

SCH 3U

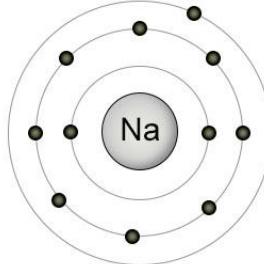
PERIODIC TRENDS involving SIZE & ENERGY LEVELS of ATOMS

① ATOMIC RADIUS

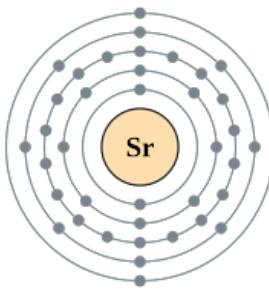
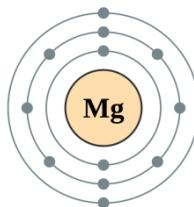
- Measured in picometres (pm)
- Distance from nucleus to valence shell

(a) as you go down a family, the radius increases

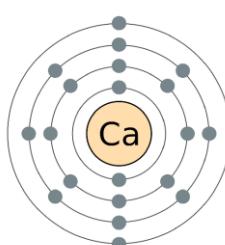
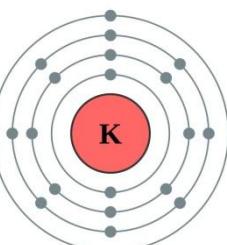
- Valence shell farther from nucleus
- Valence electrons attracted less by nucleus
- Inner electrons "shield" the valence electrons from nuclear attraction.



Which atom is larger -- Mg or Sr?



Which atom is larger -- Br or Cl?



(b) as you go from left to right along a period, the radius decreases

- Nucleus gets stronger (more positive)
- Valence electrons pulled closer by stronger attraction

Which atom is larger -- K or Ca?

Which atom is larger -- S or Al?

Order the atoms according to size: Na P Rb

INCREASING ATOMIC RADIUS

1	2	INCREASING ATOMIC RADIUS																		2	
1	2	H	He	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	
3	4	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
5	6	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
7	8	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
9	10	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
11	12	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
13	14	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
15	16	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
17	18	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
19	20	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
21	22	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
23	24	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
25	26	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
27	28	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
29	30	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
31	32	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
33	34	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
35	36	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
37	38	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
39	40	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
41	42	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
43	44	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
45	46	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
47	48	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
49	50	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
51	52	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
53	54	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
55	56	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
57	58	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
59	60	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
61	62	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
63	64	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
65	66	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
67	68	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
69	70	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
71	72	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
73	74	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
75	76	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
77	78	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
79	80	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
81	82	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
83	84	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
85	86	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
87	88	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
89	90	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
91	92	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
93	94	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
95	96	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
97	98	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B
99	100	Hydrogen	0.00744	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	B

② IONIZATION ENERGY

- Measured in kJ/mol
- Atom is neutral – the number of protons = the number of electrons
- Atom gains or loses electrons → forms an ion (charged particle)
- Ion gains electrons → negative charge (anion)
- Ion loses electrons → positive charge (cation)

IE = energy needed to remove an electron from the valence shell

- Easier to remove from metals than non-metals (less energy, lower IE)
- Farther valence shell is from nucleus, the lower the IE.

(a) as you go down a family, the radius increases; therefore, the IE decreases

- Valence electrons attracted less to nucleus

(b) from left to right along a period, radius decreases; therefore, the IE increases

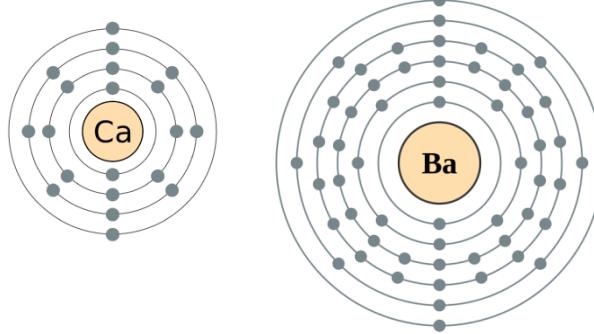
- Valence electrons attracted stronger to nucleus

In each group of atoms, which one has the larger IE?

1. Ca or Ba

2. O or C

3. Na or K or Cl



INCREASING IONIZATION ENERGY

INCREASING IONIZATION ENERGY																																																			
1	H Hydrogen 1.00794	4	Be Boron 9.012182	5	Li Lithium 6.941	6	Be Boron 9.012182	7	N Nitrogen 14.0107	8	O Oxygen 15.9994	9	F Fluorine 18.9984032	10	Ne Neon 20.1397	2	He Helium 4.003																																		
11	Na Sodium 22.989770	12	Mg Magnesium 24.31050	13	Al Aluminum 26.981538	14	Si Silicon 28.0855	15	P Phosphorus 30.973761	16	S Sulfur 32.066	17	Cl Chlorine 35.4527	18	Ar Argon 39.948	3	K Potassium 39.0983	4	Ca Calcium 40.078	5	Sc Scandium 44.95910	6	Ti Titanium 47.867	7	V Vanadium 50.9415	8	Cr Chromium 51.9861	9	Mn Manganese 54.93409	10	Fe Iron 55.845	11	Co Cobalt 58.935200	12	Ni Nickel 58.6934	13	Cu Copper 63.546	14	Zn Zinc 65.39	15	Ga Gallium 69.723	16	Ge Germanium 72.61	17	As Arsenic 74.92160	18	Se Selenium 78.90	19	Br Bromine 79.904	20	Kr Krypton 83.80
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																																		
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72																																		
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118																																		
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt																																											
Fractional (223)	Radium (226)	Actinium (223)	Roentgenium (261)	Dubnium (282)	Synthesis (253)	Bharkar (262)	Hs	Mt	(265)	(269)	(272)	(277)																																							

INCRAEASING IONIZATION ENERGY

③ ELECTRON AFFINITY

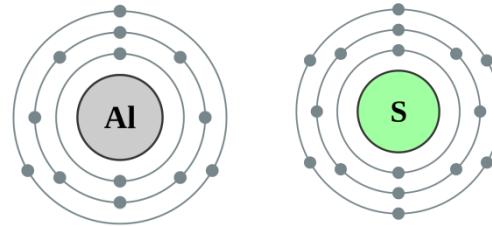
- Measured in kJ/mol

EA = change in energy when an electron added to valence shell to make an anion.

- Metals prefer to lose electrons, not gain; therefore, low electron affinity
- Non-metals prefer to gain electrons; therefore, higher EA
- Energy is released when electrons are gained
- Trend is more irregular than atomic radius and ionization energy, but resemble IE and opposite to atomic radius.

In each group of atoms, which one has the larger EA?

- Al or S
- Cs or K
- Cl or Ca or Mg



INCREASING ELECTRON AFFINITY

INCREASING ELECTRON AFFINITY																	
1 H Hydrogen 1.00744	2 He Helium 4.003	3 Li Lithium 6.941	4 Be Beryllium 9.012182	5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1397	11 Na Sodium 22.989770	12 Mg Magnesium 24.31030	13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955961	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.93861	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.935209	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90545	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.96	43 Tc Technetium 98.0	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 108.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Tl Thallium 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 132.50447	54 Xe Xenon 131.29
55 Cs Cesium 132.90445	56 Ba Barium 137.327	57 La Lanthanum 138.90355	58 Hf Hafnium 178.49	59 Ta Tantalum 180.3479	60 W Tungsten 183.84	61 Re Rhenium 186.207	62 Os Osmium 190.23	63 Ir Iridium 192.217	64 Pt Platinum 195.078	65 Au Gold 196.96655	66 Hg Mercury 200.59	67 Tl Thallium 204.3833	68 Pb Lead 207.2	69 Bi Bismuth 208.98038	70 Po Polonium (209)	71 At Astatine (210)	72 Rn Radium (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	90 Rf Rutherfordium (261)	91 Db Dubnium (262)	92 Sg Seaborgium (263)	93 Bh Bholtzen (262)	94 Hs Hassium (265)	95 Mt Moscovium (216)	96 Fr Florium (269)	97 Mc Meitnerium (272)	98 Ts Tsatsis (277)	99 Uut Uutonium (277)	100 Uup Uuponium (277)	101 Uus Uusonium (277)	102 Uuo Uuoxygen (277)	103 Uup Uupotassium (277)	104 Uup Uupalladium (277)

INCREASING ELECTRON AFFINITY

