**100 Things to Know For Your Chemistry Midyear Exam**

1. ***Protons*** are positively charged (+) with a mass of 1 amu.

 *Example: Which has the greatest nuclear charge? Cl-35 Ar-40 K-39 Ca-40*

2. ***Neutrons*** have no charge and a mass of 1 amu.

3. ***Electrons*** are small and are negatively charged (-) with a mass of almost 0 amu..

4. Protons & neutrons are in an atom’s nucleus (***nucleons***).

 *Which has the greatest number of nucleons?*

*Sn-119 Sb-122 Te-128 I-127*

5. Electrons are found in “clouds” (***orbitals***) around an atom’s nucleus.

 *Where is most of the mass of an atom found?*

 *Where is most of the size (volume) of an atom found?*

6. The ***mass number*** is equal to an atom’s number of protons and neutrons added together or the # of nucleons.

 *What is the mass number of an atom with 18 protons and 22 neutrons?*

7. The ***atomic number*** is equal to the number of protons in the nucleus of an atom.

 *Which has the greatest atomic number?*

 *S Cl Ar K*

8. The ***number of neutrons*** = mass number – atomic number.

 *Which correctly represents an atom of neon containing 11 neutrons?*

*Ne Ne Ne Ne*

9. In a neutral atom the number of protons = the number of electrons.

 *Circle the correct nuclear symbol for the neutral atom: O 2- N 3- F 1- Ne*

10. ***Isotopes*** are atoms with equal numbers of protons, but differ in their neutron numbers.

 *Two isotopes of the same element will have the same number of*

 *neutrons and electrons, neutrons and nucleons,*

*protons and nucleons, protons and electrons*

*11****. Cations*** are *positive* (+) ions and form when a neutral atom *loses* electrons.

They ***are*** *smaller* than their parent atom.

 *Which of the following will form an ion with a smaller radius that that of its atom?*

 *Cl N Br Ba*

12. ***Anions*** are negative ions and form when a neutral atom *gains* electrons.

They are larger than their parent atom.

*Which electron configuration is correct for a fluoride ion?*

*[He]2s22p5 [He]2s22p6 [He]2s22p63s1 [He]2s22p4*

13. **Ernest *Rutherford’s*** *gold foil experiment* showed that an atom is mostly empty

 space with a small, dense, positively charged nucleus.

*Describe the gold-foil experiment, explain how Rutherford was able to make his conclusions about the structure of the atom and draw a picture of the nuclear atom (~1911)*

14. ***J.J. Thompson*** discovered the electron and developed the “plum-pudding” model of the atom.

*Draw and describe his model (late 1800s):*

15. ***Dalton’s*** model of the atom was a solid sphere of matter that was uniform throughout. *Describe Dalton’s atomic theory and what important laws it included.*

16. The ***Bohr Model*** of the atom placed electrons in “planet-like” orbits around the nucleus of an atom.

 *Draw an example of his model using oxygen-16 🡪 *O *(~1916):*

17. The current, ***quantum or*** ***wave-mechanical model*** of the atom has electrons in “clouds” (orbitals) around

 the nucleus. *How many orbital(s) in the following sublevels? s \_\_ p\_\_ d\_\_ f\_\_*

18. Electrons can be excited to jump to higher energy levels.

They emit energy as light when they fall from higher energy levels back down to

lower (***ground state***) energy levels. ***Bright line spectra*** are produced. *What is the frequency of a red photon with a wavelength of 6.56 x 10-7meters? What is its energy?*

19. ***Elements*** are pure substances composed of atoms with the same atomic number.

They cannot be decomposed.

 *A compound differs from an element in that a compound*

 *Has a homogeneous composition has one set of properties*

 *Has a heterogeneous composition can be decomposed*

20. ***Binary compounds*** are substances made up of only *two* kinds of atoms.

 “Ternary” compounds contain three (or more) kinds of atoms.

*Which substance is a binary compound? (Look up the formulas if you don’t know them)*

 *Ammonia magnesium potassium nitrate methanol*

21. ***Diatomic molecules*** are elements that form two atom molecules in their natural form at STP.

 *Which element is a diatomic liquid at STP?*

 *chlorine fluorine bromine iodine*

22. Use this diagram to help determine the ***number of significant figures*** in a measured value…

 **Pacific**  **Atlantic**

If the decimal point is ***present***, start counting digits from the ***Pacific*** (left) side,

 starting with the first non-zero digit.

 0.003100 \_\_\_\_ sig. figs.

If the decimal point is absent, start counting digits from the Atlantic (right) side,

starting with the first non-zero digit.

 31,400 \_\_\_\_sig. figs.

23. When **multiplying** or **dividing** measurements, final answer must have as many digits as the measurement

 with the fewest number of digits. When **adding** or s**ubtracting**, use place value.

*What is the density of the object measured in lab by the displacement of water according to the data below:*

 *Mass of object: 23.6 g*

 *Volume of water: 15.0 mL*

 *Volume of water + object: 18.2 mL*

24. ***Solutions*** are the best examples of ***homogeneous mixtures***. They look uniform even though each substance’s

properties do not change.

 *How many phases are there in a solution or homogeneous mixture?*

25. ***Heterogeneous mixtures*** have discernable components and ***are not*** uniform throughout.

*Air is classified chemically as a(n)*

*Substance compound element mixture*

26. A ***solute*** is the substance being dissolved; the ***solvent*** is the substance that dissolves the solute.

 *NaCl (s) is added to water and mixed. The solute is \_\_\_\_\_ the solvent is \_\_\_\_\_\_\_\_ the solution is \_\_\_\_\_\_\_*

27. **Isotopes** are written in a number of ways: C-14 is also Carbon-14, and is also C

*atomic number = …….. mass number = ……..*

28. The **average atomic mass** is the weighted average mass of all the known isotopes of an element.

 *Find the average atomic mass of lithium if 7.4 % are 6Li and 92.6% are 7Li.*

29. The distribution of electrons in an atom is its ***electron configuration***.

 *Write the symbol of the element represented by the following electron configurations:*

1s22s22p63s23p5 \_\_\_\_\_ 1s22s22p63s23p64s23d10 \_\_\_\_\_ 1s22s22p5 \_\_\_\_\_

30. The outermost electrons in an atom’s electron configurations are the **valence electrons.**

*How many valence electrons do each of the elements contain in their electron configurations:*

 1s22s22p63s23p5 \_\_\_\_\_ 1s22s22p63s23p64s23d10 \_\_\_\_\_ 1s22s22p5 \_\_\_\_\_

31. ***Electron dot model*** is a way of representing the valence electron of an atom.

 * represents the electron-dot symbol of this element C O B N*

32. The ***kernel*** of an atom includes everything in an atom *except* the atom’s valence electrons.

 *The kernel of this element contains 11 protons and 10 electrons*

 *O F Ne Na*

33. **Polyatomic ions** are groups of atoms, **covalently** bonded together, with an overall charge.

 *Give the name or formula of the following:* Nitrate: ………..., NH4+: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ sulfite: ……..…..

 *Which of the following contains both ionic and covalent bonds?*

 *NaOH CH3OH NaCl Cl2*

34. **Chemical formulas** are written so that the charges of cations and anions neutralize (cancel) one another.

 *calcium phosphate*: Ca2+ PO43- = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ 🡪 remember the criss-cross method

35. When naming **binary** ionic compounds, write the name of the positive ion (cation) first, followed by the name of

the negative ion (anion) with the name ending in “-ide.”

*CaCl2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ MgS \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

36. When naming compounds containing **polyatomic ions**, keep the name of the polyatomic ion the same as it

 is written in your reference sheet.

 *NH4Cl \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ copper (I) nitrate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

37. **Roman numerals** are used to show the positive oxidation number of the cation if it has more than

 one positive oxidation number

 *FeO:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Nickel (III) sulfate: \_\_\_\_\_\_\_\_\_\_\_\_\_*

38. ***Physical changes*** do not form new substances. They merely change the appearance of the original

material. Example: (The melting of ice) H2O (s) 🡪 H2O (l)

*Give three other examples of physical changes:*

39. ***Chemical changes*** result in the formation of new substances.

 *Which process is an example of a chemical change?*

*the melting of ice the electrolysis of water the boiling of water*

40. ***Reactants*** are on the left side of the reaction arrow and ***products*** are on the right.

41. ***Temperature*** is a measure of average kinetic.

*Which sample has the highest average kinetic energy?*

 *H2O (l) at 0oC H2O (s) at 0oC CO2 (g) at STP Mg (s) at 298K*

42. The masses (and energy and charge) of the reactants in a chemical equation is always equal to

the masses (and energy and charge) of the products. “***Law of Conservation of Mass (and Energy)***.”

*An iron nail weighing 5.10 g is allowed to react with oxygen, according to the reaction below.*

*4Fe + 3O2 → 2Fe2O3*

*A layer of iron(III) oxide forms on the nail, increasing the nail’s mass. How much oxygen has reacted with the iron if the mass of the nail has increased to 5.89 g?*

43. ***6.02 x 1023*** is called ***Avogadro’s number*** and is the number of particles in ***1 mole*** of a substance.

Equal volumes of gases contain an equal number of molecules.

 *Under similar conditions,* *which sample contains the same number of moles of particles*

*as 1 liter of O2 (g)?*

*1 L Ne(g) 0.5 L SO2 (g) 2 L N2 (g) 1 L H2O(l)*

44. The **kinetic molecular theory** explains the behavior of matter as particles with energy and motion.

45. ***Solids*** have a definite shape and volume.

46. ***Liquids*** have closely-spaced particles that easily slide past one another; they have no definite shape,

but have a definite volume.

47. ***Gases*** have widely-spaced particles that are in random motion (collide with container to create pressure).

48. ***Gases*** are easily compressed and have no definite shape or volume.

49. Substances that ***sublime*** turn from a solid directly into a gas.

They have very weak attractive forces. (examples include CO2 & I2)

50. **Temperature** is a measure of the average kinetic energy of a substance. The SI unit for temp. is the Kelvin.

Degrees Kelvin = ˚C + 273

 *Room temperature = 25oC = …….K Boiling point of helium = 4 K = ……….oC*

51. Mixtures may be separated by several physical means:

***Distillation*** separates mixtures with different boiling points.

 *Fractional distillation is a common method to separate and collect*

 *Hydrocarbons Ionic solids Metals Precipitates*

 ***Filtration*** separates mixtures of solids and liquids.

 *What would collect* ***in filter paper*** *if a mixture of NaCl (aq) and CaCO3 (s) were poured*

*through?*

 ***Chromatography*** can also be used to separate mixtures of liquids and mixtures of gases.

52. ***The Periodic Law*** states that the properties of elements are periodic functions of their *atomic numbers.*

 *Elements are arranged on the modern periodic table in order of increasing …………..*

53. ***Periods*** are horizontal rows on the Periodic Table.

 *In which energy level are the valence electrons of the elements in Period 3 found?*

54. ***Groups*** are vertical columns on the Periodic Table.

####  Which group on the periodic table contains a solid, liquid, and gas(es)?

55. ***Metals*** are found left of the “**staircase**” on the Periodic Table and at the bottom, ***nonmetals*** are above it and at

the top, and ***metalloids*** border it.

##### Which of the following Group 14 elements has the greatest metallic character?

*Carbon silicon germanium tin*

56. Complete and memorize this chart.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  Metals | Malleableand ductile | All solids except \_\_\_\_\_\_\_\_. | Lustrous | Good conductors of heat & electricity | \_\_\_\_\_\_. ionization energy and electroneg. | Tend to form \_\_\_\_\_ ions |
| Nonmetals | Brittle when solid | Mostly gases at STP | Dull | Good insulators | \_\_\_\_\_\_ ionization energy and electroneg. | Tend to form \_\_\_\_\_ ions |

57. ***Noble gases*** (Group 18) are unreactive and stable due to the fact that their valence level of electrons is

completely filled. *What are the 6 noble gases?*

58. ***Ionization energy*** increases as you go up and to the right on the Periodic Table.

 *Which element among the diagrams in # 65 has the lowest ionization energy?*

59. ***Atomic radii*** *decrease* left to right across a period due to increasing nuclear charge.

 *Which period 3 element among the diagrams in # 65 has the largest radius?*

60. ***Atomic radii*** *increase* as you go down a group due to increased electron energy levels.

 *Which alkali metal among the diagrams in # 65 has the largest radius?*

61. ***Electronegativity*** is a measure of an element’s attraction for electrons.

 *Which of the following atoms has the greatest tendency to attract electrons?*

 *calcium carbon copper chlorine*

62. **Electronegativity** *increases* as you go up and to the right on the Periodic Table.

 *Which element among the diagrams in # 65 has the greatest electronegativity?*

63. The elements in Group 1 are the ***alkali metals***; those in Group 2 are the ***alkaline earth metals***.

 *Which atom below represents the alkali metal of period 2?*

64. The elements in Group 17 are the ***halogens***.

 *Which element among the diagrams below is a halogen?*

65. The elements in Group 18 are the ***noble gases***.

 *Which element among the diagrams below is a noble gas?*



66. The last digit of a representative element’s group number is equal to its ***number of valence electrons***.

 *Which contains the greatest number of valence electrons?*

 *Ca Ge Se Kr*

67. Draw one dot for each valence electron when drawing an element’s or ion’s ***Lewis electron dot diagram***.

 *Which dot model would contain the fewest dots as valence electrons?*

 *Ca Ge Se Kr*

68. **Metallic bonds** can be thought of as a crystalline lattice of kernels surrounded by a “sea” of mobile valence

electrons. *Metallic bonding occurs between atoms of*

*sulfur sodium fluoride carbon*

69. Atoms are most stable when they have 8 valence electrons (an ***octet***) and tend to form ions to obtain such a

 configuration of electrons.

 *Which of the following atoms forms a stable ion that does* ***not*** *have an octet structure?*

 *Li F Na Cl*

70. ***Ionic bonds*** form when one atom ***transfers*** an electron to another atom when forming a bond with it.

 *Which substance exhibits ionic bonding rather than covalent bonding?*

######  CO2 N2O4 SiO2 CaBr2 C6H12O6

71. **Dot models** may be used to represent the formation of ions or covalent molecules.

 *. Given the equation:*

 **

*This equation represents the formation of a*

 *fluoride ion, which is smaller in radius than a fluorine atom*

 *fluoride ion, which is larger in radius than a fluorine atom*

 *fluorine atom, which is smaller in radius than a fluoride ion*

 *fluorine atom, which is larger is radius than a fluoride ion*

72. ***Ionic bonds*** form when the electronegativity difference between two bonding atoms is *greater than* 1.7.

Normally these atoms are further apart on the periodic table.

 *What is the electronegativity difference between a sodium atom and a fluorine atom? Would they form an*

*ionic bond?*

73. Substances containing mostly ionic bonds are called ***ionic compounds***.

They are made of metal and nonmetallic ions. They are held together by electrostatic (ionic) forces. *Use Lewis electron-dot structures to illustrate the formation of ionic bonds between sodium metal and oxygen.*

74. Complete and memorize this table.

|  |  |
| --- | --- |
| Substance Type | Properties |
| **Ionic** | Hard*(Low/high) melting and boiling points*Conduct electricity when molten or aqueous |
| **Covalent (Molecular)** | Soft*(Low/high) melting and boiling points*Do not conduct electricity (insulators) |

75. Unstable atoms that are radioactive are called ***radioisotopes***. (use ***Table N***)

 *Which of the following represents a stable nuclide?*

 *Calcium-37 Potassium-42 Nitrogen-14 Phosphorus-32*

76. Each radioactive isotope has a specific mode and rate of decay (**half-life**).

 *Which sample will decay least over a period of 30 days? [Refer to Reference Table N]*

*10 g of Au-198 10 g of I-131 10 g of P-32 10 g of Rn-222*

77. Radioisotopes can decay by giving off any of the particles/emanations listed in ***Table O***.

 *Which of the following decays by positron emission(use table N)?*

 *Gold-198 Neon-19 Plutonium-239 Technetium-99*

78. ***Alpha particles*** (see Table O) are positively charged (+). ***Beta particles*** (Table O) are negatively charged (-).

 **Neutrons** and **gamma rays** lack charge.

 *Which particle cannot be accelerated in a magnetic field?*

*alpha particle beta particle neutron proton*

79. The sum of the mass numbers and atomic numbers must be equal on both sides of the reaction arrow for

**nuclear equations**.

 18 = 18

N + He 🡪 O + H

 9 = 9

 *Complete the following nuclear equations:*

a) 35 Cl + 1n 🡪 35S + \_\_\_\_\_\_\_\_\_ e) 104Ag 🡪 0e + \_\_\_\_\_\_\_

b) 229 Th 🡪 4He + \_\_\_\_\_\_\_\_\_ f) \_\_\_\_\_\_\_\_ + 0e 🡪 54Cr

c) 20O 🡪 20F + \_\_\_\_\_\_\_\_\_ g) 238U + 12C 🡪 246Cf + \_\_\_\_\_

d) 54Fe + 1n 🡪 1H + \_\_\_\_\_\_\_\_\_ h) \_\_\_\_\_\_\_\_ + 0e 🡪 207Pb

80. When radioactive nuclei **decay**, they undergo natural transmutation to form new, more stable atoms.

 *Complete the following decay equation for the alpha decay of thorium-232:*

 *Th 🡪*

81. When bombarded by radioactive particles, stable atoms undergo artificial **transmutation**

 *Identify the element produced when aluminum-27 is bombarded with an alpha particle.*

 *(A neutron is also released).*

 *Al + He 🡪 n + \_\_\_\_*

82. ***Fission reactions*** split heavy nuclei into smaller ones.

n + U 🡪 139Ba + 94Kr + 3 1n + Energy

83. ***Fusion reactions*** occur when light nuclei combine to form a heavy nucleus and *a lot of energy*.

 2H + 2H 🡪 4He + ENERGY

 *What are some of the positives of fusion reactions? The negatives?*

*What type of nuclear reactions take place on the sun?*

84. The ***half life*** of a radioisotope is the *length of time* it takes for one half of the atoms in a sample to radioactively

decay. (Table N)

*Carbon-14 has a half-life of 5,730 years. If a plant contained 2.0 g of 14C when it died, how much is left after 34,380 years?*

85. Radioactive isotopes have a variety of important uses.

Carbon-14, C-14, is used to determine the ages of organic material up to 23,000 years old.

Uranium-238, U-238, is used to determine the ages of rocks.

Iodine-131, I-131, is used to treat thyroid disorders.

Cobalt-60, Co-60, is used to treat cancer tumors.

86. The 3 main types of nuclear radiation are alpha radiation, beta radiation, and gamma radiation. The different types

of radiation can be separated by an electric field based on their charge.

 *List the characteristics of each of the 3 types of radiation including their composition, symbol, charge, mass,*

*penetrating power, and shielding.*

87. In **scientific notation**, a given number is written as the product two numbers: a coefficient and a 10 raised to a

power. *Write the following numbers in scientific notation with significant figures:*

602,000,000,000,000,000,000,000 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ 0.0000000005030 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

88. Chemists, like all scientists use the **scientific method**, a logical, systematic approach to the solution of a

scientific problem. *In the scientific method what is the testable statement giving a proposed explanation for an observation/problem called?*

89. An **experiment** is a procedure used to test a hypothesis. Within an experimental design there are **variables**, or

factors that can change.

*What is the variable that you can change during the experiment called? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

*What is the variable that is observed during the experiment called? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

90. In a quantitative experiment, success relies on the ability to make reliable measurements that are both correct

and reproducible. **Accuracy** is a measure of how close a measurement comes to the actual or true value of

whatever is measured and **precision** is a measure of how close a series of measurements are to one another.

*Three students in a lab group measured the mass of a copper cylinder using a different balance and obtained these measurements: 47.95g 47.93g 47.93g. Describe the accuracy and precision of the students if the correct mass of the cylinder is 47.32 g.*

91. **Dimensional analysis** is a way to analyze and solve problems using the units, or dimensions, of the measurements.

 *Use dimensional analy*sis *to convert .750 kg to grams and 3.25 quarts to μL.*

92. **Density** is an intensive property that depends only on the composition of the substance, not on the size of the

sample. *What quantities do you need to measure in order to calculate the density o*f *an object?*

93. The five commonly used **SI units** are the meter, kilogram, kelvin, second, and mole.

 *What type of measurements do each of the 5 units represent?*

95**. Mendeleev** arranged the elements in his periodic table in order of increasing atomic mass. He also arranged the

elements into groups or families based on a set of repeating properties. Mendeleev developed his periodic table

before scientists know about the structure of atoms.

*Who was the British physicist who determined the atomic number for each known element?*

96. There are three classes of elements: **metals**, **nonmetals**, and **metalloids**. Across a period, the properties of the

elements become less metallic and more metallic. *Classify the following elements: P \_\_\_\_ Si \_\_\_\_ K \_\_\_\_*

97. **Metals** are good conductors or heat and electric current. Metallic bonding with the metal’s mobile valence electrons

(*sea of electrons*) allow metallic substances to conduct. *What are some other properties of metals?*

98. In the modern periodic table, elements are arranged in order of increasing atomic number. The elements within a

**group** in the table have similar properties.

*What family on the periodic table has the most reactive metals? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Nonmetals?\_\_\_\_\_\_\_\_\_\_\_\_*

99. **Alloys** are mixtures of composed of 2 or more elements, at least one of which is a metal. Alloys are important

because their properties are often superior to those of their component elements.

*What are 2 important alloys?*

100. Chemistry is the study of the composition of **matter** and the changes that matter undergoes.

 *All matter has what 2 specific properties?*

**Atomic Models**



 1800 1897 1911 1916 1926

**Unit 4 Electrons in Atoms**

c 🡪 speed of light = 3.00x108 m/s

h 🡪 Planck’s constant = 6.626x10-34J•s

**λ** 🡪 wavelength (meters)

**ν** 🡪 frequency (1/s)

E 🡪 engery (J)

 1nm = 1x10-9m 1pm = 1x10-12m

**Formulas**

1. c = **λ•ν** 2. E = h•**ν** 3. E = h•c

 **λ**





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