Chemistry State Content Standards EXAM

You may use your Notes, *PowerPoint*, or Text on this exam but NO help from human beings!

You MUST HAND WRITE THESE EXAMS in INK!!

NO TYPED or PENCIL PAPERS WILL BE ACCEPTED!

Explanations and Examples MUST be in Complete Sentences!

All Calculations MUST show the Hup, Two, Three, Four.

It is NOT necessary to print this exam. Write your answers onto binder paper. Use both sides to save a tree. Be sure to PRINT your NAME and PERIOD on your papers.

Atomic and Molecular Structure

The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept:

Students know how to relate the position of an element in the periodic table to its atomic number and atomic mass.

1. State the *Periodic Law* and give five examples of this Standard.

Students know how to use the periodic table to identify metals, semimetals, nonmetals, and halogens.

2. Using the Periodic Table, give one example of a: metal, semimetal, nonmetal, and halogen.

Students know how to use the periodic table to identify alkali metals, alkaline earth metals and transition metals, trends in ionization energy, electro negativity, and the relative sizes of ions and atoms.

3. Using the Periodic Table, identify alkali metals, alkaline earth metals, and transition metals.

4. Discuss the trends of ionization energy as we move from left to right on the Periodic Table.

5. What is meant by electronegativity? How do the Halogens use it to aquire noble gas structures?

6. How does the size of a positive ion compare to that of the neutral atom that it came from.

Students know how to use the periodic table to determine the number of electrons available for bonding.

7. State the *Rules for Determining Valence Electrons.*

Students know the nucleus of the atom is much smaller than the atom yet contains most of its mass.

8. Give an analogy that gives an idea of how tiny the nucleus is compared to the atom.

9. Fine the mass of carbon nucleus, in amu (g/mol), if it contains 6 protons and 8 neutrons.

* Students know how to relate the position of an element in the periodic table to its quantum electron configuration and to its reactivity with other elements in the table.

10. Write the Electronic Configuration for the element Sodium (Na).

* Students know the experimental basis for Thomson's discovery of the electron, Rutherford's nuclear atom, Millikan's oil drop experiment, and Einstein's explanation of the photoelectric effect.

11. Describe how Thompson discovered the electron.

12. Describe how Rutherford measured the nucleus of the atom.

13. Tell how the photoelectric effect ionizes atoms.

* Students know that spectral lines are the result of transitions of electrons between energy levels and that these lines correspond to photons with a frequency related to the energy spacing between levels by using Planck's relationship (E = hv).

14. Tell how the spectral lines are produced in sparky tubes.

15. What do we learn from the spectral lines?

Chemical Bonds

Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept:

Students know atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.

16. Use Boxes and Dots to show the Covalent Bondage of NH_3.

17. Describe the Metallic Bond and its properties.

Students know chemical bonds between atoms in molecules such as H_2 , CH_4 , NH_3 , H_2CCH_2 , N_2 , Cl_2 , and many large biological molecules are covalent.

18. Use Boxes and Dots to show the structure of the N_2 molecule.

Students know salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.

19. Explain the Ionic Bond and how it forms for NaCl.

Students know the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.

20. Discuss the *Intermolecular Forces* (van de Waals) and compare them to the Covalent Bond.

Students know how to draw Lewis dot structures.

21. Draw the Lewis dot structure for the F_2 molecule.

* Students know how to predict the shape of simple molecules and their polarity from Lewis dot structures.

22. Draw the Lewis dot structure for H_2O and predict its shape.

* Students know how electronegativity and ionization energy relate to bond formation.

23. Give an example showing which sides of the Periodic Table form ionic bonds.

24. Give an example showing which sides of the Periodic Table form covalent bonds.

25. Define electronegativity. Which side of the Periodic Chart uses electronegativity?

* Students *know* how to identify solids and liquids held together by van der Waals forces or hydrogen bonding and relate these forces to volatility and boiling/ melting point temperatures.

26. Where do we find van de Waals forces (intermolecular forces)?
27. What is a hydrogen bond?
28. Where do we find hydrogen bonding?
29. Compare the strength of van der Waals forces, hydrogen bonding, and covalent bonding.

Conservation of Matter and Stoichiometry

The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants. As a basis for understanding this concept:

Students know how to describe chemical reactions by writing balanced equations.

30. Balance the equation: $H_2 + N_2 \rightarrow NH_3$

Students know the quantity one mole is set by defining one mole of carbon-12 atoms to have a mass of exactly 12 grams.

31. Carbon-12, ^{12}C, is an isotope. Show how many protons and neutrons are in its nucleus.

Students know one mole equals 6.02×10^{23} particles (atoms or molecules).

32. Find how many moles are in 12.04×10^{23} molecules of Br_2.

Students know how to determine the molar mass of a molecule from its chemical formula and a table of atomic masses and how to convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure. The molar volume for all gases at STP is 22.4L/mol.

33. Find the molar mass of NH_4Br.

34. Calculate how many moles are in 50.0g of H_2O.

35. Find how many molecules are in 28.0moles of $ZnSO_4$.

36. Calculate how many liters are in 96.0 moles of CO_2 gas at STP.

Students know how to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products and the relevant atomic masses.

37. Given the equation $CH_4 + 2O_2 \rightarrow CO_2 + 2H_20$

Find how many grams of O_2 are needed to burn 5.0g of CH_4.

38. Now find how many liters of CO_2 are formed at STP.

* Students know how to identify reactions that involve oxidation and reduction and how to balance oxidation-reduction reactions.

39. Define oxidation.

40. Define reduction.

41. Define REDOX.

Gases and Their Properties

The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept:

Students know the random motion of molecules and their collisions with a surface create the observable pressure on that surface.

42. Define the Kinetic Theory.

43. What causes the pressure of a confined gas?

44. List nine evidences supporting the Kinetic Theory.

Students know the random motion of molecules explains the diffusion of gases.

45. State Graham's Law of Diffusion.

Students know how to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.

46. State Boyle's Law of Gases.
47. State Charles' Law of Gases.
48. Write the formula for the combined gas laws.

Students know the values and meanings of standard temperature and pressure (STP).

49. Define standard temperature and pressure (STP).

Students know how to convert between the Celsius and Kelvin temperature scales.

50. Write the fromula to change Celsius into Kelvin.
51. Convert 25°C into K.
52. Convert 250K into °C.

Students know there is no temperature lower than 0 Kelvin.

53. Explain why is there no temperature lower than 0 Kelvin?

* Students kno*w* how to solve problems by using the ideal gas law in the form PV = nRT.

54. Fine the Volume, V, when the Pressure, P = 95.0 kPa, the number of moles, n = 3.00 mol, the temperature, T = 325 K, and R = 8.31 L•kPa/mol•K.

* Students know how to apply Dalton's law of partial pressures to describe the composition of gases and Graham's law to predict diffusion of gases.

55. State Dalton's Law of Partial Pressure.
56. Explain which gas difuses faster: CO_2 or NH_3.

Acids and Bases

Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:

Students know the observable properties of acids, bases, and salt solutions.

57. List three properties of acids.
58. List three properties of bases.
59. List three properties of salts.

Students know acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.

60. Write an equation showing an acid donating a hydrogen ion (a proton) to a base which will be accepting the hydrogen ion.

Students know strong acids and bases fully dissociate and weak acids and bases partially dissociate.

61. Write the Big K for ionization. Explain that weak acids have a low value for K.

Students know how to use the pH scale to characterize acid and base solutions.

62. Diagram and Discuss the pH scale.

* Students know how to calculate pH from the hydrogen-ion concentration.

63. Find the pH of an acid whose [H^+] = 1 X 10^2 M.

Solutions

Solutions are homogeneous mixtures of two or more substances. As a basis for understanding this concept:

Students know the definitions of solute and solvent.

64. Define Solute and Solvent.

Students know how to describe the dissolving process at the molecular level by using the concept of random molecular motion.
65. Using the Kinetic Theory, explain how a solute dissoves into a solvent.

Students know temperature, pressure, and surface area affect the dissolving process.
66. Explain this Standard.

Students know how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.
67. Write the formula for finding the concentration of a solution.
68. Find the concentration of a solution of CaF_2 when 25.0 g are zing point or elevated boiling point.

* Students know how molecules in a solution are separated or purified by the methods of chromatography and distillation.
69. Explain how distillation separates liquids of differing boiling points.
70. Explain how Graham's Law of Diffusion causes the separation of a mixture of compounds of differing molar masses.

Chemical Thermodynamics

Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept:

Students know how to describe temperature and heat flow in terms of the motion of molecules (or atoms).
71. Using the Kinetic Theory, explain this Standard.

Students know chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
72. Draw the Activation Energy curves for both exothemic and endothermic reactions and explain them.

Students know energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.
73. Draw the warming/cooling curve for water and explain its five parts.

74. Explain what is happing at the two plateaus.

Students know how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.

75. Using the formula, $Q = mc\Delta t$, find the calories needed to warm 80.0g of water from 20°C to 40°C. c = 1.00 cal/g•C°.

76. It takes 538 cal/g to evaporate water. Find how many calories are needed to evaporate 200.0 g of water.

77. It takes 80.0 cal/g to melt ice. Find how may calories are needed to melt 500.0 g of ice.

Reaction Rates

Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept:

Students know the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.

78. Explain what happens to the rate of a reaction if one of the reactants has its concentration tripled.

Students know how reaction rates depend on such factors as concentration, temperature, and pressure.

79. Discuss this Standard.

Students know the role a catalyst plays in increasing the reaction rate.

80. Define catalyst.

81. Using an activation energy diagram, discuss the role a catalyst plays in a reaction.

* Students know the definition and role of activation energy in a chemical reaction.

82. What two factors determing the value of the activation energy.

Chemical Equilibrium

Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept:

Students know how to use Le Chatelier's principle to predict the effect of changes in concentration, temperature, and pressure.

83. State the Principle of le Chatelier.

84. Explain the effect of changing the concentration of a reaction at equilibrium.

85. Explain the effect of changing the temperature of a reaction at equilibrium.

86. Explain the effect of changing the pressure of a reaction at equilibrium.

Students know equilibrium is established when forward and reverse reaction rates are equal.

87. Discuss this Standard.

* Students know how to write and calculate an equilibrium constant expression for a reaction. Remember it's Products over Reactants.

88. Write the Big K for the following reaction at equilibrium:

$2KBr + H_2SO_4 \leftrightarrow K_2SO_4 + 2HBr$

Organic Chemistry and Biochemistry

The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life. As a basis for understanding this concept:

Students know large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.

89. Write the structural formula for 2,2,4-trimethylpenane.

Students know the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.

Write a general formula for:

90. an alkane
91. an alkene
92. an alkene
93. a benzene
94. an aldehyde
95. a ketone
96. an alcohol
97. an organic acid
98. an ester

Students know amino acids are the building blocks of proteins.
90. Write the formula for an amine.

* Students know the system for naming the ten simplest linear hydrocarbons and isomers that contain single bonds, simple hydrocarbons with double and triple bonds, and simple molecules that contain a benzene ring.
100. Write the first ten of the alkane homologous series.

* Students know how to identify the functional groups that form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.
101. Write the functional groups for this Standard.

Nuclear Processes

Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:

Students know protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.
102. Discuss this Standard.

Students know the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E = mc^2$) is small but significant in nuclear reactions.
103. What are E, m, c in this equation?
. How do we figure m in this equation?

Students know some naturally occurring isotopes of elements are radioactive,

as are isotopes formed in nuclear reactions.

104. List two radioactive isotopes.

Students know the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.

105. Define alpha ray.

106. Define beta ray.

107. Define gamma ray.

Students know alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.

108. List the three rays of radioactivity in order of penetration ability.