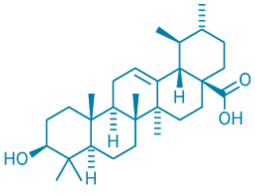
URSOLIC ACID MIGHT KEEP THE DOCTOR AWAY

Natural product found in apples is identified as a promising compound to treat age- and disease-related muscle atrophy

A polycyclic natural product called ursolic acid that's found in large amounts in apple peels might be just what the doctor should order to treat age- and disease-related muscle atrophy, according to a University of Iowa study.

A team led by Christopher M. Adams monitored gene activity in the muscles of people and mice that were fasting in order to study muscle weakening. The researchers then compared mRNA expression signatures with the response of cells to some 1,300 bioactive molecules.

They singled out ursolic acid as a lone inhibitor of atrophy-associated gene expression. The researchers next gave ursolic acid to mice and observed that it helps protect fasting mice against muscle weakening and helps mice with a normal diet grow muscle. The mice also became leaner and had lower blood levels of glucose, cholesterol, and triglycerides. It seems the adage "an apple a day keeps the doctor away" might have real therapeutic merit, Adams says.



Ursolic acid

For more information, see
Chemical & Engineering News, June 20, **2011**

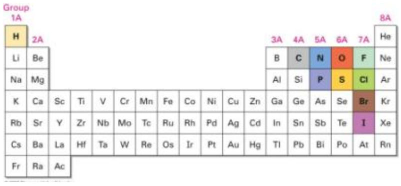
TIME MANAGEMENT BLITZ

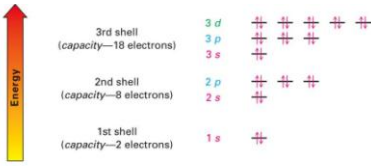
10 MINUTE AGENDA CHECK-UP

Wed., Sept. 21, 11 am to 1 pm, Science Atrium
Wed., Sept. 28, 11 am to 1 pm, Concourse
Learn time management strategies to keep you on track.

CLASS PLAN – WEDNESDAY, SEPTEMBER 21

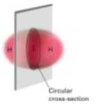
- **Prior Learning Assessment – Summary and Feedback**
- **Learning Activity 1 – Lewis structures, VSEPR and Hybridization**
- **Learning Activity 2 – Curved Arrows and Resonance Structures**
- **Learning Activity 3 – Brønsted-Lowry Acids and Bases**
- **Learning Activity 4 – Lewis Acids and Bases**
- **Tonight’s Class – Summary and Feedback**
- **What’s next?**

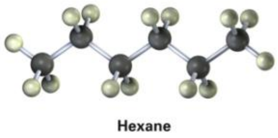


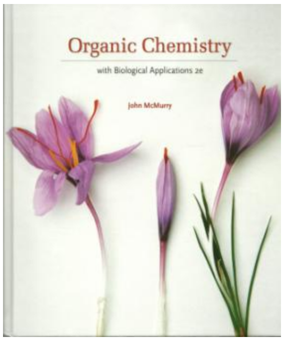


McMurry Chapter 1

STRUCTURE AND BONDING

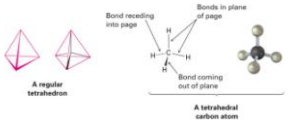


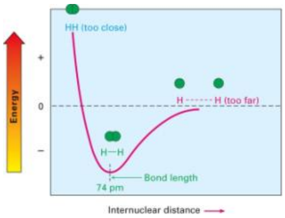


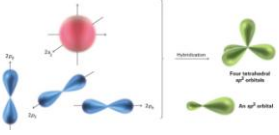

Organic Chemistry

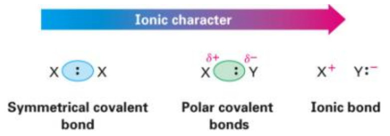
with Biological Applications 2e

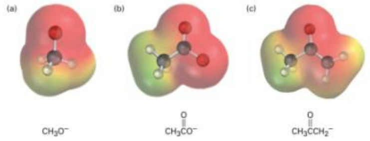
John McMurry





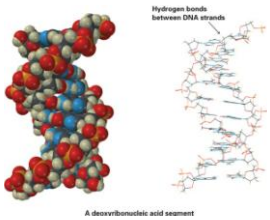


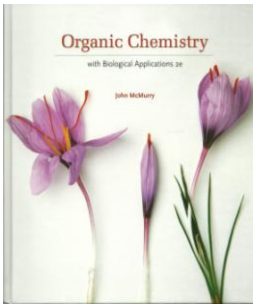


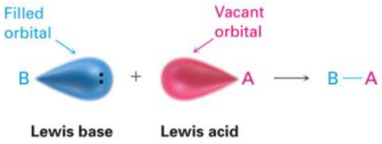


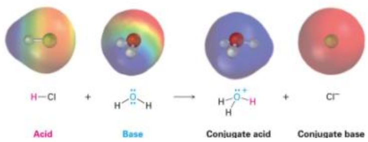
McMurry Chapter 2

POLAR COVALENT BONDS; ACIDS AND BASES

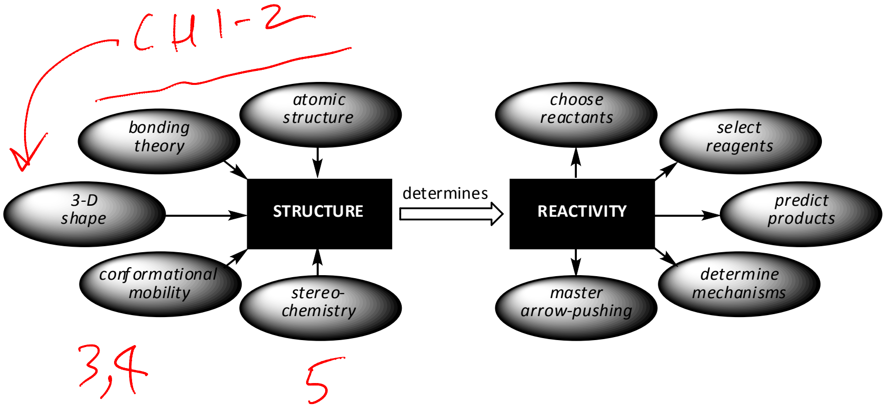








CH202/204 COURSE OVERVIEW



CH 1-2

bonding theory

atomic structure

3-D shape

conformational mobility

stereo-chemistry

STRUCTURE

determines

REACTIVITY

choose reactants

select reagents

predict products

master arrow-pushing

determine mechanisms

3,4

5

MCMURRY SECTIONS COVERED

Chapter 1	**Structure and Bonding**
1.1-1.3	Atomic Structure: the nucleus, orbitals, electron configurations
1.5, 1.11	The Nature of Chemical Bonds: Valence Bond Theory and Molecular Orbital Theory
1.6-1.10	Orbital Hybridization
Supplement:	*Molecular Geometry: The VSEPR Theory*
1.4	Development of Chemical Bonding Theory: Lewis Structures
1.12	Drawing Chemical Structures

MCMURRY SECTIONS COVERED

Chapter 2	**Polar Covalent Bonds; Acids and Bases**
2.1-2.3	Electronegativity, Dipole Moments and Formal Charges
2.12	Noncovalent Interactions Between Molecules
2.4-2.6	Resonance
2.7	Acids and Bases: The Brønsted-Lowry Definition
2.8-2.10	Acid and Base Strength; Predicting Acid-Base Reactions from pK_a Values
Supplement:	*Effect of Structure on Acidity*
2.11	Acids and Bases: The Lewis Definition

PRIOR LEARNING ASSESSMENT

PRIOR LEARNING ASSESSMENT
“COLD”

285 completed quiz (~95% participation)

class average: 57%

27% failure rate

DONE WELL (>70%)

- **g.s. e-configs (83%)**
- **E.N. trend, u-d (86%)**
- **E.N. trend, l-r (84%)**
- **atom size trend, u-d (74%)**
- **struct representations (74%)**
- **acid vs base strength (78%)**

SO SO (50-70%)

- **counting σ/π bonds (53%)**
- **hybrid’n states (61%)**
- **VSEPR (52%)**
- **e-static maps (58%)**
- **determining polarity (62%)**
- **high/low bp (54%)**
- **K_a/pK_a vs acidity (56%)**
- **rank acidity, l-r (62%)**
- **struct effects acidity (50%)**

NOT DONE WELL (<50%)

- **atom size trend, l-r (41%)**
- **formal charge (40%)**
- **correct Lewis struct (48%)**
- **H-X acidity (41%)**
- **A/B, CA/CB (42%)**
- **identifying LA/LB (25%)**
- **recognizing res (47%)**

PRIOR LEARNING ASSESSMENT (REVISITED)

281 completed quiz (~93% participation)

class average: 88% (31% increase!)

0% failure rate (27% decrease!)

THINGS YOU ARE STILL STRUGGLING WITH (<70%)

- **knowing when resonance is possible (47% → 68%)**
- **identifying Lewis acids and bases (25% → 65%)**
- **identifying correct Lewis structures (25% → 65%)**
- **relative acid strength, left/right (62% → 68%)**

Grades improved for the Prior Learning Assessment because:

A. some real learning occurred this week

B. I used course resources when I took the test for 5% of my final grade

C. *some* learning occurred this week **and** I used resources when I took the test for 5% of my final grade

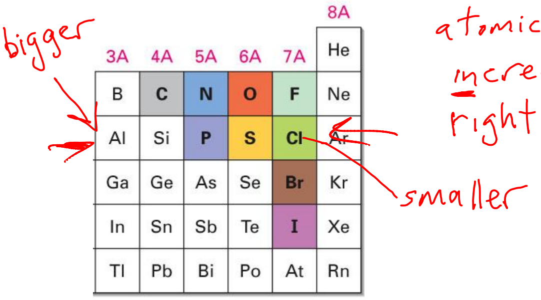
Rank the following elements in terms of their relative atomic sizes (smallest to largest): phosphorous, aluminum, chlorine, sulfur, silicon.

A. aluminum (smallest) < sulfur < phosphorous < silicon < chlorine (largest)

B. aluminum (smallest) < silicon< phosphrous < sulfur < chlorine (largest)

C. phosphorous (smallest) < aluminum < chlorine < sulfur < silicon (largest)

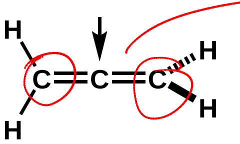
D. chlorine (smallest) < sulfur < phosphorous < silicon < aluminum (largest)



3A	4A	5A	6A	7A	8A
					He
B	C	N	O	F	Ne
Al	Si	P	S	Cl	Ar
Ga	Ge	As	Se	Br	Kr
In	Sn	Sb	Te	I	Xe
Tl	Pb	Bi	Po	At	Rn

atomic size increases from right to left

What is the hybridization state of the indicated carbon in the following structure?



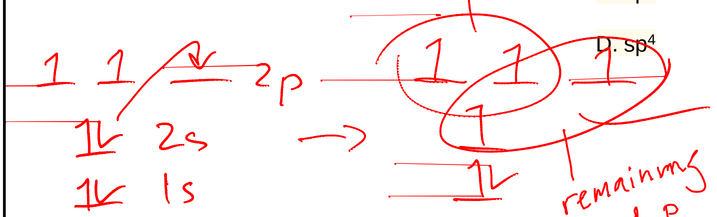
A. sp

B. sp^2

C. sp^3

D. sp^4

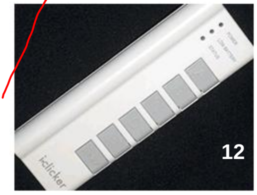
1 pure p-orbital required for each π-bond



ground state e- configuration for carbon

remaining s and p orbitals "mixed" to yield

2 sp-hybrid orbitals



LEARNING ACTIVITY 1:
LEWIS STRUCTURES, VSEPR AND HYBRIDIZATION

LEARNING ACTIVITY 1:

1. Draw a Lewis structure for CH_3NH_2.

2. Using VSEPR theory, predict the geometry about nitrogen in CH_3NH_2.

electronic
considers non-bonding electrons as substituents

molecular
ignores non-bonding electrons

3. What is the hybridization state (sp, sp^2, sp^3) of the nitrogen in CH_3NH_2?

1. Draw a Lewis structure for CH_3NH_2.

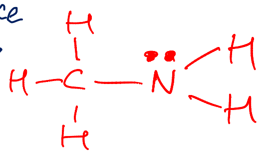
electrons required

26

14 # valence electrons available

12 ÷2 → 6 ← # bonds required

electrons that must shared



14 (available)
− 12 (used for bonds)
2 = # nonbonding electrons

2. Using VSEPR theory, predict the geometry about nitrogen.

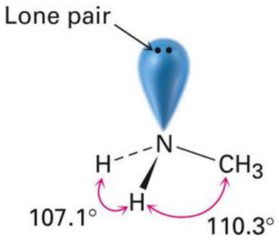
electronic

tetrahedral

molecular

trigonal pyrimidal

3. What is the hybridization state (sp, sp^2, sp^3) of the nitrogen in CH_3NH_2?



sp^3

nonbonding pair

↿ ↿ ↿ 2p
⇅ 2s
⇅ 1s

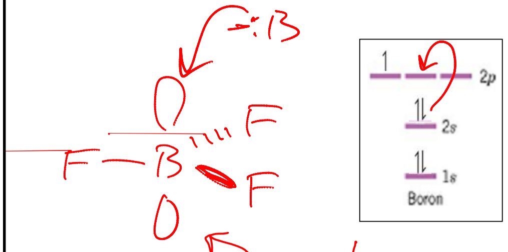
g.s. e− config for N

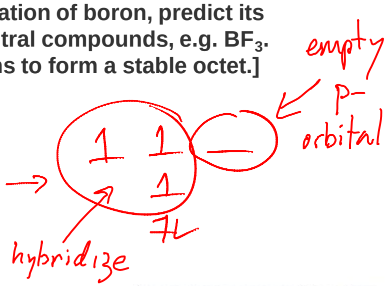
hybridization →

⇅ ↿ ↿ ↿

4 sp^3-hybrid orbitals

Given the ground state electronic configuration of boron, predict its hybridization state and geometry in its neutral compounds, e.g. BF$_3$. [Hint: BF$_3$ readily accepts a pair of electrons to form a stable octet.]



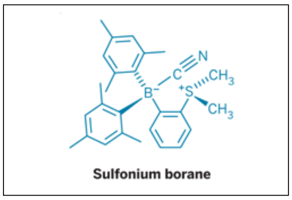


empty p-orbital

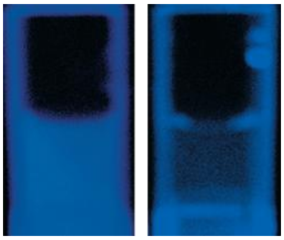
- A. sp
- [✓ B.] sp^2
- C. sp^3

- A. linear
- B. bent
- [✓ C.] trigonal planar
- D. trigonal pyramidal
- E. tetrahedral

BORANE COMPOUND TURNS OFF WHEN SENSING CYANIDE



Sulfonium borane



Fluorescence of a sulfonium borane solution (left) is quenched when 100 ppb CN- is added (right).

A sulfonium borane compound can sense the presence of cyanide ions in water at concentrations less than 1 ppm, an important development for efforts to test drinking water for the poison, reports a group led by François P. Gabbaï of Texas A&M University.

The compound contains adjacent sulfonium and dimesitylboryl moieties connected by an o-phenylene linker. The trigonal planar boron center is coordinatively unsaturated and mediates the π-conjugation of its aromatic ligands, resulting in a fluorescent blue chromophore. When CN- is present in solution, it latches onto the boron and quenches the fluorescence.

Structural analysis of the B-CN adduct reveals that the sulfonium group stabilizes cyanide through donor-acceptor and Coulombic interactions. The researchers found that the compound's fluorescence is almost completely quenched within an hour for 200 ppb CN-, the maximum contaminant level for drinking water set by EPA, and 33% quenched after an hour for 50 ppb CN-, the maximum contaminant level for drinking water in the European Union. The sulfonium borane "is one of the rare molecular systems competent for cyanide sensing at the sub-parts-per-million level in water," the researchers write.

Chemical & Engineering News, June 15, **2009**

FOLLOW UP ACTIVITY FOR HOME

THE CHEMICAL STRUCTURE OF AN ALCOHOL

e's needed: 24 (8 each for C and O; 2 for each H)

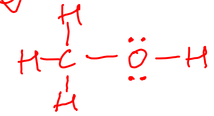
e's available: 4+6+1(4) = 14

e's to share: 24−14 = 10 (or 5 bonds)

1. Draw a Lewis structure for CH_3OH. 14−10 = 4 = # non bonding e's

2. Using VSEPR theory, predict the geometry about oxygen in CH_3OH.

3. What is the hybridization state (sp, sp^2, sp^3) of the oxygen in CH_3OH?



2)

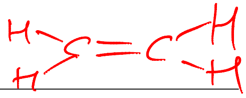
electronic geometry = tetrahedral

molecular geometry = bent

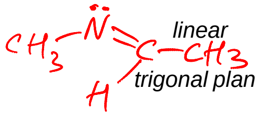
3) sp^3 – connected to 4 "things" – 2Hs + 2 n.b. e-pairs

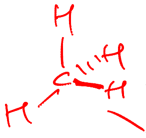
RELATIONSHIP BETWEEN HYBRIDIZATION AND VSEPR THEORY

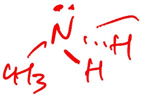
$H-C\equiv C-H$



Hybridization	Lone Pairs	~ Bond Angle	Molecular Geometry
sp	*0*	*180°*	*linear*
sp^2	*0*	*120°*	*trigonal planar*
sp^2	*1*	*120°*	*bent*
sp^3	*0*	*109.5°*	*tetrahedral*
sp^3	*1*	*109.5°*	*trigonal pyramidal*
sp^3	*2*	*109.5°*	*bent*



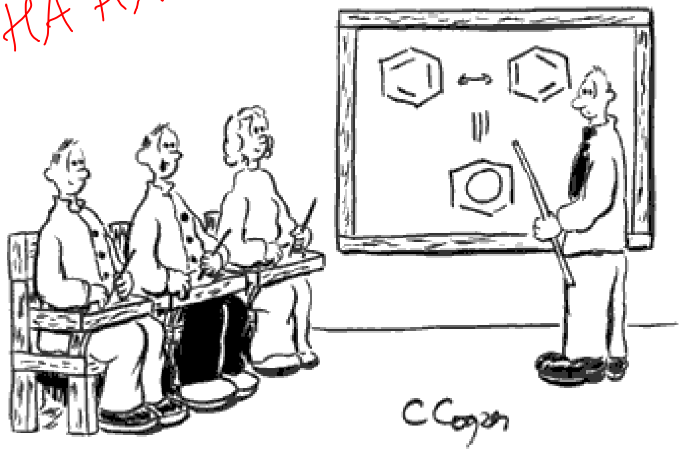




see previous slide

RESONANCE

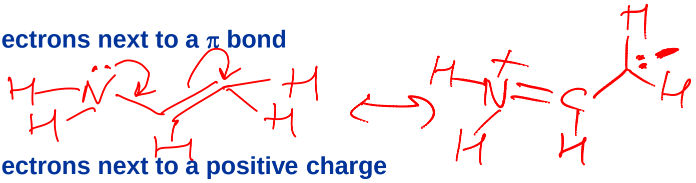
HA HA



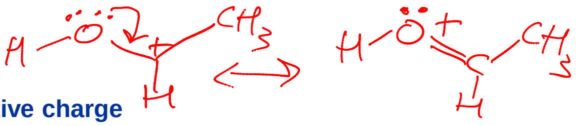
"Define 'resonance'? Sure, that's where you live."

WHEN IS RESONANCE POSSIBLE?

1. lone pair electrons next to a π bond

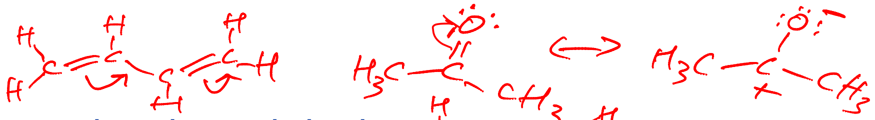


2. lone pair electrons next to a positive charge



3. π bond next to a positive charge

4. π bond between two atoms where one atom is electronegative



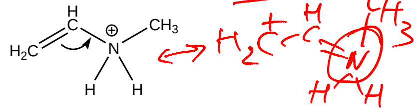
5. alternating σ and π bonds

LEARNING ACTIVITY 2.
CURVED ARROWS AND RESONANCE STRUCTURES

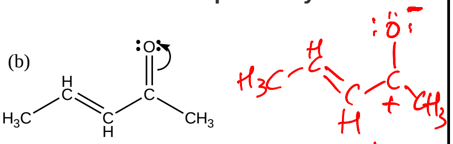
For each of the following, draw the structure that would result from the movement of electrons indicated, including formal charges. State whether or not the resulting structure is a valid resonance structure. Explain why or why not.

not valid

(a)



(b)

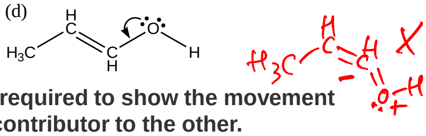


ok

(c)

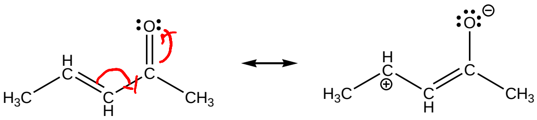
ok

(d)

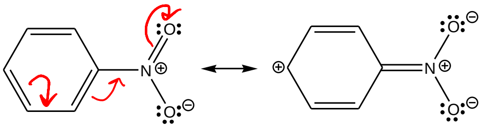


For each of the following, draw the arrows required to show the movement of electrons in going from one resonance contributor to the other.

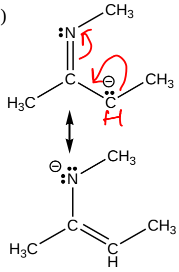
(a)



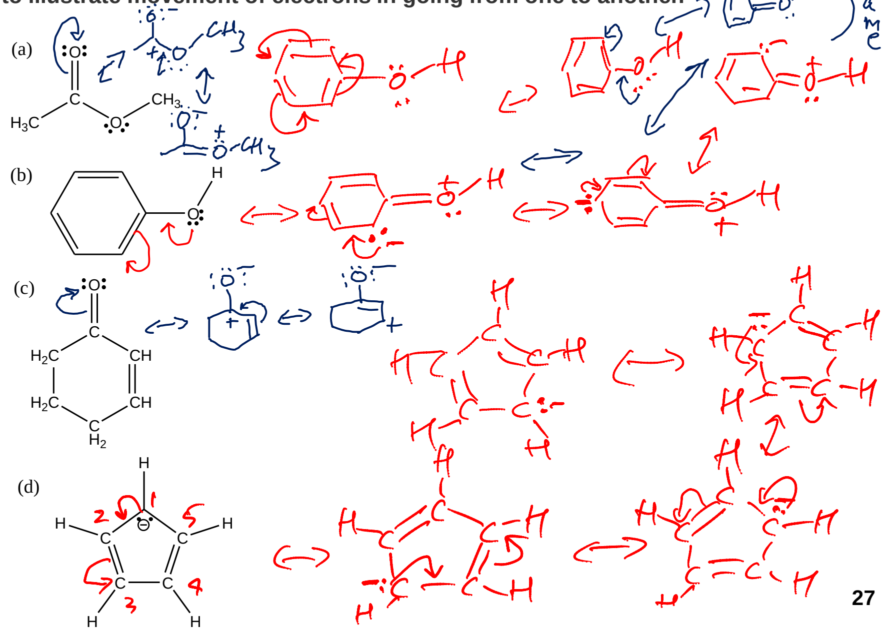
(b)



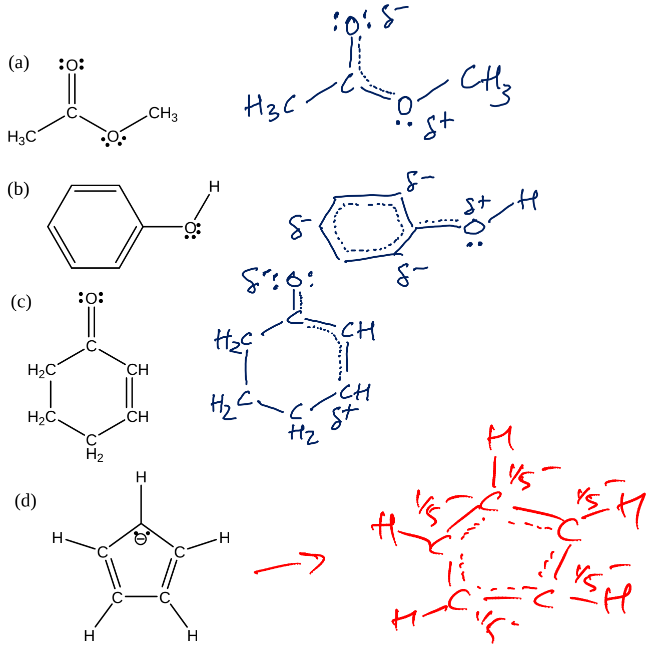
(c)



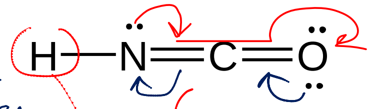
Draw all resonance structures for the following compounds, using arrows to illustrate movement of electrons in going from one to another.



Draw resonance hybrids for each of these structures.

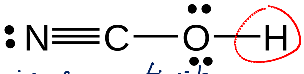


In the illustration below, the best contributing resonance structure for the molecule is shown. Using the guidelines for drawing resonance structures, select the next most important contributing structure for this molecule.



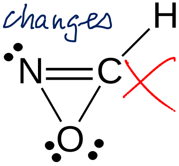
∴ not resonance structures

A.

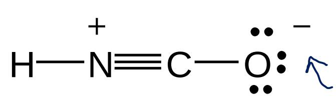


atomic connectivity changes

B.



C.



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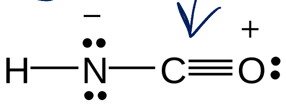

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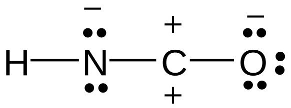


better to put neg charge on more electroneg. atom

ACIDS AND BASES

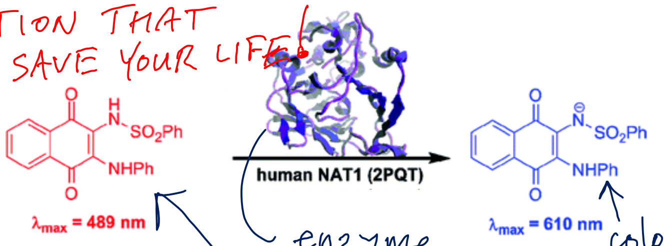
Small Molecule Colorimetric Probes for Specific Detection of Human Arylamine *N*-Acetyltransferase 1, a Potential Breast Cancer Biomarker

J|A|C|S COMMUNICATIONS

Nicola Laurieri,[†,‡] Matthew H. J. Crawford,[†,‡] Akane Kawamura,[‡] Isaac M. Westwood,[‡] James Robinson,[‡] Ai M. Fletcher,[†] Stephen G. Davies,[†] Edith Sim,[‡] and Angela J. Russell*,[†,‡]

Department of Chemistry, Chemistry Research Laboratory, University of Oxford, Mansfield Road, Oxford, OX1 3TA, U.K., and Department of Pharmacology, University of Oxford, Mansfield Road, Oxford, OX1 3QT, U.K.

AN ACID-BASE REACTION THAT COULD SAVE YOUR LIFE!



enzyme deprotonates this compound

color change observed

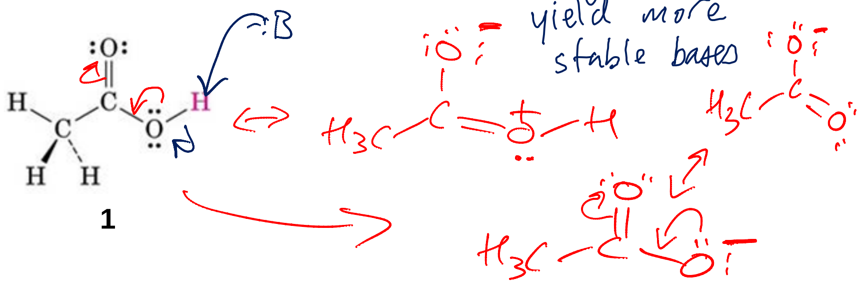
- NAT = *N*-acyltransferase
- *h*NAT1 = implicated in cancer
- one of most highly overexpressed genes in estrogen-receptor-positive (ER+ve) breast tumors
- candidate biomarker in ER+ve breast cancer

J. AM. CHEM. SOC. 2010, *132*, 3238–3239

LEARNING ACTIVITY 3:
BRØNSTED-LOWRY ACIDS AND BASES

Which of the following is a stronger acid?

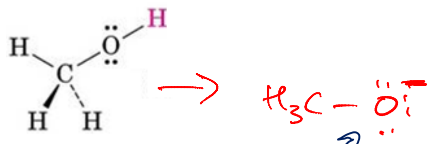
stronger acids yield more stable bases



1

resonance stabilized

∴ easier to form



2

"localized" electrons less stable

∴ harder to form

A. 1

B. 2

For the following Brønsted-Lowry acid-base reaction:

proton acceptor

1

proton donor

2

3

4

A. 1 is the acid, 2 is the base; 3 is the conjugate acid, 4 is the conjugate base

✓ **B.** 1 is the base, 2 is the acid; 3 is the conjugate acid, 4 is the conjugate base

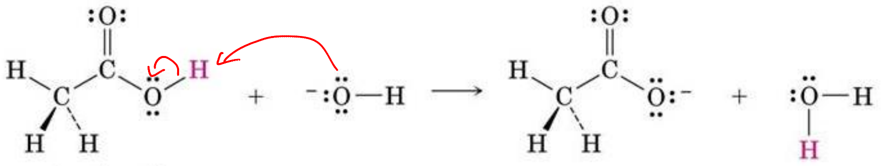
C. 1 is the acid, 2 is the base; 3 is the conjugate base, 4 is the conjugate acid

D. 1 is the base, 2 is the acid; 3 is the conjugate base, 4 is the conjugate acid

Draw curved arrows to indicate the movement of electrons during this acid-base reaction.

PREDICTING THE OUTCOME OF AN ACID-BASE REACTION FROM pK$_a$ VALUES

Will this reaction occur to an appreciable extent? Yes!



Acetic acid (pK_a= 4.76)

Hydroxide ion

Acetate ion

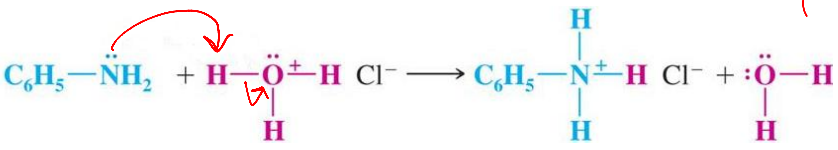
Water (pK_a= 15.74)

stronger acid → weaker acid

Acid-base reactions always proceed from stronger to weaker acid

PREDICTING THE OUTCOME OF AN ACID-BASE REACTION FROM pK$_a$ VALUES

Will the following reaction occur to an appreciable extent? Yes!



$$C_6H_5-\ddot{N}H_2 + H-\overset{+}{\ddot{O}}H-H\ Cl^- \longrightarrow C_6H_5-\overset{+}{N}H_3\ Cl^- + :\ddot{O}H_2$$

hydronium ion

(pK$_a$ = -1.74)

an ammonium ion

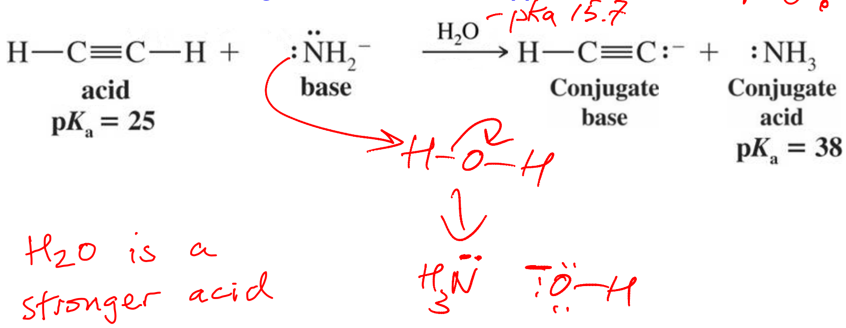
(pK$_a$ = 9-10)

stronger → weaker

✓

ADDITIONAL CONSIDERATIONS

Will the following reaction occur to an appreciable extent? NO!



$$H{-}C{\equiv}C{-}H + :\ddot{N}H_2^- \xrightarrow{H_2O} H{-}C{\equiv}C:^- + :NH_3$$

H_2O is a stronger acid than the one we want to deprotonate.

"Leveling" effect — when H_2O is the solvent, no base stronger than hydroxide ($H\ddot{O}:^-$) can be used

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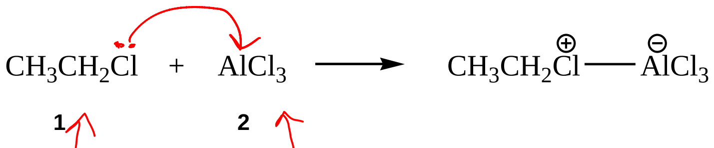
LEARNING ACTIVITY 4:
LEWIS ACIDS AND BASES

Identify the Lewis acid in the following Lewis acid-base reaction.



$$CH_3CH_2\ddot{C}l + AlCl_3 \longrightarrow CH_3CH_2\overset{\oplus}{Cl}—\overset{\ominus}{Al}Cl_3$$

electron donor

electron acceptor

A. 1

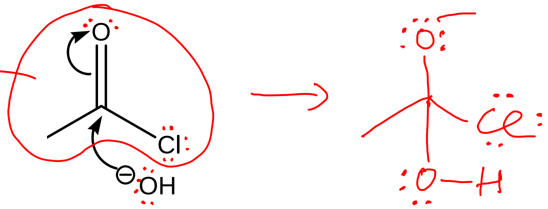
B. 2 ✓

Draw curved arrows to indicate the movement of electrons during this acid-base reaction.

(a) Identify the Lewis acid and Lewis base in the following reaction.
(b) Provide the structure(s) that result after the indicated arrow-pushing mechanism. ***Pay particular attention to changes in formal charge. (Note that non-bonding pairs have been omitted).***

Lewis acid

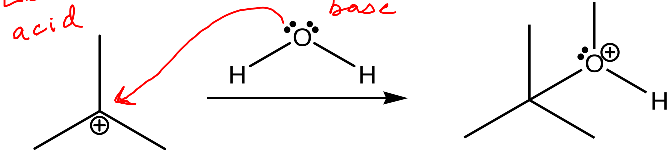
= electron acceptor



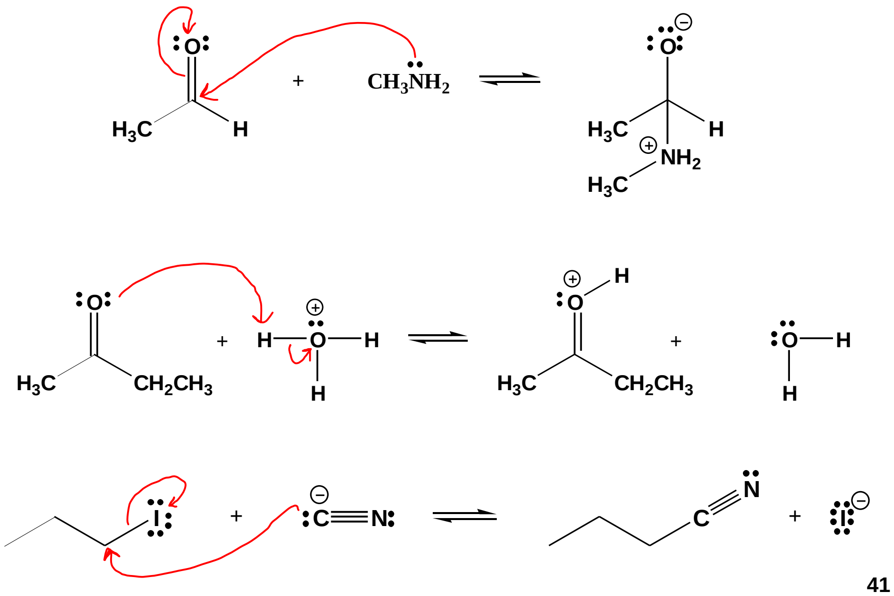
Provide an arrow-pushing mechanism for the following Lewis acid-base reaction.

Lewis acid

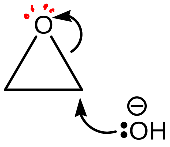
Lewis base

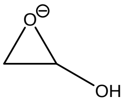


Supply curved arrows necessary for the following reactions.

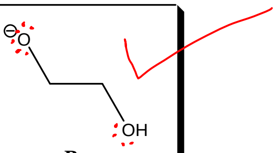


Provide the structure of the product that results from the following arrow-pushing mechanism.

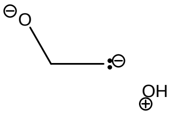




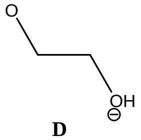
A



B



C



D

CLASS SUMMARY – WEDNESDAY, SEPTEMBER 21

- **Lewis structures, VSEPR and hybridization**
- **resonance and curved arrows**
- **identifying Brønsted-Lowry and Lewis acids and bases**
- **supplying curved arrows for Brønsted-Lowry and Lewis acids and bases**
- **determining whether or not a given Brønsted-Lowry acid-base reaction will occur**
- **PRACTICE, PRACTICE, PRACTICE!**

→ post-class *optional* resonance and acid-base MyLS "quizzes"

  - **take as often as you want, whenever you want**
  - **no points but very valuable**

→ *required* OWL homework

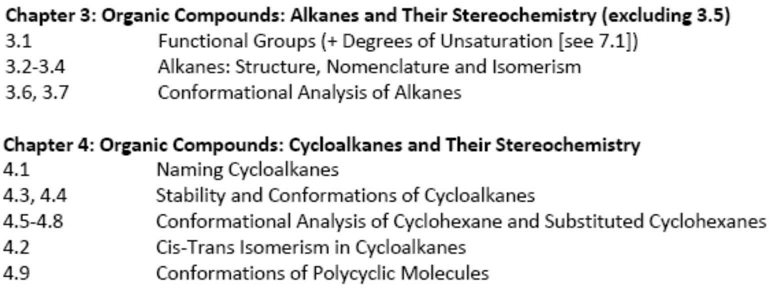
  - **available at 9pm; due by 11:59pm on Saturday**
  - **three chances to master each assignment**

→ *optional* OWL homework

  - **available for the term**
  - **unlimited chances to master each assignment**

→ end-of-chapter textbook questions and MyLS links

WHAT'S NEXT



Chapter 3: Organic Compounds: Alkanes and Their Stereochemistry (excluding 3.5)

3.1	Functional Groups (+ Degrees of Unsaturation [see 7.1])
3.2-3.4	Alkanes: Structure, Nomenclature and Isomerism
3.6, 3.7	Conformational Analysis of Alkanes

Chapter 4: Organic Compounds: Cycloalkanes and Their Stereochemistry

4.1	Naming Cycloalkanes
4.3, 4.4	Stability and Conformations of Cycloalkanes
4.5-4.8	Conformational Analysis of Cyclohexane and Substituted Cyclohexanes
4.2	Cis-Trans Isomerism in Cycloalkanes
4.9	Conformations of Polycyclic Molecules

- **Chapters 3/4 resources (learning tasks, video lectures, PP slides) 12:01am on Sunday**

MUST COMPLETE "CHAPTERS 1 AND 2 LEARNING TASKS INVENTORY" (UNDER SURVEYS) FIRST

- **required OWL Homework released 12:01am on Sunday; due Wednesday at 12:01pm**
- **optional OWL Homework released 12:01am on Sunday; available for term**
- **extensions and applications in class next Wednesday**