

# 109 Things to Know to Pass the Chemistry Midterm

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(NOTE: this is NOT all inclusive- you must study old tests, review sheets, and other review materials)

- 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
- Neutrons have no charge and a mass of 1 amu.
- Electrons are small and are negatively charged (-) with a mass of almost 0 amu..
- Protons & neutrons are in an atom's nucleus (**nucleons**).  
Which has the greatest number of nucleons? Sn-119 Sb-122 Te-128 I-127
- 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? \_\_\_\_\_
- The **mass number** is equal to an atom's number of protons and neutrons added together.  
What is the mass number of an atom with 18 protons and 22 neutrons? \_\_\_\_\_
- 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
- The **number of neutrons** = mass number - atomic number. Which correctly represents an atom of neon containing 11 neutrons?  $^{11}\text{Ne}$   $^{21}\text{Ne}$   $^{20}\text{Ne}$   $^{22}\text{Ne}$
- In a neutral atom the number of protons = the number of electrons.
- 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
- 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 than that of its atom?  
Cl N Br Ba
- 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? 2-7 2-8 2-8-1 2-6
- Ernest Rutherford's gold foil experiment** showed that an atom is mostly empty space with a small, dense, positively charged nucleus.
- J.J. Thompson** discovered the electron and developed the "plum-pudding" model of the atom.  
+ - + - Positive & negative  
+ - + - + particles spread throughout  
- + - + entire atom.
- Dalton's** model of the atom was a solid sphere of matter that was uniform throughout.
- The **Bohr Model** of the atom placed electrons in "planet-like" orbits around the nucleus of an atom.
- The current, **wave-mechanical model** of the atom has electrons in "clouds" (orbitals) around the nucleus.
- 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.
- 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
- 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?  
Ammonia magnesium potassium nitrate methanol
- 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
- Use this diagram to help determine the **number of significant figures** in a measured value... OR NAS-D



**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 subtracting, 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 have **two** sets of properties.

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

*Air is classified chemically as a(n)*

Substance      compound      element      mixture

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

$^{14}\text{C}$

6

atomic number = .....      mass number = .....

27. 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  $^6\text{Li}$  and 92.6% are  $^7\text{Li}$ .*

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

29. Electron configurations are written in the bottom center of an element's box on the periodic table in your reference tables. The outermost electrons are the valence electrons.



2 = # of electrons in .....

8 = # of electrons in .....

3 = # of electrons in .....

30. Use the **mole map** to help you solve conversions between moles, grams, numbers of molecules/atoms at STP.

*Given the reaction  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ ,*

*How many grams of  $\text{CO}_2$  are produced if 5.5 moles are produced?*

1 gram      44grams      .125 grams      242 grams

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

$\overset{\cdot\cdot}{\underset{\cdot\cdot}{\text{X}}}$  represents the electron-dot symbol of this element      C      O      B      N

32. Energy is **absorbed** when a chemical bond breaks. Energy is **released** when a chemical bond forms. The greater the energy, the more stable the bond that forms. *Which of the following releases energy?*

$\text{H}_2 \rightarrow \text{H} + \text{H}$        $2\text{NaCl} \rightarrow 2\text{Na} + \text{Cl}_2$        $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$        $2\text{LiOH} \rightarrow 2\text{LiH} + \text{O}_2$

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

Nitrate: .....,       $\text{NH}_4^+$ : .....,      sulfite: ....., etc.

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

$\text{NaOH}$        $\text{CH}_3\text{OH}$        $\text{NaCl}$        $\text{Cl}_2$

34. **Coefficients** are written in front of the formulas of reactants and products to balance chemical equations. They give the ratios of reactants and products in a balanced chemical equation.

.....Na + ..... $\text{Cl}_2$  → .....NaCl

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

calcium phosphate:  $\text{Ca}^{2+} \text{PO}_4^{3-} = \dots\dots\dots$

36. 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."  $\text{CaCl}_2$  .....       $\text{MgS}$  .....

37. When naming compounds containing polyatomic ions, keep the name of the polyatomic ion the same as it is written in Table E.  $\text{NH}_4\text{Cl}$  .....      Dimercury (I) nitrate .....

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

$\text{FeO}$ : .....      Nickel (III) sulfate: .....

39. **Physical changes** do not form new substances.

They merely change the appearance of the original material. (The melting of ice)  $\text{H}_2\text{O} (\text{s}) \rightarrow \text{H}_2\text{O} (\text{l})$

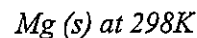
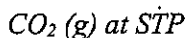
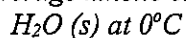
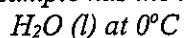
40. **Chemical changes** result in the formation of new substances. *Which process is an example of a chemical change?*

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

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

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

Which sample has the highest average kinetic energy?



43. **Exothermic reactions** release energy (energy is a product of the reaction) while

**Endothermic reactions** absorb energy and the energy is a reactant in the reaction.

Given the reaction:  $CH_4(g) + 2 O_2(g) \rightarrow 2 H_2O(g) + CO_2(g) + \text{heat}$

What is the overall result when  $CH_4(g)$  burns according to this reaction?

Energy is absorbed.

Energy is released.

44. Only coefficients can be changed when balancing chemical equations!

Given the unbalanced equation:  $Al + O_2 = Al_2O_3$

When this equation is balanced using the smallest whole numbers, what is the coefficient of Al?

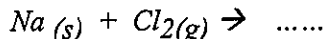
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45. **Synthesis reactions** occur when two or more reactants combine to form a single product.

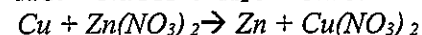
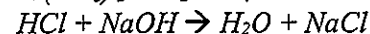
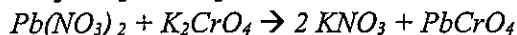
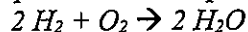


46. **Decomposition reactions** occur when a single reactant forms two or more products



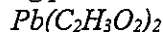
47. **Single replacement reactions** occur when one element replaces another element in a compound.

Which equation below represents a reaction classified as a "single replacement" reaction?



48. **Double replacement reactions** occur when two compounds react to form two new compounds.

Potassium sulfide is mixed with lead acetate. Which of the following products is expected?



49. 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)**."

50. The gram formula mass (molar mass) of a substance is the sum of the atomic masses of all the atoms in it.



$2 \times H = 2 \times \dots g = \dots g$      $1 \times S = 1 \times \dots g = \dots g$      $4 \times O = 4 \times \dots g = \dots g$

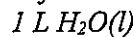
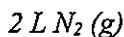
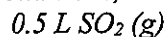
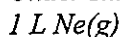
51. Know how to calculate the percentage composition of a compound. (Formula is on Table T.)

Find the percent by mass of oxygen in  $CaCO_3$ .

52.  $6.02 \times 10^{23}$  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  $O_2(g)$ ?



53. Know how to convert a molecular formula into an empirical formula.

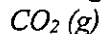
A compound has the molecular formula  $N_6O_{12}$ . Find its empirical formula.



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

55. The particles in a **solid** are rigidly held together, closely packed in a **lattice** arrangement.

Which of the following has a regular geometric arrangement at 298 K and 1.0 atm?



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

In what region of the graph below would you only find molecules with definite shape and volume?

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

but have a definite volume.

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

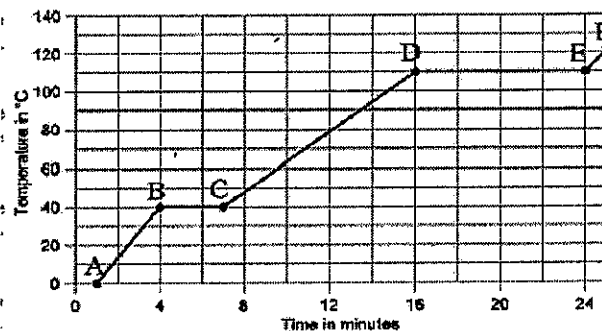
59. **Gases** are easily compressed and have no definite shape or volume.

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*In what region of the graph below would you only find a sample with no definite shape or volume?*

60. Be able to read and interpret heating/cooling curves as pictured below.

*During which interval on the graph are solid and liquid in equilibrium?*



61. Substances that **sublime** turn from a solid directly into a gas. They have very weak attractive forces. (examples include  $\text{CO}_2$  &  $\text{I}_2$ )

62. As they evaporate, liquids become gases, which create vapor pressure. (Reference Table H). As temperature increases, vapor pressure increases. *This liquid on Reference Table H has the weakest attractive forces:*

Propanone      ethanol      water      acetic acid

63. "**STP**" means "Standard Temperature and Pressure." Reference Table B

These conditions define STP       $P = \dots \text{atm}$        $T = \dots \text{K}$

64. Degrees Kelvin =  $C + 273$

Room temperature =  $25^\circ\text{C} = \dots \text{K}$       Boiling point of helium =  $4 \text{ K} = \dots \text{C}$

65. Heat is a transfer of energy from a material at higher temperature to one at lower temperature.

*When an ice pack is applied to a bruised arm, ..... transfers from ..... to .....*

66. Use this formula to calculate heat absorbed/released by substances.       $q = mc\Delta t$

$q$  = heat absorbed or released (Joules)

$m$  = mass of substance in grams

$c$  = specific heat capacity of substance (J/gC) ... for water it's 4.18 J/g C.

$\Delta t$  = temperature change in degrees Celsius

*What is the total number of joules of heat energy absorbed by 12 grams of water when it is heated from  $30^\circ\text{C}$  to  $40^\circ\text{C}$ ?*

67. The heat absorbed or released when 1 gram of a substance changes between the solid and liquid phases is the substance's **heat of fusion**. (Reference Table B: 334 J/g for water). *How many joules are required to melt 15 g  $\text{H}_2\text{O}$  (s)?*

68. The heat absorbed or released when 1 gram of a substance changes between the liquid and gaseous phases is the substance's **heat of vaporization**. (Reference Table B)

*How many joules are required to boil 120 g  $\text{H}_2\text{O}$  (l)?*

69. Always use Kelvins for temperature when using the **combined gas law**.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

*Set up the equation to calculate the volume of 50. mL of methane gas collected at STP when the pressure rises to 2.4 atm and the temperature drops to 240 K.*

70. As the **pressure** exerted on a gas increases, the **volume** decreases proportionally.

*25 L of a gas is held at 1.2 atm pressure. Find the new volume if pressure drops to 0.80 atm at constant temperature.*

71. As the **pressure** on a gas increases, **temperature** increases.

*A sample of gas exerts a pressure of 220. kPa at 373 K. Find the pressure at 373 K at constant volume.*

72. As the **temperature** of a gas increases, **volume** increases.

*15 mL of oxygen gas is collected at  $0^\circ\text{C}$ . Find the volume at  $50^\circ\text{C}$  at constant pressure. Temp must be in Kelvin!*

73. **Real gas** particles have volume and are attracted to one another. They don't always behave like **ideal gases**.

Lighter gases (with weaker attractive forces) are often most ideal.

*Which of the following is the most ideal gas?*

He      Ne      Ar      Kr

74. Real gases behave more like ideal gases at **low pressures and high temperatures**.

75. 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  $\text{NaCl}$  (aq) and  $\text{CaCO}_3$  (s) were poured through?*

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

76. **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 .....*

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

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

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

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

79. **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

80. Complete and memorize this chart.

Metals	Malleable and 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

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

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

*Which element among the diagrams below has the lowest ionization energy? \_\_\_\_\_*

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

*Which period 3 element among the diagrams below has the largest radius? \_\_\_\_\_*

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

*Which alkali metal among the diagrams below has the largest radius? \_\_\_\_\_*

85. **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

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

*Which element among the diagrams below has the greatest electronegativity? \_\_\_\_\_*

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

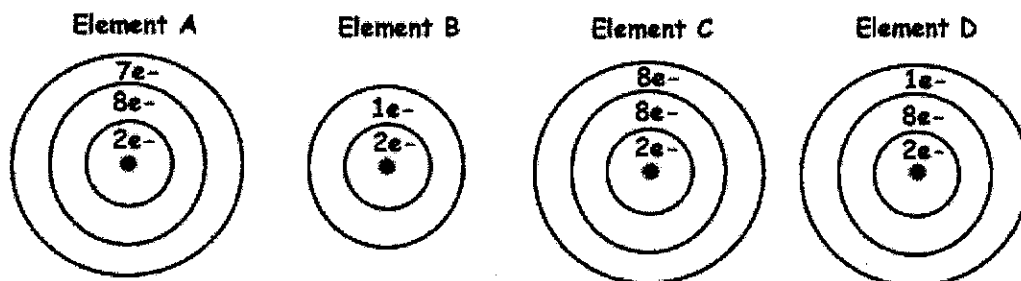
*Which atom below represents the alkali metal of period 2? \_\_\_\_\_*

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

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

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

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



90. Use **Table S** to compare and look up the properties of specific elements.

*The freezing point of phosphorus is .....°C*

91. The last digit of an element's group number is equal to its **number of valence electrons**.

*Which contains the greatest number of valence electrons?*

Ca                  Ge                  Se                  Kr

92. 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

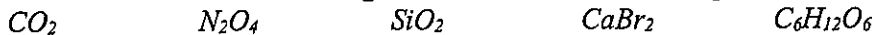
93. Atoms are most stable when they have 8 valence electrons (an **octet**) and tend to form ions to obtain such a configuration of electrons.

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

Li                  F                  Na                  Cl

94. **Covalent bonds** form when two atoms *share* a pair of electrons.  
 95. **Ionic bonds** form when one atom *transfers* an electron to another atom when forming a bond with it.

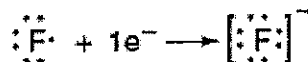
Which substance exhibits ionic bonding rather than covalent bonding?



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

Given the equation:

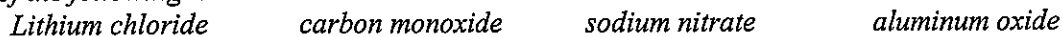
This equation represents the formation of a



- 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

97. Substances containing mostly covalent bonds are called **molecular substances**.

Which of the following is a molecular substance?



98. **Hydrogen bonds** are attractive forces that form when hydrogen bonds to the elements N, O, or F and gives the compound unexpectedly high melting and boiling points.

The strongest forces of attraction occur between molecules of



99. 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.

100. Liquids **boil** when their vapor pressure is equal to the atmospheric pressure. (Reference Table H)

Water will boil at  $90^\circ\text{C}$  when the atmospheric pressure is .....kPa.

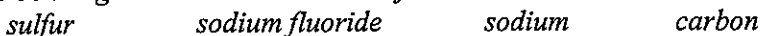
101. The **normal boiling point** of a substance is the temperature at which it boils at 1 atm pressure.

(Reference Table H)

What is the normal boiling point of propanone?

102. **Combustion reactions** occur when a hydrocarbon reacts with oxygen to make  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .

103. **Metallic bonds** can be thought of as a crystalline lattice of cations surrounded by a "sea of mobile valence electrons."  
 Metallic bonding occurs between atoms of...



104. **Non-polar Covalent bonds** form when two atoms of the same element bond together

105. **Polar covalent bonds** form when there is an electronegativity difference greater than ) but less than ionic (not a metal and a non-metal) Which of the following combinations would form a polar covalent bond?



106. **Van der Waals** attractive forces are the attractions between non-polar molecules, Non-polar molecules are molecules with structural symmetry.

107. **Intermolecular forces** in non-polar molecules become stronger with increasing molar mass which causes the boiling point to increase. Which of the following samples has the greatest forces of attraction?



108. **Polar molecules:** have stronger forces of attraction and they lack structural symmetry (they are asymmetrical). Which of the following is a polar molecule?



109. Memorize this table of properties of the different types of compounds:

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