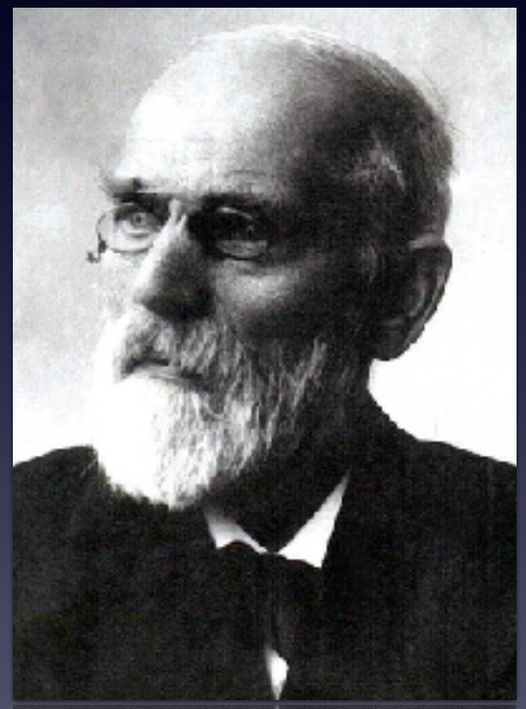
Previously in Molecularity…

Intermolecular forces

in ~order of decreasing strength…

- … between two ions
- … between ions and a permanent dipole
- … between ions and *induced* dipoles
- … hydrogen bonds
- … between two permanent dipoles (Willem Hendrik Keesom)
- … between a permanent dipole and an *induced* dipole (Peter Debye)
- … between a fluctuating dipole and an *induced* dipole (Fritz London)

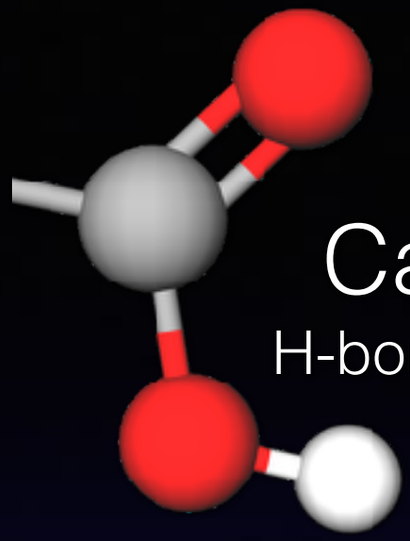


Johannes van der Waals

en.wikipedia.org

Johannes_Diderik_van_der_Waals.jpg

Trends in T_{boil}...



Carboxylic acids

H-bond acceptors and donors

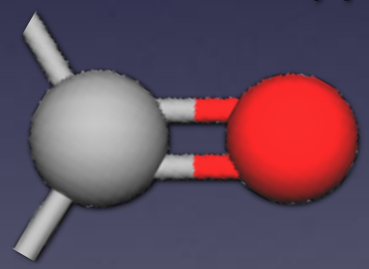
Alcohols

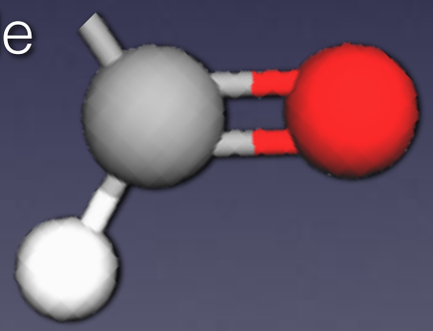
H-bond acceptors and donors

Ketones and aldehydes

H-bond acceptors

Strong dipole

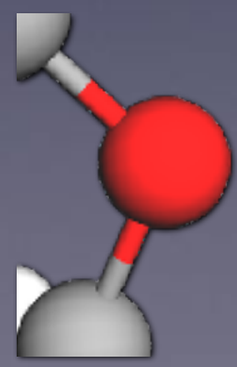




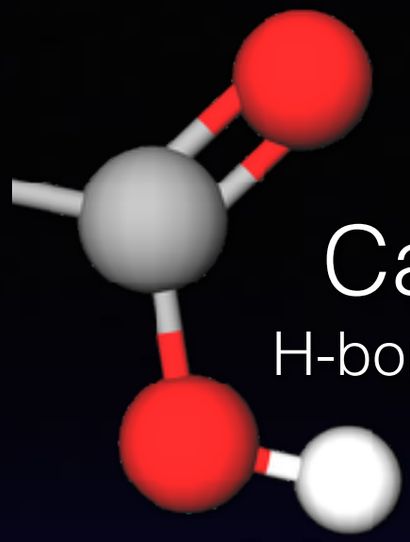
Ethers

H-bond acceptors

Weak dipole



Trends in solubility



Carboxylic acids

H-bond acceptors and donors

very soluble

Alcohols

H-bond acceptors and donors

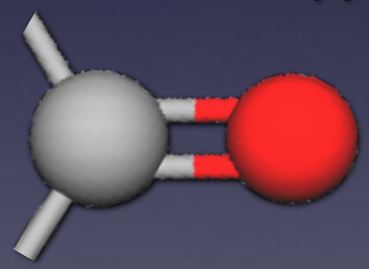
very soluble

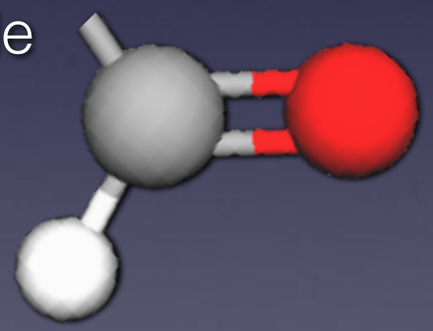
Ketones and aldehydes

H-bond acceptors

Strong dipole

soluble



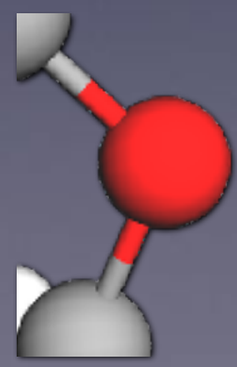


Ethers

H-bond acceptors

Weak dipole

poorly soluble



Where are we going today?

Ch1010-A17-A03 Lecture 25

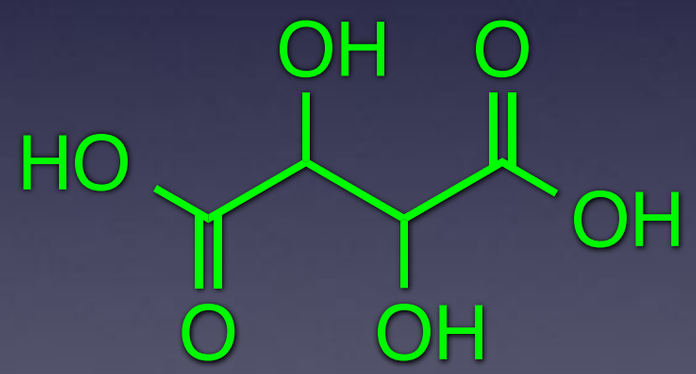
- Why I became a chemist…
- §4.11 Combustion analysis (i.e. setting fire to things)

http://stevedeace.com/wp-content/uploads/2012/11/

Molec. weight from formula, §4.?

Formula mass = (**Number of atoms of 1st element in chemical formula** × **Atomic mass of 1st element**) + (**Number of atoms of 2nd element in chemical formula** × **Atomic mass of 2nd element**) + …

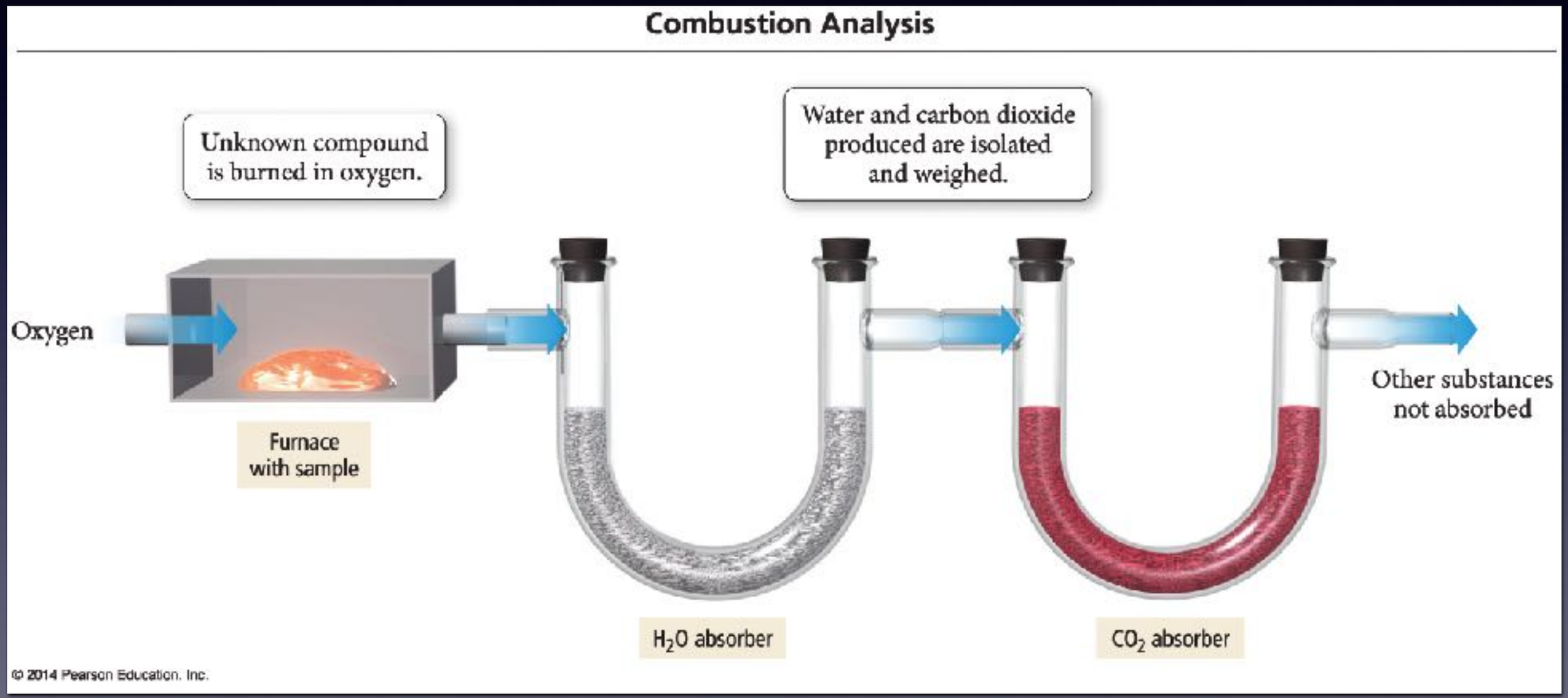
Tro



Tartaric acid, $C_4H_6O_6$
Molecular weight = ?

$$\begin{array}{rr} & (4 \times 12.011\ \text{g mol}^{-1}) \\ & (6 \times 1.008\ \text{g mol}^{-1}) \\ + & (6 \times 15.999\ \text{g mol}^{-1}) \\ \hline & 150.056\ \text{g mol}^{-1} \end{array}$$

Ascertaining a chemical formula from experiment, §4.11



Tro

Tro

Start out with 0.1156 g of unknown containing C, H, and N

H_2O absorber gains 0.1676 g

CO_2 absorber gains 0.1638 g

Tro

Start out with 0.1156 g of unknown containing C, H, and N

H_2O absorber gains 0.1676 g

CO_2 absorber gains 0.1638 g

1. Assume all C becomes CO_2, find mass of C
2. Assume all H becomes H_2O, find mass of H
3. N (or O or …) comprises the mass difference
4. Convert to an atom count (i.e. moles)
5. Find molar ratio

	Grams of …	Moles of …	Ratio
C			
H			
N			

	Grams of …	Moles of …	Ratio
C	0.0447 g		
H	0.0187 g		
N	0.0522 g		

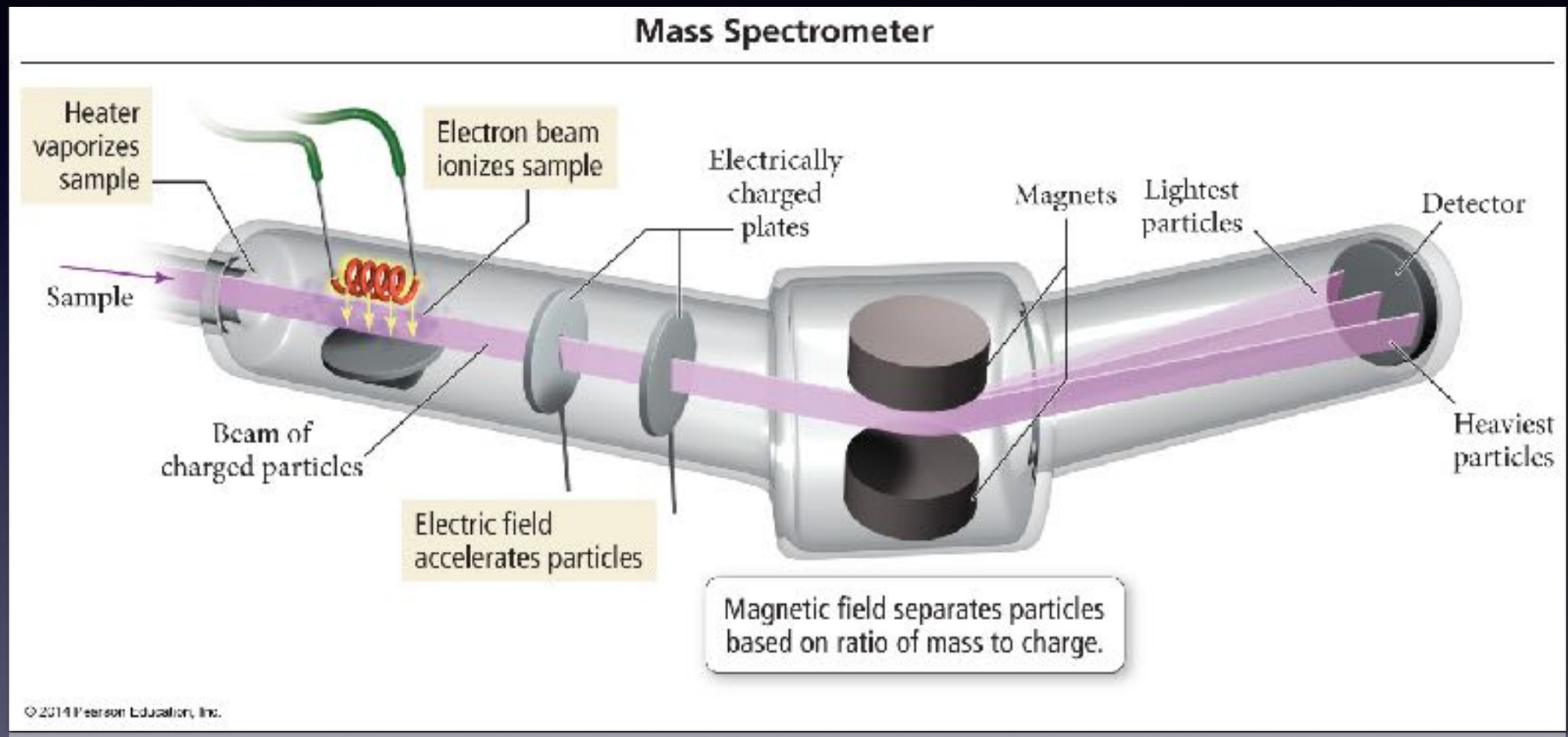
	Grams of …	Moles of …	Ratio
C	0.0447 g	3.722 mmol	
H	0.0187 g	18.603 mmol	
N	0.0522 g	3.727 mmol	

	Grams of …	Moles of …	Ratio
C	0.0447 g	3.722 mmol	1
H	0.0187 g	18.603 mmol	5
N	0.0522 g	3.727 mmol	1

	Grams of …	Moles of …	Ratio
C	0.0447 g	3.722 mmol	1
H	0.0187 g	18.603 mmol	5
N	0.0522 g	3.727 mmol	1

CH_5N is an *empirical* formula. Is the molecular formula CH_5N, $C_2H_{10}N_2$, $C_3H_{15}N_3$, $C_4H_{20}N_4$, or other?

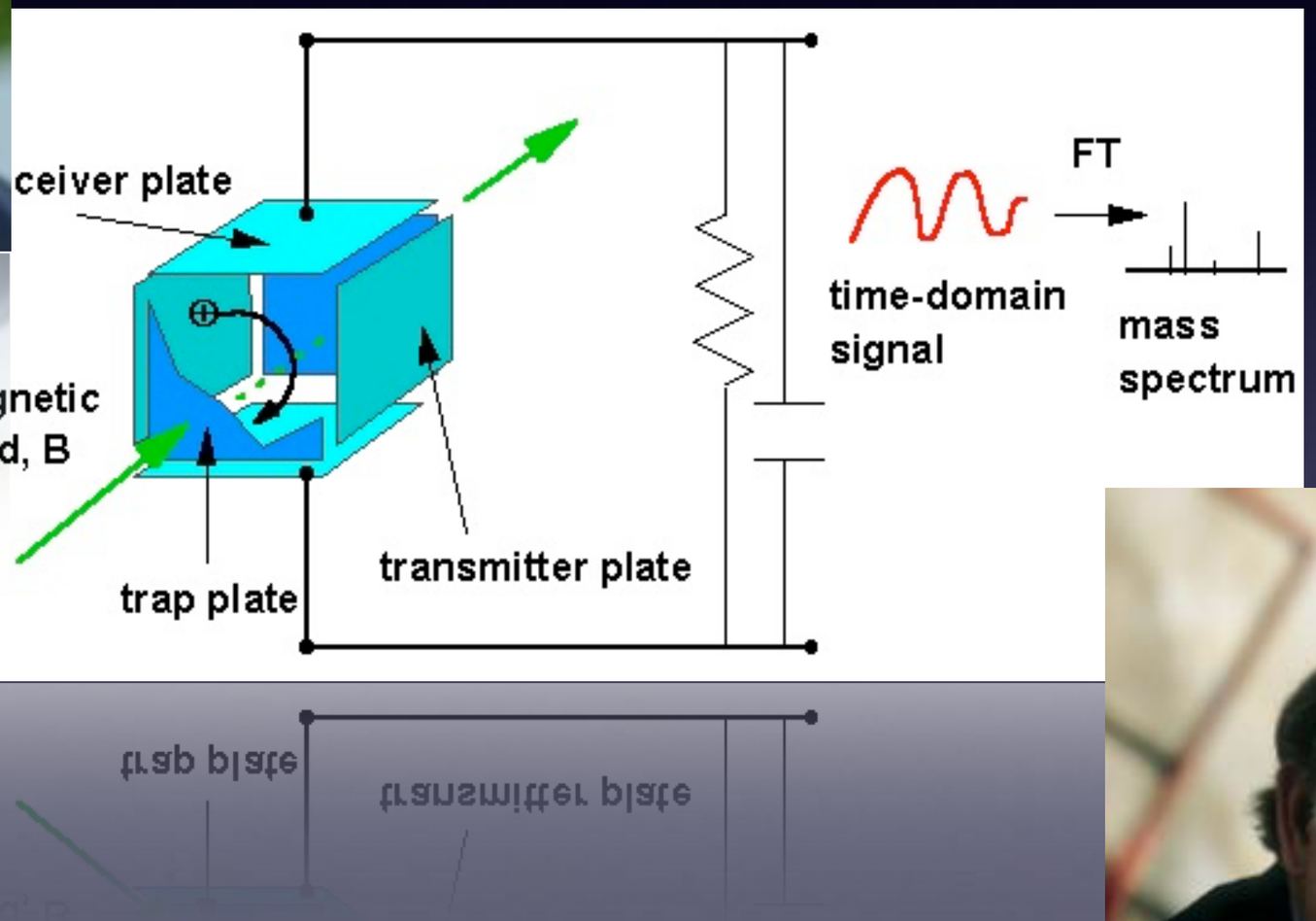
Mass spectrometry can determine actual formula



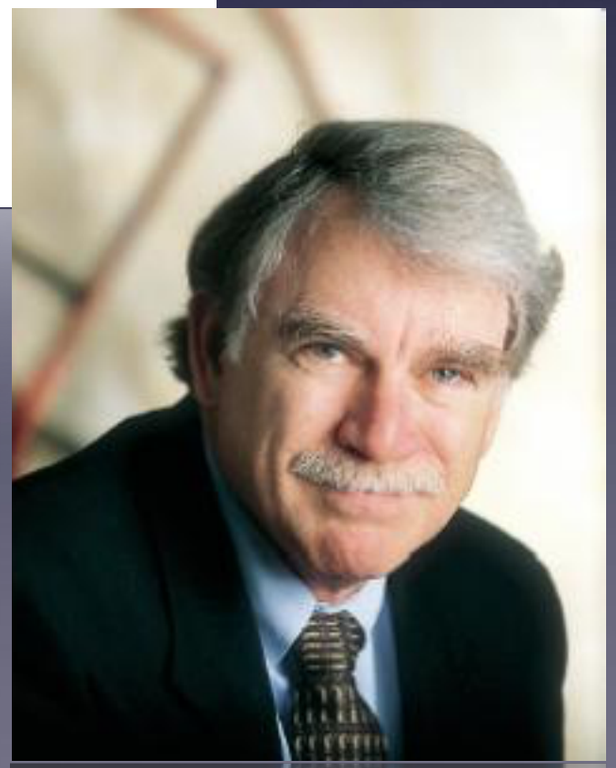
Tro

Ion cyclotron resonance mass spectrometry

Jack Beauchamp
Caltech



Sensitive enough
to tell mass differences
between CH_2 and Nitrogen



Alan Marshall
Florida State

CH_5N
$C_2H_{10}N_2$
$C_3H_{15}N_3$
$C_4H_{20}N_4$

CH_5N is an *empirical* formula. Is the molecular formula CH_5N, $C_2H_{10}N_2$, $C_3H_{15}N_3$, $C_4H_{20}N_4$, or other?

	Molecular weight
CH_5N	
$C_2H_{10}N_2$	
$C_3H_{15}N_3$	
$C_4H_{20}N_4$	

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	Molecular weight
CH_5N	31.0574 g mol^{-1}
$C_2H_{10}N_2$	62.1149 g mol^{-1}
$C_3H_{15}N_3$	93.1723 g mol^{-1}
$C_4H_{20}N_4$	124.2298 g mol^{-1}

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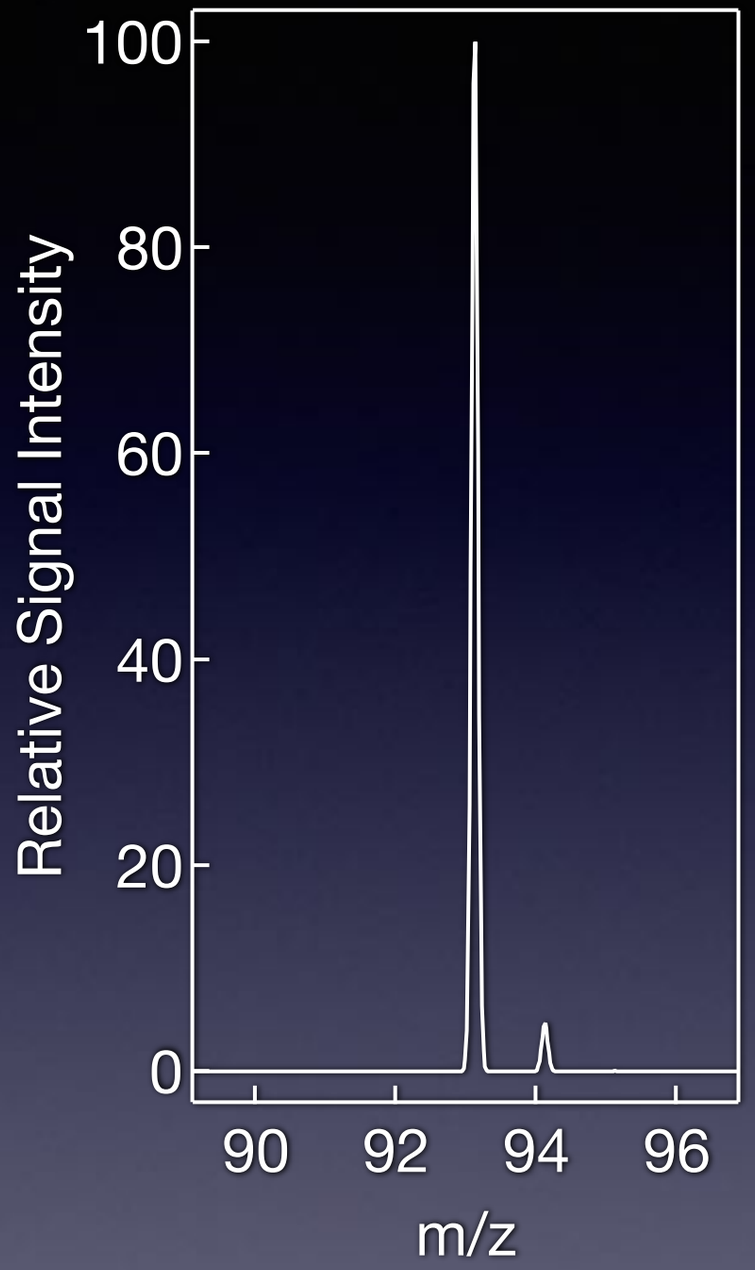

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Summary §4.11
How to attack combustion probs.

Tro

1. Assume all C becomes CO_2, find mass of C
2. Assume all H becomes H_2O, find mass of H
3. N (or O or …) comprises the mass difference
4. Convert to an atom count (i.e. moles)
5. Find molar ratio

Where did we go today?

Ch1010-A17-A03 Lecture 25

- §4.11 Combustion analysis

Next time…

- Nothing!

http://stevedeace.com/wp-content/uploads/2012/11/