General Chemistry 1 *(CHEM 1141)*

Shawnee State University – Autumn 2023

November 30, 2023

Exam # 4B

Name _____

Please print your full name, and the exam version (4B) that you have on the scantron sheet!
(Bubble in the best answer choice for each question on the scantron sheet in pencil!)

Please ☑ check the box next to your correct section number.

Section #:

- ❒ 1. (Mon Lab, 11:10 AM – 1:55 PM) } **Fleeman**
- ❒ 2. (Wed Lab, 11:10 AM – 1:55 PM) } **Fleeman**
- ❒ 3. (Tue Lab, 11:00 AM – 1:50 PM) } **Napper**
- ❒ 4. (Thu Lab, 11:00 AM – 1:50 PM) } **Napper**

Multiple Choice:	_____	**/ 70 (+5 BONUS)**
Q31:	_____	**/ 10**
Q32:	_____	**/ 10**
Q33:	_____	**/ 10**
TOTAL:	_____	**/ 100**

Each problem in this section (multiple choice) is worth 2.5 points!

Q1. Determine the total number of valence electrons for the bicarbonate ion, HCO_3^-

A) 32

B) 24

C) 16

D) 12

1 + 4 + 6×3 + 1

= 24

Q2. Which of the following compounds is an exception to the octet rule?

A) BBr_3

B) NF_3

C) OF_2

D) CO_2

B (e⁻ deficient)

Q3. Which is classified as nonpolar covalent bond?

A) the H-Cl bond in HCl

B) the C-C bond in C_2H_6

C) the O-H bond in H_2O

D) the C-Cl bond in CCl_4

Q4. In which of the geometries listed below is the smallest bond angle represented?

A) linear 180°

B) trigonal planar 120°

C) tetrahedral 109.5°

D) octahedral 90°

Q5. Which of the following molecules has the shortest C-C bond length?

A) CH_4

B) C_2H_2

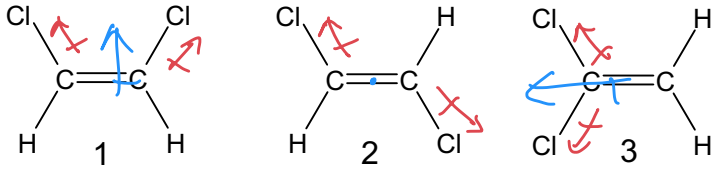
C) C_2H_4

D) C_3H_8

triple bond! (strong + short)

H–C≡C–H

Q6. Three possible structures of $C_2H_2Cl_2$ are shown below. Which of these structure(s) are polar molecules?



A) 2

B) 1, 2

C) 2, 3

D) 1, 3

↦ = bond dipole

⟶ = overall molecular dipole

Q7. Determine the formal charges for the carbon atom and nitrogen atom, respectively, in the cyanide ion, CN^-.

A) -1, 0

B) 0, -1

C) 0, 0

D) 1, 0

:C≡N:

	C	N
orig:	4	5
now:	5	5
fc:	-1	0

Q8. Which of the following atoms will be **paramagnetic** in their ground state?

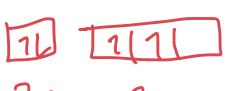
A) magnesium

B) argon

C) silicon

D) zinc

[Ne] $3s^2 3p^2$



2 unpaired e⁻s!

Q9. Which of the following elements will likely be an exception to the **auf bau** principle?

A) $_{19}K$

B) $_{21}Sc$

C) $_{29}Cu$

D) $_{32}Ge$

Q10. How many core and valence electrons does a single atom of sulfur have?

A) 6 core, 10 valence

B) 10 core, 6 valence

C) 18 core, 0 valence

D) 12 core, 4 valence

$1s^2 2s^2 2p^6$ $3s^2 3p^4$

core valence

Q11. The best explanation for why elements in the same group have similar chemical properties is that they have:

A) similar electronegativities

B) similar first ionization energies

C) the same number of valence electrons

D) the same atomic radius

Q12. The electron configuration of V^{3+} is

A) [Ar] $4d^2$

B) [Ar] $3d^2$

C) [Ar] $4s^2$

D) [Ar] $3f^2$

Q13. In units of kJ/mol, the first four ionization energies for an element are:

578, 1820, 2750, and 11,600.

The most likely identity of this element would be:

A) oxygen

B) beryllium

C) carbon

D) aluminum

Big jump in IE from 3rd → 4th

→ 3 valence e's

(4th must be core)

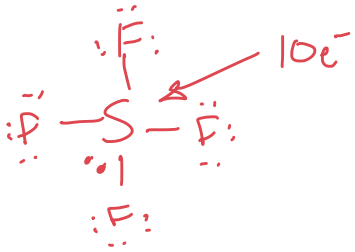
Q14. Which Lewis structure will require an expanded octet about the central atom?

A) SF_4

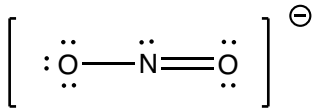
B) F_2S

C) $BeCl_2$

D) O_3



Q15. Experimentally, both NO bonds in the nitrite ion are identical in length and strength despite the Lewis structure showing the presence of two different kinds of bonds:



The best explanation for this fact involves:

A) electron delocalization

B) the more negative formal charge being assigned to oxygen

C) expansion of nitrogen's octet

D) resonance structures

Q16. The breaking of a covalent bond results in a ΔH value of:

A) >0

B) =0

C) <0

D) sometimes >0, but often <0

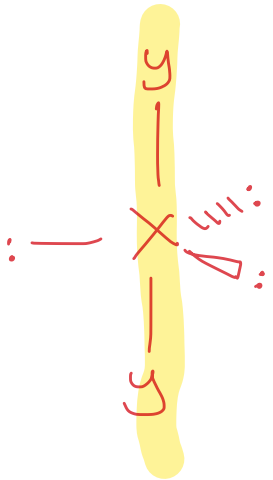
Q17. The molecular geometry of a molecule where the central atom makes 2 bonds and is surrounded by three lone pairs is:

A) linear

B) bent

C) trigonal bipyramidal

D) trigonal pyramidal



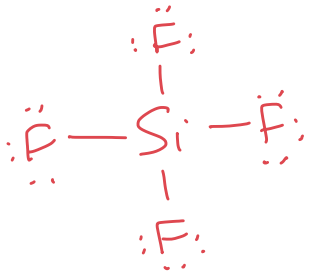
Q18. The bond angle(s) in a molecule of SiF_4 should be:

A) 90°

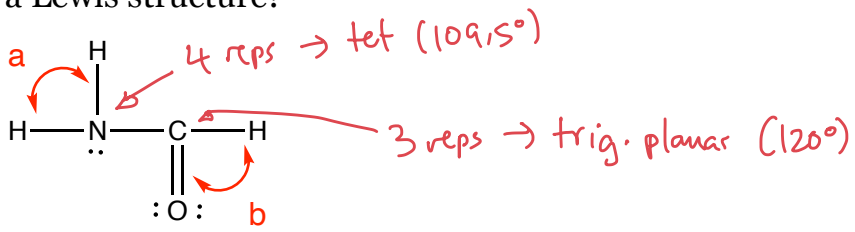
B) 109.5°

C) 120°

D) 90° and 120°



Q19. What are the ideal bond angles **a** and **b** (respectively) of the actual molecule of which this is a Lewis structure?



A) 90°, 90°

B) 109.5°, 120°

C) 90°, 120°

D) 109.5°, 109.5°

Q20. Which of the following bonds should be the **most** polar?

A) F—F

B) F—Cl

C) F—Br

D) F—I

Q21. Who is credited with the creation of the first periodic table?

A) Dmitri Mendeleyev

B) Niels Bohr

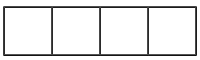
C) Amadeo Avogadro

D) Yuri Gagarin

Q22. Which would best represent the orbital diagram for an empty **d-subshell**?

A) 

B) 

C) 

D) 

Q23. Which pair of elements would you expect to exhibit the greatest similarity in their physical and chemical properties?

A) K, Ca

B) H, He

C) C, N

D) As, Sb Same group

Q24. What noble gas should be used to write the noble-gas core configuration for Te?

A) Ar

B) Xe

C) Kr

D) I

Q25. Ionization energy is:

A) a measure of the ability of an atom to attract electrons

B) energy required to add an electron to an atom in its gaseous state

C) energy required to remove an electron from an atom in its gaseous state

D) energy required to shield an electron from the nucleus

Q26. The atom with the largest atomic radius in Period 3 is:

A) Mg (Na would be largest, but of the ones listed...)

B) Al

C) Cl

D) Ar

Q27. Which of the following species is isoelectronic with Ba^{2+}?

A) Sr^{2+}

B) La^{2+}

C) Cs

D) I^-

Q28. An atom of the element X has an electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^3$. The compound most likely formed with Br is:

A) XBr

B) XBr_2

C) XBr_3

D) X_3Br

X needs 3 more e⁻s to complete outer shell.
Br shares 1e⁻ from p-orbital to bond

Q29. Which of the following atoms have the greatest number of unpaired electrons?

A) Ti

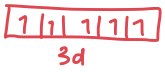
B) V

C) Mn

D) Fe

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

5 unpaired d-electrons!



Cr would actually have 6!
$4s^1$ $3d^5$

Q30. The Pauli exclusion principle states:

A) no two electrons in an atom can have the same four quantum numbers

B) the most stable arrangement of electrons in subshells, has the greatest number of parallel spins

C) it is not possible to know the precise position and momentum of an electron

D) electrons fill lower-energy orbitals first before filling higher-energy orbitals

Each problem in this section (short answer) is worth 10 points!

All work must be shown to receive credit!

You must use the factor–label (conversion–factor) method for all conversions!

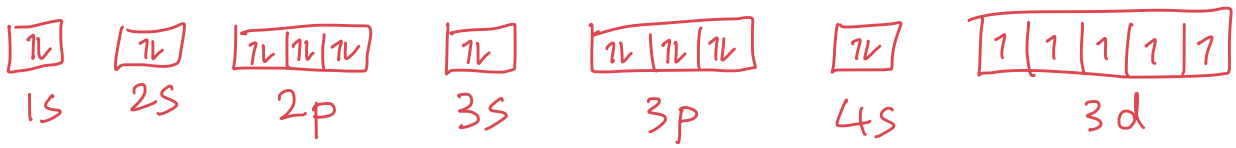
Be sure to include units where applicable!

All numeric answers must be rounded to the correct number of significant figures!

Q31. (A) Write out the **full** electron configuration for an atom of $_{25}Mn$

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^5$

(B) Write out the orbital diagram for $_{25}Mn$



(C) Write out the electron configuration for the Mn^{2+} ion using an appropriate noble-gas core:

$[Ar]\ 3d^5$ (loses valence 4s before core 3d)

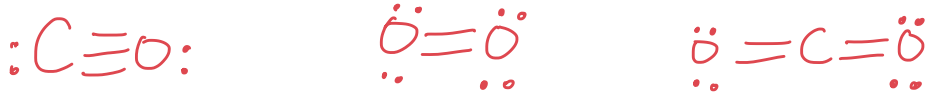
(D) EXPLAIN whether Mn^{2+} is diamagnetic or paramagnetic.

Paramagnetic. (Still) has 5 unpaired e⁻s

(E) Write a short definition of **Hund's Rule.**

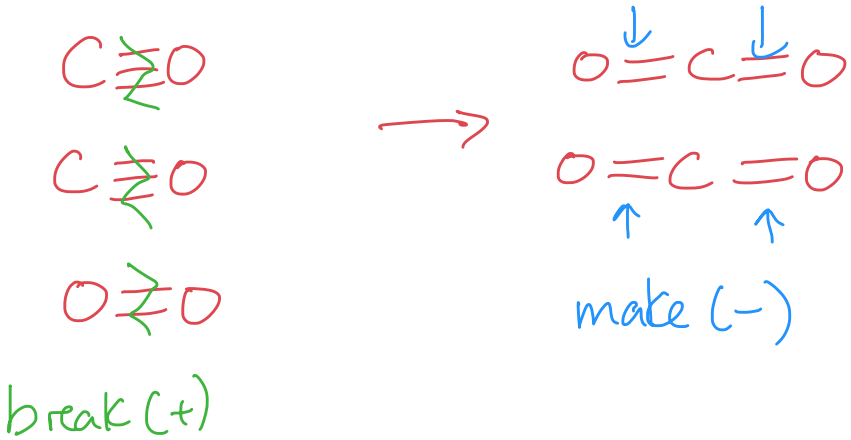
Electrons enter different orbitals in a subshell with parallel spins, before pairing up in same orbitals.

Q32. a) For the following equation (see part b), draw a valid Lewis structure for each of the reactants and the product. Be sure to show all bonding pairs and lone pairs clearly.



b) Use bond energies to calculate ΔH_{rxn} for this chemical reaction given below. Show your work clearly.

$$2\ CO(g) + O_2(g) \rightarrow 2\ CO_2(g)$$



$\Delta H^\circ_{rxn} \approx [2 \times C{\equiv}O + 1 \times O{=}O] - [4 \times C{=}O]$

$\approx -543\ kJ/mol$

Bond	Bond Enthalpy (kJ/mol)	Bond	Bond Enthalpy (kJ/mol)
H—H	436	C—O	347
N—F	272	C═O	745
N—N	193	C═O	799 (in CO_2) ✗
N═N	418	C≡O	1077
N≡N	946	O—O	142
C—H	414	O═O	499
O—H	460	N—H	393

Q33. Predict the molecular geometry and polarity of BrF_3.
Include the following information in your answer.

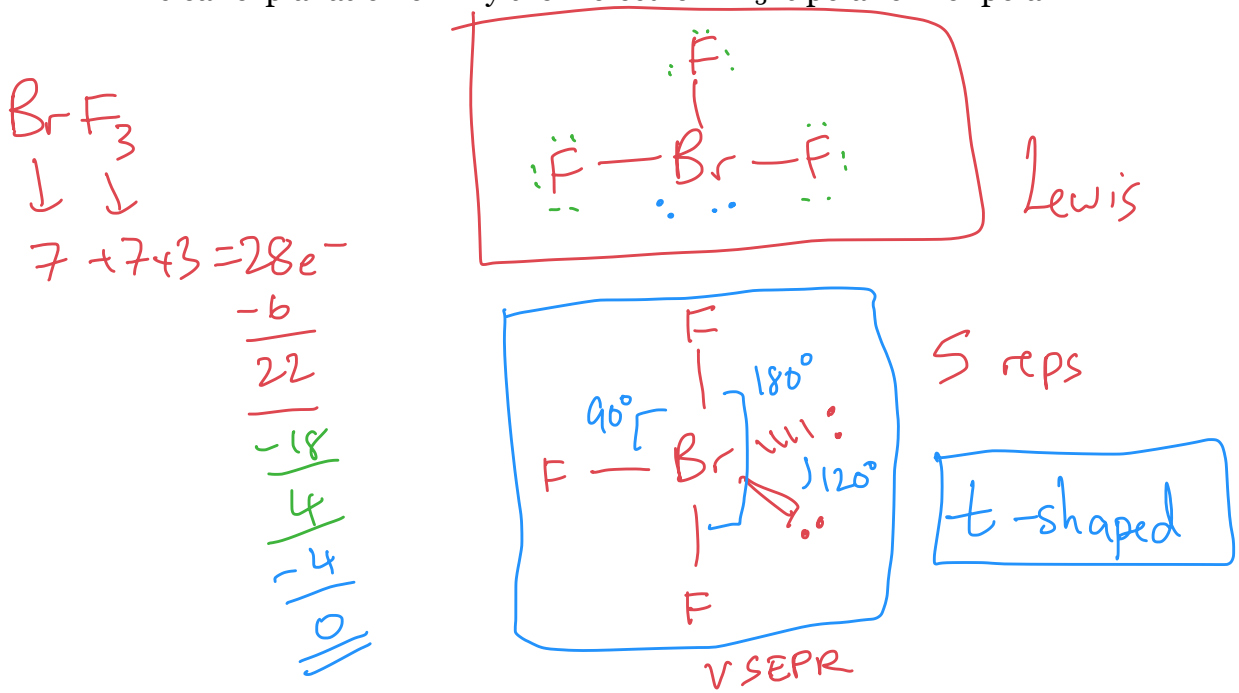
☐ A valid Lewis structure

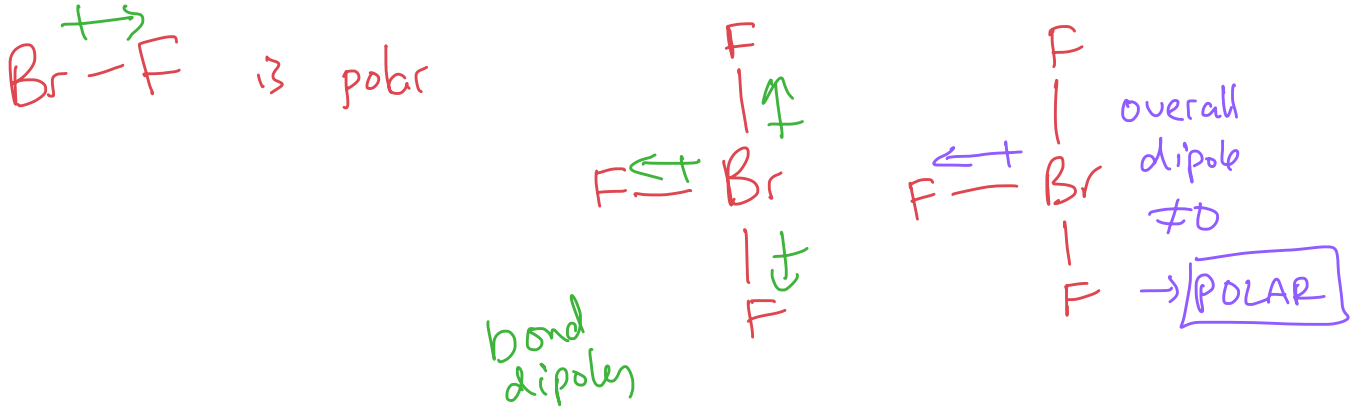
☐ A sketch of the geometry of the molecule using line/dash/wedge notation

☐ The value of the bond angle(s) written out

☐ The name of the molecular geometry

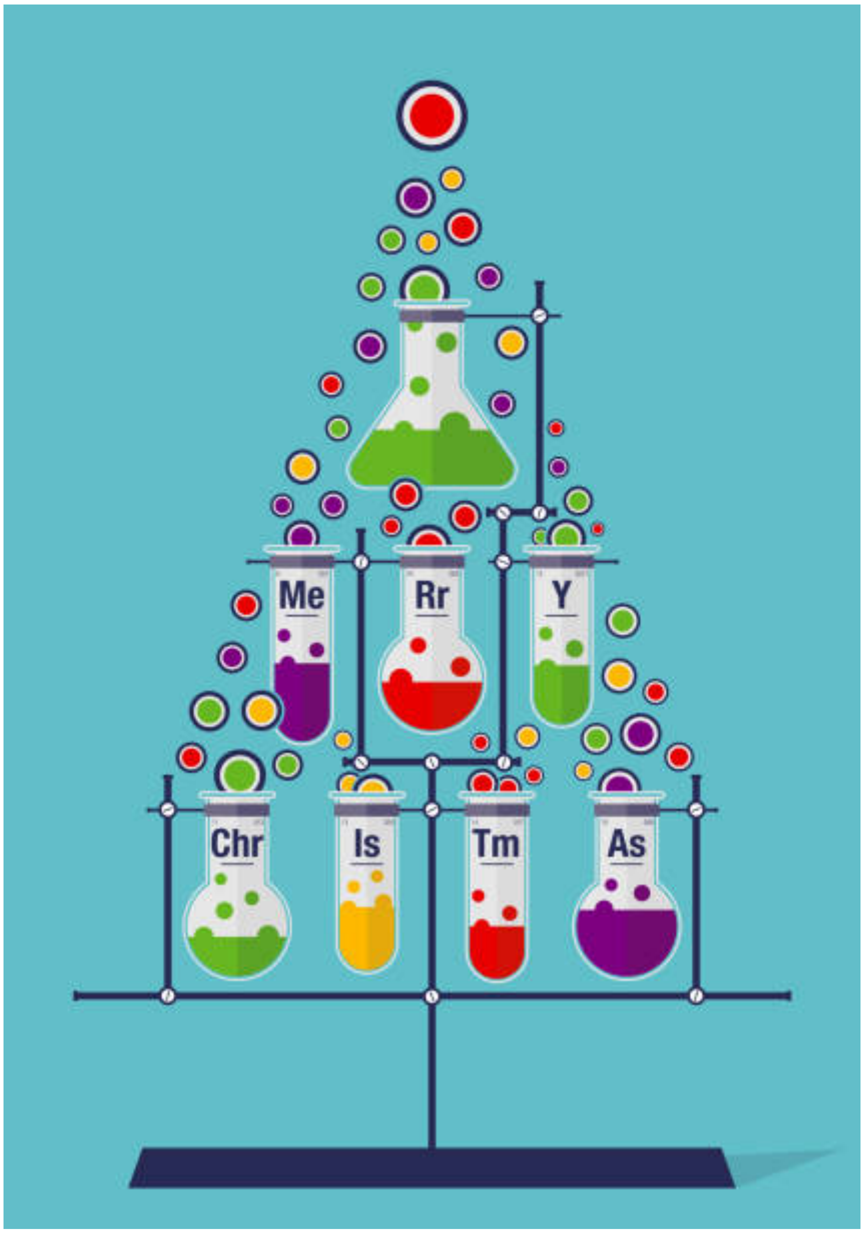
☐ A clear explanation of why the molecule BrF_3 is polar or nonpolar





5 Point Bonus Question

Surprise, you have already answered the BONUS questions!! We have chosen two of the multiple-choice questions to count as the BONUS questions.



Exam checklist:

(Check the boxes to certify the following:)

❒ My full name is written legibly on the front page

❒ My correct lab section has been indicated on the front page

❒ My full name is written legibly on the scantron sheet

❒ My exam version (A or B) is written on the scantron sheet

Thank you from the Chemistry Professors and Good Luck!

Useful information:

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA
1												*13*	*14*	*15*	*16*	*17*	*18*
1 **H** 1.008	*2*																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	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	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** 74.92160	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** [98]	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** 127.60	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba*** 137.3	71 **Lu** 175.0	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** [210]	85 **At** [210]	86 **Rn** [222]
87 **Fr** [223]	88 **Ra**** [226]	103 **Lr** [262]	104 **Rf** [261]	105 **Db** [262]	106 **Sg** [266]	107 **Bh** [264]	108 **Hs** [265]	109 **Mt** [268]	110 [269]	111 [272]	112 [277]	113	114 [285]	115	116 [289]	117	118 [293]

*	57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** [145]	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.50	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0
**	89 **Ac** [227]	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** [237]	94 **Pu** [244]	95 **Am** [243]	96 **Cm** [247]	97 **Bk** [247]	98 **Cf** [251]	99 **Es** [252]	100 **Fm** [257]	101 **Md** [258]	102 **No** [259]