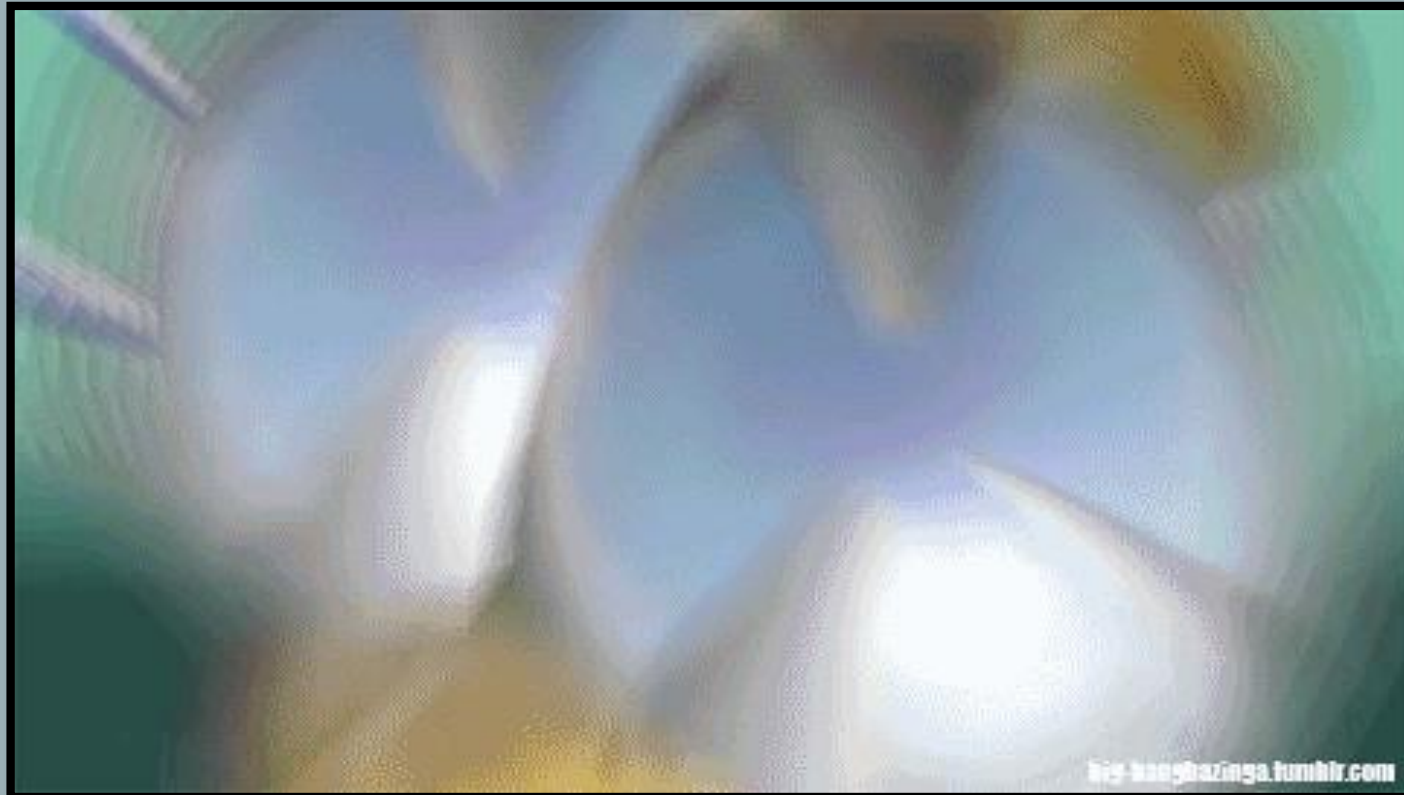


ATOMIC THEORY



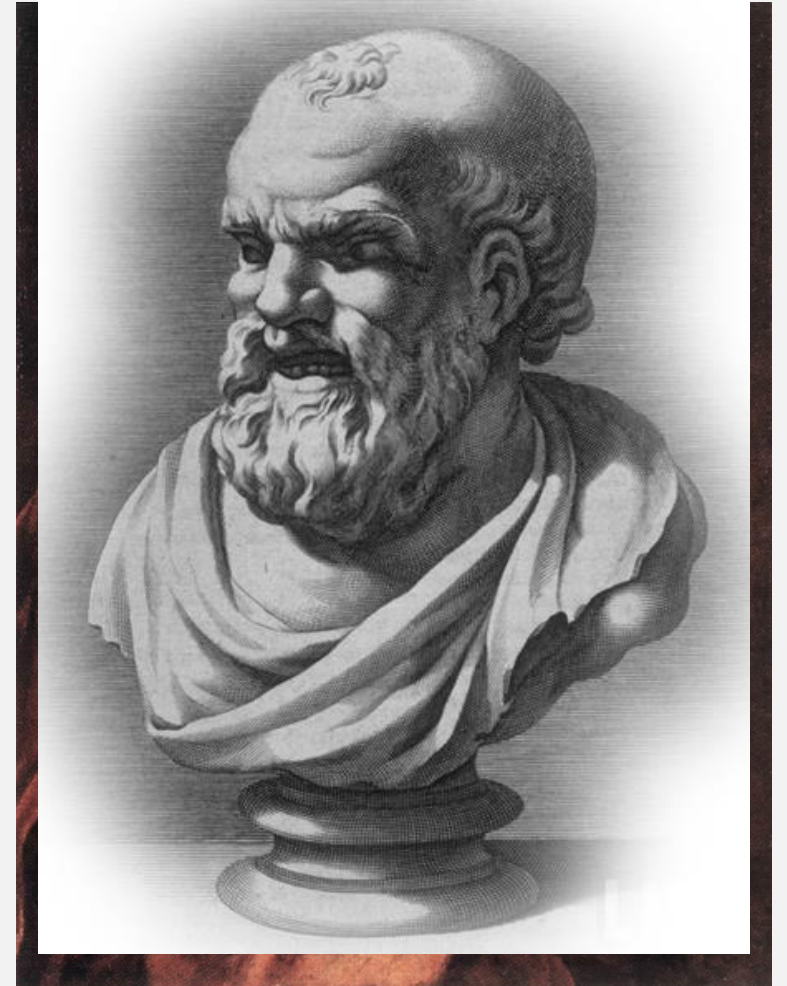
ONCE UPON A TIME...

- People have been fascinated with matter for a long time.
 - What is matter?
 - What is all this “stuff” around us made of?
 - Can it be broken down?
 - Are there different types of matter?

Time to develop a model...

ONCE UPON A TIME...

- **Democritus (~465BC)**
- Believed that the whole universe was made up of 2 things:
 - **Tiny particles (atoms) and empty space**
 - “The universe is composed of two elements: the atoms and the void in which they exist and move.”



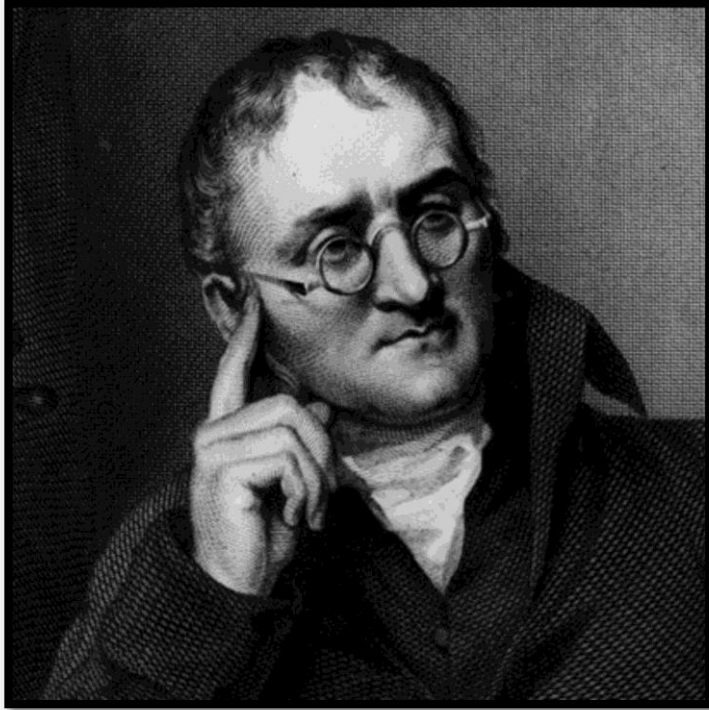
ONCE UPON A TIME...

- **Aristotle (~340BC)**
 - Did not agree with Democritus
 - Did not believe in atoms
 - He said all matter was composed of **5 elements**:
 - **Earth, Water, Air, Fire and Aether (divine element)**



FAST FORWARD THROUGH TIME...

ONCE UPON A TIME...



- **John Dalton (1808)**
- Since the time of Democritus and Aristotle a lot of advances had been made in Chemistry... and these generally involved the idea that matter was composed of particles
- Ex: **Law of Conservation of Mass**

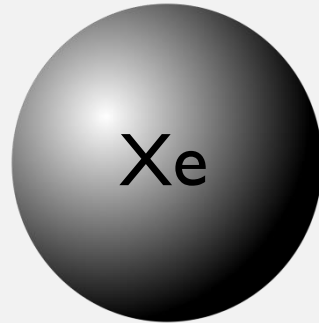
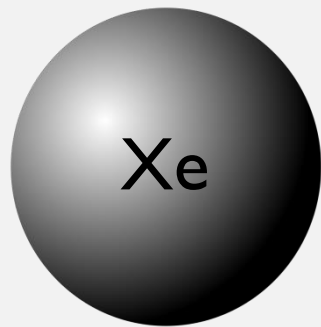
ONCE UPON A TIME...

- **John Dalton (1808)**

- Matter is composed of tiny indivisible particles called atoms.
 - Atoms are the smallest units of matter; they cannot be broken up further
- All atoms of a single element are identical
 - All He atoms are identical; all Xe atoms are identical, etc
- The atoms of different elements are different
 - He atoms are different from Xe atoms
- Atoms of different elements could combine to form compounds

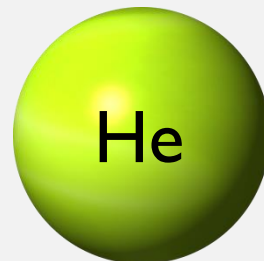
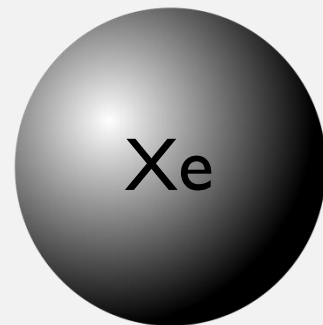
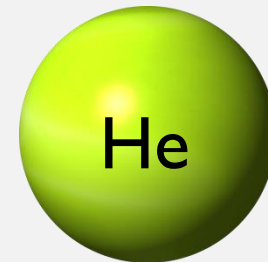
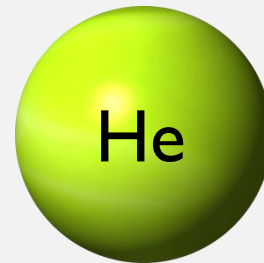
DALTON'S ATOMIC MODEL

1803



Identical

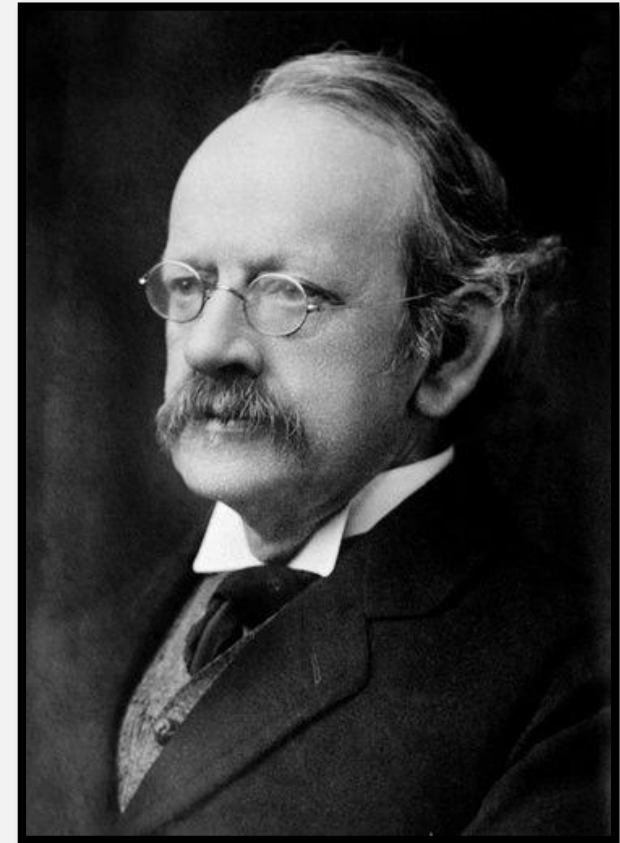
Identical



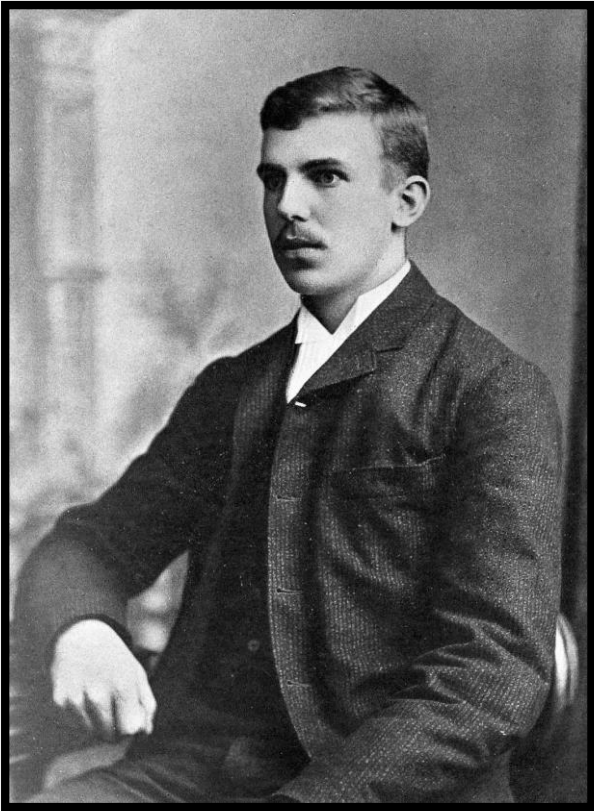
Different

ONCE UPON A TIME...

- J.J. Thomson (1897)
 - Discover that there were particles that were smaller and lighter than the smallest atoms known (Hydrogen)
 - Therefore atoms had small building blocks that made them



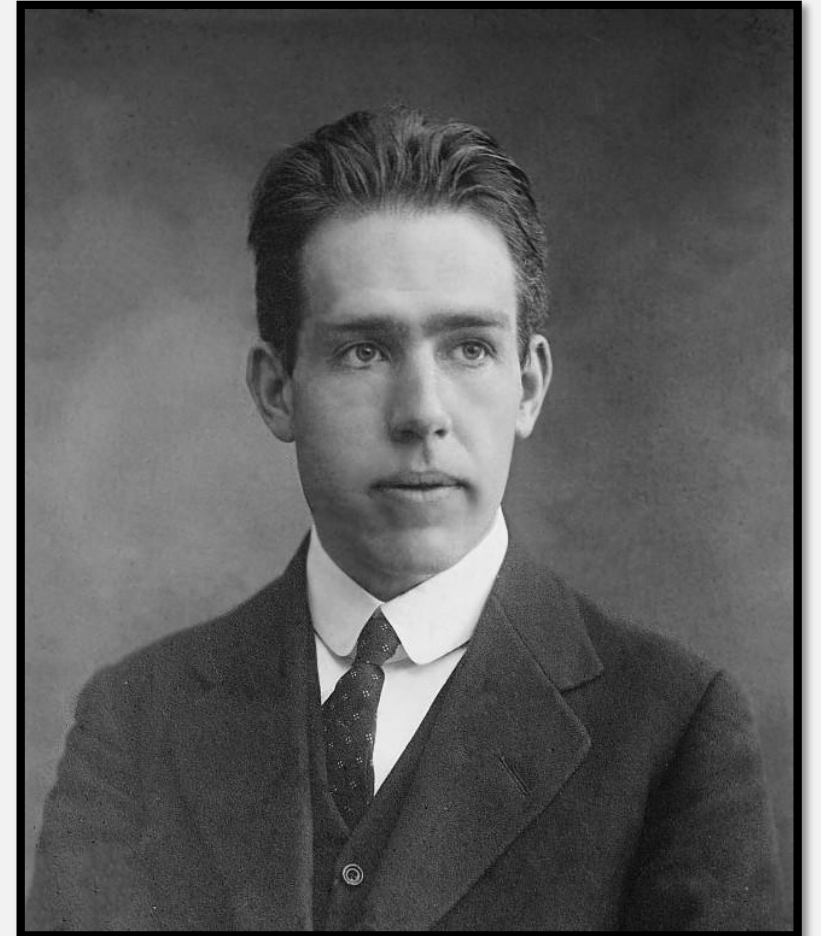
ONCE UPON A TIME...



- Ernest Rutherford (1911)
- Discovered that the atom must be made up mostly of empty space, with small electrons floating around and a more massive central positive (+) nucleus

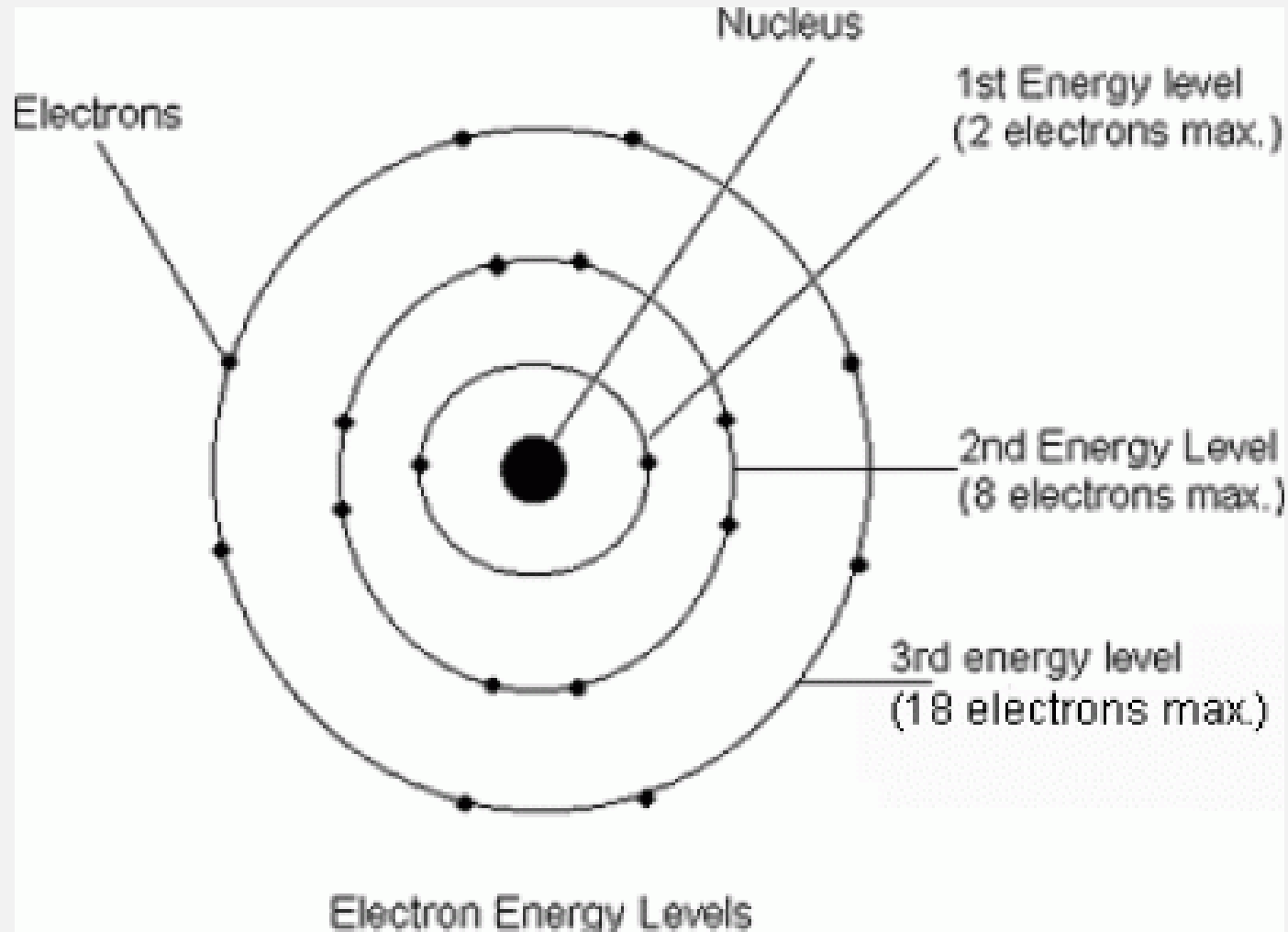
ONCE UPON A TIME...

- **Niels Bohr (1913)**
- Another one of Thomson's students
- Bohr hypothesized that electrons must be in specific orbitals around the nucleus
- Also determined that each orbital (energy level) could only accommodate a certain number of electrons
 - We'll come back to this later!



BOHR'S ATOMIC MODEL

1913



ONCE UPON A TIME...

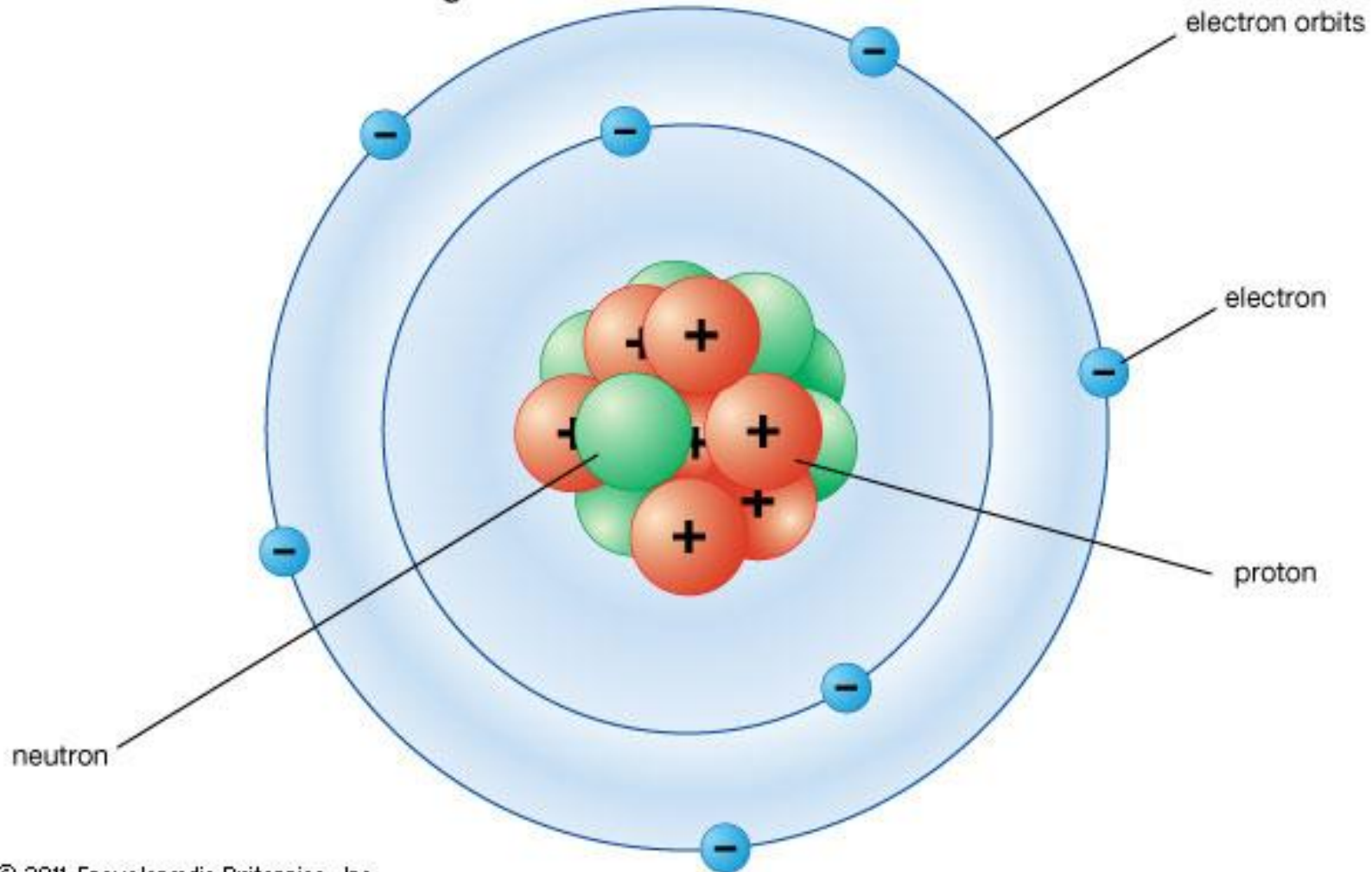
- **Rutherford-Bohr Model**
- Rutherford later made the discovery of the proton
- The nucleus is not just one large positive particle, but rather made up of several positive particles (protons) depending on the element

ONCE UPON A TIME...

- **Rutherford-Bohr Model**
 - It is this number of protons that determines the element!
 - Different elements have different numbers of protons
 - Atoms have the same number of protons (+) as electrons (-) so that they are overall neutral (no charge)

RUTHERFORD-BOHR MODEL

Bohr atomic model of a nitrogen atom



THE BOHR-RUTHERFORD MODEL

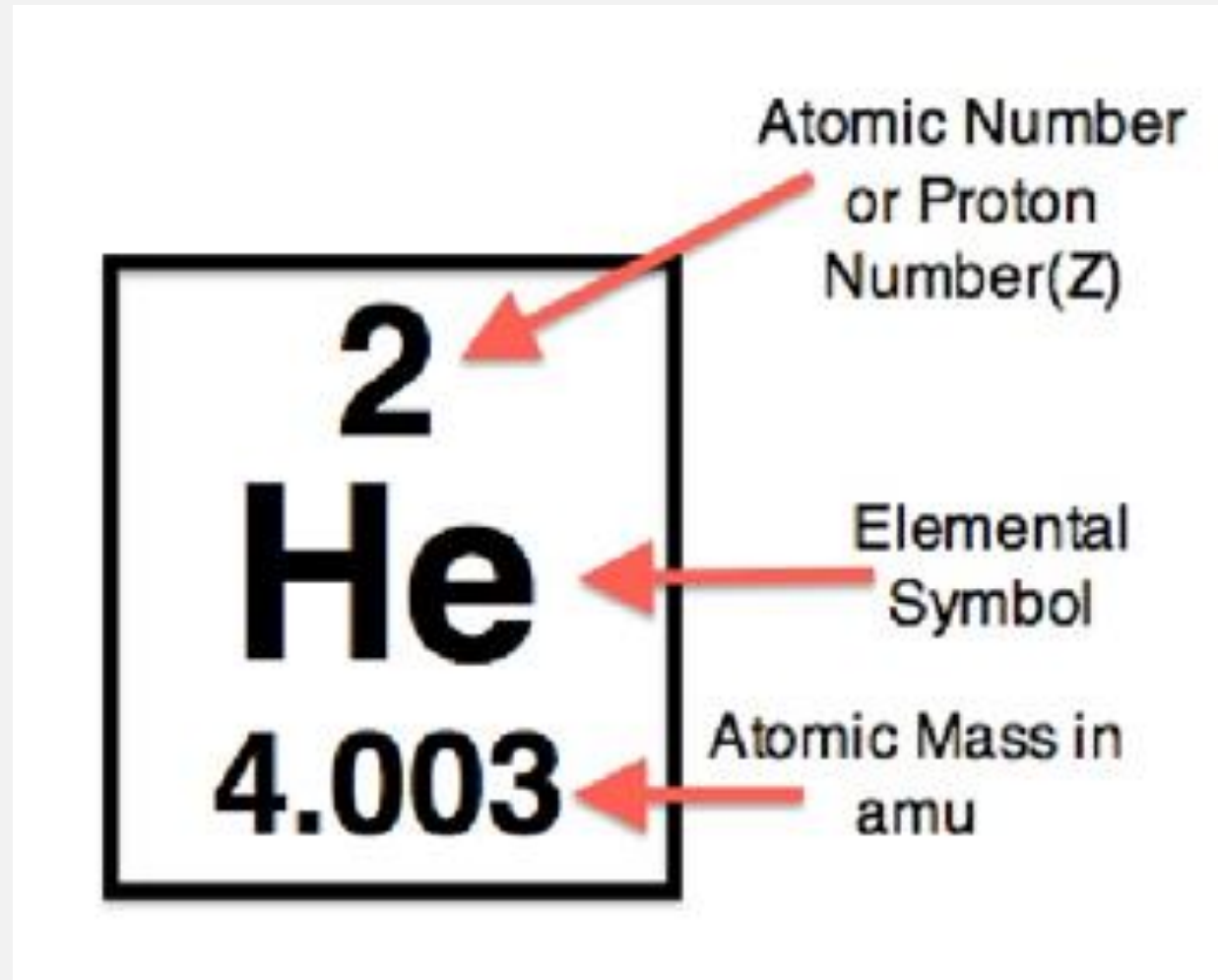
- Protons → in the nucleus
- Number of protons = atomic number on Periodic Table
- Electrons → in orbitals around the nucleus
- The total number of electrons is the same as the number of protons
 - overall charge has to be neutral

THE BOHR-RUTHERFORD MODEL

- Remember: each orbital can only hold a certain number of electrons
 - 1st orbital: max 2 e-
 - 2nd orbital: max 8 e-
 - 3rd orbital: max 8 e-

PERIODIC TABLE

READING THE PERIODIC TABLE



PERIODIC TABLE

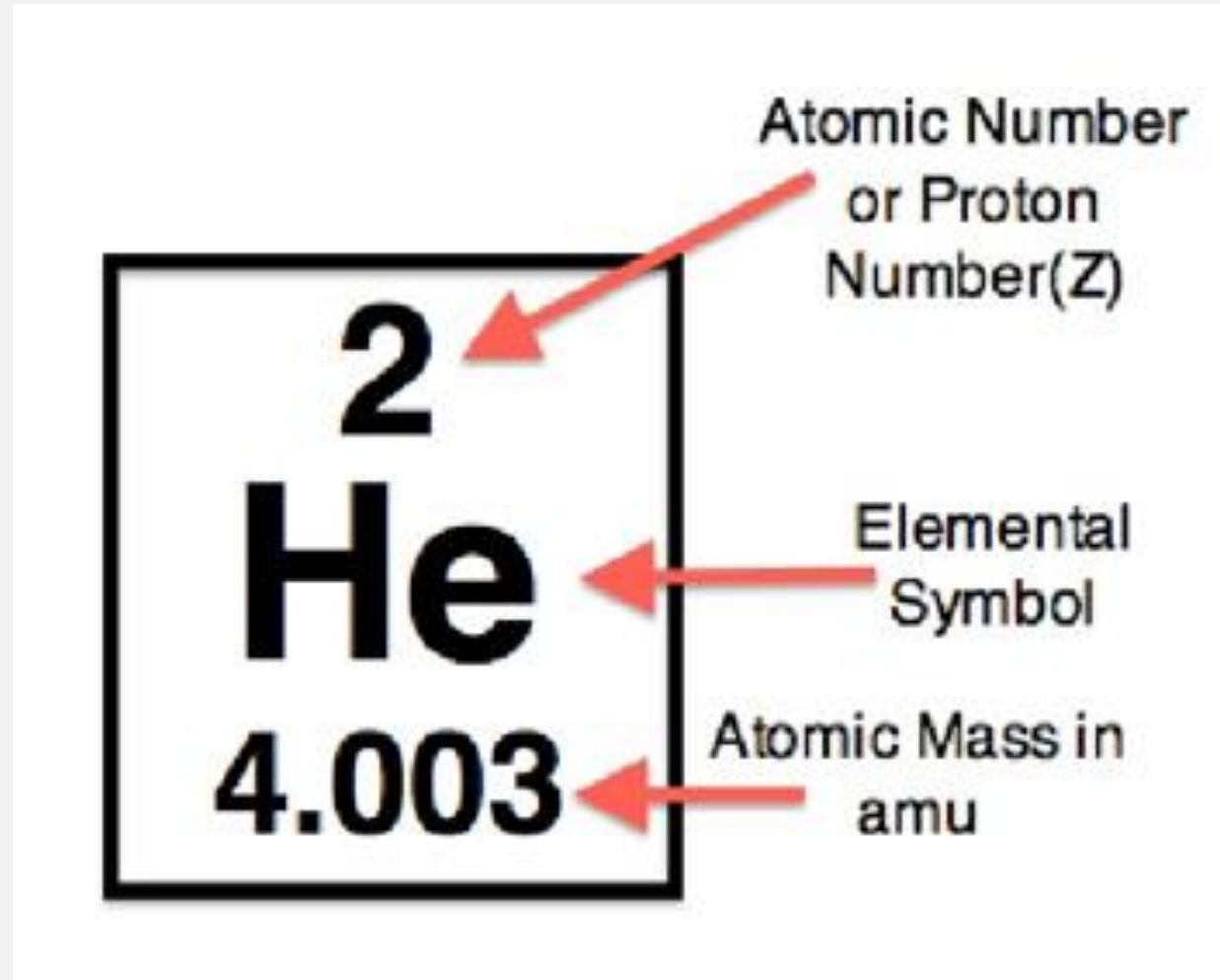
- **Atomic Number**
 - Tells you the number of protons each atom of an element has
 - This is different for every element
 - This differing number of protons gives each element different properties

PERIODIC TABLE

- **Atomic Mass**
 - Protons have a mass of 1 amu (atomic mass unit)
 - Neutrons also have a mass of **1 amu**
 - Electrons are so small they have almost no mass
 - We say their mass is negligible

READING THE PERIODIC TABLE

Therefore
must have 2
neutrons



Helium has
2 protons

Has a mass
of ~4 amu

Periodic Table of the Elements

1 H Hydrogen 1.01																	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.63	33 As Arsenic 74.92	34 Se Selenium 78.97	35 Br Bromine 79.90	36 Kr Krypton 84.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.98	86 Rn Radon 222.02
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

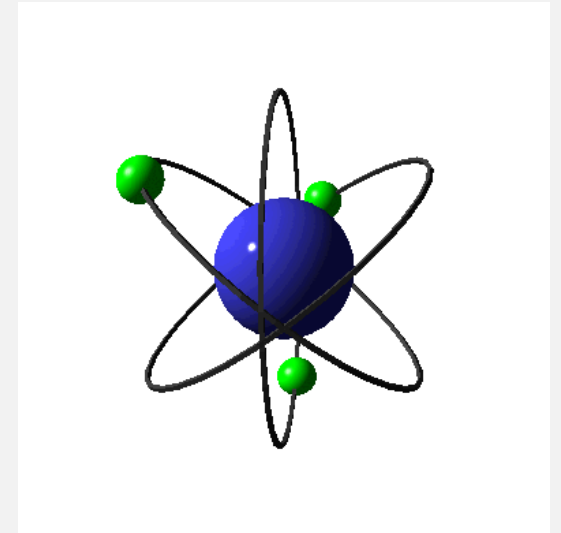
57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.06	71 Lu Lutetium 174.97
89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium [262]

Periodic Table of the Elements

1																	18
1 H Hydrogen 1.01																	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3	4	5	6	7	8	9	10	11	12	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.63	33 As Arsenic 74.92	34 Se Selenium 78.97	35 Br Bromine 79.90	36 Kr Krypton 84.80

SUMMARY/REVIEW

- **Matter**
 - Anything that takes up space and has mass
- **Atom**
 - Smallest unit of matter
 - Made of electrons, neutrons, protons
 - Centre is called the nucleus



SUMMARY/REVIEW

- **Nucleus**
 - Centre of an atom
 - Contains the protons and neutrons
- **Proton**
 - Sub-particle of an atom with a positive charge
 - Found in the nucleus

SUMMARY/REVIEW

- **Electron**
 - Sub-particle of an atom with a negative charge
 - **Found in the orbits around the nucleus**
- **Neutron**
 - Sub-particle of an atom with a neutral charge
 - **Found in the nucleus**

SUMMARY/REVIEW

- **Nucleus**

- Centre of an atom

- **Contains the protons and neutrons**

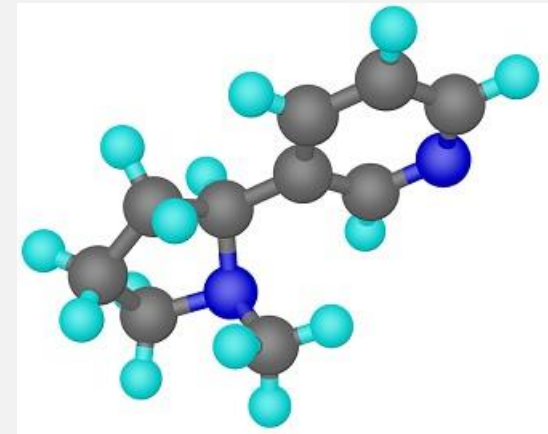
- **Element**

- Substance made from **one type of atom only**

SUMMARY/REVIEW

- **Molecule**

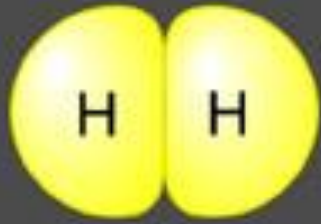
- A group of atoms that are chemically bonded



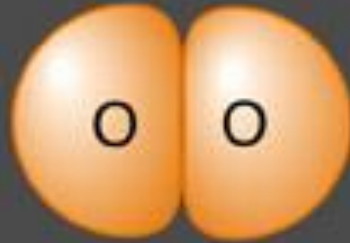
- **Compound**

- A molecule formed by combining two or more different types of atoms

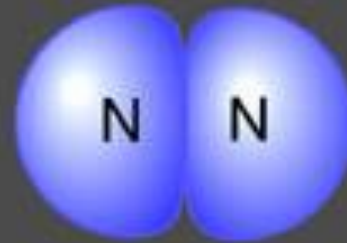
All molecules



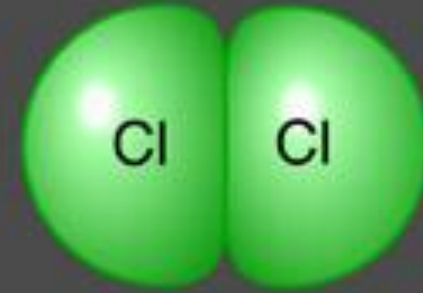
H_2
hydrogen



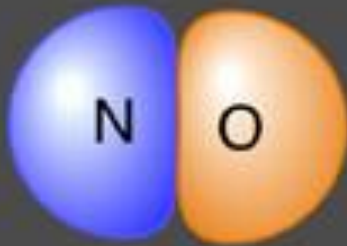
O_2
oxygen



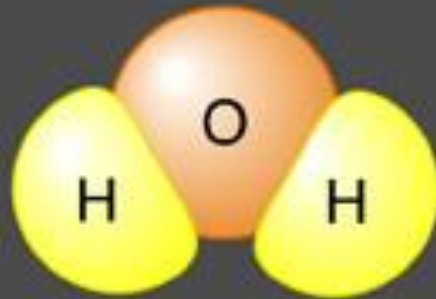
N_2
nitrogen



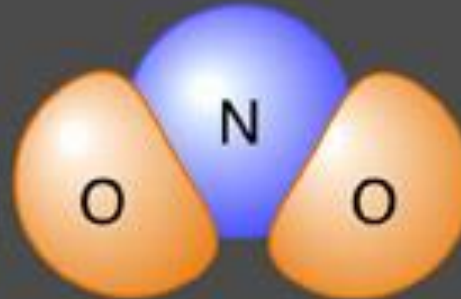
Cl_2
chlorine



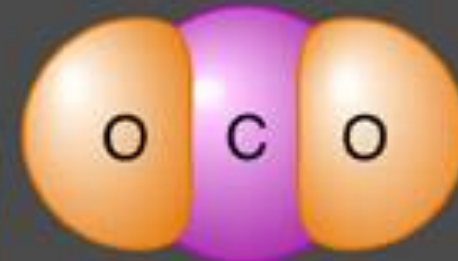
NO
nitrogen oxide



H_2O
water



NO_2
nitrogen dioxide



CO_2
carbon dioxide

These are compounds