

VBS 2019

Trinity Lutheran Church

Denver

Colorado

This presentation is available at: <http://oss4us.com/noodle/>

Genesis 1

1In the beginning, God created the heavens and the earth. 2The earth was without form and void, and darkness was over the face of the deep. And the Spirit of God was hovering over the face of the waters.

3And God said, “Let there be light,” and there was light. 4And God saw that the light was good.

The Great Commandment

35And one of them, a lawyer, asked him a question to test him.36“Teacher, which is the great commandment in the Law?”

37And he said to him, “You shall love the Lord your God with all your heart and with all your soul and with all your **mind**. 38This is the great and first commandment. 39And a second is like it: You shall love your neighbor as yourself. 40On these two commandments depend all the Law and the Prophets.” Matt 22 from ESV

Some speak of using your **noodle**, meaning use your **mind**.

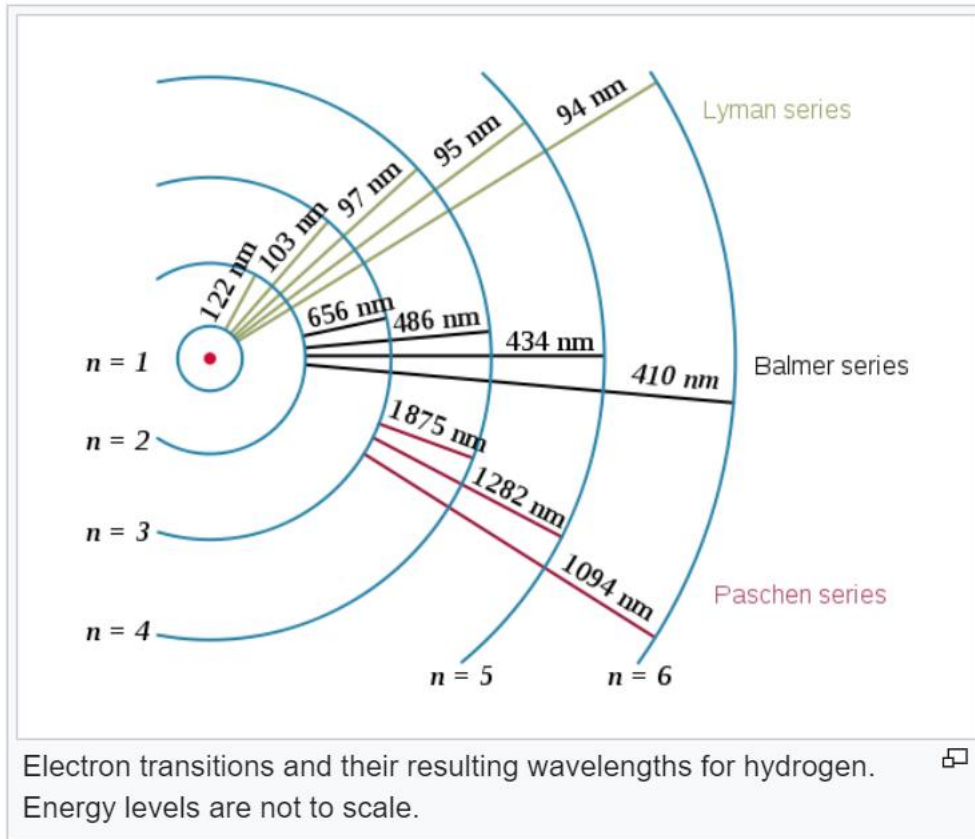
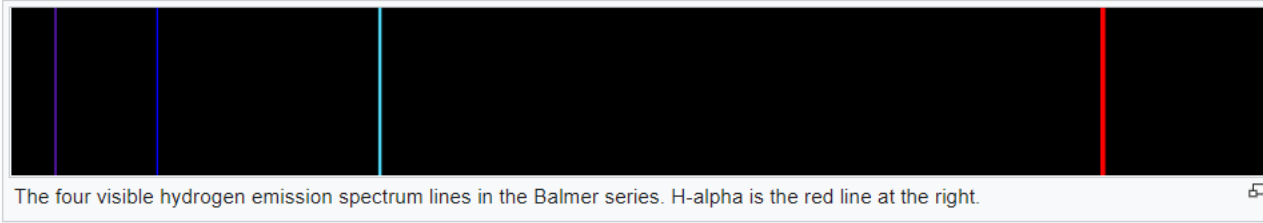
$$E = mc^2$$

"Energy equals mass times the speed of light squared." On the most basic level, the equation says that energy and mass (matter) are interchangeable; they are different forms of the same thing. Under the right conditions, energy can become mass, and vice versa."

Hydrogen spectral series

Balmer series ($n' = 2$) [edit]

Main article: Balmer series



Hydrogen Balmer Spectral Series (fingerprint)

- 4 Hydrogen Balmer Spectral lines seen above
- Energy state diagram seen to the left

All atoms have a unique spectra (fingerprint)

All molecules have unique spectra (fingerprint)

https://en.wikipedia.org/wiki/Hydrogen_spectral_series

Periodic Table of Elements

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																																											
1	H Hydrogen 1.00794	Atomic # Symbd Name Atomic Mass																	2	He Helium 4.002602																																									
2	Li Lithium 6.941	Be Beryllium 9.012182	<table border="1"> <tr> <td>C Solid</td> <td colspan="4">Metals</td> <td colspan="3">Nonmetals</td> </tr> <tr> <td>Hg Liquid</td> <td>Alkali metals</td> <td>Alkaline earth metals</td> <td>Lanthanoids</td> <td>Transition metals</td> <td>Poor metals</td> <td>Other nonmetals</td> <td>Noble gases</td> </tr> <tr> <td>H Gas</td> <td></td> <td></td> <td>Actinoids</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Rf Unknown</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>															C Solid	Metals				Nonmetals			Hg Liquid	Alkali metals	Alkaline earth metals	Lanthanoids	Transition metals	Poor metals	Other nonmetals	Noble gases	H Gas			Actinoids					Rf Unknown								5	B Boron 10.811	6	C Carbon 12.0107	7	N Nitrogen 14.0067	8	O Oxygen 15.9994	9	F Fluorine 18.9984032	10	Ne Neon 20.1797
C Solid	Metals				Nonmetals																																																								
Hg Liquid	Alkali metals	Alkaline earth metals	Lanthanoids	Transition metals	Poor metals	Other nonmetals	Noble gases																																																						
H Gas			Actinoids																																																										
Rf Unknown																																																													
3	Na Sodium 22.98976928	Mg Magnesium 24.3050	11	Al Aluminum 26.9815386	12	Si Silicon 28.0855	13	P Phosphorus 30.973762	14	S Sulfur 32.065	15	Cl Chlorine 35.453	16	Ar Argon 39.948																																															
4	K Potassium 39.0983	Ca Calcium 40.078	19	Sc Scandium 44.955912	20	Ti Titanium 47.867	21	V Vanadium 50.9415	22	Cr Chromium 51.9961	23	Mn Manganese 54.938045	24	Fe Iron 55.845	25	Co Cobalt 58.933195	26	Ni Nickel 58.6934	27	Cu Copper 63.546	28	Zn Zinc 65.38	29	Ga Gallium 69.723	30	Ge Germanium 72.64	31	As Arsenic 74.92160	32	Se Selenium 78.96	33	Br Bromine 79.904	34	Kr Krypton 83.796																											
5	Rb Rubidium 85.4678	Sr Strontium 87.62	37	Y Yttrium 88.90585	38	Zr Zirconium 91.224	39	Nb Niobium 92.90638	40	Mo Molybdenum 95.96	41	Tc Technetium (97.9072)	42	Ru Ruthenium 101.07	43	Rh Rhodium 102.90550	44	Pd Palladium 106.42	45	Ag Silver 107.8682	46	Cd Cadmium 112.411	47	In Indium 114.818	48	Sn Tin 118.710	49	Sb Antimony 121.760	50	Te Tellurium 127.60	51	I Iodine 126.90447	52	Xe Xenon 131.29																											
6	Cs Caesium 132.9054519	Ba Barium 137.327	55	Hf Hafnium 178.49	56	Ta Tantalum 180.94788	57-71	W Tungsten 183.84	72	Re Rhenium 186.207	73	Os Osmium 190.23	74	Ir Iridium 192.222	75	Pt Platinum 195.084	76	Au Gold 196.966569	77	Hg Mercury 200.59	78	Tl Thallium 204.3833	79	Pb Lead 207.2	80	Bi Bismuth 208.98040	81	Po Polonium (209.9824)	82	At Astatine (208.9804)	83	Rn Radon (222.0176)																													
7	Fr Francium (223)	Ra Radium (226)	87	Rf Rutherfordium (261)	88	Db Dubnium (262)	89-103	Sg Seaborgium (266)	104	Bh Bohrium (264)	105	Hs Hassium (277)	106	Mt Meitnerium (268)	107	Ds Darmstadtium (271)	108	Rg Roentgenium (272)	109	Uub Ununbium (285)	110	Uut Ununtrium (284)	111	Uuq Ununquadium (289)	112	Uup Ununpentium (286)	113	Uuh Ununhexium (288)	114	Uus Ununseptium (289)	115	Uuo Ununoctium (284)																													

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

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57	La Lanthanum 138.9047	58	Ce Cerium 140.116	59	Pr Praseodymium 140.90765	60	Nd Neodymium 144.242	61	Pm Promethium (145)	62	Sm Samarium 150.36	63	Eu Europium 151.964	64	Gd Gadolinium 157.25	65	Tb Terbium 158.92535	66	Dy Dysprosium 162.500	67	Ho Holmium 164.93032	68	Er Erbium 167.259	69	Tm Thulium 168.93421	70	Yb Ytterbium 173.054	71	Lu Lutetium 174.9668
89	Ac Actinium (227)	90	Th Thorium 232.03806	91	Pa Protactinium 231.03688	92	U Uranium 238.02891	93	Np Neptunium (237)	94	Pu Plutonium (244)	95	Am Americium (243)	96	Cm Curium (247)	97	Bk Berkelium (247)	98	Cf Californium (251)	99	Es Einsteinium (252)	100	Fm Fermium (257)	101	Md Mendelevium (258)	102	No Nobelium (259)	103	Lr Lawrencium (262)

1	1	Atomic #
H		Symbol
Hydrogen		Name
1.00794		Atomic Mass
3	2	
Li		
Lithium		
6.941		
4	2	
Be		
Beryllium		
9.012182		
11	2	
Na		
Sodium		
22.98976928		
12	2	
Mg		
Magnesium		
24.3050		

The table of the elements has the simple top left. The most complex are at the bottom.

The elements are all made up of protons, electrons and neutrons.

All of the elements are numbered by how many protons they contain.

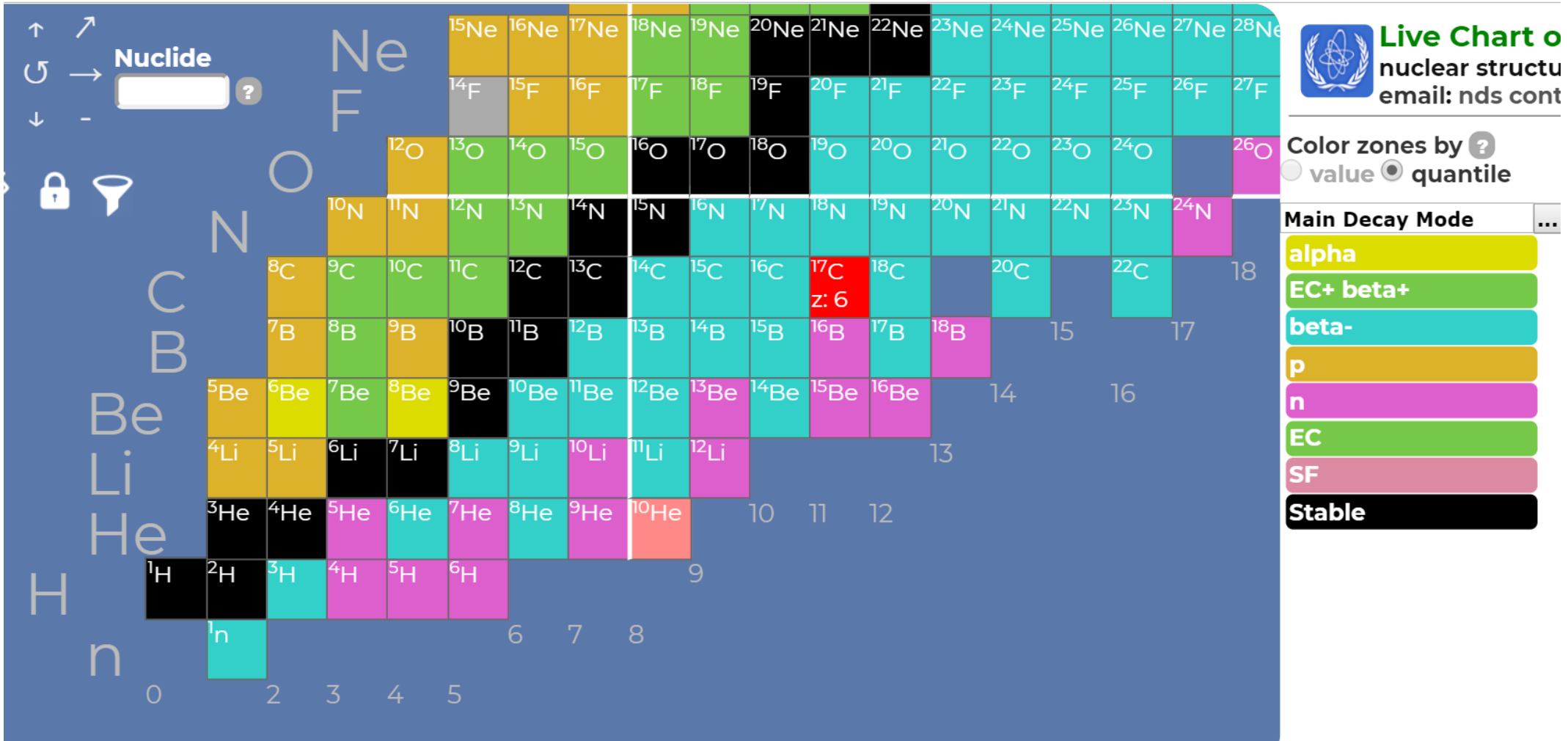
Chart of the Nucleids, Hydrogen top Left

Z →	0	1	2																									
n ↓	n	H	He	3	4	5																						
0		¹ H		Li	Be	B	6																					
1	¹ n	² H	³ He	⁴ Li	⁵ Be	⁶ B	C	7																				
2		³ H	⁴ He	⁵ Li	⁶ Be	⁷ B	⁸ C	N	8																			
3		⁴ H	⁵ He	⁶ Li	⁷ Be	⁸ B	⁹ C	¹⁰ N	O	9																		
4		⁵ H	⁶ He	⁷ Li	⁸ Be	⁹ B	¹⁰ C	¹¹ N	¹² O	F	10	13																
5		⁶ H	⁷ He	⁸ Li	⁹ Be	¹⁰ B	¹¹ C	¹² N	¹³ O	¹⁴ F	Ne	11	12	Al														
6		⁷ H	⁸ He	⁹ Li	¹⁰ Be	¹¹ B	¹² C	¹³ N	¹⁴ O	¹⁵ F	¹⁶ Ne	Na	Mg	¹⁹ Al	14													
		⁷ He	⁹ Li	¹⁰ Be	¹¹ B	¹² C	¹³ N	¹⁴ O	¹⁵ F	¹⁶ Ne	¹⁷ Na	¹⁸ Mg	¹⁹ Al	Si	15													
		⁸ He	¹⁰ Li	¹¹ Be	¹² B	¹³ C	¹⁴ N	¹⁵ O	¹⁶ F	¹⁷ Ne	¹⁸ Na	¹⁹ Mg	²⁰ Al	²¹ Si	P	16												
		⁹ He	¹¹ Li	¹² Be	¹³ B	¹⁴ C	¹⁵ N	¹⁶ O	¹⁷ F	¹⁸ Ne	¹⁹ Na	²⁰ Mg	²¹ Al	²² Si	²³ P	S	17											
			¹² Li	¹³ Be	¹⁴ B	¹⁵ C	¹⁶ N	¹⁷ O	¹⁸ F	¹⁹ Ne	²⁰ Na	²¹ Mg	²² Al	²³ Si	²⁴ P	²⁵ S	Cl	18										
				¹⁴ Be	¹⁵ B	¹⁶ C	¹⁷ N	¹⁸ O	¹⁹ F	²⁰ Ne	²¹ Na	²² Mg	²³ Al	²⁴ Si	²⁵ P	²⁶ S	²⁷ Cl	Ar	19									
					¹⁵ B	¹⁶ C	¹⁷ N	¹⁸ O	¹⁹ F	²⁰ Ne	²¹ Na	²² Mg	²³ Al	²⁴ Si	²⁵ P	²⁶ S	²⁷ Cl	²⁸ Ar	K	20								
						¹⁶ C	¹⁷ N	¹⁸ O	¹⁹ F	²⁰ Ne	²¹ Na	²² Mg	²³ Al	²⁴ Si	²⁵ P	²⁶ S	²⁷ Cl	²⁸ Ar	²⁹ K	Ca								
							¹⁹ C	²⁰ N	²¹ O	²² F	²³ Ne	²⁴ Na	²⁵ Mg	²⁶ Al	²⁷ Si	²⁸ P	²⁹ S	³⁰ Cl	³¹ Ar	³² K	Ca							
								²⁰ C	²¹ N	²² O	²³ F	²⁴ Ne	²⁵ Na	²⁶ Mg	²⁷ Al	²⁸ Si	²⁹ P	³⁰ S	³¹ Cl	³² Ar	³³ K	³⁴ Ca	21	22				
									²² N	²³ O	²⁴ F	²⁵ Ne	²⁶ Na	²⁷ Mg	²⁸ Al	²⁹ Si	³⁰ P	³¹ S	³² Cl	³³ Ar	³⁴ K	³⁵ Ca	Sc	Ti	23			
										²⁴ O	²⁵ F	²⁶ Ne	²⁷ Na	²⁸ Mg	²⁹ Al	³⁰ Si	³¹ P	³² S	³³ Cl	³⁴ Ar	³⁵ K	³⁶ Ca	³⁷ Sc	³⁸ Ti	V	24		
											²⁶ F	²⁷ Ne	²⁸ Na	²⁹ Mg	³⁰ Al	³¹ Si	³² P	³³ S	³⁴ Cl	³⁵ Ar	³⁶ K	³⁷ Ca	³⁸ Sc	³⁹ Ti	40V	Cr	25	26

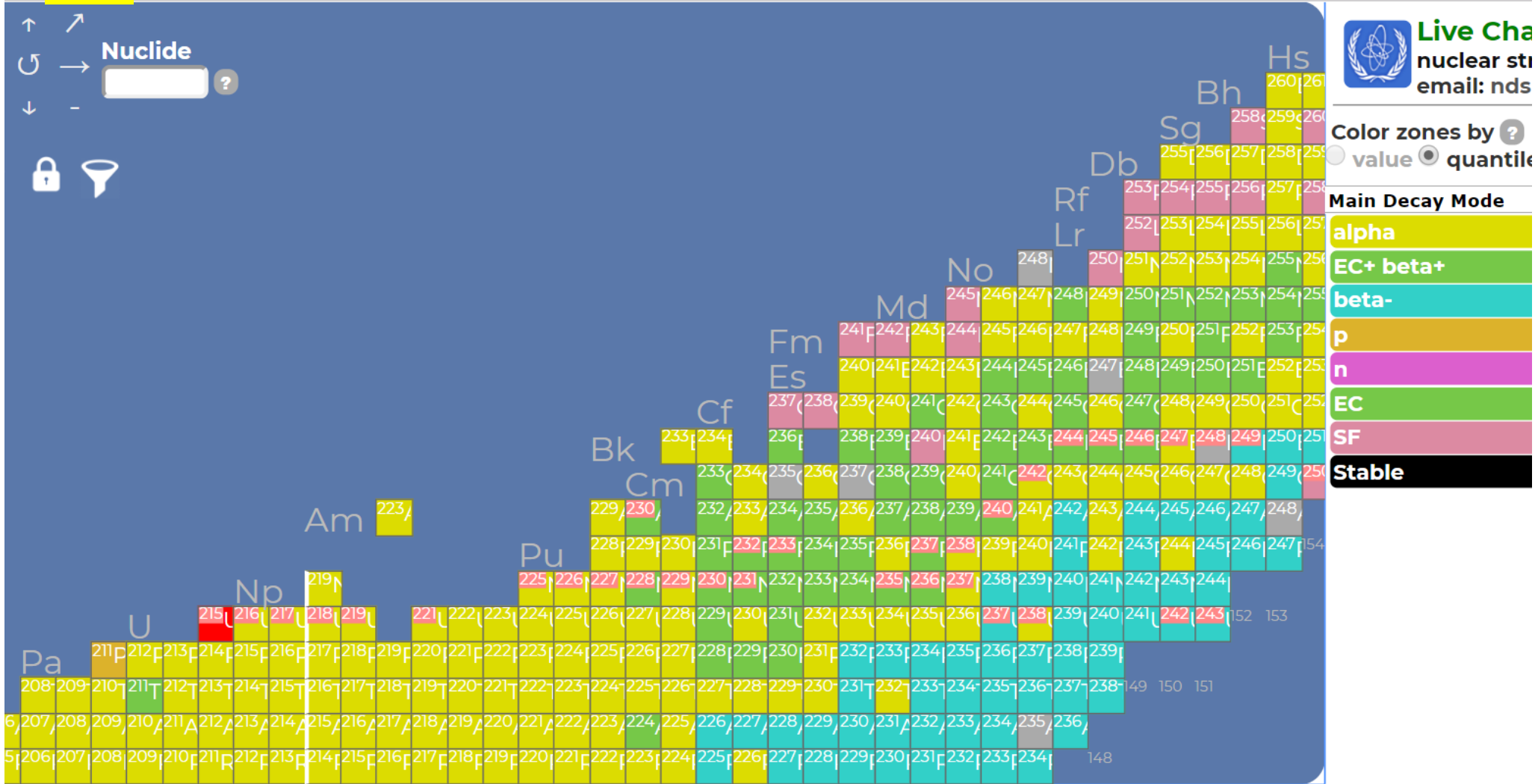
- Each element comes with
- a unique number of electrons
 - a unique spectrum
 - multiple numbers of neutrons

158	²⁵⁶ Cf	²⁵⁷ Es	²⁵⁸ Fm	²⁵⁹ Md	²⁶⁰ No	²⁶¹ Lr	²⁶² Rf	²⁶³ Db	²⁶⁴ Sg	²⁶⁵ Bh	²⁶⁶ Hs			111	
159		²⁵⁸ Es	²⁵⁹ Fm	²⁶⁰ Md		²⁶² Lr	²⁶³ Rf		²⁶⁵ Sg	²⁶⁶ Bh	²⁶⁷ Hs	²⁶⁸ Mt	²⁶⁹ Ds	Rg	
160			²⁶⁰ Fm		²⁶² No				²⁶⁶ Sg	²⁶⁷ Bh	²⁶⁸ Hs		²⁷⁰ Ds		
161							²⁶⁵ Rf	²⁶⁶ Db	²⁶⁷ Sg		²⁶⁹ Hs	²⁷⁰ Mt	²⁷¹ Ds	²⁷² Rg	
162							²⁶⁶ Rf	²⁶⁷ Db			²⁷⁰ Hs			112 113	
163					²⁶⁶ Lr	²⁶⁷ Rf	²⁶⁸ Db	²⁶⁹ Sg	²⁷⁰ Bh	²⁷¹ Hs		²⁷³ Ds	²⁷⁴ Rg	Cn Nh	
164						²⁶⁸ Rf			²⁷¹ Bh						
165							²⁷⁰ Db	²⁷¹ Sg	²⁷² Bh	²⁷³ Hs	²⁷⁴ Mt		²⁷⁷ Cn	²⁷⁸ Nh	
166							²⁷⁰ Rf				²⁷⁵ Mt				
167									²⁷⁴ Bh	²⁷⁵ Hs	²⁷⁶ Mt	²⁷⁷ Ds	²⁷⁸ Rg		
168											²⁷⁷ Mt	²⁷⁹ Rg		114	
169									²⁷⁷ Hs	²⁷⁸ Mt	²⁷⁹ Ds	²⁸⁰ Rg	²⁸¹ Cn	²⁸² Nh	Fl 115
170										²⁸⁰ Ds	²⁸¹ Rg	²⁸² Cn	²⁸³ Nh	²⁸⁴ Fl	Mc 116
171										²⁸¹ Ds	²⁸² Rg	²⁸³ Cn	²⁸⁴ Nh	²⁸⁵ Fl	Lv 117
172											²⁸⁴ Cn	²⁸⁵ Nh	²⁸⁶ Fl	²⁸⁷ Mc	Ts 118
173											²⁸⁵ Cn	²⁸⁶ Nh	²⁸⁷ Fl	²⁸⁸ Mc	Og
174												²⁸⁸ Fl	²⁸⁹ Mc	²⁹⁰ Lv	
175												²⁸⁹ Fl	²⁹⁰ Mc	²⁹¹ Lv	
176													²⁹² Lv	²⁹³ Ts	²⁹⁴ Og
177													²⁹³ Lv	²⁹⁴ Ts	

Chart of the Nucleids , Hydrogen bottom Left



Live Chart of the Nuclides , Uranium (U) last natural element shown



<https://www-nds.iaea.org/relnsd/vcharthtml/VChartHTML.html>

The Elements

The elements primary components

1. Electron
2. Proton
3. Neutron

They each come in only one size.

Observing that they each have a unique quantity of mass and charge is the first step toward understanding the elements.

Millikan's Oil Drop Experiment

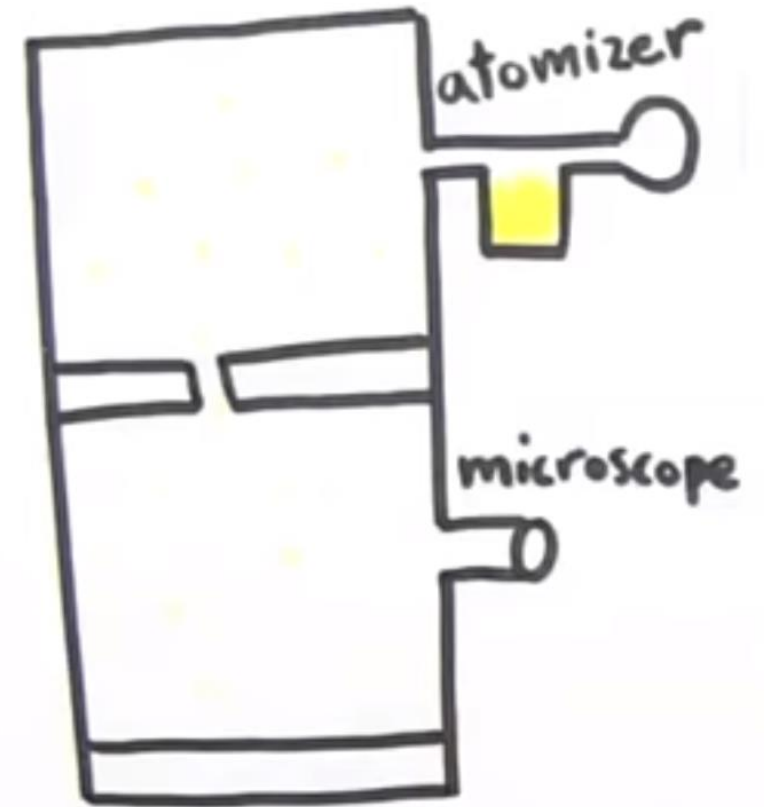
Measure the Charge of an **Electron**

Oil Drop Experiment: Discovery of the charge on an electron
Robert Millikan and Harvey Fletcher (1913)

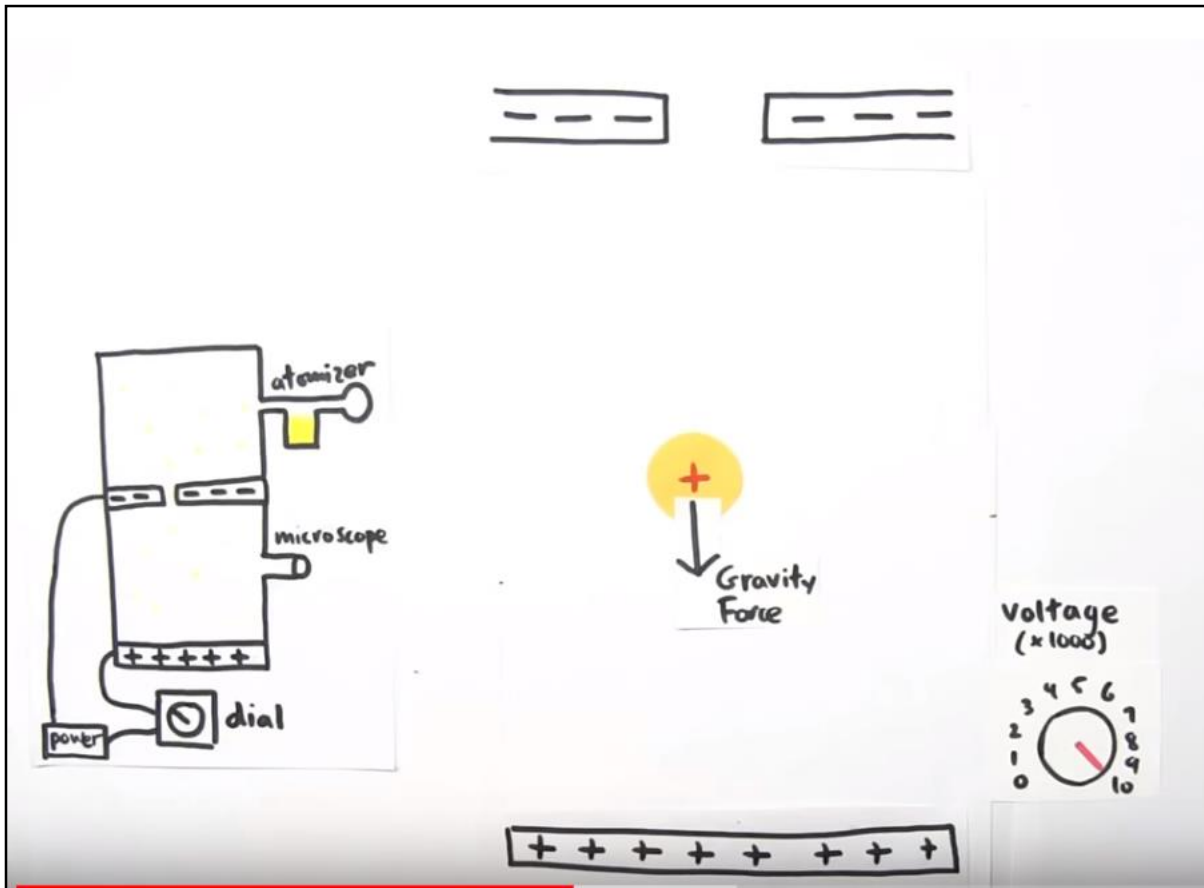
1897 : J.J. Thompson discovers electrons
-discovers they have negative charge

Most of the slides describing this experiment are from:

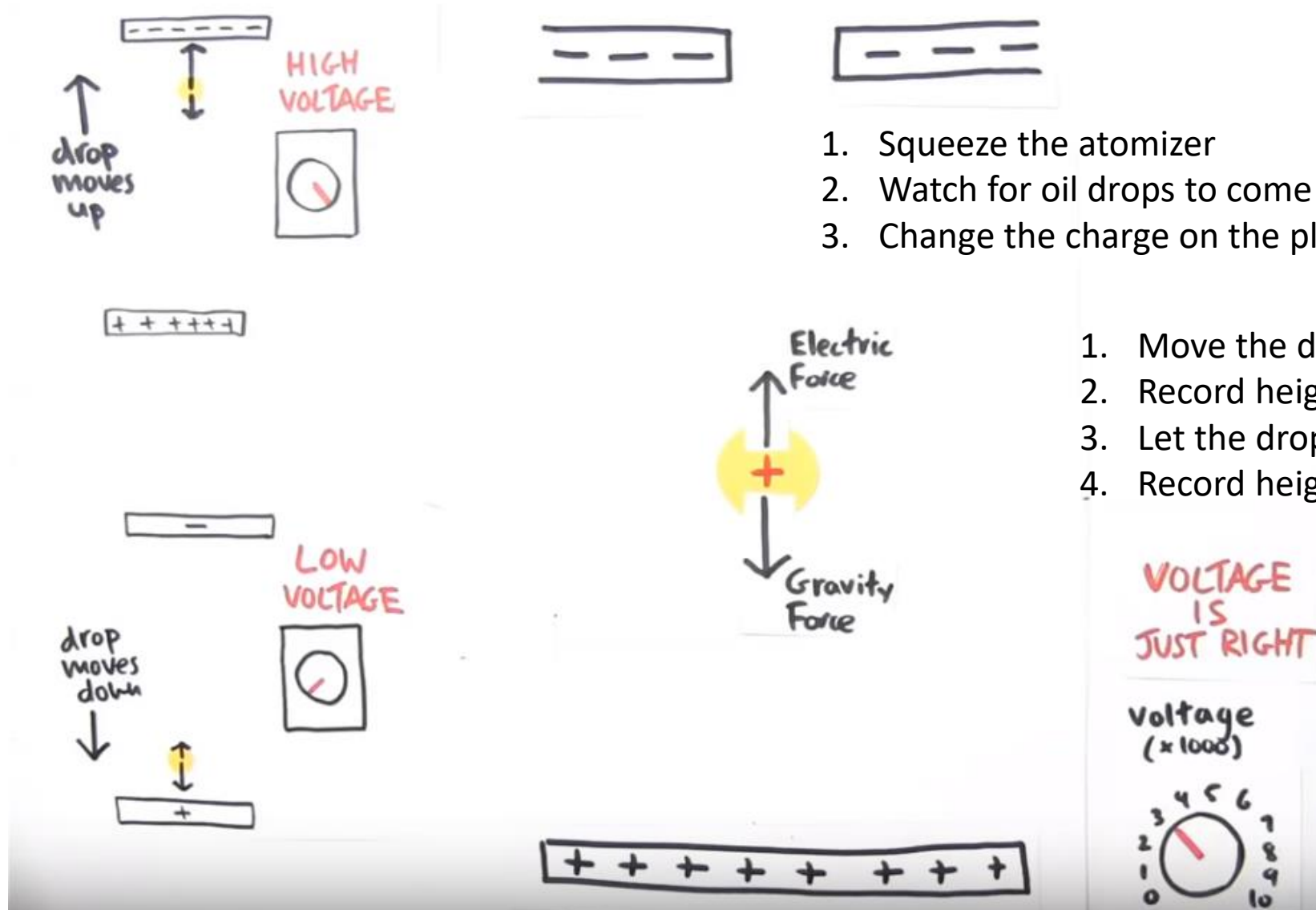
<https://www.youtube.com/watch?v=2HhaQtvICe8&feature=youtu.be>



Using the Apparatus

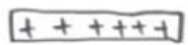
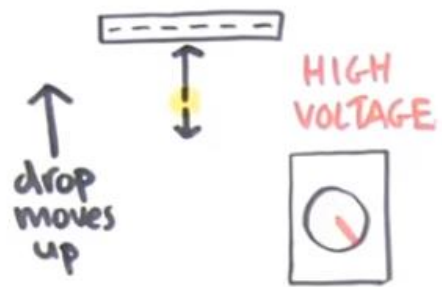


Balancing forces of gravity and electricity



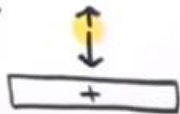
1. Squeeze the atomizer
2. Watch for oil drops to come down through the hole
3. Change the charge on the plates so that a drop stops

1. Move the drop up and stop
2. Record height and the time
3. Let the drop fall and stop it again.
4. Record height and the time

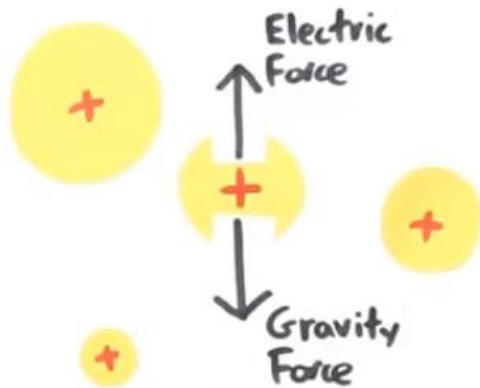


LOW VOLTAGE

drop moves down



When drop stays still,
Electric Force = Gravity Force



Mass ($\times 10^{-15}$ kg)	voltage when balanced (Volts)
5.9	3,551
4.2	1,841
3.7	4,729
9.8	2,501
6.2	2,783
3.3	4,568
5.8	1,787

Mass ($\times 10^{-15}$ kg)	voltage when balanced (Volts)
5.9	3,551
4.2	1,841
3.7	4,729
9.8	2,501
6.2	2,783
3.3	4,568
5.8	1,787

VOLTAGE IS JUST RIGHT

voltage
($\times 1000$)



Laws Obeyed

- Gravity
- Electrical Force
- Aerodynamic Drag

Commandment

... love the Lord your God with all your heart and with all your soul and with all your mind. Matt 22:37 from ESV

Law

There are God given natural laws.

- Gravity
- Electrical Force
- Aerodynamic Drag

Some speak of using your noodle, meaning use your mind.

Law of Universal Gravitation

Every object in the Universe attracts every other object with a force directed along the line of centers for the two objects that is proportional to the product of their masses and inversely proportional to the square of the separation between the two objects.

$$F_g = G \frac{m_1 m_2}{r^2}$$



F_g is the gravitational force

m_1 & m_2 are the masses of the two objects

r is the separation between the objects

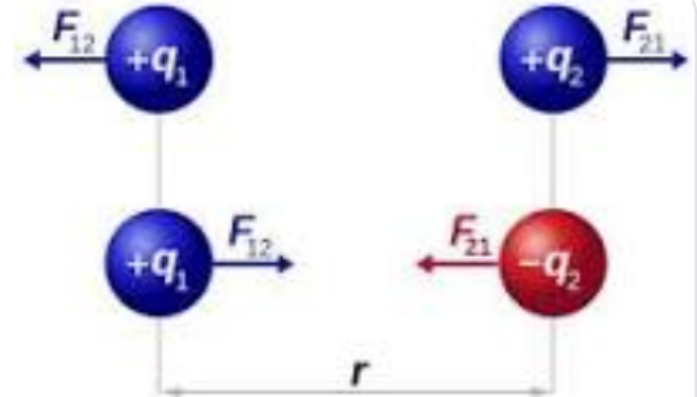
G is the universal gravitational constant

Law for Electrical Force

Coulomb's law states that: The magnitude of the electrostatic force of **attraction** or repulsion between two point charges is directly proportional to the product of the magnitudes of charges and inversely proportional to the square of the distance between them.

[Coulomb's law - Wikipedia](https://en.wikipedia.org/wiki/Coulomb%27s_law)

https://en.wikipedia.org/wiki/Coulomb%27s_law



x-engineer.org $F = F_{21} = k \frac{q_1 q_2}{r^2}$

(Law of) Aerodynamic Drag


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The Drag Equation


$$D = C_d \frac{\rho V^2 A}{2}$$

Drag = coefficient x density x velocity squared x reference area
two

Coefficient **Cd** contains all the complex dependencies and is usually determined experimentally.

Choice of reference area **A** affects the value of **Cd**.

Drag depends on the density of the air, the square of the velocity, the air's viscosity and compressibility, the size and shape of the body, and the body's inclination to the flow. In general, the dependence on body shape, inclination, air viscosity, and compressibility is very complex.

One way to deal with complex dependencies is to characterize the dependence by a single variable. For drag, this variable is called the drag coefficient, designated "Cd." This allows us to collect all the effects, simple and complex, into a single equation. The drag equation states that drag D is equal to the drag coefficient Cd times the density times half of the

For this experiment, the equation can be simplified to:

Drag = Constant x radius² x Velocity²
Knowing the density of the oil used, and the observed speed of the drops falling enables calculating the weight of each drop and the drag force on each drop.

Matter and Mind

3And God said, “Let there be light,”

energy and mass (matter) are interchangeable
(light is and gives evidence of energy)

love the Lord your God with all your heart and with all your soul and with all your mind.

Millikan loved God by using his mind, trusted His laws, and saw an electron.

Microscopes

1. Optical

2. Electron

3. Ion

4. Raman

Optical Microscope



[Google search for optical microscope](#)

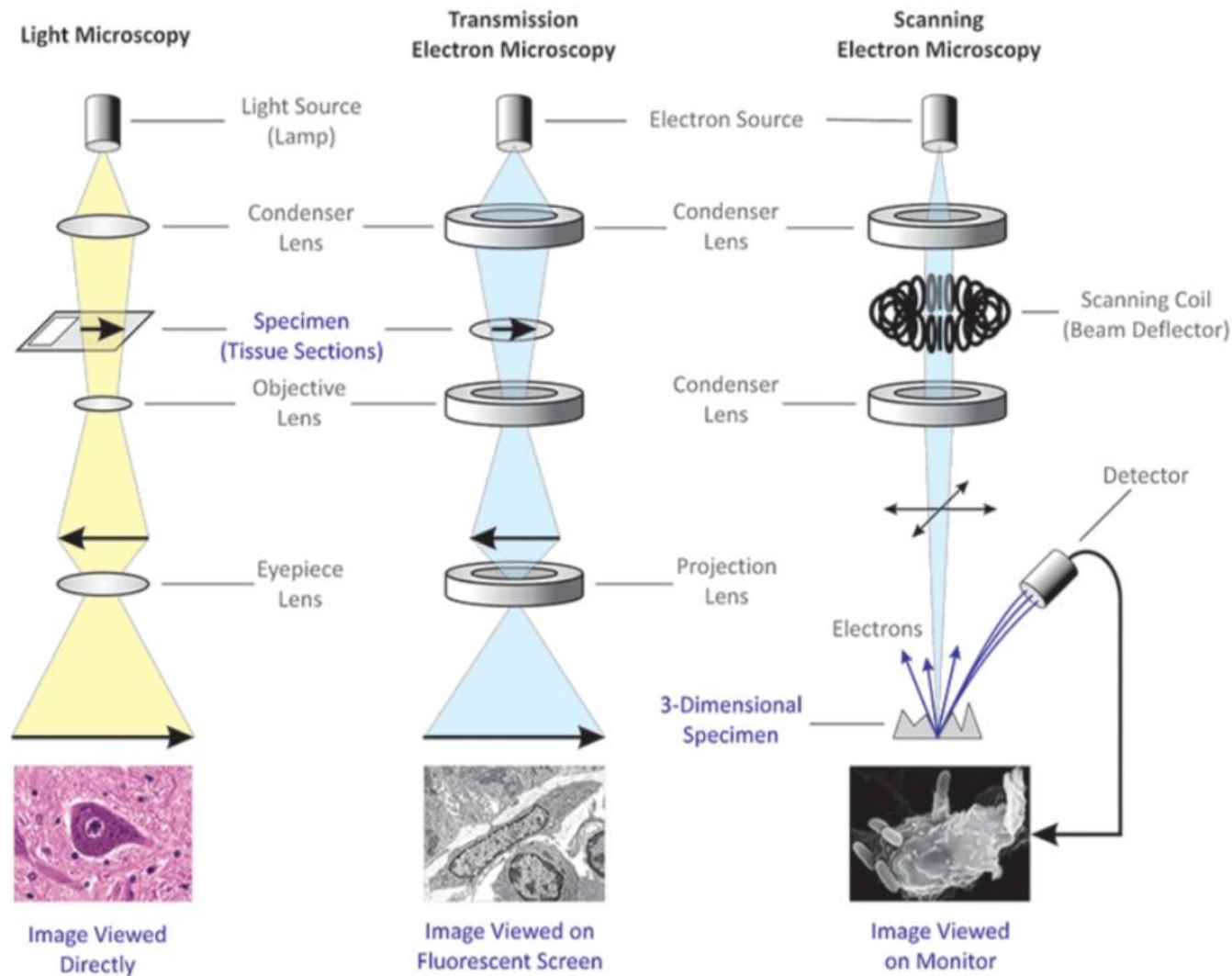
Electron Microscope



[Google Search for electron microscope](#)

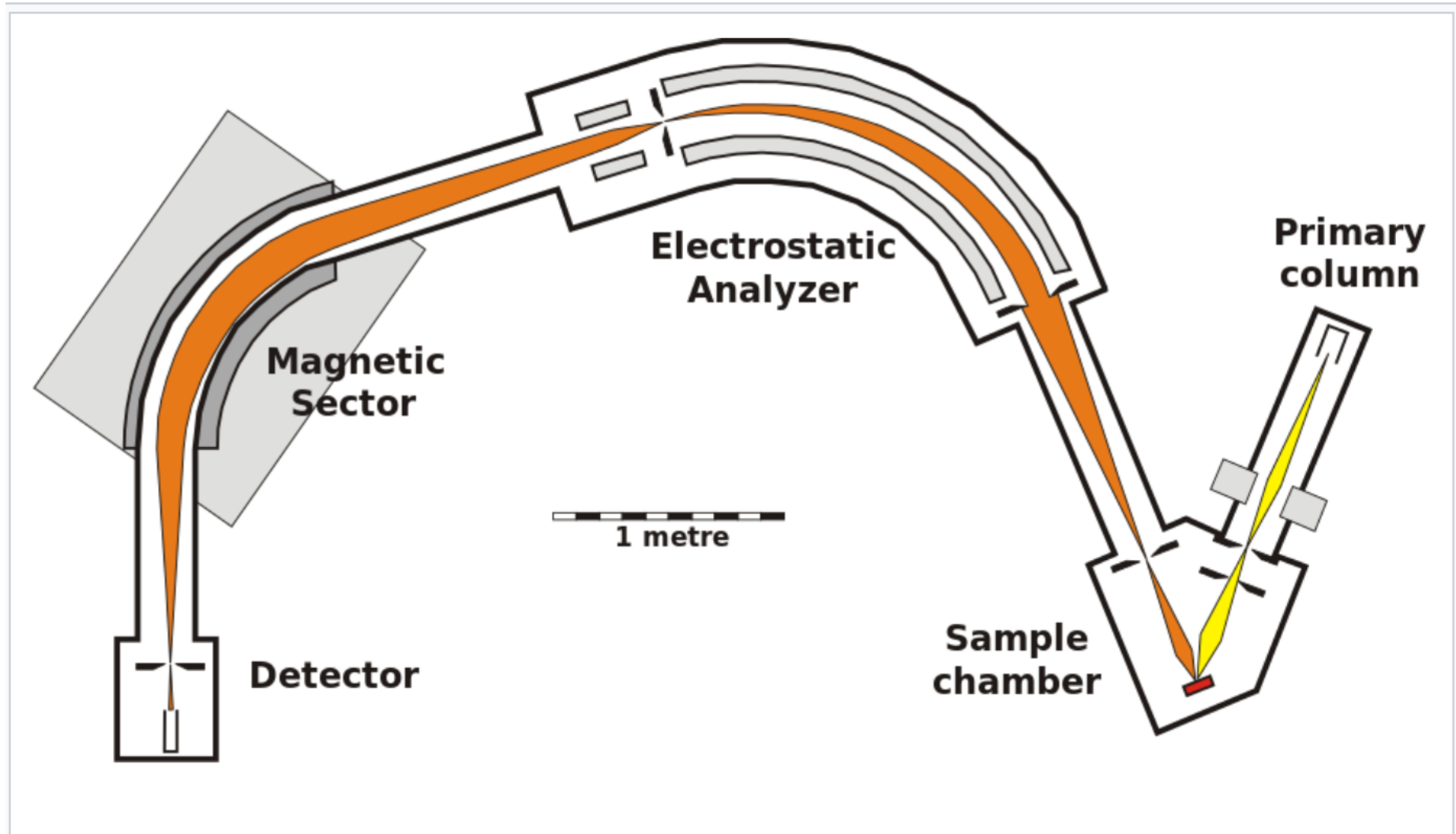
Scanning Electron Microscope

Differences between Light and Electron Microscopes



<https://microbiologyinfo.com/differences-between-light-microscope-and-electron-microscope/>

Ion Microscope

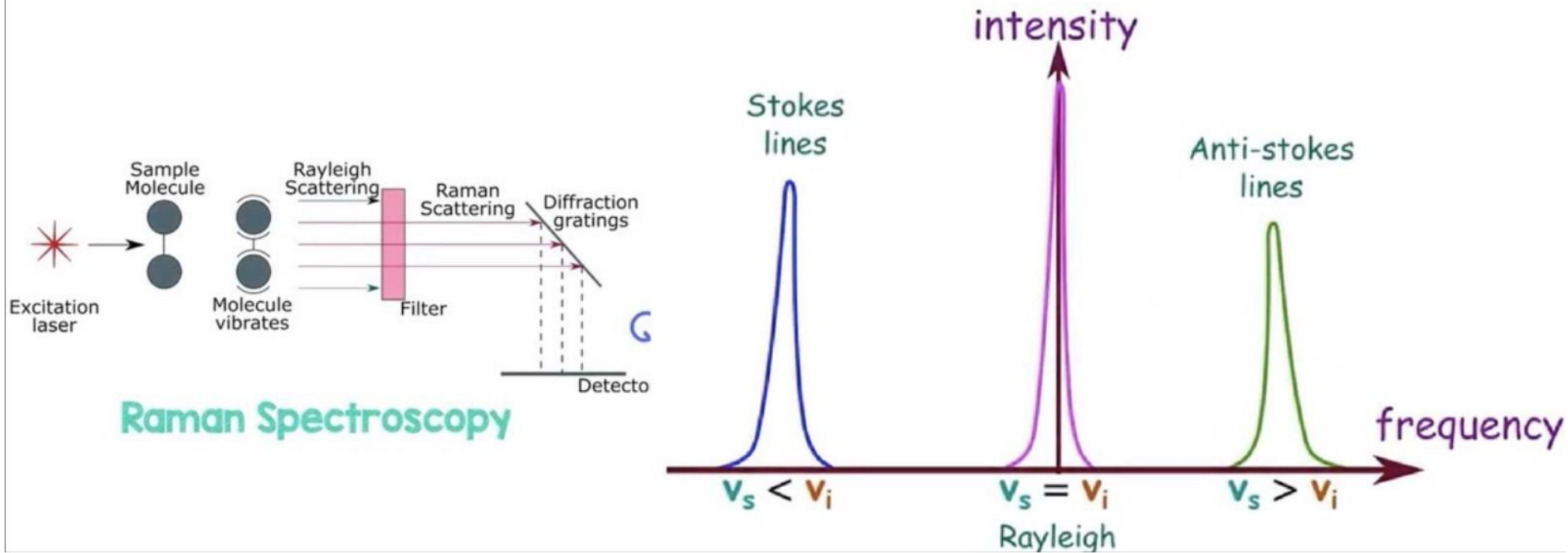


Schematic diagram of a SHRIMP instrument illustrating the ion beam path. After Figure 4, Williams, 1998.^[26]

Raman Spectroscopy

It is possible to build a Raman microscope

Basics and Principles



[Raman spectroscopy Google Reference](#)

The Great Commandment

35And one of them, a lawyer, asked him a question to test him.36“Teacher, which is the great commandment in the Law?”

37And he said to him, “You shall love the Lord your God with all your heart and with all your soul and with all your **mind**. 38This is the great and first commandment. 39And a second is like it: You shall love your neighbor as yourself. 40On these two commandments depend all the Law and the Prophets.” Matt 22 from ESV

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