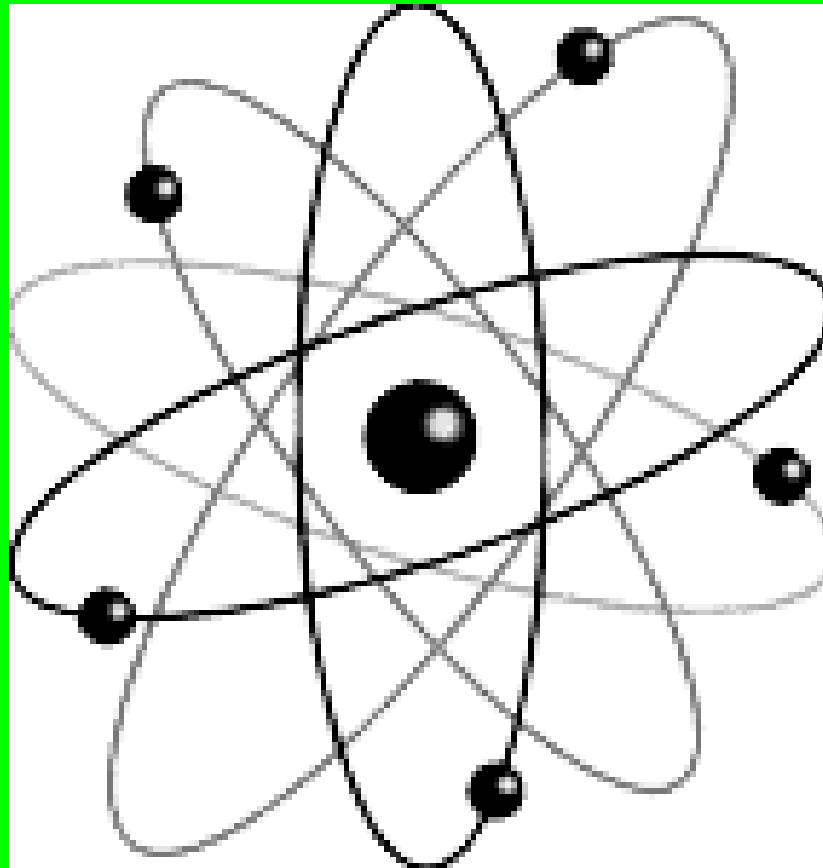
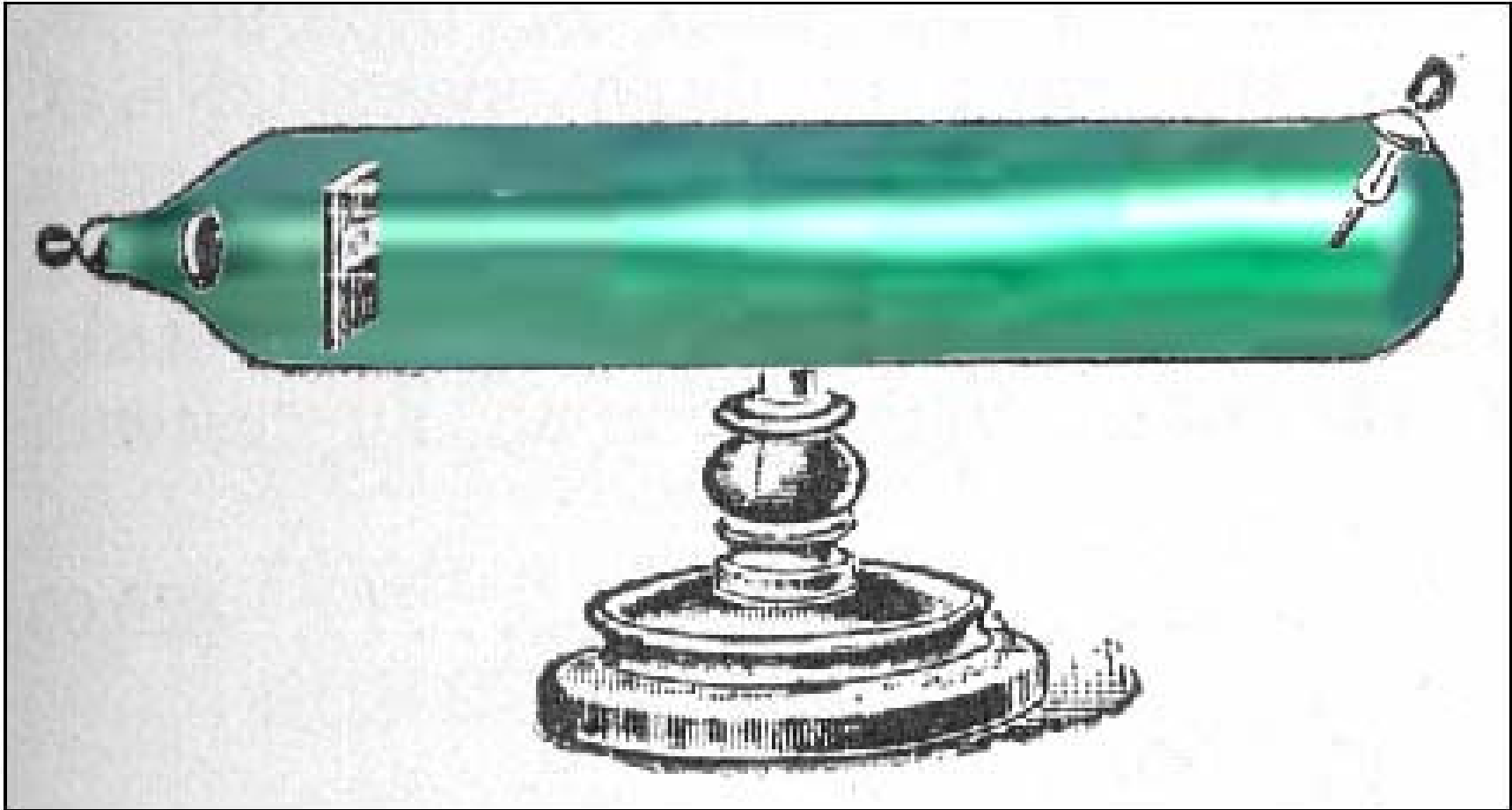


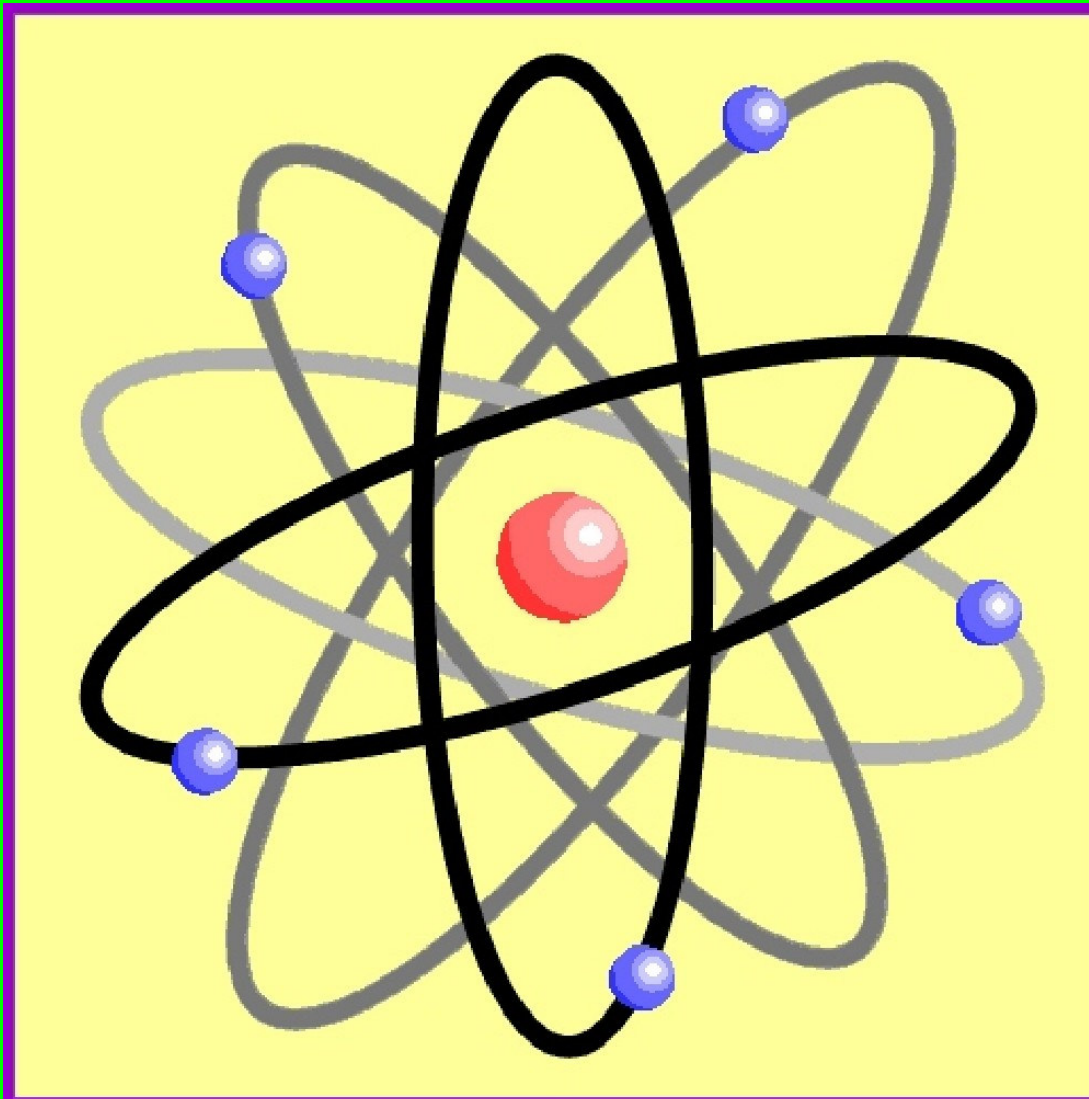
The Modern Theory of Atomic Structure

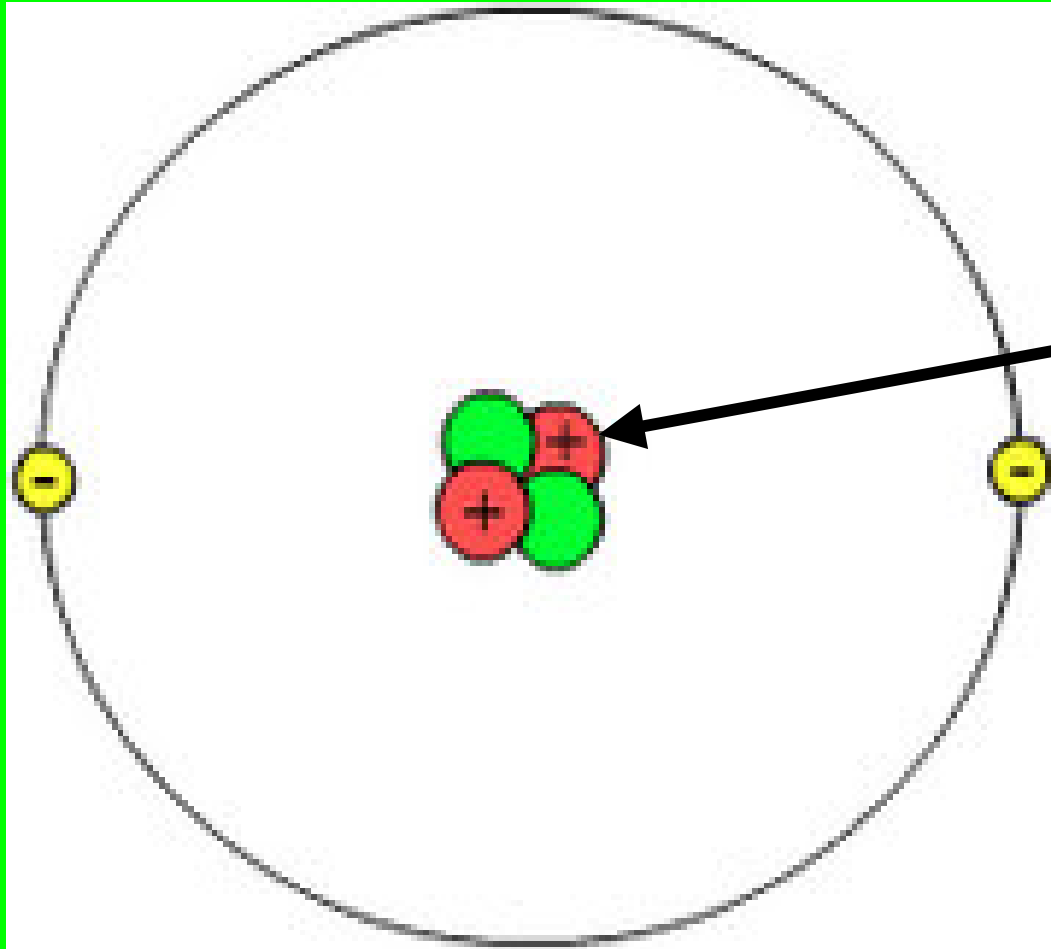




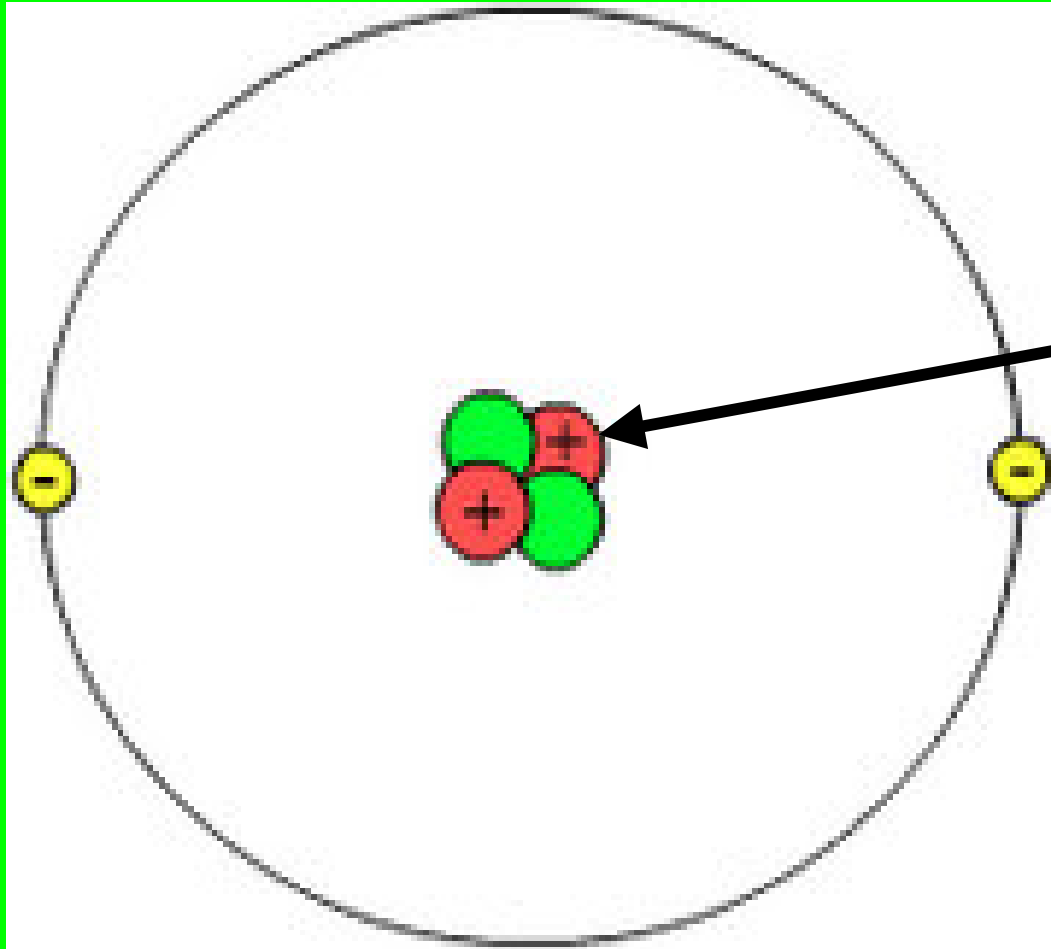
Atoms can be broken down into smaller particles. This was first done with a Crooke's Tube.

Particles which make up the atom are called **subatomic particles**.

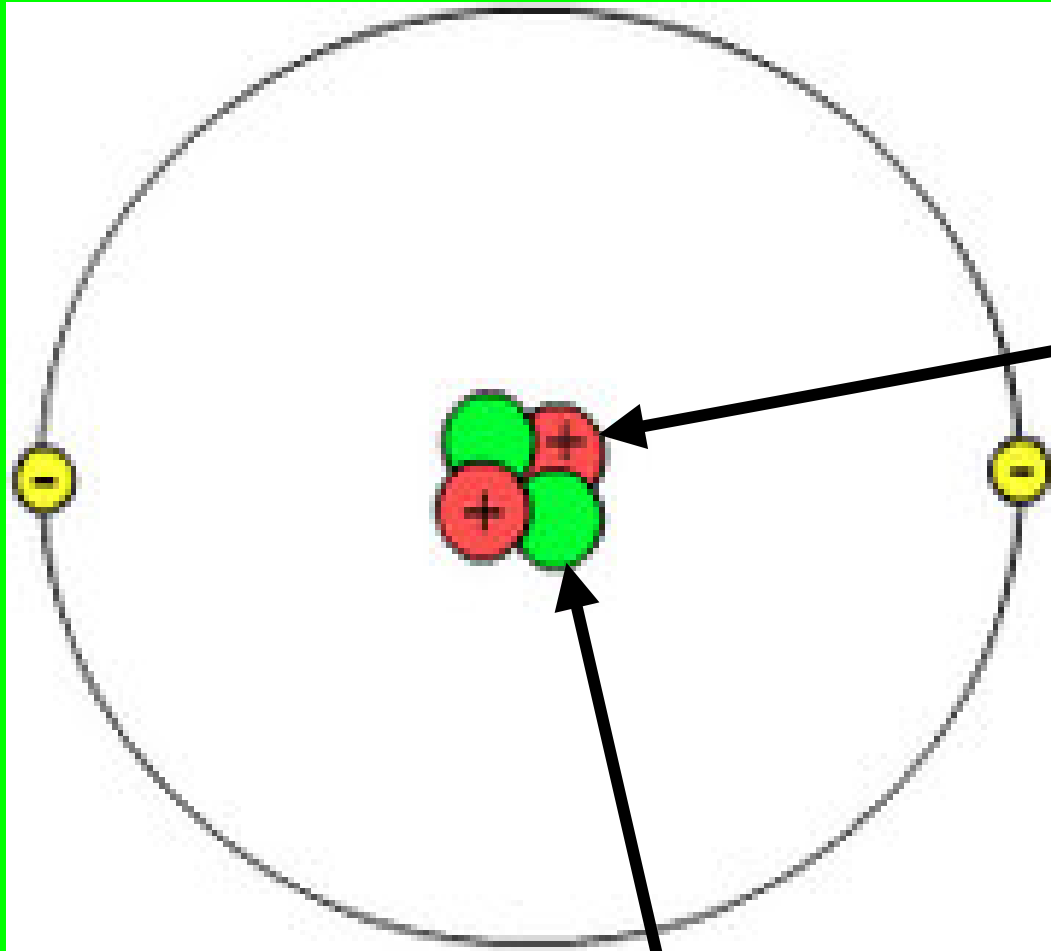




Protons

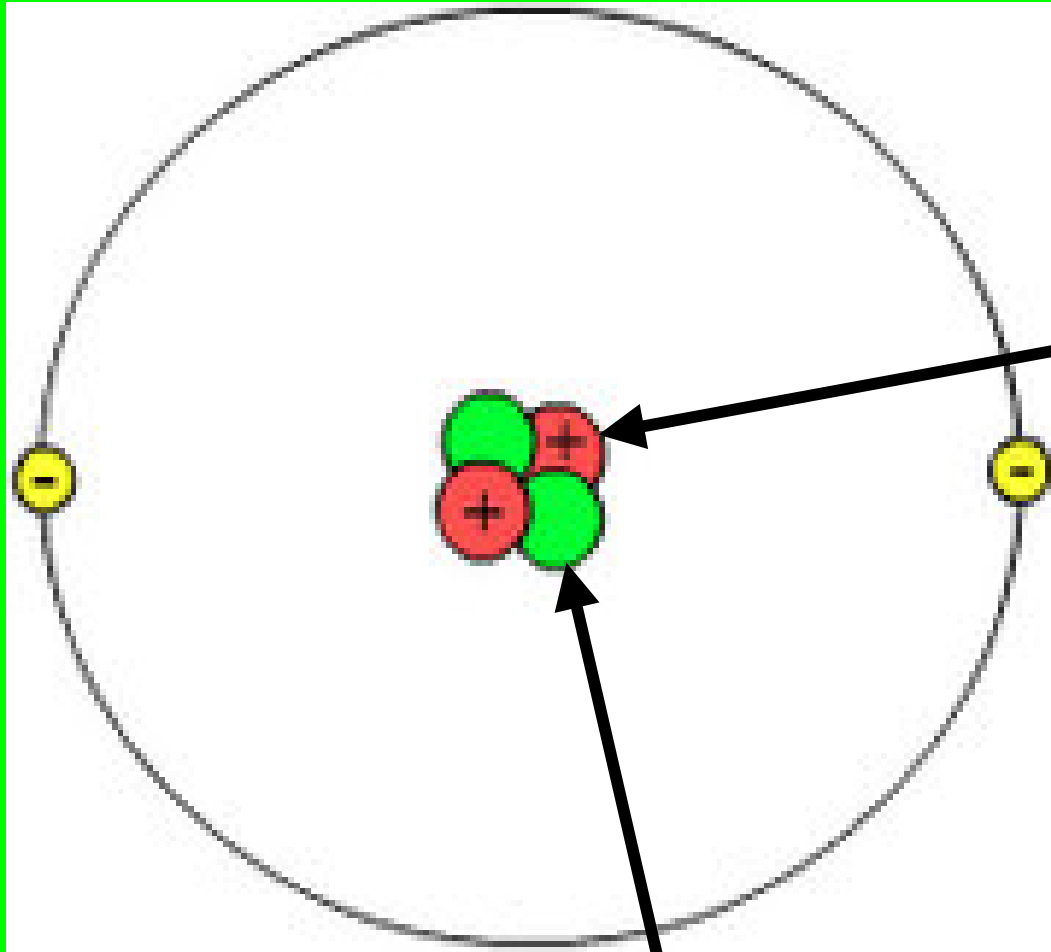


Protons
Positively
charged
particles in
the nucleus



Protons
Positively
charged
particles in
the nucleus

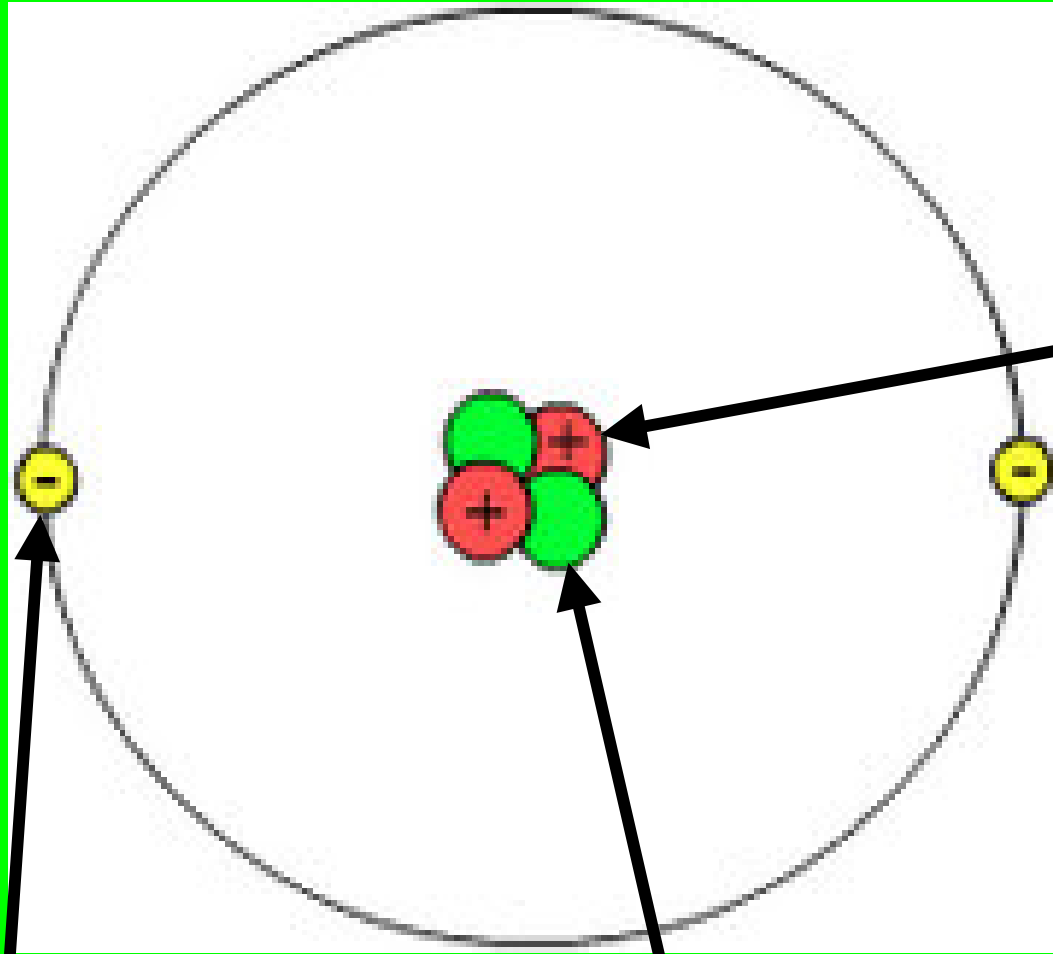
Neutrons



Protons

**Positively
charged
particles in
the nucleus**

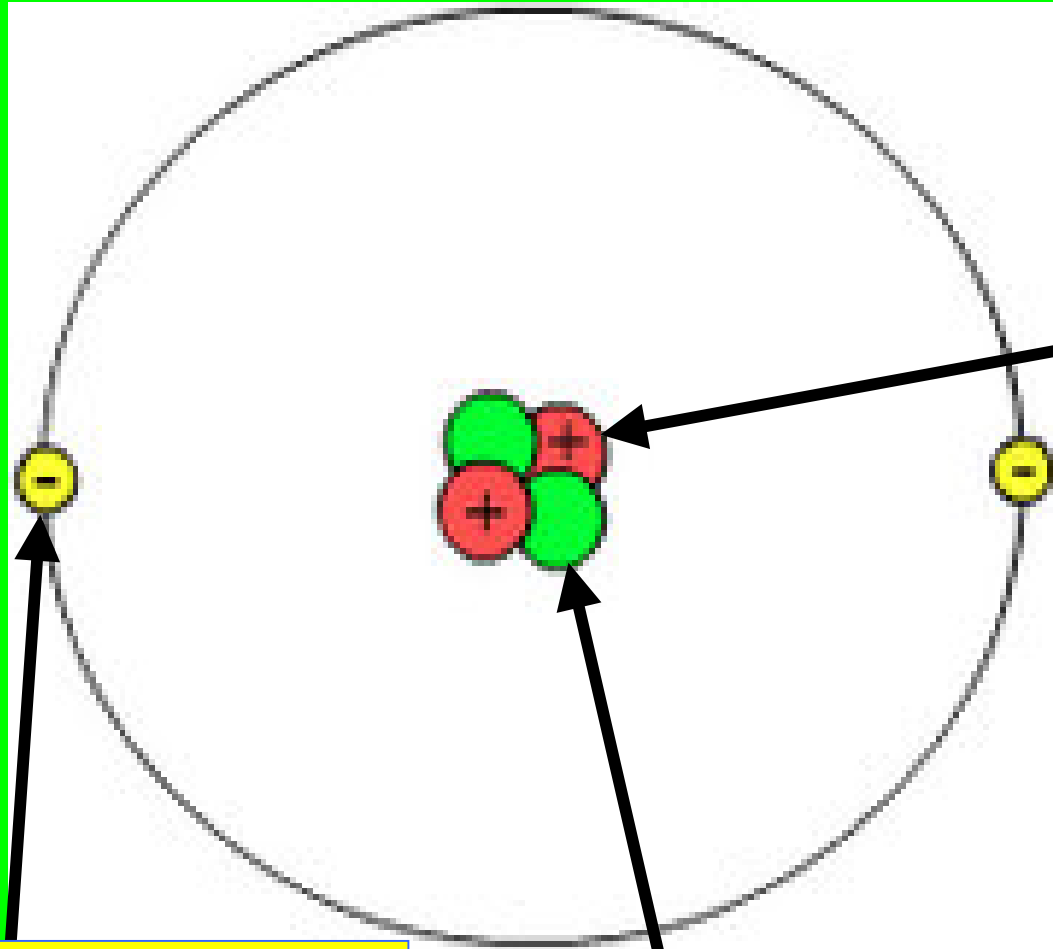
**Neutrons - Neutral
particles in the nucleus**



Protons
Positively
charged
particles in
the nucleus

Electrons

**Neutrons - Neutral
particles in the nucleus**



Protons
Positively charged particles in the nucleus

Neutrons - Neutral particles in the nucleus

Electrons – Small negative particles outside the nucleus

Particle	Mass (P = 1)	Charge	Location
Proton			
Neutron			
Electron			

Particle	Mass (P = 1)	Charge	Location
Proton	1	+	nucleus
Neutron			
Electron			

Particle	Mass (P = 1)	Charge	Location
Proton	1	+	nucleus
Neutron	1	0	nucleus
Electron			

Particle	Mass (P = 1)	Charge	Location
Proton	1	+	nucleus
Neutron	1	0	nucleus
Electron	$\frac{1}{1837}$	-	outside

Atomic Number = The # of Protons in the Nucleus

Found on top of element symbol

Atomic Number → 22 4+
Symbol → **Ti** 3+ ← Ion charge(s)
Name → Titanium
Atomic Mass → 47.9

Do “Instant Practice” on top of page 170

Element	Symbol	Atomic Number	Number of Protons
Hydrogen		1	
Beryllium		4	
Carbon			
Cobalt			
Krypton		36	

Do “Instant Practice” on top of page 170

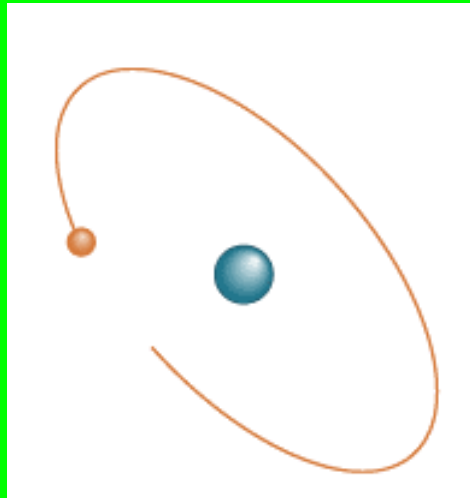
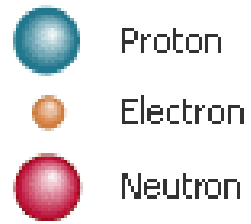
Element	Symbol	Atomic Number	Number of Protons
Hydrogen	H	1	
Beryllium	Be	4	
Carbon	C		
Cobalt	Co		
Krypton	Kr	36	

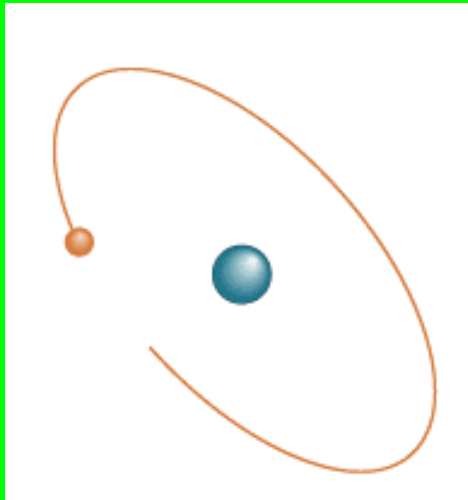
Do “Instant Practice” on top of page 170

Element	Symbol	Atomic Number	Number of Protons
Hydrogen	H	1	
Beryllium	Be	4	
Carbon	C	6	
Cobalt	Co	27	
Krypton	Kr	36	

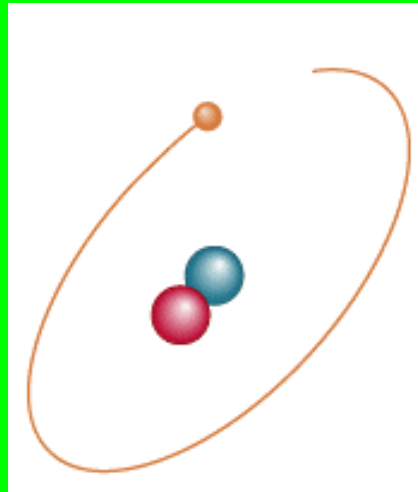
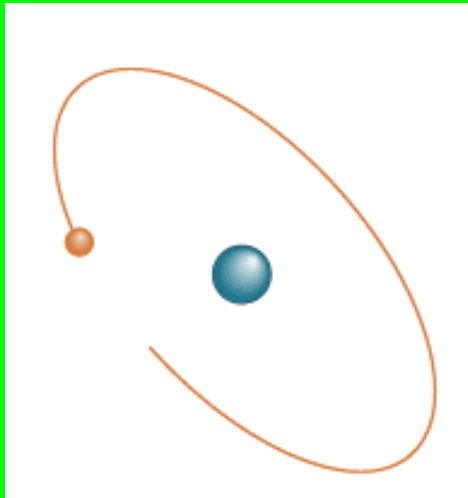
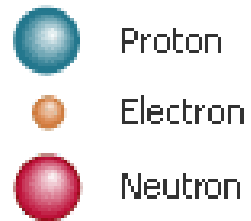
Do “Instant Practice” on top of page 170

Element	Symbol	Atomic Number	Number of Protons
Hydrogen	H	1	1
Beryllium	Be	4	4
Carbon	C	6	6
Cobalt	Co	27	27
Krypton	Kr	36	36

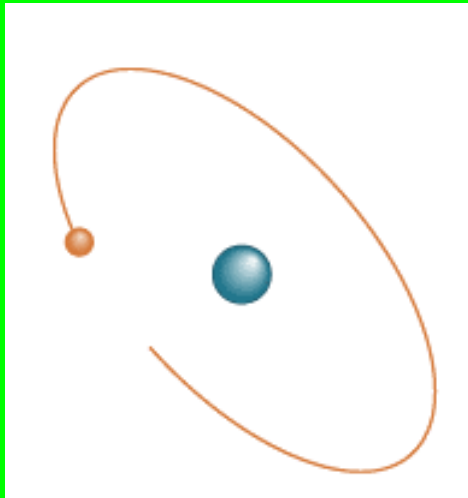
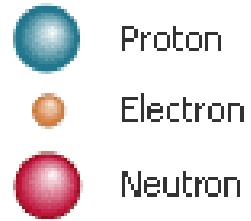




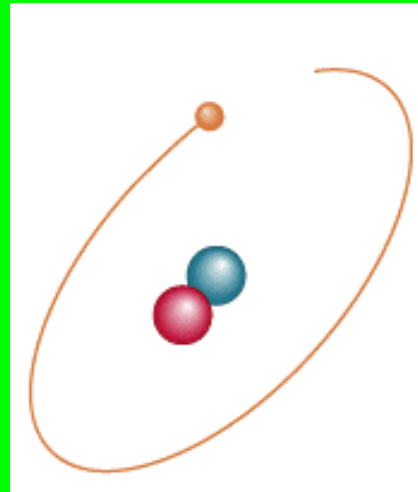
Hydrogen



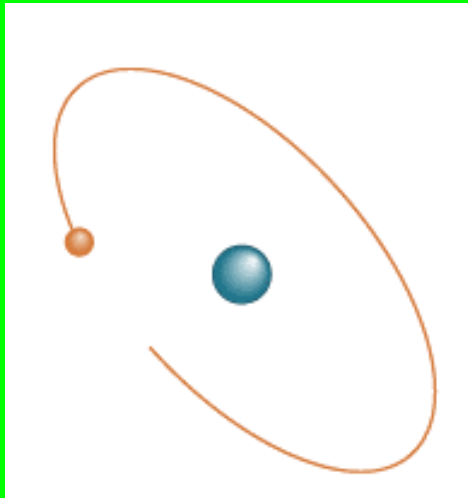
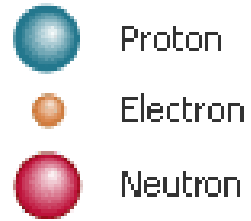
Hydrogen



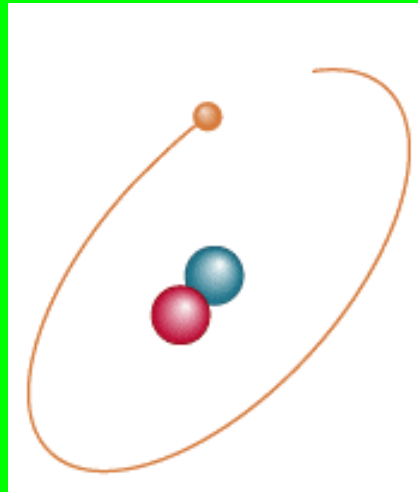
Hydrogen



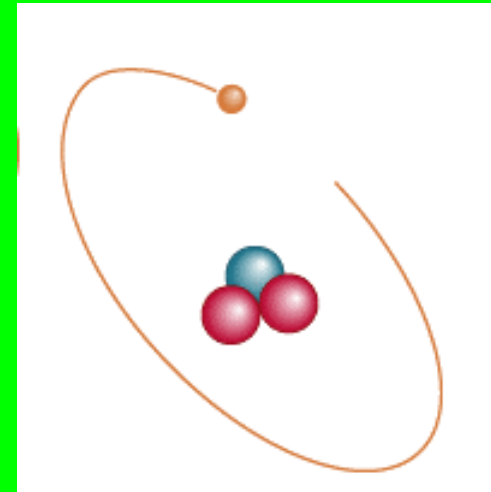
Hydrogen

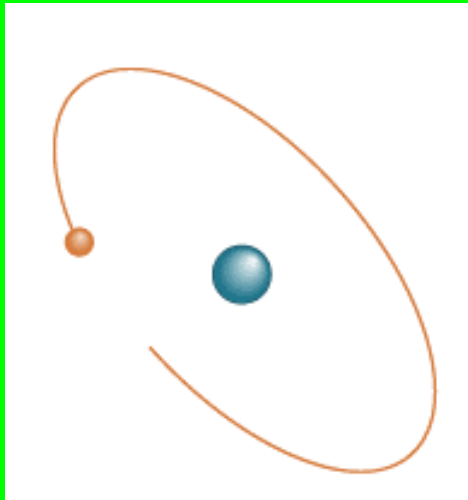
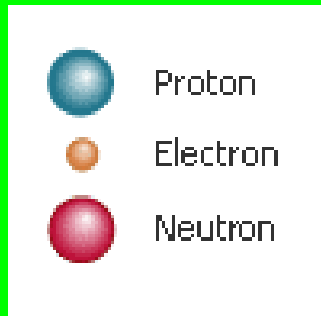


Hydrogen

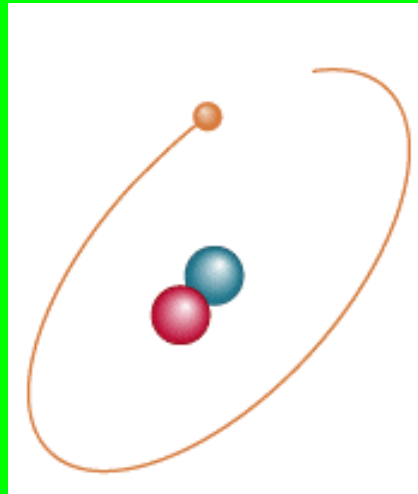


Hydrogen

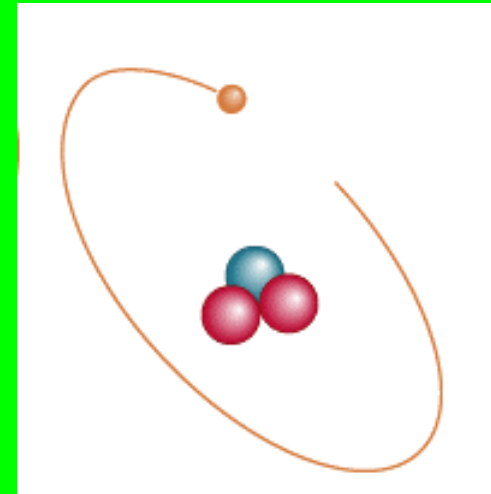




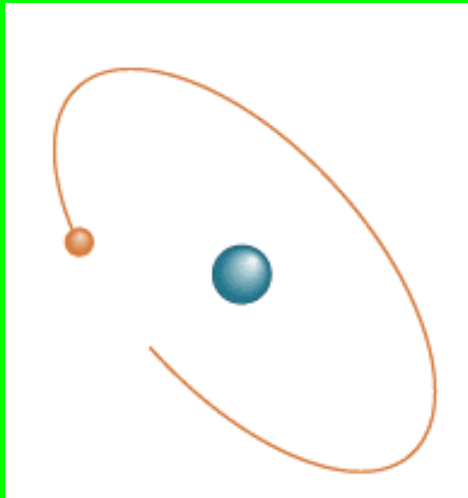
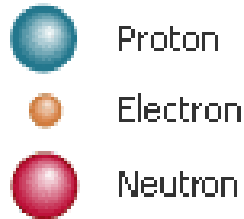
Hydrogen



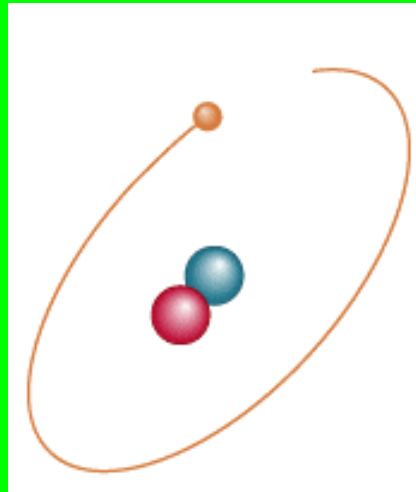
Hydrogen



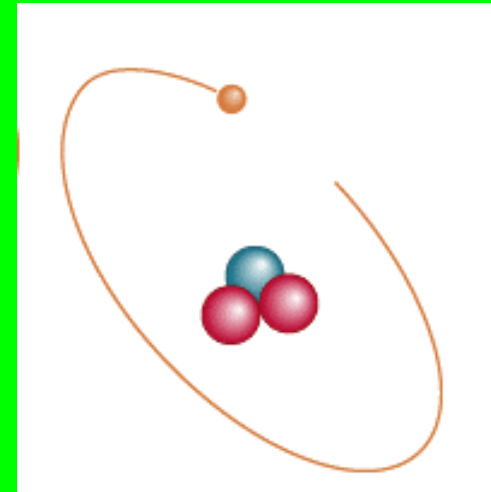
Hydrogen



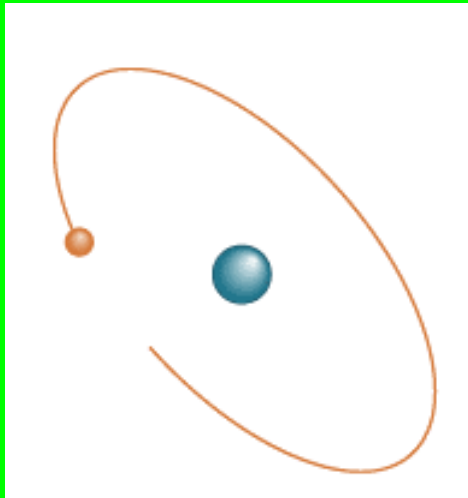
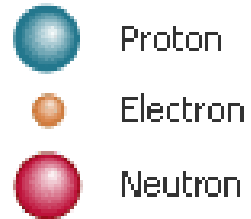
Hydrogen-1



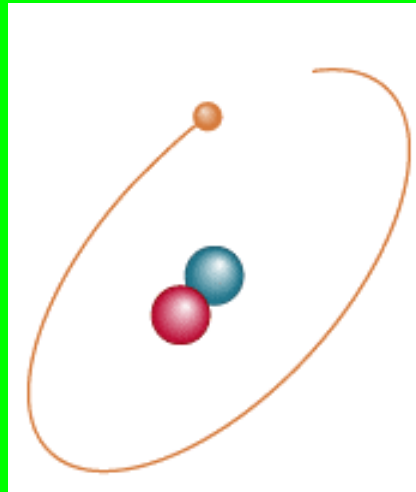
Hydrogen



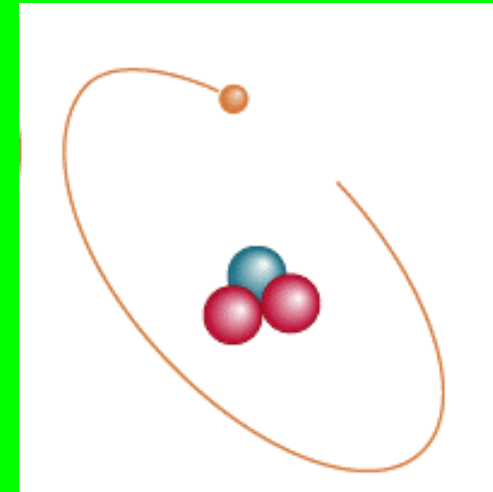
Hydrogen



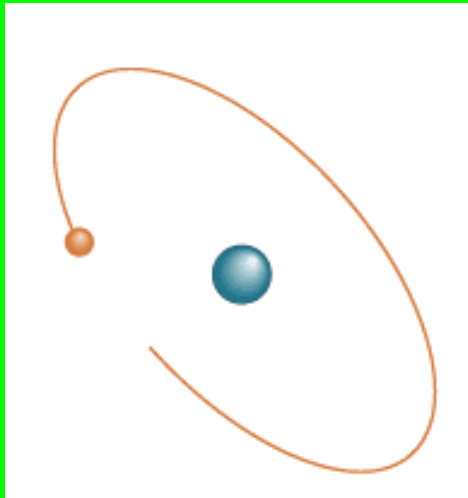
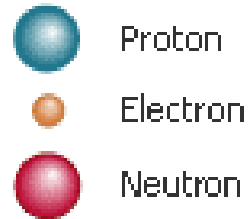
Hydrogen-1



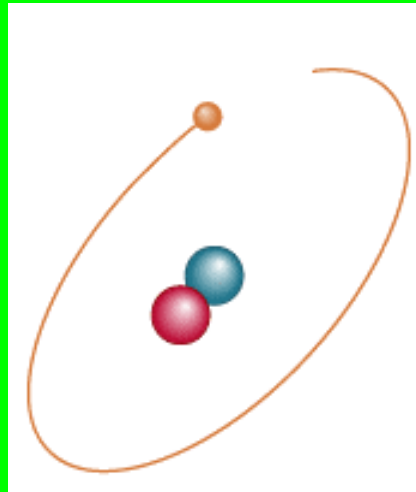
Hydrogen-2



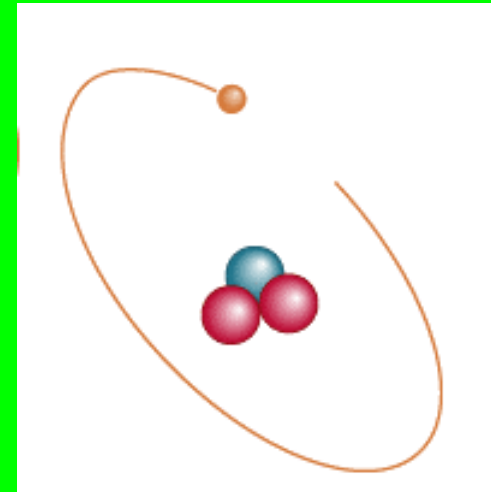
Hydrogen



Hydrogen-1

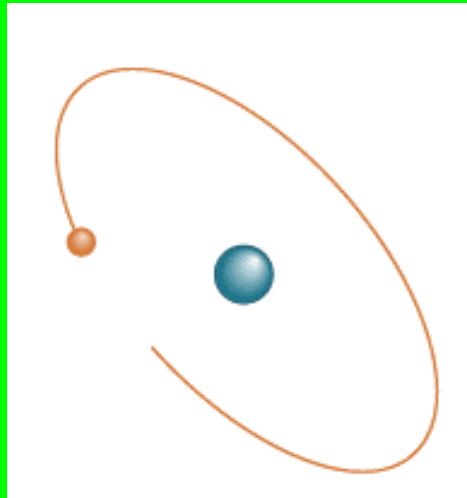
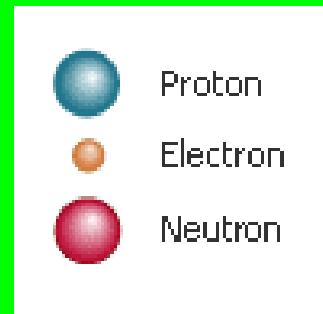


Hydrogen-2

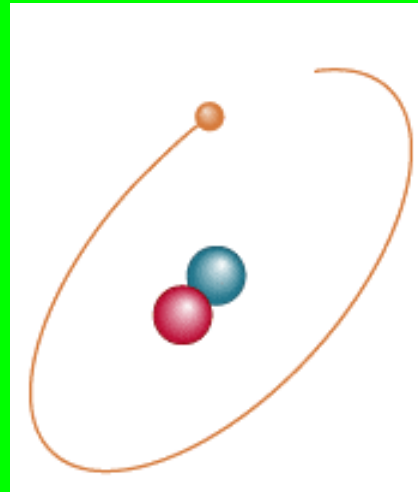


Hydrogen-3

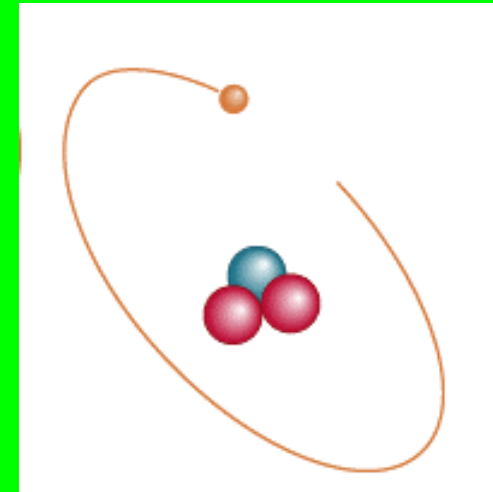
Isotopes of Hydrogen



Hydrogen-1



Hydrogen-2

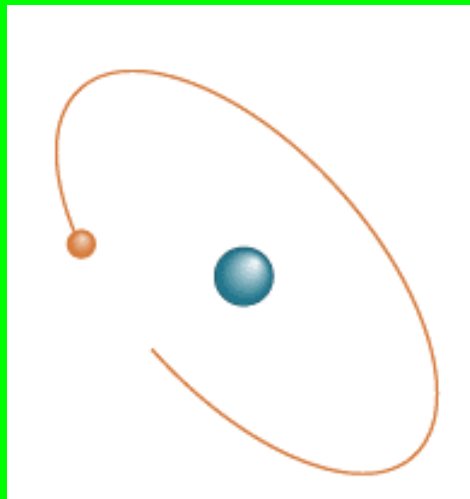


Hydrogen-3

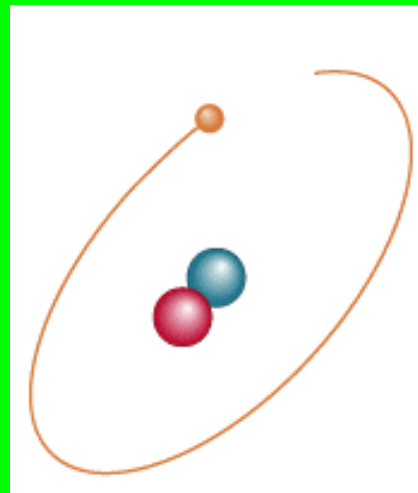
Isotopes are:

**Different forms of the same element
with the SAME # of Protons but with
DIFFERENT #'s of Neutrons**

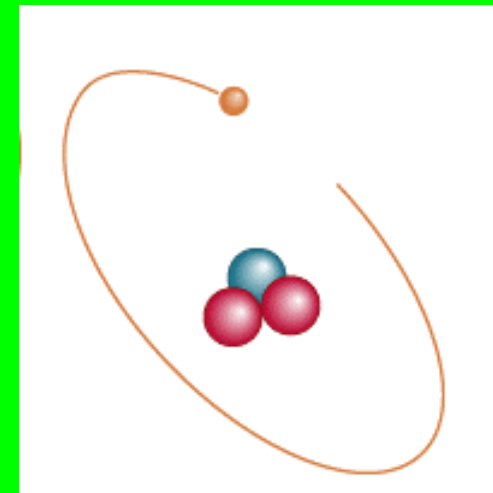
Isotopes of Hydrogen



Hydrogen-1

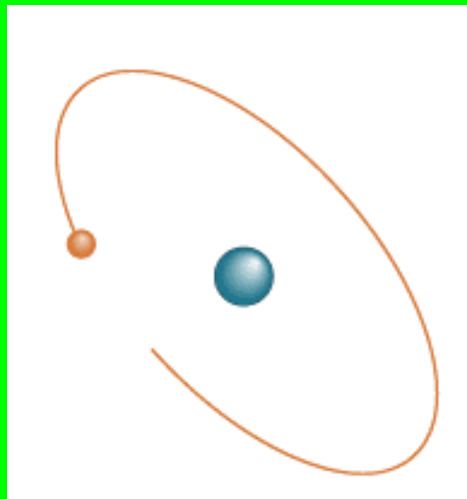


Hydrogen-2

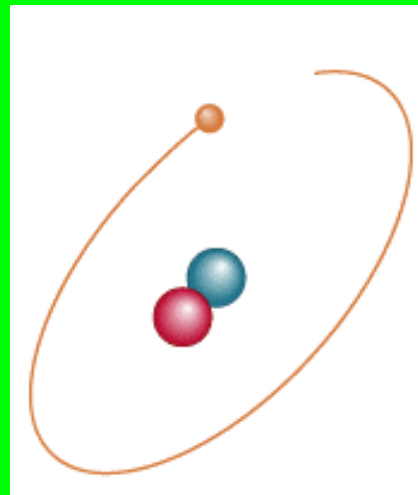


Hydrogen-3

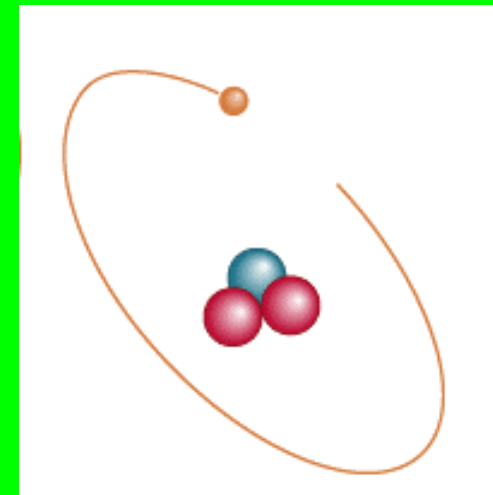
Isotopes of Hydrogen



Hydrogen-1

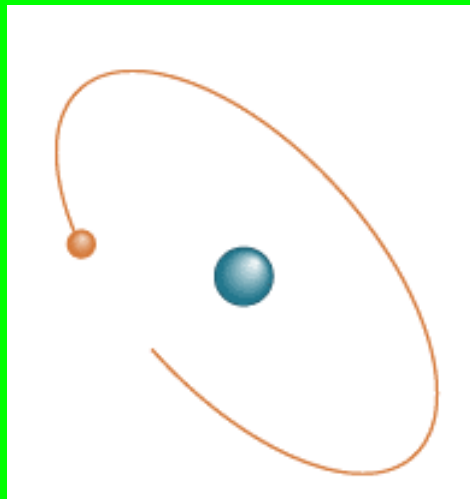
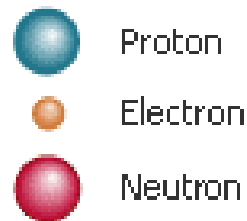


Hydrogen-2

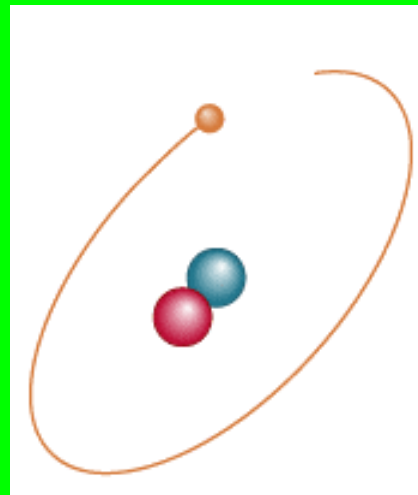


Hydrogen-3

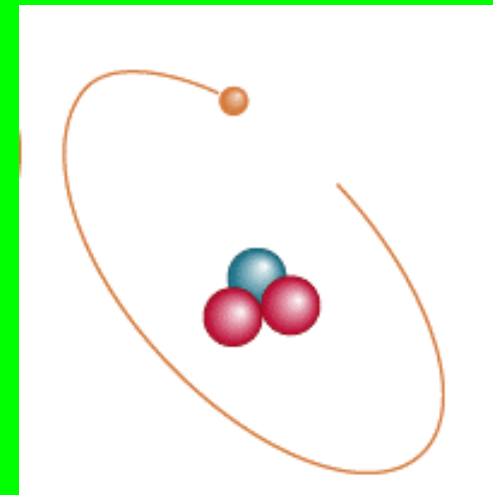
Isotopes of Hydrogen



Hydrogen-1



Hydrogen-2

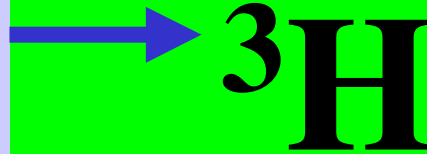


Hydrogen-3



Mass Number = Total Protons + Neutrons
in an isotope of an element

Mass Number
P + N

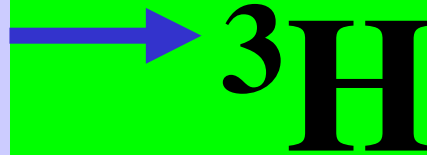


Mass Number = Total Protons + Neutrons
in an isotope of an element

Mass Number

P + N

1 P + 2 N's



Mass Number = Total Protons + Neutrons
in an isotope of an element

Mass Number

P + N

1 P + 2 N's

3H

Also called "Hydrogen - 3"



Called the “Nuclear Notation”

To find P's and N's from Nuclear Notation



To find P's and N's from Nuclear Notation



Calcium's atomic
Number = 20


To find P's and N's from Nuclear Notation



Calcium's atomic
Number = 20

So it has **20 Protons**

To find P's and N's from Nuclear Notation


To find # of
Neutrons, put
Atomic Number
Here: 

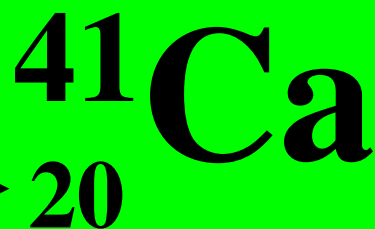


Calcium's atomic
Number = 20

So it has **20 Protons**

To find P's and N's from Nuclear Notation

To find # of
Neutrons, put
Atomic Number
Here: 




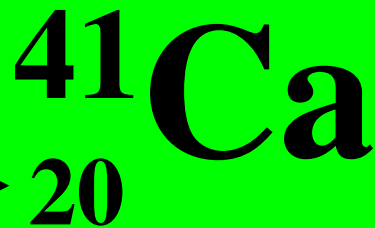
Calcium's atomic
Number = 20

So it has **20 Protons**

To find P's and N's from Nuclear Notation

$$\text{Mass \#} = \text{P} + \text{N}$$

To find # of
Neutrons, put
Atomic Number
Here: 




Calcium's atomic
Number = 20

So it has **20 Protons**

To find P's and N's from Nuclear Notation

$$\text{Mass \#} = \text{P} + \text{N}$$

To find # of
Neutrons, put
Atomic Number
Here: 



Subtract to get #
of Neutrons

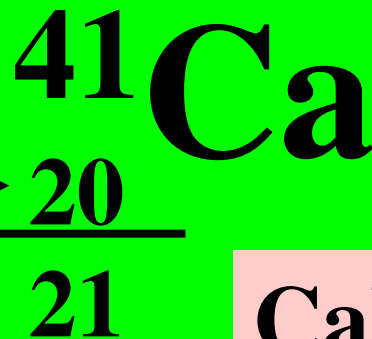
Calcium's atomic
Number = 20

So it has **20 Protons**

To find P's and N's from Nuclear Notation

$$\text{Mass \#} = \text{P} + \text{N}$$

To find # of
Neutrons, put
Atomic Number
Here: \longrightarrow



Subtract to get #
of Neutrons

Calcium's atomic
Number = 20

So it has **20 Protons**

To find P's and N's from Nuclear Notation

$$\text{Mass \#} = \text{P} + \text{N}$$

To find # of Neutrons, put Atomic Number Here: \longrightarrow



20

21

Subtract to get # of Neutrons

Calcium's atomic Number = 20

So it has **20 Protons**

So it has **21 Neutrons**

Find the # of Protons and # of Neutrons in Each of the Following Isotopes:

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{54}Fe				
^{56}Mn				
^{237}Np				
^{12}C				

Find the # of Protons and # of Neutrons in Each of the Following Isotopes:

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{54}Fe	54			
^{56}Mn				
^{237}Np				
^{12}C				

Find the # of Protons and # of Neutrons in Each of the Following Isotopes:

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{54}Fe	54	26	26	$54 - 26 =$ 28
^{56}Mn				
^{237}Np				
^{12}C				

Find the # of Protons and # of Neutrons in Each of the Following Isotopes:

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{54}Fe	54	26	26	$54 - 26 = 28$
^{56}Mn	56	25	25	31
^{237}Np				
^{12}C				

Find the # of Protons and # of Neutrons in Each of the Following Isotopes:

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{54}Fe	54	26	26	$54 - 26 = 28$
^{56}Mn	56	25	25	31
^{237}Np	237	93	93	144
^{12}C				

Find the # of Protons and # of Neutrons in Each of the Following Isotopes:

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{54}Fe	54	26	26	$54 - 26 = 28$
^{56}Mn	56	25	25	31
^{237}Np	237	93	93	144
^{12}C	12	6	6	6

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
		55		78

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
		55	55	78

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
	$55 + 78 =$ 133	55	55	78

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78
			82	128
	130	54		
		17		20

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78
		82	82	128
	130	54		
		17		20

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78
	210	82	82	128
	130	54		
		17		20

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78
^{210}Pb	210	82	82	128
	130	54		
		17		20

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78
^{210}Pb	210	82	82	128
	130	54	54	
		17		20

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78
^{210}Pb	210	82	82	128
	130	54	54	$130 - 54 =$ 76
		17		20

Now try the other way!

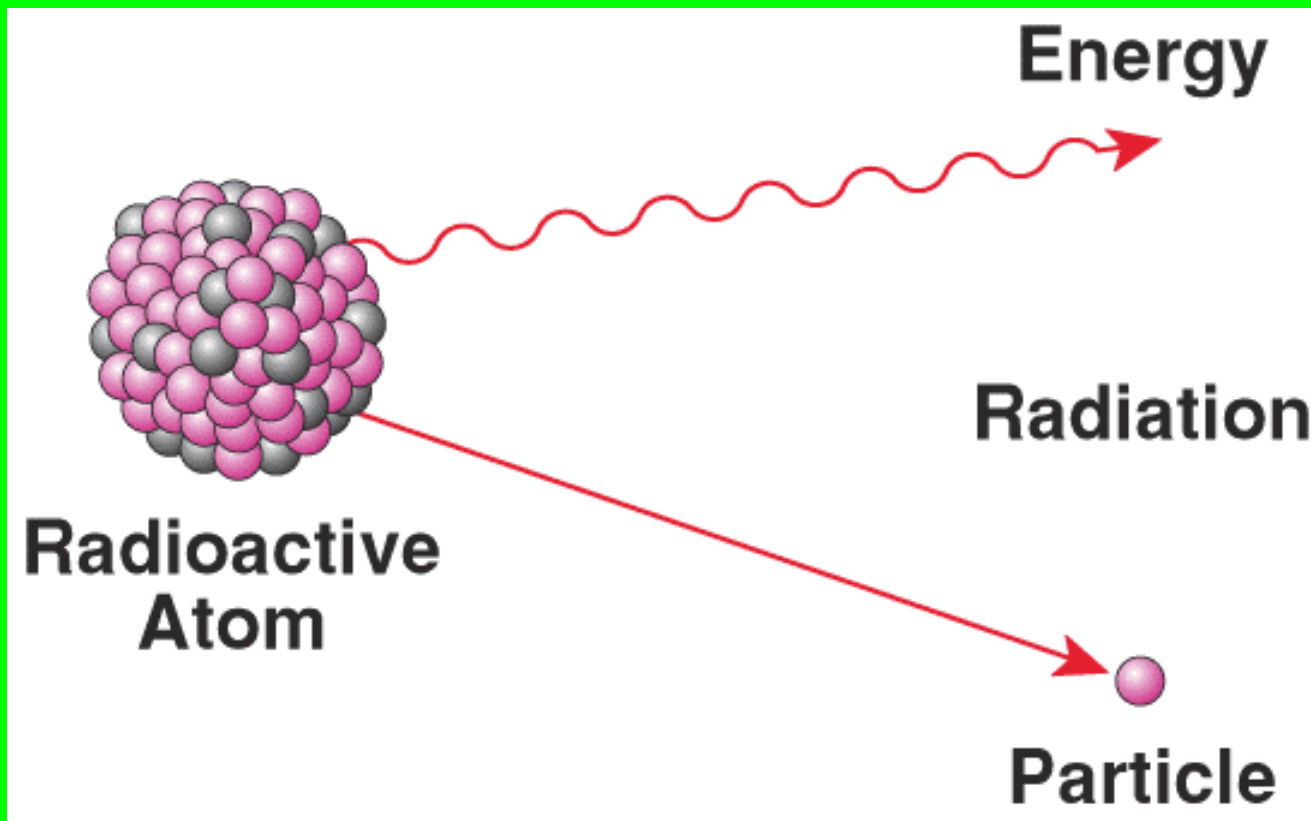
Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78
^{210}Pb	210	82	82	128
^{130}Xe	130	54	54	$130 - 54 =$ 76
		17		20

Now try the other way!

Isotope	Mass #	Atomic #	# of Protons	# of Neutrons
^{133}Cs	$55 + 78 =$ 133	55	55	78
^{210}Pb	210	82	82	128
^{130}Xe	130	54	54	$130 - 54 =$ 76
^{37}Cl	37	17	17	20

Radioactive Isotopes

- Isotopes that have unstable nuclei
- They “fall apart” giving off radiation

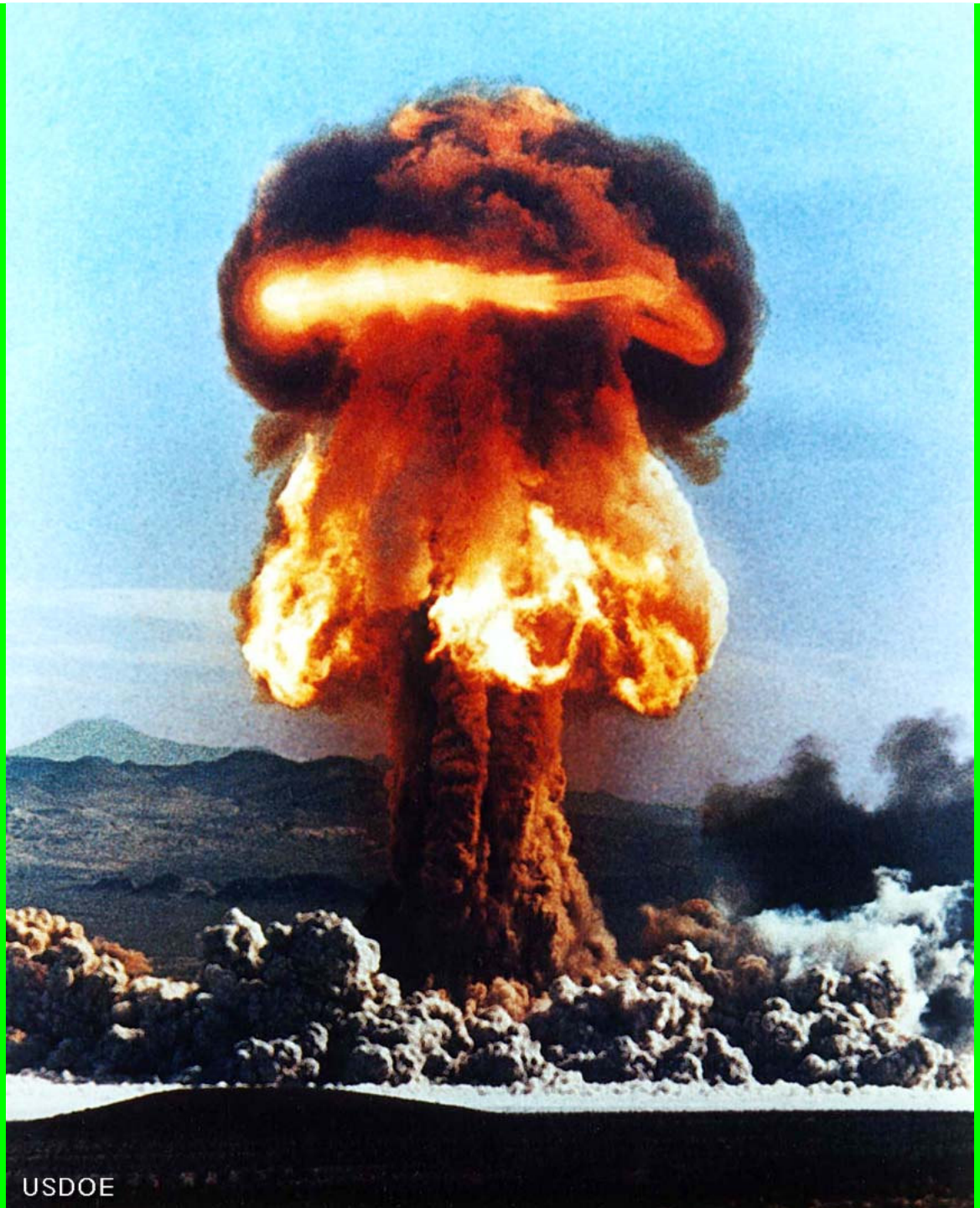


Cobalt – 60 or ^{60}Co

-Is used to kill cancer cells in radiation therapy



**Uranium-235
or ^{235}U is
used to make
atomic
bombs!**



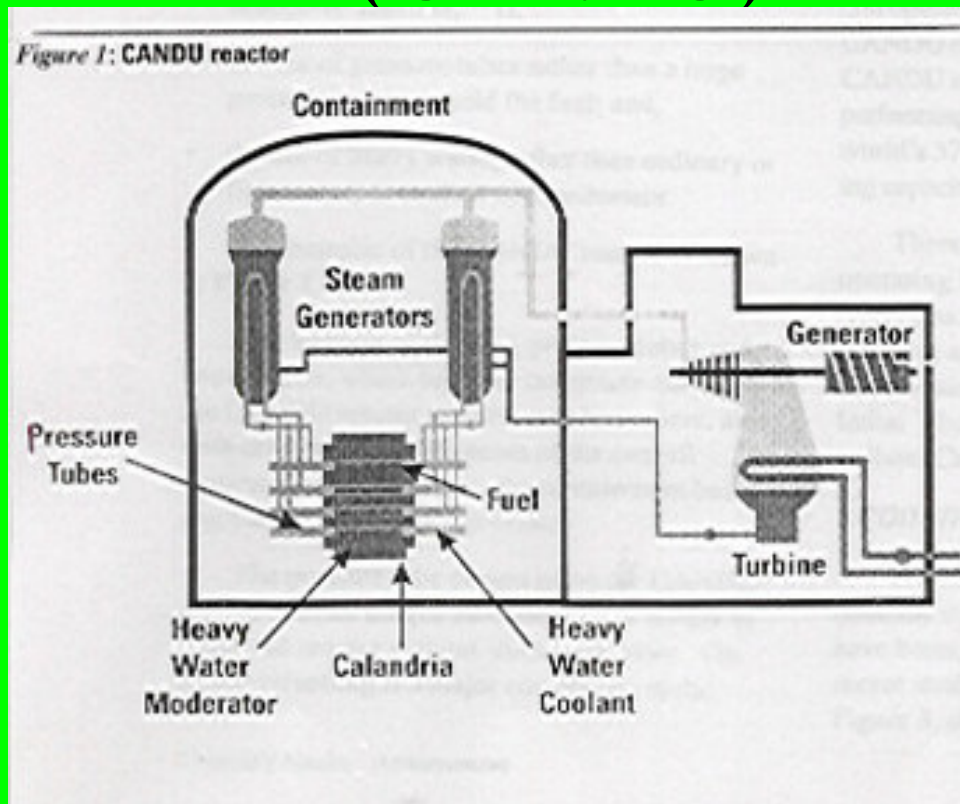


**Radiation from
atomic bombs can
cause severe
radiation burns
to the skin!**

Hydrogen-2 or ^2H is called deuterium.

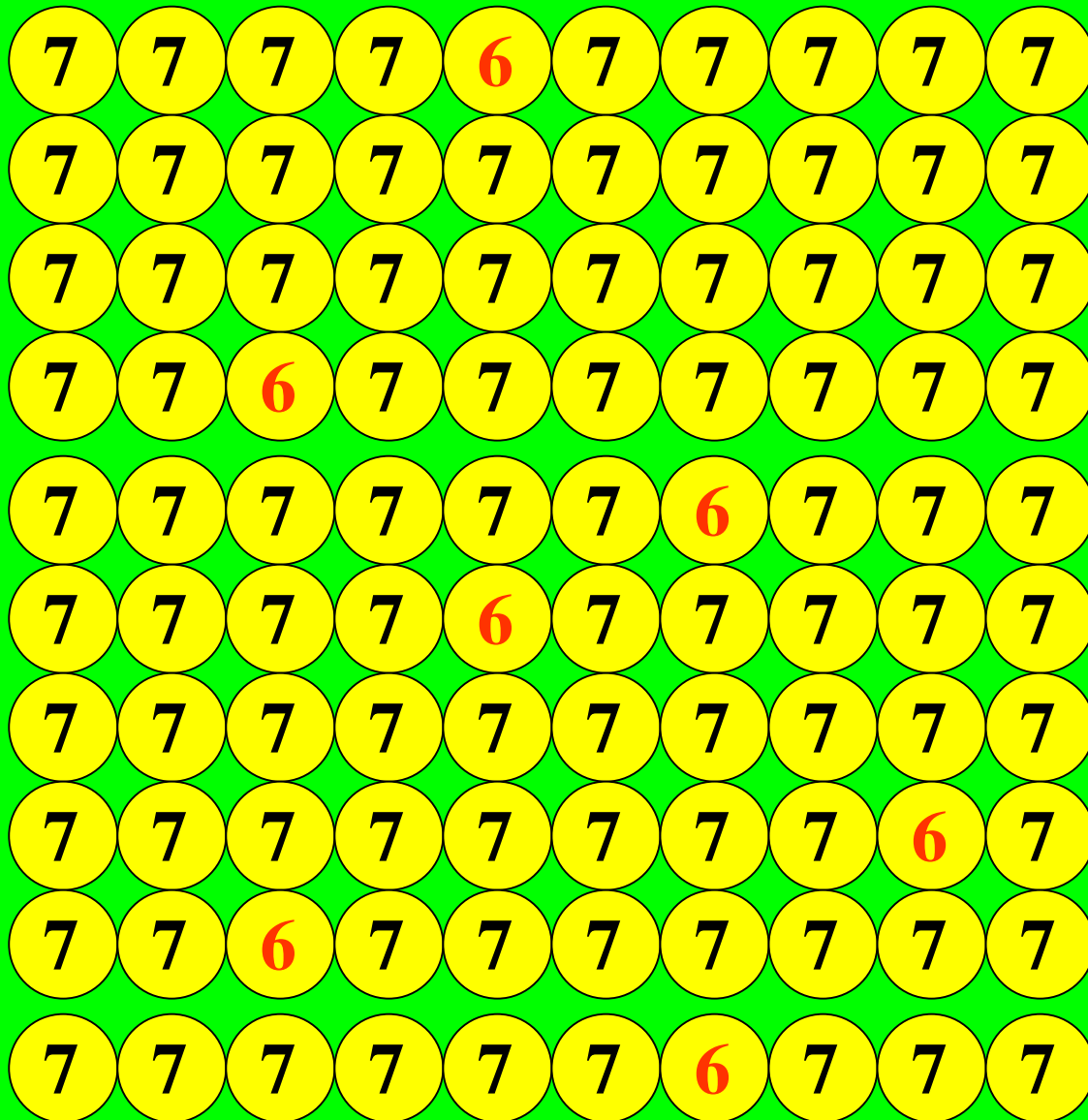
**Deuterium oxide $^2\text{H}_2\text{O}$ is also called
“Heavy Water”**

**It is used in Canadian (CANDU) nuclear
power plants.**

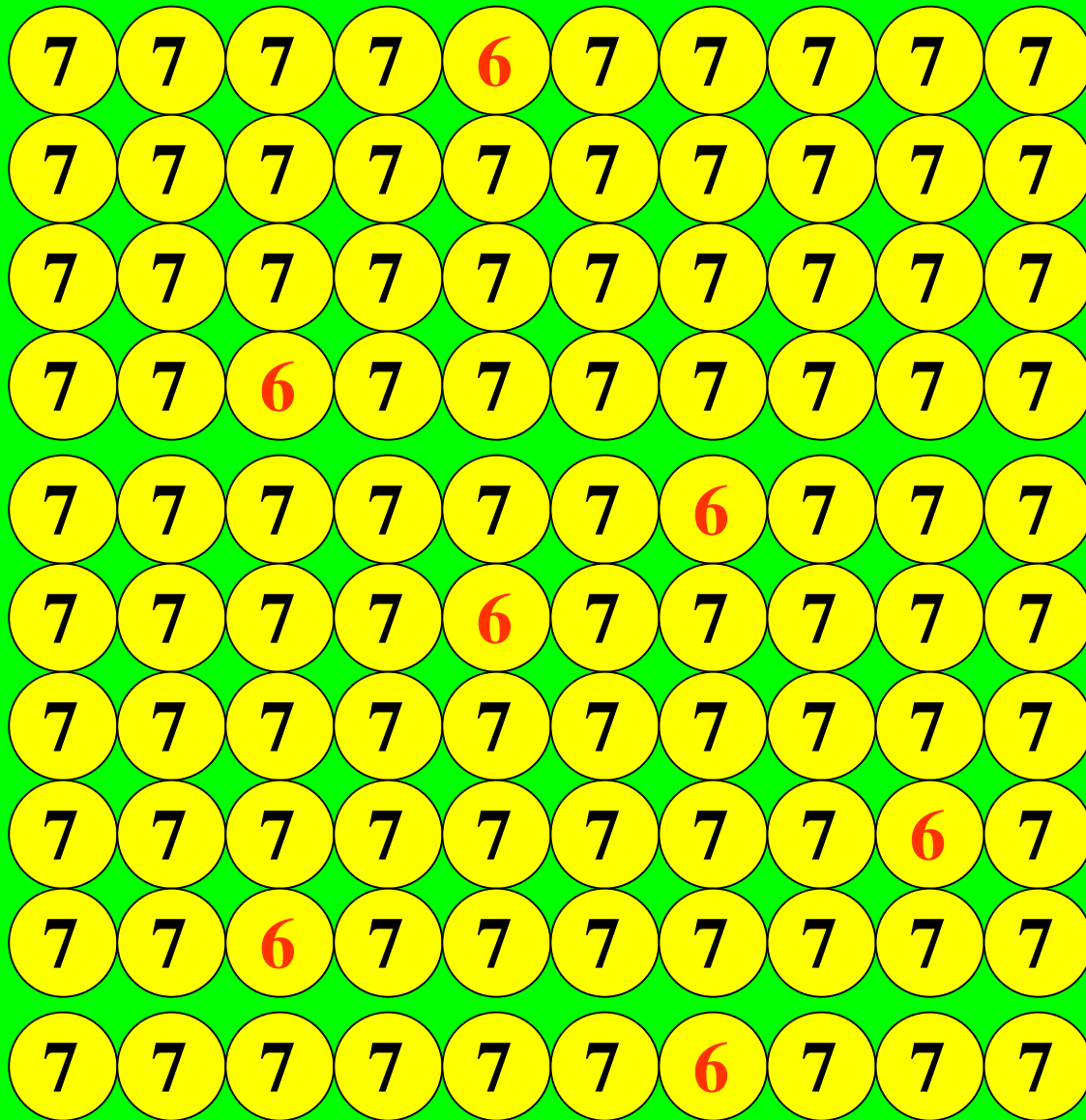




Lithium on Earth is about 7% ${}^6\text{Li}$ and 93% ${}^7\text{Li}$.

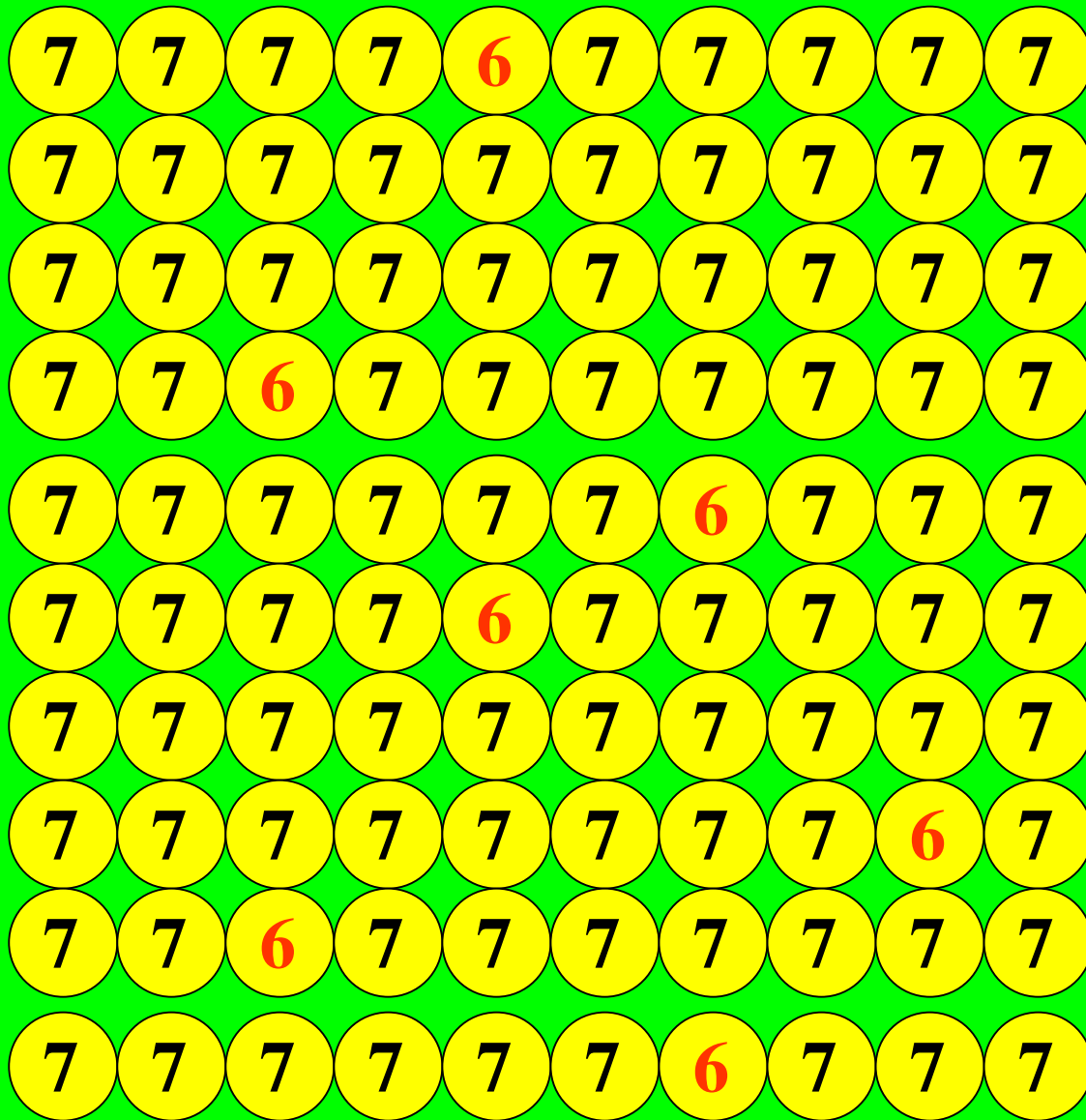


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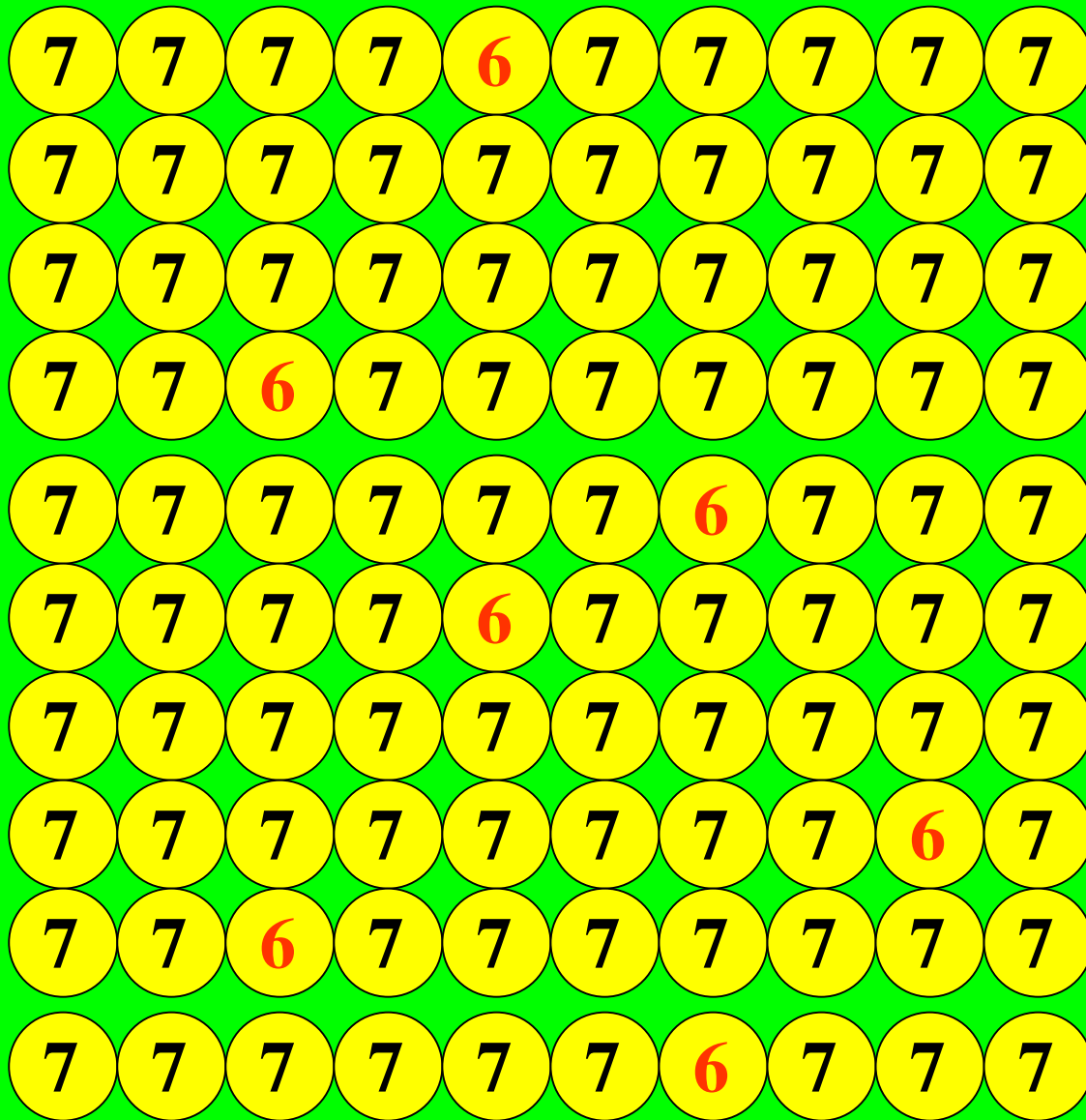
Total Mass of ${}^6\text{Li}$
=

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Total Mass of ${}^6\text{Li}$
 $= 7 \times 6 = 42$

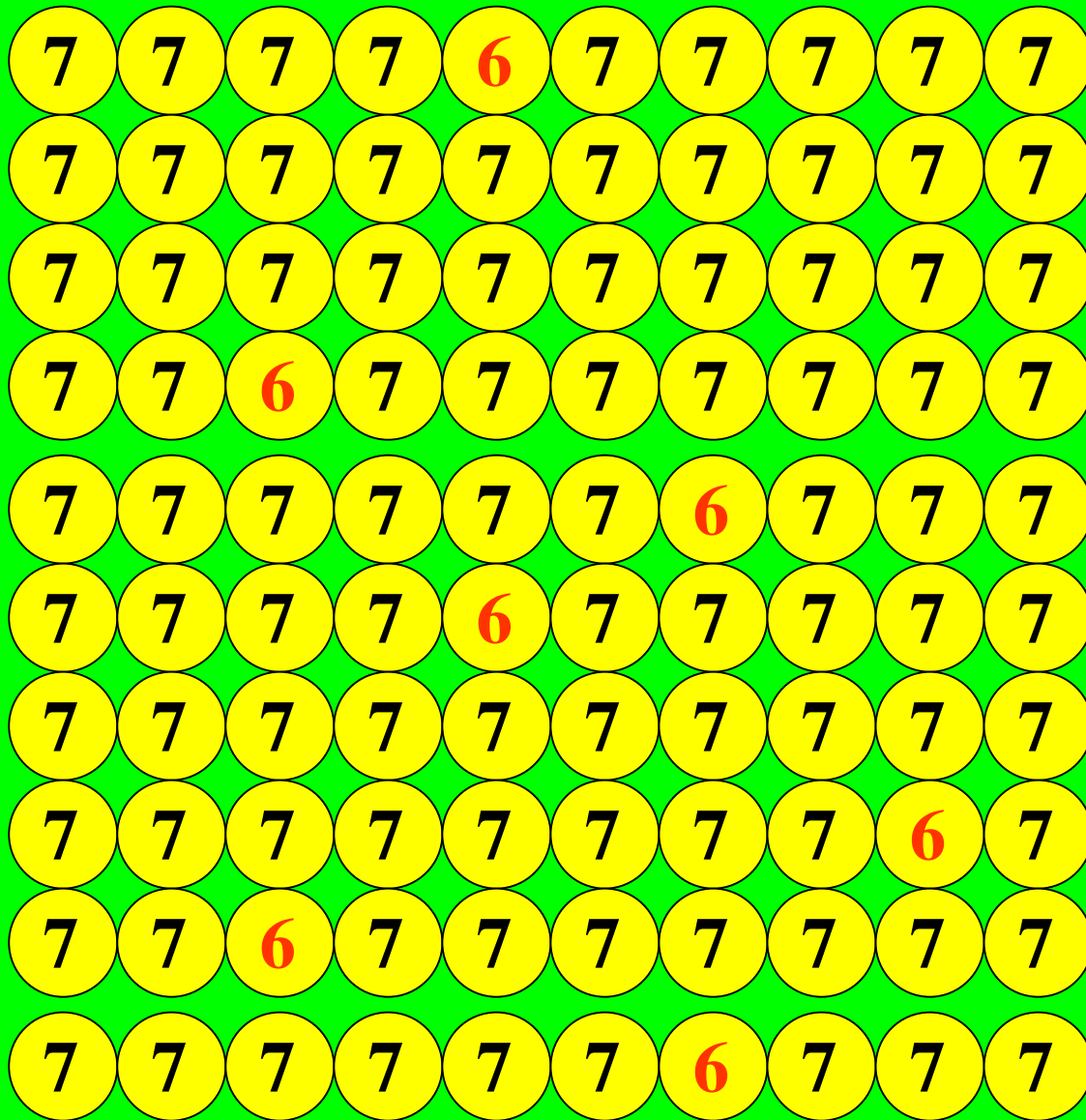
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Total Mass of ${}^7\text{Li}$
 $=$

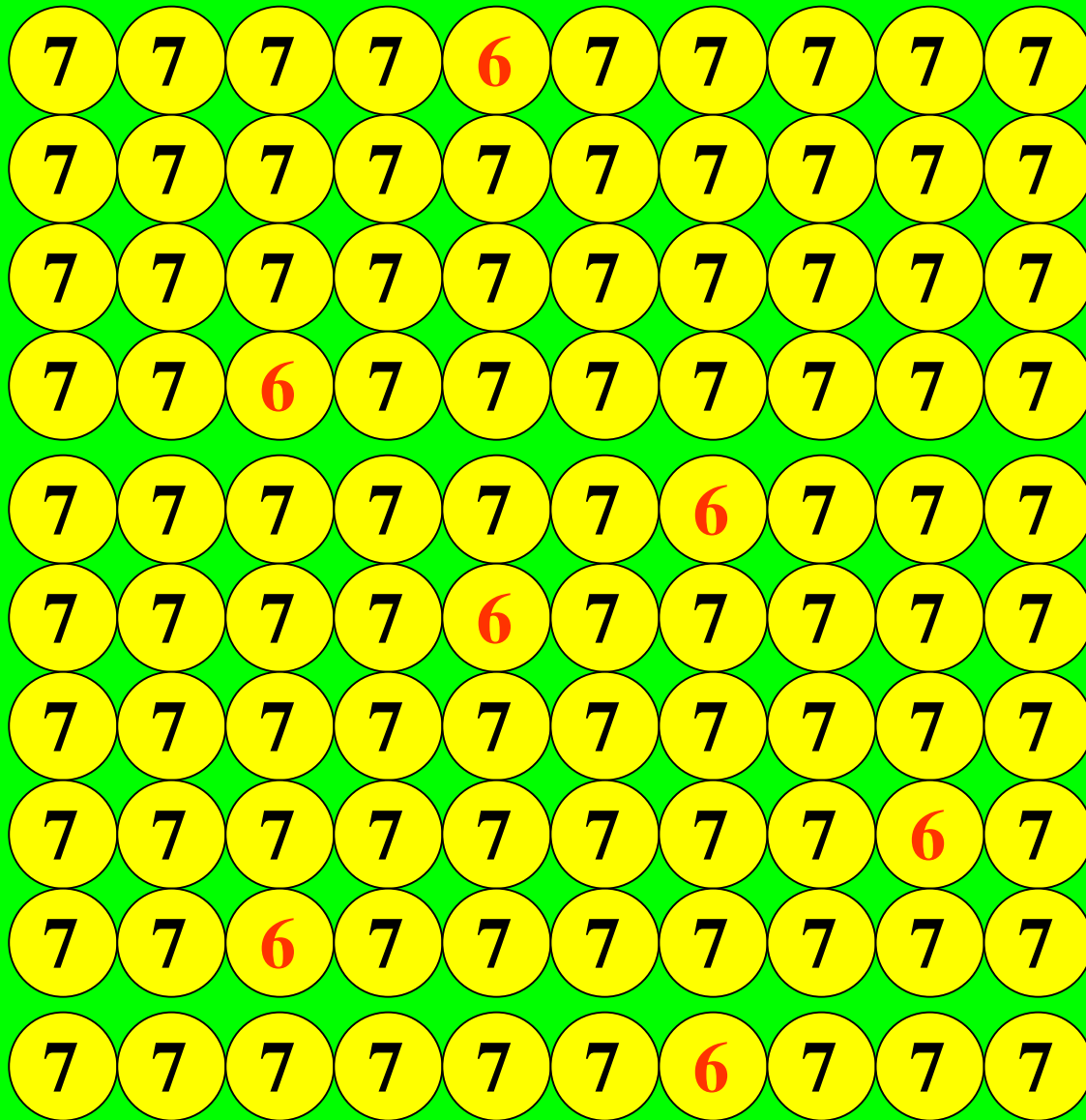
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Total Mass of ${}^6\text{Li}$
 $= 7 \times 6 = 42$

Total Mass of ${}^7\text{Li}$
 $= 93 \times 7 = 651$

Lithium on Earth is about 7% ${}^6\text{Li}$ and 93% ${}^7\text{Li}$.

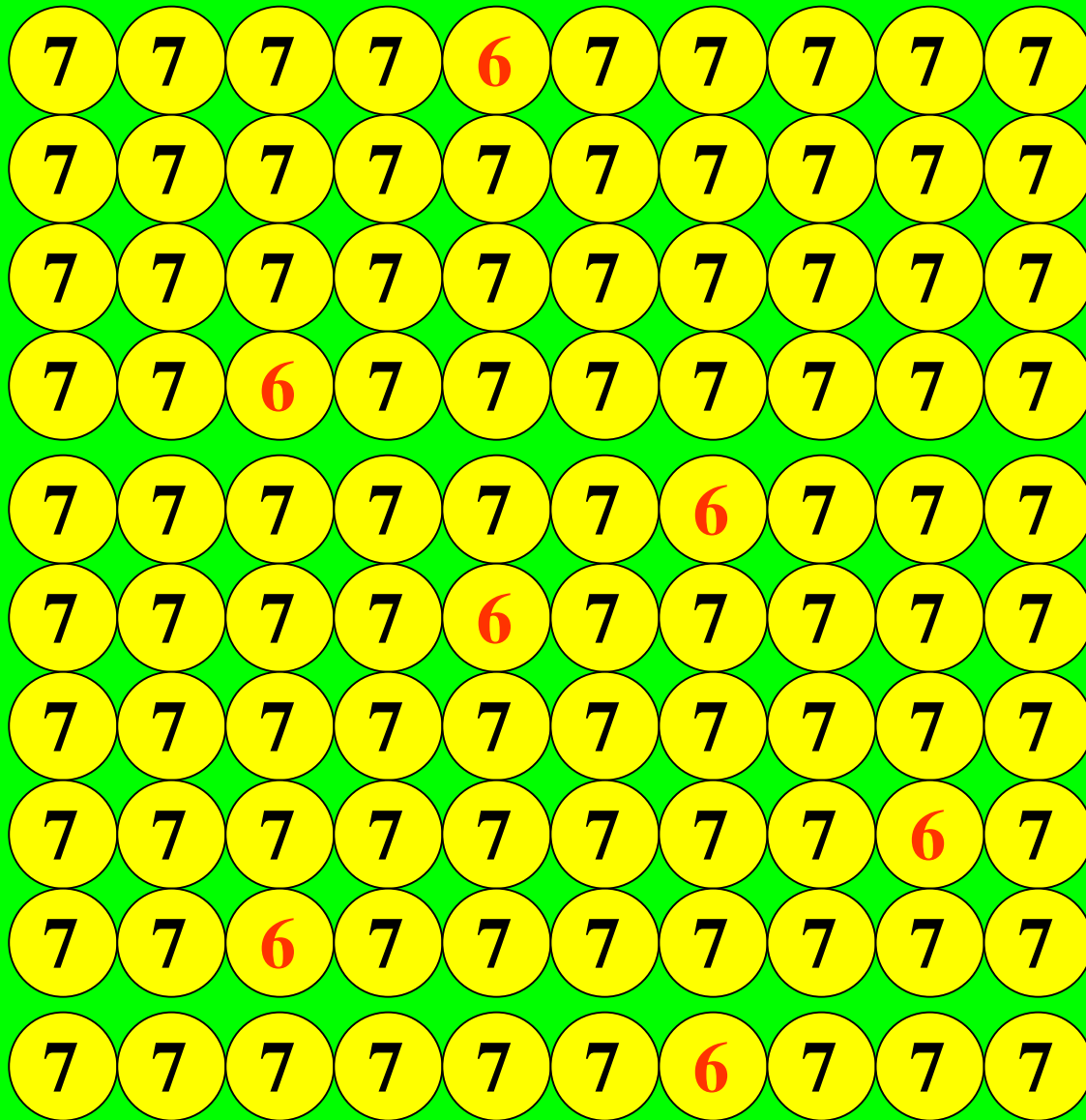


Total Mass of ${}^6\text{Li}$
 $= 7 \times 6 = 42$

Total Mass of ${}^7\text{Li}$
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Total Mass of 100
Lithium Atoms
 $=$

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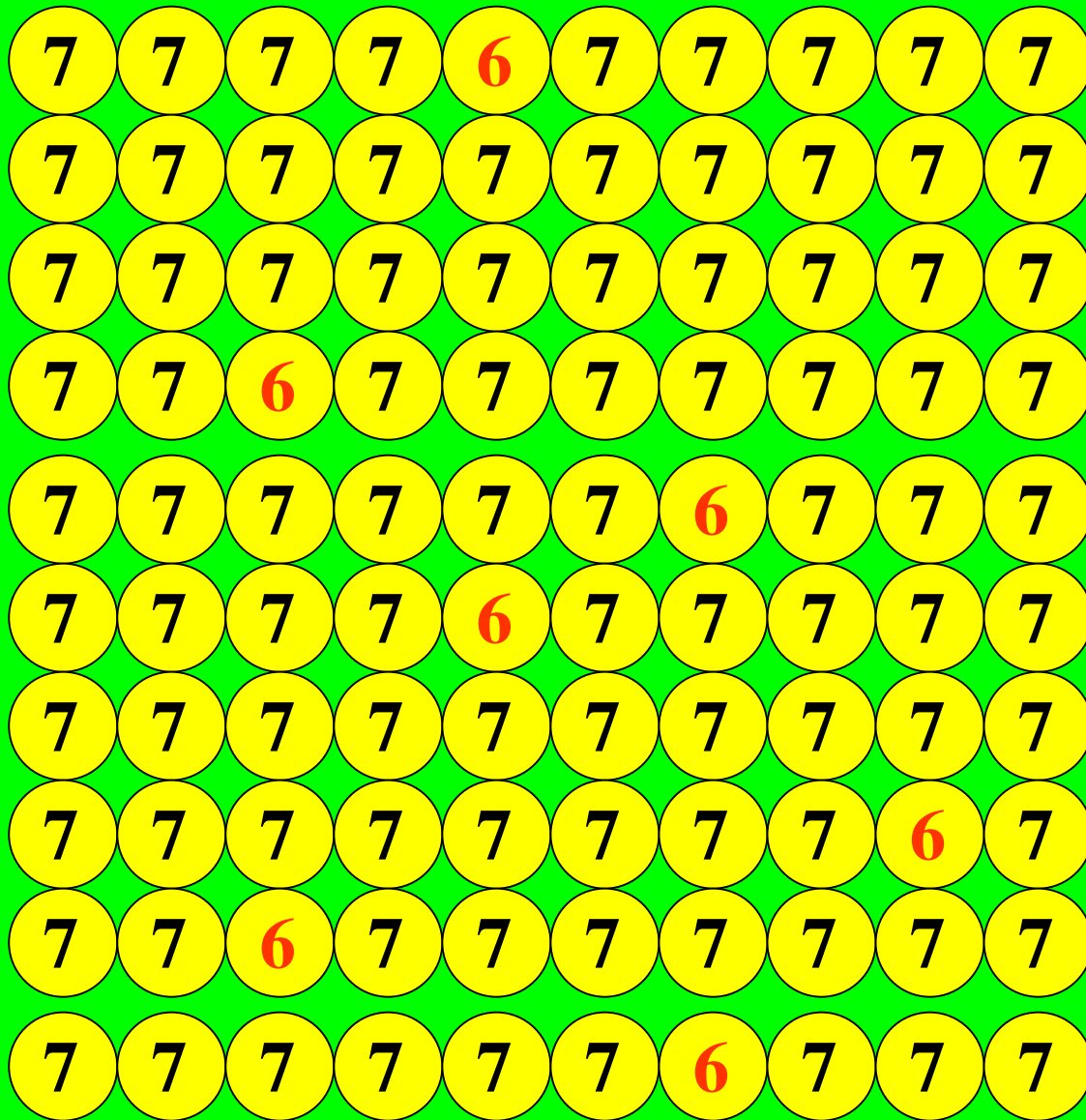


Total Mass of ${}^6\text{Li}$
 $= 7 \times 6 = 42$

Total Mass of ${}^7\text{Li}$
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Total Mass of 100
Lithium Atoms
 $= 42 + 651 = 693$

Lithium on Earth is about 7% ${}^6\text{Li}$ and 93% ${}^7\text{Li}$.



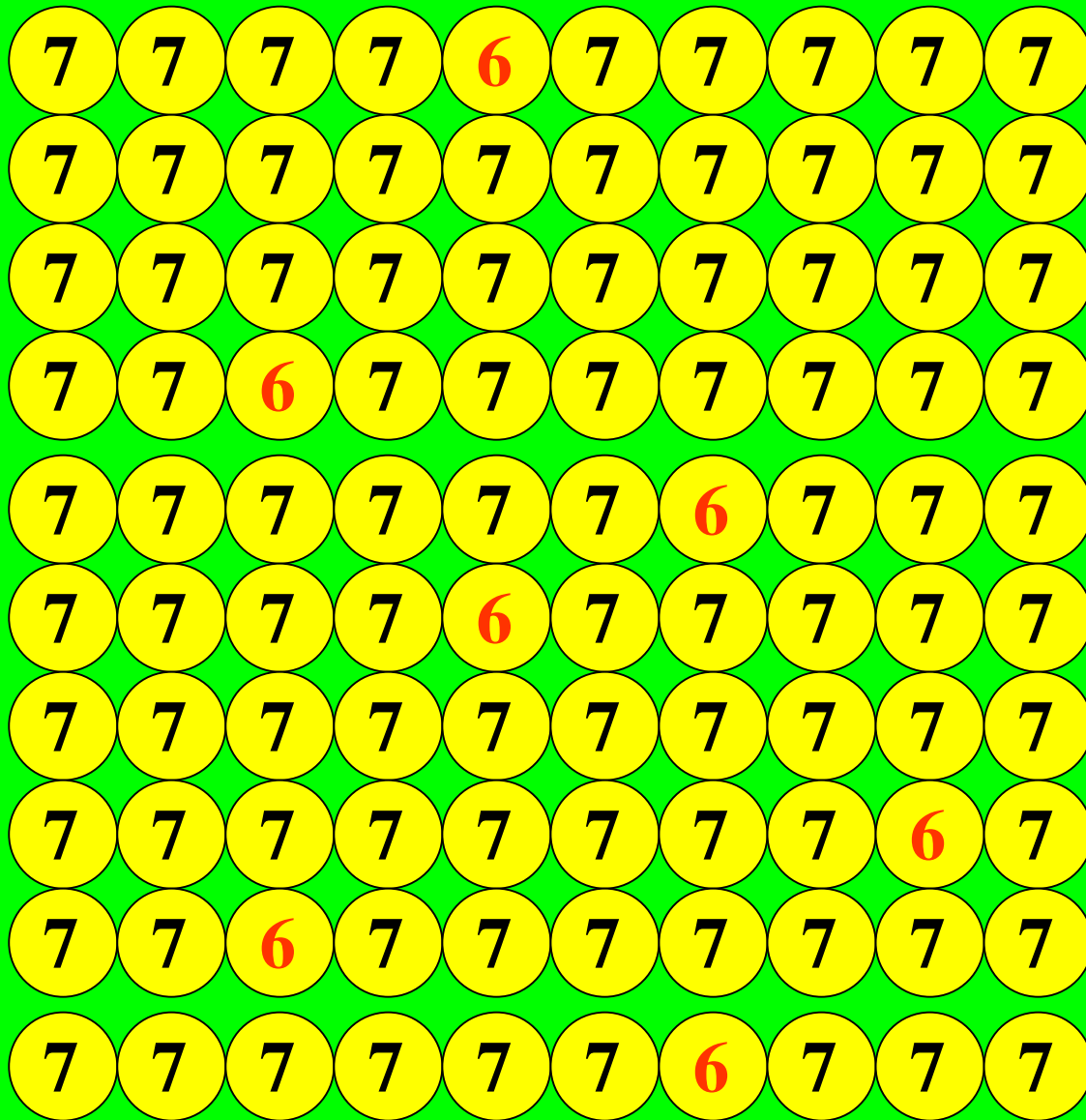
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Average Mass of 1 Li
Atom $= 693/100 =$

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Total Mass of ${}^6\text{Li}$
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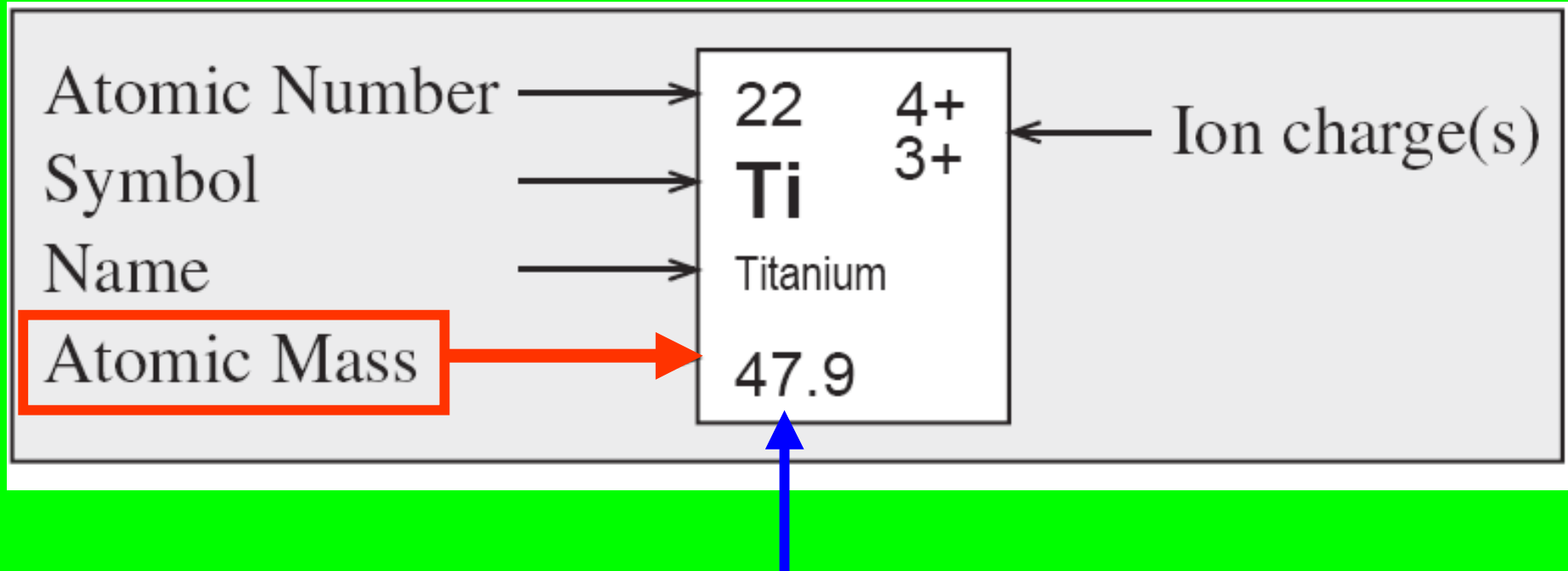
Total Mass of 100
Lithium Atoms
 $= 42 + 651 = 693$

Average Mass of 1 Li
Atom $= 693/100 = 6.93$

The “weighted average” mass of isotopes of an element is called its **Atomic Mass**

The “weighted average” mass of isotopes of an element is called its **Atomic Mass**

Atomic Number	→	22	4+	← Ion charge(s)
Symbol	→	Ti	3+	
Name	→	Titanium		
Atomic Mass	→	47.9		



It is shown underneath the symbol on the Periodic Table

Element	Atomic Number	Number of Protons	Atomic Mass
Ag			
Se			
Bh			

Element	Atomic Number	Number of Protons	Atomic Mass
Ag	47	47	107.9
Se			
Bh			

Element	Atomic Number	Number of Protons	Atomic Mass
Ag	47	47	107.9
Se	34	34	79.0
Bh			

Element	Atomic Number	Number of Protons	Atomic Mass
Ag	47	47	107.9
Se	34	34	79.0
Bh	107	107	262

Element	Atomic Number	Number of Protons	Atomic Mass
Ag	47	47	107.9
Se	34	34	79.0
Bh	107	107	262

Mass of most stable isotope

In a Neutral Atom of an Element:

The # of Electrons(-) = The # of Protons(+)

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Neutral Carbon has _____ Protons

In a Neutral Atom of an Element:

The # of Electrons(-) = The # of Protons(+)

Neutral Carbon has 6 Protons

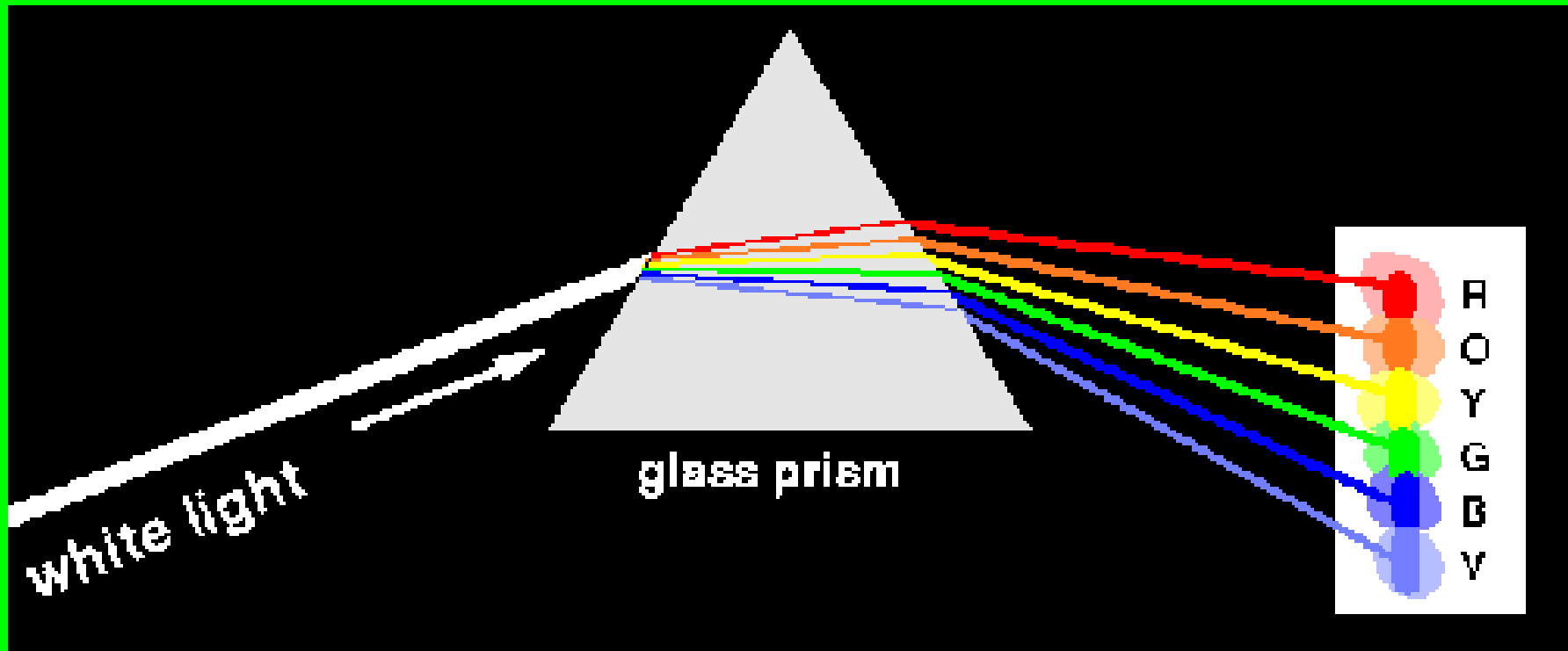
Neutral Carbon has ___ Electrons

In a Neutral Atom of an Element:

The # of Electrons(-) = The # of Protons(+)

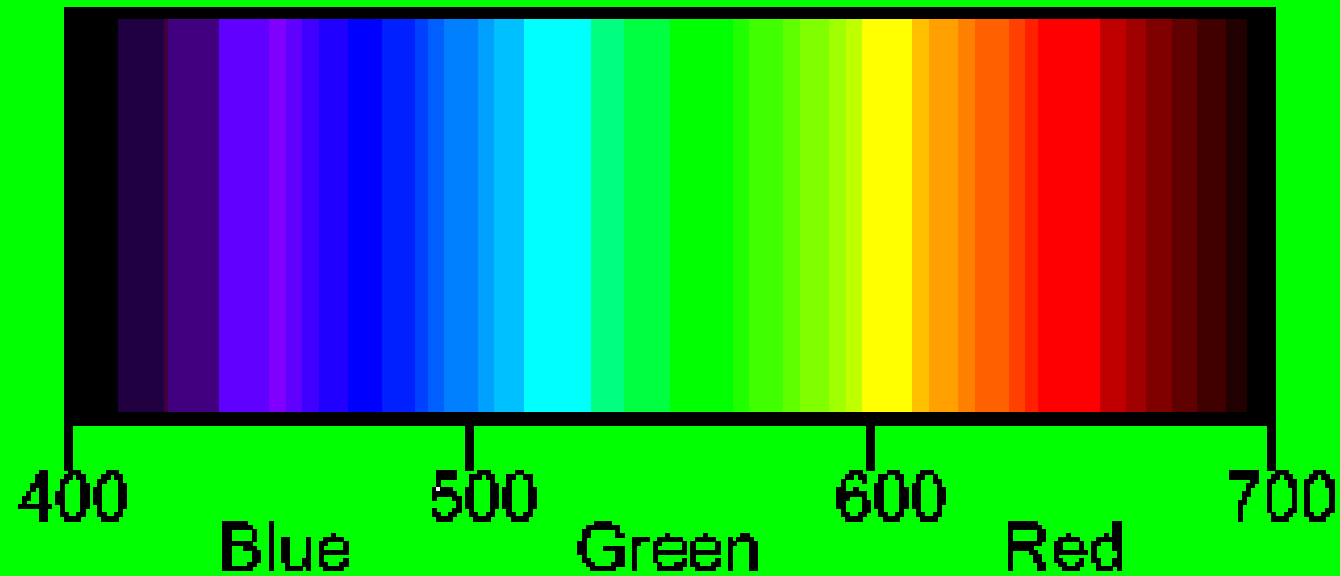
Neutral Carbon has 6 Protons

Neutral Carbon has 6 Electrons



When white light is shone through a prism, it is separated into different colours.

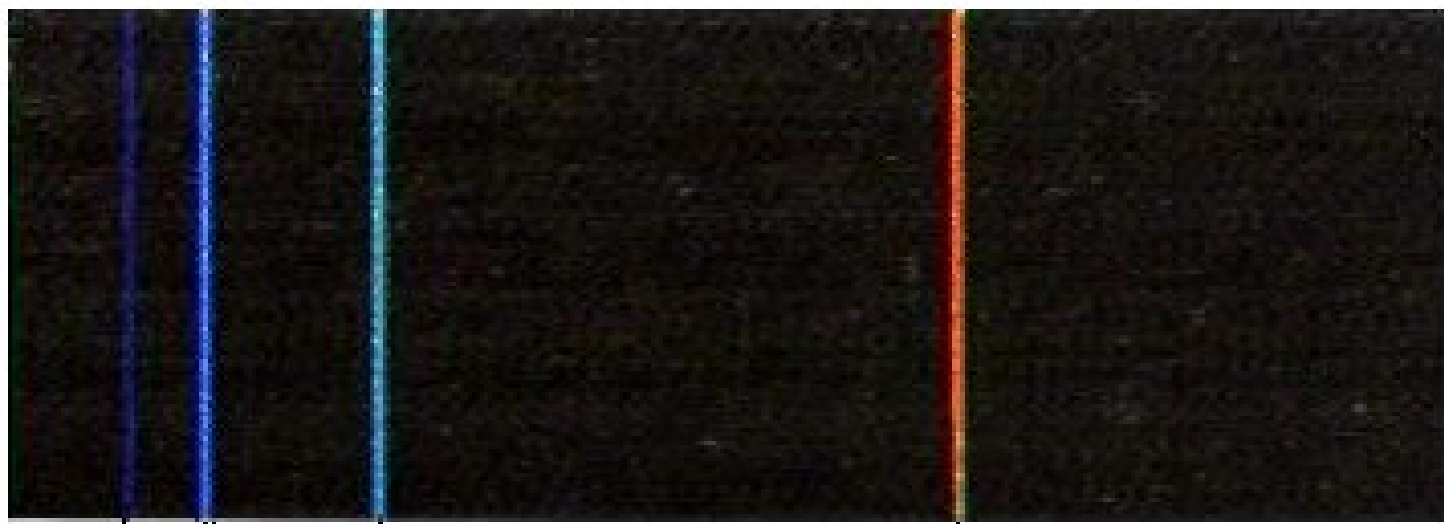
VISIBLE SPECTRUM



The Pattern of Colours is called a
SPECTRUM

If a single element is subjected to a high voltage, it has a spectrum too, but it is different!

If a single element is subjected to a high voltage, it has a spectrum too, but it is different!

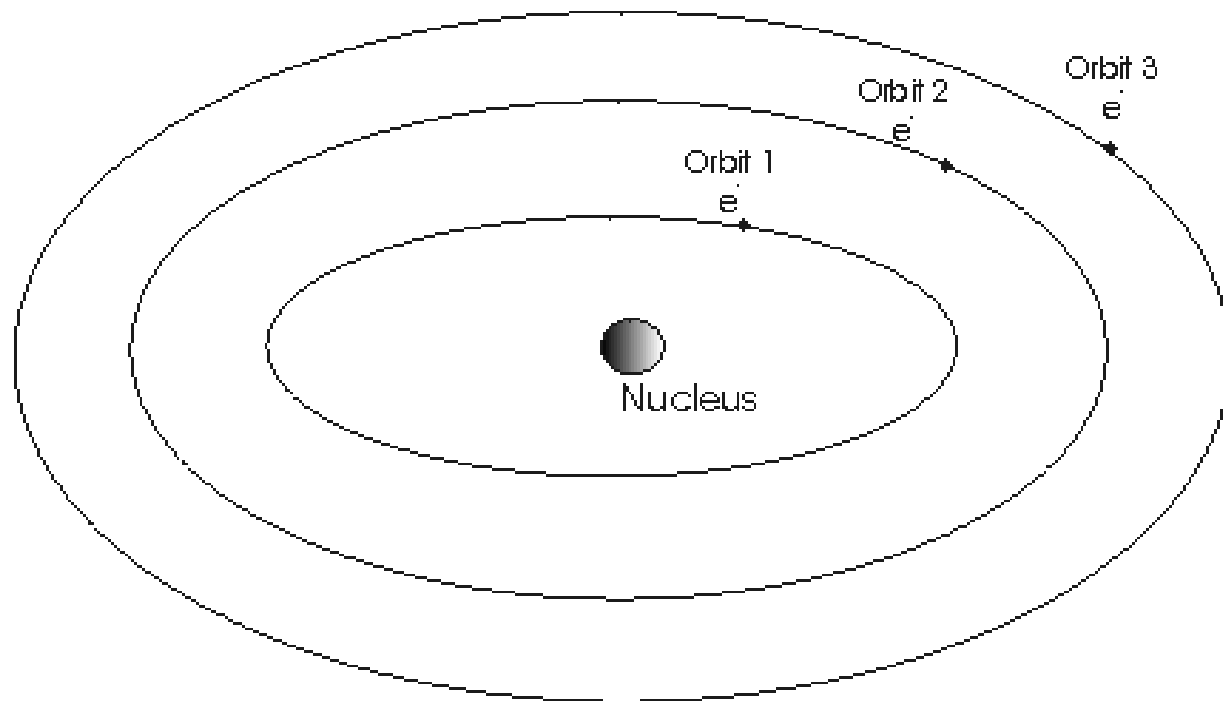


The spectrum of Hydrogen only has a few “lines”

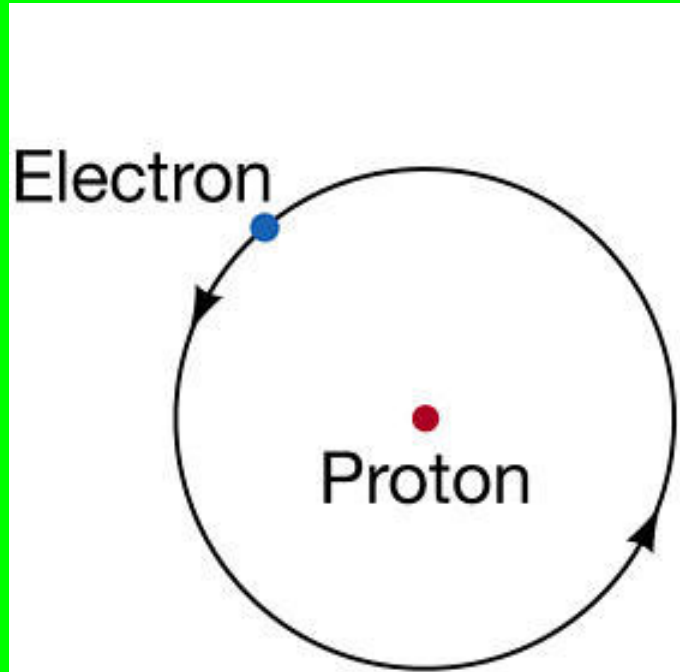
Niels Bohr

**A Danish
Physicist**

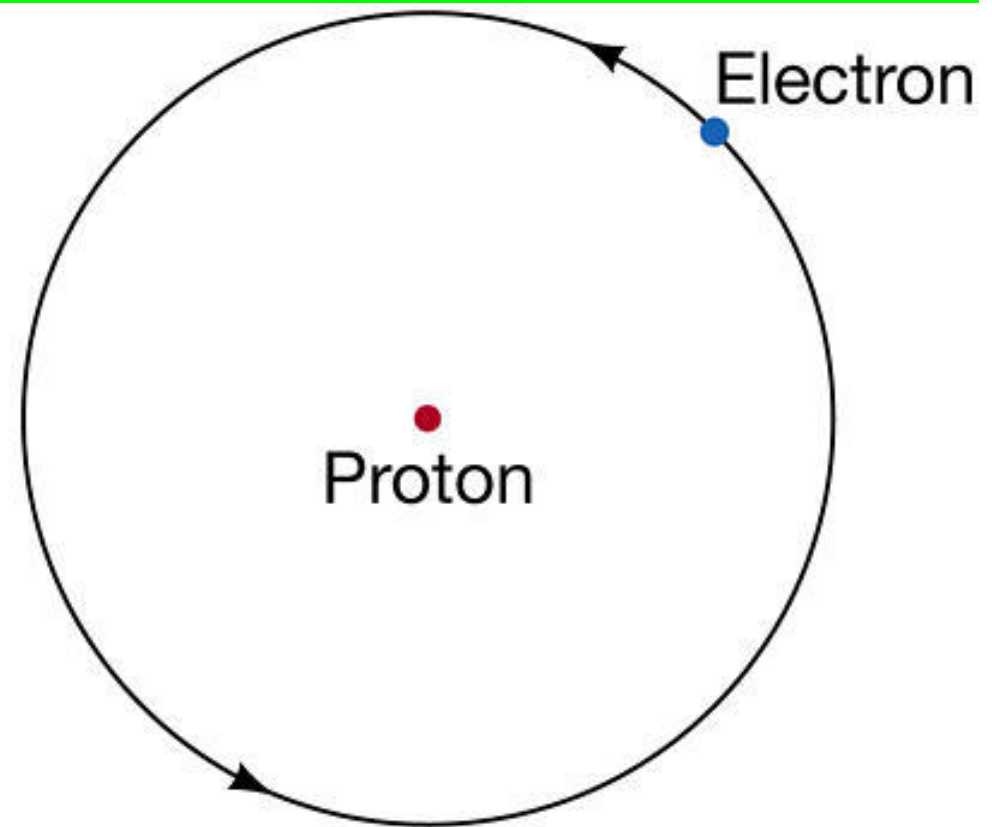




Bohr said the atom has different “Energy Levels” or “Orbits” or “Shells” which the electrons could inhabit.



(a) Ground state

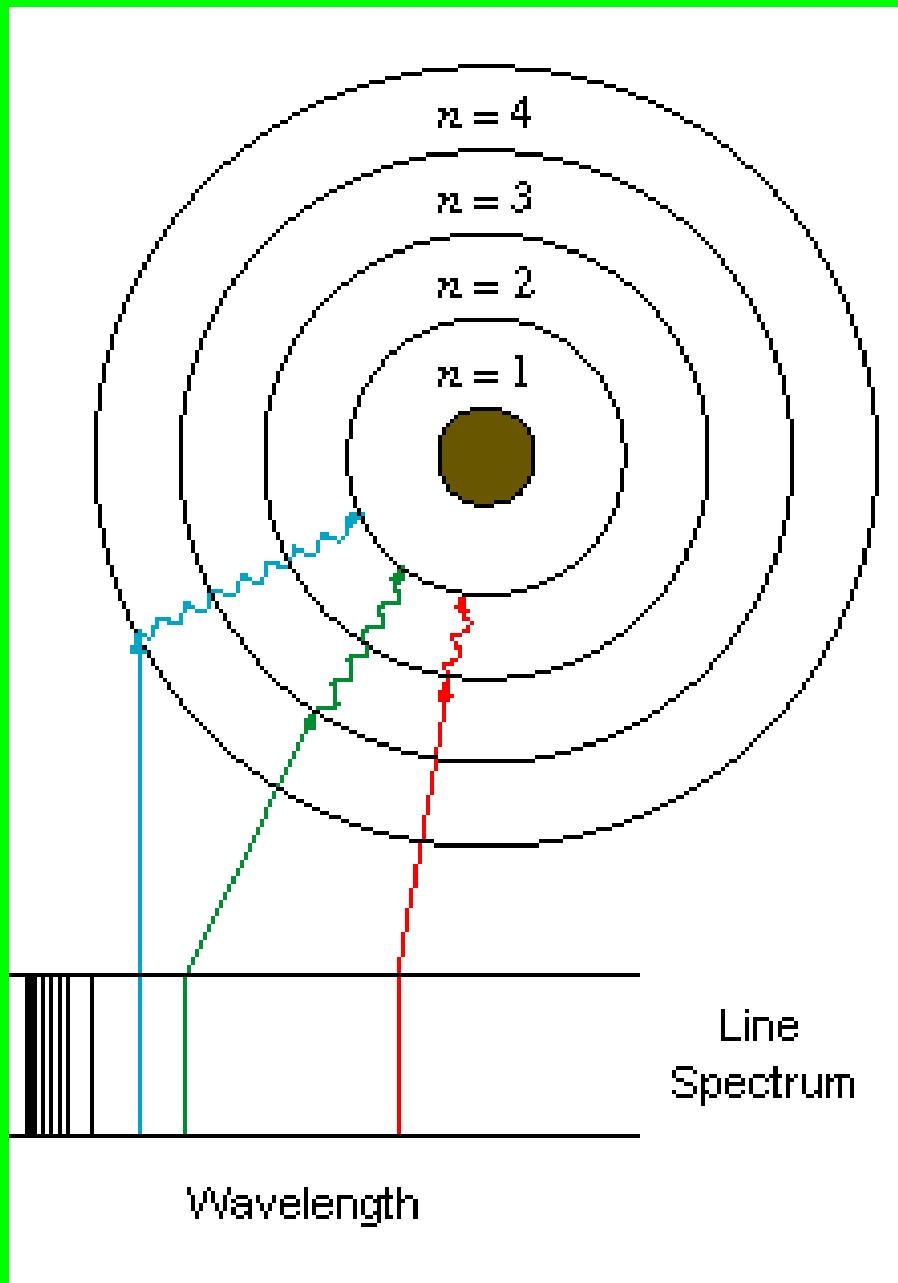


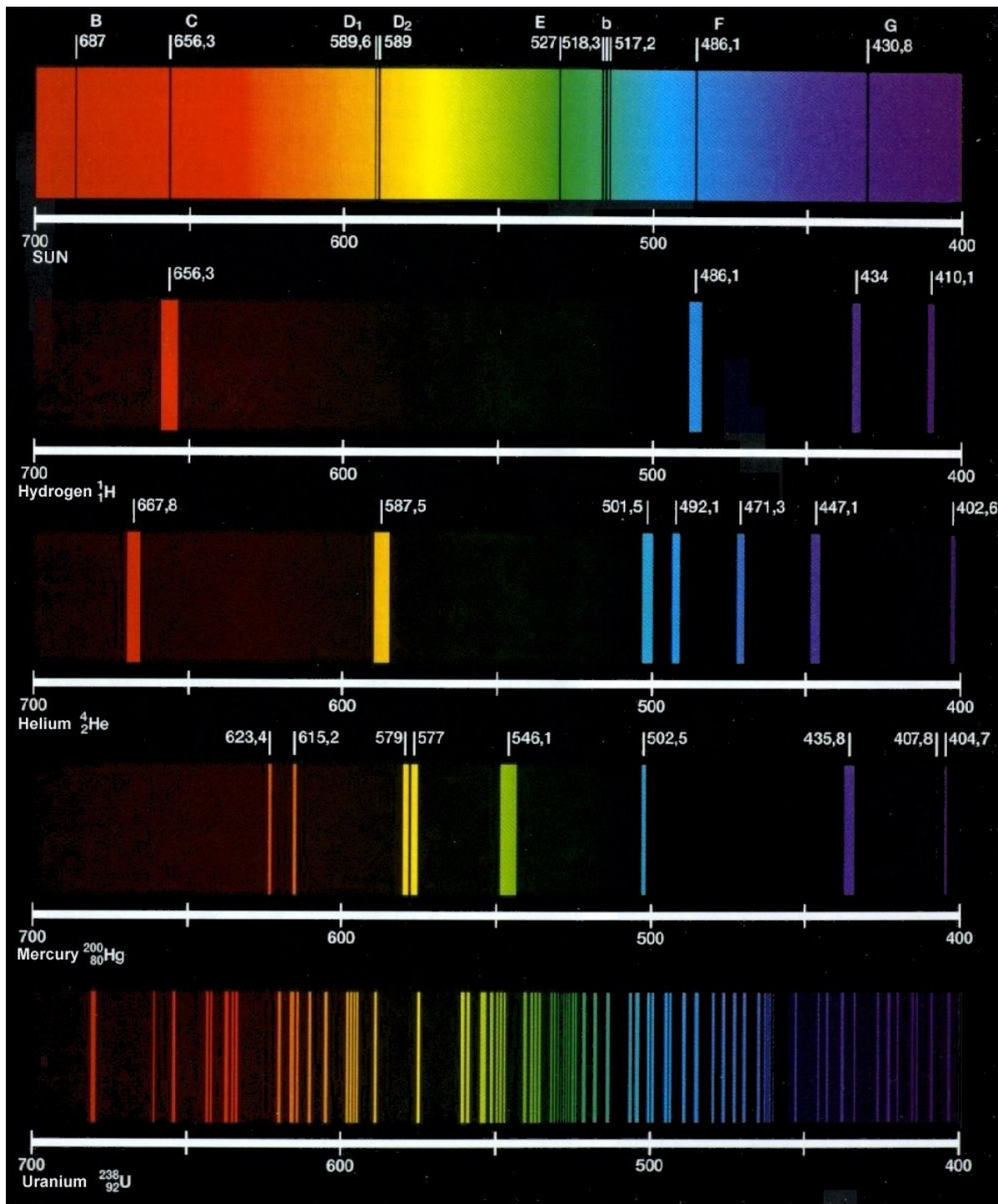
(b) Excited state

When energy is added to an atom, the electron “jumps” to a higher orbit (the atom is then in an “excited state”)

When electrons jump from higher orbits back to lower orbits, they “give off” energy in the form of light.

Different “jumps” give different colours.

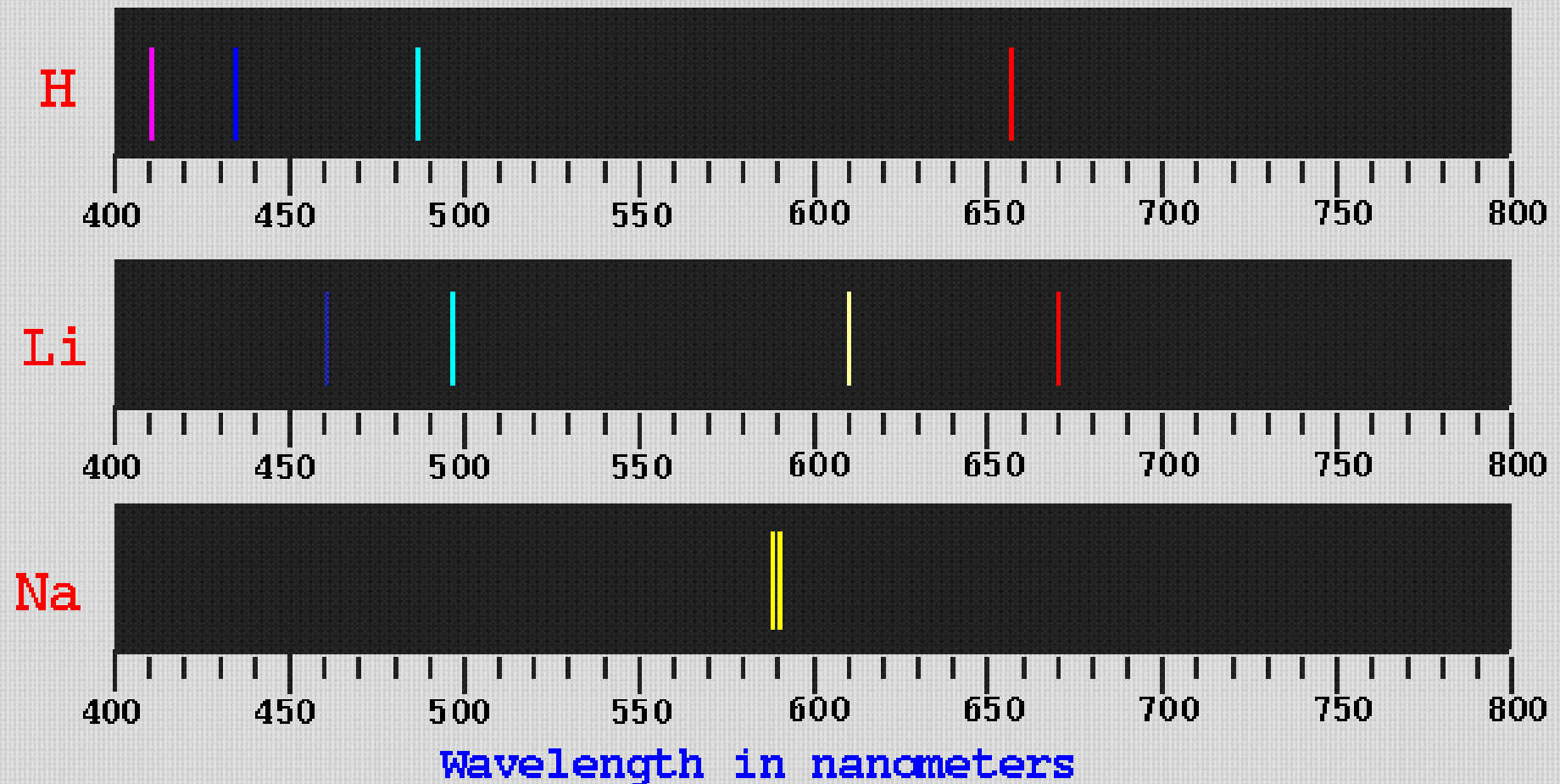




Since atoms of different elements have different electron arrangements, each element has its own unique spectrum!

Spectra can be used to “identify” an unknown element – like a fingerprint!

Atomic Emission Spectra



Bohr's Orbits

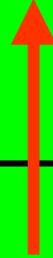
	First Orbit	Second Orbit	Third Orbit
Maximum # of Electrons	2	8	8

Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
He					

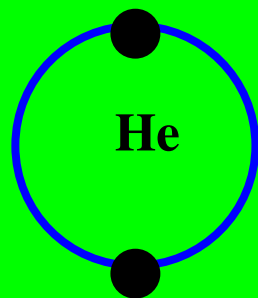
Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
He	2	2	2	0	0



Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
He	2	2	2	0	0



Bohr Models:

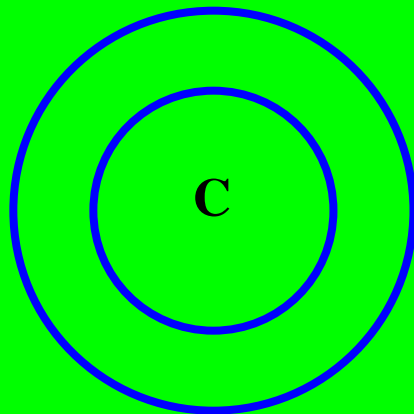
Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
C					

Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
C	6	6	2	4	0

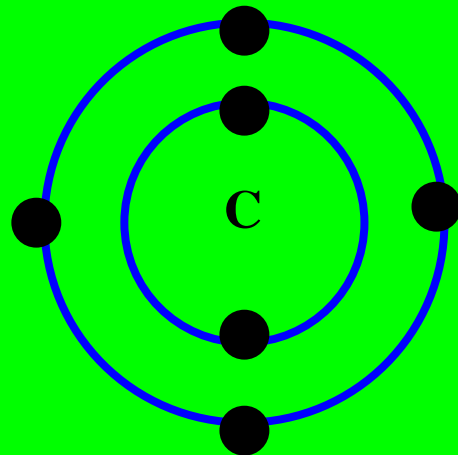
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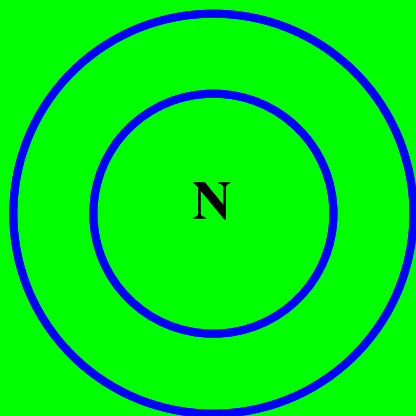


Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
N					

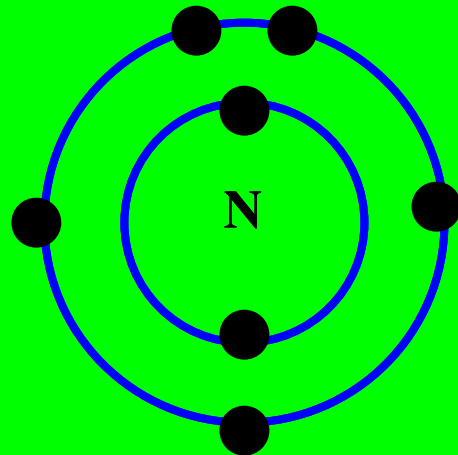
Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
N	7	7	2	5	0



Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
N	7	7	2	5	0

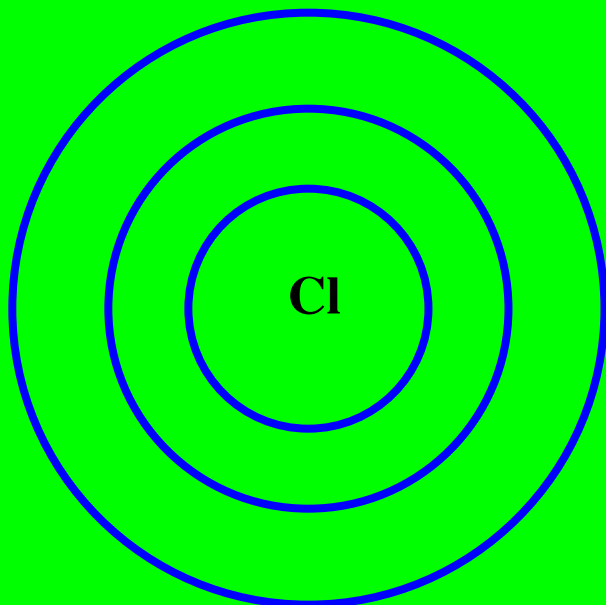


Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
Cl					

Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
Cl	17	17	2	8	7



Bohr Models:

Element	Atomic Number	Total # of Electrons	Electrons in First Orbit	Electrons in Second Orbit	Electrons in Third Orbit
Cl	17	17	2	8	7

