+}	Silver†
Zn^{2+}	Zinc†
Cd^{2+}	Cadmium†

*Note that mercury(I) ions always occur bound together to form Hg_2^{2+} ions.
†Although these are transition metals, they form only one type of ion, and a Roman numeral is not used.

Naming Compounds
(continued)

Binary compounds (Type III):

- Compounds formed between ***two nonmetals.***
- First element in the formula is named first.
  It is the more "electropositive".
- Second element is named as if it were an anion.
- Uses prefixes to count the # of atoms.

Prefixes Used to Indicate Number in Chemical Names

Prefix	Number Indicated
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

mono is not often used, but for this course please use it

Naming Compounds
(continued)

Binary compounds (Type III):

- Compounds formed between ***two nonmetals.***
- First element in the formula is named first.
- Second element is named as if it were an anion.
- Use prefixes to count the # of atoms.

CCl_4 = carbon tetrachloride
CO = carbon monoxide
CO_2 = carbon dioxide
P_2O_5 = diphosphorus pentoxide

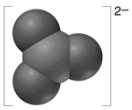
Prefixes Used to Indicate Number in Chemical Names

Prefix	Number Indicated
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

Compounds with more than two different elements

- Polyatomic ions: [oxygen as the third atom]

http://chemconnections.org/general/chem120/polyatomics.html



Carbonate ion CO_3^{2-}

Common Polyatomic Ions

Ion	Name	Ion	Name
Hg_2^{2+}	Mercury(I)	NCS^-	Thiocyanate
NH_4^+	Ammonium	CO_3^{2-}	Carbonate
NO_2^-	Nitrite	HCO_3^-	Hydrogen carbonate (bicarbonate is a widely used common name)
NO_3^-	Nitrate		
SO_3^{2-}	Sulfite	ClO^-	Hypochlorite
SO_4^{2-}	Sulfate	ClO_2^-	Chlorite
HSO_4^-	Hydrogen sulfate (bisulfate is a widely used common name)	ClO_3^-	Chlorate
		ClO_4^-	Perchlorate
OH^-	Hydroxide	$C_2H_3O_2^-$	Acetate
CN^-	Cyanide	MnO_4^-	Permanganate
PO_4^{3-}	Phosphate	$Cr_2O_7^{2-}$	Dichromate
HPO_4^{2-}	Hydrogen phosphate	CrO_4^{2-}	Chromate
$H_2PO_4^-$	Dihydrogen phosphate	O_2^{2-}	Peroxide
		$C_2O_4^{2-}$	Oxalate

Polyatomic Ions

- Cation: A positive ion
  - Ca^{2+}
- Anion: A negative "polyatomic" ion
  - $(CO_3)^{2-}$
- Ionic plus Covalent Bonding: second type of bonding, "shared electrons" form bonds
- Compounds & Formulas: $CaCO_3$

Naming Compounds
(continued)

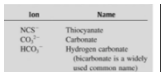
Polyatomic ions:

- Name the cation
- Find the name of the polyatomic ion and use it as an anion.

$CaCO_3$
Calcium Ca^{2+}

$CaCO_3$
Carbonate CO_3^{2-}

$CaCO_3$
Calcium carbonate



Ion	Name
NCS^-	Thiocyanate
CO_3^{2-}	Carbonate
HCO_3^-	Hydrogen carbonate (bicarbonate is a widely used common name)

Sodium hydroxide = NaOH **Ammonium carbonate = $(NH_4)_2CO_3$**

Naming Hydrates
Handouts: a second page #29

PERCENT WATER IN A HYDRATE

A hydrate is a solid substance, which contains water bound within the crystal lattice of a salt. Water molecules are present in definite proportions in hydrates. Epsom salts, also known as the mineral *epsomite*, is pure magnesium sulfate heptahydrate, $MgSO_4 \cdot 7\ H_2O$. There are seven water molecules present for every one molecule of the salt. Magnesium sulfate heptahydrate can react to produce other hydrates with one, two, three and six molecules of water respectively for each magnesium sulfate. The common name, Epsom salts, comes from the name of a small town in England where in the early 1600s the town's well water was regarded as being curative. Today, it is still regarded as being able to treat splinters, scrapes, insect bites, minor sprains and bruises, to produce lush, healthy lawns, vibrant plants and vegetables as well as a smoother softer skin, and to provide relief from everyday stress. In Shakespeare's 17th century, no one understood the therapeutic mystery of the town's water, and it wasn't until many, many decades later that modern chemistry identified the active mineral component as this particular hydrate.

magnesium sulfate heptahydrate
$MgSO_4 \cdot 7\ H_2O$

First name the "salt" and then count the number of water molecules ("hydrates") & describe with a prefix

Naming Hydrates
Handouts: Replace Report page #29 in Lab Manual

1) Name the following hydrates:

$CoSO_4 \cdot 6\ H_2O$

$MgCl_2 \cdot 6\ H_2O$

$CuSO_4 \cdot 5\ H_2O$

2) Write formulas for the following hydrates:

Sodium dihydrogenphosphate nonahydrate

Potassium chromate tetrahydrate

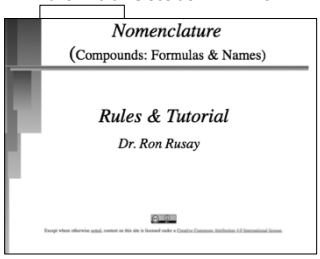
Lead (II) acetate trihydrate

Show completed pg. 29 data & questions (both pages except Post-Lab Question) on individual Reports to Dr. R. before leaving lab.

magnesium sulfate heptahydrate
$MgSO_4 \cdot 7\ H_2O$

First name the "salt" and then count the number of water molecules ("hydrates") & describe with a prefix

Your Lab Group of 4 is to complete Lab manual pages 110-115.
ONLY 1 Set of pages to be turned in per group
Select Responsible Group Leader: DUE in 2 weeks
End of Lab: October 14th /16th



REFER to: http://www.chemconnections.org/general/chem108/Nomenclature.htm