Test Review № 5

Development of the Periodic Table. Dmitri Mendeleev (1869) prepared a card for each of the known elements listing the symbol, the atomic mass, and the chemical properties. He arranged the cards in order of increasing atomic mass and noticed a pattern: *MENDELEEV'S PERIODIC LAW* – When the elements are arranged in increasing order of atomic mass, the chemical properties repeat themselves periodically. Moseley noticed that when all the elements were arranged in order of mass a few were not in the right family with respect to properties. He used a procedure called X-ray diffraction to determine the atomic number of the elements. When the elements were arranged in increasing order of atomic number, the discrepancies in Mendeleev's table disappeared. *THE PERIODIC LAW* – When the elements are arranged in increasing order of atomic number, the chemical properties repeat themselves periodically. The modern Periodic Table is arranged in order of increasing atomic number.

Organization of the Periodic Table. The modern Periodic Table is arranged in order of increasing atomic number in vertical columns and horizontal rows. The vertical columns are elements with about the same number of outer electrons (valence electrons). They are called groups or families. Elements in the same family have similar properties. Horizontal rows are elements with the same number of shells or energy levels. They are called periods. The major divisions of the Periodic Table are: Alkali metals - Group 1; Alkaline earth metals - Group 2; Halogens - Group 17; Noble gases (Inert gases) - Group 18; Transition metals - Groups 3-12; Lanthanides - Row 6, elements 57 - 71;and Actinides - Row 7, elements 89 - 103.

Trends in the Periodic Table. Going across the table from left to right within a row or period the number of protons increases, so the pull on the electrons increases. As a result the covalent atomic radius decreases and metallic properties decrease (except in the transition elements). In addition the number of valence electrons increases and the number of shells remains the same. Going down the table within a group or family the number of protons also increases, but the number of shells increases too. As a result, the atomic radius increases, the pull on the electrons decreases, and metallic properties increase. In a family the number of valence electrons remains the same. This results in the following organization of the Periodic Table:

	1							18
1	1 **M** 1	2	13	14	15	16	17	2 **N** 2 **O**
2	3 **E** 2-1	4 2-2	5 2-3	6 2-4	7 2-5	8 2-6	9 **N** 2-7 **O**	10 **B** 2-8 **L**
3	11 **T** 2-8-1	12 2-8-2	13 2-8-3	14 2-8-4	15 2-8-5	16 2-8-6	17 **N** 2-8-7 **M**	18 **E** 2-8-8
4	19 **A** 2-8-8-1	20 2-8-8-2					**E** **T**	**G** **A**
5	**L**						**A** **L**	**S** **E**
6	**S**						**S**	**S**
7								

Bonding. The electrons of one atom are attracted to the protons of another. When atoms combine, there is a tug of war over the valence electrons. The combining atoms either lose, gain, or share electrons in such a way that they complete their outer shells. Whether atoms gain, lose, or share electrons depends how tightly they hold onto their own electrons and how strongly they pull on the electrons of another atom.

Ionic Bonds. Ionic bonds are caused by the attraction between oppositely charged ions. Ions form as follows: The electrons of one atom are attracted to the protons of another. Metals hold onto electrons loosely while nonmetals hold onto electrons tightly. As a result, metals lose electrons and nonmetals gain electrons in such a way that they complete their outer shells. Atoms that gain or lose electrons become electrically charged. Metals become positively charged ions by losing electrons. Nonmetals become negatively charged ions by gaining electrons. Metal cations and nonmetal anions become ionically bonded because they are oppositely charged. Atoms gain or lose electrons in such a way that they complete their outer shells. This gives them the same electron configuration as a noble gas. For example, potassium, with an electron configuration of 2-8-8-1 loses an electron to become K^+ with an electron configuration of 2-8-8, the same as argon. Chlorine, with an electron configuration of 2-8-7, gains an electron to become Cl^-, with an electron configuration also of 2-8-8.

Covalent Bonds. Covalent bonds are bonds formed by sharing electrons. The electrons of one atom are attracted to the protons of another, but neither atom pulls strongly enough to remove an electron from the other. Covalent bonds form when the electronegativity difference between the elements is less than 1.7 (see the Electronegativity table on the back of the Periodic Table) or when hydrogen behaves like a metal. When a covalent bond forms, no valence electrons are transferred, rather, they are shared. During covalent bonding, unpaired electrons pair up in such a way that the atoms complete their outer shells. This can be illustrated with electron dot diagrams.

Bond Type and Polarity. When the electronegativity difference is greater than or equal to 1.7, the atom with the greater electronegativity gains the electron, and an **ionic bond** is formed. Electronegativity differences below 1.7 result in covalent bonds or sharing. If the electronegativity difference is close to zero (<0.4), the atoms share equally and a **nonpolar bond** forms. Higher electronegativity differences (still below 1.7) result in unequal sharing or **polar bonds**.

Electron Dot Diagrams. Electron dot diagrams show valence electrons as dots at 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock, and the rest of the atom, known as the kernel, as a symbol. Electrons will move into the *s* orbital first. Once the *s* is filled, additional electrons will go into each of the three *p* orbitals without pairing until each *p* orbital has one electron. During bonding, however, the outer shell of the atom is composed of four equal orbitals. Electrons do not pair up until each orbital contains an electron.

Answer the questions below by circling the number of the correct response

1. In the Periodic Table, the elements are arranged in order of increasing (1) atomic size, (2) atomic number, (3) atomic mass, (4) ionization energy

2. The chemical properties of the elements are periodic functions of their atomic (1) spin, (2) isotopes, (3) mass, (4) number.

3. Which pair contains elements which have the most similar chemical properties? (1) Mg and Ca (2) N and S (3) H and Li (4) Na and Cl

4. The element with an atomic number of 34 is most similar in its chemical behavior to the element with an atomic number of (1) 19 (2) 31 (3) 36 (4) 16

5. Silicon is most similar in chemical activity to (1) carbon, (2) lead, (3) sulfur, (4) nitrogen

6. The element 2–8–6 belongs in Period (1) 6, (2) 2, (3) 3, (4) 4

7. Most of the elements in the Periodic Table are classified as (1) metalloids, (2) nonmetals, (3) noble gases, (4) metals

8. Phosphorus is best classified as a (1) nonmetal, (2) metalloid, (3) metal, (4) transition element

9. The Group 1 metals all have the same (1) electronegativity, (2) atomic radius, (3) oxidation state, (4) ionization energy

10. Which Group in the Periodic Table contains the most active metals? (1) 1 (2) 2 (3) 13 (4) 14

11. In which Group of the Periodic Table would this element, 2–5, most likely be found? (1) 1 (2) 2 (3) 13 (4) 15

12. As the elements in Period 3 are considered in order of increasing atomic number, the number of principal energy levels in each successive element (1) decreases (2) increases (3) remains the same

13. Which Group contains elements which are metalloids? (1) 1 (2) 11 (3) 14 (4) 4

14. The elements with the least chemical reactivity are in Group (1) 1, (2) 18, (3) 3 (4) 16

15. Which element is a metalloid? (1) arsenic (2) neon (3) potassium (4) bromine

16. Which Group of elements exhibits all three phases of matter at room temperature? (1) 2 (2) 14 (3) 15 (4) 17

17. What are two properties of most nonmetals?
    (1) high ionization energy and poor electrical conductivity
    (2) high ionization energy and good electrical conductivity
    (3) low ionization energy and poor electrical conductivity
    (4) low ionization energy and good electrical conductivity

18. Which element is classified as a noble gas at STP? (1) hydrogen (2) neon (3) oxygen (4) nitrogen

19. In which shell are the valence electrons of the elements in Period 2 found? (1) 1 (2) 2 (3) 3 (4) 4

20. Of the following, which element has the smallest atomic radius? (1) Mg (2) Ca (3) Sr (4) Ba

21. As one proceeds from lithium to fluorine in the Periodic Table, the tendency for the elements to lose electrons (1) decreases, (2) increases, (3) remains the same

22. As the elements in Period 3 are considered from left to right, the ability of each successive element to gain electrons (1) decreases, (2) increases, (3) remains the same

23. Of the following, which is the element with the most metallic character in Group 16 is (1) O, (2) S, (3) Se, (4) Te

24. As the elements in Group 14 are considered in order of increasing atomic number, the metallic properties of successive elements (1) decreases, (2) increases, (3) remains the same

25. In Period 3 of the Periodic Table, the element with the smallest atomic radius is in Group (1) 1 (2) 2 (3) 15 (4) 17

26. Of the following, which Group 2 element has the greatest tendency to lose electrons? (1) calcium (2) barium (3) strontium (4) magnesium

27. Which Group in the Periodic Table contains atoms that have an oxidation state of –2? (1) 1 (2) 2 (3) 16 (4) 17

28. The elements in Group 2 have similar chemical properties primarily because they have the same (1) ionization energies, (2) reduction potentials, (3) number of principal energy levels, (4) number of electrons in the outermost shell

29. As one proceeds from left to right across Period 2 of the Periodic Table, the decrease in atomic radius is primarily due to an increase in the number of (1) orbitals, (2) protons, (3) neutrons, (4) principal energy levels

30. The most active metal in Period 4 of the Periodic Table is (1) Fe, (2) Sc, (3) K, (4) Ca.

31. In Period 3, as the atomic numbers increase, the pattern according to which the properties of the elements change is
(1) metal → metalloid → nonmetal → noble gas
(2) metal → nonmetal → noble gas → metalloid
(3) nonmetal →metalloid → metal → noble gas
(4) nonmetal → metal → noble gas → metalloid

32. In going down the Group 15 elements on the Periodic Table, the metallic properties of the elements (1) decrease, (2) increase, (3) remain the same

33. As one proceeds from left to right across Period 3 of the Periodic Table, there is a decrease in (1) ionization energy (2) electronegativity (3) metallic characteristics (4) valence electrons

34. As one proceeds from fluorine to astatine in Group 17, the electronegativity (1) decreases and the atomic radius increases, (2) decreases and the atomic radius decreases, (3) increases and the atomic radius decreases, (4) increases and the atomic radius increases.

35. As the elements in Period 3 are considered in order of increasing atomic number, the number of principal energy levels in each successive element (1) decreases, (2) increases, (3) remains the same

36. If the elements are considered from top to bottom in Group 17 the number of electrons in the outermost shell will (1) decrease, (2) increase, (3) remain the same

37. Which represents the correct order of activity for the Group 17 elements [> means greater than]
(1) bromine > iodine > fluorine > chlorine
(2) fluorine > chlorine > bromine > iodine
(3) iodine > bromine > chlorine > fluorine
(4) fluorine > bromine > chlorine > iodine

38. Which is most characteristic of metals with very low ionization energies? (1) they are very reactive (2) they have a small atomic radius (3) they form covalent bonds (4) they have a high electronegativity

39. Metallic elements usually possess
(1) low electronegativities and high ionization energies
(2) high electronegativities and low ionization energies
(3) high electronegativities and high ionization energies
(4) low electronegativities and low ionization energies

40. If the members of Group 17 are arranged in order of increasing electronegativity, they are also arranged in order of increasing (1) ionization energy, (2) atomic radius, (3) atomic mass, (4) nuclear charge

41. As the elements are considered from top to bottom in Group15 of the Periodic Table, the ionization energy (1) decreases, (2) increases, (3) remains the same

42. An element that has both a high ionization energy and a high electronegativity is most likely a (1) metal (2) metalloid (3) nonmetal (4) noble gas

43. The element with the lowest first ionization energy in any given Period will always belong to Group (1) 1 (2) 2 (3) 17 (4) 18

44. An element that exhibits the largest variety of oxidation states is (1) Li (2) O (3) C (4) N

45. Which Group in the Periodic Table contains both metals and nonmetals? (1) 11 (2) 2 (3) 18 (4) 14

46. This element assumes only a +3 oxidation state in chemical combination (1) Na (2) Si (3) Al (4) Cl

47. Which Period contains elements that are all gases at STP ? (1) 1 (2) 2 (3) 3 (4) 4

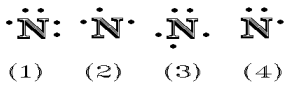
48. Which Group 18 (0) element in the ground state has a maximum of 2 completely filled principal energy levels? (1) Kr (2) Xe (3) He (4) Ne

49. A nonmetal which exists in the liquid state at room temperature is (1) aluminum (2) hydrogen (3) mercury (4) bromine

50. The only metal which is a liquid at STP is in Period (1) 5 (2) 6 (3) 3 (4) 4

51. Which Group contains an element that is a liquid at room temperature? (1) 18 (2) 2 (3) 16 (4) 17

52. Which of the following is the correct electron dot diagram for nitrogen?



(1) (2) (3) (4)

53. Barium combines by (1) gaining two electrons, (2) losing two electrons, (3) sharing two electrons, (4) sharing 3 electrons.

54. In water, the bond between hydrogen and oxygen is (1) ionic, (2) polar covalent, (3) nonpolar covalent, (4) nonpolar noncovalent.

55. Which of the following occurs during covalent bonding? (1) Electrons are lost. (2) Electrons are gained. (3) Valence electrons fall from the excited state to the ground state. (4) Unpaired electrons form pairs.

56. Which of the following is an example of a substance with a nonpolar covalent bond? (1) HCl (2) Cl_2 (3) $HClO_2$ (4) NaCl

57. The electronegativity of sulfur is (1) 16, (2) 239, (3) 2.6, (4) 32.

58. Which of the following elements has the highest electronegativity? (1) fluorine (2) chlorine (3) barium (4) hydrogen

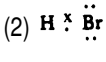
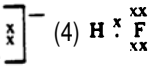
59. When calcium combines, it usually (1) loses two electrons, (2) gains six electrons, (3) shares two electrons, (4) shares six electrons.

60. Which compound contains a bond with the *least,* ionic character? (1) CO (2) K_2O (3) CaO (4) Li_2O

61. Which type of bond is contained in a water molecule? (1) nonpolar covalent (2) ionic (3) polar covalent (4) electrovalent

62. The bonding in NH_3 most similar to the bonding in (1) H_2O (2) MgO (3) NaCl (4) KF

63. Which electron dot formula represents a molecule that contains a nonpolar covalent bond?

(1)  (2)  (3)  (4)

64. When a reaction occurs between atoms with ground state electron configurations 2–1 and 2–7, the predominant type of bond formed is (1) polar covalent, (2) ionic, (3) nonpolar covalent, (4) metallic.

65. The P—Cl bond in a molecule of PCl_3 is (1) nonpolar covalent, (2) coordinate covalent, (3) polar covalent, (4) electrovalent.

66. A Ca^{2+} ion differs from a Ca atom in that the Ca^{2+} ion has (1) more protons, (2) more electrons, (3) fewer protons, (4) fewer electrons.

67. Which of the following compounds has the most ionic character? (1) KI (2) NO (3) HCl (4) MgS

68. Which atom has the strongest attraction for electrons? (1) Cl (2) F (3) Br (4) I

69. Which compound is ionic? (1) HCl (2) $CaCl_2$ (3) SO_2 (4) H_2O

70. Two atoms of element A unite to form a molecule with the formula A_2. The bond between the atoms in the molecule is (1) electrovalent, (2) nonpolar covalent, (3) ionic, (4) polar covalent.

71. When an ionic bond is formed, the atom that transfers its valence electron is the atom that has the (1) higher electronegativity value, (2) lower atomic number. (3) higher atomic mass, (4) lower ionization energy.

72. When an ionic bond is formed, the atom that transfers its valence electron becomes an ion with (1) positive charge and more protons, (2) positive charge and no change in the number of protons, (3) negative charge and more protons, (4) negative charge and no change in the number of protons.

73. Which compound best illustrates ionic bonding? (1) CCl_4 (2) $MgCl_2$ (3) H_2O (4) CO_2

74. An atom that loses or gains one or more electrons becomes (1) an ion, (2) an isotope, (3) a molecule, (4) an electrolyte

75. Which kind of bond is formed when two atoms share electrons to form a molecule? (1) ionic (2) metallic (3) electrovalent (4) covalent

76. Which type of bonding is usually exhibited when the electronegativity difference between two atoms is 1.2? (1) ionic (2) metallic (3) network (4) covalent

Answers

1. 2	20. 1	39. 4	58. 1
2. 4	21. 1	40. 1	59. 1
3. 1	22. 2	41. 1	60. 1
4. 4	23. 4	42. 3	61. 3
5. 1	24. 2	43. 1	62. 1
6. 3	25. 4	44. 4	63. 1
7. 4	26. 2	45. 4	64. 2
8. 1	27. 3	46. 3	65. 3
9. 3	28. 4	47. 1	66. 4
10. 1	29. 2	48. 4	67. 1
11. 4	30. 3	49. 4	68. 2
12. 3	31. 1	50. 2	69. 2
13. 3	32. 2	51. 4	70. 2
14. 2	33. 3	52. 3	71. 4
15. 1	34. 1	53. 2	72. 2
16. 4	35. 3	54. 2	73. 2
17. 1	36. 3	55. 4	74. 1
18. 2	37. 2	56. 2	75. 4
19. 2	38. 1	57. 3	76. 4