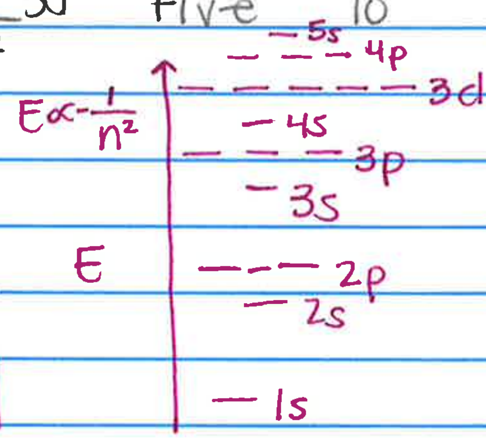
October 9th

$n = 1, 2, 3 \ldots \quad 0 \ldots n-1 \quad -\ell \ldots +\ell$

Total for n^2	n	ℓ	m_ℓ	name of orbital	# of orbitals	max occ.
$n^2 = 1$	1	0	0	1s	one	2
$2^2 = 4$	2	0	0	2s	one	2
		1	-1 0 +1	2p	three	6
$3^2 = 9$	3	0	0	3s	one	2
		1	-1 0 +1	3p	three	6
		2	-2 -1 0 +1 +2	3d	five	10

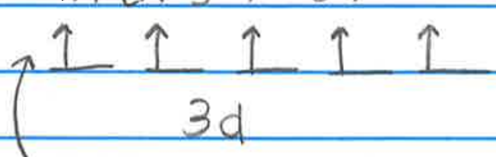
$\ell = 0$

1s		
2s		2p
3s		3p
4s	3d	4p
5s	4d	5p



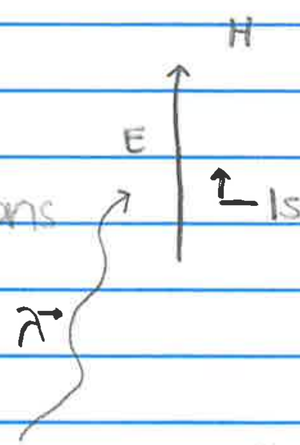
Pauli Exclusion Principle → cannot have same exact quantum #'s

Mn [Ar] $4s^2 3d^5$



Hund's rule → order in which you fill the orbitals (fill each with 1 e^- b4 going back to double up)

$n = 3$
$\ell = 2$
$m_\ell = -2$
$m_s = +1/2$



Anomalous electron configurations

↳ Cr [Ar] $4s^2 3d^4$ (predicted)

[Ar] $4s^1 3d^5$ (actually)

H in ground state $1s^1$ (only one)

H in excited states countless possibilities all short-lived

↳ H $2s^1$ H $3d^1$ H $4f^1$ H $6p^1$ H $74d^1$

Effective Nuclear charge [Nuclear charge ≡ # protons ≡ atomic #] october 9th

Z^* or Z_{eff}

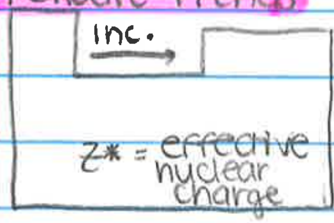
H $Z = 1$ $Z^* = 1$

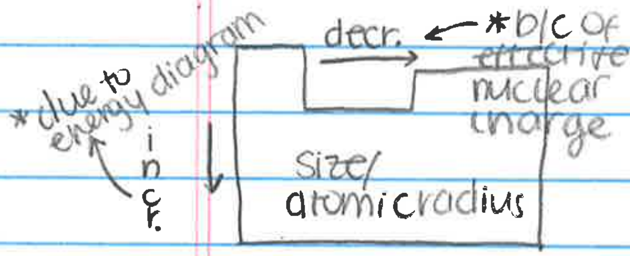
He $Z = 2$ $Z^* = 1.7$ protons

	Li ($1s^2 2s^1$)	Be	B ($2p^1$)	C	N	O	F	Ne
Z	3 protons	4	5	6	7	8	9	10
Z^*	1.3 protons	1.95	2.60	3.25	3.90	4.55	5.20	5.85
atomic radius	152 pm	112 pm	83 pm	77 pm	75 pm	73 pm	72 pm	38 pm

protons felt by $2p^6$ electrons

Periodic trends





r atomic (pm)

Li 152 pm
Na 186 pm
K 227 pm
Rb 248 pm

} because we are starting to fill a new shell

First Ionization Energy (removing one electron)

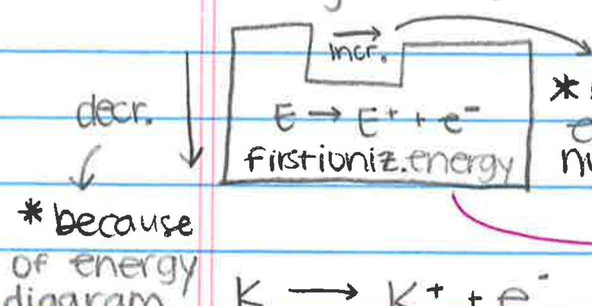
$Na \rightarrow Na^+ + e^-$ $E_{i1} = +496$ KJ/mol

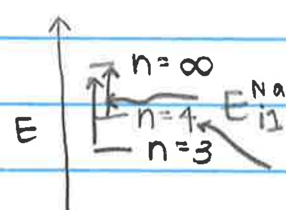
$[Ne]3s^1 \rightarrow [Ne]3s^0$ ↳ takes energy $\Delta E = +496$ KJ

3s electron → $n = \infty$ (gets removed)

$Na^+ + e^- \rightarrow Na$ $\Delta E = -496$ KJ (energy given off)

$Mg \rightarrow Mg^+ + e^-$ $E_{i1} = +738$ KJ/mol





$K \rightarrow K^+ + e^-$

$[Ar]4s^1 \rightarrow [Ar]4s^0$

$Al \rightarrow Al^+ + e^-$ $E = +578$ KJ/mol

$3s^2 3p^1$ $3s^2 3p^0$

First Ionization Energies

$Na \rightarrow Na^+ + e^-$ $E = +496$ KJ/mol

$3s^1 \rightarrow 3s^0$

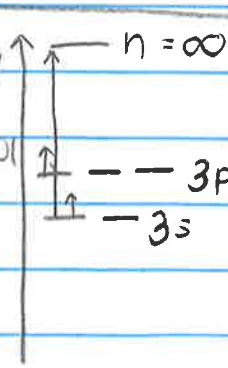
11p 11e⁻   11p 10e⁻

$Mg \rightarrow Mg^+ + e^-$ $E = +738$ KJ/mol

$3s^2$ $3s^1$

12p 12e⁻   12p 11e⁻

$Z^* > Z^*$ for Na



Electron configurations for ions

October 9th

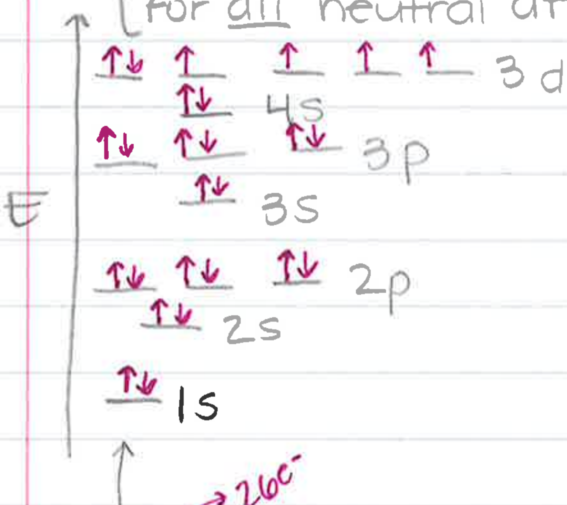
Na $1s^2 2s^2 2p^6 3s^1$

Na^+ $1s^2 2s^2 2p^6 3s^0$

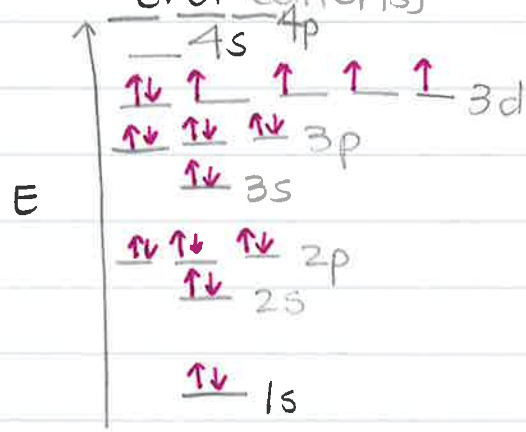
F $1s^2 2s^2 2p^5$

F^- $1s^2 2s^2 2p^6$

[for all neutral atoms]



[for cations]



Fe [Ar] $4s^2 3d^6$ → $26e^-$

Fe^{2+} [Ar] $4s^0 3d^6$ → $24e^-$

↳ * take away s electrons first !

Ni [Ar] $4s^2 3d^8$ Ni^{2+} [Ar] $4s^0 3d^8$

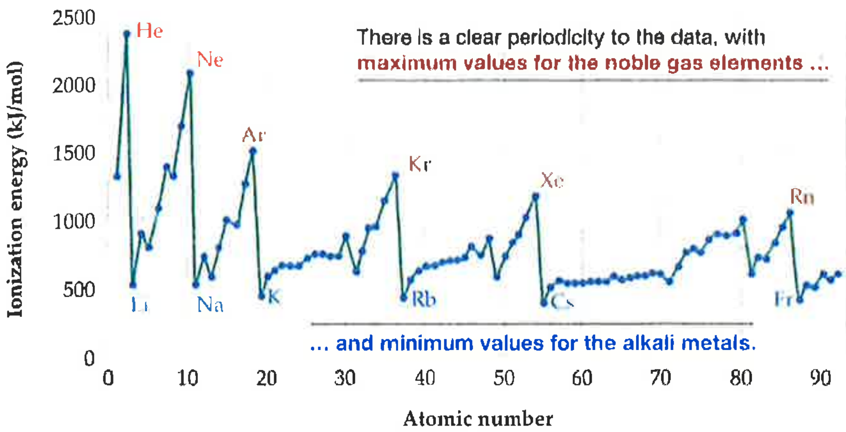


Figure 6.3
Ionization energies of the first 92 elements.

TABLE 6.2 Higher Ionization Energies (kJ/mol) for Main-Group Third-Row Elements

Group	1A	2A	3A	4A	5A	6A	7A	8A
***E*ᵢ Number**	**Na**	**Mg**	**Al**	**Si**	**P**	**S**	**Cl**	**Ar**
E_{i1}	496	738	578	787	1,012	1,000	1,251	1,520
E_{i2}	4,562	1,451	1,817	1,577	1,903	2,251	2,297	2,665
E_{i3}	6,912	7,733	2,745	3,231	2,912	3,361	3,822	3,931
E_{i4}	9,543	10,540	11,575	4,356	4,956	4,564	5,158	5,770
E_{i5}	13,353	13,630	14,830	16,091	6,273	7,013	6,540	7,238
E_{i6}	16,610	17,995	18,376	19,784	22,233	8,495	9,458	8,781
E_{i7}	20,114	21,703	23,293	23,783	25,397	27,106	11,020	11,995

Electronegativity increases from left to right.

Electronegativity decreases from top to bottom.

H 2.1																	He
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe
Cs 0.7	Ba 0.9	Lu 1.1	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.9	Bi 1.9	Po 2.0	At 2.1	Rn

TABLE 7.1 Average Bond Dissociation Energies, *D* (kJ/mol)

H—H	436[a]	C—H	410	N—H	390	O—F	180	I—I	151[a]
H—C	410	C—C	350	N—C	300	O—Cl	200	S—F	310
H—F	570[a]	C—F	450	N—F	270	O—Br	210	S—Cl	250
H—Cl	432[a]	C—Cl	330	N—Cl	200	O—I	220	S—Br	210
H—Br	366[a]	C—Br	270	N—Br	240	O—N	200	S—S	225
H—I	298[a]	C—I	240	N—N	240	O—O	180		
H—N	390	C—N	300	N—O	200	F—F	159a		
H—O	460	C—O	350	O—H	460	Cl—Cl	243[a]		
H—S	340	C—S	260	O—C	350	Br—Br	193[a]		
Multiple covalent bonds[b]									
C=C	728	C≡C	965	C=O	732	O=O	498[a]	N≡N	945[a]

Chapter 6 Day 1 (Sections 6.1 – 6.4) (Unit 3) 9 October 2019

1. Write the electron configuration for each of the following. You may use core notation for all ions with Z > 18.

(a) Na^+
(b) O^{2-}
(c) Sr^{2+}
(d) Sn^{2+}
(e) Cr^{3+}
(f) P^{3-}

2. How many unpaired electrons does each of the elements in Question 1 possess?

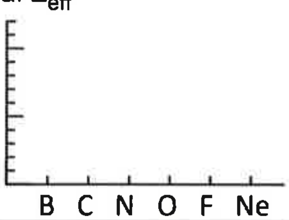
(a) Na^+	(b) O^{2-}	(c) Sr^{2+}
(d) Sn^{2+}	(e) Cr^{3+}	(f) P^{3-}

3. List each set of atoms/ions from smallest to largest.

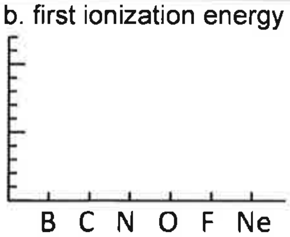
(a) Na^+ Mg^{2+} Al^{3+}	(b) Na^+ K^+ Rb^+
(c) S^{2-} Se^{2-} Te^{2-}	(d) Sn Sn^{2+}
(e) F F^-	(f) P^{3-} S^{2-} Cl^-

4. Graph the following periodic trends. The y-axis increases in value upward.

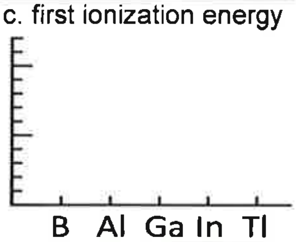
a. Z_{eff}



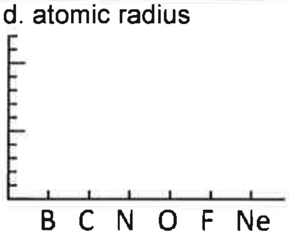
b. first ionization energy



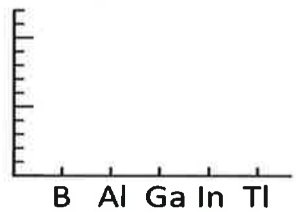
c. first ionization energy



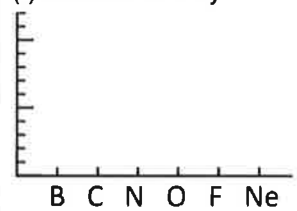
d. atomic radius



e. atomic radius



(f) electron affinity



Questions in final exam format (multiple choice):

5. Arrange the ions N^{3-}, O^{2-}, Mg^{2+}, Na^+, and F^- in order of increasing ionic radius, starting with the smallest first.
   A. Mg^{2+}, Na^+, F^-, O^{2-}, N^{3-}
   B. N^{3-}, Mg^{2+}, O^{2-}, Na^+, F^-
   C. N^{3-}, O^{2-}, Mg^{2+}, F^-, Na^+
   D. N^{3-}, O^{2-}, F^-, Na^+, Mg^{2+}

6. Of the following, which element has the highest first ionization energy?
   A. Li B. F C. Cs D. At

7. Which period 3 element has successive first through seventh ionization energies (kJ/mol) of E_{i1} = 578; E_{i2} = 1,817; E_{i3} = 2,745; E_{i4} = 11,575; E_{i5} = 14,830; E_{i6} = 18,376; and E_{i7} = 23,293?
   A. Mg B. Al C. S D. Cl

8. Which of the following atoms with the specified electronic configurations would have the lowest first ionization energy?
   A. [He] $2s^2 2p^3$
   B. [Ne] $3s^2 3p^4$
   C. [Xe] $6s^1$
   D. [Xe] $6s^2 4f^{14} 5d^{10} 6p^1$

9. 20) List the elements Cs, Ca, Ne, Na, Ar in order of decreasing first ionization energy.
   A. Ar > Ca > Cs > Na > Ne
   B. Ne > Ar > Ca > Na > Cs
   C. Ne > Ar > Na > Cs > Ca
   D. Ne > Na > Cs > Ca > Ar

Now try these problems from the book:

Section 6.1. (Electron configurations of ions) Problems 1, 2, and 34 – 36, even.
Section 6.2. (Ionic radii) Problems 3, 4, 22, and 48 – 54, even.
Section 6.3. (Ionization energy) Problems 5, 6, 26, 26, 56 and 58.
Section 6.4. (Higher ionization energies) Problems 7, 8, 24, 60, 62, and 64.
Practice Exam (pg. 231) Problems 1 - 8