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**TEST 1: ATOMIC STRUCTURE, VALENCE ELECTRONS,
AND ELECTRON CONFIGURATION**

Instructions: You have the whole period to complete this test. Please show all your work in order to receive full credit for each question. Each question is worth a different number of points, marked in parenthesis. The total number of points for this test is 340.

1. (12 pts) Draw Lewis Structures for each of the following. How many electron pairs are in the outer shell of each?

a. Gallium

d. Nitrogen

b. Arsenic

e. Germanium

c. Carbon

f. Neon

2. (2 pts) The number of protons in one atom of an element determines the atom's _____, and the number of electrons determines _____ of an element.

3. (3 pts) The atomic number tells you the number of _____ in one atom of an element. It also tells you the number of _____ in a neutral atom of that element. The atomic number gives the "identity" of an element as well as its location on the Periodic Table. No two different elements will have the _____ atomic number.

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4. (2 pts) The _____ of an element is the average mass of an element's naturally occurring atoms, or isotopes, taking into account the _____ of each isotope.
5. (2 pts) The _____ of an element is the total number of protons and neutrons in the _____ of the atom.
6. (2 pts) The mass number is used to calculate the number of _____ in one atom of an element. In order to calculate the number of neutrons you must subtract the _____ from the _____.
7. (20 pts) Write the electron configuration of the following elements:
- | | |
|-------|-------|
| a. Na | f. Ag |
| b. Pb | g. Ti |
| c. U | h. Ce |
| d. Sr | i. Cl |
| e. N | j. Hg |
8. (12 pts) Write a ground state electron configuration for these ions:
- | | |
|--------------|--------------|
| a. O^{2-} | d. Ni^{2+} |
| b. Fe^{2+} | e. K^+ |
| c. B^{3+} | f. Co^{3+} |
9. (8 pts) Write an excited state electron configuration for the following:
- | | |
|-------|------|
| a. Al | c. K |
| b. Ar | d. C |
10. (5 pts) If each orbital can hold a maximum of two electrons, how many electrons can each of the following hold?
- | | |
|-------|-------|
| a. 2s | d. 3d |
| b. 5p | e. 4d |
| c. 4f | |
11. (1 pt) What is the shape of an s orbital?

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12. (1 pt) How many s orbitals can there be in an energy level?
13. (1 pt) How many electrons can occupy an s orbital?
14. (1 pt) What is the shape of a p orbital?
15. (1 pt) How many p orbitals can there be in an energy level?
16. (1 pt) Which is the lowest energy level that can have an s orbital?
17. (1 pt) Which is the lowest energy level that can have a p orbital?
18. (1 pt) Can two electrons in the same atom to have exactly the same set of quantum numbers?
19. (3 pts) Distinguish between an atom in its ground state and an excited atom.

20. (1 pt) How many d orbitals can there be in an energy level?
21. (1 pt) How many d electrons can there be in an energy level?
22. (1 pt) Which is the lowest energy level having d orbitals?
23. (1 pt) How many f electrons can there be in an energy level?
24. (1 pt) Which is the lowest energy level having f orbitals?
25. (1 pt) How many f orbitals can there be in an energy level?
26. (1 pt) How many energy levels are partially or fully occupied in a neutral atom of calcium?
27. (4 pts) Why do the 2nd, 3rd, 4th, and 5th series of elements contain 18 elements, rather than 8?

28. (2 pts) Which sublevels of the 3rd energy level are filled in the following elements:
 - a. Ar
 - b. Kr

29. (2 pts) Why does it take more energy to remove an electron from Al⁺ than from Al?

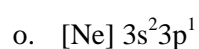
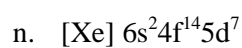
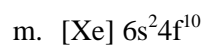
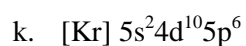
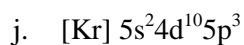
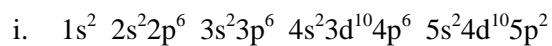
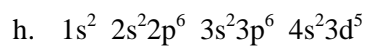
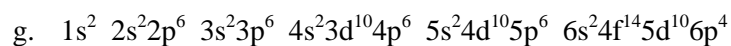
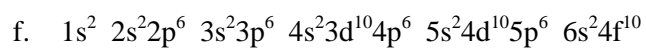
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30. (3 pts) What does the term principal quantum number refer to?
31. (3 pts) What is meant by the electron configuration of an atom?
32. (2 pts) What is the maximum number of electrons that can be present in an atom having three principal energy levels?
33. (3 pts) Which of the following notations shows the electron configuration of a neutral atom in an excited state? Name the element, and explain how you know it is excited:
- $1s^2 2s^2 2p^1$
 - $1s^2 2s^2 2p^3 3s^1$
 - $1s^2 2s^2 2p^6 3s^2 3p^1$
34. (3 pts) Isoelectronic species have similar electron configurations. Which of these are isoelectronic?
- Li^+ , H^- , He
 - Ca^{2+} , Ne, S^{2-}
35. (45 pts) For the following electron configurations choose 3 possible elements (or ions) they may represent:
- $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^1$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^1 5f^{14} 6d^8$

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36. (50 pts) Complete the following chart with consideration for the Octet Rule:

Element	Atomic Number	Nº of e ⁻ in each E level	Electron Configuration	Nº of e ⁻ lost or gained	Nº of e ⁻ after loss or gain	Charge on ion
O	8	2, 6	$1s^2 2s^2 2p^4$	Gain 2	10	-2
Na	11	2, 8, 1	$1s^2 2s^2 2p^6 3s^1$	Lose 1	10	+1
S						
K						
Al						
Cl						
Xe						

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Element	Atomic Number	N ^o of e ⁻ in each E level	Electron Configuration	N ^o of e ⁻ lost or gained	N ^o of e ⁻ after loss or gain	Charge on ion
Ca						
F						
Br						
N						
Ar						
I						
Sr						

37. (28 pts) Give the symbol, the number of protons, and the number of electrons in a neutral atom of:

Lithium _____

Bromine _____

Iron _____

Copper _____

Oxygen _____

Mercury _____

Arsenic _____

Helium _____

Uranium _____

Chlorine _____

Boron _____

Iodine _____

Antimony _____

Argon _____

38. (16 pts) Give the isotope symbol and number of neutrons in one atom of the following elements. Show your calculations.

Barium – 138 _____

Sulfur – 32 _____

Carbon – 12 _____

Hydrogen – 1 _____

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Fluorine – 19 _____

Magnesium – 24 _____

Silicon – 28 _____

Mercury – 202 _____

39. (12 pts) Name the element which has the following numbers of particles. Be specific. (Include charges and mass numbers where possible.)

26 electrons, 29 neutrons, 26 protons _____

53 protons, 74 neutrons _____

2 electrons (neutral atom) _____

20 protons _____

86 electrons, 125 neutrons, 82 protons (charged atom) _____

0 neutrons _____

40. (4 pts) If you know **ONLY** the following information can you always determine what the element is? (Yes/No).

Number of protons _____

Number of neutrons _____

Number of electrons in a neutral atom _____

Number of electrons _____

41. (45 pts) Fill in the missing items in the table below. Complete the table. Use a periodic table where needed.

Symbol	Atomic Number(Z)	Mass Number(A)	Number of Protons	Number of Electrons	Number of Neutrons
^{23}Na					

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Symbol	Atomic Number(Z)	Mass Number(A)	Number of Protons	Number of Electrons	Number of Neutrons
K		40		19	
			38	38	52
F					10
	20	41		18	
	50			50	72
¹³¹ I					
²⁶ Mg					
		109	47	46	
	1	2		1	
³⁶ S					
	26			23	32
²⁷ Al					
	2	4		2	
Cr		53			

42. (5 pts) Draw the structure of the Bohr atom and label all the parts. Include the energy levels with their n values.

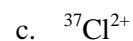
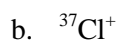
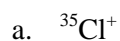
43. (4 pts) If the energy of the lowest energy state of the Bohr atom is n=1, what energy does the electron have in this level? How much energy does it take to just ionize a Bohr atom where the electron is in the n=1 state?

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44. (3 pts) Do the positions of the energy levels change among the three hydrogen isotopes protium, deuterium and tritium?

45. (2 pts) Which ion would be deflected most in a mass spectrometer?



46. (5 pts) Ionization, vaporization, deflection, acceleration, and detection are the steps in getting a mass spectrum but placed in random order. Place the steps in the correct order.

47. (4 pts) Why are relative atomic masses used and why is ^{12}C used as a standard?

48. (2 pts) Use the following table to calculate the average atomic mass of Neon.

Isotope	% Abundance	Mass (amu)
^{20}Ne	90.48	19.992
^{21}Ne	0.27	20.993
^{22}Ne	9.25	21.991

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49. (4 pts) $^{23}_{11}\text{Na}$ is the only form of sodium that exists. It has a mass of 22.989amu. What is the atomic mass of elemental Na in amu and what is the mole mass of sodium.

50. (3 pts) What does the l quantum number tell us about an electron-suborbital?