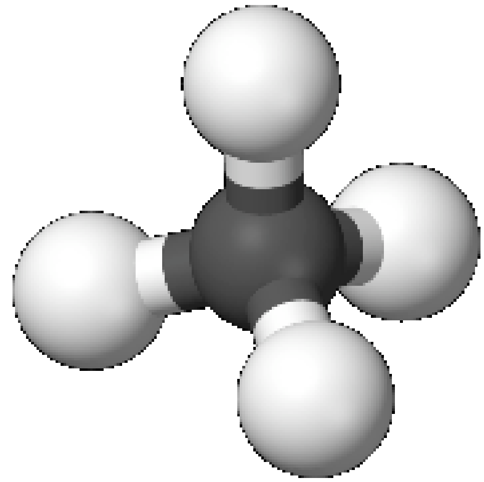
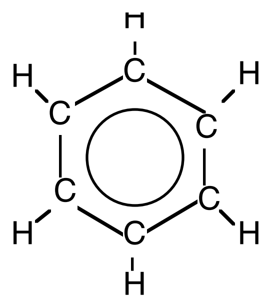
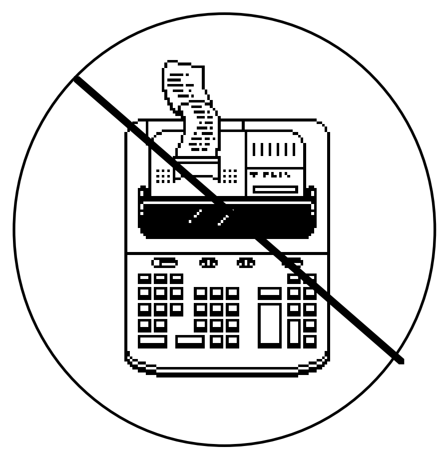
Name: ______________________________

Packet 12 :
Organic Chemistry







Due Date	Assignment
Tue 4/19	___ Do WS 12.1
Wed 4/20	___ Do WS 12.2 #1-13
Thu 4/21	___ Do WS 12.2 #14-30
	___ Bring 1 Dry Erase Marker (*please*...?)
Fri 4/22	___ gather data for WS 12.11 **(20% complete)**
	___ Do WS 12.3 #1-7
	___ bring dry erase markers
Mon 4/25	___ Do WS 12.3 #8-15
	___ bring dry erase markers
Tue 4/26	___ Do WS 12.4
	** mini quiz today * * Don Showalter video today **
Wed 4/27	___ Do WS 12.5
Thu 4/28	___ gather data for WS 12.11 **(40% complete)**
Fri 4/29	___ bring dry erase markers
	___ Do WS 12.6 #1-7
Mon 5/2	___ Do WS 12.6 #8-15
	___ Finish Ester Lab ?'s
Tue 5/3	___ Do WS 12.7
Wed 5/4	___ gather data for WS 12.11 **(65% complete)**
	*** **mini quiz today** **
Thu 5/5	___ Do WS 12.8
	*** Make Crossed Linked Polymer Today! ***(bring zip-lock bag?)***
Fri 5/6	___ Finish Cross Linked Polymer Lab ?'s
	___ Bring dry erase markers
	___ gather data for WS 12.11 **(90% complete)**
Mon 5/9	___ Do WS 12.9
	°°° Don Showalter Video Today °°°
Tue 5/10	*** Plastic ID lab today **(WS 12.11 100% complete)**
Wed 5/11	*** Polymer Demos Today! ***
Thu 5/12	*** More Polymer Demos Today ***
Fri 5/13	___ Finish Polymer Demo Wkst (Mustard Day)
Mon 5/16	___ Do WS 12.10
	Quiz Today

<u>packet order</u>:

- assignment sheet
- WS 12.1 - 12.11 (don't forget WS 12.2 on own paper!)
- polymer demo log
- plastic ID lab

<u>penalties</u>:

- no grade sheet (-1/2)
- no folder (-1/2)
- no name on top (-1/2)
- turning in non-relavent material (-1/2)

<u>Don Showalter extravaganza</u>:

Wednesday, May 18th

Be there! Critics are saying "wow!" This will definitely get your bulb lit! See Don party-down. See Don disco. See Don make 1 aspirin tablet. Hear Don mispronounce potassium. See Don say "nothing" an inordinate # of times. See Don make a small brownish pile. There it goes!

+ WS 12.1 Chemical Bonding in Alkanes

1. Hydrogen has how many valence electrons?____ Draw its Lewis dot formula: _____

2. Carbon has how many valence electrons?____ Draw its Lewis dot formula: _____

3. Carbon likes to have 8 valence electrons when it forms molecules. How many hydrogens are needed to make 1 carbon satisfy this "octet rule"? _____

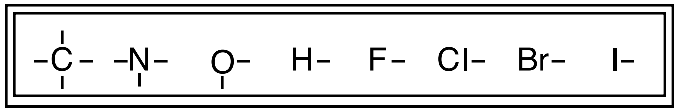
Draw the Lewis dot formula for 1 carbon atom with the proper number of hydrogens surrounding it to give carbon a total of 8 valence electrons:

A covalent bond is formed by two shared electrons. Re-draw the carbon-hydrogen molecule, replacing the dots with bonds:

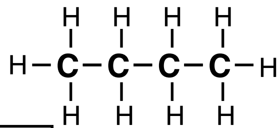
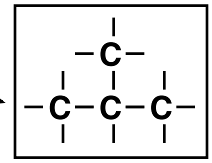
4. Complete the following **alkane** table: *WRITE SMALL!*

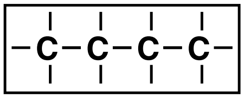
IUPAC name	# of carbons	chemical formula	structural formula	condensed formula
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			

+WS 12.2 ISOMERS

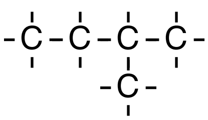
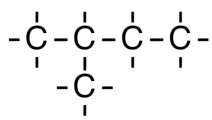
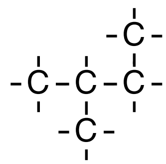
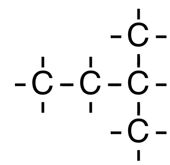
The building blocks: 

Define "isomer":

example C_4H_{10}  and C_4H_{10} 

(w/o the H's): 

Caution!: Molecules are constantantly being bent, twisted and flipped as they collide with one another, but this does not change their bonding arrangements. Thus, bending, twisting and flipping of a structural formula does not give rise to new isomers.

so  and  and  and 

are not isomers, they are all repeats of the same structure.

Consider the following chemical formulas:

1) CH_4 ___ 2) CH_5 ___ 3) C_2H_6 ___ 4) CH_3 ___ 5) CH_3F ___ 6) C_2H_7 ___ 7) C_3H_8 ___

8) CH_2F_2 ___ 9) C_2H_5 ___ 10) C_2H_5Br ___ 11) CH_4O ___ 12) C_2H_6O ___ 13) $C_2H_4F_2$ ___

14) $C_2H_3F_3$ ___ 15) $C_2H_6O_2$ ___ 16) C_3H_7F ___ 17) C_3H_9N ___ 18) C_3H_6FBr ___

19) C_3H_8O ___ 20) C_4H_9Cl ___ 21) C_2H_4 ___ 22) C_2H_2 ___ 23) C_3H_6 ___ 24) C_4H_8 ___

25) C_7H_{16} 26) $C_6H_{13}Br$ 27) C_5H_{10} 28) C_5H_8 29) C_4H_8O 30) $C_5H_{10}F_2$

(just draw 5 isomers for #25-30)

ON A SEPARATE SHEET OF PAPER, DRAW AS MANY DIFFERENT STRUCTURAL FORMULAS (ISOMERS) AS YOU CAN FOR EACH OF THE ABOVE COMPOUNDS. Hint: for #1-24, none of them has more than six possible structures (see answers below)

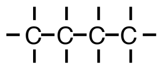
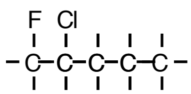
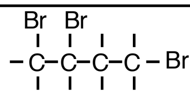
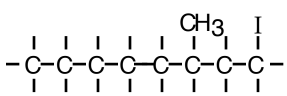
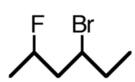
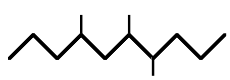
If only one possible structure exists, draw it and write a "1" in the space after the formula above. If more than one structure exists, draw all of the possible isomers (but no repeats), and indicate how many are possible in the space. If a compound is impossible, then write "X" in the space. If a compound can only exist as a free radical (a molecule containing one or more open bonding sites), then write "R" in the space. ***For compounds #25-30, draw just five different isomers***.

Ans (for #1-13, IRO): X X R R 1 1 1 1 1 1 1 2 2

Ans (for #14-24, IRO): 1 1 2 2 2 3 4 4 5 5 5

+WS 12.3 ORGANIC NAMING

Name (yours): ________________________

Name	Complete structural formula	Line formula	Condensed structural formula	Mol. form
1) butane			$CH_3CH_2CH_2CH_3$	C_4H_{10}
2) heptane				
3) 2-fluorooctane				
4) 3-iododecane				
5) 1,1,1 - tribromo- 2,2 difluoropropane				
6)				
7)				
8)				
9)				
10)				
11)				
12)				
13)			$CH_3CHFCHFCH_2CH_3$	
14)			$CBr_3CHF(CH_2)_4CH_2CH_3$	
15)				CH_4

+WS 12.4 Organic Compounds

1. Write the structural formula for the following:
   a) 5-ethyl-2,8-dimethyldecane

   b) 2,2,4,4,-tetramethylpentane

   c) 2,2,6-trimethyloctane

   d) 3-ethyl-3,5-dimethylheptane

2. Write all of the <u>structural formulas</u> **and** <u>IUPAC names</u> for the **three** isomers of C_5H_{12}. *(no repeats!)*

3. Draw the **<u>line</u>** formula for each of the following **<u>cycloalkanes</u>**:
   a) ethylcyclobutane

   b) 1,1-dimethylcyclopentane

   c) 1,3,5-trimethylcyclohexane

4. Write the **<u>line</u>** formula for each of the following **<u>haloalkanes</u>**:
   a) 1,1-dichloro-2,2-difluororoethane

   b) 2,4-dichloro-2,4-difluorohexane

   c) 1,1,3,5-tetrachlorocyclohexane

+ WS 12.5 Alkane Reactions: Combustion & Halogenation of Alkanes

1. What is combustion?

2. For the following reactions, write the balanced equations for the complete combustion of the following:

   a) propane, $\mathbf{C_3H_8}$ (gas used in torches and gas grills)

   b) octane, $\mathbf{C_8H_{18}}$ (component of gasoline)

   c) methanol, $\mathbf{CH_3OH}$ (race car fuel)

3. For the following reactions, write the structural formulas of the products that have multiple halogen atoms. **For full points,** include <u>all</u> possible isomers, and their <u>percent formation</u>:

   a) $CH_3\text{-}CH_2\text{-}CH_3 + Cl_2 \xrightarrow{\text{Light}}$
   (hint: there are 2 isomers)

   b) $CH_4 + Br_2 \xrightarrow{\text{Heat}}$

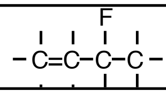
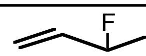
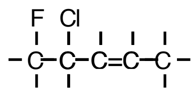
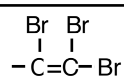
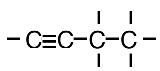
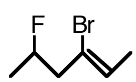
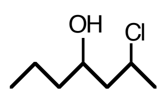
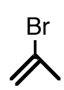
   c) $CH_4 + Cl_2 \xrightarrow{\text{Dark}}$

   d) $CH_3\text{-}CH_2\text{-}CH_2Cl + Cl_2 \xrightarrow{\text{Light}}$
   (hint: there are 3 isomers)

   e) $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_3 + F_2 \xrightarrow{\text{Light}}$
   (hint: there are 2 isomers)

   f) $CHBr_3 + I_2 \xrightarrow{\text{Heat}}$
   (hint: there is 1 isomer)

+WS 12.6 Organic Nomenclature, part 2

Name	Complete structural formula	Line formula	Condensed structural formula
1) 3-fluoro,1-butene			CH_2=CHCHFCH_3
2) 2-heptene			
3) 2,3-difluoro-1-pentene			
4) 6-iodo,4-methyl-2-decyne			
5) 4,4-dibromo-1,2-butandiol			
6)			
7)			
8)			
9)			
10)			
11)			
12)			
13)			CH_3CHFCHFC≡CH
14)			C(OH)Br_2CHF$(CH_2)_4$CH_2CH_3
15)			$CH_3(CH_2)_3$CH=CH$(CH_2)_2$CH_3

+ WS 12.7 GEOMETRIC ISOMERS

1. Write and label the cis-trans isomers of the following: *(use bow-tie structures)*

a) 1,2-dichloroethene

cis	trans

b) 2-butene

cis	trans

c) 2,3- dibromo-2-pentene

cis	trans

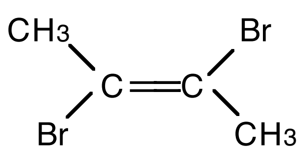
d) 3-hexene

cis	trans

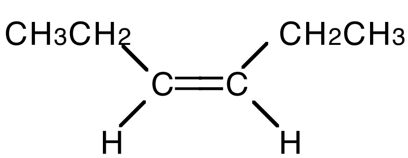
e) 1,2-difluoro-1-butene

cis	trans

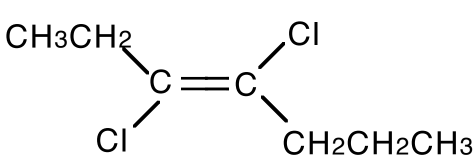
2. Give the name of each of the following bow-tie structures: (don't forget 'trans' or 'cis')

a)


____

b)


____

c)


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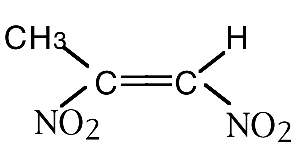
d)


____

Ans #2 (IRO): trans-3,4-dichloro-3-heptene cis-3-hexene cis-1,2-dinitropropene trans-2,3-dibromo-2-butene

+WS 12.8 More Organic Reactions

1. Write the structural formula of the product for each of the following **alkene** reactions:

a) $CH_3-CH=CH-CH_3 \ + \ H_2 \xrightarrow{Pt}$

b) $H-C\equiv C-H \ + \ 2H_2 \xrightarrow{Pt}$

c) $CH_3-CH=CH-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3 \ + \ Cl_2 \longrightarrow$

d) $CH_3-CH=\overset{\displaystyle CH_3}{\overset{|}{C}}-CH_2-CH_3 \ + \ HBr \longrightarrow$

e) $CH_3-CH=CH_2 \ + \ H_2O \xrightarrow{H^+}$

2. For d) and e) above, what rule did you use to determine what goes where? ________________

3. Write an equation, using **structural** or **line** formulas, and any catalysts for the following reactions:

a) hydrogenation of 2-methylpropene

b) addition of chlorine to 2-pentene *(halogenation)*

c) addition of hydrogen fluoride to 2-methyl-2-butene *(hydrohalogenation)*

d) hydration of 1-methylcyclobutene

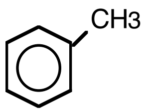
e) addition of bromine to cyclopentene *(halogenation)*

+WS 12.9 AROMATIC COMPOUNDS

1. What do the terms ortho, meta, and para mean?

2. Write the IUPAC name for each of the following: *(remember- if there are 2 functional groups, use o, m, p)*

....check answer bank below....

a) 

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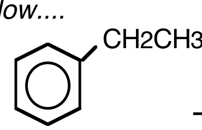
e) 

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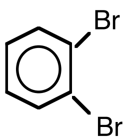
b) 

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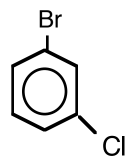
f) 

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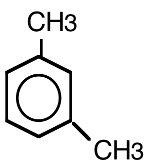
c) 

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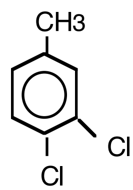
g) 

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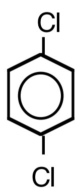
d) 

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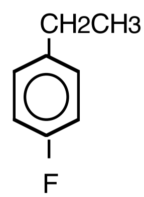
h) 

____

3. Write the **<u>line</u>** formula for each of the following:

a) toluene

e) p-ethyltoluene

b) phenol

f) nitrobenzene

c) 1,3,5-tribromobenzene

g) 2,4,6-trinitrotoluene

d) naphthalene

h) paradichlorobenzene

4. Which of the above is used as an explosive? ______________________

5. Which two above are used in mothballs? ______________________ ______________________

Ans #2 (IRO+1): m-bromochlorobenzene, o-dibromobenzene, p-dichlorobenzene, 3,4-dichlorotoluene, ethylbenzene, p-ethylfluorobenzene, m-methyltoluene, toluene

+WS 12.10 Review

1. Which of these 2 compounds is more likely to be a liquid? Why?

   $CH_3CH_2CH_3$ vs. $CH_3CH_2CH_2OH$

2. Write **6,6-dibromo-2-methyl-1-hexene** as a ***structural*** formula and as a ***condensed*** formula:

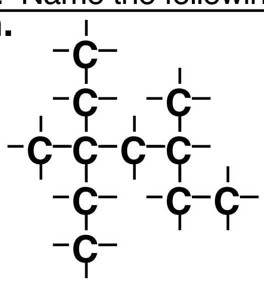
3. Draw all <u>line</u> isomers for C_4H_8:

3. Draw the following (*line or structural*):

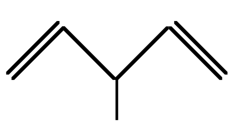
1-iodo-2-butyne	2,2-dichloro-1,3-cyclopentadiol	cis-2,3-diiodo-2-pentene
m-diaminobenzene	p-chlorotoluene	1,3-dipropylcyclobutene

4. Name the following:

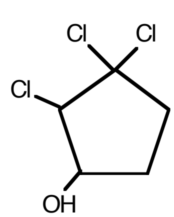
a.



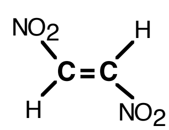
b.



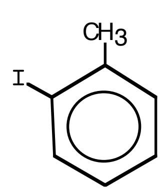
c.



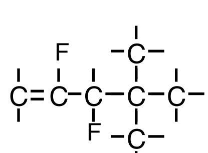
d.



e.



f.



a.

b.

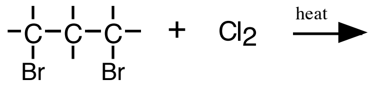
c.

d.

e.

f.

5. Write all products, then determine the % formation of each isomer: (alkane halogenation rxn)



6. Write the equation for the hydration of 1-pentene. Name the product.

7. Write the balanced equation for the complete combustion of methandiol:
(hint- 1st, draw the structural formula. 2nd, determine the molecular formula. 3rd, write the chemical reaction.)

8. Write the equation for the halogenation of **2-methyl-1-butene** with **fluorine gas**.
Name the product.

+ WS 12.11 Plastic Recycling Data Gathering Name: ____________________

Look around the house, and take a personal field-trip to a local supermarket, and find as many plastic containers as you can. There are seven different types of recyclable plastics and they can be easily identified by the number (1-7) in the triangle (usually on the bottom, but sometimes on the side or on the label). Don't use a lot of repeats of the same exact product type (so if you use Pepsi, then don't use Coke, Vess..., but Hi-C would be different enough). List them in the appropriate boxes below, and record: (two have been done for you)

the product name and what it is (such as "Dial, liquid soap"),

the general product category(**F**ood, **B**everage, **C**ondiment, **P**ersonal hygiene, **M**edicinal, **H**ousehold cleanser, , **O**ther)

the size of the container (rounded to the nearest 100 mL), Approximate if it is not given.

the flexibility / rigidity of the plastic on a scale from 1-10 (1=very pliable...10 = very rigid),

the clarity / opaqueness on a scale from 1-10 (1 = very clear... 5 = translucent... 10 = opaque)

the color of the plastic not the label(**R**ed, **O**range, **Y**ellow, **G**reen, **B**lue, **V**iolet, brow**N**, blac**K**, **W**hite, gr**A**y, ,**C**olorless)

1

Name	cat	size	f/r	c/o	color

2

Name	cat	size	f/r	c/o	color

3

Name	cat	size	f/r	c/o	color

4

Name	cat	size	f/r	c/o	color

5

Name	cat	size	f/r	c/o	color

6

Name	cat	size	f/r	c/o	color

7

Name	cat	size	f/r	c/o	color

resin ID codes:	**abbrev.**	**name of polymer**
1=	**PET**	
2=	**HDPE**	
3=	**PVC**	
4=	**LDPE**	
5=	**PP**	
6=	**PS**	
7=	**(other)**	PC = PU=

Polymer Demos

In each box, explain each of the following demos using **words** and **diagrams**:

1- packing peanuts

type 1:

type 2:

2- celluloid

3- co-polymers

4- water mystery

bottle game

common use:

what decreases its effectiveness?

5- holy balloons!

skewer

ester

6- sticky polymers

7- voice-activated polymers

8- whatisit?

ESTER LAB *"The smelliest lab of the year"* Name: ________________________

INTRO: When an organic acid ($R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OH$) and an alcohol (R-OH) are mixed together and heated in the presence of an acid catalyst (such as H_2SO_4), the two will react to form an ester (plus H_2O). This process is called ***esterification***.

Each ester has its own unique odor, and with a discriminating nose, one can use this fact to help identify them. In this lab you will be reacting various organic acids (acetic acid & salicylic acid) with various alcohols (methanol, isopentanol, & ethanol). You will make three different esters with odors that should be familiar to you.

Procedure: GOGGLES MUST BE WORN AT ALL TIMES!

1. Get 3 test tubes, labeled: "1", "2", & "3"
2. **Test Tube #1**: Add 10 drops of acetic acid, 10 drops of isopentanol, and 2 drops of H_2SO_4.
3. **Test Tube #2**: Add 1 scoop of salicylic acid, 15 drops of methanol, and 2 drops of H_2SO_4.
4. **Test Tube #3**: Add 10 drops of acetic acid, 10 drops of ethanol, and 2 drops of H_2SO_4.
5. Mix the contents of each test tube by the ***knocking method***.
6. Place all 3 test tubes together in the warm water bath for approximately 1 minute.
7. Remove (carefully!) the test tubes from the hot water and place them in the test tube rack.
8. Note the smell of each ester by pouring each into its appropriate "smelling cup". Describe the odors in the Data Table below.
9. To clean-up, empty out your test tubes into the waste container, and place the test tubes inside the soaking bin.

Data Table:

	odor	reactants	product (name of ester)
Test Tube #1:		acetic acid + isopentanol --->	
Test Tube #2		salicylic acid + methanol --->	
Test Tube #3		acetic acid + ethanol --->	

Questions:

1. Why do you think you were instructed to use an electric hot plate to heat the water instead of a Bunsen burner?

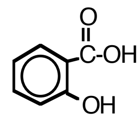
2. Why do you think you were instructed to waft the odors instead of sniffing them directly?

3. What role did the H_2SO_4 play? (see opening paragraph) ________________________________

4. Why did you use warm water instead of boiling hot water?

5. Explain a) how we are able to smell certain smells in the first place (what goes on in the nose and the brain). If you are not certain of the "correct" answer, at least make up a good theory!! (Use diagrams.)

next, "draw" the structures you just smelled! (see back side)

name:	structural formula:	
acetic acid	$CH_3-C(=O)-OH$	organic acids
salicylic acid		
methanol	CH_3-OH	alcohols
ethanol	CH_3-CH_2-OH	
isopentanol	$CH_3-CH(CH_3)-CH_2-CH_2-OH$	

5. Use the structural formulas to write the equations for each of the esterification reactions:

organic acid + **alcohol** ⟶ **ester**

(1) + ⟶

(acetic acid) (isopentanol) ________ (name of ester?)

(2) + ⟶

(salicylic acid) (methanol) ________ (name of ester?)

(3) + ⟶

(acetic acid) (ethanol) ________ (name of ester?)

(Bonus): With 2 organic acids and 3 alcohols, there are 6 possible combinations we could have made. We only did 3 of the 6 in class (the 3 esters above). On a separate page, write the equations for the remaining 3 esterification reactions, using the structural formulas. Determine the name of the 3 esters as well!

Plastic Identification Lab

Name: ____________________

Plastics belong to a class of chemical compounds called *polymers*. There are many different types of plastics, each made from a different polymer. A milk jug is a different type of plastic than a yogurt container. Not all plastics can be recycled the same way. Just like not all metals can be recycled the same way: aluminum recycling centers can't recycle steel or lead. Plastic recycling centers must separate the different types of plastics and recycle them differently. One way of distinguishing the different types of plastic is with the Resin Identification Code. Six of the more common are listed here: fig 1:

Polymer Name	Resin Code	Common Packaging Application
polyethylene terephthalate	1 PETE	Plastic soft drink bottles, mouthwash bottles, peanut butter and salad dressing containers
high-density polyethylene	2 HDPE	Milk, water and juice containers, grocery bags, toys, liquid detergent bottles
polyvinyl chloride	3 V	Clear food packaging, shampoo bottles
low-density polyethylene	4 LDPE	Bread bags, frozen food bags, grocery bags
polypropylene	5 PP	Ketchup bottles, yogurt containers, margarine tubs, and medicine bottles
polystyrene	6 PS	Videocassette cases, compact disc jackets, coffee cups; knives, spoons and forks; cafeteria trays, grocery store meat trays and fast-food sandwich containers

You will be using a **flow chart** to help separate and identify these 6 different plastics. A flow chart is a graphic representation of a sequence of operations (often used by computer programmers).

Pre-Lab Questions:
Use your flow chart (fig 2) to answer the following questions by placing the correct resin codes in the blanks:

1. Which plastic(s) will burn with a green flame? _________

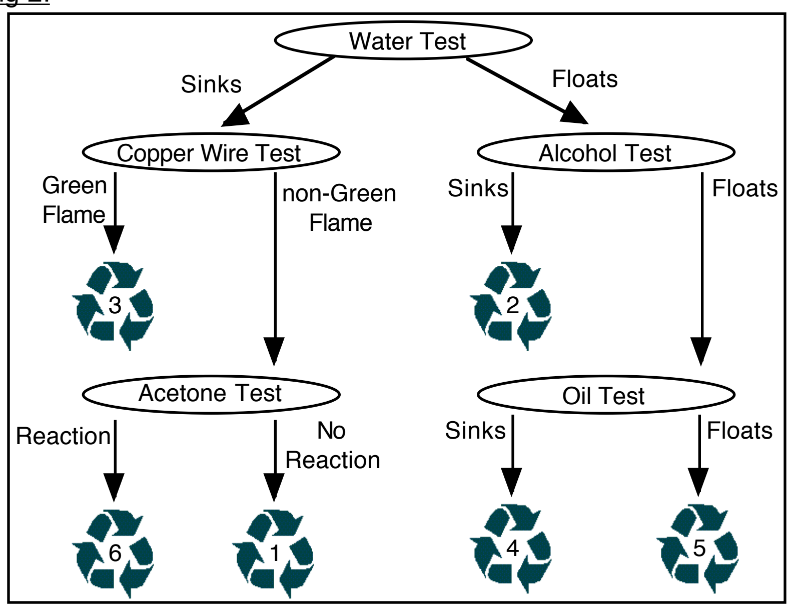
2. Which plastic(s) sink in alcohol? _______

3. Which plastic(s) float in water? _________

4. Which plastic(s) are more dense than water? _________

5. Which plastic(s) require the minimum number of tests in order to determine their identity? _________

fig 2:



Procedure:
At the front desk are cups labeled "A" -- "F", each containing samples of the plastics.

1. Obtain about 5 pieces of one type of plastic (you choose -- **just remember which unknown you're working with!!!**)

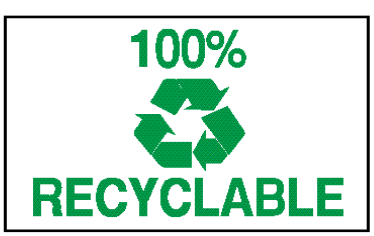
2. Take your unknown sample to your lab station. Perform the flow chart tests, according to the instructions on the back, until you've determined which plastic you have. Record your results in the results table.

3. Repeat steps 1 and 2 until you've discovered the identity of each unknown!

Results Table

unknown letter	color	resin ID Code
A		
B		
C		
D		
E		
F		

THIS LAB IS...



plastic ID lab (side 2)

Flow Chart Tests:

Water Test

At this lab station, you have a plastic cup filled 1/2 way with water. Place about 3 of your plastic pellets in the water, and poke the pellets with your finger to knock off any adhering bubbles & to overcome any surface tension. Note if they sink or float. Remove the plastic pellets with your fingers and save them (the pellets and your fingers) for later use. *Do not throw pellets down the sink - they are not water soluble!*

Copper Wire Flame Test

Carefully hold the copper wire in a Bunsen burner flame until the wire is hot. Remove the wire from the flame and touch it to a plastic pellet. Place the wire back into the flame and observe its color. Dispose of pellet in trash after testing. *Do not burn the pellet in the flame!*

Acetone Test

At this lab station, you have a small bottle of acetone and a watch glass. Place one plastic pellet on the watch glass, and a squirt (about 15 drops) of acetone. Let it soak for 30 seconds. Remove the pellet and scratch it with your fingernail. If the pellet is "gooey" this means that the acetone has reacted with the plastic my "loosening up" the polymer chains. If the pellet is unchanged, this means no reaction has taken place. Dispose of pellets in trash after testing.

Alcohol Test

At this lab station, you have a 100 mL beaker of an alcohol solution covered with a watch glass. Uncover the beaker and place 2 clean plastic pellets in the beaker. Poke them with a stirring rod to knock off any adhering bubbles & to overcome any surface tension. Note whether most the pellets float or sink. Scoop the pellets out with a clean plastic spoon and dry them. They can be reused.

Oil Test

At this lab station, you have a small beaker with oil. Place 2 clean plastic pellets in the beaker. Poke them with a spoon to knock off any adhering bubbles. If the pellet hovers in the middle, consider it a "sinker". Scoop the pellets out with a clean spoon & dispose of pellets on towel.

Questions:

1. Using fig. 3, approximate the density of the alcohol solution, and explain your reasoning.

2. Why was it important to dislodge any adhering bubbles & overcome surface tension in the density tests?

3. Why would it not be wise to make a canoe paddle out of PVC? What might you use instead?

4. You decide to jazz up your bathroom cabinet by transferring your fingernail polish remover into a more stylish plastic bottle. The next day, reaching for the bottle, you find a messy blob of goo. What was the bottle probably made of? And what is the active ingredient in the polish remover?

fig 3:

DENSITY RANGES (in g/mL) for #1-#6

#1 PET	1.38 - 1.39	#4 LDPE	0.92 - 0.94
#2 HDPE	0.95 - 0.97	#5 PP	0.90 - 0.91
#3 PVC	1.16 - 1.35	#6 PS	1.05 - 1.07

(water = 1.00)

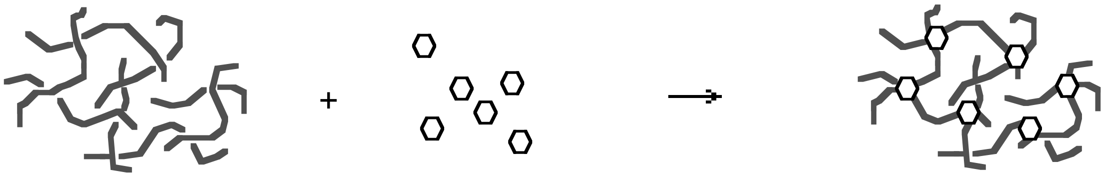
HELP PRESERVE OUR ENVIRONMENT

PLACE RECYCLABLE PRODUCTS IN THEIR APPROPRIATE CONTAINER

5. Two different samples (Y & Z) are placed in concentrated salt water; Y sinks. When more water is mixed in, Z sinks. Given the density of NaCl water = 1.10, what is the identity of Z? ____ What are the possible identies of Y? ___ / ___

CROSS-LINKED POLYMER LAB Name: _______________ Partner: _____________

Elmer's glue contains, among other ingredients, a short-chain polymer known as polyvinyl acetate, which, at least in part, accounts for its high viscosity. Sodium borate (more commonly known as the laundry freshener "Borax") contains borate ions which have the ability to hook together the polyvinyl acetate chains into a hammock-like network called a "cross-linked polymer." This reaction is represented below.

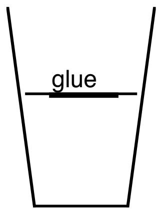


polyvinyl acetate molecules **borate ions** **cross-linked polymer**

In this lab you will observe this reaction and have the opportunity to investigate the properties of this cross-linked polymer, and another one made of cross-linked polyvinyl alcohol -- especially focusing on their viscosity and elasticity.

Procedure 1: ***polyvinyl acetate slime***

1. Measure 15 mL of water into a small vial, add one scoop of sodium borate (the white granular solid), cover and shake for 15 seconds. Set aside and allow the undissolved particles to settle while doing the next step.



2. Into the small plastic cup measure just enough polyvinyl acetate to reach the black line. Then pour it into the paper cup.

3. Carefully **decant** (pour out) the sodium borate solution into the paper cup, leaving behind in the vial any undissolved granules. Using the wooden stick, stir the mixture well, making sure the liquid gets absorbed into the polymer. Remove from cup & knead with hands.

4. Continue kneading the product until the slime is somewhat dry. Let it sit for a few minutes while you clean out the plastic cup!

Procedure 2: ***polyvinyl alcohol slime***

1. Measure 15 mL of water into the small vial, add one scoop of sodium borate (the white granular solid), cover and shake for 15 seconds. Set aside and allow the undissolved particles to settle while doing the next step.

2. Use the graduated cylinder to measure 60 mL of polyvinyl alcohol* solution; pour into a ziplock bag.

*(choose your own color!)

3. Carefully **decant** (pour out) the sodium borate solution into the bag, leaving behind in the vial any undissolved granules. Zip the bag shut and gently knead the bag to mix the liquids.

4. Continue kneading the product until the bag is completely clean on the inside. Let it sit for a few minutes while you clean out the glassware! **(dirty glassware = loss of points!)**

Now that you've made your two "slimes", perform the tests listed on the back side of this sheet ---->

cross-linked polymer lab (side 2)

You have just made two types of cross-linked polymers that chemists (and kids) have nick-named "slime!" The following steps will allow you to test some of the physical properties of your "slimes."

cross-linked polyvinyl acetate:	**cross-linked polyvinyl alcohol:**

1. Response to Agitation: Knead the slimes as forcefully as you can. How do they respond? Set them back on the lab counter for a while. How do they respond? Record observations:

2. Stretchability: Try stretching the slimes very slowly. How do they respond? Try stretching them quickly. How do they respond? Try stretching them into a thin sheet. How thin can you get them? Record observations:

3. Viscosity: Hold each slime in fingers for a ***few minutes*** and allow it to "drip" down. Does one seem to flow quicker than the other? Record observations:

4. Resilience: Shape the slimes into balls and try dropping them onto the lab bench. Can you get them to bounce? Record observations:

5. When you are done, **clean your lab area!** Return the slime to the bags. You & your lab partner can divide the slime between yourselves (you each should already have one Ziplock bag). KEEP IT AWAY FROM CARPETS, WOOD FURNITURE, AND FROM LITTLE ONES (UNDER FIVE) WHO MAY THINK IT LOOKS TASTY. **Note**: The slime will eventually turn moldy.

Write-Up: Along with recording all your observations above, answer the following questions on a separate sheet of paper:

1. Define viscosity. How did the viscosity of the slime compare to the viscosity of the original polyvinyl acetate (the glue) and polyvinyl alcohol from which they were made? What might have caused the viscosity to change?
2. Use diagrams to show what cross-linking is. How does cross-linking affect a polymer's viscosity?
3. With cross-linking in mind, explain why you think the polyvinyl acetate (glue) was diluted with water before you added the borax solution. What would have happened if it wasn't diluted with water? What would have happened if you had added extra water?
4. What happened when you stretched the slimes quickly? When you stretched them slowly? Explain why fast and slow stretching might cause different responses in the slimes.
5. If you had to choose one or the other, would you categorize your slimes as a liquid or a solid (consider all the tests you performed on it). Justify your answer.
6. Other than as a toy, think up some practical use for your slimes and predict what their benefits and drawbacks might be. Be creative!