Let me introduce myself

Dr. Kenneth DORRIS
EDUCATION:

- 1965. The University of Texas at Austin. Ph.D. (Microwave and Infrared Spectroscopy)
- 1961. The University of Texas at Austin. B.S. (Chemistry)
EXPERIENCE:


Professor of Chemistry Lamar University at Beaumont. 1965 - present.
PROFESSIONAL:


Listed in American Men of Science

Consultant on Chemical related problems including Environmental.
RESEARCH:

• **Molecular Spectroscopy**-Structure Correlation.

• **Computer analysis** of Molecular Vibrations

• **Environmental Chemistry**
Chemistry

1. What is Chemistry
2. Why should you like Chemistry
3. What Chemistry is Not
What is CHEMISTRY?

THE STUDY OF MATTER

and

THE CHANGES IT UNDERGOES
What is MATTER?

Anything that occupies space and has mass

The physical material of the universe
What Changes does it undergo?

Physical and Chemical Changes:

*Physical*: ice melts

*Chemical*: Natural gas burns
Why should you like Chemistry?

1. Chemistry is often called the “Central Science” because all other sciences revolve around it.

2. Chemistry provides the basis for much of what goes on in our world.
Chemicals are used in everyday life

EVERTHING Is Made Of Chemicals. There Is NO Meaningful Distinction Between a "NATURAL" Substance And A "SYNTHETIC" One
Toxicity & Risk

Some Chemicals Are TOXIC And Some Chemicals Are HARMLESS
“Stuff” I use all the time

Many “things” you buy & use daily are “chemicals”
Chemicals I buy in the store

Many “things” you buy & use daily are “chemicals”
I should know what chemicals are used around me

- What is the active ingredient in Bleach?
  
  Sodium hypochlorite \( \text{NaClO} \)

- What is vinegar?
  
  Acetic acid \( \text{HC}_2\text{H}_3\text{O}_2 \text{ (aq)} \)
What Chemistry is Not

Chemistry is NOT Mathematics

But

Math is often used to convey concepts

For example

What does $E = mc^2$ mean to you?
CHEMISTRY IS COMMONLY BELIEVED TO BE MORE DIFFICULT THAN OTHER SUBJECTS

MAYBE IT’S ALL THE ELEMENTS & COMPOUNDS

WHICH ONES DO YOU ALREADY KNOW?
Do you know what is in the air you breath?

Should you know what is in the air you breath?
<table>
<thead>
<tr>
<th>Name</th>
<th>%</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>78.03%</td>
<td>N₂</td>
</tr>
<tr>
<td>Oxygen</td>
<td>20.99%</td>
<td>O₂</td>
</tr>
<tr>
<td>Argon</td>
<td>0.94%</td>
<td>Ar</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>0.033%</td>
<td>CO₂</td>
</tr>
<tr>
<td>Neon</td>
<td>0.0015%</td>
<td>Ne</td>
</tr>
<tr>
<td>Helium</td>
<td>0.000524%</td>
<td>He</td>
</tr>
<tr>
<td><strong>Krypton</strong></td>
<td>0.00014%</td>
<td>Kr</td>
</tr>
<tr>
<td>Xenon</td>
<td>0.000006%</td>
<td>Xe</td>
</tr>
</tbody>
</table>
Why do I like Krypton best?

Because it makes Superman or Superwoman weak
IS CHEMISTRY MORE DIFFICULT THAN OTHER SUBJECTS?

MAYBE IT’S ALL THE Chemical Reactions WHICH ONES DO YOU ALREADY KNOW?
How Do These Gases React With Water?

\[
\begin{align*}
N_2 + H_2O & \rightarrow \text{?} & \text{NO REACTION} \\
O_2 + H_2O & \rightarrow \text{?} & \text{NO REACTION} \\
He + H_2O & \rightarrow \text{?} & \text{NO REACTION} \\
Ne + H_2O & \rightarrow \text{?} & \text{NO REACTION} \\
Ar + H_2O & \rightarrow \text{?} & \text{NO REACTION} \\
Kr + H_2O & \rightarrow \text{?} & \text{NO REACTION} \\
Xe + H_2O & \rightarrow \text{?} & \text{NO REACTION} \\
CO_2 + H_2O & \rightarrow \text{?} & H_2CO_3 (aq) \text{ Carbonic}
\end{align*}
\]
Observing Signs of Chemical Reaction

1. **Formation of a precipitate** – formation of a substance that is insoluble
2. **A color change** – usually indicates a change in oxidation state – a Redox reaction
3. **Evolution of a gas** – result of an active metal and an acid
4. **A Temperature change** - increase or decrease
CHEMISTRY IS More DIFFICULT THAN Many OTHER SUBJECTS

OR IS IT THE MATH?
In order to keep the attention of my audience, I like to completely change the subject. The next slide illustrates this technique.
Medical Terminology for the layman

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artery</td>
<td>The study of fine paintings</td>
</tr>
<tr>
<td>Barium</td>
<td>What you do when CPR fails</td>
</tr>
<tr>
<td>Coma</td>
<td>A punctuation mark</td>
</tr>
<tr>
<td>Dilate</td>
<td>To live long</td>
</tr>
<tr>
<td>Medical Staff</td>
<td>A doctor’s cane</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Lower that the day rate</td>
</tr>
</tbody>
</table>
Strategies in Chemistry

Problem Solving
Key to Success in Problem Solving

Step 1: Analyze the Problem
Step 2: Develop a plan for solving the problem
Step 3: Put your plan into action
Step 4: Did you solve the problem?
A sample of ascorbic acid (vitamin C) is synthesized in the laboratory. It contains 1.50 g of carbon and 2.00 g of oxygen.

Another sample of ascorbic acid isolated from citrus fruits contains 6.35 g of carbon. How many grams of oxygen does it contain?

What principle is involved in this problem?
Analyze the Problem

1. Both samples are vitamin C
2. No Distinction Between a “Natural” Substance and a “Synthetic” One
3. So Both samples are the same chemically
The Law of Constant Composition

A pure compound has the same composition and properties regardless of its source
Develop a plan for solving the problem

1. Any sample of vitamin C has the same RELATIVE amount of carbon to oxygen

2. Therefore, the ratio of oxygen to carbon in the natural sample is the same as the ratio in the synthesized vitamin C
Put your plan into action

• Grams of C to O in synthesized vitamin C
  \[
  \frac{2.00 \text{ grams oxygen}}{1.50 \text{ grams carbon}} = 1.333333333
  \]

• Grams of C to O in natural vitamin C
  \[
  \frac{x \text{ grams of oxygen}}{6.35 \text{ grams carbon}} = 1.333333333
  \]

Solve for \(x = (6.36)(1.333333) = 8.47 \text{ grams oxygen}\)
Did you solve the problem?

Yes, it was a direct ratio and proportion problem

\[
\frac{2.00 \text{ gms O}}{1.50 \text{ gms C}} = \frac{x \text{ gms O}}{6.35 \text{ gms C}}
\]

\[
x = \frac{(2.00 \text{ gms O})(6.35 \text{ gms C})}{1.50 \text{ gms C}} = 8.47 \text{ gms O}
\]
Stoichiometry

- Stoichiometry is the use of quantitative relation among the substances in a reaction.

- What is quantitative?
Interpretation of a Chemical Reaction

Hydrogen reacts with Nitrogen to form Ammonia

1st Write Reaction

\[ \text{H}_2 + \text{N}_2 \rightarrow \text{NH}_3 \]

Next Balance Equation

\[ 3 \text{H}_2 + \text{N}_2 \rightarrow 2 \text{NH}_3 \]

Finally, Interpret Balanced Equation
Interpretation of a Chemical Reaction

\[ 3 \text{ H}_2 + 1 \text{ N}_2 \rightarrow 2 \text{ NH}_3 \]

Three moles of Hydrogen \quad One mole of Nitrogen \quad Two moles of Ammonia

Mole Ratio MUST Always be 3 : 1 : 2

Which is the same as

\[ 1 : 1/3 : 2/3 \quad \text{or} \quad 2 : 2/3 : 4/3 \]
\[3 \text{H}_2 + \text{N}_2 \rightarrow 2 \text{NH}_3\]

How many moles of Nitrogen are needed to react with
(a) 1 \(\frac{1}{2}\) moles of Hydrogen?
\[
\frac{1}{2} \text{mole} \text{ or (} \frac{1}{2} \text{ mole) } \times (28 \text{ grams/mole})
\]
(b) Three grams of Hydrogen?
\[
3 \text{ g } \times \frac{1 \text{ mole}}{2 \text{ g}} = 1 \frac{1}{2} \text{ moles of H}_2
\]

\text{same as part a} . . . . \frac{1}{2} \text{ mole} = 14 \text{ g}
How many moles of Ammonia (NH₃) are produced from

(a) 3 grams of H₂ and ½ mole of N₂?

1 mole NH₃ = (1 mole)x(17 g/mole) grams of NH₃

(b) 3 grams of H₂ and 28 grams of N₂?

1 mole NH₃ with 14 g of Nitrogen in excess
3 \( H_2 \) + 1 \( N_2 \) \rightleftharpoons 2 \( NH_3 \)

With a 50% Yield, How many moles of \( NH_3 \) are produced from

(a) 3 grams of \( H_2 \) and \( \frac{1}{2} \) mole of \( N_2 \)?

\( \frac{1}{2} \text{ mole} = (\frac{1}{2} \text{ mole}) \times (17 \text{ g/mole}) \text{ grams of } \text{NH}_3 \)

(b) 3 grams of \( H_2 \) and 28 grams of \( N_2 \)?

\( \frac{1}{2} \text{ mole} \text{NH}_3 \)

with 14 g of Nitrogen in excess
A Problem that has consequences for all of us is Chemistry of the Environment
Limiting & Excess Reagents

• The depletion of ozone in the stratosphere is a matter of great concern. Ozone can react with nitrogen monoxide that is discharged from high altitude jet planes to produce Oxygen and nitrogen dioxide.
If 0.720 grams Ozone reacts with 0.600 grams of nitrogen monoxide, how many grams of nitrogen dioxide will be produced? How much excess reagent will remain?

Write Reaction: \( \text{O}_3 + \text{NO} \rightarrow \text{NO}_2 \)

Balance: \( 2 \text{ O}_3 + 3 \text{ NO} \rightarrow 3 \text{ NO}_2 \)

Mole Ratio: \( 2 : 3 : 3 \)
\[ 2 \text{O}_3 + 3 \text{NO} \rightarrow 3 \text{NO}_2 \]

Moles \( O_3 \) = \((0.720 \text{ g}) \times \frac{1 \text{ mol}}{48 \text{ g}} = 0.015 \)

Moles \( \text{NO} \) = \((0.600 \text{ g}) \times \frac{1 \text{ mol}}{30.0 \text{ g Mole}}\)

\( 2\text{NO} \) needed = \((3/2)(0.015) \times 30 \text{ g / mol} \)

Grams \( \text{NO} \) needed = 0.675 grams

BUT only have 0.600 grams

Therefore Ozone is limiting reagent

Now what?
\[ 2 \text{O}_3 + 3 \text{NO} \rightarrow 3 \text{NO}_2 \]

Moles NO = \((0.600 \text{ g}) \times \left( \frac{1 \text{ mol}}{30.0 \text{ g}} \right) = \)
Moles NO = 0.0200

Moles O_3 \text{ needed} = \frac{2}{3} \times (0.0200)

Gms O_3 \text{ needed} = \frac{2}{3} \times (0.0200) \times 48 \text{ g/mol}

Grams O_3 \text{ needed} = 0.64 \text{ grams}

Grams O_3 \text{ excess} = 0.720 - 0.640 = 0.080
Chemistry of the Environment

This could involve problem solving in the area of

1. The Earth’s Atmosphere
2. Ozone in the Upper Atmosphere
3. The World Ocean
4. Freshwater
5. Green Chemistry
Analyze the Problem

Focus On The Environment

Water Pollution
Water

• Water covers 72% of Earth’s surface
• 97.2% of the water on Earth is in the world ocean with a volume of $1.35 \times 10^9$ km$^3$
• 2.1% is in the form of ice caps and glaciers
• All the freshwater – in lakes, rivers, and groundwater – amounts to only 0.6%
• The remaining 0.1% is brackish water
Freshwater

Freshwater is one of our most precious resources. An adult needs about 2 liters per day for drinking. O₂ is necessary for fish and other aquatic life. The amount of dissolved O₂ is an important indicator of the quality of water. Water saturated contains about 9 ppm of O₂. Fish require at least 5 ppm O₂ for survival.
Water Pollution

Some Sources of water pollution Include

1. **Industrial wastes** - which include heavy metals such as Pb, Hg, Cd, Ni, & others
2. **Sewage**
3. **Agricultural waste** - Nutrients contribute to water pollution by stimulating excessive growth of aquatic plants.
The most visible results of excessive plant growth are floating algae and murky water.
Oxygen-demanding Wastes

• Aerobic bacteria consume dissolved O$_2$ in order to oxidize organic materials

• Sources of biodegradable materials include sewage, paper mills, industrial wastes from food processing plants and aquatic plants.
Develop a plan for solving the problem

The Modern Thinking in the area of Waste Treatment is Increasingly in the area of SYMBIOTIC RELATIONS

The Use of WASTE of one INDUSTRY by ANOTHER Which in Turn BENEFITS BOTH INDUSTRIES.
Some Waste Material Might Include

1. Sea Food Industry
2. Lumber / Timber / Paper Industry
3. Agricultural waste producing excessive plant growth

1. Crab Shells
2. Sawdust
3. Water Hyacinth, duckweed, etc which inhibit navigation
Put your plan into action


- **SORPTION OF PHENOL** FROM AQUEOUS SOLUTIONS BY USE OF ORGANOCLAYS AND ACTIVATED CARBON submitted to Journal of Chemistry and Environment
Metal ions uptake from aqueous solution by water hyacinth

• It was found that water hyacinth could effectively remove metal ions such as mercury, chromium and lead from wastewater and most of them were found to concentrate in the root system.
REMOVAL OF HEAVY METALS FROM WASTEWATER BY CRAB SHELLS

Crab shells were used to remove Pb, Cd, and Ni in aqueous solutions.

Advantages of crab shell waste include availability, low cost, and high biocompatibility.
What do you want to be?

- Do you have enough desire to do it?
- What would your family and friends say is the driving force in your life?
- Science & Engineering courses generally require a great deal of effort
THE STUDENT’S “JOB”

READ AND UNDERSTAND ASSIGNED MATERIAL DAILY

WORK PROBLEMS The more the better

ASK QUESTIONS In Class or After Class
NO ONE CAN NOT LEARN FOR YOU
YOU MUST DO IT FOR YOURSELF !!!

IT MIGHT BE EASIER FOR
EVERYONE IF SOMEONE ELSE COULD LEARN FOR YOU BUT THEY CAN’T
How to study Chemistry

**Do Not** cut class unless REALLY necessary

**Take Notes** even if “the material is covered in the text”

**Rewrite** your notes as soon as possible – while you can still read them
THE INSTRUCTOR’S “JOB”

- EXPLAIN THE MATERIAL IN A CLEAR, EASY TO UNDERSTAND MANNER
- MAKE THE SUBJECT INTERESTING
WHAT IS THE PROPER WAY OF LEARNING?

• 1. REPEAT, REDO, REITERATE, DO IT AGAIN, RE-EXAMINE, GO BACK OVER IT

• 2. REPETITION, REPETITION, REPETITION, REPETITION
In Conclusion

Hard work goes a long way in overcoming ignorance