chemistryacademy
high school chemistry

1. introduction to chemistry

periodic table of the elements

1 valence electron
+1
alkali metals
group 1

2 valence electrons
+2
alkaline earth metals
group 2

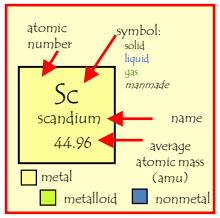
valence electrons: 3 4 5 6 7 8
common charges: +3 −3 −2 −1 halogens
0 noble gases group 18
metal / nonmetal

	group 3	group 4	group 5	group 6	group 7	group 8	group 9	group 10	group 11	group 12	group 13	group 14	group 15	group 16	group 17	group 18
1s																2 He helium 4.00
2s											5 B boron 10.81	6 C carbon 12.01	7 N nitrogen 14.01	8 O oxygen 16.00	9 F fluorine 19.00	10 Ne neon 20.18
3s											13 Al aluminum 26.98	14 Si silicon 28.09	15 P phosphorus 30.97	16 S sulfur 32.07	17 Cl chlorine 35.45	18 Ar argon 39.95
4s	21 Sc scandium 44.96	22 Ti titanium 47.90	23 V vanadium 50.94	24 Cr chromium 52.00	25 Mn manganese 54.94	26 Fe iron 55.85	27 Co cobalt 58.93	28 Ni nickel 58.71	29 Cu copper 63.55	30 Zn zinc 65.37	31 Ga gallium 69.72	32 Ge germanium 72.59	33 As arsenic 74.92	34 Se selenium 78.96	35 Br bromine 79.91	36 Kr krypton 83.80
5s	39 Y yttrium 88.91	40 Zr zirconium 91.22	41 Nb niobium 92.91	42 Mo molybdenum 95.94	43 Tc technetium 96.91	44 Ru ruthenium 101.07	45 Rh rhodium 102.91	46 Pd palladium 106.40	47 Ag silver 107.87	48 Cd cadmium 112.40	49 In indium 114.82	50 Sn tin 118.69	51 Sb antimony 121.75	52 Te tellurium 127.60	53 I iodine 126.90	54 Xe xenon 131.30
6s	55 Cs cesium 132.91	56 Ba barium 137.33	to 4f	71 Lu lutetium 174.97	72 Hf hafnium 178.49	73 Ta tantalum 180.95	74 W tungsten 183.85	75 Re rhenium 186.21	76 Os osmium 190.20	77 Ir iridium 192.22	78 Pt platinum 195.09	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.37	82 Pb lead 207.19	83 Bi bismuth 208.980	84 Po polonium 208.982	85 At astatine 209.99	86 Rn radon 222.02
7s	87 Fr francium 223.02	88 Ra radium 226.03	to 5f	103 Lr lawrencium 262.11	104 Rf rutherfordium 267.12	105 Db dubnium 268.13)	106 Sg seaborgium 171.13	107 Bh bohrium 270.13	108 Hs hassium 277.15	109 Mt meitnerium 278.16	110 Ds darmstadtium 281.17	111 Rg roentgenium 281.16	112 Cn copernicium 285.18	113 Nh nihonium 286.19	114 Fl flerovium 289.19	115 Mo moscovium 289.19	116 Lv livermorium 293.20	117 Ts tennessine 294	118 Og oganesson 294

(H is a nonmetal)

transition metals

3d 4d 5d 6d



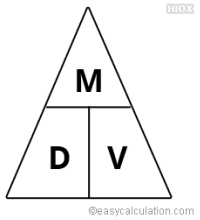
common ions

4f	57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium (144.91)	62 Sm samarium 150.41	63 Eu europium 151.96	64 Gd gadolinium 157.25	65 Tb terbium 158.92	Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.04	to 5d
5f	89 Ac actinium 227.03	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium 237.05	94 Pu plutonium 244.06	95 Am americium 243.06	96 Cm curium 247.07	97 Bk berkelium 247.07	98 Cf californium 251.08	99 Es einsteinium 252.08	100 Fm fermium 257.10	101 Md mendelevium 258.10	102 No nobelium 259.10	to 6d

common ions

acetate $CH_3CO_2^-$	bisulfite HSO_3^-	chlorite ClO_2^-	hydroxide OH^-	nitrite NO_2^-	phosphide P^{3-}
ammonium NH_4^+	bromide Br^-	chromate CrO_4^{2-}	hypochlorite ClO^-	oxide O^{2-}	sulfate SO_4^{2-}
bromide Br^-	carbonate CO_3^{2-}	cyanide CN^-	iodide I^-	perchlorate ClO_4^-	sulfide S^{2-}
bicarbonate HCO_3^-	chlorate ClO_3^-	dichromate $Cr_2O_7^{2-}$	nitrate NO_3^-	permanganate MnO_4^-	sulfite SO_3^{2-}
bisulfate HSO_4^-	chloride Cl^-	fluoride F^-	nitride N^{3-}	phosphate PO_4^{3-}	thiosulfate $S_2O_3^{2-}$

chemistry equations



1. introduction to chemistry

$d = \frac{m}{V}$ d = density; m = mass in g; v = volume in mL

SI unit prefixes

giga	billion (10^9)
mega	million (10^6)
kilo	thousand (10^3)
deka	ten (10^0)
deci	tenth (10^{-1})
centi	hundredth (10^{-2})
milli	thousandth (10^{-3})
micro	millionth (10^{-6})
nano	billionth (10^{-9})
pico	trillionth (10^{-12})

2. data

$$\%\ \text{yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100cv$$

$$\%\ \text{error} = \frac{\text{error}}{\text{accepted valued}} \times 100$$

temperature: $K = {}^\circ C + 273.15$

${}^\circ C = ({}^\circ F - 32) \times \frac{5}{9}$ ${}^\circ F = \frac{9}{5}{}^\circ C + 32$

3. matter, 4. atom: no formulas

5. electrons

$s = wf$ $e = hf$ $e = hs/w$ $w = hs/e$

s = the speed of light = 3×10^8 m/s
w = wavelength in meters
f = frequency, per second.
e = energy in joules
h = Plancks constant = 6.626×10^{-34} j sec

Balmer formula for hydrogen :

$$w_{nm} = \frac{1}{.01097\left(\frac{1}{\text{inner}^2} - \frac{1}{\text{outer}^2}\right)}$$

w = wavelength in nanometers
inner = inner shell #; outer = outer shell #.
similarly:

$$E_{\text{hydrogen}} = 2.18 \times 10^{-18}\text{joules}\left(\frac{1}{\text{inner}^2} - \frac{1}{\text{outer}^2}\right)$$

9. the mole: is an amount! = 6.02×10^{23}

mol-mol conversions: $\text{mol A} \times \frac{\text{mol B}}{\text{mol A}} = \text{mol B}$

gram – mol conversions: $g\text{A} \times \frac{\text{mol A}}{g\text{A}} \times \frac{\text{mol B}}{\text{mol A}} = \text{mol B}$

mol – g conversions: $\text{mol A} \times \frac{\text{mol B}}{\text{mol A}} \times \frac{g\ \text{B}}{\text{mol B}} = g\ \text{B}$

g– g conversions: $g\text{A} \times \frac{\text{mol A}}{g\text{A}} \times \frac{\text{molB}}{\text{mol A}} \times \frac{g\text{B}}{\text{molB}} = g\text{B}$

10. gas laws

units

P pressure
V = volume (L)
T = Kelvin Temp (K)
n = # of moles (mol)
R = 0.0821 L atm/mol K
M = molar masses (g/mol)
d = density

1 atm = 14.7 psi = 760 mm Hg or Torr = 101 3 kPa

STP = standard temp and pressure = 1 atm, 273.15 K

formulas

boyles: $P_1V_1 = P_2V_2$ charles: $\frac{T_1}{V_1} = \frac{T_2}{V_2}$ gay-lussac: $\frac{T_1}{P_1} = \frac{T_2}{P_2}$ combined: $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$

must use K for temperature; other units must cancel

ideal gas law:

$PV = nRT$ must use L atm mol K

avogadro's law: 22.4 L = 1 mole gas at STP

density formula: $d = \frac{PM}{RT}$

graham's law: $\frac{\text{rate}_1}{\text{rate}_2} = \sqrt{\frac{M_2}{M_1}}$

partial pressure

$$\text{partial pressure of gas a} = \frac{\text{moles of gas a}}{\text{total moles of gas}} \times \text{total pressure}$$

6. periodic table; 7. bonding 8. reactions: no formulas ☺

11. energy:

$q = mc\Delta T$

q = heat, m = mass, c = specific heat ($J/g^\circ C$), ΔT = temp change in °C.

energy needed to melt and boil water:

$c_{water(l)} = 4.184\ J/g\ {}^\circ C$
$c_{water(s)} = 2.03\ J/g{}^\circ C$
$c_{water(g)} = 2.01\ J/g{}^\circ C$
$\Delta H_{vap\ water} = 2260\ J/g$; $\Delta H_{fus\ water} = 334\ J/g$
water boils/condenses at 100°C
water melts/freezes at 0°C

$\Delta H_{fus\ water} = 334\ J/g$
$\Delta H_{vap\ water} = 2260\ J/g$

1 Nutritional Calorie = 4184 Joules = 4 BTU = 1000 calories = 0.0016 kilowatt hours

$\Delta G = \Delta H - T\Delta S$

ΔG = change in free energy
ΔH = change in enthalpy
T = temperature
ΔS = change in entropy

15. acids and bases

K_a for example of HCl $= [H+][Cl^-]/[HCl]$

$K_w = [H+][OH^-] = 10^{-14}$

titration:

$pH = -\log[H+]$
$10^{-pH} = [H^+]$
$pOH = -\log[OH^-]$
$10^{-pOH} = [OH^-]$
$pH + pOH = 14$

$$\text{molarity}_{\text{unknown}} = \frac{(\text{volume}_{\text{standard}})(\text{molarity}_{\text{standard}})}{\text{volume}_{\text{unknown}}}$$

14. equilibrium

for:

$$aA + bB \rightleftarrows cC + dD$$

$$K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

omit liquids and solids

13. rates

reaction rate = $\Delta_{concentration}/\Delta_{time}$

M = Molarity = moles per liter = moles/liter

$\Delta_{concentration}{}^{order} = \Delta_{rate}$

$$E_a = \frac{(\ln\frac{K_1}{K_2})R}{\frac{1}{T_2} - \frac{1}{T_1}}$$

E_a = activation energy (j/mol)
K_1, K_2 =rate constants
T_1, T_2, = temperatures (K)
R = 8.314 j/k mol

12. solutions

1. percent concentration by volume (%v/v)
= volume of solute x 100
volume of solution

2. percent concentration by mass (%m/m)
= mass of solute x 100
mass of solution

3. Molarity (M)
= moles of solute
Liters of solution

4. molality (m)
= moles of solute
Kilograms of solvent

5. mole fraction (X)
= moles of solute
moles of solution

6. concentration and dilution
6. $C_1V_1 = C_2V_2$
where C_1 and C_2 are concentrations;
and V_1 and V_2 are volumes

7. Henry's Law:
Solubility is proportional to Pressure
$S_1/P_1 = S_2/P_2$

8. pressure and volume units units:
1 **atm** = 760 mm Hg = 14.7 psi = 101.3 KPa
1 **L** = 1000 mL

9. boiling point elevation (ΔT_b) and freezing point depression (ΔT_f) of solutions

$\Delta T_f = K_f m \cdot pm$
$\Delta T_b = k_b m \cdot pm$

ΔT_f= change in freezing temp; ΔT_b = change in boiling temperature; K_f = freezing point constant; K_b = boiling point constant; m = molality; pm = particle molality (ion count)
(K_f is for the solvent; pm is for the solute)

Name (include the first name you'd like to be called in class)_____ Period_____

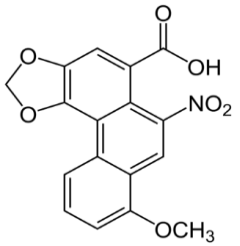
day 1 survey

welcome to chemistry!

please always include the period; it helps me keep things in the right folders

please fill out the survey below to get started.

1. What science course did you take last year? Course _____Teacher_____
2. What did you think of the course and/or the teacher?



aristolochic acid

3. What do you think of science?
4. How hard a worker are you?
5. What do you plan to do after high school?
6. Please let me know the names of any brothers or sisters you had that took my course.
7. Please list any accommodations that you have that you are aware of (extra time on tests, preferential seating, etc.- this would be as a result of a 504 plan or similar)
8. Tell me a little bit about yourself. Long answers are welcome ☺

Student Safety Contract

Science is a hands-on laboratory class. However, science activities may have potential hazards. We will use some equipment and animals that may be dangerous if not handled properly. Safety in the science classroom is an important part of the scientific process. To ensure a safe classroom, a list of rules has been developed and is called the Science Safety Contract. These rules must be followed at all times. Additional safety instructions will be given for each activity. No science student will be allowed to participate in science activities until this contract has been signed by both the student and a parent or guardian.

SAFETY RULES

1. Conduct yourself in a responsible manner at all times in the science room. Horseplay, practical jokes, and pranks will not be tolerated.
2. Follow all written and verbal instructions carefully. Ask your teacher questions if you do not understand the instructions.
3. Do not touch any equipment, supplies, animals, or other materials in the science room without permission from the teacher.
4. Perform only authorized and approved experiments. Do not conduct any experiments when the teacher is out of the room.
5. Never eat, drink, chew gum, or taste anything in the science room.
6. Keep hands away from face, eyes, and mouth while using science materials or when working with either chemicals or animals. Wash your hands with soap and water before leaving the science room.
7. Wear safety glasses or goggles when instructed. Never remove safety glasses or goggles during an experiment. There will be no exceptions to this rule!
8. Keep your work area and the science room neat and clean. Bring only your laboratory instructions, worksheets, and writing instruments to the work area.
9. Clean all work areas and equipment at the end of the experiment. Return all equipment clean and in working order to the proper storage area.
10. Follow your teacher's instructions to dispose of any waste materials generated in an experiment.
11. Report any accident (fire, spill, breakage, etc.), injury (cut, burn, etc.), or hazardous condition (broken equipment, etc.) to the teacher immediately.
12. Consider all chemicals used in the science room to be dangerous. Do not touch or smell any chemicals unless specifically instructed to do so.
13. Handle all animals with care and respect.
    a. Open animal cages only with permission.
    b. Never handle any animals when the teacher is out of the room.
    c. Do not take animals out of the science room.
    d. Do not tease or handle animals roughly.
    e. Keep animals away from students' faces.
    f. Wear gloves when handling animals.
    g. Report any animal bite or scratch to the teacher immediately.
14. Always carry a microscope with both hands. Hold the arm with one hand; place the other hand under the base.
15. Treat all preserved specimens and dissecting supplies with care and respect.
    a. Do not remove preserved specimens from the science room.
    b. Use scalpels, scissors, and other sharp instruments only as instructed.
    c. Never cut any material towards you—always cut away from your body.
    d. Report any cut or scratch from sharp instruments to the teacher immediately.
16. Never open storage cabinets or enter the prep/storage room without permission from the teacher.
17. Do not remove chemicals, equipment, supplies, or animals from the science room without permission from the teacher.
18. Handle all glassware with care. Never pick up hot or broken glassware with your bare hands.
19. Use extreme caution when using matches, a burner, or hot plate. Only light burners when instructed and do not put anything into a flame unless specifically instructed to do so. Do not leave a lit burner unattended.
20. Dress properly: long hair must be tied back, no dangling jewelry, and no loose or baggy clothing. Wear aprons when instructed.
21. Learn where the safety equipment is located and how to use it. Know where the exits are located and what to do in case of an emergency or fire drill.

AGREEMENT

I, _____ ,(student's name) have read and understand each of the above safety rules set forth in this contract. I agree to follow them to ensure not only my own safety but also the safety of others in the science classroom or laboratory. I also agree to follow the general rules of appropriate behavior for a classroom at all times to avoid accidents and to provide a safe learning environment for everyone. I understand that if I do not follow all the rules and safety precautions, I will not be allowed to participate in science activities.

***Student Signature: _____Date:_____

Dear Parent or Guardian:

We feel that you should be informed of the school's effort to create and maintain a safe science classroom/ laboratory environment. Please read the list of safety rules. No student will be permitted to perform science activities unless this contract is signed by both the student and parent/guardian and is on file with the teacher. Your signature on this contract indicates that you have read this Science Safety Contract, reviewed it with your child, and are aware of the measures taken to ensure the safety of your son/daughter in the science classroom.

Parent/Guardian Signature:_____Date:_____

Important questions:

Does your child wear contact lenses? Y or N
Is your child color blind? Y or N
Does your child have any allergies? Y or N
If so, please list:_____
_____

Name _____ Date _____

score:

science safety quiz

1. If a fire erupts, immediately
   A. notify the teacher.
   B. run for the fire extinguisher.
   C. throw water on the fire.
   D. open the windows.
2. Approved eye protection devices (such as goggles) are worn in the laboratory
   A. to avoid eye strain.
   B. to improve your vision.
   C. only if you do not have corrective glasses.
   D. any time chemicals, heat, or glassware are used.
3. If you do not understand a direction or part of a laboratory procedure, you should
   A. figure it out as you do the lab.
   B. try several methods until something works.
   C. ask the teacher before proceeding.
   D. skip it and go on to the next part.
4. After completing an experiment, all chemical wastes should be
   A. left at your lab station for the next class.
   B. disposed of according to your teacher's directions.
   C. dumped in the sink.
   D. taken home.
5. You have been injured in the laboratory (cut, burned, etc.). First you should
   A. visit the school nurse after class.
   B. see a doctor after school.
   C. tell the teacher at once.
   D. apply first aid yourself.
6. Long hair in the laboratory must be
   A. cut short.
   B. held away from the experiment with one hand.
   C. always neatly groomed.
   D. tied back or kept entirely out of the way with a hair band, etc.
7. Which of the following should NOT be worn during a laboratory activity?
   A. loose clothing
   B. dangling jewelry
   C. sandals
   D. All of the above.
8. Horseplay, practical jokes, or pranks in the classroom are
   A. always against the rules.
   B. okay.
   C. not dangerous.
   D. okay if you are working alone.
9. When handling animals, students should
   A. open cages only with permission.
   B. not tease or handle animals roughly.
   C. report bites or scratches to the teacher immediately.
   D. All of the above.
10. If a piece of equipment is not working properly, stop, turn it off, and tell
   A. the principal.
   B. your lab partner.
   C. your best friend in the class.
   D. the teacher.
11. When you finish working with chemicals, biological specimens, and other lab substances, always
   A. treat your hands with skin lotion.
   B. wash your hands thoroughly with soap and water.
   C. wipe your hands on a towel.
   D. wipe your hands on your clothes.
12. The following activity is permitted in the laboratory:
   A. chewing gum
   B. eating
   C. drinking
   D. None of the above.

13. When using a razor blade or scalpel, always cut material

A. away from you.
B. toward you.
C. in your hand.
D. perpendicular.

14. Before you leave the science room, you should

A. clean your work area and equipment.
B. return all equipment to the proper storage area.
C. wash your hands with soap and water.
D. All of the above.

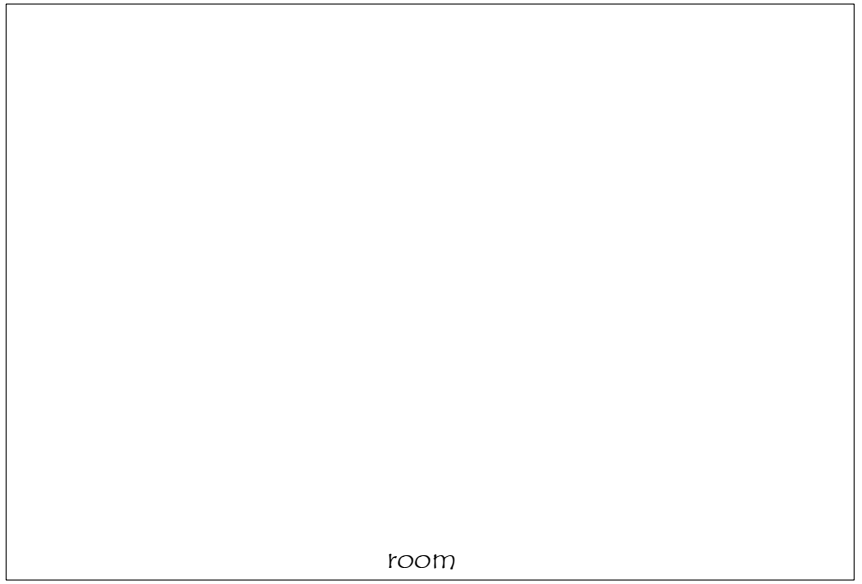
15. Draw a diagram of your science room below and label the locations of the following:

- Fire Blanket
- Fire Extinguisher(s)
- Exits
- Eyewash Station
- Emergency Shower
- Waste Disposal Containers
- Fume Hood
- Emergency Shut-off (gas)

True—False

enter T or F

16. ____ All chemicals in the lab (including foodstuffs and store-bought chemicals) should be treated as if they could be hazardous.
17. ____ Work areas should be kept clean and tidy.
18. ____ Laboratory work may be started immediately upon entering the laboratory even if the teacher is not yet present.
19. ____ Never remove chemicals, specimens, or other equipment from the laboratory.
20. ____ Always carry a microscope using both hands.
21. ____ Read all procedures thoroughly before performing a laboratory investigation.
22. ____ All unauthorized experiments are prohibited.
23. ____ You are allowed to enter the chemical preparation/storage area any time you need to get an item.
24. ____ It is okay to pick up broken glass with your bare hands as long as the glass is placed in the trash can.
25. ____ Do not leave a lit burner unattended.



room

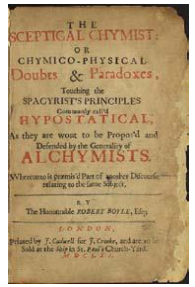
syllabus

all about this course

Welcome to chemistry! I look forward to working with you this school year. The purpose of this syllabus is to summarize the goals, content, grading policy, and class expectations for this school year.

what is everything made out of?

That is the essential question for this course- the same question that the we all naturally ask as we look at the world around us. It also makes one wonder why some substances are inert, while other substances react violently when mixed. For a few of you, opening your mind to the world of chemistry may change the course of your life (or at least your college major), as it did for me. For all of you this course will help you to understand the world around you.



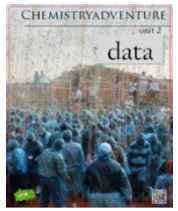
So, how do we answer this question? Certainly the most enjoyable way is to roll up your sleeves and find out for yourself. Teachers call this inquiry-based learning, and it is very effective (and, hopefully, fun!). We begin each unit by asking a simple question, and you and your lab partner then try to find out on your own. No, not by looking it up on wikipedia- by experiment. What you discover you aren't likely to forget. It gives you a understanding of things that uses all of your senses. And, best of all, although it usually makes you question your own research, there are those rare occasions your own observations may make you question what the "experts" say, or the way that they say it. The best chemist is a skeptical chemist:

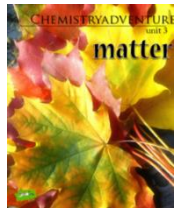
...by having Thus drawn the Chymists Doctrine out of their Dark and Smoakie Laboratories,
and both brought it into the open light,
and shewn the weakness of their Proofs,
that have hitherto been wont to be brought for it,
either Judicious Men shall henceforth be allowed calmly and after due information to disbelieve it,
or those abler Chymists,
that are zealous for the reputation of it,
will be oblig'd to ***speak plainer*** *then hitherto has been done*

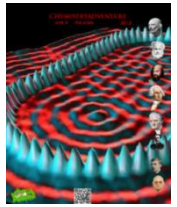
Robert Boyle
The Skeptical Chymist (1661)

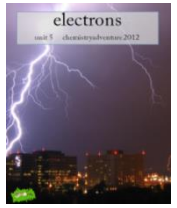
The best chemist is a skeptical chemist. An original copy of The Skeptical Chymist (1661) from the University of Pennsylvania. Full text is available as is a scanned copy of the 1661 manuscript

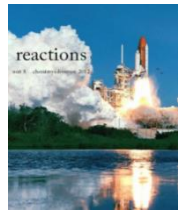
Here are the units we will cover. Each chapter will last for 1-2 weeks, and most units will be tested individually. These 15 packets include or will direct you to everything you need to know about chemistry. Students receive paper copies of each packet, and it is online at the class website (chemistryacademy.org)

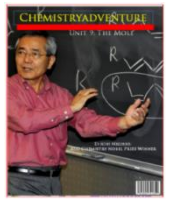


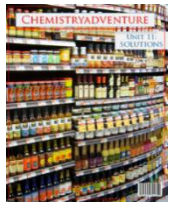


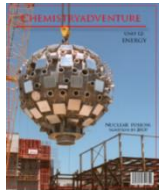












Grading Policy

This class uses a "pure points" system: your grade will be determined by the points accumulated from homework, tests, and lab reports. For, example, you might earn 90 points on a 100 point exam, and 5 points on a 10 point quiz. Your average at that point would be 95 points out of a possible 110 total points for an "average" of 86%. Your grade can be accessed on PowerSchool, through the GHS website, also available on the chemistryacademy.com website. Test scores usually incorporate a citizenship component: arriving late to class or being unprepared results in a minor deduction for each occurrence. Assisting others and other meritorious behavior can lead to a small increase in your test score. During any type of testing, there can be no communications in any form with any other student(s). Should such communications take place, the student(s) will receive a grade of zero on the test. Be aware that it is a big deal if your cellphone is out for any reason during a test– this can result in severe consequences.

What to bring to class

All parents should receive an email a few days before the first day of class outlining what each student should bring on day 1. Each day students should bring:

1. A laptop or tablet. If you don't have one a chromebook will be supplied to you in class. Check for updates on this since the school policy is somewhat fluid at this point.
2. A chronologically organized small **3 ring binder** that includes the current semester of handouts, all additional handouts , and tests.
3. **Loose leaf paper** in the binder.
4. A **scientific calculator**
5. A **pen or pencil**
6. Your **homework**
7. **Ear buds or Headphones** for listening to screencasts.
8. A chromebook or laptop.

On the first day of class you will receive this chapter, and each chapter will be handed out a the end of the previous one..**Notebook checks occur during tests (5 points each)**, mostly to see that you are taking effective notes and completing all worksheets, and staying organized.

Homework

The homework for each week is posted in the classroom and on powerschool. Have it out at the beginning of class so it can be collected. Sorry, no credit for late homework.

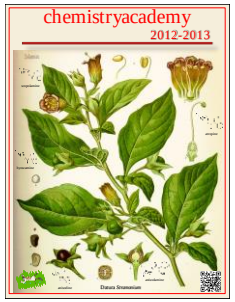
in this class extensive use will be made of screencasts which include a scored follow-up quiz. Have a look at them at the chemistryacademy.org website; stay tuned for further details.

Absences and Makeup Tests

If you missed a class it's easy to find out what you missed. The weekly schedules and homework are posted in class and on chemistryacademy.org. Rather than asking what you missed when you return from an absence, come in with your homework completed. For extended absences, check in with your instructor to schedule any makeup work. Note that an absence does not excuse you from your work; you will receive a zero until the work is made up. F

With the exception of the hands-on labs, this class is fully set up for distance learning. All lectures have screencasts that can be viewed online, and each chapter is available online. Use your packet, go online. Watch the screencasts for each lecture. Complete the worksheets. Email me if you get stuck. Call your friends. Please try to avoid asking me "What did I miss?"- check powerschool first. Instead, say hello when you return to class and let me know that you are on track. Be aware that you will still have to take the test on the day scheduled, or soon after your return if you for excused absences.

Makeup tests are available for verified absences. Sorry, no retests.



This course uses a series of chapters which are available online. Students are given a hard copy of each successive chapter during each chapter test

Cellphones

Please don't take out your cellphone without permission. If it is impeding your work it may be confiscated.

Media Privacy

Occasionally there may be photographs or videos taken of us in the classroom. Although these are usually popular with the students and are good for class morale, it is important for each student to know that their right not to be photographed or videotaped is important and will be respected. Additionally, any photos or videos that are taken in the classroom will never be shared outside the classroom. Each student was mailed a media privacy form at the beginning of the year. Please let me know if you prefer not to be photographed or videotaped.

Welcome to Chemistry! Please email me if you have any questions.

Dr B

Common Issues

1. Late to class
   Students who are late to class without a pass will receive a minor point deduction on their next test. Two tardies results in an email to your parents. Three tardies leads to a detention.
2. Arriving unprepared.
   Students who do not have a binder, calculator, and a pencil will receive a minor point deduction on their next test. Daily homework is worth 5 points, and is due at the beginning of class
3. Cellphones visible in class
   Once class begins, any cellphone seen will result in a 5 point deduction on the next test. Additional consequences such as detentions may follow.
4. Lab Groups of more than 2
   To receive credit for a lab experiment your group must be no more than 2 students.
4. Absences and makeup tests
   Unexcused absences are treated in accordance with the student-parent handbook. Students are responsible for making up lost work and will still have to take each test. There are no makeups, but students may drop one test per quarter
5. Homework from other classes
   Will be confiscated if students work on it in class unless specifically instructed otherwise.
6. Students not seated or not in assigned seats
   Please remain seated in your assigned seat unless instructed otherwise to me marked as present.
7. Unsafe laboratory practices
   This is a serious offense and will result in immediate removal from class and administrative action.

name _____ period _____ lab 1.1

please always fill this in- it helps me stay organized.

flame lab

an opportunity to safely light things on fire and identify unknown samples

safety warnings:
- flames present
- alcohols are toxic and flammable

Each of you will be given authentic control samples of water, methanol, ethanol, propanol, isopropanol, and butanol, as well as unknown numbered samples of each of those six substances.
Your goal is to identify each. unknown sample by matching it with the control sample. It is suggested that you safely ignite each sample and observe the flame, and complete the tables below.

Consider identifying features such as the odor, flame color, and solubility in water of each sample. For your other observations, you can use any method you like to identify these samples as long as you work safely. Goggles must be worn. Never light a match without permission. Tie your hair back, and listen carefully to the safety instructions provided by your teacher. You must have signed the safety agreement (parents too) and completed the safety quiz to perform this fun but dangerous experiment.

equipment needed:
- matches or equivalent
- aluminum weighing boats
- methanol
- ethanol
- propanol
- isopropanol
- butanol
- disposable pipettes

Complete the data tables below. All blocks must be completed:

control samples			
sample	odor	flame color	Other observations *must be completed*
Water	none	none	answers vary
Methanol	faint	blue	answers vary
ethanol	answers vary	yellow and blue	answers vary
propanol	rubbing alcohol	yellow and blue	answers vary
isopropanol	rubbing alcohol	yellow and blue	answers vary
butanol	distinct strong	yellow and blue, long lasting	answers vary

unknown samplese			
unknown #	odor	flame color	Other observations *must be completed*
1	answers vary	yellow and blue	answers vary
2	none	none	answers vary
3	distinct	yellow and blue	answers vary
4	rubbing alcohol	yellow and blue	answers vary
5	faint	blue	answers vary
6	rubbing alcohol	yellow and blue	answers vary

conclusions:

identify each unknown sample based on your data above. After that, clean up, receive your cleanup stamp, and answer the questions on the next page.

cleanup stamp

1. ethanol 2. water 3. butanol 4. propanol 5. methanol 6. isopropanol

most common error: students leave areas blank, resulting in a low score.

questions

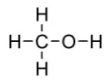
1. You are given the chemical structures of each substance on the right. Water has a molecular formula of H_2O, ethanol has a formula of C_2H_6O. Provide the formulas for the others.

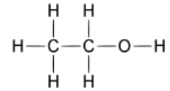
H_2O	CH_4O	C_2H_6O	C_3H_8O	C_3H_8O	$C_4H_{10}O$
water	methanol	ethanol	propanol	isopropanol	butanol

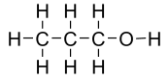
note how the elements are listed alphabetically

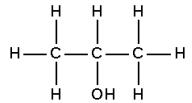
chemical structures of water, and some common alcohols.

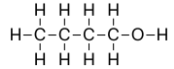
water: H-O-H

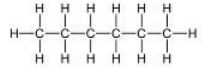
methanol 

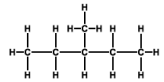
ethanol: 

n-propanol: 

isopropanol: 

butanol: 

hexane 

3-methylpentane: an isomer of hexane it is "branched" at carbon 3 

2. Hydrogen prefers to have one chemical bond, and oxygen (O) always has 2. How many bonds does carbon contain?

4

3. There is a saying: "HONC if you love chemistry". How many bonds does nitrogen (N) normally form? 4

these are known as the **HONC rules of bonding**: H, O, N, and C tend to form 1, 2, 3, and 4, bonds respectively.

4 As for most combustion reactions, each of these combustion reactions combines the alcohol with oxygen to form carbon dioxide and water. This is a theme we will return to throughout the year. We can write a chemical reaction:

$$C_2H_6O + O_2 \rightarrow CO_2 + H_2O$$

something is wrong here…how can we start with two carbon atoms but only end with one?

Taken literally this says that one molecule of ethanol combines with one molecule of oxygen to make one molecule of carbon dioxide and one molecule of water. The problem is that this is impossible as written. Note for example that we started with **two** carbon atoms, and ended with one. We fix it by balancing it:

$$C_2H_6O + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$$

convince yourself that all atoms are retained by this equation

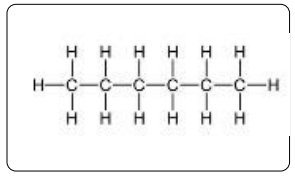
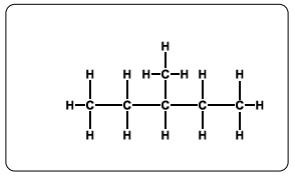
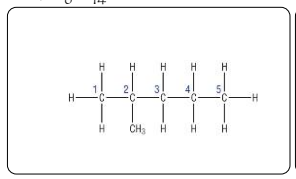
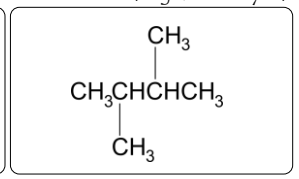
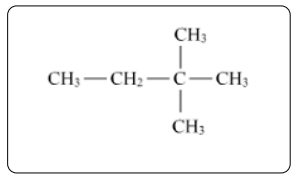
Note that now that nothing has magically disappeared or appeared- there are the same number of atoms for each element: C (2), H(6), and O (7).

Ok, your turn. Write a balanced chemical equation for the combustion of butanol ($C_4H_{10}O$)

__ $C_4H_{10}O$ + __ O_2 → __ CO_2 + __ H_2O

5. On the right is the structural formula for the major component of gasoline: hexane, (C_6H_{14}). Note that if you "branch" the molecule (see 3-methylpentane on the right) it can be drawn in more than one way- these are called **isomers**: substances with identical molecular formulas, but different structures. Two isomer of hexane are shown. Draw as many additional isomers of hexane as you can below. Hints: don't just bend it- they bend on their own. Try <u>branching</u> it differently. There are five possible isomers.

Draw the five isomers with molecular formula C_6H_{14} : note the HONC rules of bonding are obeyed.

note that it is a bit easier to draw hexane as
CH_3-CH_2-CH_2-CH_2-CH_2-CH_3
or $CH_3CH_2CH_2CH_2CH_2CH_3$
these are called **condensed structures**

another hint: Consider branching at the second carbon, two branches at the second carbon, and at the second and third carbon atoms. Note that these molecules are flexible- changing the bond angle does not create a new substance. Placing the branched carbons on top or bottom doesn't matter- they can rotate.

6 . Write a balanced chemical equation for the combustion of ethanol (C_2H_6O). The products are carbon dioxide and water.

__ C_2H_6O + __ _____ → __ _____ + __ _____

7. Write a balanced chemical equation for the combustion of hexane (C_6H_{14}). The products are carbon dioxide and water.

__ _____ + __ _____ → __ _____ + __ _____

name _____ period _____

lab 1.2 molecular model lab

an opportunity to see what molecules look like

what do molecules look like?

To really understand what everything is made out of, we need to magnify things down to a molecular level. In the flame lab, we were shown the molecular structure of ethanol. Here are several different ways of representing that molecule:

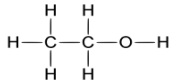
all of these are correct for ethanol; but some provide more information than others.

C_2H_6O

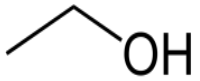
molecular formula

CH_3CH_2OH

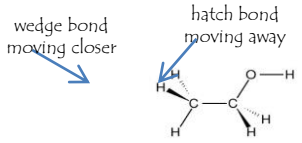
condensed structural formula



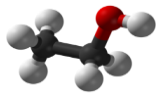
structural formula



skeletal formula
H added to show alcohol functional group

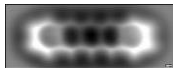


structural formula with stereochemistry



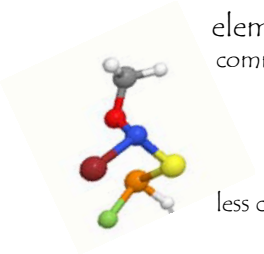
molecular model
ball and stick

molecular model
space filling



and perhaps the most useful of all:
a genuine image (in this case of pentacene)

The three most common atoms attached to organic (carbon based) molecules are hydrogen, oxygen, and nitrogen. In the flame lab you observed that these tend to form the same number of bonds: H1, O2, N3, and C4. For convenience the same colors are used to assemble these molecules; there are also colors for some of the less common elements.



element colors for molecular models

common elements:
- Hydrogen: white (1 bond)
- Oxygen: red (2 bonds)
- Nitrogen: blue (3 bonds
- Carbon: black (4 bonds)

less common elements
- sulfur: yellow
- phosphorus: orange
- chlorine or fluorine: green
- bromine: brown

the HONC rules are significant: over 95% of our body is composed of those four elements.

1. Using the molecular models at your desk, assemble a molecule of ethanol (C_2H_6O) using the color conventions listed. Draw it using both **structural** and **skeletal** formulas

2. There is one other way C_2H_6O can be assembled with the proper number of bonds on each atom (HONC). Assemble it and draw it using both structural and skeletal formulas.

structural formula of one isomer of C_2H_6O

skeletal formula of one isomer of C_2H_6O

structural formula of another isomer of C_2H_6O

skeletal formula of another isomer of C_2H_6O

each carbon should have 4 bonds, one for each hydrogen, and two for oxygen.

lab 1.2 (continued)

To help "see" molecules we will practice making molecular models, and then drawing those molecules in various ways.

1. Assemble each molecule (some can be assembled more than one way). Show your instructor your models when you are finished and receive a stamp. Use the HONC rules for bonding: H1, O2, N3, and carbon tends to form 4 bonds.

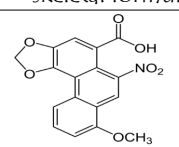
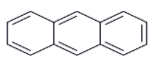
C_2H_7N	$C_2H_6O_2$	C_3H_8	C_3H_6
stamp	stamp	stamp	stamp (hint: use double bonds or rings
			this one requires some creativity

2. Draw the structural formula for each model. Refer to the previous page if you need to.

3. Draw the skeletal formula for each model. Note that for oxygen and nitrogen (sometimes called "heteroatoms") it is common to draw each hydrogen *explicitly* for a skeletal formula to avoid confusion.

4. Are isomers possible? These are other was to assemble your molecule. If there are, draw the structural formula. If not, write "no isomers"

5. Here are some more complex molecules. Complete each row of the table below; you may look up the structure of leucine.

molecular formula	skeletal formula	common name
		aristolochic acid
		anthracene
		leucine (look it up)

name _____ period _____

botanical art project

One of the most enjoyable aspects of chemistry is that it is a great tool for solving mysteries. Each day people use chemistry to solve crimes, heal, and identify mysterious substances. In this lab you will bring in a plant, and learn as much about it as you can.

The chemistry-related goal of this project is to find out the unique substances in your plant and then to create a framed botanical drawing. Every plant contains a bewildering assortment of chemicals, some of which are unique to that plant those are it. We are particularly interested in those unique *natural products* that your plant produces. We will summarize the biological and chemical aspects of your plant with our botanical art project. A sample completed project is shown below – model your work using it.

birthwort

Instructions

Part one: bring in a labeled plant, and any art supplies you need to precisely represent it. Due _____

_____/5 Bring in a safe plant and fill out the information below:

1. Common name of plant:_____
2. Scientific name of plant:_____

Clearly label your plant with those pieces of information and bring it to class. In this experiment you will create a framed botanical drawing of your plant, and identify the natural products it contains.

Part two: Create a framed two page botanical drawing and description of your plant. An example is shown at the bottom of this page.

Note that both pages use parchment given to you and use an old fashioned font of your choice. Due_____

The first page contains:

_____/5 A hand-drawn botanical art drawing of a plant (up to 15 points for neatness and utility; important parts drawn separately; see the bottom of this page for examples). Also include the Latin (genus and species) and common name of the plant.

Remember, the idea is that someone could easily identify your plant using this work of botanical art.

The second page will have

_____/5 A chemical structure of at least one natural product present in that plant (up to 5 points if drawn correctly and medically significant)

_____/5 The name of the chemical below the drawing (5 points)

_____/5 The common name of the plant with the scientific name beneath it, (5 points)

_____/5 A description of the plant and the natural products it contains(5 points)

_____/5 To support your claims include one relevant reference about your plant from Google Scholar. This entire article must be available online; your instructor will show you how to do this. Format as follows: **Authors, title, journal, (year), volume, pages. Available on line at (include hyperlink).**

_____/5 Print the entire article and include it in your submission.

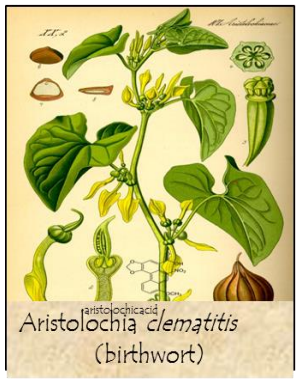
_____/5 Your name at the bottom right of the page (5 points)

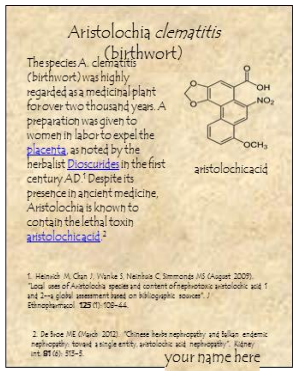
_____/5 All text uses an old fashioned font (5 points)

_____/5 The type of paper used paper should be parchment, or old fashioned as well. (5 points)

____/5 Each page is framed. Please bring in your own; they can be provided if necessary.

_____/5 this page checked and submitted.





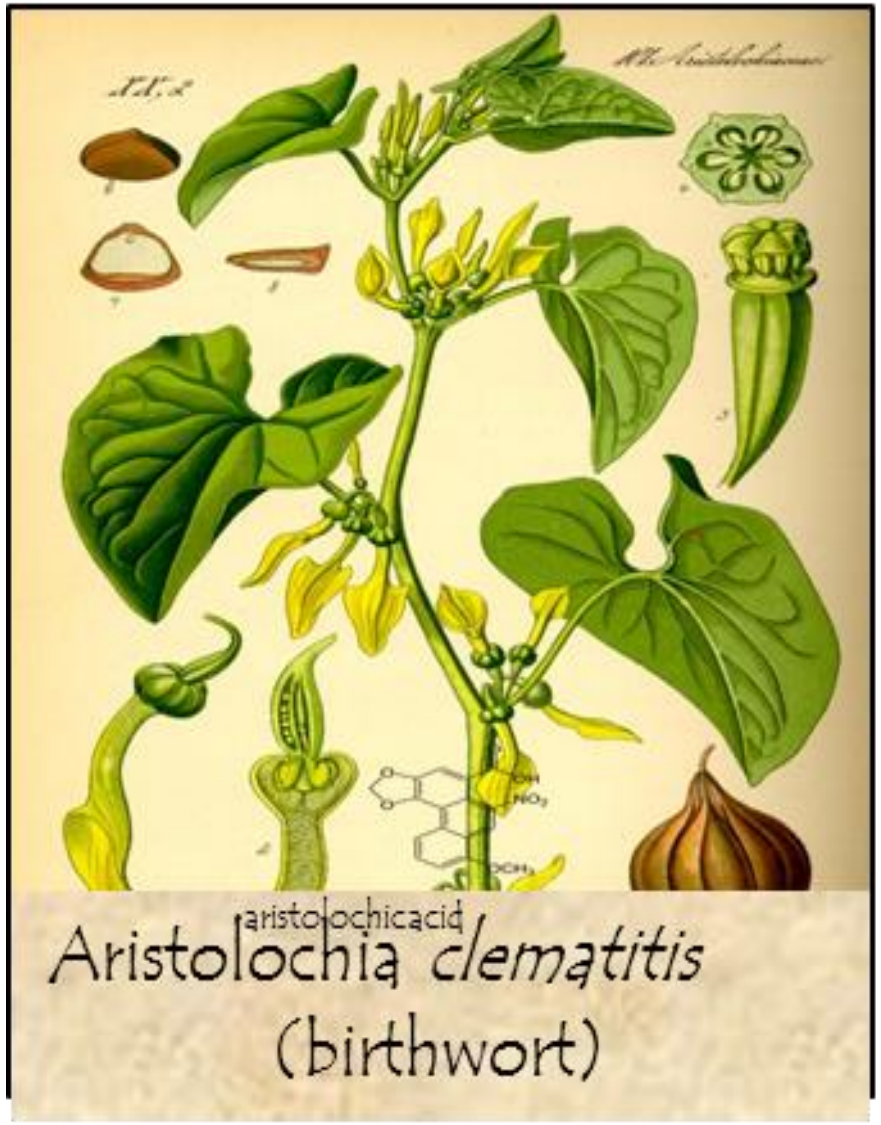
Here is an example of a finished botanical art project. Note how it is on parchment, and the hand drawing includes close-ups of important parts, and describes the common and scientific names of the plant.

On the second page, note how the medicinal aspects of the plant are described, and a medicinal natural product is drawn and named.

Finally, note how this work is supported with two peer-reviewed scientific papers, and the citations do not include websites.

Model your own project based on this one.

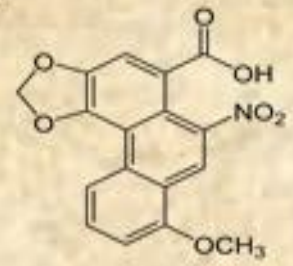
botanical art project exemplar



note common and scientific name provided, old fashioned font used, botanical art includes blowups or unique regions of plant

Aristolochia *clematitis* (birthwort)

The species A. clematitis (birthwort) was highly regarded as a medicinal plant for over two thousand years. A preparation was given to women in labor to expel the placenta, as noted by the herbalist Dioscurides in the first century A.D.[1] Despite its presence in ancient medicine, Aristolochia is known to contain the lethal toxin aristolochicacid.[2]



aristolochicacid

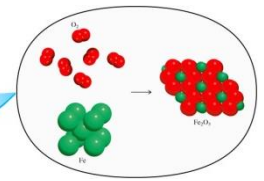
1. Heinrich M, Chan J, Wanke S, Neinhuis C, Simmonds MS (August 2009). "Local uses of Aristolochia species and content of nephrotoxic aristolochic acid 1 and 2--a global assessment based on bibliographic sources". J Ethnopharmacol. **125** (1): 108–44.

2. De Broe ME (March 2012). "Chinese herbs nephropathy and Balkan endemic nephropathy: toward a single entity, aristolochic acid nephropathy". Kidney Int. **81** (6): 513–5.

your name here

note interesting description of plant and uses, labeled relevant chemical structure, and properly formatted peer reviewed source from google scholar.
Note: Please add a hyperlink to journal article.

The study of chemistry



why chemistry is awesome:

yes, we blow stuff up

provide molecular answers

make a difference: cancer… pain… energy…

gateway to great fields- medicine, engineering,…

chemistry is :

the study of matter
and how it changes

a chemical is:

a pure form of
matter (a *substance*)

ok…what is matter?

anything that has mass *and* takes up space.

is it matter?

you? yes

air? yes

an idea? no

energy? no

religion? no

compare mass and weight:

mass: how much matter is in an object. Location independent. Weight is gravity dependent.

a perfect vacuum?
a black hole? theoretically, no

chemists

what do chemists do? they all study matter

the branches of chemistry

carbon-based:
ex: plastics

not carbon-based
ex: mining

physical change:
ex: reaction rates

Medicines:
ex: viagra

organic

inorganic

physical

medicinal

where does chemistry fit in?

basic → applied

analysis

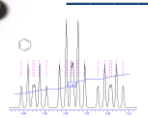
analytical

crime solvers:

forensic

chemistry of life:

biochemical



physics

chemistry

biology

math

social science

chemistry is the central science

what kind of chemist am I?

I make aspirin: I am a medicinal chemist.

I analyze: I am an analytical chemist

I study the chemistry of fruit flies, so I am a bio chemist

I solve crimes using chemistry : I am a forensic chemist.

I make plastics: I am a polymer chemist.

I study physical processes: I am a physical chemist

I study gold; this is inorganic chemistry

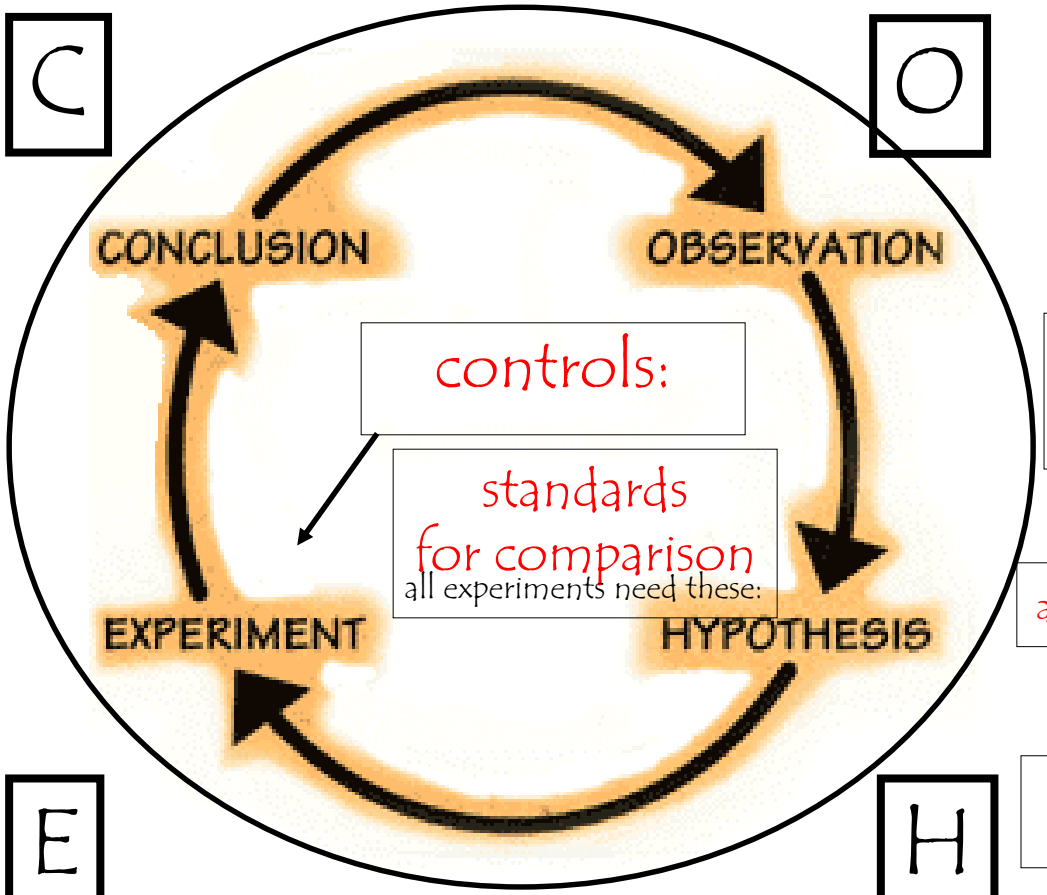
the "ohec" scientific method

what might each letter stand for?

oh heck I know that

C

O



E

H

controls:

standards for comparison

all experiments need these:

example:
pain medication study

positive control:

benchmark ex: aspirin

negative control:

placebo: no effect prevents false positives
ex: sugar pill

hypothesis:

a tentative explanation for a set of observations.

theory:

A ***theory*** is a unifying principle that explains a body of facts and/or laws

law

A ***law*** is a concise and permanent statement of a relationship between phenomena

supplemental terms: qualitative (no numbers),
quantitative (numbers),

classification of matter

a pure form of matter: substance

a sample containing more than one substance: mixture:

matter — a substance that cannot be separated into simpler substances by *chemical means*: element

element, compound, or mixture?

a substance composed of atoms of two or more elements chemically united in fixed proportions. compound

molecule

gold — element

ocean — mixture

milk — mixture

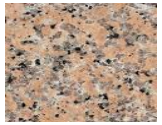
copper — element (Cu)

glass — compound (SiO_2)

nothing is pure in this world. what can we say about mixtures?

classify a drop of blood:

classify granite:



suggest a solution:

gas-gas: air

looks pure but isn't
one thing visible

doesn't look pure
multiple things visible

solid-liquid: salt water

gas-liquid: soda

homogeneous mixture

heterogeneous mixture

liquid-liquid: gasoline; vinegar

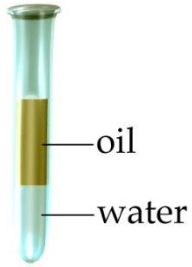
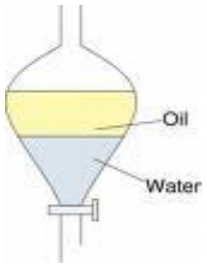
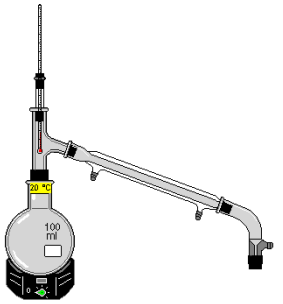
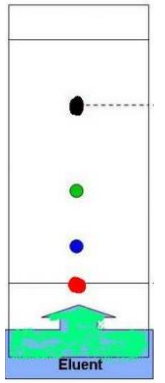
"a solution"

"a mixture"

solid-solid: brass; steel

either way it's still a mixture…until it is separated we don't know much about it.

purification: how would you separate these mixtures?

you have:				
				
oil/water	wet sand	sugar/water	oils	???
want pure:				
oil	dry sand	sugar	each pure oil	each pure solute
method:				
				
decant	filter	crystallize	distill	chromatograph

physical vs. chemical

p6

chemical property: reacts- new substance(s) formed

physical property: no reaction- same substance all along.

suggest the property responsible and if it is physical or chemical:

boiling

boiling point (physical)

rusting

reactivity (chemical)

melting

melting point (physical)

rising

density (physical)

burning

flammability (chemical)

crystallizing

solubility (physical)

flattening

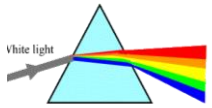
malleability (physical)

molding

decomposition (chemical)

stretching

ductility (physical)

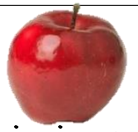


light bending

refractive index (physical)

observing

color (physical)



shining

luster (physical)

extensive and intensive properties

amount-dependent

"extent"

doesn't matter how much

in

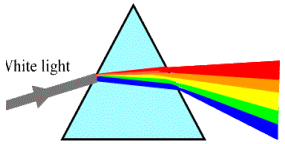
melting point

mass

ex

in

density



refractive index

in

toxicity

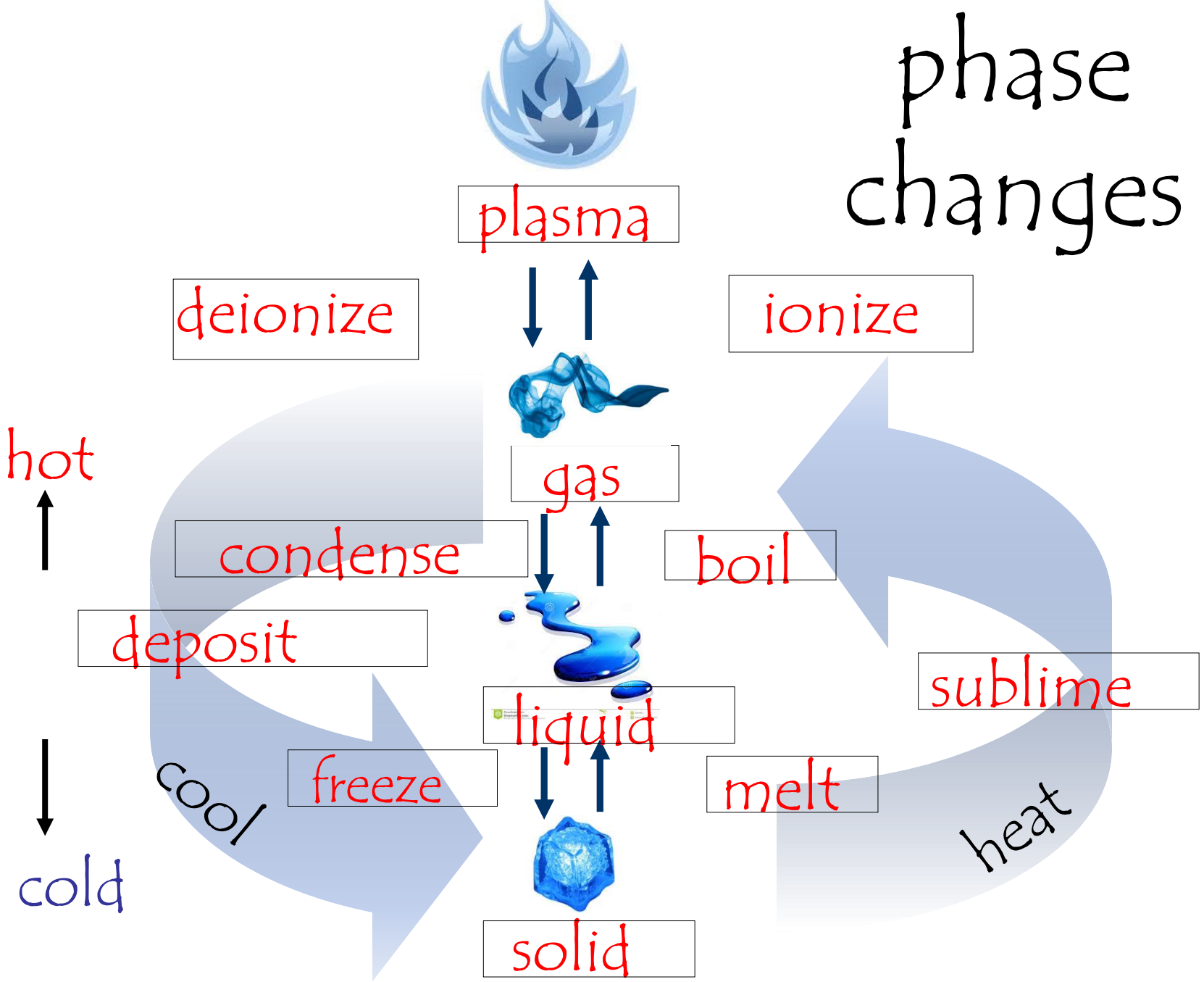
ex

crystalline or amorphous?

crystalline (shiny)

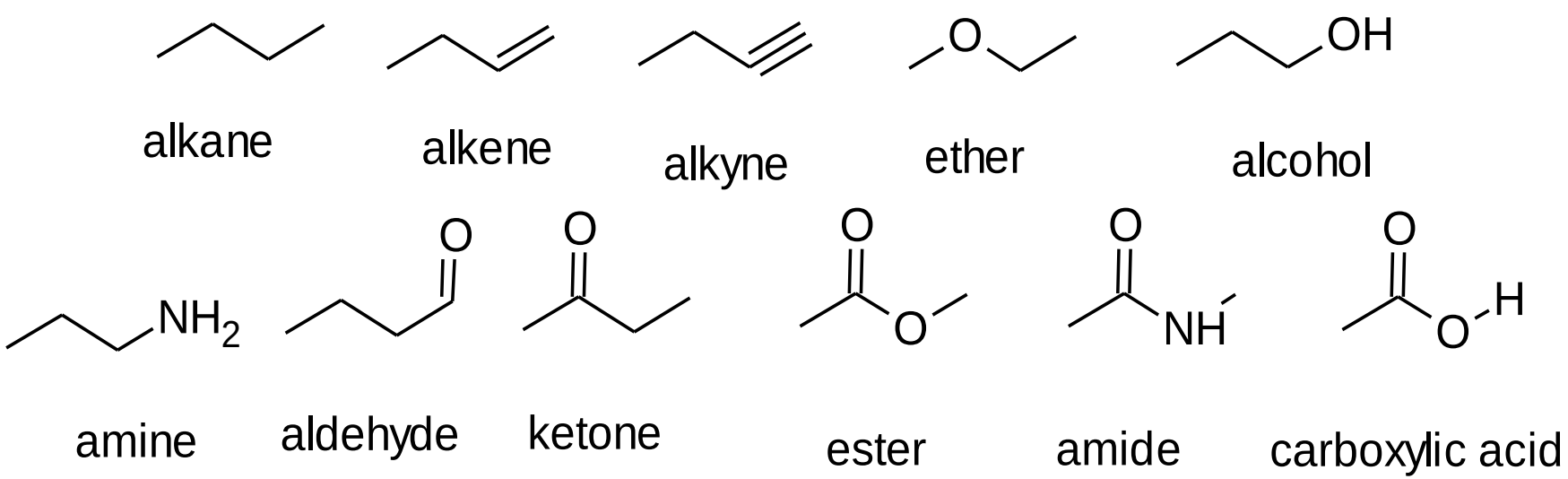
amorphous (dull)

phase changes



Here are the skeletal formulas of some common types of organic compounds, known as functional groups.

what types of organic molecules are there?



The groups shown above generally contain **more hydrogen** and **less oxygen** as one reads across from alkanes to carboxylic acids: they become **more oxidized**.

Each student should be able to recognize and draw these functional groups.

balancing chemical reactions

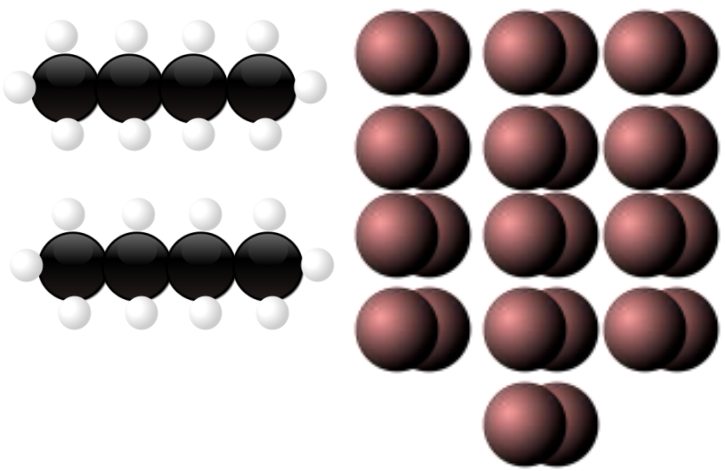
$$\_2\_\ Na + \_\_\_Cl_2 \rightarrow \_2\_\ NaCl$$

$$\_2\_\ NH_3 \rightarrow \_\_\_N_2 + \_3\_\ H_2$$

$$\_2\_\ C_4H_{10} + \_13\_\ O_2 \rightarrow \_8\_\ CO_2 + \_10\_\ H_2O$$

1 6.5 4 5

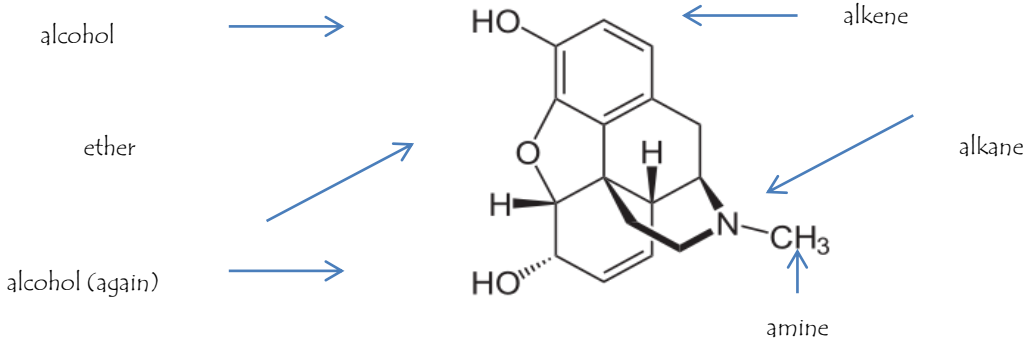
13 O



review this page and ask questions during the lecture which follows.

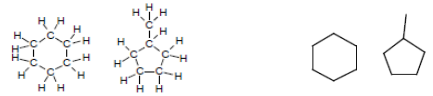
lecture 1.2: organic functional groups (continued)

Now when we look at an organic compound like, say, morphine, we can identify the parts – the functional groups- it contains:



The skeletal formula of morphine, a powerful and powerfully addictive painkiller

Note that there are only four elements shown- hydrogen, oxygen, nitrogen, and carbon. Count the number of bonds each element contains. You'll find that hydrogen forms one bond, oxygen two, nitrogen three, and carbon four bonds. Remember this by using the mnemonic device: **HONC if you love chemistry** (H1, O2, N3, C4). The bonds can be single, double (note the two lines together in acetone and benzaldehyde), or even triple. The molecules may be straight chains like ethanol, branched like triethylamine, or rings, like cyclohexane and benzaldehyde. With the simple HONC bonding pattern we can assemble all sorts of molecules.

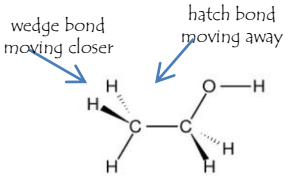


*Both cyclohexane (left) and methyl-cyclopentane (right) have a molecular formula of C_6H_{12}; they are **isomers**. The structural formulas are shown on the left, the skeletal formulas are shown on the right.*

Consider cyclohexane, for example. This molecule contains six carbon and twelve hydrogen atoms per molecule: it has a molecular formula of C_6H_{12}. However, there are many other molecules with the same molecular formula- these are called **isomers**: different substances with the same molecular formula. Here are two examples:

Drawing these molecules showing every carbon and hydrogen can become tedious. To simplify drawing these organic (carbon-based) molecules, skeletal formulas are used more often.

Note that every *end* or *bend* in a line of a structural formula implies a carbon atom, and the hydrogen atoms are omitted. They are implied based on the fact that carbon contains four bonds. Atoms other than carbon or hydrogen are called **heteroatoms**, and are explicitly drawn, usually with their hydrogen's as well.



structural formula with stereochemistry

Stereochemistry

A big limitation of these 2-dimensional representations of molecules is that they give us no 3-dimensional information. Consider the molecule shown at right. If you assemble it using molecular models, you can place the two chlorine atoms adjacent to each other, or far away. These are clearly different molecules. To designate their structure two types of bonds are used: *wedges* (coming toward you) and *hatches* (going away from you). Note that molecules that are more spread out tend to be more stable, as one might predict.

Scientists often use molecular models, since they are a fairly good representation of what the molecule looks like. If you assemble organic structures using single,

double, and triple bonds, you can get a good idea of bond angles:

single bonds: C-C- bond angle of 109.5°

double bonds: C-C-C bond angle of 120°

triple bond are linear (bond angles of 180°

name _____ period ___ (always complete both of these please) ws 1.1

worksheet 1.1: balancing chemical equations, structural and skeletal formulas, and isomers

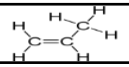
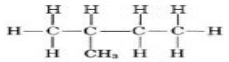
balance the following chemical equations

1. ___CH_4 + ___O_2 → ___CO_2 + ___H_2O
2. ___C_2H_6 + ___O_2 → ___CO_2 + ___H_2O
3. ___Mg + ___O_2 → ___MgO
4. ___ C_3H_8O + ___O_2 → ___CO_2 + ___H_2O
5. ___$C_4H_{10}O$ + ___O_2 → ___CO_2 + ___H_2O
6. ___C_6H_{14} + ___O_2 → ___CO_2 + ___H_2O
7. ___S_8 + ___O_2 → ___SO_2
8. ___$C_6H_{12}O_6$ + ___O_2 → ___CO_2 + ___H_2O
9. ___C_2H_2 + ___O_2 → ___CO_2 + ___H_2O
10. __C_2H_7N + __O_2 → ___CO_2 + __H_2O + __N_2

Hints:

-balance C, then H, then O
-total the O's on the right, adjust O_2 on the left
-if you got all even numbers, divide by 2

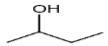
fill in the blanks.

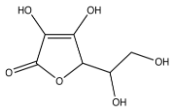
	molecular formula	structural formula	skeletal formula
11	C_2H_2		
12			
13			
14	C_3H_9N (draw any isomer)		
15			
16			
17	O_2		
18			
19			
20			

hint:
# of bonds: H1 O2 N3 C4
structural formulas: draw all bonds and atoms
skeletal formulas: an end or a bend in a line is a C; hydrogen's are implied.

hints: bent or flipped forms are not isomers. Try <u>branching and rearranging</u>*; make sure the molecular formulas match.*

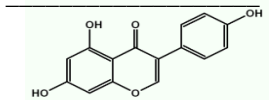
draw as many isomers as you can.

21		(one possible)
22		(four possible)
23		(three possible)
24		(one possible)
25		(four possible)



26. molecular formula:

_____



27. molecular formula:

_____

name _____ period _____ *please complete*

worksheet 1.2

completion stamp

worksheet 1.2: introduction to chemistry

Answer the following questions based on the chapter 1 screencasts.

learn an overview of what chemistry is all about

1. What is chemistry?	2. What do chemists do?	3. What is matter?

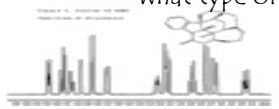
4. I synthesize experimental medicines for Pfizer in Groton, CT. Type of chemist:

_____

5. I study the molecules in tree frogs. What type of chemist am I?

_____

_____ what type of chemist am I?



6. I determine the molecular structure of substances using a Nuclea Magnetic Resonance Spectrometer (NMR). I am what type of chemist?

_____

7. I study aluminum. Type of chemist?

_____

8. I solve crimes. I am a ___ chemist:

_____

9. Schools need to carefully consider the chronological order that classes are taught in. For high school science, many schools are modifying their system so the courses are taught in the order physics, then chemistry, then biology. Consider the advantages and disadvantages of this system.

Advantages of this system:

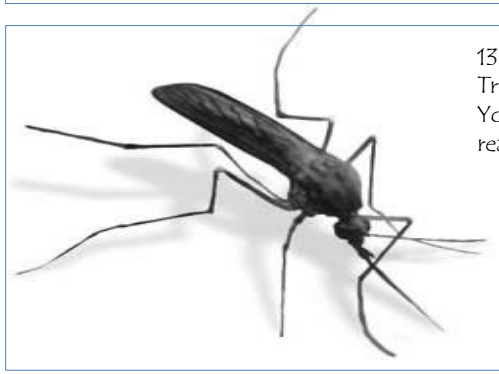
Disadvantages of this system:

Should your high school use this system? Defend your answer.

10. You are designing lightweight, bulletproof body armor. Suggest a positive control: _____

11. Your are synthesizing experimental medications for pain. Suggest a negative control: _____

12. To help us remember a simplified form of the scientific method, we memorized a four letter mnemonic,_____, which spells out the four principal steps: _____, _____, _____, and _____.

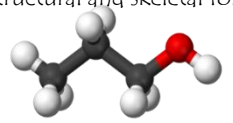


13. It has been said that chemistry can solve any problem that is based on matter. To really do this, one must think on a molecular level. Try to do this as you answer this question.
Your task is to create a new, effective, environmentally friendly insect repellant. How would you accomplish this? Before answering, read the brief article on "Structure-Activity Relationships" on the wikidpedia website or by clicking here..

14. We are on average 95.3% carbon, hydrogen, oxygen, and nitrogen. In this unit we learned a simple mnemonic to recall the number of bonds that each element commonly forms. The mnemonic is " _____!", telling us that hydrogen tends to form ____ bonds, oxygen forms _____ bonds, nitrogen forms _____ bonds, and carbon is very versatile in that it tends to form ___ bonds.

Draw propanol (C_3H_8O) using both structural and skeletal formulas

15. Structural formula of propanol (C_3H_8O)

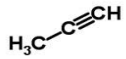


a ball-and-stick model of n-propanol ((C_3H_8O)

16. Skeletal formula of propanol (C_3H_8O)

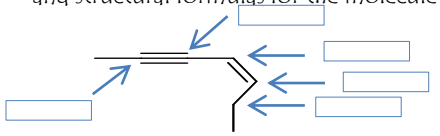
17. There are two isomers of propanol. Both have the alcohol "OH" functionality. Draw the other isomer using a skeletal formula. Hint- you may need to move the oxygen atom.

18. Draw two isomers of propyne shown below..



propyne (C_3H_4) contains a carbon-carbon triple bond.

19. Single C-C-C bonds have a bond angle of 109.5°, double bonds (C=C-C) 120°, and triple bonds 180°. Label the bond angles and provide the molecular and structural formulas for the molecule shown.



molecular formula

structural formula

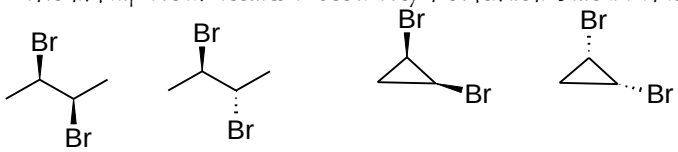
20. Convert the molecule on the left into a molecular and skeletal formula.

aspirin (look it up)

molecular formula

skeletal formula

21. Circle the 2 identical molecules. Hint: Rotate and flip the molecules to see if they are identical. Stuck? Make them using models.Review stereochemistry if needed.

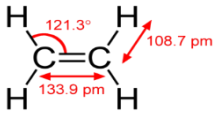


Remember, the wedges are coming out at you, the dotted bonds are going away from you- this is stereochemistry.

name _____ period ___ (always complete both of these please)

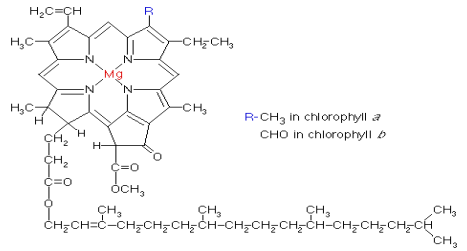
worksheet 1.3: organic functional groups

All living things are composed primarily of individual molecules which have different arrangements of hydrogen, oxygen, nitrogen, and carbon, with numerous other less abundant elements. These organic (carbon based) substances are the basic molecules of life. Some are small, such as ethylene, which is a four atom plant hormone that signals for cell growth. Others, like DNA are large and polymeric (consisting of repeated linked units) and can consist of more than a million atoms bonded together.



Carbon-based molecules can be very small or very large. Ethylene is a plant hormone which has only four atoms, and is less than 200 picometers (0.00000000002 meters) across, while DNA can include millions of atoms and may be long enough to see with the naked eye.

Carbon-based substances are so ubiquitous that chemists organize matter as being carbon based (organic) or not (inorganic). Inorganic substances can be metallic, like aluminum for example, can be rusty (oxidized) forms of metal, like aluminum oxide (Al_2O_3), can be salts like sodium chloride, or can simply be water (H_2O). Carbon based substance can be classified by their functional groups, as we have seen, and other substances may be organometallic like chlorophyll, containing an inorganic metal atom within a carbon framework.

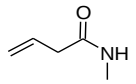


The structure of chlorophyll

In this worksheet we will practice drawing and identifying functional groups

Example: Draw a molecule that contains both an alkene and an amide

Solution: numerous answers are possible; here's one:



Draw molecules which include the functional group or groups indicated. Refer to the lecture on the previous page only if necessary.

1. alkyne

2. ester

3. alcohol

4. amide

5. Alkene and alkane

6. Cyclic ketone (a ketone that is part of a ring

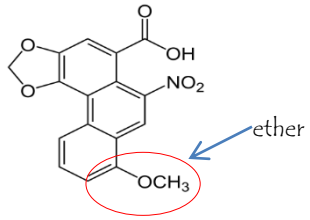
7. A cyclic ether

8. Draw a molecule which contains a ring and any four functional groups, and identify each one

worksheet 1.3: organic functional groups (continued)

Shown below are some naturally occurring organic molecules. Circle the functional groups indicated on each.

example



Aristolochic acid is present in birthwort, a member of the aristolochia genus. Used in traditional Chinese medicine, it is unfortunately carcinogenic, mutagenic, and nephrotoxic.

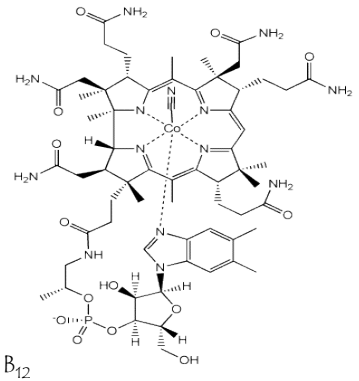
9. Locate the carboxylic acid, ether (done for you), and cyclic ethers.

caffeine

Caffeine is a legal central nervous system stimulant, and the worlds most widely consumed psychoactive substance.

Many of the functional groups in caffeine are so close to each other that they overlap. For example, one can identify several amides; however one can still locate individual parts.

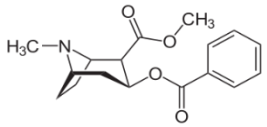
12. On the caffeine molecule above, circle and label two carbonyl groups (carbon doubly bonded to oxygen), three methyl groups (carbon with three hydrogen's), and one imine (carbon doubly bonded to nitrogen)



vitamin B_{12}

Vitamin B_{12} is a vitamin that is necessary for the metabolism of every cell in the human body. Interestingly it is not present in any plant, and contains the biochemically rare element cobalt. Watch the online video to learn more about how this vitamin works

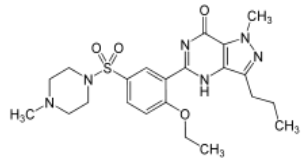
10. On, vitamin B12 above, circle and label an amides, nitrile (carbon triply bonded to nitrogen), and an alcohol.



cocaine

Cocaine is an illegal highly addictive nervous system stimulant.

11. Circle and label the amine, esters, and the six-membered benzene ring



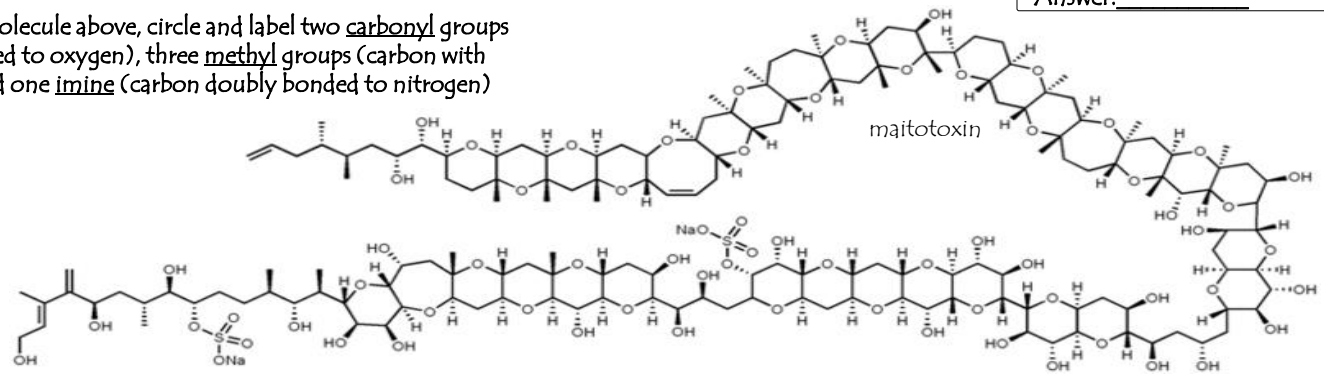
viagra

Viagra (sildenafil citrate) is a synthetic (man-made) substance marketed by Pfizer Pharmaceuticals in Groton, Connecticut to treat erectile dysfunction.

13. Identify the amine, and the sulfonamide (SO_2N) functional groups.

14. Here's a big one! How many alcohol functional groups can you find in maitotoxin, one of the most toxic substances known?

Answer:_____



Each chapter ends with a "how to ace it" guide that contains sample questions. Students should complete it. Before the test be sure to also review the screencasts and associated quizzes, all lab experiments, and each page in this chapter. Students in advanced classes should also review any advanced lecture topics and should review any hyperlinked material in this chapter.

How to ace the introduction to chemistry unit.

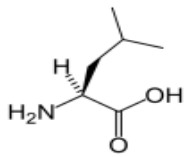
All battles are decided before they begin.

Sun-tzu
The Art of War

I'm sure you would all like to ace your first chemistry test. Here's how:

1. Test yourself on the topics below to see what you know and don't know.
2. Review this packet in its entirety. Be familiar with each of the topics that were covered in the powerpoint presentation.
3. Write down what you don't know yet. If you don't know something, ask a friend or ask me.
4. If you are missing anything it may be available on the class website: http://www.chemistryacademy.org

1. What is chemistry?
2. What is matter?
3. What is not matter? Give examples.
4. What do chemists do?
5. Where does chemistry fit in with the other branches of science?
6. Name a branch of science more basic than chemistry.
7. List the branches of science from basic to applied.
8. What is our simple scientific method?
9. Give an example of a positive and negative control
10. What is a synonym for a negative control?
11. Why are negative controls important for most drug studies?
12. Provide a positive control for an experiment designed to produce bubble gum that blows big bubbles
13. How many bonds to the atoms C, N , H, and O form?
14. What is a useful mnemonic device for the bonding pattern of hydrogen, oxygen, nitrogen, and carbon?
15. omit
16. omit
17. Why is chemistry awesome?
18. Compare and explain the flammability of liquids to gases.
19. True or false: most combustion reactions produce water
20. What is the difference between a physical and a chemical change?
21. Provide an example of a physical and a chemical change.



leucine, a naturally occurring amino acid.

22. How could you identify methanol?

23. Provide two isomers of C_3H_8O by drawing their structural and skeletal formulas

24. Draw an ether with the formula C_3H_8O.

25. Draw an amine, an alcohol, a carboxylic acid, an ester, and an amide.

26. Provide the molecular formula of leucine shown on bottom.

27. What organic functional groups are present in sodium chloride, NaCl?

28. Explain what is implied by the wedges and hatches used in the drawing of leucine. Does it contain straight chains, branched chains, or rings?

29. What happens to molecular formulas when double bonds replace singe bonds and rings replace linear molecules? (Hint: check the molecular formulas).

30. omit

31. Draw a chart organizing chemistry into functional groups, including inorganic, and organic domains on a separate page.

32. Provide a balanced chemical equation for the combustion of isopropanol, C_3H_8O.

33. Be prepared to answer the essential question for this course: What is everything made out of?

34. Be prepared to answer the essential question for this unit: what is chemistry all about?

34. Show all of the possible phase changes between solids, liquids, gases, and plasmas

35. What is a plasma? Why is it called a "non-classical" phase?

36. List the functional groups from alkanes through carboxylic acids.