PRINCIPLES OF ATOMIC STRUCTURE CHAPTER 1 Chem 1A #9

ATOMS CONSIST OF A NUCLEUS MADE FROM PROTONS AND NEUTRONS SURROUNDED BY A "CLOUD" OF ELECTRONS

ATOMS ARE NUMBERED BY THEIR NUMBER OF PROTONS AND USUALLY CONTAIN A SIMILAR NUMBER OF NEUTRONS

CARBON HAS 6 PROTONS, 6 NEUTRONS → ATOMIC # 6 MASS 12 $^{12}C$

1% OF CARBON ATOMS HAVE 7 NEUTRONS → $^{13}C$ ISOTOPE

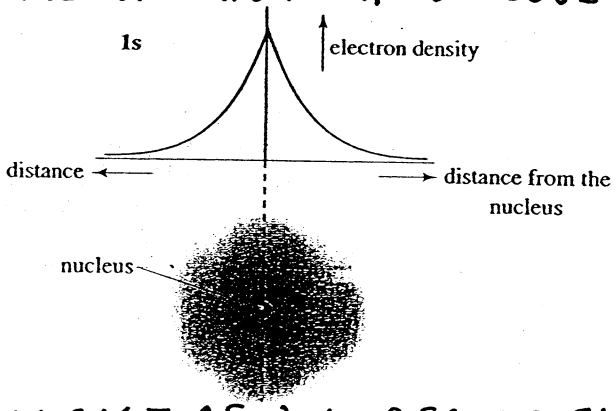
AN EVEN SMALLER NUMBER OF CARBONS HAVE 8 NEUTRONS $^{14}C$ RADIOACTIVE

ELECTRONS EXIST IN ORBITALS - REGIONS OF SPACE AROUND THE NUCLEUS WITH DEFINED PROBABILITIES OF FINDING AN ELECTRON IN THEM

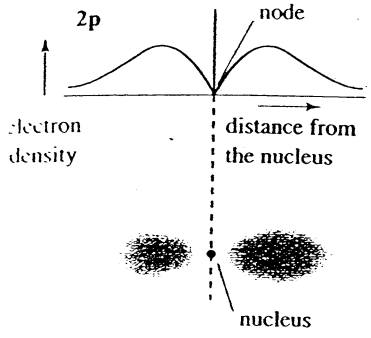
ORBITALS ARE GROUPED INTO SHELLS WITH PRINCIPAL QUANTUM NUMBER N

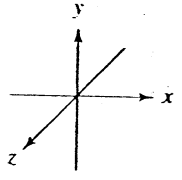
THE FIRST 2 ROWS OF THE PERIODIC TABLE HAVE ELEMENTS WITH N = 1 OR N = 2

S ORBITALS ARE SPHERICAL AND CLOSE TO THE NUCLEUS

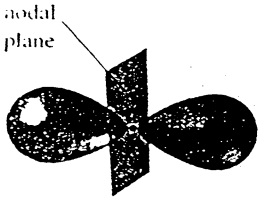



P ORBITALS CONSIST OF 2 LOBES OF ELECTRON DENSITY, ONE ON EACH SIDE OF THE NUCLEUS. THERE ARE 3, $P_x$ $P_y$ $P_z$

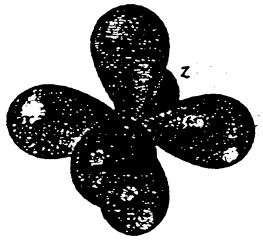



directions of axes
(z comes out toward us)




the $2p_x$ orbital




the $2p_x$, $2p_y$, and $2p_z$ orbitals superimposed at 90° angles

**◀ Figure 1-4**
The 2*p* orbitals. There are three 2*p* orbitals, oriented at right angles to each other. Each is labeled according to its orientation along the *x*, *y*, or *z* axis.

## BOND FORMATION

ATOMS MAKE BONDS WITH ONE ANOTHER TO TRANSFER (IONIC) OR SHARE (COVALENT) ELECTRONS TO ATTAIN A FILLED SHELL OF ELECTRON THIS IS THE OCTET RULE. AN OCTET IS ALSO KNOWN AS A NOBLE GAS CONFIGURATION AND HAS GREAT STABILITY

IONIC BONDING: $Li\cdot + \cdot\ddot{F}: \rightarrow Li^+ + :\ddot{F}:$ (He) (Ne) ELECTRONS ARE TRANSFERRED

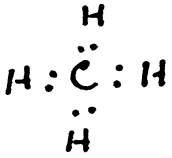
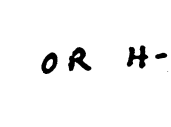
COVALENT BONDING

$H\cdot + H\cdot \rightarrow H:H$ (He) ELECTRONS ARE SHARED

LEWIS STRUCTURES

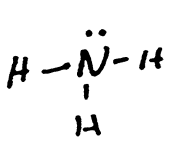
DOTS FOR ELECTRONS OR — FOR ELECTRON PAIR BONDS

THE SECOND ROW ELEMENTS, SUCH AS C, GET AN OCTET IF POSSIBLE

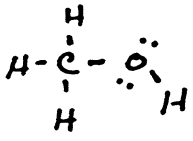



METHANE

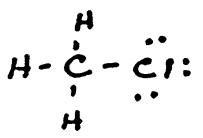
MANY ATOMS AND COMPOUNDS WILL HAVE NONBONDING ELECTRONS, USUALLY AS A LONE PAIR



AMMONIA



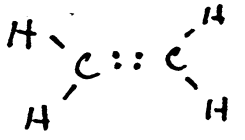
METHYL ALCOHOL



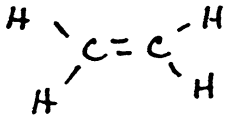
CHLOROMETHANE

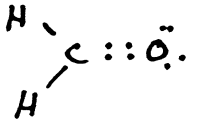
CHEMISTS OFTEN USE SHORTHAND, OMITTING NONBONDING ELECTRONS

MULTIPLE BONDING - SHARING MORE THAN ONE ELECTRON PAIR

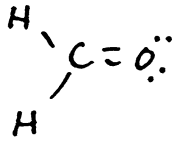


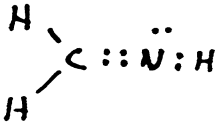
ETHYLENE



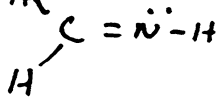


FORMALDEHYDE

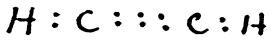




FORMALDIMINE

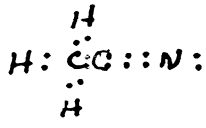


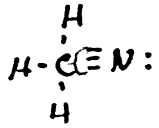
TRIPLE BONDS



ACETYLENE

HC≡CH





ACETONITRILE

## ELECTRONEGATIVITY

WE USE THE PAULING ELECTRONEGATIVITY SCALE TO MEASURE HOW MUCH EACH ATOM WANTS ELECTRONS

| H | C | N | O | F | Cl | Br | I |
|---|---|---|---|---|---|---|---|
| 2.2 | 2.5 | 3.0 | 3.4 | 4.0 | 3.2 | 3.0 | 2.7 |

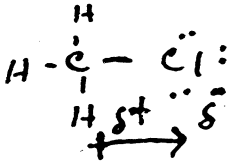
ELECTRONS IN BONDS MAY BE SHARED EQUALLY, UNEQUALLY OR VERY UNEQUALLY

H:H — NON POLAR COVALENT

POLAR COVALENT

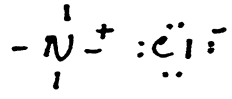
$Na^+ :\ddot{Cl}:^-$ — IONIC

A TYPICAL POLAR BOND

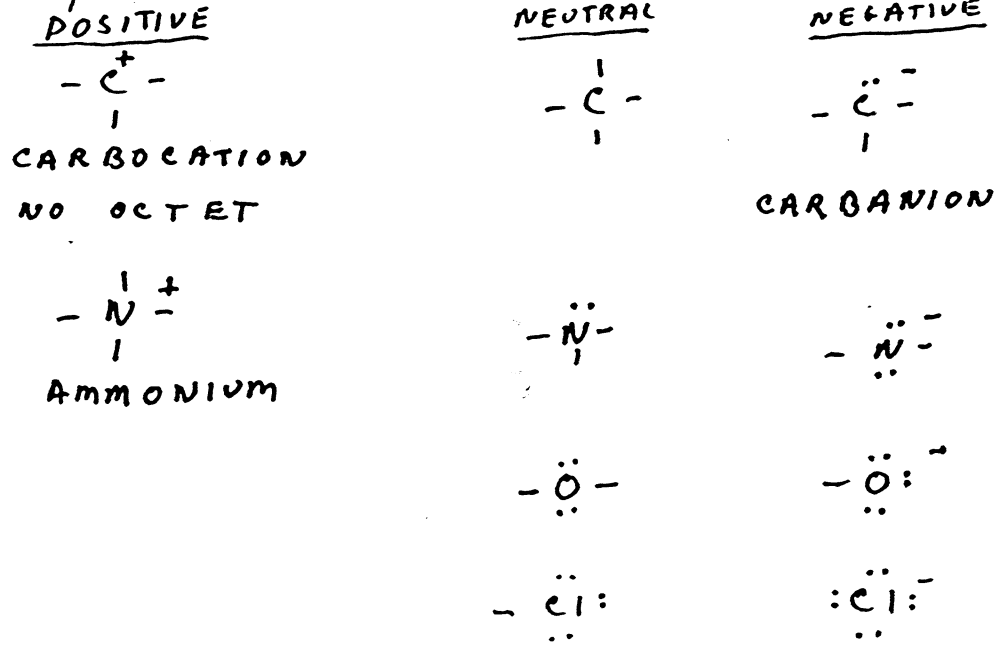


CHLORINE HAS MOST OF THE ELECTRON DENSITY AND A PARTIAL CHARGE $\delta^-$

SOME COMPOUNDS CONTAIN IONIC BONDS

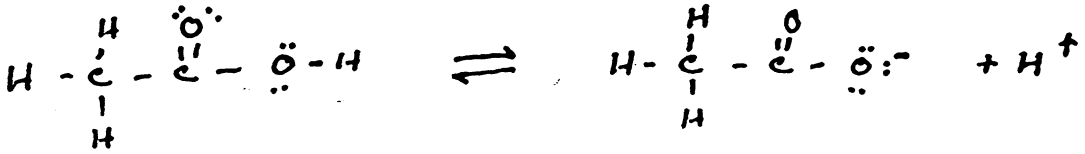


SUMMARY OF COMMON BONDING PATTERNS

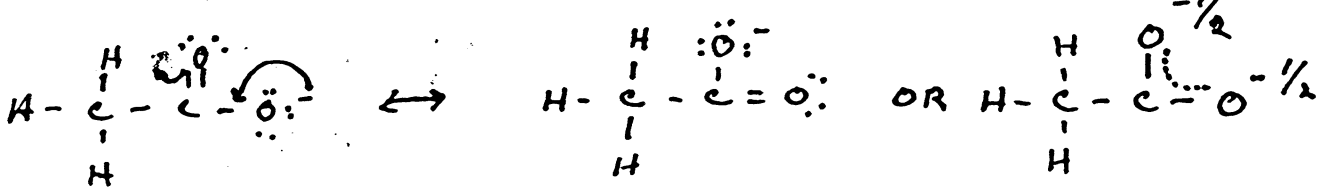


RESONANCE HYBRIDS

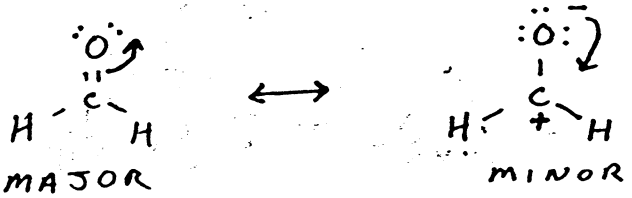
CARBOXYLIC ACIDS IONIZE



THE CARBOXYLATE ION



MAJOR AND MINOR RESONANCE CONTRIBUTORS




GENERAL RULES FOR RESONANCE STRUCTURES

1) VALID LEWIS STRUCTURES
2) ONLY ELECTRONS MAY BE SHIFTED (MOSTLY DOUBLE BONDS, LONEPAIRS)
3) THE MAJOR CONTRIBUTOR IS THE MOST STABLE, (LOWEST ENERGY)

LOW ENERGY OR STABILITY COMES FROM:

- AS MANY OCTETS AS POSSIBLE
- AS MANY BONDS AS POSSIBLE
- AS LITTLE CHARGE SEPARATION AS POSSIBLE
- NEGATIVE CHARGES ON ELECTRONEGATIVE ATOMS

STRUCTURAL FORMULAS

LEWIS STRUCTURES SYMBOLIZE BONDING ELECTRON PAIRS WITH A DASH OR A PAIR OF DOTS AND LONE PAIRS AS A PAIR OF DOTS

CONDENSED STRUCTURAL FORMULAS

DO NOT SHOW BONDS OR NON BONDING ELECTRONS

EACH OF THE CENTRAL ATOMS (USUALLY CARBON) ARE SHOWN TOGETHER WITH THE ATOMS ATTACHED TO IT

PARENTHESES AND A SUBSCRIPT 2, 3, 4... INDICATE IDENTICAL GROUPS OF ATOMS

DOUBLE AND TRIPLE BONDS ARE OFTEN DRAWN

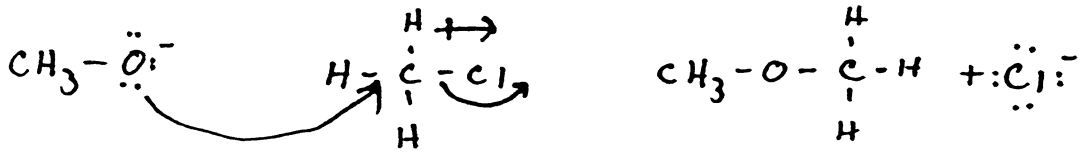
CHEMISTS FREELY MIX CONDENSED AND LEWIS STRUCTURES

THE LEWIS ACID ELECTRON ACCEPTOR IS CALLED AN ELECTROPHILE
THE LEWIS ACID ELECTRON DONOR IS CALLED A NUCLEOPHILE

IN BRONSTEAD-LOWRY ACID/BASE REACTIONS THE PROTON IS THE ELECTROPHILE

ELECTROPHILE NUCLEOPHILE

HERE IS A CLASSIC ORGANIC CHEMISTRY REACTION (CHAPTER 6)
NUCLEOPHILIC SUBSTITUTION



| CHAPTER 1 SKILLS | PROBLEMS |
|---|---|
| DRAW AND UNDERSTAND LEWIS, CONDENSED AND LINE-ANGLE STRUCTURES | 6, 2, 3, 25c, 9a, 10b 27d |
| UNDERSTAND COMMON BONDING PATTERNS | SUMMARY PG 13 |
| DRAW RESONANCE STRUCTURES | 7d, 26, 35 |
| UNDERSTAND MULTIPLE BOND STRUCTURES | TABLE 1-3 |
| UNDERSTAND RELATIVE ACID AND BASE STRENGTH USING ELECTRONEGATIVITY STRUCTURE AND RESONANCE | 51, 52, 15, 16, 41, 42, 17A-D |
| BE ABLE TO USE $K_a$, $k_b$ | 43 |
| RECOGNIZE NUCLEOPHILES (LEWIS BASES) AND ELECTROPHILES (LEWIS ACIDS) AND WRITE LEWIS ACID/BASE REACTIONS | 18 |
| UNDERSTAND BOND POLARITY | 5, 34 A-E, H-J |

# CHAPTER 1

| SKILLS | PROBLEMS |
| --- | --- |
| DRAW AND UNDERSTAND LEWIS STRUCTURES | 15, 16, 17, 33, 35 |
| USE ELECTRONEGATIVITY TO TELL IF BONDING IS IONIC COVALENT, OR POLAR COVALENT | 15 |
| RECOGNIZE POLAR BONDS | 40 |
| DETERMINE THE SHAPE OF A MOLECULE FROM ITS LEWIS STRUCTURE | 22, 29 |
| DETERMINE THE POLARITY OF A MOLECULE | 24, 40 |
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