

## AP Chemistry Summer Assignment

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Welcome to AP Chemistry!

In order to effectively cover all the material in this course, we will have to move quickly through the topics that you are already familiar with from Honors Chemistry. Therefore, you are expected to review several topics (listed below) on your own prior to September. These topics are covered in the first three chapters of your AP textbook (Chemistry, The Molecular Nature of Matter and Change, Silberberg 7e).

Problems (with answers) have been included below to help you. Although these practice problems will not be collected, **you can expect a graded primary assessment with similar problems on the third class meeting of the school year**. Therefore, you should complete this assignment thoroughly, preferably in August so that the material is fresh when we begin. If you would like more practice, additional problems with answers can be found at the end of each chapter.

If you run into trouble, or have any questions about the course, please email me. I will be checking my email periodically, but not daily. Good luck, and enjoy your summer. I look forward to meeting you in the fall!

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Objective Checklist (with relevant chapters):

- \_\_\_ Use the Unit Factor Method (Dimensional Analysis) to convert from one quantity to another (1.4)
- \_\_\_ Report answers with correct units (1.4)
- \_\_\_ Report answers to the correct number of significant figures (1.5)
- \_\_\_ Distinguish between accuracy and precision (1.5)
- \_\_\_ Describe the structure of the atom (2.5)
- \_\_\_ MEMORIZE charges, formulas, and names of common monatomic and polyatomic ions found on the last page of this assignment
- \_\_\_ Quickly name and write formulas for ionic and covalent compounds (2.8)
- \_\_\_ Convert between moles, mass, and number of particles (3.1)
- \_\_\_ Determine the formula of an unknown compound (3.2)
- \_\_\_ Write and balance chemical equations (3.3)
- \_\_\_ Use stoichiometry to calculate quantities of reactant and product (3.4)

Part I: Review "Ch 1: Keys to the Study of Chemistry" (textbook). Then, solve the following problems.

**Solve the following using the factor label method. Show all work: You must write out all conversion factors and show how units cancel. Report all answers with units and to the correct number of significant figures.**

**Example: If you ate 2.0 pounds of jelly beans, how many jelly beans did you eat? (Given: 1 jelly bean = 1.18 g; 454 g = 1 lb.)**

$$2.0 \cancel{\text{lb}} \times \frac{454 \cancel{\text{g}}}{1 \cancel{\text{lb}}} \times \frac{1 \text{ jelly bean}}{1.18 \cancel{\text{g}}} = 770 \text{ jelly beans}$$

1. What is the length, in inches, of a 100. m soccer field, given that 1 in = 2.54 cm?
2. The average radius of a molecule of lysozyme, an enzyme in tears, is 1430 pm. What is its radius in nanometers (nm)?
3. The radius of a barium atom is  $2.22 \times 10^{-10}\text{m}$ . What is its radius in angstroms ( $\text{\AA}$ )?  
(Note:  $10^{-12}\text{ m} = 1\text{ pm}$ ;  $100\text{ pm} = 1\text{ \AA}$ )
4. The center on your school's basketball team is 6 ft 10 in tall. How tall is the player in millimeters (mm)?  
(Note:  $1\text{ cm} = 10\text{ mm}$ ;  $1\text{ in} = 2.54\text{ cm}$ ;  $12\text{ in} = 1\text{ ft}$ )
5. The speed of light in a vacuum is  $2.9983 \times 10^8\text{ m/s}$ . What is its speed in...
  - a. km/h?
  - b. mi/min? (Note:  $1\text{ km} = 0.62\text{ mi}$ )
6. A small hole in the wing of a space shuttle requires a  $20.7\text{ cm}^2$  patch.
  - a. What is the patch's area in square kilometers ( $\text{km}^2$ )?
  - b. If the patching material costs NASA  $\$3.25/\text{in}^2$ , what is the cost of the patch?
7. The area of a telescope lens is  $7903\text{ mm}^2$ . (Note:  $2.54\text{ cm} = 1\text{ in}$  and  $12\text{ in} = 1\text{ ft}$ ).
  - a. What is the area in square feet ( $\text{ft}^2$ )?
  - b. If it takes a technician 45 s to polish  $135\text{ mm}^2$ , how long does it take her to polish the entire lens?

8. The volume of a certain bacterial cell is  $2.56 \text{ } \mu\text{m}^3$ . (Note:  $1 \text{ mL} = 1 \text{ cm}^3$ )
- What is its volume in cubic millimeters ( $\text{mm}^3$ )?
  - What is the volume of  $10^5$  cells in L?
9. Answer the following, given that  $1 \text{ quart} = 946.4 \text{ mL}$ ,  $1 \text{ gallon} = 4 \text{ quarts}$ , and  $1 \text{ mL} = 1 \text{ cm}^3$ .
- How many cubic meters of milk are in 1 qt?
  - How many liters of milk are in 835 gal?
10. Perform the following conversions:
- $20.^\circ\text{C}$  (a pleasant spring day) to K
  - $-164^\circ\text{C}$  (the boiling point of methane, the main component of natural gas) to K
  - 0 K (absolute zero, theoretically the coldest possible temperature) to  $^\circ\text{C}$
  - $6.1 \times 10^3 \text{ K}$  (the surface temperature of the Sun) to  $^\circ\text{C}$
11. Round off each measurement to the indicated number of significant figures.
- $0.0003554 \text{ m}$  (to 2 sf)
  - $35.8348 \text{ g}$  (to 4 sf)
  - $22.4555 \text{ s}$  (to 3 sf)
  - $231.554 \text{ kg}$  (to 4 sf)
  - $144,000 \text{ mL}$  (to 2 sf)
  - $1.030 \times 10^3 \text{ L}$  (to 2 sf)
12. Carry out the following calculations, and record your answer with the correct number of significant figures.
- $1.110 \text{ cm} + 17.3 \text{ cm} + 108.2 \text{ cm} + 316 \text{ cm}$
  - $\frac{2.420 \text{ g} + 15.6 \text{ g}}{4.8 \text{ g}}$
  - $\frac{7.87 \text{ mL}}{16.1 \text{ mL} - 8.44 \text{ mL}}$
  - $V = \pi r^2 h$ , where  $r = 6.23 \text{ cm}$  and  $h = 4.630 \text{ cm}$
13. Which statements include exact numbers?
- Angel Falls is 3212 ft high.
  - There are 8 known planets in the Solar System.
  - There are 453.59 g in 1 lb.
  - There are 1000 mm in 1 m.

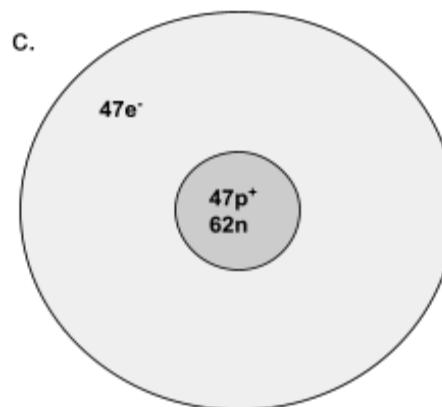
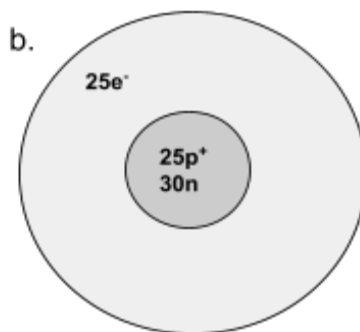
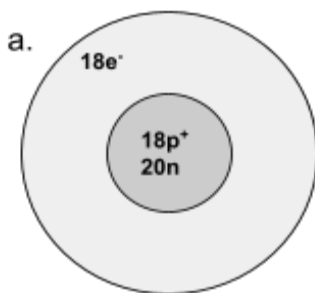
Answers: 1)  $3.94 \times 10^3 \text{ in}$  2)  $1.43 \text{ nm}$  3)  $2.22 \text{ } \text{\AA}$  4)  $2.1 \times 10^3 \text{ mm}$  5a)  $1.0794 \times 10^9 \text{ km/h}$  5b)  $1.1 \times 10^7 \text{ mi/min}$  6a)  $2.07 \times 10^{-9} \text{ km}^2$  6b)  $\$10.43$  7a)  $8.507 \times 10^{-2} \text{ ft}^2$  7b)  $2.6 \times 10^3 \text{ s}$  8a)  $2.56 \times 10^{-9} \text{ mm}^3$  8b)  $10^{-10} \text{ L}$  9a)  $9.464 \times 10^{-4} \text{ m}^3$  9b)  $3.16 \times 10^3 \text{ L}$  10a)  $293 \text{ K}$  10b)  $109 \text{ K}$  10c)  $-273^\circ\text{C}$  10d)  $5.8 \times 10^3 \text{ }^\circ\text{C}$  11a)  $0.00036 \text{ m}$  11b)  $35.83 \text{ g}$  11c)  $22.5 \text{ s}$  11d)  $231.6 \text{ kg}$  11e)  $140,000 \text{ mL}$  11f)  $1.0 \times 10^3 \text{ L}$  12a)  $443 \text{ cm}$  12b)  $3.8$  12c)  $1.0$  12d)  $565 \text{ cm}^3$  13) b,d

Part II: Review "Chapter 2: The Components of Matter." Then, answer the following questions.

1. Complete the table below for the following neutral atoms.

Name	# of Protons	# of Neutrons	# of Electrons	Atomic Number (Z)	Mass Number (A)	Nuclide Symbol
	26	30				
						$^{35}_{17}\text{Cl}$
	17				37	
Iodine-127						
	16	17				

2. Write the nuclide symbol ( $^A_Z\text{X}$  notation) for each of the following.



3. Draw atomic representations for the atoms below (similar to those shown in the previous problem).



4. Atom "A" has 11 neutrons and Atom "B" also has 11 neutrons. Are these atoms isotopes? Explain.
5. The atomic masses of elements are generally not whole numbers. Explain why.

6. Naturally occurring chlorine is 75.78% Cl - 35 (34.9689 amu) and 24.22% Cl - 37 (36.9659 amu). Calculate the average atomic mass.
7. An element is found to gain three electrons when it forms an ion.
- What group number would this element be found in?
  - Is there enough information provided to determine what period it is in? Explain.
8. Look at the average atomic mass of Ar and K.
- Explain why early scientists might have been tempted to have K follow Cl on the periodic table.
  - Propose two reasons as to why they placed Ar after Cl instead of K
9. Identify the following elements.
- An alkali metal in the 5th period.
  - A transition metal in period 4
  - An atom in the 3rd period that forms a  $-1$  ion
  - Period 3 element that has two valence electrons
  - Group 17 element with fewer than 15 protons
  - Noble gas in period 5
10. Explain why atoms tend to gain or lose electrons relative to the number of valence electrons. How can you predict the number of electrons lost or gained?
11. Classify each element as metal, nonmetal, or metalloid. What ion(s) would each element be likely to form?
- |             |           |             |             |
|-------------|-----------|-------------|-------------|
| a. nitrogen | c. sulfur | e. hydrogen | g. bromine  |
| b. calcium  | d. carbon | f. oxygen   | h. aluminum |
12. How many total ions (cations and anions) are present in the following compounds?
- |                     |                        |                      |
|---------------------|------------------------|----------------------|
| a. sodium acetate   | c. copper(II) chloride | e. carbon dioxide    |
| b. Aluminum nitrate | d. copper (I) chloride | f. calcium phosphate |
13. Aluminum reacts with a certain nonmetallic element to form a compound with the general formula  $Al_2X_3$ . Element X must be from which group on the periodic table?
14. Complete the table on the next page. (No answer key - these can be easily checked online.)

	Chemical Formula	Chemical Name	Type of compound
1	NaI	Sodium iodide	Ionic
2	KNO <sub>2</sub>		
3	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>3</sub>		
4	CuSO <sub>4</sub> •5H <sub>2</sub> O		Ionic
5	AuNO <sub>2</sub>		
6	Al <sub>2</sub> (CrO <sub>4</sub> ) <sub>3</sub>		Ionic
7	IF <sub>7</sub>		Covalent
8	Cu(OH) <sub>2</sub>		
9	NO		
10	CO <sub>2</sub>		Covalent
11	CuI <sub>2</sub>		
12	P <sub>4</sub> O <sub>10</sub>		
13		Manganese II sulfide	
14		Potassium peroxide	
15		Lithium permanganate	
16		Mercury (I) chloride	
17		Aluminum cyanide	
18		Manganese (II) nitride	
19		Ammonium sulfide	
20		Diphosphorus pentoxide	
21		Barium hydroxide octahydrate	
22		Sodium acetate	
23		Aluminum nitrate	
24		Copper (II) chloride	
25		Iron (III) Carbonate	

Answers: 1) iron-56, 26e<sup>-</sup>, Z=26, A=56; chlorine-35, 17p<sup>+</sup>, 18n, 17e<sup>-</sup>, Z=17, A=35; chlorine-37, 20n, 17e<sup>-</sup>, Z=17, A=37; 53p<sup>+</sup>, 74n, 53e<sup>-</sup>, Z=53, A=74 2a) Z=18 and A=38, Ar 2b) Z=25 and A=55, Mn 2c) Z=47 and A=109, Ag 3a) 22p<sup>+</sup>, 26n, 22e<sup>-</sup> 3b) 34p<sup>+</sup>, 45n, 34e<sup>-</sup> 3c) 5p<sup>+</sup>, 6n, 5e<sup>-</sup> 4) No, isotopes have same Z (# of protons), but different A (# of protons+neutrons) 5) Weighted average of all isotopes 6) 35.45 amu 7a) group 15 7b) No 8a) K has a greater average atomic mass than Ar 8b) Ar behaves like other group 18 elements 9a) Rb 9b) Any element Z= 21 to 30 9c) Cl 9d) Mg 9e) F 9f) Xe 10) metals gain nonmetals lose to get same # of e<sup>-</sup>s as the nearest noble gas 11a) NM 3- 11b) M 2+ 11c) NM 2- 11d) NMI 4+ or 4- 11e) NM +1 11f) NM 2- 11g) NM 1- 11h) M +3 12a) 2 15b) 4 12c) 3 12d) 2 12e) 0, it's covalent 12f) 5 13) group 16

Part III: Review "Chapter 3: Stoichiometry of Formulas and Equations." Then, solve the following problems.

**Solve the following using the factor label method. Show all work: You must write out all conversion factors and show how units cancel. Report all answers with units and to the correct number of significant figures.**

1. Answer the following questions for the compound aluminum sulfate.

- a. What is the molar mass of this compound?
- b. What is the mass of a 1.5 mole sample?
- c. How many oxygen atoms are present in the 1.5 mol sample?

2. Consider a 0.433 mol sample of calcium nitrate.

- a. Calculate the mass of the sample in grams.
- b. How many formula units of calcium nitrate are present?
- c. How many nitrate ions are present?

3. Answer the following questions for the compound aluminum chloride.

- a. What is the molar mass of this compound?
- b. What is the mass of a 0.65 mole sample?
- c. How many formula units are in the 0.65 mole sample?
- d. How many ions are in the 0.65 mole sample?
- e. How many protons are in the 0.65 mole sample?

4. What mass of rhodium contains the same number of atoms as there are
- gallium atoms in 36.0 g gallium
  - indium atoms in 36.0 g indium
5. Carbon has two isotopes C-12 (99%) and C-13 (1%).
- How many atoms of C would be present in a 34 gram sample of pure diamond (pure carbon)?
  - How many atoms of those are C-13 atoms?
6. Calculate each of the following quantities.
- Mass (in g) of  $6.4 \times 10^{-2}$  mol of manganese (II) sulfate
  - Amount (in moles) of formula units in 15.8 kg of  $\text{Fe}(\text{ClO}_4)_3$
  - Number of nitrogen atoms in 92.6 mg of ammonium nitrite
7. A sample of  $\text{Ni}(\text{CO})_4$ , a toxic transition-metal complex, has  $5.23 \times 10^{24}$  atoms of carbon. How many atoms of Ni does it contain?
8. Calculate each of the following:
- Mass % of H in ammonium bicarbonate
  - Percent by mass of Mn in potassium permanganate



9. Find the molecular formula for each compound.

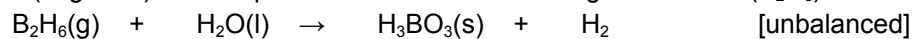
a. Empirical formula  $\text{CH}_2$  (molar mass = 42.08 g/mol)

b. Empirical formula  $\text{NO}_2$  (molar mass = 92.02 g/mol)

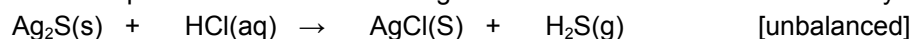
c. Empirical formula  $\text{CHN}$  (molar mass = 135.14 g/mol)

10. Cortisol (molar mass = 362.47 g/mol) is a steroid hormone involved in protein synthesis. Medically, it is used to reduce inflammation from arthritis. Cortisol is 69.6% C, 8.34% H, and 22.1% O by mass. What is its molecular formula?

11. Calculate the mass (in grams) of each product formed when 43.82 g of diborane ( $\text{B}_2\text{H}_6$ ) reacts with excess water.



12. Calculate the mass of each product formed when 174 g of silver sulfide reacts with excess hydrochloric acid.



13. Consider the following reaction:  $4\text{HCl(aq)} + \text{MnO}_2(\text{s}) \rightarrow \text{MnCl}_2(\text{aq}) + 2\text{H}_2\text{O(g)} + \text{Cl}_2(\text{g})$

- How many moles of hydrochloric acid are needed to make 500. g of water?
- What mass, in g, of hydrochloric acid is required to produce 0.88 moles of  $\text{MnCl}_2$ ?
- If 25.0 g of hydrochloric acid reacts completely, how many molecules of chlorine gas are formed?

14. Consider the formation of copper (I) sulfide from its elements:  $16\text{Cu(s)} + \text{S}_8(\text{s}) \rightarrow 8\text{Cu}_2\text{S(s)}$

- How many moles of sulfur are needed to react with 32.0 moles of copper?
- How many moles of copper (I) sulfide are formed if 32.0 moles of copper react completely?
- How many molecules of  $\text{S}_8$  are consumed during the production of 14.55 g of copper (I) sulfide?

15. Consider the following reaction:  $2\text{C}_6\text{H}_6(\text{l}) + 7\text{O}_2(\text{g}) \rightarrow 2\text{C}_4\text{H}_2\text{O}_3(\text{l}) + 4\text{H}_2\text{O(l)} + 4\text{CO}_2(\text{g})$

- How many grams of oxygen gas are needed to make 250 grams of maleic anhydride,  $\text{C}_4\text{H}_2\text{O}_3$ ?
- Continuing from the previous question, what mass of carbon dioxide will be released as a byproduct?

Answers: 1a)  $\text{Al}_2(\text{SO}_4)_3$ : 342.145 g/mol 1b) 510 g 1c)  $1.1 \times 10^{25}$  O atoms 2a) 71.1 g 2b)  $2.61 \times 10^{23}$  formula units 2c)  $5.21 \times 10^{23}$  nitrate ions 3a)  $\text{AlCl}_3$ : 133.33 g/mol 3b) 87 g 3c)  $3.9 \times 10^{23}$  formula units 3d)  $1.6 \times 10^{24}$  ions 3e)  $2.5 \times 10^{25}$  protons 4a) 53.1 g 4b) 32.3 g 5a)  $1.71 \times 10^{24}$  atoms C 5b)  $1.71 \times 10^{22}$  atoms C-13 6a) 9.7 g  $\text{MnSO}_4$  6b) 44.6 mol  $\text{Fe}(\text{ClO}_4)_3$  6c)  $1.74 \times 10^{21}$  N atoms 7)  $1.31 \times 10^{24}$  atoms Ni 8a) 6.375 % H 8b) 34.58 % O 9a)  $\text{C}_3\text{H}_6$  9b)  $\text{N}_2\text{O}_4$  9c)  $\text{C}_5\text{H}_5\text{N}_5$  10)  $\text{C}_{21}\text{H}_{30}\text{O}_5$  11) 195.8 g  $\text{H}_3\text{BO}_3$  and 19.16 g  $\text{H}_2$  12) 201 g  $\text{AgCl}$  and 23.9 g  $\text{H}_2\text{S}$  13a) 55.5 mol  $\text{HCl}$  13b) 130 g  $\text{HCl}$  13c)  $1.03 \times 10^{23}$  molecules  $\text{Cl}_2$  14a) 2.00 mol  $\text{S}_8$  14b) 16.0 mol  $\text{Cu}_2\text{S}$  14c)  $6.87 \times 10^{21}$  molecules  $\text{S}_8$  15a) 280 g  $\text{O}_2$  15b) 220 g  $\text{CO}_2$

## Monatomic Ions

1	2											13	14	15	16	17	18
Li <sup>+1</sup>	Be <sup>+2</sup>												C <sup>-4</sup>	N <sup>-3</sup>	O <sup>-2</sup>	F <sup>-1</sup>	
Na <sup>+1</sup>	Mg <sup>+2</sup>	3	4	5	6	7	8	9	10	11	12	Al <sup>+3</sup>		P <sup>-3</sup>	S <sup>-2</sup>	Cl <sup>-1</sup>	
K <sup>+1</sup>	Ca <sup>+2</sup>				Cr <sup>+2</sup> Cr <sup>+3</sup>	Mn <sup>+2</sup> Mn <sup>+3</sup>	Fe <sup>+2</sup> Fe <sup>+3</sup>	Co <sup>+2</sup> Co <sup>+3</sup>	Ni <sup>+2</sup> Ni <sup>+3</sup>	Cu <sup>+1</sup> Cu <sup>+2</sup>	Zn <sup>+2</sup>				Se <sup>-2</sup>	Br <sup>-1</sup>	
Rb <sup>+1</sup>	Sr <sup>+2</sup>									Ag <sup>+1</sup>	Cd <sup>+2</sup>		Sn <sup>+2</sup> Sn <sup>+4</sup>		Te <sup>-2</sup>	I <sup>-1</sup>	
Cs <sup>+1</sup>	Ba <sup>+2</sup>										Hg <sub>2</sub> <sup>+2</sup> Hg <sup>+2</sup>		Pb <sup>+2</sup> Pb <sup>+4</sup>				

## Polyatomic Ions

Charge	Formula	Name
+1	NH <sub>4</sub> <sup>+</sup>	ammonium
	H <sub>3</sub> O <sup>+</sup>	hydronium
-1	CH <sub>3</sub> COO <sup>-</sup>	acetate
	CN <sup>-</sup>	cyanide
	OH <sup>-</sup>	hydroxide
	ClO <sub>3</sub> <sup>-</sup>	chlorate
	NO <sub>3</sub> <sup>-</sup>	nitrate
	MnO <sub>4</sub> <sup>-</sup>	permanganate
-2	CO <sub>3</sub> <sup>2-</sup>	carbonate
	CrO <sub>4</sub> <sup>2-</sup>	chromate
	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	dichromate
	O <sub>2</sub> <sup>2-</sup>	peroxide
	C <sub>2</sub> O <sub>4</sub>	oxalate
	SeO <sub>4</sub> <sup>2-</sup>	selenate
	SO <sub>4</sub> <sup>2-</sup>	sulfate
	SiO <sub>3</sub> <sup>2-</sup>	silicate
	C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> <sup>2-</sup>	tartrate
-3	AsO <sub>4</sub> <sup>3-</sup>	arsenate
	BO <sub>3</sub> <sup>3-</sup>	borate
	PO <sub>4</sub> <sup>3-</sup>	phosphate

Polyatomic ions can be altered as follows:

- **hypo\_\_ite**
  - two fewer oxygen atoms
  - ex) **hyposulfite**, SO<sub>2</sub><sup>2-</sup>
- **\_\_ite**
  - one fewer oxygen atom
  - ex) **sulfite**, SO<sub>3</sub><sup>2-</sup>
- **\_\_ate**
  - unaltered form
  - ex) **sulfate**, SO<sub>4</sub><sup>2-</sup>
- **per\_\_ate**
  - one more oxygen atom
  - ex) **persulfate**, SO<sub>5</sub><sup>2-</sup>
- **hydrogen \_\_**
  - add a hydrogen atom, increase the charge by 1
  - ex) **hydrogen sulfate**, HSO<sub>4</sub><sup>1-</sup>

**DO NOT DETACH FROM BOOK.**

$$\frac{18}{2}$$

18	2	<b>He</b>	4.00	10	<b>Ne</b>	20.18	18	<b>Ar</b>	39.95	36	<b>Kr</b>	83.80	54	<b>Xe</b>	131.29	86	<b>Rn</b>	(222)	118	<b>Uuo</b>	(294)
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58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu
140.12		140.91		144.24	(145)	150.4		151.97		157.25		158.93		162.50		164.93		167.26		168.93		173.05		174.97			
90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No	103	Lr
232.04		231.04		238.03	(237)	(244)		(243)		(247)		(247)		(247)		(251)		(252)		(257)		(258)		(259)		(262)	

232.04	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
	231.04	238.03	(237)	(244)	(243)	(247)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(262)