ANSWER KEY - with Nuclear Chem

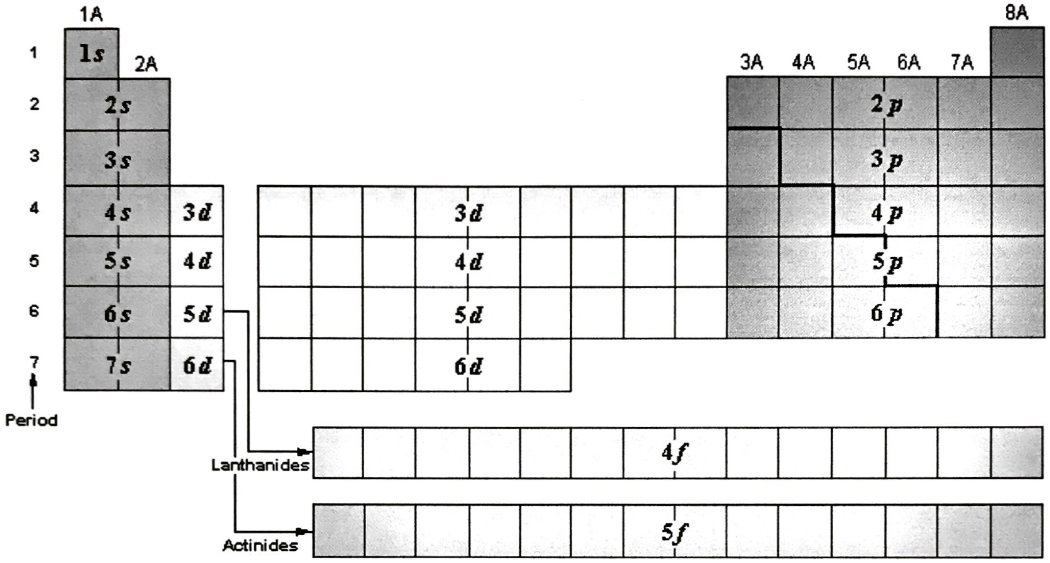
Unit 2: All Practice

Name: ______________________

Period: _____ Date: ______________

Purpose: This exercise reinforces electron sublevels and all of the methods used to express electron configurations (Long Hand, Orbital Notation, Noble Gas Notation). You will also explore how they are related to the Periodic Table.

The Periodic Table shown below indicates the sublevel into which the ***OUTERMOST***, or **LAST** electron(s) are placed for each element, also known as ***VALENCE ELECTRONS***. For example, Calcium has its outermost electrons placed in the 4s sublevel.



1. Name ***two (2)*** elements in which the outermost (last) electron(s) to be added are placed in the " **5s** " sublevel.

   Rubidium (Rb) & Strontium (Sr)

2. How many **maximum** electrons can be placed in the " **5f** " sublevel? How do you know?

   $\boxed{14e^-}$ → Energy level does not matter here; "f" sublevel has (7) sublevels, each of which can hold $2e^-$ max ∴ (7 orbitals) × ($2e^-$ each) = $14e^-$ max

3. Name ***two (2)*** elements for which the outermost (last) electron(s) to be added are placed in the " **3p** " sublevel.

   Aluminum (Al) = $3p^1$ / Silicon (Si) = $3p^2$ / Phosphorus (P) = $3p^3$ / Sulfur (S) = $3p^4$ / Chlorine (Cl) = $3p^5$ / Argon (Ar) = $3p$

4. List **ALL** elements with six (6) electrons in the outermost " **p** " sublevel (valence electrons).

   Group 16: Oxygen (O); Sulfur (S); Selenium (Se); Tellurium (Te); Polonium (Po)

5. Name ***two (2)*** elements for which the outermost (last) electron(s) to be added are placed in the " **3s** " sublevel.

   Sodium (Na) = $3s^1$ / Magnesium (Mg) = $3s^2$

6. How many ***orbitals*** are placed in the " **4d** " sublevel? How do you know?

   $\boxed{\text{5 orbitals}}$ → Each "4d" sublevel can hold a maximum of $10e^-$ or 5 pairs of electrons

7. A total of 18 electrons can be placed in the 3rd energy level. Explain why. **(Do not just simply say $2n^2$)**

   $\boxed{n=3 \rightarrow \text{3 sublevels } (s,p,d)}$ →
   $2e^-$ from "3s" sublevel
   $6e^-$ from "3p" sublevel
   $10e^-$ from "3d" sublevel
   > Total = $18e^-$ in $n=3$

8. How many ***total orbitals*** are used (containing at least one electron) in $1s^22s^22p^63s^23p^64s^23d^{10}4p^2$? ***Explain.***

   $\boxed{\text{17 total orbitals}}$ →
   $1s^2 = 1$
   $2s^2 = 1$
   $2p^6 = 3$
   $3s^2 = 1$
   $3p^6 = 3$
   $4s^2 = 1$
   $3d^{10} = 5$
   $4p^2 = 2$
   > Total = 17 orbitals occupied

9. Determine which element is associated with each long-hand electron configuration notation in the table below.

Long-Hand Electron configuration Notation	**Element (Symbol)**
$1s^2 2s^1$	Lithium (Li)
$1s^2 2s^2 2p^3$	Nitrogen (N)
$1s^2 2s^2 2p^6 3s^2 3p^5$	Chlorine (Cl)
$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$	Iron (Fe)
$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^2$	Germanium (Ge)
$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^4$	Tellurium (Te)

10. Refer to the following electron configuration and answer the questions that follow: → **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$**

1 1 3 1 3 1 5

a. How many ***total electrons*** does this element have? → 25e⁻

b. What ***element*** is this? → Manganese (Mn)

c. How many ***energy levels*** are represented? → 4 → n=1 ; n=2 ; n=3 ; n=4

d. How many ***sublevels*** are represented? → 3 → s, p, d

e. How many ***total orbitals*** are represented? → 15

11. Write the ***long-hand*** electron configuration notation for the following elements:

14e⁻

a. Silicon = $1s^2 2s^2 2p^6 3s^2 3p^2$

18e⁻

b. Calcium Cation = $Ca^{2+} \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6$ → Isoelectronic with Argon (Ar)

74e⁻

c. Tungsten = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^4$

12. Write the ***orbital (diagram) notation*** for the following elements:

35e⁻

a. Bromine = ↑↓ / ↑↓ / ↑↓ ↑↓ ↑↓ / ↑↓ / ↑↓ ↑↓ ↑↓ / ↑↓ / ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ / ↑↓ ↑↓ ↑

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$ $3d^{10}$ $4p^5$

55e⁻

b. Cesium = ↑↓ / ↑↓ / ↑↓ ↑↓ ↑↓ / ↑↓ / ↑↓ ↑↓ ↑↓ / ↑↓ / ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ / ↑↓ ↑↓ ↑↓ / ↑↓ / ↑↓ ↑↓ ↑↓ ↑↓ ↑↓

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$ $3d^{10}$ $4p^6$ $5s^2$ $4d^{10}$

/ ↑↓ ↑↓ ↑↓ / ↑

$5p^6$ $6s^1$

10e⁻

c. Neon = ↑↓ / ↑↓ / ↑↓ ↑↓ ↑↓

$1s^2$ $2s^2$ $2p^6$

13. Write the ***noble gas notation*** (short hand method) for the following elements:

56e⁻

a. Barium = $[Xe] 6s^2$

16e⁻

b. Sulfur = $[Ne] 3s^2 3p^4$

82e⁻

c. Lead = $[Xe] 6s^2 4f^{14} 5d^{10} 6p^2$

14. Determine which elements are denoted by the following electron configurations. Include element name with correct spelling **AND** element symbol in parentheses.

a. $1s^2 2s^2 2p^6 3s^2 3p^2$ 14e⁻ = Silicon (Si)

b. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ 26e⁻ = Iron (Fe)

c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^8$ 46e⁻ = Paladium (Pd)

15. Determine whether the following electron configurations are **VALID** or **INVALID**. If invalid, **CIRCLE** the source of the error **AND** rewrite the correct electron configuration in the space provided. *(Retain same number of electrons as the original configuration)*

a. $1s^2 2s^2 2p^6 3s^2 3p^6 \overset{3}{4}s^2 4d^7$ Invalid

i. Correct electron configuration: 27e⁻ = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$

b. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^2$ Valid

i. Correct electron configuration: N/A

c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^2 5f^{\overset{14}{12}} 7s^2 5f^0$ Invalid

i. Correct electron configuration: 102e⁻ = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^2 5f^{14}$

16. Complete the following table:

Isotope Symbol	Charge	Mass #	# of Protons	# of Neutrons	# of Electrons
$^{54}_{26}Fe$	0	54	26	28	26
$^{24}_{18}Ar$	0	24	18	6	18
$^{10}_{4}Be^{2+}$	2+	10	4	6	2
$^{54}_{25}Mn^{2+}$	2+	54	25	29	23
$^{163}_{79}Au^{3+}$	3+	163	79	84	76

17. Atomic Spectra:

→ high → low

a. Excited aluminum atoms may emit radiation having a wavelength of 475 nm. What is the ***frequency***? (1m = 10^9 nm)

$$① \ \frac{475\text{ nm}}{1}\left|\frac{1\text{ m}}{1\times10^{9}\text{ nm}}\right. = \lambda = 4.75\times10^{-7}\text{ m}$$

$$② \ C = \lambda\nu \rightarrow \nu = \frac{c}{\lambda} \rightarrow \nu = \frac{(3.00\times10^{8}\text{ m/s})}{(4.75\times10^{-7}\text{ m})} \rightarrow \boxed{\nu = 6.32\times10^{14}\text{ s}^{-1}}$$

b. A radio broadcasting station has a frequency of 105.1 MHz. Find the ***wavelength*** in meters. (1 MHz = 10^6 Hz)

($\text{Hz} = \text{s}^{-1}$)

$$① \ \frac{105.1\text{ MHz}}{1}\left|\frac{1\times10^{6}\text{ Hz}}{1\text{ MHz}}\right. = \nu = 1.051\times10^{8}\text{ Hz }(\text{s}^{-1})$$

$$② \ C = \lambda\nu \rightarrow \lambda = \frac{c}{\nu} \rightarrow \lambda = \frac{(3.00\times10^{8}\text{ m/s})}{(1.051\times10^{8}\text{ s}^{-1})} \rightarrow \boxed{\lambda = 2.854\text{ m}}$$

c. What is the ***energy*** of a photon of light whose wavelength is 4.85 x 10^{-7} m?

$$① \ C = \lambda\nu \rightarrow \nu = \frac{c}{\lambda} \rightarrow \nu = \frac{(3.00\times10^{8}\text{ m/s})}{(4.85\times10^{-7}\text{ m})} \rightarrow \nu = 6.19\times10^{14}\text{ s}^{-1}$$

$$② \ E_{photon} = h\nu \rightarrow E_{photon} = (6.626\times10^{-34}\text{ Js})(6.19\times10^{14}\text{ s}^{-1}) \rightarrow \boxed{E_{photon} = 4.10\times10^{-19}\text{ J}}$$

18. Nuclear Reactions and Balancing: Balance each nuclear reaction by filling in the missing particle in each case.

a) ${}_{14}^{35}\text{Si} \rightarrow {}_{-1}^{0}\text{e} + {}_{15}^{35}\text{P}$

c) ${}_{92}^{238}\text{U} \rightarrow {}_{2}^{4}\text{He} + {}_{90}^{234}\text{Th}$

b) ${}_{53}^{110}\text{I} \rightarrow {}_{2}^{4}\text{He} + {}_{51}^{106}\text{Sb}$

d) ${}_{56}^{140}\text{Ba} \rightarrow {}_{-1}^{0}\text{e} + {}_{57}^{140}\text{La}$

Half-Life: Solve each Half-Life problem from the given information and show all work for full credit.

19. A meteorite strikes Earth in western Wyoming. Chemical analysis shows that it contains 44.6 kilograms of radioactive Iron-59. How many kilograms (kg) of this isotope will remain in the meteorite after 220 days? The half-life of Iron-59 is 44.0 days.

m_i = 44.6 kg
m_f = ?
Time = 220 days
H-L = 44 days
#H-L = 5

$$\#\text{H-L} = \frac{\text{Time}}{\text{H-L}} \rightarrow \#\text{H-L} = \frac{220\text{ days}}{44\text{ days}} = 5$$

$$\boxed{m_f = 1.39375\text{ kg}}$$

#H-L	mass
0	44.6 kg
1	22.3 kg
2	11.15 kg
3	5.575 kg
4	2.7875 kg
5	1.39375 kg

20. A sample of Gallium-67 was ordered by a research laboratory 75.0 hours ago, with an original mass of 492 grams. When it was first received in the lab, the sample had a mass of 15.375 grams. What is the half-life of Gallium-67?

m_i = 492 g
m_f = 15.375 g
Time = 75.0 hrs
H-L = ?
#H-L = 5

$$\#\text{H-L} = \frac{\text{Time}}{\text{H-L}} \rightarrow \text{H-L} = \frac{\text{Time}}{\#\text{H-L}}$$

$$\text{H-L} = \frac{75.0\text{ hrs}}{5} \rightarrow \boxed{\text{H-L} = 15.0\text{ hrs}}$$