Welcome to Jeff's CHEM 4 lecture!

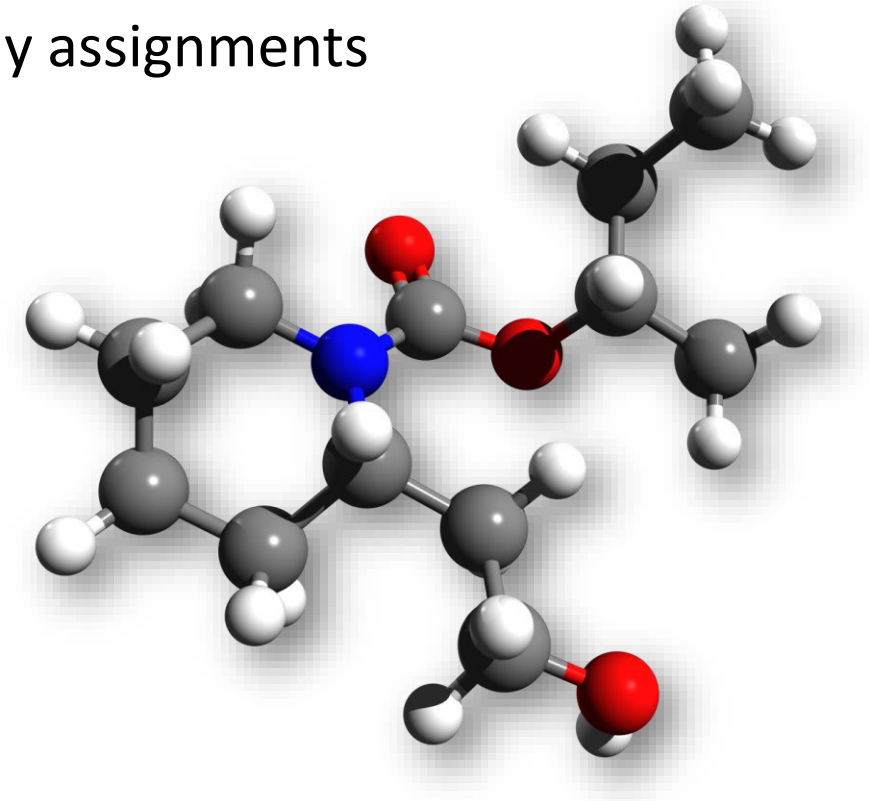
We'll be starting in just a bit…

While you are waiting:

1) Go to LearningCatalytics.com to prepare for today's clicker questions. Login with your MasteringChemistry login. (Session # = 95469934)
2) Turn off your camera and microphone. We'll use the chat feature to ask questions.
3) *I'm proud to be a professor who is known for helping students.* Now it's your turn to BRAG a little! Please share in the chat the accomplishment that you are most proud of.

Where you should be now…

- ✓ Explored our website: tinyurl.com/SacStateChem4
- ✓ Check our August/September calendar for daily assignments
- ✓ Read over the syllabus
- ✓ Joined optional PAL
- ✓ Review PowerPoint slides
- ✓ Registered MasteringChemistry
  - ✓ Completed Assignment #0 and #1
  - ✓ Located the e-text
  - ✓ Read 3.1 – 3.6, 4.1 – 4.2 and 4.6
  - ✓ Download “Pearson eText mobile app”
- ✓ Attend open student hours if you need any help (academic and non-academic)
- X ~~Commit to Study~~ = nothing to do yet



Review clicker question (covers material from last class)
Go to LearningCatalytics.com and login with your MasteringChemistry login.

1) Which of the following statements is false?

A) Being soluble in water is a physical property of salt (as opposed to a chemical property).

B) Chemists use categories such as “pure substance” and “mixture” to classify matter.

C) The temperature at which any phase change occurs would be an example of a physical property.

D) A bowl of cereal with milk would be a heterogeneous mixture.

E) Our definition of matter includes only inanimate objects (not living things).

Note: for A) and C), we have not made any new substances, so they are physical properties.

CHEM 4 lecture

Friday – September 4, 2020

Sec 4.6

Periodic table

Reading clicker question (covers material from today's assigned reading)
Go to LearningCatalytics.com and login with your MasteringChemistry login.

2) Based on your assigned reading (Sec 4.6) for today which of the following statements is true?

A) *Metalloids* are the best conductors of electricity.

B) The *noble gases* are the most expensive elements, so historically, only nobility could afford them.

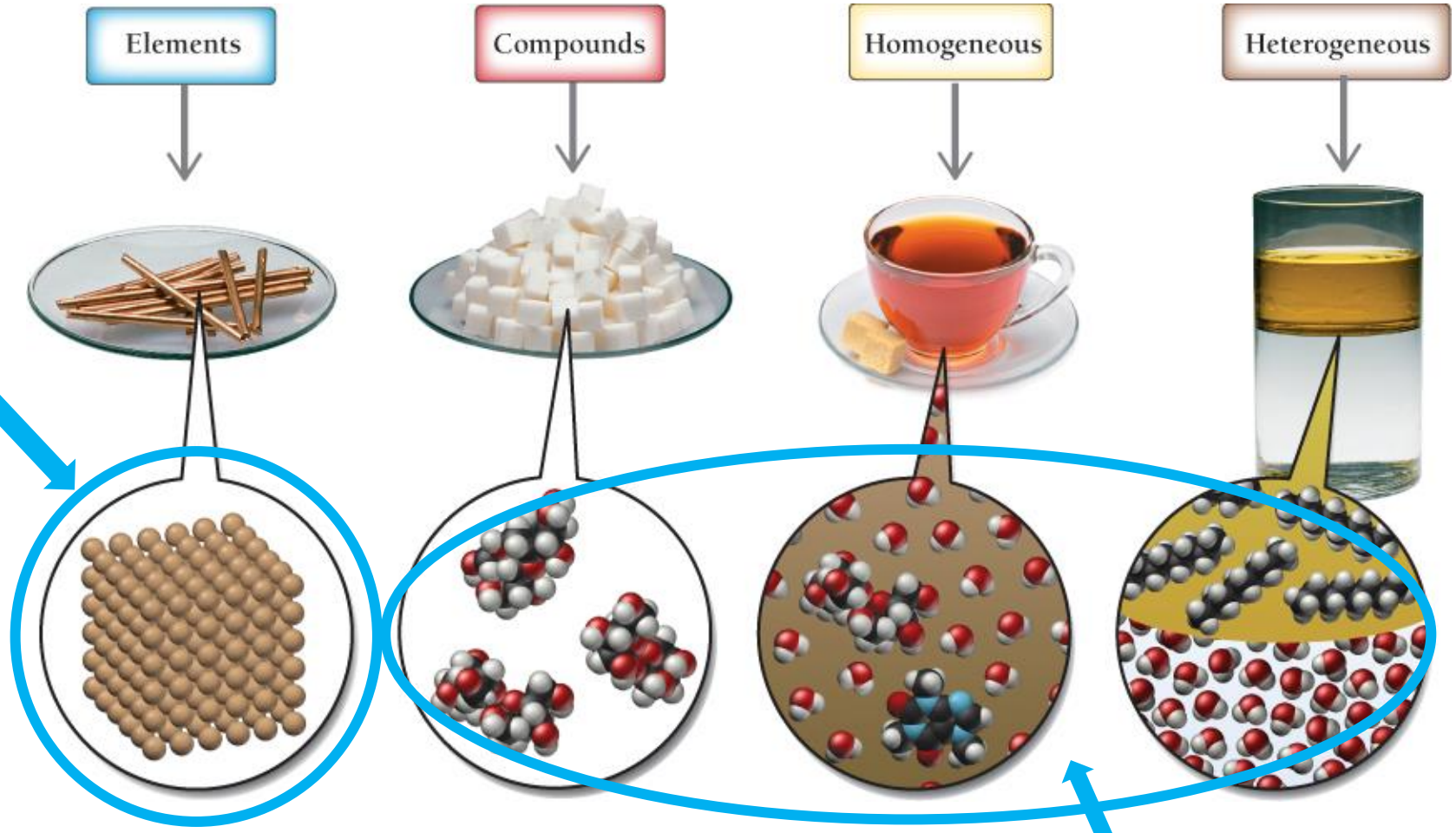
C) The properties of the *transition elements* tend to be more predictable based on their position in the PT than the *main-group elements*.

D) The original periodic table was used to predict the existence of undiscovered elements.

E) Each horizontal row within the periodic table is called a *family* or *group* of elements.

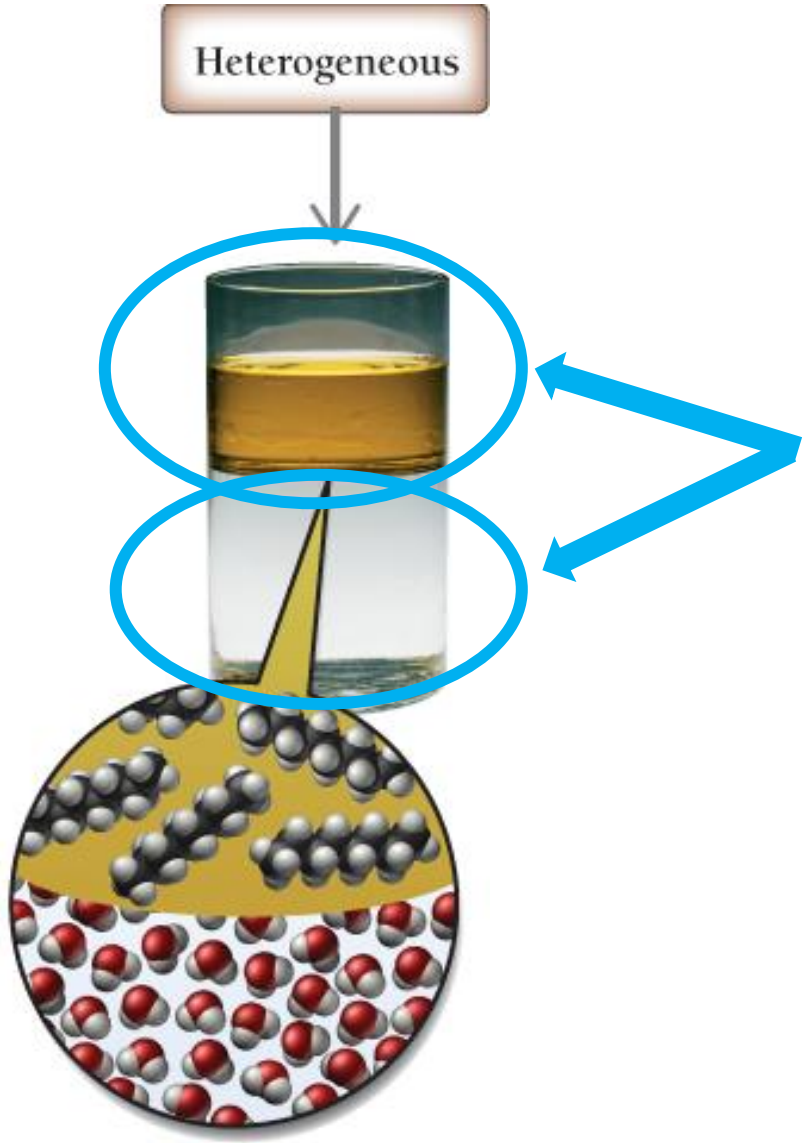
Background: Elements

Element = pure substance made up of the same type of atom.



All of the other types of matter contain 2 or more different types of atoms

Background: Heterogenous mixtures



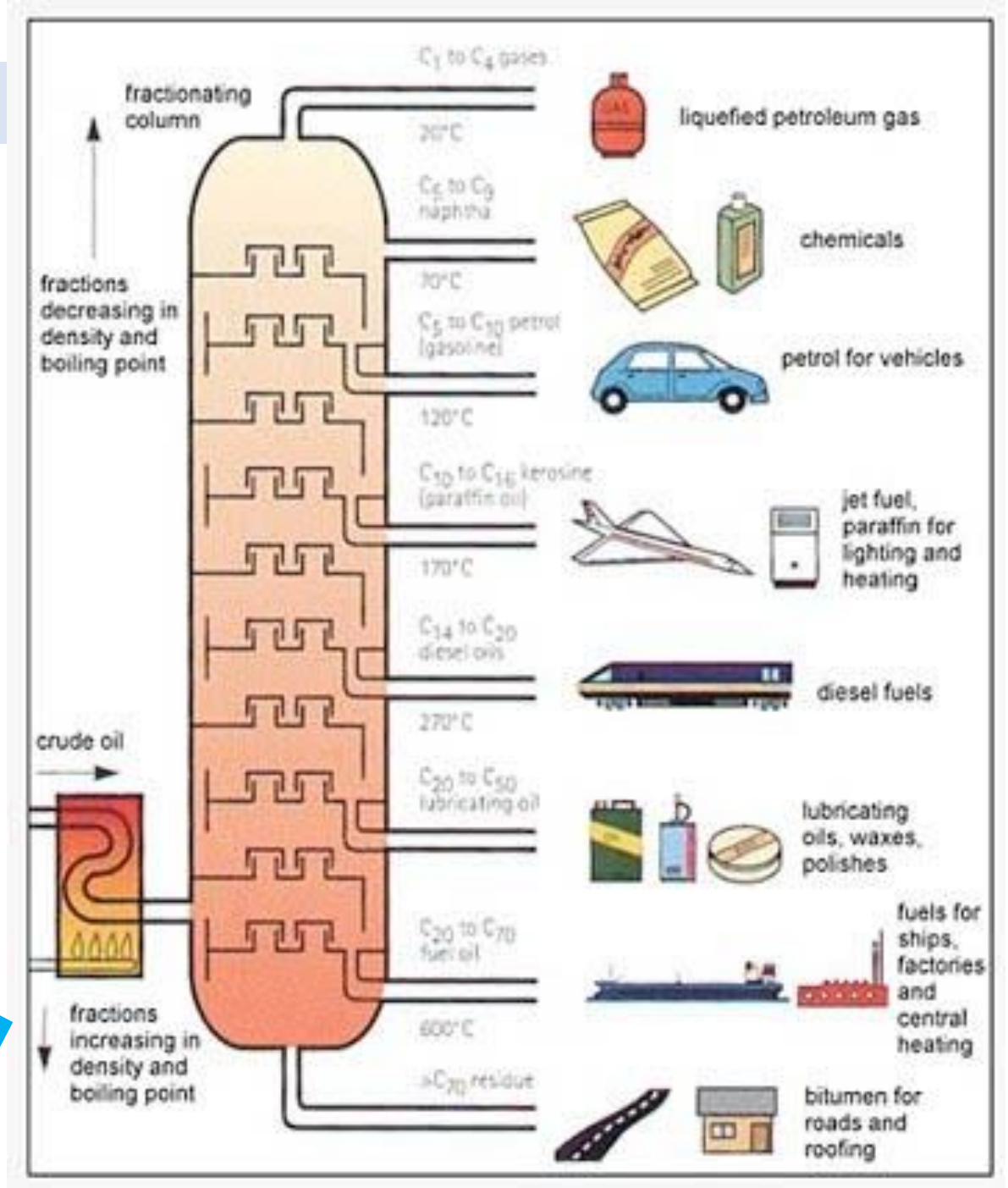
You can tell something is a **heterogenous mixture** just by looking at it. Clearly this sample of matter is made of at least two components.

However…

Background: Homogenous mixtures

…it is not possible to distinguish elements, compounds, and homogeneous mixtures by looking at them. Scientists have to do experiments on the sample to tell the difference:

- If the sample can be separated by physical means (like filtering or melting) then it is a **homogenous mixture**.
- As an example, this is the process that takes place when an petroleum chemist refines/distills crude oil to separate it into its components.



Background: Homogenous mixtures

- The Valero crude oil refinery in Benicia.
- The central valley has the worst air quality and the highest asthma rate for children in the nation, in part because of crude oil processing.

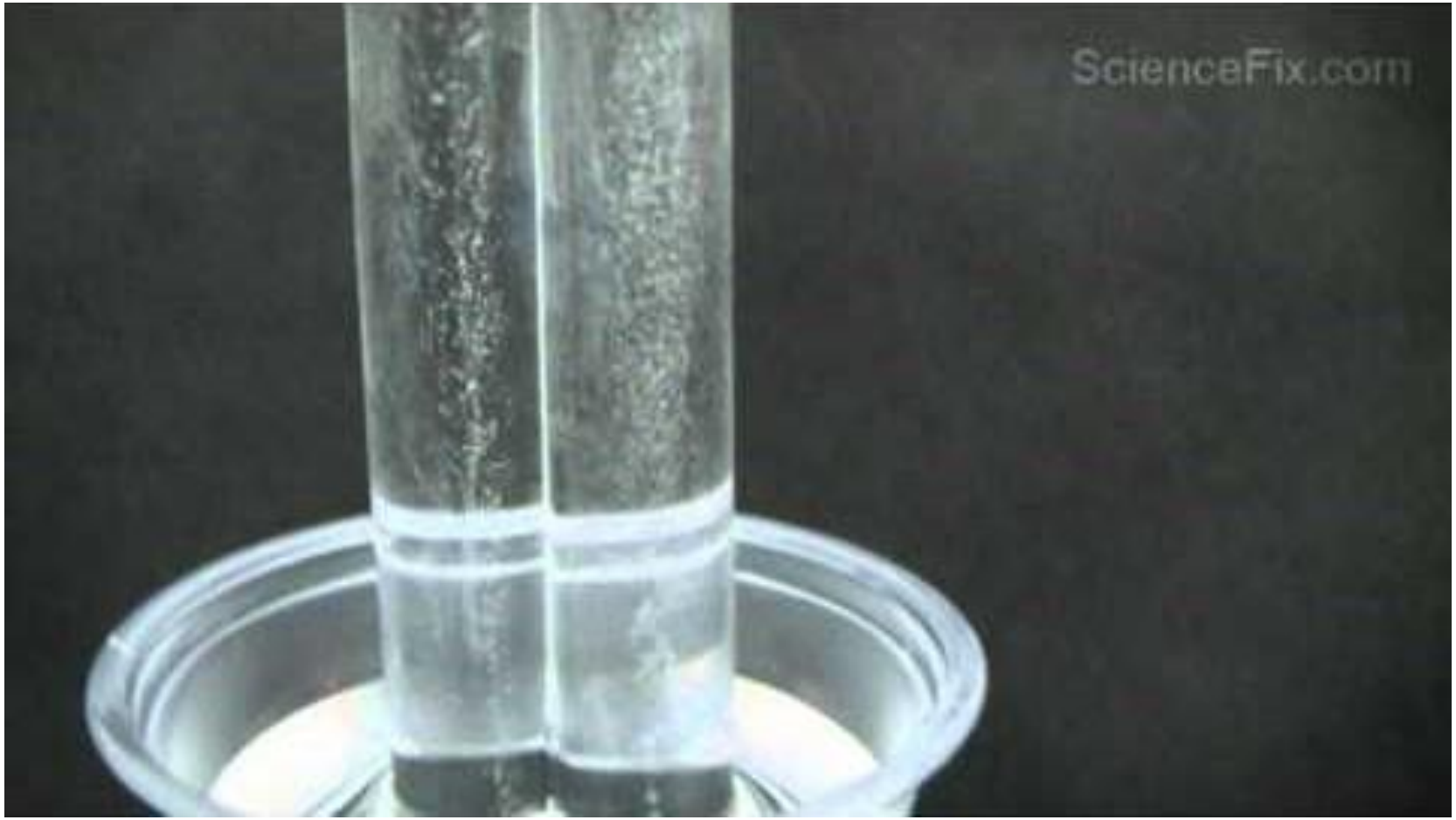
(Chris Riley/Times-Herald)

Background: Pure substances (elements and compounds)

- To distinguish between an **element** and a **compound**, scientists try various chemical separation techniques. If it can be broken down further by a chemical process, it is a **compound**. If no chemical process can separate the sample into simpler substances, then it is a **element**.

- An example of this chemical separation is the electrolysis of water where an electrical current breaks water into hydrogen and oxygen. Water can be broken down so that makes it a **compound**. Hydrogen and oxygen can not be broken down further, so that makes them **elements**. [See video on next slide.]

Background: Electrolysis of water



- This process has application for hydrogen fuel cells as a way to use solar energy to convert water into hydrogen. The hydrogen is then used as the fuel for the fuel cell.

Background: History of the elements

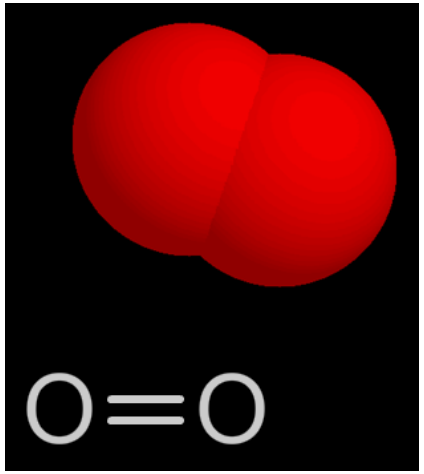
- Some **elements** have been know since ancient times: carbon, sulfur, iron, tin, lead, copper, mercury, silver, and gold. ☺
- The largest number of **elements** were discovered in the 1800's. ☺
- Historically, scientists occasionally thought that they had discovered a new element only for another scientist to realize that either it was a compound or it was an already known element. ☹
- In 1999, the physicist, Victor Ninov published data that suggested he had created elements 116 and 118. Other scientists were unable to replicate his experiments. It was later found that he had faked the data and he was fired from LBNL. ☹

Background: Elements

What does Jeff want you to know about **elements**?

1) Pure elements are rare in nature.
   - For example, you can't just go and dig up pure iron (Fe).
   - Instead, iron is found in nature in one of its various compounds/ores such as hematite (Fe_2O_3), magnetite (Fe_3O_4) and siderite ($FeCO_3$).
   - The air, the ocean, and all living things are mixtures.
2) Some are elements are **diatomic**:
   - Always found as pairs of atoms that are bound together.
   - H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2
3) Each element has its own distinct set of properties.
4) The known elements are organized by their properties on the **periodic table**.

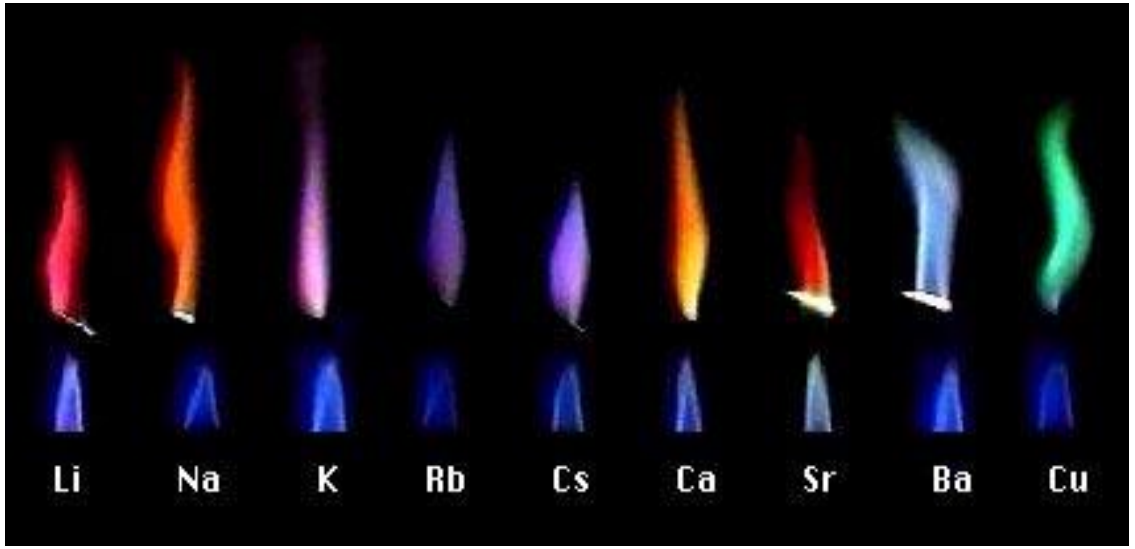
A sample of iron ore



Representations of O_2

Background: Each element has it own distinct properties

For example, when enough energy is added to an element, it gives off a characteristic color…



Flame tests for various elements

Fireworks are flame tests in action!

Helium

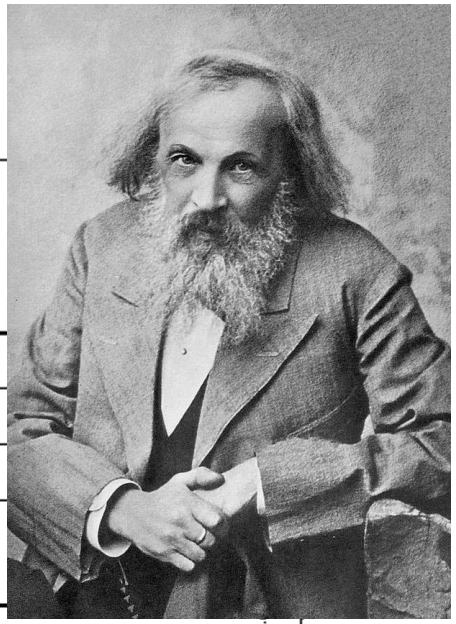
Emission spectra are an important tool in chemistry and astronomy

Background: Mendeleev's Periodic Table - 1869

Mendeleev took all the know elements at the time (about 60 of them) and organized them from lightest to heaviest relative mass, with H = 1 up to U = 240

He left blanks for missing elements and predicted their properties.

He put elements with the same properties in the same column.



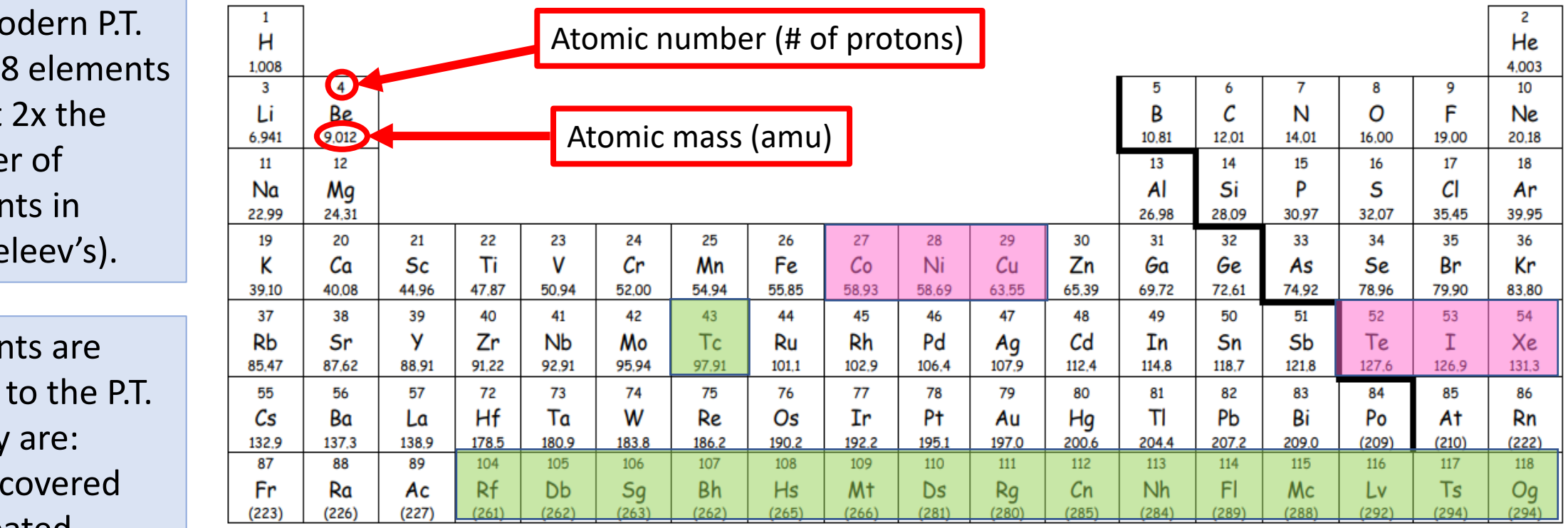
Series	Group I R_2O	Group II RO	Group III R_2O_3	Group IV RH_4 RO_2	Group V RH_3 R_2O_5	Group VI RH_2 RO_3	Group VII RH R_2O_7	
1	H=1							
2	Li=7	Be=9·4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27·3	Si=28	P=31	S=32	Cl=35·5	
4	K=39	Ca=40	?=44	Ti=48	V=51	Cr=52	Mn=55	
5	Cu=63	Zn=65	?=68	?=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	Yt=88	Zr=90	Nb=94	Mo=96	--=100	Ru=104 Rh=104 Pd=106 Ag=108
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	I=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	–	–	–	--- --- --- ---
9	(--)	–	–	–	–	--	–	
10	–	–	?Er=178	?La=180	Ta=182	W=184	--	Os=195 Ir=197 Pt=198 Au=199
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208			
12	–	--	–	Th=231	–	U=240	–	--- --- --- ---

Background: The modern Periodic Table

The modern P.T. has 118 elements (about 2x the number of elements in Mendeleev's).

Elements are added to the P.T. as they are:

- Discovered
- Created



1 H 1.008																2 He 4.003
3 Li 6.941	4 Be 9.012										5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31										13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 97.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (292)	117 Ts (294)	118 Og (294)

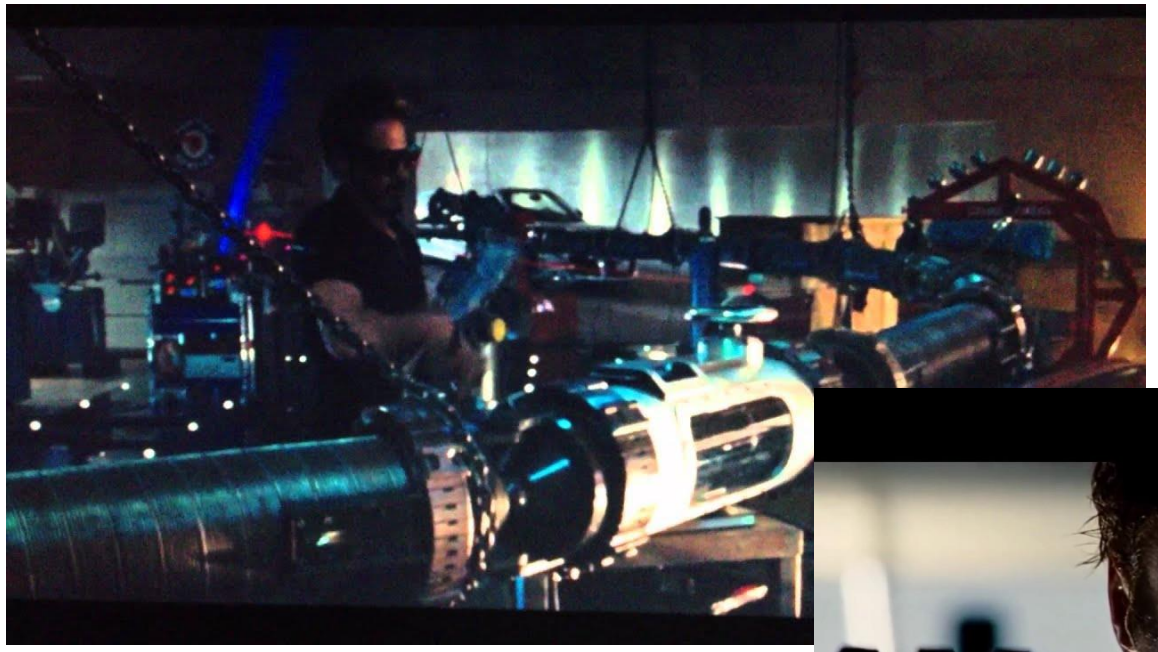
58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 144.9	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu 244.1	95 Am 243.1	96 Cm 247.1	97 Bk 247.1	98 Cf 251.1	99 Es 252.1	100 Fm 257.1	101 Md 258.1	102 No 259.1	103 Lr (260)

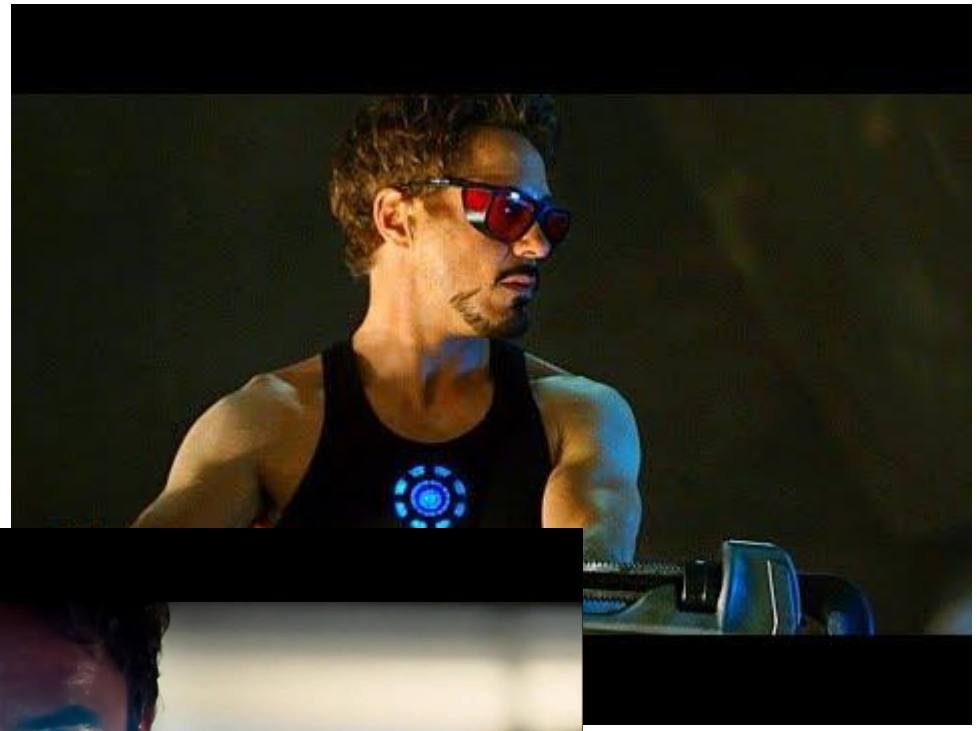
Issues with mass =

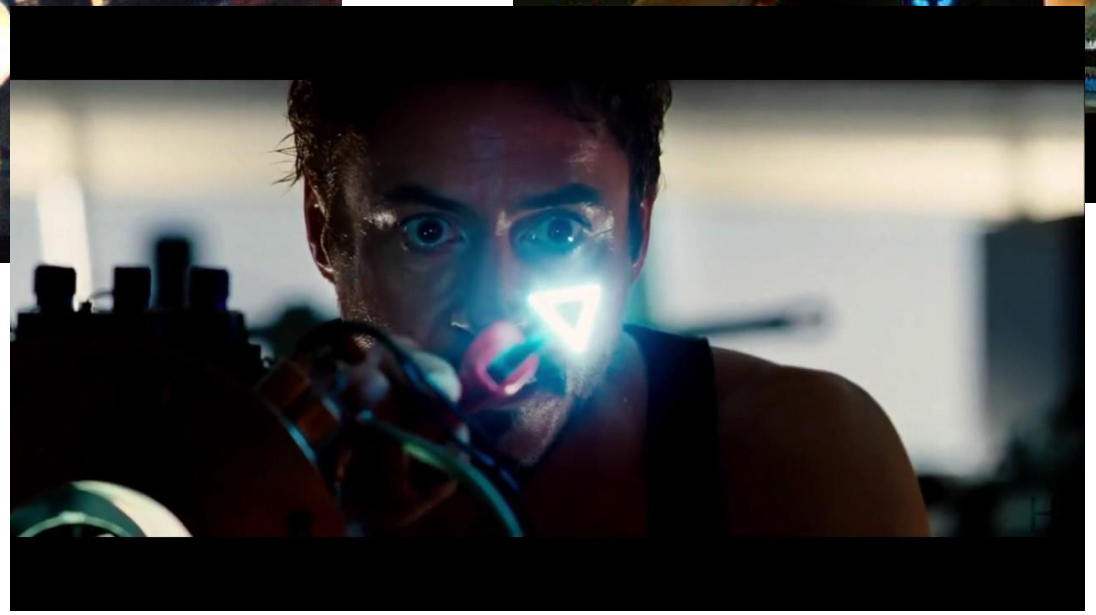
Created elements =

Background: Creating new elements

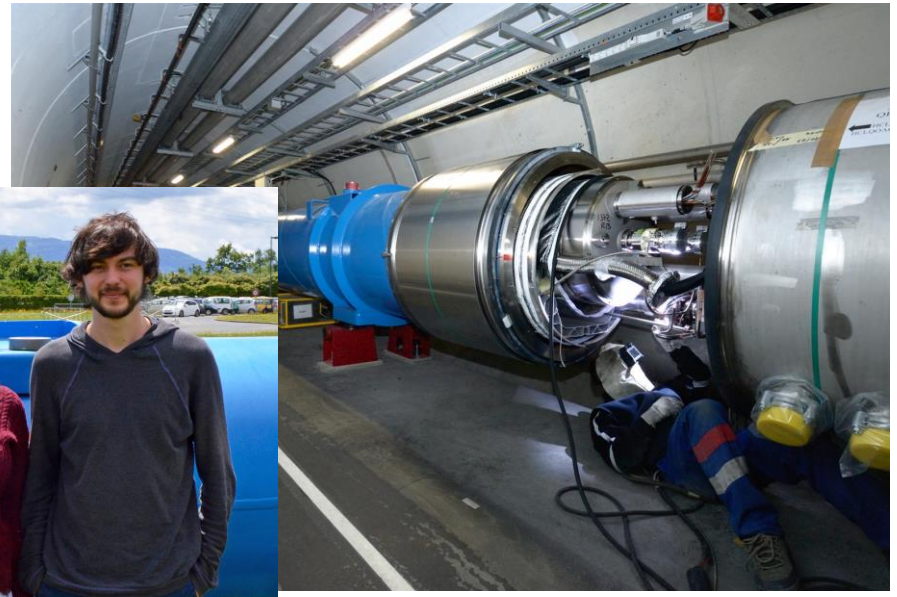
If you are Tony Stark…

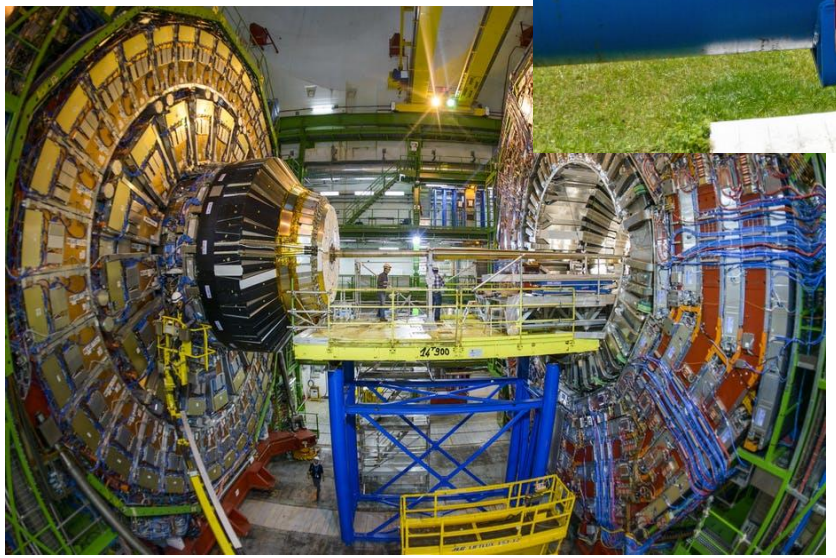






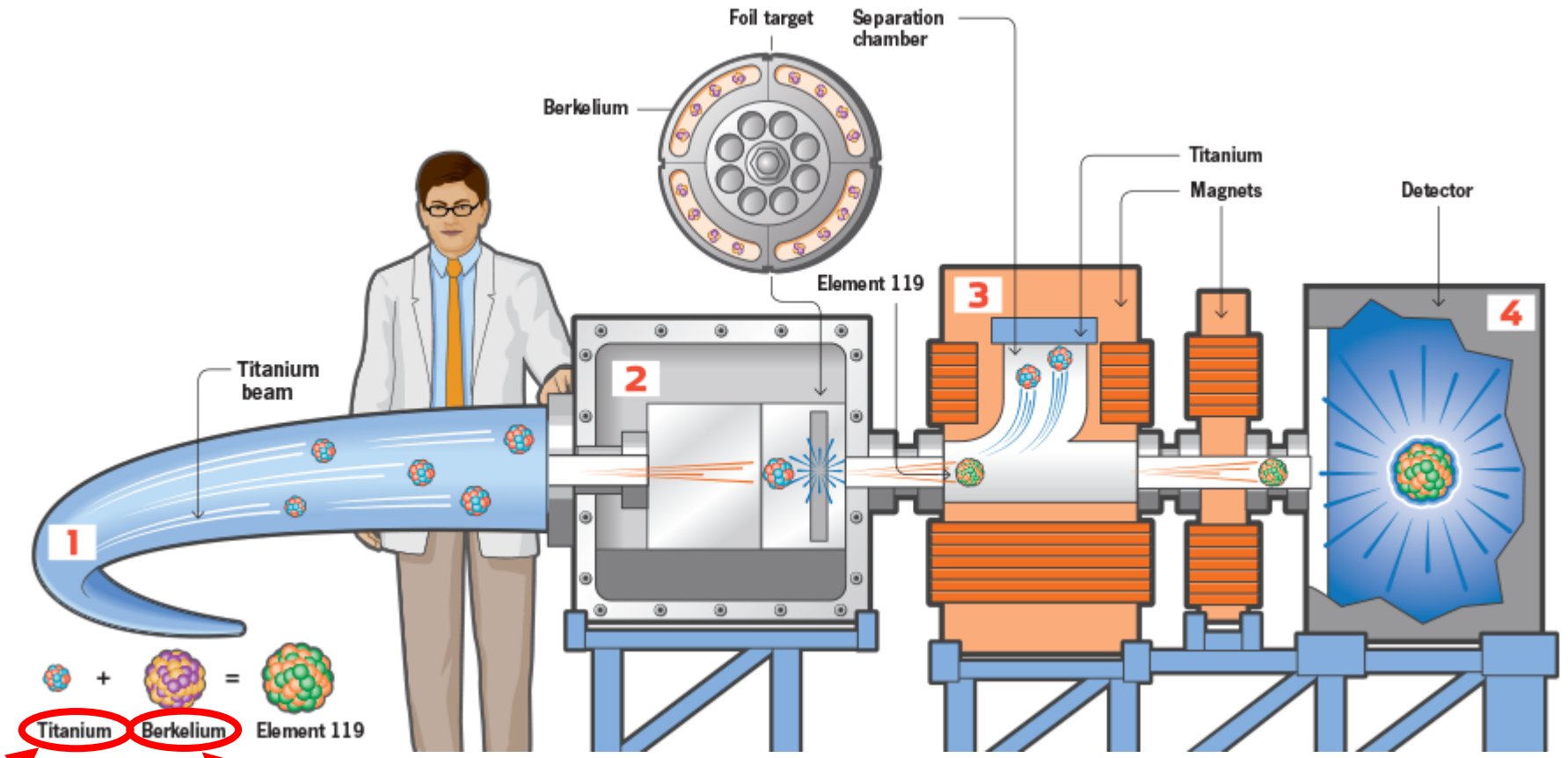
Background: Creating new elements





SacState students Haley Marez and Caleb Mosakowski at the ATLAS experiment in Switzerland. They worked with SacState Professor Joshua Moss.

Background: Creating new elements… what's next



https://www.popsci.com/science/article/2013-04/making-new-elements/?dom=tw&src=SOC

22 protons

97 protons

Progress clicker question (covers material we are learning now)
Go to LearningCatalytics.com and login with your MasteringChemistry login.

3) Which of the following statements is false?

A) Physical methods can be used to separate the components of a mixture.

B) Pure elements are rare in nature. Most elements naturally occur as compounds or mixtures.

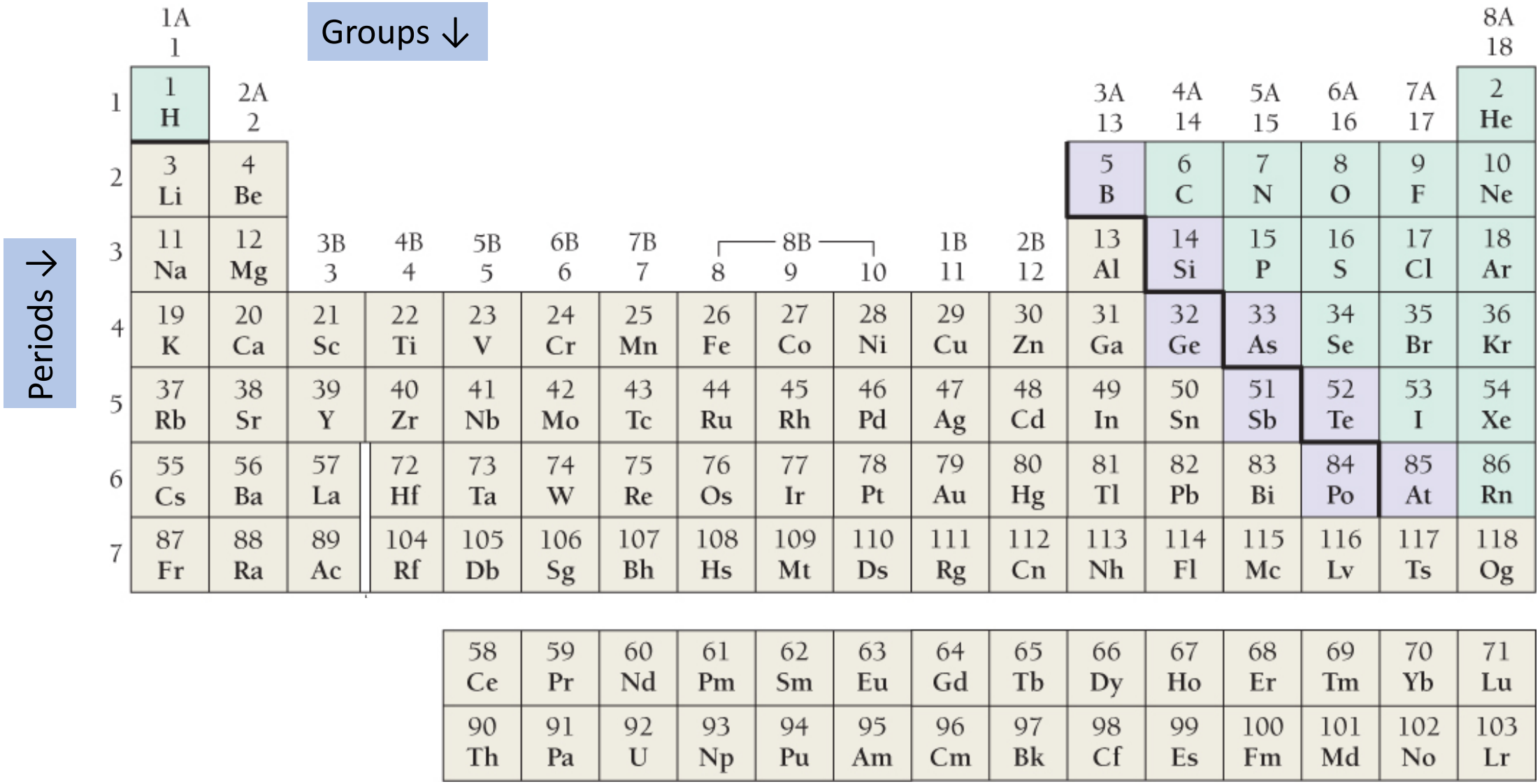
C) Mendeleev's periodic table left empty spaces for elements that had not been discovered yet.

D) Each element has its own characteristic set of properties.

E) You can tell if something is an element just by looking at it.

F) New elements are added to the periodic table as they are discovered or created.

Background: Important parts of the Periodic Table



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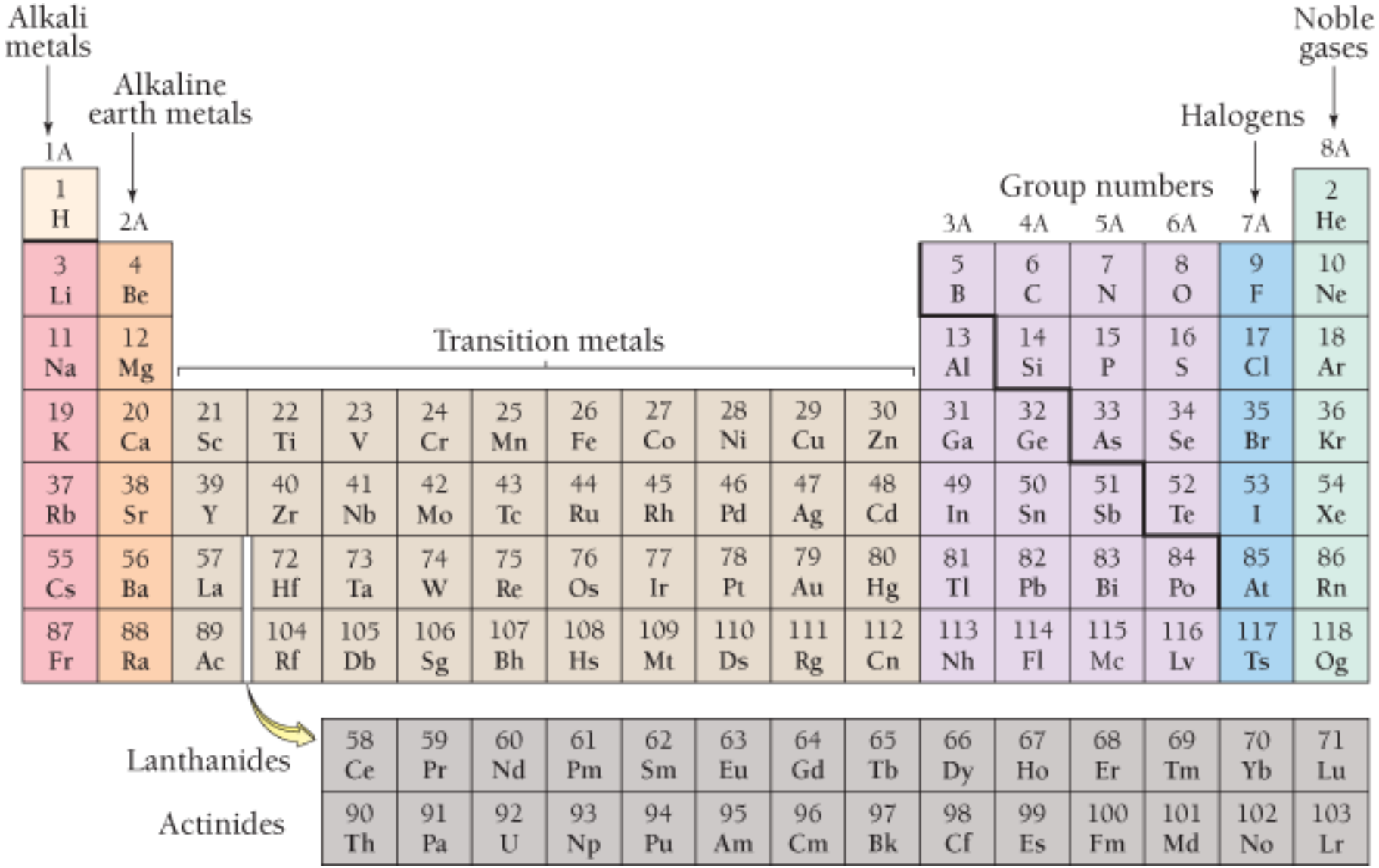

Diatomic elements:

H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2

H																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	N	O	F	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	Cl	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	Br	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 97.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	I	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
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Don't have to memorize this semester, but you should be aware of the common element symbols and names.

1) Even though you can use your book, notes, and handouts for the exams, you just won't have time to look up every little thing.

2) If we are back in person for Chem 1A, you'll need to memorize.

Element	Symbol	Element	Symbol
aluminum	Al	krypton	Kr
antimony	Sb	lead	Pb
argon	Ar	lithium	Li
arsenic	As	magnesium	Mg
barium	Ba	manganese	Mn
beryllium	Be	mercury	Hg
bismuth	Bi	neon	Ne
boron	B	nickel	Ni
bromine	Br	nitrogen	N
cadmium	Cd	oxygen	O
calcium	Ca	phosphorus	P
carbon	C	potassium	K
cesium	Cs	radium	Ra
chlorine	Cl	rubidium	Rb
chromium	Cr	selenium	Se
cobalt	Co	silicon	Si
copper	Cu	silver	Ag
fluorine	F	sodium	Na
francium	Fr	strontium	Sr
gold	Au	sulfur	S
helium	He	tin	Sn
hydrogen	H	titanium	Ti
iodine	I	xenon	Xe
iron	Fe	zinc	Zn

Monatomic ion	Symbol
bromide ion	Br^-
chloride ion	Cl^-
fluoride ion	F^-
iodide ion	I^-
nitride ion	N^{3-}
oxide ion	O^{2-}
sulfide ion	S^{2-}

Ions made by adding "H^+"	Symbol
hydrogen carbonate ion (bicarbonate)	HCO_3^-
hydrogen oxalate ion (bioxalate)	$HC_2O_4^-$
hydrogen phosphate ion	HPO_4^{2-}
dihydrogen phosphate ion	$H_2PO_4^-$
hydrogen sulfate ion (bisulfate)	HSO_4^-
hydrogen sulfide ion (bisulfide)	HS^-
hydrogen sulfite ion (bisulfite)	HSO_3^-

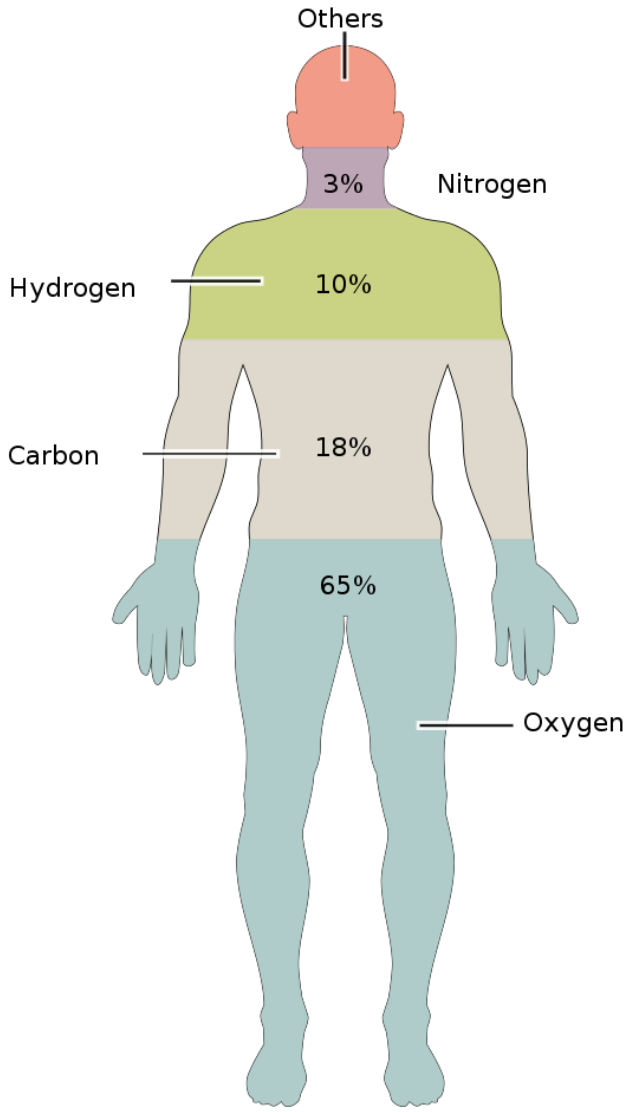
Polyatomic ion	Symbol
acetate ion	$C_2H_3O_2^-$
ammonium ion	NH_4^+
arsenate ion	AsO_4^{3-}
borate ion	BO_3^{3-}
bromate ion	BrO_3^-
bromite ion	BrO_2^-
carbonate ion	CO_3^{2-}
chlorate ion	ClO_3^-
chlorite ion	ClO_2^-
chromate ion	CrO_4^{2-}
cyanide ion	CN^-
dichromate ion	$Cr_2O_7^{2-}$
hydroxide ion	OH^-
hypobromite ion	BrO^-
hypochlorite ion	ClO^-

Polyatomic ion	Symbol
hypoiodite ion	IO^-
iodate ion	IO_3^-
iodite ion	IO_2^-
nitrate ion	NO_3^-
nitrite ion	NO_2^-
oxalate ion	$C_2O_4^{2-}$
perbromate ion	BrO_4^-
perchlorate ion	ClO_4^-
periodate ion	IO_4^-
permanganate ion	MnO_4^-
phosphate ion	PO_4^{3-}
phosphite ion	PO_3^{3-}
sulfate ion	SO_4^{2-}
sulfite ion	SO_3^{2-}
thiosulfate ion	$S_2O_3^{2-}$

Background: The elements and the human body

Essential for humans
Suggested to be essential for humans
Nonessential for humans

	1												13	14	15	16	17	18
1	1 H	2																2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg	3	4	5	6	7	8	9	10	11	12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	113 Uut	114 Uuq	115 Uup			



Background: The elements and your smart phone