

UNIT 5 - PERIODIC TABLE & PERIODIC LAW

LOCATING MAIN GROUP ELEMENTS ON THE PERIODIC TABLE NOTES

Given the electron configuration or noble gas configuration for an element, it is possible to determine its location on the Periodic Table without actually looking at a Periodic Table.

- * To tell which period this element is in... ~ find the highest occupied energy level for this element
- You can do this by... ~ finding the largest coefficient number

The largest coefficient number is the number of the period where the element is located.

- * To tell which "block" (s, p, d, f) this element is in... ~ find the highest occupied sublevel for this element
- You can do this by... ~ finding the last lowercase letter written

The last lowercase letter written in the configuration is the "block" where the element is located.

- * To tell which group this element is in... ~ find the highest occupied energy level for this element
- Then... ~ add up the exponents of the largest coefficient number

This gives you the number of valence electrons in the element.

You will then know that 1 valence e- indicates that the element is in Group 1, 2 valence e- indicates that the element is in Group 2, 3 valence e- indicates that the element is in Group 13, 4 valence e- indicates that the element is in Group 14, 5 valence e- indicates that the element is in Group 15, 6 valence e- indicates that the element is in Group 16, 7 valence e- indicates that the element is in Group 17, and 8 valence e- indicates that the element is in Group 18.

Look at the following EXAMPLE: [Ar] 4s² 3d¹⁰ 4p⁵

It is possible to tell the period, group, and "block" where this element is located.

- * Period -- largest coefficient number is 4, so element is in Period 4
- * Block-- last lowercase letter written is "p", so element is in "p" block
- * Group-- largest coefficient number is 4... 2 electrons in 4s, 5 electrons in 4p --> total of 7 valence electrons, so this element is in Group 17.

LOCATION OF ELEMENTS WORKSHEET

	Noble Gas Config.	Period	Block (s, p, d, f)	Group
1	[Ne] 3s ² 3p ²			
2	[Ar] 4s ² 3d ¹⁰ 4p ⁶			
3	[Xe] 6s ²			
4	[Kr] 5s ² 4d ¹⁰ 5p ⁵			
5	[Ar] 4s ² 3d ¹⁰ 4p ¹			
6	[He] 2s ² 2p ³			
7	[Kr] 5s ² 4d ¹⁰ 5p ⁴			
8	[He] 2s ¹			
9	[Xe] 6s ² 4f ¹⁴ 5d ¹⁰ 6p ²			
10	[Rn] 7s ²			

MAIN GROUP (GROUPS 1, 2, AND 13 - 18) ELEMENTS NOTES

GROUP	NAME	ENDING OF CONFIG.	# OF VALENCE e-	ELECTRON DOT DIAGRAM	WANTS TO (lose or gain) TO BE LIKE NOBLE GAS?	CHARGE OF ION & OXIDATION #	ION (smaller or larger) THAN ATOM
1							
2							
13							
14							
15							
16							
17							
18							

HISTORY OF THE PERIODIC TABLE NOTES

I. Mendeleev and Chemical Periodicity

- A. Wanted to organize elements according to their _____
- B. When elements were arranged in order of increasing atomic mass*, similarities in chemical properties appeared at regular intervals (_____)
- C. *Several elements did not quite fit this pattern - Mendeleev put elements with similar _____ in the same column or group
- D. 1871 - Mendeleev predicted the existence and properties of several (then undiscovered) elements. These elements were:
- E. Within 15 years, those elements with those properties had been discovered

II. Moseley and the Periodic Law

- A. When elements were arranged in order of increasing _____, there was a distinct regular pattern.
- B. _____: The physical and chemical properties of the elements are periodic functions of their atomic numbers.

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- C. In other words, when elements are arranged in order of increasing atomic number, elements with similar properties appear at regular intervals.
 - D. Bottom line = elements in the same group have similar properties
- III. Modern Periodic Table: arrangement of the elements in order of their atomic numbers so that elements with similar properties fall in the same group

ELECTRON CONFIGURATION & THE PERIODIC TABLE NOTES

- I. Stability of Noble Gases
- A. Noble gases undergo very few chemical reactions - why?
 - B. Highest occupied energy level contains _____
 - C. Electrons in the highest occupied energy level are what determines an element's _____
- II. Periods and Blocks of the Periodic Table
- A. Horizontal row = _____; 7 on modern Periodic Table
 - B. Length of period determined by the sublevels being filled in that period
 - C. Period 1: only _____ sublevel being filled; can hold a maximum of _____ electrons; period contains _____ elements
 - D. Period 4: _____, _____, and _____ sublevels being filled; s can hold _____ electrons, d can hold _____ electrons, & p can hold _____ electrons; total of _____ electrons; Period 4 contains _____ elements
 - E. Period can be determined from the element's electron configuration
 - 1. Bromine: $[\text{Ar}] 4s^2 3d^{10} 4p^5$
 - 2. Highest number in front of letter is the element's highest occupied _____ - tells which period the element is in
 - 3. For bromine, _____ is highest number, so it is in Period _____
- III. The "s" block elements: Groups 1 and 2
- A. Group 1 - Alkali Metals
 - 1. generalized outermost energy level (valence) electron configuration:
 - 2. silvery appearance
 - 3. soft enough to cut with a knife
 - 4. not found in nature as free elements - they're always part of a compound
 - B. Group 2 - Alkaline Earth Metals
 - 1. generalized valence electron configuration:
 - 2. harder, stronger, more dense than Group 1
 - 3. less reactive than Group 1, but still not found in nature as free elements
 - C. Exceptions: Hydrogen and Helium
 - 1. Hydrogen (H)
 - a. electron configuration:
 - b. properties do not resemble those of any other element on the periodic table
 - 2. Helium (He)
 - a. electron configuration:
 - b. in Group 18 because
- IV. The "d" block elements: Groups 3 - 12
- A. called
 - B. have typical metallic properties: ductile, malleable, shiny, solid, conduct electricity
 - C. less reactive than "s" block elements
 - D. found in nature as free elements
 - E. usual ending of electron configuration:
- V. The "p" block elements: Grps 13 - 18 ("s" & "p" block elements together referred to as MAIN GROUP elements)
- A. ending electron configurations of _____ through _____
 - B. properties vary greatly b/c there are metals, metalloids, and nonmetals
 - C. Group 17 - Halogens
 - 1. most reactive nonmetals
 - 2. seven electrons in outermost energy level
 - E. "p" block metals are harder and more dense than "s" block, but not as hard or dense as the "d" block metals

PERIODIC TRENDS NOTES

Electronegativity/Electron Affinity (EN/EA): measure of how much an atom wants to gain an electron

EN/EA Left to Right across a Period: INCREASES (not including Noble Gases)

Why?

* Elements on the left side of the P.T. (metals) want to lose electrons. Elements on the right side of the P.T. (nonmetals) want to gain electrons. Trend does not include Noble Gases because these elements do not want to lose or gain electrons.

EN/EA Top to Bottom in a Group: DECREASES

Ionization Energy (IE): amount of energy required to remove an atom's most loosely held electron

IE Left to Right across a Period: INCREASES

Why?

* Elements on the left side of the P.T. (metals) want to lose electrons. Therefore, it will not require much energy to remove an electron. Elements on the right side of the P.T. (nonmetals) want to gain electrons. Consequently, a lot of energy will be needed to remove (take away) an electron.

IE Top to Bottom in a Group: DECREASES

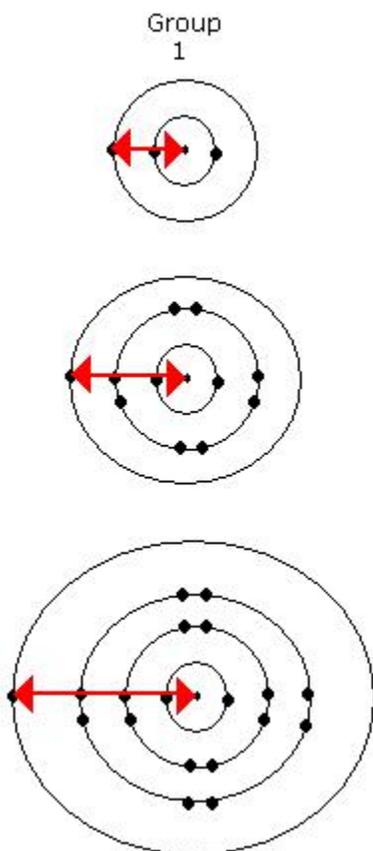
Atomic Radius (AR): distance from the nucleus to the H.O.E.L.

AR Left to Right across a Period: DECREASES

AR Top to Bottom in a Group: INCREASES

Why?

* There are more occupied energy levels as you move towards the bottom of the P.T.



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Metallic Character: how easily an atom will lose valence electrons (easier to lose = more metallic = more reactive METAL)

Which metal loses its valence electron(s) most easily? Fr

Why?

* Francium has one valence electron. It is more reactive than elements at the top of Group 1 because there are many inner shell electrons that decrease the attraction the nucleus has for the valence electrons.

Nonmetallic Character: how easily an atom will gain electrons (easier to gain = more nonmetallic = more reactive NONMETAL)

Which nonmetal gains electron(s) most easily? F

Why?

* Fluorine has seven valence electrons. It is more reactive than elements at the bottom of Group 17 because there are only a few inner shell electrons. Consequently, the nucleus has a strong attraction for other electrons.

PERIODIC TRENDS (multiple choice w/o using Periodic Table) WORKSHEET

- 1.) Which element is most metallic? Group 14, Period ____
(A) 2 (B) 3 (C) 4 (D) 5
- 2.) Which element is most nonmetallic? Group 16, Period ____
(A) 2 (B) 3 (C) 4 (D) 5
- 3.) Which has the largest atomic radius? Group ____, Period 2
(A) 1 (B) 13 (C) 15 (D) 17
- 4.) Which has the highest ionization energy? Group 2, Period ____
(A) 3 (B) 4 (C) 5 (D) 6
- 5.) Which has the most metallic properties? Group ____, Period 5
(A) 13 (B) 14 (C) 15 (D) 16
- 6.) Which has the greatest electron affinity?
(A) Grp 16, Pd 4 (B) Grp 16, Pd 5 (C) Grp 17, Pd 5 (D) Grp 17, Pd 4
- 7.) Which has the smallest atomic radius? Group 15, Period ____
(A) 2 (B) 3 (C) 4 (D) 5
- 8.) Which has the lowest electron affinity? Group ____, Period 3
(A) 13 (B) 15 (C) 17 (D) 18
- 9.) Which has the lowest ionization energy? Group 1, Period ____
(A) 2 (B) 3 (C) 4 (D) 5
- 10.) Which has the most metallic properties?
(A) Grp 15, Pd 5 (B) Grp 16, Pd 5 (C) Grp 15, Pd 6 (D) Grp 16, Pd 6
- 11.) Which would most easily lose its valence electrons?
(A) Grp 1, Pd 3 (B) Grp 14, Pd 2 (C) Grp 17, Pd 3 (D) Grp 18, Pd 2
- 12.) Which would most easily gain electrons?
(A) Grp 13, Pd 3 (B) Grp 14, Pd 2 (C) Grp 15, Pd 2 (D) Grp 17, Pd 3
- 13.) Which has an octet of electrons in its outermost energy level?
(A) Grp 13, Pd 3 (B) Grp 14, Pd 2 (C) Grp 18, Pd 2 (D) Grp 17, Pd 5
- 14.) Which has chemical properties most similar to [Ar] 4s¹? Group ____, Period 3
(A) 1 (B) 2 (C) 13 (D) 14

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- 15.) Which is most reactive? Group ____, Period 2
(A) 14 (B) 15 (C) 17 (D) 18
- 16.) Which is most reactive?
(A) Grp 13, Pd 2 (B) Grp 1, Pd 5 (C) Grp 2, Pd 5 (D) Grp 13, Pd 5
- 17.) Which has chemical properties most similar to $[\text{Ne}] 3s^2 3p^5$?
(A) Grp 16, Pd 3 (B) Grp 18, Pd 3 (C) Grp 17, Pd 4 (D) Grp 18, Pd 2
- 18.) Which would never be found in the free state?
(A) Grp 1, Pd 4 (B) Grp 13, Pd 3 (C) Grp 15, Pd 3 (D) Grp 14, Pd 4
- 19.) Which is the least reactive gas? Group ____, Period 2
(A) 16 (B) 15 (C) 17 (D) 18
- 20.) Which is the most reactive gas? Group ____, Period 2
(A) 16 (B) 15 (C) 17 (D) 18
- 21.) Which would never be in a compound?
(A) Grp 1, Pd 1 (B) Grp 18, Pd 1 (C) Grp 13, Pd 2 (D) Grp 1, Pd 2
- 22.) Which would be found in the "d" block of elements?
(A) Grp 1, Pd 3 (B) Grp 11, Pd 4 (C) Grp 17, Pd 5 (D) Grp 14, Pd 2

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In this exercise, you will use your knowledge of periodic properties and a list of clues to arrange the main group (representative) elements into a periodic table. Use the clues below to arrange the letters A - Z into their appropriate positions in the grid of the periodic table provided. (Please note that the letters A - Z in no way correspond to the real symbols for these elements.)

The following elements belong together in groups (not necessarily in this order):

BFT DGLZ JNV CMS QXY AEO IPH UKWR

Use the following clues to determine which group each set of elements belongs to:

- 1.) G is a noble gas.
- 2.) U is an alkali metal.
- 3.) E has 5 electrons in its outermost energy level.
- 4.) N has 2 valence electrons.
- 5.) T has an outer electron configuration of $4s^2 4p^1$.
- 6.) Q is a halogen.
- 7.) C has a valence electron configuration of $2s^2 2p^4$.

Use these clues to determine where each element is placed within each group.

- 8.) W is a gas at room temperature.
- 9.) F has the smallest atomic mass in its group.
- 10.) P has the lowest ionization energy in its family.
- 11.) Atoms of Z have a total of 2 electrons.
- 12.) Atoms of D contain 10 protons.
- 13.) The electrons of atom G are distributed over three energy levels.
- 14.) H is the least metallic element in its group.
- 15.) The atomic mass of V is less than that of J, but more than that of N.
- 16.) J has a lower ionization energy than V, but a higher ionization energy than K.
- 17.) The atomic number of R is one greater than that of Z.
- 18.) Y is a liquid at room temperature.
- 19.) The atomic radius of M is greater than that of S.
- 20.) A is more metallic than either O or E.
- 21.) Atoms of K are larger than those of U.
- 22.) T is more metallic than B.
- 23.) X has an atomic number that is one less than that of G.
- 24.) E is a gas at room temperature.

1						18
	2	13	14	15	16	17

PERIODIC TABLE CROSSWORD PUZZLE CLUES**ACROSS**

1. has 4 valence electrons and the largest mass in its group
2. its electron configuration ends with $3p^4$
3. exception to electron configuration rule because of the stability of a filled 3d sublevel
4. 1 mole of this element has a mass of 39.10 grams
5. noble gas (with 8 valence electrons) with the lowest atomic number
6. only gas in Group 15
7. exception to electron configuration rule because of the stability of a half-filled 3d sublevel
8. heaviest non-radioactive noble gas
9. has 76 protons
10. alkali metal that has its valence electron in the 5th energy level
11. halogen whose ion has the same electron configuration as argon
12. named after a very famous scientist and has an atomic number of 99
13. lightest metalloid in Group 14
14. 6.022×10^{23} atoms of this element have a mass of 24.3 grams
15. non-radioactive halogen with highest atomic number
16. only noble gas without 8 valence electrons
17. Lanthanide Series named after this element
18. noble gas with its valence electrons in the 4th energy level
19. known to be a poison; will gain 3 electrons to become stable
20. "coinage metal" with 2nd largest atomic radius
21. 5th period, Group 4
22. used in jewelry; 6th period, Group 10
23. lightest solid metal
24. has the highest atomic number of all elements that do not have any occupied "f" orbitals
25. basis for organic chemistry; only true nonmetal in Group 14
26. radioactive element in Group 18
27. used in light bulb filaments; end of its electron configuration should be $5d^4$
28. radioactive element that has 94 electrons when it is a neutral atom
29. 2nd lowest ionization energy in Group 15
30. largest atomic radius in Group 1; non-radioactive
31. its symbol is Mo
32. location of this metal would lead us to believe that it is a metalloid

DOWN

1. its last electron is the first electron occupying the 4p sublevel
2. only gas in Group 1
3. has 63 protons; named after a continent
4. most electronegative element
5. lowest ionization energy of all alkaline earth elements
6. its symbol is Nd
7. Actinide Series element that is named after the scientist who arranged Periodic Table by atomic mass
8. 10 moles of this element would have a mass of 876.2 grams
9. its electron configuration ends with $3d^{10}$
10. only liquid metal
11. transition element with only 1 completely filled 3d orbital
12. makes up 21% of Earth's atmosphere; vital for human life
13. solid Group 15 element with the highest electron affinity
14. mass of 2 atoms of this element is 117.9 amu
15. most common Actinide Series element
16. Group 16 element whose ion has the same electron configuration as krypton
17. has 2 electrons in its 4s orbital and 1 electron in each 3d orbital
18. has 77 protons
19. Group 15 element with the lowest electronegativity
20. only liquid nonmetal
21. alkaline earth metal needed for strong bones and teeth
22. Group 17 element with the lowest electron affinity
23. 18 grams of this element contains the same number of atoms as 24 grams of carbon
24. same name as an American coin
25. heaviest noble gas that does not have any electrons in ANY "d" orbital
26. lightest metalloid
27. 2nd largest atomic radius in Group 14
28. heaviest "coinage metal"
29. 0.5 moles of this element have a mass of 56.2 grams
30. Group 1 element that is a part of common table salt

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