



Chemistry for Contractors 101

Adapted for Europe by

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Chemistry for Contractors 101



- Is this Chemistry or Greek?
 - Polyurea Basics, Periodic table, reaction basics, reading, writing, and talking chemistry
- So why is polyurea... polyurea?
 - Isocyanates, amines, chain extenders, and additives
- ...and this means what?
 - Cure times, hardness, elasticity, tensile strength, and other physical properties
- Preparing polyurea formulations
 - What does your manufacturer really do?

Presentation content



- Chemistry basics
 - Periodic Table
 - Elements and Compounds
 - Symbols
- Reaction Basics
- Polyurea Basics
 - Building blocks
 - Properties

Periodic Table



hydrogen 1 H 1.0079																	helium 2 He 4.0026						
lithium 3 Li 6.941	beryllium 4 Be 9.0122																	boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305																	aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80						
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29						
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]					
francium 87 Fr [223]	radium 88 Ra [226]	89-102 **	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]	ununquadium 114 Uuq [289]										

Key:
 element name
 atomic number
symbol
 atomic weight (mean relative mass)


*lanthanoids

**actinoids

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

Chemical Elements

Some You Might Recognize

- 
- A large, semi-transparent molecular structure is centered in the background. It features a central yellow sphere with several purple spheres radiating from it, and further out, smaller cyan spheres are visible, suggesting a complex organic or inorganic molecule.
- Hydrogen - H
 - Carbon - C
 - Nitrogen - N
 - Oxygen - O
 - Helium - He
 - Aluminium - Al
 - Calcium - Ca
 - Potassium - K
 - Sodium - Na
 - Iron - Fe
 - Copper - Cu
 - Silver - Ag
 - Gold - Au
 - Platinum - Pt
 - Mercury - Hg
 - Lead - Pb

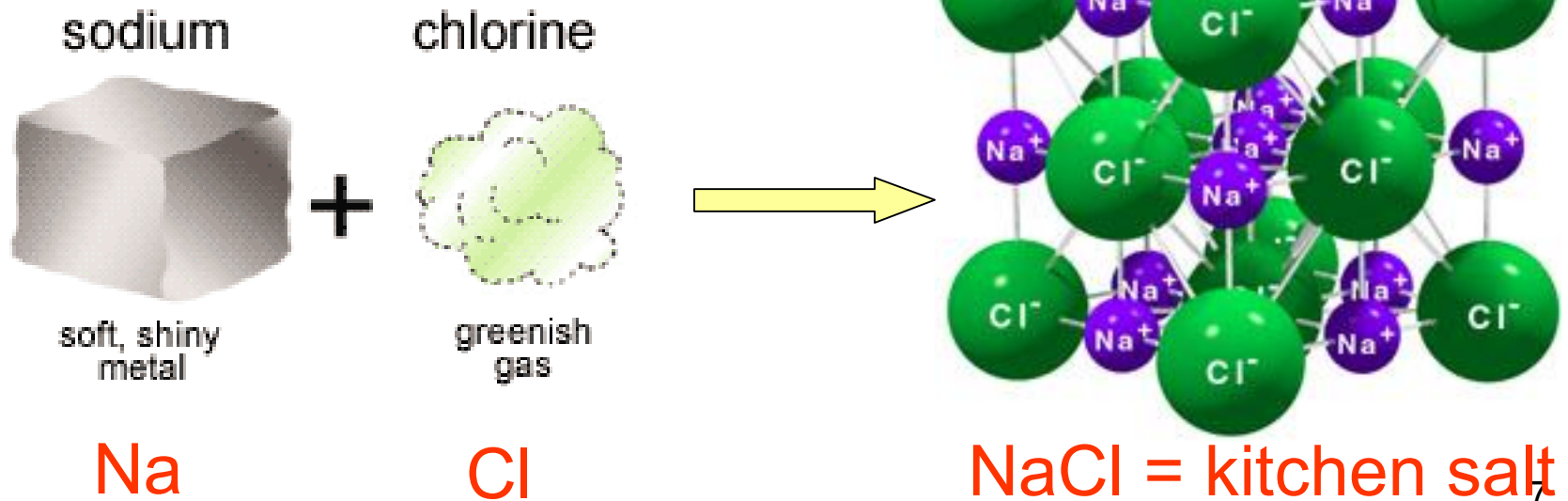
Compounds

- A **chemical compound** is a **substance** consisting of two or more different elements chemically bonded together in a fixed proportion by mass

Salt

Sodium is a soft silvery white metal that reacts violently with water with heat release

Chlorine is a powerful oxidant and is used in bleaching and disinfectants



Periodic Table



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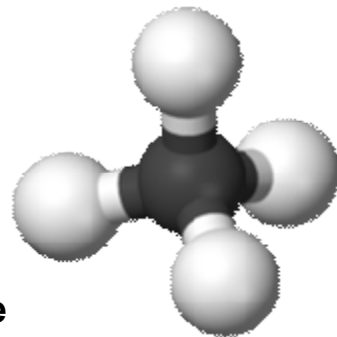
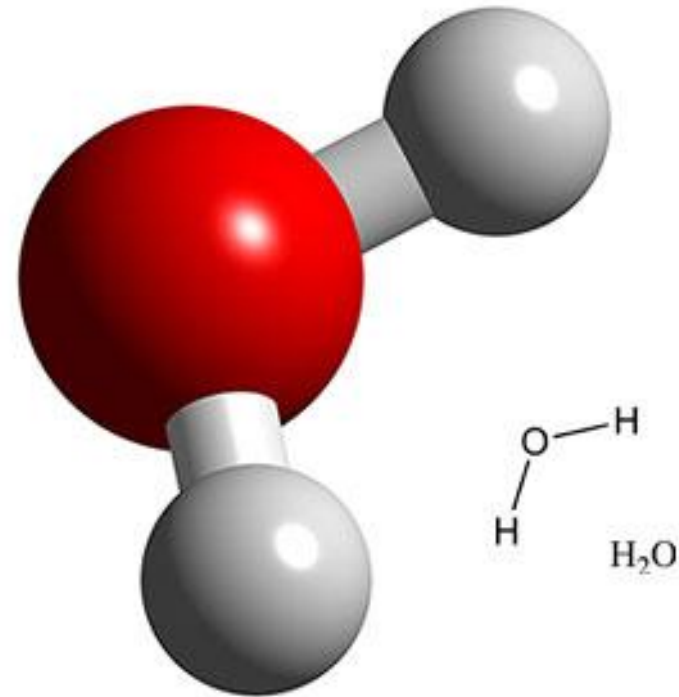
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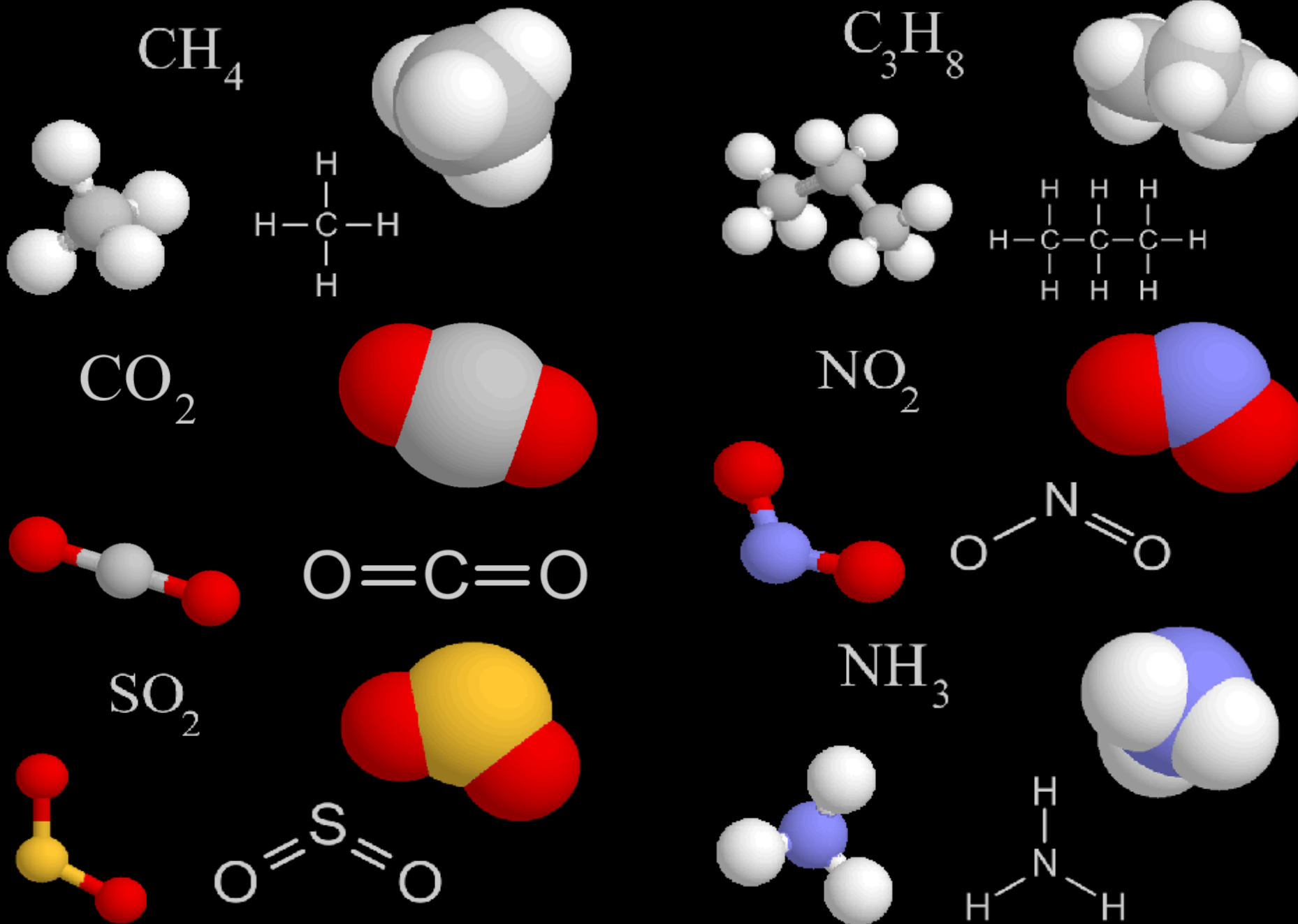
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Bonding

- Reactive Sites
 - 1: Hydrogen
 - 2: Oxygen
 - 3: Nitrogen
 - 4: Carbon

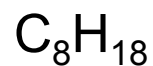
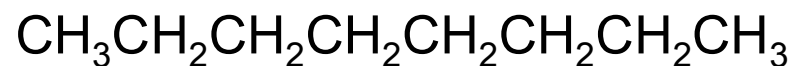
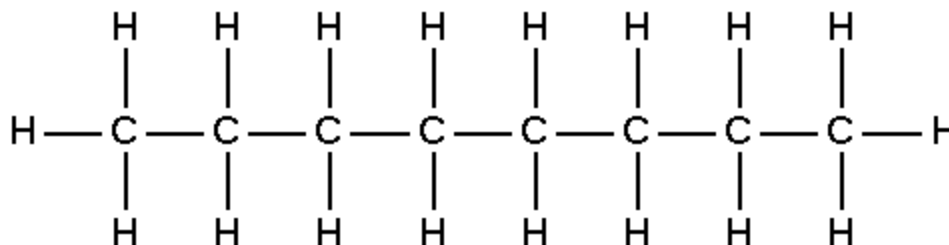
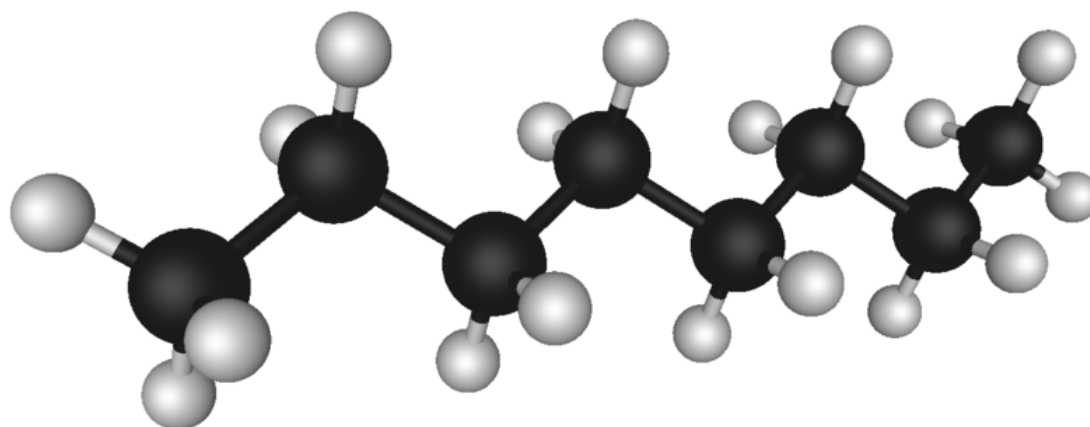


Methane



Writing a molecule

Short hand and Shorter Hand



Writing a molecule in short

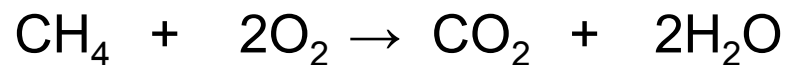
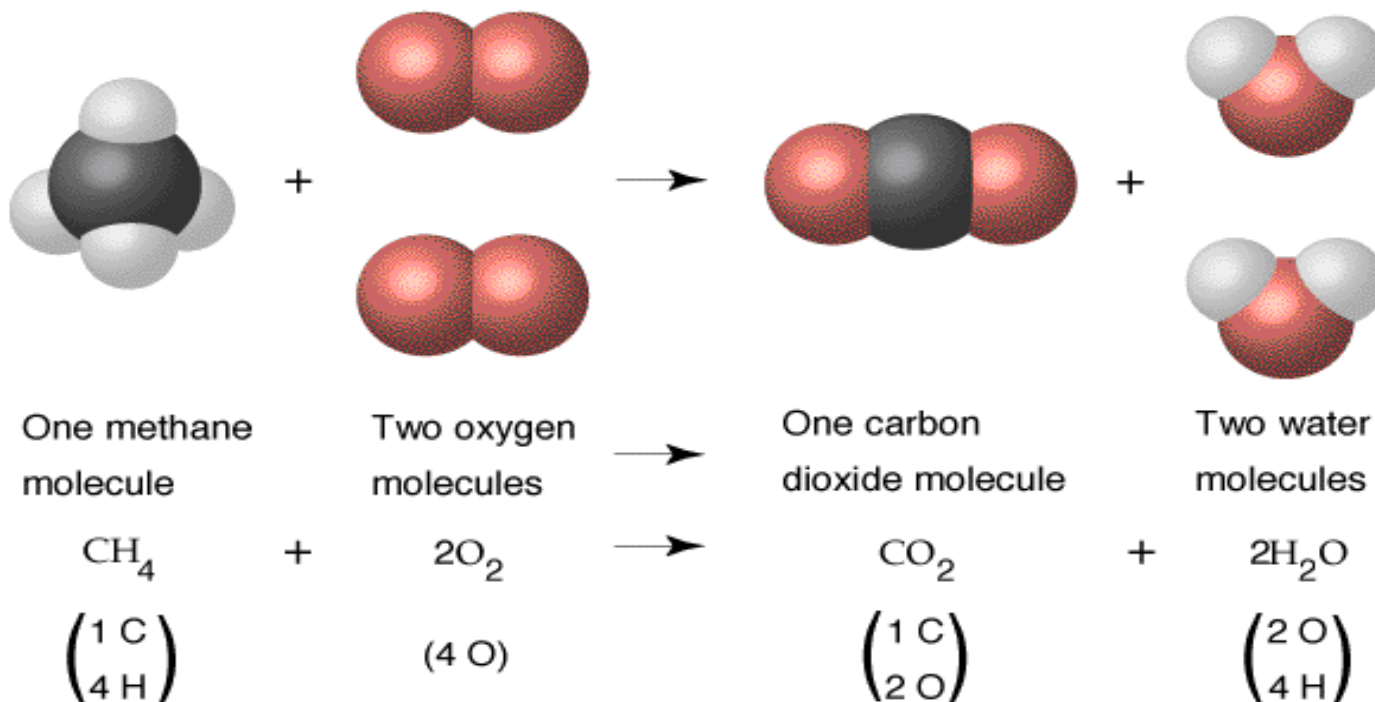
R huh? R' what? Prime who?

- R represents any unwritten, non-reactive unit
- R' or R prime is a second unwritten, non-reactive unit
- There can be any number of Rs in an equation
- In polymers, the R is unreactive, but important for the physical properties of the end product

Writing a reaction

+	Adding together
R	non-reactive segment
R'	A second non-reactive segment
→	Results in...
()	Unit "mer"
	Bond
Λ	Understood Carbon
n	number

Writing a reaction



Polyurea Basics

- You make polyurea
- Reaction of an isocyanate and amine

- Polymer

- Polyurea

“poly” many

“mer” unit

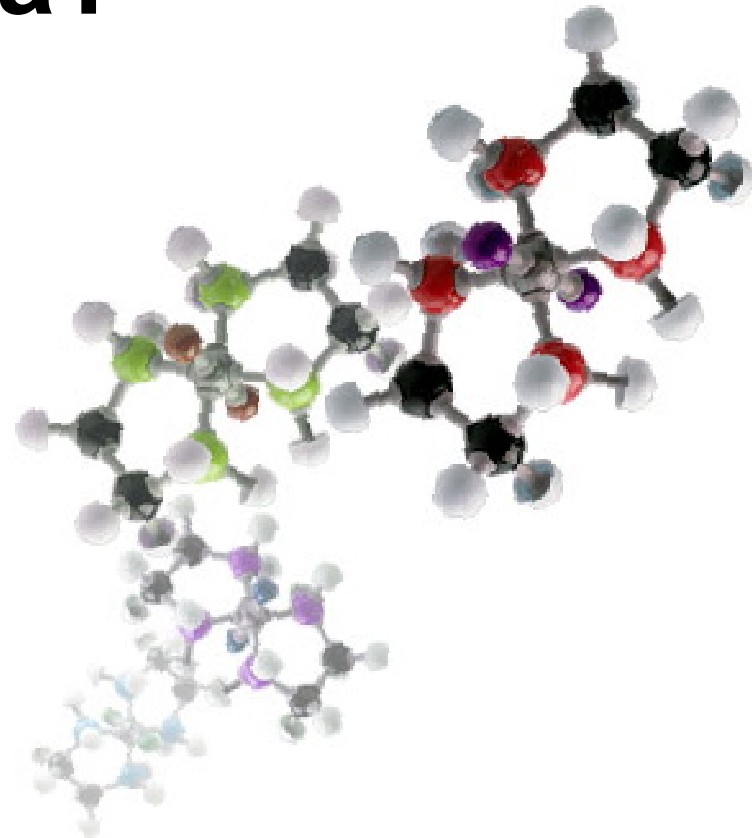
“poly” many

“urea”

So, what makes polyurea...

polyurea?

- Amines
- Isocyanate
- The total package
- Additives
 - Pigments
 - UV Stabilizers
 - Thix agent



Amines

- An amine occurs when one or more hydrogen atoms of an ammonia molecule is replaced by an organic compound (any compound containing carbon).
- Various amine terminated molecules of varying size and type



Isocyanate

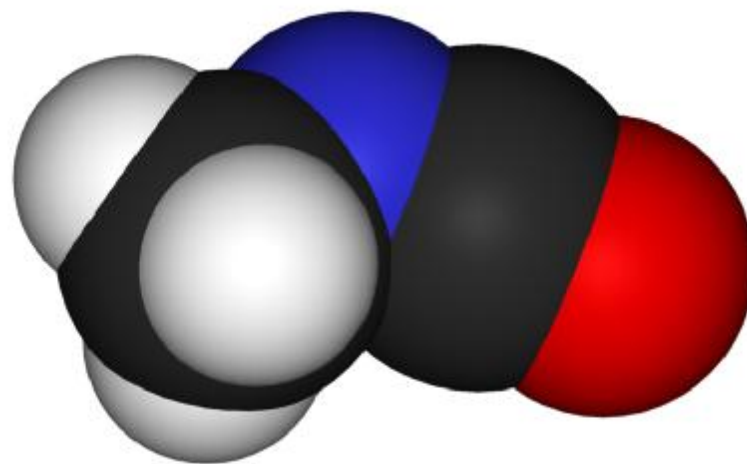
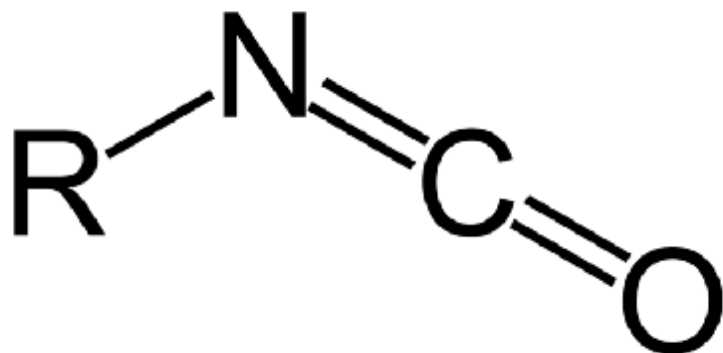
A-Side - Polyisocyanate Pre-Polymer

- Influences most of the physical properties
- Aliphatic or Aromatic
- NCO is the reactive portion

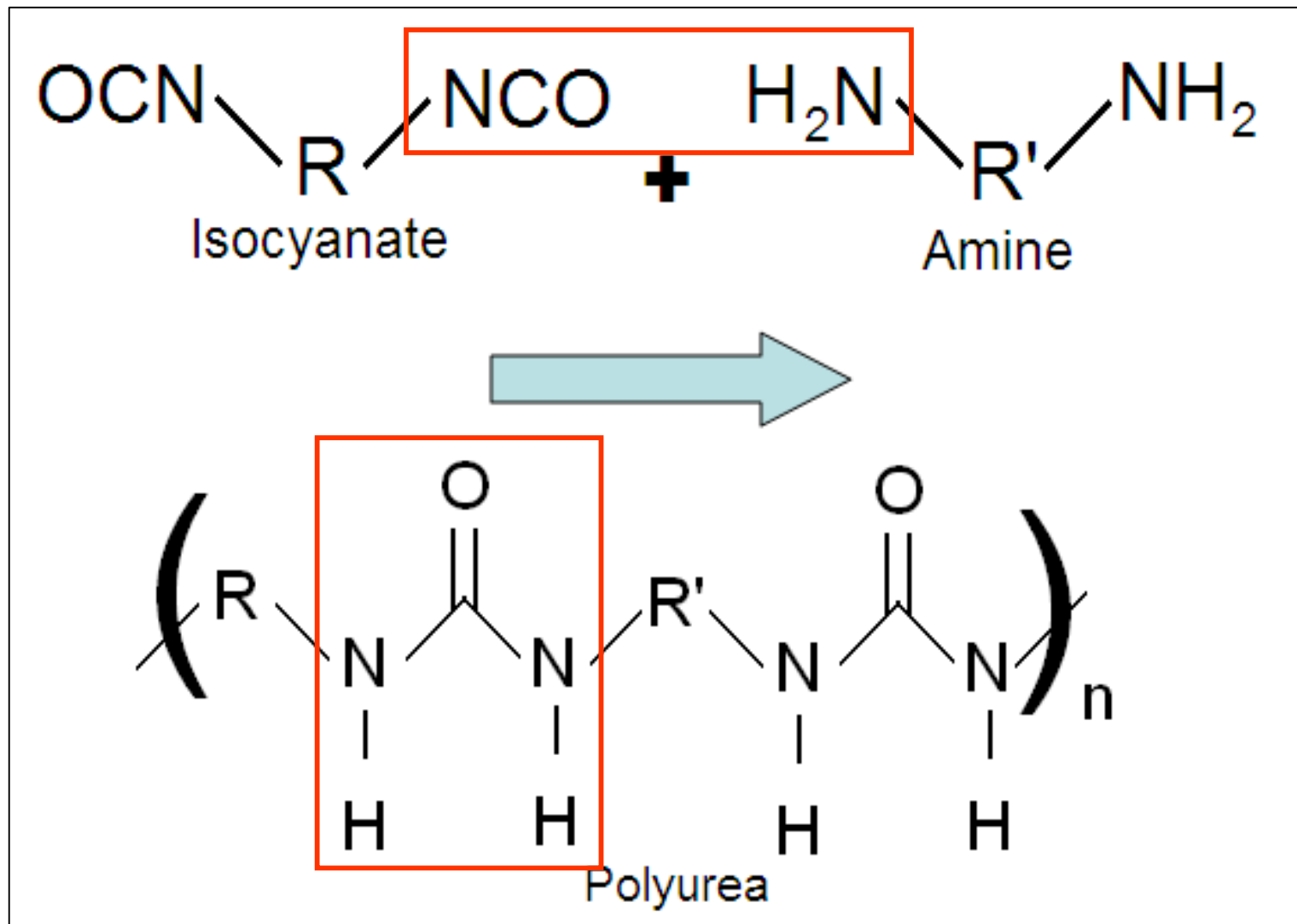


Reactive Isocyanate Group

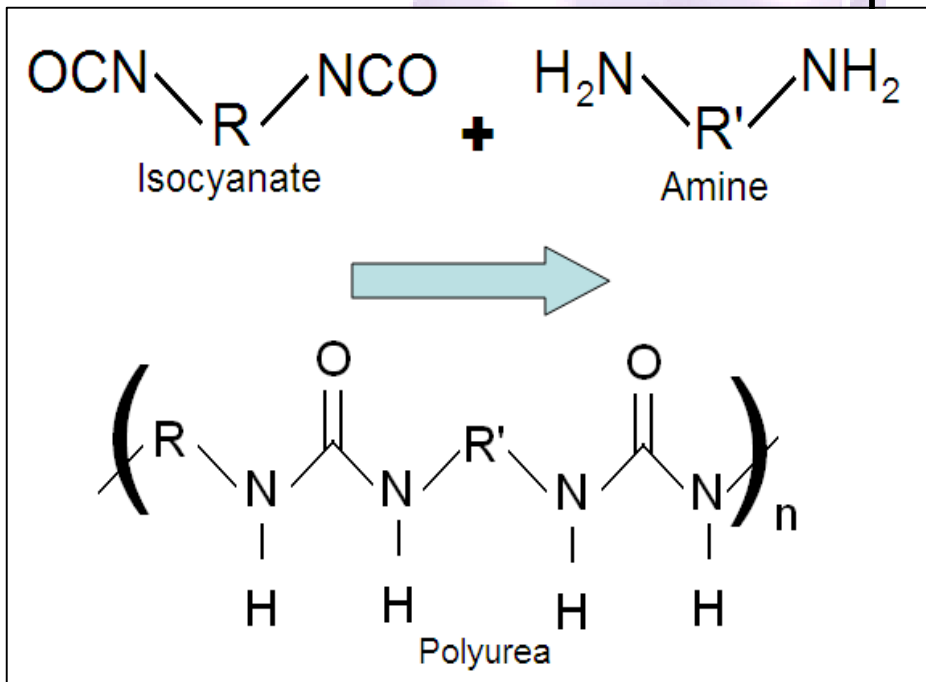
Isocyanate is the functional group of atoms
 $\text{-N}=\text{C}=\text{O}$ (1 nitrogen, 1 carbon, 1 oxygen)



Polyurea

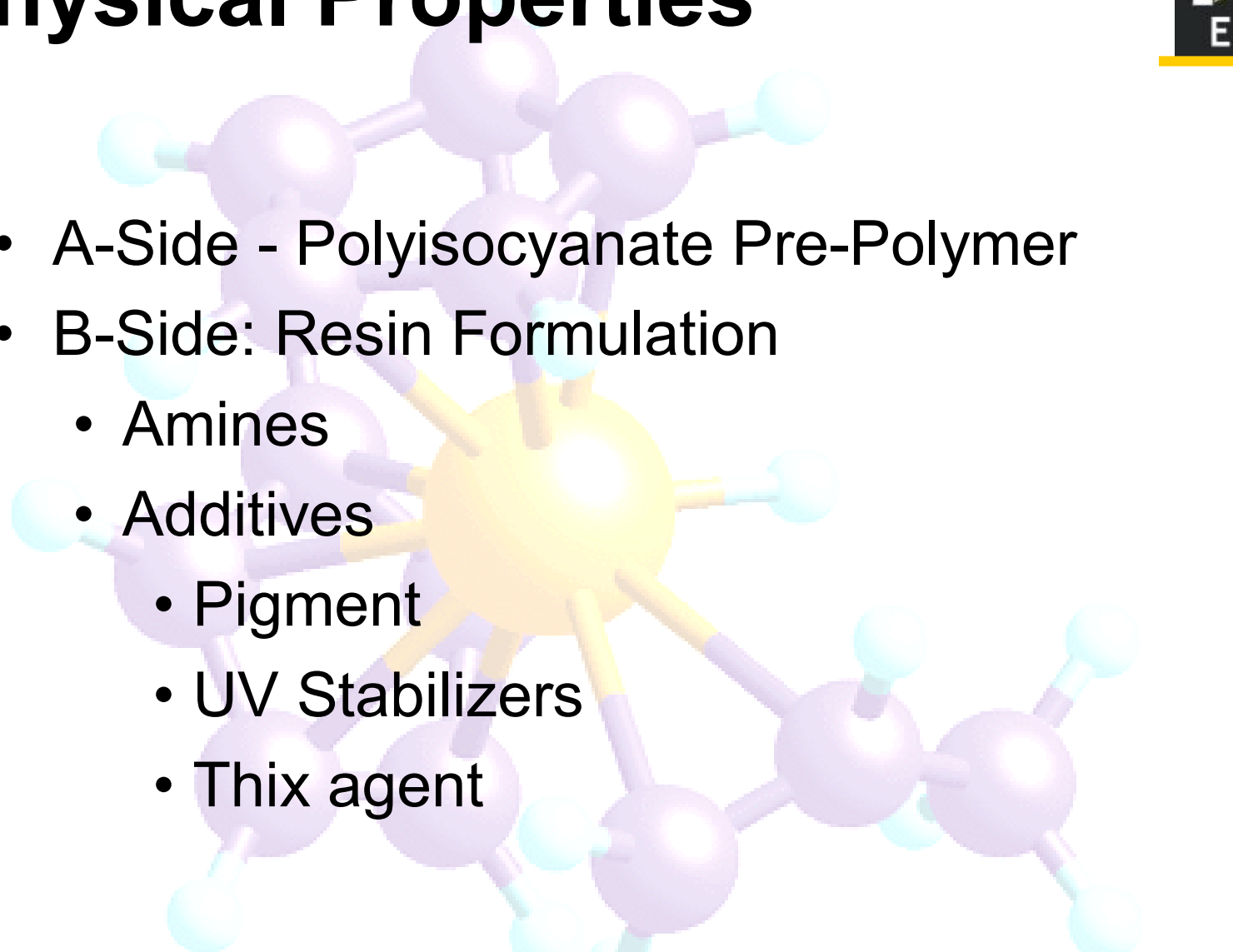


Polyurea



+	Adding together
R	non-reactive segment
R'	A second non-reactive segment
→	Results in...
()	Unit "mer"
	Bond
Λ	Understood Carbon
n	Number
NCO	Isocyanate (Nitrogen, Carbon, Oxy
NH ₂	Amine (Nitrogen, Hydrogen)

Physical Properties

- 
- A large, semi-transparent molecular structure is centered on the slide. It consists of a central yellow sphere with several purple spheres radiating from it, and further out, more purple and cyan spheres connected by thin lines, representing a complex chemical network.
- A-Side - Polyisocyanate Pre-Polymer
 - B-Side: Resin Formulation
 - Amines
 - Additives
 - Pigment
 - UV Stabilizers
 - Thix agent

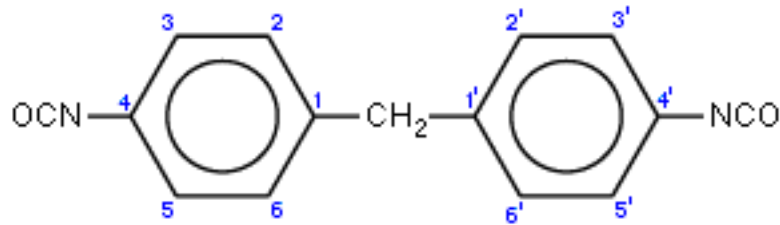
Physical Properties

A-Side - Polyisocyanate Pre-Polymer

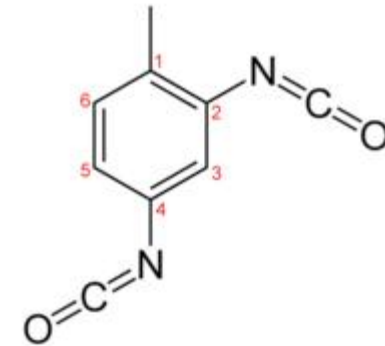
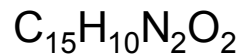
Influences most of the physical properties

- Types of Isocyanate
- NCO content
- The Backbone

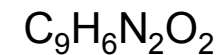
Types of Isocyanate



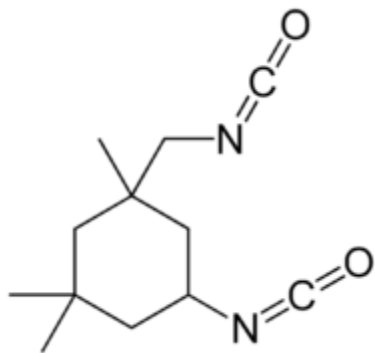
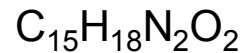
Methylene diphenyl 4,4'-diisocyanate (MDI)



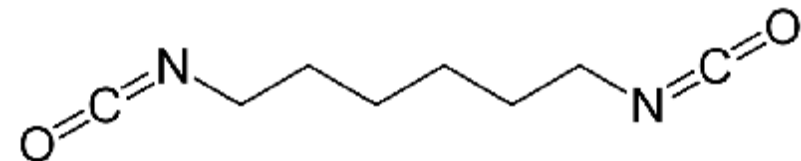
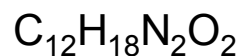
Toluene diisocyanate (TDI)



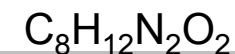
4,4'-diisocyanato dicyclohexylmethane (H12MDI)



Isophorone diisocyanate (IPDI)



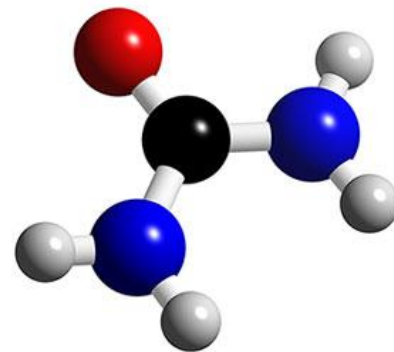
Hexamethylene diisocyanate (HDI)



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NCO Content

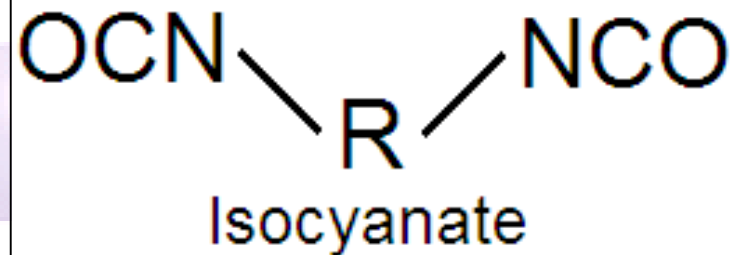
- Reactive Sites of the Isocyanate
- Pre-polymer?
- Range 10 to 25%
- Hardness, Stiffness, Strength, Speed of Reaction



The Backbone

Oh, that tricky old R

- Effects Chemical/Solvent Resistance
- Effects Strength Properties (Elongation)



Physical Properties

B-Side: Resin Formulation

- Various Amine Terminated Molecules
- Pigments and other Additives
- Chain Extenders

Physical Properties

Amine Terminated Molecules Oh, that R' again

- Vary in size
- Elongation
- Cure Time
- Cross-Linking, “Branching” and Polymer Networking



Chain Extenders

- Extend the Chain
 - Forms hard block
- Build properties
- Regulate Systems Reactivity
 - Primary and Secondary Amines

Pigments and Additives

- Color
- UV Stabilizers
- Adhesion Promoters
- Viscosity reducers
- Thix agents
- ...

What Does Your Formulator Do?

- Develops the Polyurea Systems
 - Based on
 - Available Raw Materials
 - Needed Performance
 - Available Equipment
- Blends the Polyurea Systems

Conclusions

So This all Means What?

- Chemistry Basics
- Polyurea
- Preparing Polyurea Formulations

Safety was not a subject in this presentation but remember that you are working with **reactive** chemicals that need the **protective** measures as described on the product information

References

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- www.pda-europe.org
- www.polyurea.com
- Moore, John T. Ed.D, Chemistry for Dummies, Wiley Publishing, Inc., 2003
- Everyone in and around PolyVers International and VersaFlex Inc.
- Dudley Primeaux

Thank you!



Questions?