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CHEMISTRY

VOLUME 8

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PREFACE

Believe That You Can Pass the UPCAT!
by Leopold Laset

Do you sometimes find it hard to believe that your dream to pass the UPCAT can become a reality? If so, then there is something very important that you need to know.

UPCAT is for dreamers like you.

Every student who passed the UPCAT began thinking or dreaming of passing the UPCAT.

Your near-perfect or perfect score in a quarterly test, your cellphone, PSP, or any gadget, your out-of-town (or out-of-country) vacation, your new pair of shoes, and any other stuff that you desired and now possess - are all the result of your 'dream come true'.

What this means is that throughout your lifetime, you have had an idea, you have desired for many things and worked hard for them, overcome problems and ultimately transformed your dream into reality.

And if hundreds and thousands of students have been able to pass the UPCAT in the past, by starting with a dream, then it stands to reason, that you can do it too.

Often we make the mistake of thinking that UPCAT is for a small number of bright students who have the brains and intelligence that we don't possess.

But this is simply not true.

The fact that thousands of average students have brought their dreams of passing the UPCAT to fruition in the past demonstrates that the opportunity to qualify in the UPCAT is something that is available to each UPCAT aspirant – average or bright.

Right now, hundreds of UPCAT dreamers are taking the steps necessary to achieve the goals of passing the UPCAT. Some are studying this early, some are joining community of fellow dreamers, and some are attending review classes. What is it that you need to do?

In order to achieve your goal of passing the UPCAT, the only things you really need are:

(1) A crystal clear picture that you already passed the UPCAT
(2) An unshakeable determination to do whatever it takes to make your dream of passing the UPCAT a reality

As soon as you take these two steps, passing the UPCAT becomes achievable. If you need a help – you look for it. If you encounter a difficult concept – you find a way to understand it. If you can't solve a math problem – you try and try and practice more.

And gradually, step-by-step, you bring your UPCAT dream into reality to join the dreams of the thousands of UPCAT dreamers who have gone before you.

So today I'd like to encourage you to believe in yourself and appreciate the fact that you live in a world where 'dreams do come true'.

Understand that thousands of students have made their UPCAT dream a reality in the past – Thousands more will make their UPCAT dream a reality in the near future and you CAN be one of them.

CHEMISTRY CONTENTS

- ***Measurements in Chemistry***
- ***Matter***
- ***Chemical Shorthand***
- ***Concepts Involving Gases***
- ***The Mole Concept and Stoichiometry***
- ***The Atom and Electron in Focus***
- ***The Periodic Table***
- ***Chemical Bonds***
- ***Intermolecular Forces, Solids and Phase Changes***
- ***Solutions***

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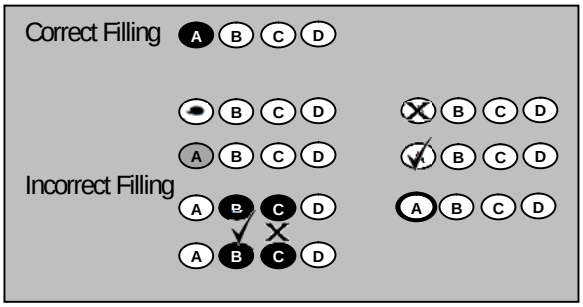
ANSWER SHEET – CHEMISTRY



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CHEMISTRY REVIEW TEST

1. Which pair is INCORRECT?

A. nano – 10^{-9} B. kilo - 10^{3} C. centi -10^{-2} D. pico - 10^{12}

2. In scientific notation, the number 0.000251 is written as

A. 2.51 x 10^{4} B. 2.51 x 10^{-4} C. 2.51 x 10^{6} D. 2.51 x 10^{-6}

3. Which has the correct number of significant figures?

A. 420 – 2 SF B. 0.100 – 1 SF C. 0.0528 - 4 SF D. 2.03 – 2 SF

4. The sum of 2.5 x 10^{2} and 4 x 10^{-4} is

A. 2.5 x 10^{3} B. 2.50004 x 10^{2} C. 2.500004 x 10^{2} D. 4.000002 x 10^{2}

5. In Kelvin, 450 F is equivalent to

A. 386 B. 318 C. 280 D. 113

6. The volume (in m^3) of a substance having a density of 1.5 kg/m^3 and mass of 105 kg is

A. 0.014 B. 106.5 C. 70 D. 157.5

7. The product of 7.4 x 10^{-3} and 0.000130 divided by 8.006 x 10^{-2} is

A. 1.20 x 10^{-3} B. 1.20 x 10^{-4} C. 1.20 x 10^{-5} D. 1.20 x 10^{-9}

8. A vehicle travels at a speed of 33 meters per second. What is the car's speed in kilometers per hour?

A. 80 B. 120 C. 220 D. 1980

9. The height in centimeters of a basketball player who is 6 feet tall would be

A. 15 B. 28 C. 72 D. 183

10. The number of pounds in 0.25 kg is _____.

A. 0.11 B. 0.13 C. 0.55 D. 250

11. Which conversion factor is NOT true?

A. 1 ft = 2.54 cm B. 1 hr = 3600 sec C. 1 cm^3 = 1 mL D. 1 kg = 2.2 lbs

12. All statements are true EXCEPT

A. A compound is a composed of two or more elements that are chemically combined
B. An element cannot be decomposed into simpler substances by ordinary chemical means
C. Mixtures are composed of substances in fixed mass ratios which can be separated by physical means
D. A molecule is the smallest unit of a compound

13. A heterogeneous mixture which exhibits the properties of Brownian motion and Tyndall effect is known as

A. suspension B. solution C. colloid D. aqueous

14. Which process indicates a chemical change?

A. cutting of paper
B. applying nail polish
C. evaporation of water
D. rusting of metal

15. A method used to separate heterogeneous solid-liquid mixture is

A. chromatography
B. distillation
C. evaporation
D. filtration

16. Which phrase about a gas is TRUE?

A. has a rigid shape and fixed volume
B. has a fixed volume but not rigid in shape
C. cannot diffuse nor be compressed
D. has neither a fixed volume nor rigid shape

17. All are categories of elements EXCEPT

A. metals B. metalloids C. molecules D. non-metals

18. The principle stating that 'the masses of one element that combine with a fixed mass of the second element are in ratios of small whole numbers' is known as

A. Law of Mass Conservation
B. Law of Definite Proportion
C. Law of Energy Conservation
D. Law of Multiple Proportions

19. The ability of metals to be hammered into thin sheets is referred to as

A. brittleness B. ductility C. luster D. malleability

20. Which phase change is correctly defined?

A. Condensation is the change from gas to liquid
B. Melting involves a change from liquid to gas
C. Evaporation is a change from solid to gas without passing the liquid state
D. Sublimation is a change from solid to liquid

21. Which property describes an acid or acidic solution?

A. ph greater than 7
B. pinkish in phenolphthalein solution
C. turns blue litmus paper into red color
D. releases OH- ion in aqueous solution

22. All are assumptions of Dalton's Atomic Theory EXCEPT

A. Matter is made up of indestructible atoms
B. All atoms of an element are identical
C. Atoms can be created and destroyed
D. Atoms combine in small whole number ratios when forming compounds

23. Which pair of atomic model and proponent is CORRECT?

A. Plum Pudding Model : JJ Thomson
B. Planetary Model : John Dalton
C. Nuclear Model : Niels Bohr
D. Electron Cloud Model : Ernest Rutherford

24. The number of protons (or electrons) in atom refers to the atom's

A. atomic number
B. atomic mass
C. mass number
D. isotopic mass

25. By analysis, a compound of X and Y was found to have a mass ratio of 4:1, respectively. If available are 20 g each of X and Y, how many grams of which reactant will remain unreacted?

A. 5g X B. 10g X C. 15g Y D. 25g Y

26. Twenty grams of a metal chlorate was decomposed by heat producing a metal chloride and oxygen gas. If the amount of oxygen gas released was 4 grams, what percent of the compound was the metal chloride?

A. 20 B. 25 C. 64 D. 80

27. The formula mass (in amu) of ammonium phosphate, $(NH_4)_3PO_4$ is (At masses in amu: N- 14, H-1, P-31, O- 16)

A. 68 B. 116 C. 121 D. 149

28. The nucleus of ^{39} K has

A. 19 electrons and 19 protons
B. 19 protons and 19 neutrons
C. 19 electrons and 20 protons
D. 19 protons and 20 neutrons

29. Which statement is TRUE regarding the periodic table?

A. Dobereiner's periodic table was referred to as Law of Octaves
B. The horizontal rows in the periodic table are called groups
C. Atomic size generally increases within a period
D. Group VIIA elements are also known as the halogens

30. Given the following hypothetical atoms with their corresponding electron configuration:

R $1s^2\ 2s^2\ 2p^6$
M $1s^2\ 2s^2\ 2p^6\ 3s^1$
L $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

Which atom has the LEAST first ionization energy?

A. R B. M C. L D. insufficient data

31. An element having an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ belongs to which group and period in the periodic table?

A. Group IIIA, period 3
B. Group IIIA, period 5
C. Group VA, period 7
D. Group VIIA, period 3

32. The correct electron configuration for an element having 22 electrons would be

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4p^2$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^8\ 4s^2$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^2$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$

33. Which statement is INCORRECT?

A. In the notation $4s^2$, the no.4 indicates shell number or main energy level
B. Aufbau principle states that 'no two electrons in an atom have the same set of four quantum numbers'
C. The magnetic quantum number (ml) describes the space orientation of an orbital
D. To determine the total number of electrons in a particular shell, the formula $2n^2$ may be applied

34. The electron configuration of a certain element stopped a $4p^2$. The element's atomic number would be

A. 10 B. 20 C. 22 D. 32

35. Which set of quantum numbers correctly describes the last electron of the element nitrogen (Z= 7)?

A. 2 0 0 -1/2 B. 2 1 0 1/2 C. 2 1 0 -1/2 D. 2 1 1 1/2

36. Which pair of scientist and discovery/proposed theory is NOT true?

A. Antoine Lavoisier : Atomic Theory
B. Robert Boyle : Pressure-Volume relationship in gases
C. James Chadwick : neutron
D. Dmitri Mendeleev : periodic law

37. A type of chemical reaction involving the displacement of one element by another is known as

A. decomposition C. replacement reactions
B. redox reactions D. synthesis

38. Which is an example of an endothermic process?

A. bond formation C. condensation
B. evaporation D. freezing

39. Which test is used to identify the type of gas evolved during a chemical reaction?

A. flame test C. litmus paper test
B. iodine test D. splinter test

40. Which statement is INCORRECT?

A. Specific heat refers to the amount of heat required to raise the temperature of one gram of a substance by 1°C
B. Boiling is the temperature at which the vapor pressure of a liquid equals the pressure applied on the liquid
C. Critical temperature is the highest temperature above which gases cannot be liquefied no matter how much pressure is applied
D. Le Chatelier's principle states that when a system at equilibrium is disturbed, the system will respond in order to relieve the disturbance

41. Which chemical formula is correctly named?

A. $H_2SO_{3\,(aq)}$: sulfurous acid C. Fe_2O_3 : ferrous oxide
B. $K_2Cr_2O_7$: dipotassium chromate D. CCl_4 : carbon chloride

42. The correct coefficients to balance the equation $C_2H_2 + O_2 \rightarrow CO_2 + H_2O$ would be

A. 1 2 2 1 B. 1 2 1 1 C. 2 5 4 2 D. 3 2 2 1

43. Which pair is INCORRECT?

A. calcium, Ca^{2+} C. dichromate, CrO_4^{2-}
B. chlorite, ClO^{2-} D. plumbic, Pb^{4+}

44. All are balanced equations EXCEPT

A. $Na_2CO_3 + 4\,C + N_2 \rightarrow 2\,NaCN + 3\,CO$
B. $2\,KrF_2 + 2\,H_2O \rightarrow 2\,Kr + O_2 + 4\,HF$
C. $PbS + 3\,H_2O_2 \rightarrow PbSO_4 + 3\,H_2O$
D. $4\,NH_3 + 5\,O_2 \rightarrow 4\,NO + 6\,H_2O$

45. The empirical formula of a compound of nitrogen and oxygen which is 64% N by mass is (molar masses in g/mol – N= 14, O= 16)

A. NO B. NO_2 C. N_2O D. N_2O_5

46. The charge of chromium (Cr) in potassium dichromate ($K_2Cr_2O_7$) is

A. 2+ B. 3+ C. 6+ D. 12+

47. The compound HClO (aq) has an IUPAC name of

A. chloric acid
B. chlorous acid
C. hypochlorous acid
D. perchloric acid

48. Which statement is NOT true?

A. $Mg(OH)_2$ is milk of magnesia
B. NH_3 is methane gas
C. $CaCO_3$ is present in limestone
D. $CO_2(s)$ is also known as dry ice

49. The oxidizing agent in the equation $Ca + H_2 \rightarrow CaH_2$ is

A. Ca B. CaH_2 C. H_2 D. insufficient data

50. A compound of U and P was found to contain 17.2% P. What is the actual formula of the compound if its molecular weight is 58? (molar masses in g/mol – U- 12, P- 1)

A. UP_4 B. U_2P_2 C. U_3P_6 D. U_4P_{10}

51. The number of atoms in 25 g Al is (Al is 27 g/mol)

A. 0.93 B. 25 C. 1.5 x 1025 D. 5.6 x 1023

52. What mass (in grams) of Na is present in 35 grams NaOH? (molar masses in g/mol- Na- 23, NaOH- 40)

A. 0.88 B. 20 C. 61 D. 805

53. The volume (in liters) of 40 g methane, CH_4 (16 g/mol) gas at standard conditions is

A. 22 B. 29 C. 56 D. 896

54. How many moles of water will be produced from the decomposition of 100 g ammonium nitrate, NH_4NO_3 (80 g/mol)
$NH_4NO_3 \rightarrow N_2O + 2\ H_2O$

A. 1.25 B. 2.50 C. 45 D. 200

For items 55 – 58, use the equation: $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$
(molar masses in g/mol- NH_3 – 17, O_2 – 32, NO – 30, H_2O – 18)

55. Calculate the mass (in grams) of NH_3 needed to produce 50 g of NO.

A. 1.7 B. 7.0 C. 28 D. 850

56. The number of molecules of water formed from the reaction of 10 moles of O_2 is

A. 12 B. 60 C. 6.02×10^{24} D. 7.22×10^{24}

57. The number of moles O_2 required to prepare 18 moles of water would be

A. 15 B. 22 C. 90 D. 9.03×10^{24}

58. If 10 moles each of NH_3 and O_2 are allowed to react, which substance is the limiting reactant?

A H_2O B. NH_3 C. NO D. O_2

59. Given the combustion reaction of propane, C_3H_8

$$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

What mass (in grams) of CO_2 is formed when 15 g of C_3H_8 reacts with 10 g O_2?

(molar masses in g/mol- C_3H_8- 44, O_2- 36, CO_2- 44)

A. 7 B. 25 C. 45 D. 220

60. What is the percent yield of the reaction if 15 moles of HCl was obtained from the reaction of 9 moles Cl_2 gas?

Equation: $H_2 + Cl_2 \rightarrow 2\ HCl$

A. 32 B. 40 C. 80 D. 83

61. All are variables affecting gas behavior EXCEPT

A. inertia B. pressure C. temperature D. volume

62. A certain gas occupies a volume of 30 mL at a certain pressure and temperature. Calculate the new volume (in mL) when the pressure is decreased to one-third the original volume and the temperature increased five times.

A. 18 B. 50 C. 90 D. 450

63. The pressure of a 5 L sample of a noble gas is 725 torr. Calculate the new pressure(in torr) if the volume becomes 9 L.

A. 0.5 B. 2.0 C. 403 D. 1305

64. A sample of nitrogen gas has a volume of 3 liters at 35°C. What is the new volume (in mL) of the gas if the Celsius temperature is doubled?

A. 2.7 B. 3.3 C. 2700 D. 3300

65. A gas is originally at a temperature of 50 °C. To what temperature (in °C) must it be heated to triple its pressure?

A. 150 B. 323 C. 696 D. 969

66. Calculate the volume (in mL) of a 0.012 mol of gas sample at 2 atm and 30°C.

A. 0.15 B. 0.30 C. 14.8 D. 149

67. A mixture of gases at standard atmospheric pressure contains 65% N_2, 15% O_2, and 20% CO_2 by volume. What is the partial pressure (in torr) of CO_2 in the mixture?

A. 114 B. 152 C. 494 D. 760

68. The molar mass (in g/moL) of a 0.58 gram gas sample occupying a volume of 250 mL at 24°C and 743 mmHg is

A. 0.76 B. 58.0 C. 145 D. 466

69. The ratio of diffusion of HCl and NH_3 gases is
(molar masses in g/mol- NH_3- 17, HCl- 36)

A. 1 : 1 B. 1 : 1.5 C. 2 : 1 D. 3 : 2

70. Which assumption is NOT part of the Kinetic Molecular Theory of gases?

A. Gases are made up of molecules in random motion.
B. Molecular collisions are perfectly elastic.
C. The lighter the gas, the faster is its diffusion
D. The average kinetic energy of a gas particle is directly proportional to the temperature in Kelvin

71. Which characteristic does NOT describe a solution?

A. mixture of one or more solutes dissolved in a solvent
B. a homogenous mixture
C. components are present in constant proportions
D. components can be separated by physical means

72. What is the molar concentration (M) of commercial HNO_3 solution having a purity of 69% by mass? Solution density is 1.42.

A. 0.160 B. 1.095 C. 7.70 D. 15.6

73. What volume of solution (in mL) should be diluted in order to prepare a 500 mL 1 M HCl solution from an initial concentration of 6M?

A. 83 B. 100 C. 500 D. 1000

74. Which statement is TRUE?

A. temperature is a factor affecting solubility
B. dilution is a process of adding more solute to lessen concentration
C. aqueous solutions are solutions dissolved in alcohol
D. concentration refers to the amount of solute that dissolve in a given amount of solvent at a specific temperature

75. Calculate the mole fraction of methyl alcohol, CH_3OH in a solution of 1.2 g methyl alcohol dissolved in 16.8 g water. (molar masses in g/mol- CH_3OH- 32, H2O- 18)

A. 0.04 B. 0.38 C. 0.93 D. 0.96

76. Which is NOT an example of a solution?

A. amalgam B. alloy C. brine D. emulsion

77. Calculate the molality of a solution of ammonia (17 g/mol) in water which is 33% NH_3 by mass.

A. 1.94 B. 29.0 C. 33 D. 67

78. What mass (in grams) of sugar is present in 200 g syrup that is 20% sugar by mass?

A. 20 B. 40 C. 80 D. 120

79. Solutions which produce ions in solution are known as

A. dilute B. electrolytes C. saturated D. unsaturated

80. The volume percent of a solution of 35 mL alcohol dissolved in 80 mL water is

A. 30 B. 44 C. 70 D. 80

81. All of these compounds were formed through covalent bonding EXCEPT

A. CO_2 B. H_2O C. NaCl D. NH_3

82. Ionic, metallic, molecular, network are types of _____

A. bonds B. phase changes C. solids D. weak forces

83. The Lewis structure of nitrogen molecule shows how many bonds between the nitrogen atoms?

A. 4 B. 3 C. 2 D. 1

84. Which is NOT a characteristic of an ionic bond?

A. also known as electrovalent bond
B. leads to the formation of a molecule
C. exists between a metal and a non-metal
D. involves complete transfer of electrons

85. Which molecule is polar?

A. NH_3 B. CH_4 C. O_2 D. CO_2

86. Which pair is INCORRECT?

A. bent (104.5°) B. linear (180°) C. pyramidal (120°) D. tetrahedral (109.5°)

87. The molecule that could undergo H-bonding is

A. HCl B. HBr C. H_2S D. H_2O

88. Which statement is TRUE?

A. Intermolecular forces are stronger than bonds
B. London force is also known as dispersion force
C. Dipole-dipole interaction involves an attraction between temporary dipoles
D. H-bond exists among molecules containing hydrogen atom attached to any halogen

89. These gases exist in diatomic form EXCEPT

A. chlorine B. neon C. nitrogen D. oxygen

90. Valence Shell Electron Pair Repulsion (VSEPR) theory predicts

A. bond formation C. order of reaction
B. molecular geometry D. type of chemical reaction

91. Boiling point elevation, freezing point depression and osmotic pressure are

A. variables affecting gas behavior C. factors affecting rate of dissolution
B. types of intermolecular forces D. colligative properties of solutions

92. A compound containing an –OH group attached to a hydrocarbon chain is

A. alcohol B. aldehyde C. ester D. ketone

93. Which statement is FALSE?

A. Galvanic cell is also known as voltaic cell
B. Electrolysis is a process that uses electric current to decompose a compound into its elements
C. The electrode at which oxidation takes place is called the cathode
D. Fuel cells use a combustion reaction to generate electrical energy

94. Amino acids are building blocks of _____

A. carbohydrates B. lipids C. nucleic acids D. proteins

95. Which is NOT a law of thermodynamics?

A. energy can neither be created nor destroyed
B. spontaneous processes occur with an increase in entropy
C. for every action there is an equal and opposite reaction
D. entropy of a perfect crystal is zero at 0 K.

96. The time required to convert half of the original amount of reactant to product is the

A. activation energy C. rate of reaction
B. half-life D. shift in equilibrium

97. All are factors affecting rate of reaction EXCEPT

A. concentration of reactants C. temperature
B. particle orientation D. time of reaction

98. A blood sample has a hydronium ion concentration of 4.5×10^{-8} M. The value of the hydroxide ion concentration would be

A. 1.0×10^{-14} B. 1.0×10^{-7} C. 2.2×10^{-7} D. 4.5×10^{-8}

99. This refers to the process in which the emission of infrared radiation by the atmosphere warms the planet's surface

A. acid rain formation C. greenhouse effect
B. eutrophication D. el niño phenomenon

100. Bronsted-Lowry acid is defined as

A. a substance producing H+ ions in solutions
B. base neutralizer
C. electron-pair acceptor
D. proton donor

Review Masters

UPCAT Review

CHEMISTRY

VOLUME 8

Answers and Explanations

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1. Refer to the table below:

Prefix	10^n	Decimal
tera	10^{12}	1000000000000
giga	10^{9}	1000000000
mega	10^{6}	1000000
kilo	10^{3}	1000
hecto	10^{2}	100
deca	10^{1}	10
	10^{0}	1
deci	10^{-1}	0.1
centi	10^{-2}	0.01
milli	10^{-3}	0.001
micro	10^{-6}	0.000001
nano	10^{-9}	0.000000001
pico	10^{-12}	0.000000000001

Thus, the answer is **D**.

2. ***Scientific notation is a method of expressing very large/small numbers which has the general form***

A x 10 ^{B} where

A is a number equal to/greater than 1 but less than 10 (this means that there will only be one digit to the left of the decimal point)

B (exponent/power) indicates the number of places the decimal point is moved when an ordinary number is written in scientific notation. If the movement is to the *left*, the sign is positive (+) and if to the right, the sign becomes negative (-).

*To write the given **0.000251** in scientific notation, the decimal point at the end of the last zero should be moved **four places to the right** to place the decimal point after the digit **2** so that there will only be one digit to the left of the decimal point. Since the movement is **4 places to the right**, the exponent will be **-4**. The correct form would be **2.51×10^{-4}**.*

Thus, the answer is **B**.

3. ***Significant figures or digits** are those digits in a measurement that are known with certainty and the last digit uncertain or estimated. Some helpful rules/guidelines in determining the number of significant digits are as follows:*

General Guidelines in Determining Significant Figures (SF)

A. Non-zero digits are always SIGNIFICANT. So the number 5432 has 4 SF

B. ZEROS may or may not be considered significant. If zeros are:

- *In between two non-zero digits, they are SIGNIFICANT. Thus* **106 has 3 SF.**
- *At the right of a decimal point and a non-zero digit, they are SIGNIFICANT. The example* **66.0 has 3 SF.**
- *Used to locate a decimal point or used as place holders, they are NOT SIGNIFICANT. For example*
  0.132500 - 6 SF **0.00502 - 3 SF**
- *Zeros following a non-zero digit (also called TERMINAL ZEROS) are NOT SIGNIFICANT. So a number like* **4000** contains **1 SF.** *However, if such zeros are SIGNIFICANT, scientific notation may be used to indicate the zeros that are significant Thus* **4000** may be expressed as
  $4000 - 4 \times 10^3$ **1 SF**
  4.00×10^3 **3 SF**

Now, applying these rules to the given choices:

A. **420** **2 SF** - 0, being a ***terminal zero*** is ***not significant***.

B. **0.100** **3 SF** - the two zeros are at the right of the decimal point and a non-zero digit, thus they are ***both significant***.

C. **0.0528** **3 SF** - the 0 at the right of the decimal point is used as a ***place holder***, thus it is ***not significant***.

D. **2.03** **3 SF** - the zero is in between two non-zero digits, thus it is ***significant***.

Thus, the answer is **A**.

CHEMISTRY TIP:

EXACT NUMBERS (*results of counting or a defined equivalence*) are said to have an infinite number of significant figures. They do not limit the number of significant figures in a given measurement and are therefore ***not*** considered in the counting of significant figures.

4. *In the given item, the exponents are not the same; one of them must be changed, either 2 becomes -4 or vice versa. Solving the problem can be done in two ways*:

- ***(changing the exponent 2 to -4)***

($\mathbf{2500000 \times 10^{-4}}$) + ($4 \times 10^{-4}$) = 2500004×10^{-4} *and because this value is not correct form (the number to the left of the decimal point is greater than 10) this would have to be converted. The correct form would be* 2.500004×10^{2} *and in correct number of significant figures final answer would be* $\mathbf{2.500004 \times 10^{2}}$.

- ***(changing the exponent -4 to 2)***

(2.5×10^{2}) + ($\mathbf{0.000004 \times 10^{2}}$)
= $\mathbf{2.500004 \times 10^{2}}$. (*already in correct form).*

Although both methods would arrive at the same answer, it is better to select the method that gives the final answer in correct scientific notation form.

Thus, the answer is **C**.

5. ***This problem involves conversion from one temperature scale to another. Conversions from one scale to another may be carried out by applying any of the following temperature formulas.***

$^0C \rightarrow {}^0F$	$9/5\ (^0C) + 32$
$^0F \rightarrow {}^0C$	$5/9\ (^0F - 32)$
$^0C \rightarrow K$	$^0C + 273$

Since the given value is expressed in degree Fahrenheit, the required unit of Celcius maybe obtained using the formula

$$^0C = 5/9\ (^0F - 32)$$

Substituting the values:

$$= 5/9\ (45 - 32) = 7.22\ ^0C$$

Now, to convert Celcius to Kelvin,

$$K = {}^0C + 273 = 7 + 273 = 280\ K$$

Thus, the answer is **C**.

6. *To solve for the volume, the formula Density = mass/volume should be used. Manipulating the formula, we have:*

$$\textbf{Volume = mass/density}$$

*Using the given value of mass (**105 kg**) and density of* $\mathbf{1.5\ kg/m^3}$ *and substituting in the formula, the solution would be as follows:*
Volume = mass /density = $105kg / 1.5\ kg/m^3$

$$= \mathbf{70\ m^3}$$

Thus, the answer is **C**.

7. *Before answering this particular question, let's have a look at the rule on multiplying and dividing numbers in scientific notation*

When multiplying (or dividing) numbers in scientific notation, the numbers (A) are simply multiplied (or divided) and the exponents are added simply added algebraically to give the exponent of the product for multiplication. In the case of division, the exponent of the divisor is subtracted from the exponent of the dividend to give the final exponent of the quotient.

Let's convert first 0.000130 to scientific notation:

$$\mathbf{0.000130 = 1.30 \times 10^{-4}}$$

Applying the rule to the given, $\mathbf{(7.4 \times 10^{-3})\ (1.3 \times 10^{-4})}$*, we first multiply **7.4** and **1.3** which would result to **9.62**. Next, adding the given exponents we have **-3** + **(-4)** or **-7**. The answer then would become* $\mathbf{9.62 \times 10^{-7}}$.

Now let's divide the resulting product $\mathbf{9.62 \times 10^{-7}}$ *by* $\mathbf{8.006 \times 10^{-2}}$ *(divide **9.62** by **8.006**, then subtract the given exponents **-7** and **-2**):*

$$\mathbf{9.62 \times 10^{-7} \div 8.006 \times 10^{-2} = 1.20 \times 10^{-5}}$$

Thus, the answer is **C**.

CHEMISTRY TIP:

Measurements are expressed as a number defined by an *appropriate unit*.

- ***Accuracy*** *refers to the closeness of measurements to a true value.*
- ***Precision*** *refers to agreement among measurements or consistency among measurement results.*

8. ***Given:*** *33 meters per second*
Required: *kilometers per hour*

In this type of problem, since double units are involved, then two conversion factors will be needed to solve the problem:

Relationships: ***1 km = 1000 meters***
and 1 hour = 3600 seconds

Both of these ratios can be incorporated in the solution at the same time and corresponding units are set up in a way that unwanted units will be cancelled bringing out the unit required. The solution then goes:

Thus: $33 \frac{m}{s} \times \frac{1\ km}{1000\ m} \times \frac{3600\ s}{1\ hr} =$ ***118.8 km/hr***

Rounding to 2 SF, the answer is 120 km/hr

Thus, the answer is **C**.

9. There are 30.48 cm in 1 foot. Therefore,

6 feet = 6 ft x 30.48 cm/ft = 182.88 cm = 183 cm

Thus, the answer is **D**.

10. There are 2.205 pounds in 1 kilogram. Therefore,

0.25 kg = 0.25 kg x 2.205 lb/kg = 0.55125 lb
= 0.55 lb

Thus, the answer is **C**.

11. ***1 ft = 30.48 cm***
1 in = 2.54 cm

The rest of the conversion factors are ***true***.

Thus, the answer is **A**.

12. Statements **A**, **B**, and **D** are all ***true***.
Sometimes, it is mistakenly concluded that the smallest unit of a ***compound*** is an ***atom***. But it's a ***molecule***. An ***atom*** is the smallest unit of an ***element***.

C is false because **heterogeneous mixtures** do not have uniform compositions (i.e. ***fixed mass ratios***) although they ***can be separated by physical means***.

Thus, the answer is **C**.

13. ♥ **Suspension** is a heterogeneous mixture in which the solid is large enough to settle.
♥ **Colloids** are mixtures containing particles smaller in size than those of suspensions and bigger in size than those of true solutions.
♥ **Aqueous solutions** are solutions using water as the solvent.
♥ **Brownian motion** is the chaotic movement of ***colloidal particles***.
♥ **Tyndall effect** is the effect of ***colloidal particles*** to scatter visible light in all directions.

Thus, the answer is **C**.

14. Choices **A**, **B**, and **C** only involve physical change.

Rusting of metal indicates a ***chemical change***. ***Iron rust*** is a compound of iron. It is formed when iron reacts with the oxygen of the air in the presence of moisture (water) to form a brown substance known as iron oxide. The process is a chemical reaction, which takes place over a period of time. It should be noted that oxygen and water are necessarily present for iron to rust.

Iron + oxygen + water ➔ Iron rust

Rust is scientifically called ***oxidation***, which occurs when oxygen comes in long-term contact with certain metals. Over time, the oxygen combines with the metal at an atomic level, forming a new compound called an ***oxide*** and weakening the bonds of the metal itself. If the base metal is ***iron*** or ***steel***, the resulting rust is properly called ***iron oxide***. ***Rusted aluminum*** would be called ***aluminum oxide***, **copper** forms ***copper oxide*** and so on.

Thus, the answer is **D**.

15. A ***heterogeneous mixture*** of **solid and liquid** or **solid and gas** is usually fairly easy to separate because of the 2 different physical phases. The solid may settle out, allowing you to pour off the liquid. Or the mixture can be poured through a filter, catching the solid on the filter and allowing the liquid or gas to pass through. We use **filtration** frequently--in our coffee makers, automobile fuel lines, automobile air cleaners to name only a few examples.

Thus, the answer is **D**.

16. A **solid** has a rigid shape and fixed volume (*Choice A*).

A **liquid** has a fixed volume but not rigid in shape (*Choice B*).

Solids cannot diffuse nor be compressed (*Choice C*).

Gases have neither fixed shape nor volume (*Choice D*).

Thus, the answer is **D**.

17. ***Elements*** in the periodic table can be divided into three: **metals**, **non-metals**, **metalloids/semimetals**.

Molecules are ***not*** a category of elements.

Thus, the answer is **C**.

18. **LAW OF MASS CONSERVATION**
the total mass of the universe is constant; the total mass of the reactants equals the total mass of the products

LAW OF DEFINITE COMPOSITION
elements combine in fixed mass ratios when forming compounds

LAW OF ENERGY CONSERVATION
energy cannot be created nor destroyed but conserved in a chemical reaction

LAW OF MULTIPLE PROPORTIONS
when elements combine to form different compounds, the mass of one element that combine with a fixed weight are in ratios of small whole numbers.

Thus, the answer is **D**.

CHEMISTRY TIP:

CHEMICAL CHANGE involves a *change in the chemical composition* and *intensive properties* of the substances.

Some evidences of chemical change include: ***bubble formation*** or ***gas evolution***, ***precipitate formation***, ***color change*** and ***light/heat production***.

19. ♥***Brittleness*** is that characteristic of a material that is manifested by sudden or abrupt failure without appreciable prior ductile or plastic deformation. Most pure metals are either too soft, ***brittle*** or chemically reactive for practical use.
♥ ***Ductility*** is the ability of metals to be shaped into wires.
♥ ***Luster*** is the silvery gray reflectiveness of elemental metals.
♥***Malleability*** is the ability of metals to be hammered into flat shapes.

Thus, the answer is **D**.

20. ***Condensation*** is the change from **gas to liquid**.

Melting involves a change from **solid to liquid**, ***not liquid to gas*** (which is ***evaporation***).

Evaporation is a change from liquid to gas.

Sublimation is a change from **solid to gas without passing the liquid state.**

Thus, the answer is **A**.

21. An acidic solution is any aqueous solution which has a ***pH < 7.0*** ($[H+] > 1.0 \times 10^{-7}$ M). Thus, ***A*** is **FALSE**.

Phenolphthalein ***turns white in acidic solution*** and pink in basic solution. Thus, ***B*** is ***FALSE***.

Acids in water solutions ***turn blue litmus paper red***. Thus, ***C*** is ***TRUE***.

Acids ***releases H_3O^+*** is aqueous solution. Thus, ***D*** is ***FALSE***.

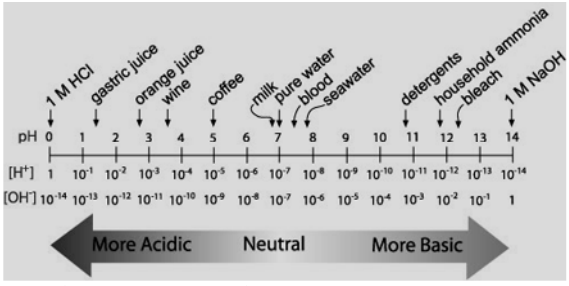


Image from http://www.mpcfaculty.net

The answer is **C**.

22. **Dalton's Atomic Theory** stated that elements consisted of tiny particles called atoms; that the atoms were tiny, indivisible, ***indestructible particles (Choice A)*** that the reason an element is pure is because all ***atoms of an element were identical (Choice B)*** and that in particular they had the same mass; that ***compounds*** have constant composition because they contain a ***fixed ratio of atoms (Choice D)***.

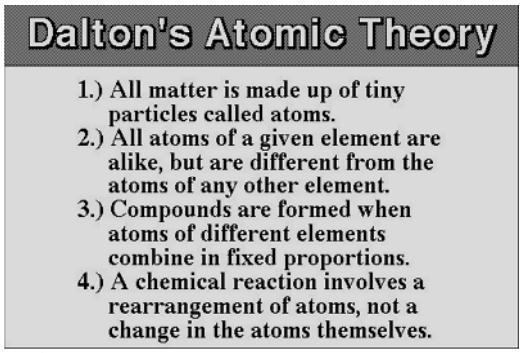
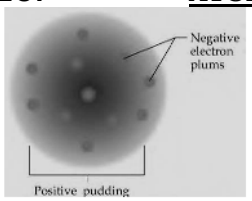


Image from http://www.hcc.mnscu.edu

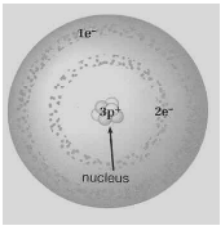
The answer is **C**.

23. **ATOMIC MODELS**



Plum Pudding Model or Raisin Bun Model proposed by J.J. Thomson

Planetary Model or Nuclear Model proposed by Ernest Rutherford



Electron Cloud Model or Quantum Mechanical Model proposed by Louis de Broglie & Erwin Schrodinger

Bohr Model or Orbit Model proposed by Neils Bohr

Solid Sphere Model or Billiard Ball Model proposed by John Dalton

Images from http://mhsweb.ci.manchester.ct.u

The answer is **A**.

24. The **atomic number** is equal to ***the number of protons*** in an atom's nucleus. The atomic number determines which element an atom is. For example, any atom that contains exactly 47 protons in its nucleus is an atom of silver.

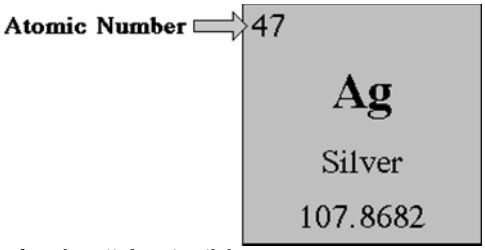


Image from http://education.jlab.org

The answer is **A**.

25.	**X**	**Y**
Ratio	4	1
If X = 20 g	**20**	**5**
If Y = 20 g	**80**	**20**

The table shows that ***20g of X*** would react with 20/4 g = ***5 g of Y*** while ***20 g of Y*** would react with 20*4 g = ***80 g of X***. Since both X and Y weighs 20 g each, X will be fully consumed while 20 – 5 = **15 g of Y** will remain unreacted.

The answer is **C**.

26. The reaction would be:

Metal chlorate → Metal Chloride +Oxygen
(20 g) (x g) (4g)

20 = **x** + **4**
x = **20** – **4** = **16 g**

% = **16**/**20** * 100 = **80%**

The answer is **D**.

27. One mole of $(NH_4)_3PO_4$ contains:

3 moles of N or 3*14 = ***42 g N***
12 moles of H or 12*1 = ***12 g H***
1 mole of P or 1*31 = ***31 g P***
4 moles of O or 4*16 = ***64 g O***

Thus, the ***formula mass*** is: 42 + 12 + 31 + 64 = **149**

The answer is **D**.

28. $^{39}_{19}K$

Atomic Mass = no. of protons + no. of neutrons

Atomic Number = no. of protons = no. of electrons (*in neutral atoms*)

No. of neutrons = Atomic Mass – Atomic Number
= 39 – 19 = **20 neutrons**

No. of Protons = Atomic Number = **19 protons**

No. of Electrons = Atomic Number = **19 electrons**

The nucleus is composed of protons and neutrons.

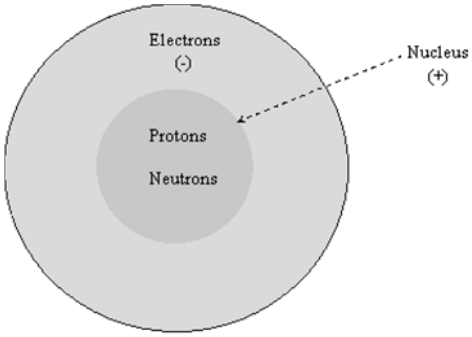


Image from http://www.chemcool.com

Thus, the answer is **D**.

29. ***Newlands*** was the first to formulate the concept of periodicity in the properties of the chemical elements. In 1863 he wrote a paper proposing the **Law of Octaves**: ***Elements exhibit similar behavior to the eighth element following it in the table***. (**A** is **FALSE**)

The elements in the periodic table are arranged in order of increasing atomic number as you go from left to right across the table. We call **the horizontal rows periods** and the **vertical rows groups**. (**B** is **FALSE**)

Atomic size generally increases as you move down a group of the periodic table and **decreases as you move from left to right across a period.** (**C** is **FALSE**)

The **halogens** are located in **Group VIIA** of the periodic table, and are a particular class of nonmetals.

The answer is **D**.

30. The ***first ionization energy*** is the energy required to remove the most loosely held electron from one mole of gaseous atoms to produce 1 mole of gaseous ions each with a charge of 1+.

In ***groups***, ***ionization energy decreases when atomic number increases*** because the added energy levels shield the power of the nuclear charge making it easier to remove outmost electrons.

In ***periods, ionization energy increase with atomic number*** because the increase in nuclear charge makes it more difficult to remove outmost electrons.

Based on the ***electron configurations***, **R** belongs to Group VIII, Period 2; **M** belongs to Group I, Period 3; and **L** belongs to Group II, Period 4. It appears that **R** has the greatest first ionization energy. **M**'s outer electron is in the third level, and is screened from the 11 protons in the nucleus by a total of 10 inner electrons. The $3s^1$ electron feels a net pull of 1+ from the center of the atom. On the other hand, **L**'s outer electron is in the fourth level, and is screened from the 20 protons in the nucleus by a total of 18 inner electrons. The $4s^2$ electron feels a net pull of 2+ from the center of the atom. Thus, **M** has a lower first ionization energy.

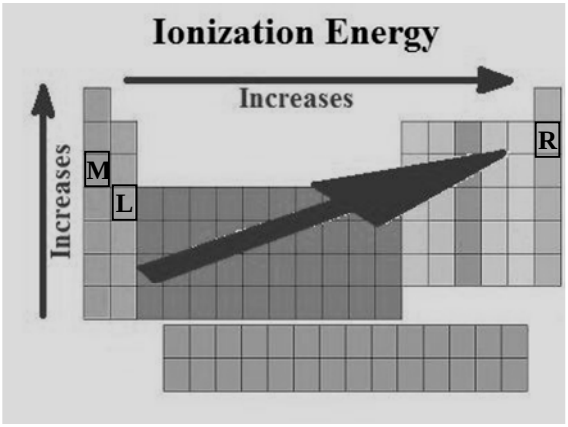


Image from http://www. ck12.org

The answer is **B**.

31. *The electron configuration of elements may be used to describe an element's location in the periodic table as follows:*

Valence shell	**(period no.)**
Valence electrons	**(group no.)**
Orbital (if ending in s or p)	**(Family A or representative elements)**
Orbital (if ending in d or f)	**(Family B or transition elements)**

$5s^2$ — valence electrons **(group no.)**

valence shell **(period no.)**

orbital type **(family A or B)**

*To locate the period where an element with a configuration of $1s^2 2s^2 2p^6 3s^2 3p^5$ belongs to, determine first the valence configuration from the given electron configuration then identify the valence shell since this indicates the period number. From the given configuration, the valence configuration is $3s^2 3p^5$. This notation indicates that the valence shell is **3**, thus equal to period 3. Therefore this element belongs to **period 3**; the orbital ends in **p** so it belongs **Family A**; the number of valence electrons is **(2 + 5) = 7**, thus equal to **group 7**.*

The answer is **D**.

CHEMISTRY TIP:

IN WRITING THE ELECTRON CONFIGURATION:

- *electrons enter lower energy orbitals first before going to a higher one following the order of increasing energy (**Aufbau Principle**)*
- *an particular orbital can only hold a maximum number of electrons*
- *electrons are written as superscripts in the sublevel notations.*

32. ***Electron configuration** describes the distribution of electrons in various shells/subshells within an atom. The following must be considered in writing the electron configuration of an element.*

- *Electrons are distributed to lower energy sublevels (orbitals) first before going to a higher one. The different sublevels in an atom are arranged in the order of increasing energy to indicate which orbital should be occupied first. The order, that is in accordance with Aufbau Principle is as follows:*

1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f 6d 7p

- *A particular sublevel or orbital can only hold a maximum number of electrons.*

ORBITAL TYPE	NO. OF TYPES	MAXIMUM ELECTRON CAPACITY
s	1	2
p	3	6
d	5	10
f	7	14

- *Number of electrons are indicated as superscripts in the sublevel notations*

*To write the **electron configuration** of an element having **22 electrons**,*

*In this case, the **22 electrons** would have to be distributed in the different subshells. Based on Aufbau, distribution starts with the lowest energy sublevel which is the 1s. Because an s-orbital can only hold up to 2 electrons the notation is written as $1s^2$. There are still 20 electrons left and the next subshell is 2s which can also hold 2 electrons. There are still 18 electrons left. They will be placed in the next sublevels (2p = 6 electrons), (3s = 2 electrons), (3p = 6 electrons), (4s = 2 electrons). After 4s, it's 3d which can accommodate a maximum of 10 electrons. But since only 2 electrons are left, only 2 electrons is placed in 3d. Distribution stops as soon as all the electrons have been accounted for. Thus the element's electron configuration is:*

$$1s^2\ 2s^2\ 2p^6 3s^2\ 3p^6 4s^2 3d^2$$

The answer is **C**.

33. In the notation **$4s^2$**, the **4 indicates the shell number**, the ***s*** is the orbital type and the superscript ***2*** indicates the no. of electrons. This notation actually means the electron is located in the ***fourth shell*** (energy level) and occupying the ***s-orbital***. Thus the symbol '**s**' is the ***orbital type*** (*letter A is **CORRECT***).

One of the four quantum numbers that characterize the electron configuration of an atom, ***the magnetic quantum number*** m_l ***labels different orbitals within a subshell***. It can take on values from -l to +l. The number of orbitals in a subshell is the same as the number of possible m values. The magnetic quantum number **describes the space orientation of an orbital** (*letter C is **CORRECT***).

An easy way to calculate the **total number of electrons that can be held by a given energy level is to use the formula $2n^2$**. For example, the fourth energy level (***n=4***) can hold $2(4)^2$ = ***32 electrons***. (*letter D is **CORRECT***).

The rules af placing electrons within shells is known as the ***Aufbau principle***. These rules are:

1. *Electrons are placed in the lowest energetically available subshell.*
2. *orbital can hold at most 2 electrons.*
3. *If two or more energetically equivalent orbitals are available (e.g., p, d etc.) then electrons should be spread out before they are paired up (**Hund's rule**).*

It is ***Pauli Exclusion Principle*** that states:

No two electrons in an atom have the same set of four quantum numbers.

The answer is **B**.

34. Since the electron configuration stopped at $4p^2$, following Aufbau's Principle below:

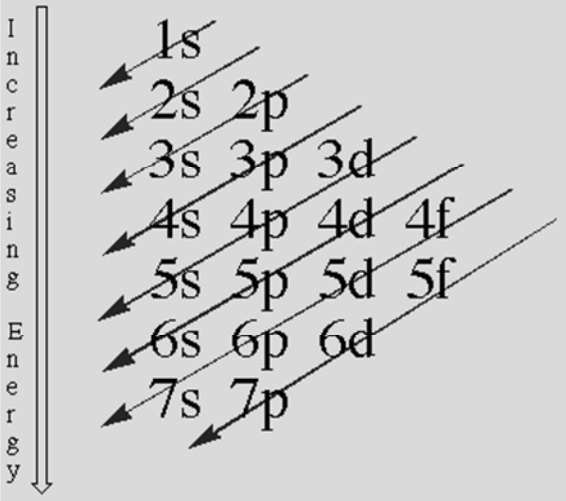


Image fromhttp://www.fordhamprep.org

the complete electron configuration of the element is:

$$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}4p^2$$

Adding the superscripts shall give us the atomic number of the element:

2 + 2 + 6 + 2 + 6 + 2 + 10 + 2 = 32

The answer is **D**.

35. There are four ***quantum numbers***: ***n***, ***l***, ***m***, and ***s***. Each one is a particular factor in an equation describing a property of the electron. The value of each quantum number is assigned to each electron in an atom by a "building up" process. Niels Bohr called this process the ***"Aufbau" principle***: aufbau means "***building up***."

n is ALWAYS the starting point for building up a series of quantum numbers. Each quantum number is then assigned according to a set of rules, each of which took years of study to finally determine. The rules ARE NOT just any old arbitrary ones; they have been determined from a study of nature.

Remember the rules:

(1) ***n*** = 1, 2, 3, and so on.
(2) ***l*** = 0, 1, 2, . . . , n-1
(3) ***m*** starts at negative 'l,' runs by whole numbers to zero and then goes to positive 'l.'
(4) after the ***n***, ***l*** and ***m*** to be used have been determined, assign the value +1/2 to one electron, then assign -1/2 to the next electron, while using the same ***n***, ***l*** and ***m*** values.

Also, keep in mind that we use only one ***n***, ***l***, ***m***, and ***s*** value each to make a set of four quantum numbers for each electron. It is the set that uniquely identifies each electron.

Nitrogen (Z = 7)

Atomic Number	Element	n	l	m	s	Orbital Name
7	Nitrogen	1	0	0	+1/2	1s
		1	0	0	-1/2	
		2	0	0	+1/2	2s
		2	0	0	-1/2	
		2	1	-1	+1/2	$2p_x$
		2	1	0	+1/2	$2p_y$
		2	**1**	**+1**	**+1/2**	**$2p_z$**

The answer is **D**.

36.

- ***John Dalton*** (1776-1844) proposed the ***Law of Multiple Proportions***. This law led directly to the proposal of the **Atomic Theory** in 1803. On the other hand, **Antoine Lavoisier** (1743-1794), the French chemist and biologist, discovered the ***Law of Conservation of Mass***, developed the metric system, and introduced a system for expressing the elements using a more rational nomenclature.

- In the mid 1600's, **Robert Boyle** studied the relationship between the **pressure *p*** and the ***volume V*** of a confined gas held at a constant temperature. Boyle observed that the product of the ***pressure*** and ***volume*** are observed to be nearly constant. The product of ***pressure*** and ***volume*** is exactly a constant for an ideal gas.

  p * V = constant

  This relationship between ***pressure*** and ***volume*** is called **Boyle's Law** in his honor.

- In 1932, **James Chadwick** proved that the atomic nucleus contained a neutral particle which had been proposed more than a decade earlier by ***Ernest Rutherford***. This particle became known as **neutron** and revolutionized the study of radioactive elements.

- **Dmitri Mendeleev** is best known for his work on the **periodic table**; arranging the ***63*** known elements into a ***Periodic Table*** based on atomic mass, which he published in ***Principles of Chemistry*** in 1869.

The answer is **A**.

37. **Basic Type of Chemical Reactions**

- ***Decomposition*** - a single compound breaks down into its component parts or simpler compounds
  Example:
  metallic carbonate, when heated, form metallic oxides and carbon dioxide gas

  $CaCO_3$ (s) → CaO (s) + CO_2 (g)

- ***Redox reactions*** - reactions in which changes in oxidation numbers of atoms in involved species occur. Those reactions can often be interpreted as transfer of electrons between different molecular sites or species.
  Example:
  the iron changes oxidation numbers from 0 to +3 and oxygen changes from 0 to -2.

  4 Fe (s) + 3 O_2 (g) → 2 Fe_2O_3 (s)

- **Replacement** – a more active element takes the place of another element in a compound and sets the less active one free
  Example:
  replacement of a metal in a compound by a more active metal

  Fe (s) + $CuSO_4$ (aq) → $FeSO_4$ (aq) + Cu (s)

- ***Synthesis*** (***composition***) - two or more elements or compounds may combine to form a more complex compound
  Examples:
  metal + oxygen → metal oxide

  2 Mg (s) + O2 (g) → 2 MgO (s)

The answer is **C**.

38. An ***endothermic reaction*** is any chemical reaction that absorbs heat from its environment.

*Examples of **endothermic or heat-absorbing processes**:*

- melting ice cubes
- melting solid salts
- **evaporating liquid water**
- converting frost to water vapor (melting, boiling, and evaporation in general are endothermic processes)
- making an anhydrous salt from a hydrate
- forming a cation from an atom in the gas phase

Many chemical reactions release energy in the form of heat, light, or sound. These are ***exothermic reactions***.

- The ***bond forming process*** is always ***exothermic***. If two atoms can release energy by forming a bond, then the atoms will be more stable by staying together than they would be as individual atoms. As a result, the atoms remain in the bonded condition. If two atoms gain energy in an attempt to form a bond, then the bond will NOT form. They need the benefit derived from a reduction of energy, not a gain of energy.
- ***Condensation*** of rain from water vapor is another example of an ***exothermic process***.
- Making ice cubes or ***freezing*** is also ***exothermic***.

The answer is **B**.

39.

- The ***flame test*** is used to visually determine the identity of an unknown metal or metalloid ion based on the characteristic color the salt turns the flame of a bunsen burner.
- The ***Iodine test*** is used to test for the presence of Starch. Iodine solution — iodine dissolved in an aqueous solution of potassium iodide — reacts with starch producing a blue black color.
- ***Litmus paper test*** is one of the most widely used ways to test the acidity or alkalinity of a solution. It is also one of the oldest ways to test for those properties, having been used for that purpose of several centuries.
- **Splinter test used to identify the type of gas evolved during a chemical reaction.** *By bringing a burning splinter near the mouth of the gas jar filled with the gas, if the gas burns with a flame, it is combustible.*

The answer is **D**.

40.

- ***Specific heat*** refers to the amount of heat required to raise the temperature of one gram of a substance by 1 °C. (**CORRECT**)
- ***Boiling*** is the temperature at which the vapor pressure of a liquid equals the pressure applied on the liquid. (**INCORRECT**). It should be ***Boiling point*** not just ***Boiling***.
- ***Critical temperature*** is the highest temperature above which gases cannot be liquefied no matter how much pressure is applied. (**CORRECT**)
- ***Le Chatelier's principle*** states that when a system at equilibrium is disturbed, the system will respond in order to relieve the disturbance. (**CORRECT**)

The answer is **B**.

41.

- **Sulfurous acid** is the chemical compound with the formula $\mathbf{H_2SO_3}$. ***Sulfuric acid*** is a strong mineral acid with the molecular formula $\boldsymbol{H_2SO_4}$.
- $\boldsymbol{K_2Cr_2O_7}$ is NOT ***dipotassium chromate*** BUT ***potassium dichromate***.
- $\boldsymbol{Fe_2O_3}$ is NOT ***ferrous oxide*** BUT ***ferric oxide***. The chemical formula for ***ferrous oxide*** is ***FeO***.
- $\boldsymbol{CCl_4}$ is NOT ***carbon chloride*** BUT ***carbon tetrachloride***.

The answer is **A**.

42. We can find the answer by ***Working Backwards*** and by ***Inspection***:

A. ***1 2 2 1*** → This is ***NOT*** correct since there would be ***4 moles of O*** in the ***reactant side*** and ***5 moles of O*** in the ***product side***.

B. ***1 2 1 1*** → This is ***NOT*** correct since there would be ***2 moles of C*** in the ***reactant side*** and only ***1 mole of C*** in the ***product side.***

C. **2 5 4 2** → This is the correct set of coefficients since there would be ***4 moles of C, 4 moles of H, and 10 moles of O*** in each of the reactant and product sides.

D. ***3 2 2 1*** → This is ***NOT*** correct since there would be ***6 moles of C*** in the ***reactant side*** and only ***2 moles of C*** in the ***product side***.

The answer is **C**.

43. ***Calcium ion*** is $\mathbf{Ca^{2+}}$.
Chlorite ion is $\mathbf{ClO_2^-}$.
Dichromate ion is $\mathbf{Cr_2O_7^{2-}}$. It's **chromate ion** that is $\boldsymbol{CrO_4^{2-}}$.
Plumbic ion is Pb^{4+}.

The answer is **C**.

44. By ***inspection*** every reaction in the choices are balanced **EXCEPT**

$$\mathbf{PbS + 3\ H_2O_2 \rightarrow PbSO_4 + 3\ H_2O}$$

It appears that there are only ***6 moles of O*** in the ***reactant side***, while there are ***7 moles of O*** in the ***product side***. The **CORRECT** balanced equation is:

$$\boldsymbol{PbS + 4\ H_2O_2 \rightarrow PbSO_4 + 4\ H_2O}$$

The answer is **C**.

45. Assume there are ***100 g*** of the compound.
Thus,
mass N = 64 g
mass O = 100 – 64 = 36 g
Computing for the number of moles of each element:
mole N = (64 g) ÷ (14 g/mol) = 4.57 mol
mole O = (36 g) ÷ (16 g/mol) = 2.25 mol
Thus, the mole ratio of ***N : O*** = ***4.57 : 2.25*** or approximately ***2 : 1***.

The ***empirical formula*** must be $\mathbf{N_2O}$.

The answer is **C**.

46. ***Potassium dichromate*** is an ***oxidant*** (oxidizing agent). The ***reduction half-equation*** is:

$$Cr_2O_7^{2-}(aq) + 14H^+ + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O$$

Chromium has a charge of (2)(3+) = **6+**.

The answer is **C**.

47. ***Chloric acid is $HClO_3$.***

Chlorous acid is $HClO_2$.

Hypochorous acid is HClO.

Perchloric acid is $HCLO_4$.

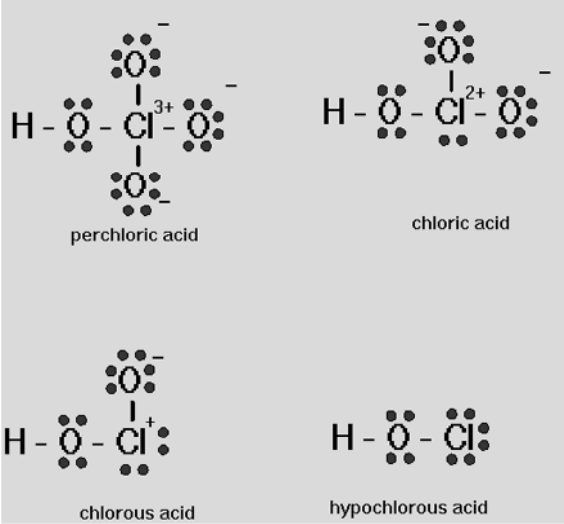


Image from http://bouman.chem.georgetown.edu

The answer is **C**.

48. ***$Mg(OH)_2$ is milk of magnesia.***

NH_3 is NOT methane gas. NH_3 is ammonis. Methane gas is CH_4.

$CaCO_3$ is present in limestone.

$CO_{2(s)}$ is also known as dry ice.

The answer is **B**.

CHEMISTRY TIP:

Calculations involving **stoichiometric relationships** apply the *mole concept* as well as understanding of a *balanced chemical equation*.

49. **REDUCING AGENT:**

- *causes reduction*
- *loses one or more electrons*
- *undergoes oxidation*
- *oxidation number of atom increases*

OXIDIZING AGENT:

- *causes oxidation*
- *gains one or more electrons*
- *undergoes reduction*
- *oxidation number of atom decreases*

Metals like ***Ca*** easily ***lose electrons***. They get ***oxidized*** and thus, they are ***reducing agents***. ***Nonmetals*** like $\mathbf{H_2}$ easily ***gain electrons***. They get ***reduced*** and thus they are **oxidizing agents**.

The answer is **C**.

50. Assume ***one mole of the compound***.

mass compound = 1 mol * (58 g/mol) = 58 g
mass P = 58 g * 0.172 = 9.976 g or 10 g
mass U = 58 g – 10 g = 48 g
mole P = 10 g ÷ (1 g/mol) = 10 mol
mole U = 48 ÷ (12 g/mol) = 4 mol

Thus the ***actual formula*** of the compound is $\mathbf{U_4P_{10}}$.

The answer is **D**.

51. The given is expressed in grams and the required quantity is atoms. The unit 'atoms' indicates that the ***Avogadro's no.*** will be used to facilitate the conversion. While the two units seem to be not directly connected with each other, both are actually linked with the mole through the following relationships:

1 mole Al = 27 g
1 mole Al = 6.02×10^{23} atoms Al

We convert the gram amount to moles then the answer is converted to number of atoms. The step-by-step solution then is

$$25\ g\ Al \times \frac{1\ mole\ Al}{27\ g\ Al} = 0.93\ mol$$

$$0.93\ mol\ Al \times 6.02 \times 10^{23}\ atoms/mol$$

$$= \mathbf{5.6 \times 10^{23}\ atoms}$$

The answer is **D**.

52. This problem involves computing the amount of an element from the given amount of compound. General strategy would be to first express the given amount in moles and be able to convert it to the required unit using the mole relationships. In this case, the mole ratio is obtained from the subscripts in the chemical formula. For instance, this problem requires the amount of sodium from the given amount of sodium hydroxide. The mole ratio needed for the conversion is taken from the subscripts in the chemical formula of ***NaOH*** since sodium (***Na***) is a component of sodium hydroxide (***NaOH***). The ***NaOH*** formula indicates that in one (1) mole of ***NaOH***, there is one mole of ***Na***. Thus the mole ratio of ***NaOH*** to ***Na*** is ***1:1***. Incorporating it in the solution,

$$35g\ NaOH\ x\ \frac{1\ mol\ NaOH}{40\ g\ NaOH}\ x\ \frac{1\ mol\ Na}{1\ mol\ NaOH}\ x\ \frac{23\ g\ Na}{1\ mol}$$

Molar masses of both NaOH (**40 g/mol**) and Na (**23 g/mol**) have been provided to facilitate the conversion. The correct answer is **20 g Na.**

The answer is **B**.

53. This problem involves the concept of molar volume as an important constant to facilitate the conversion. ***Molar volume*** is actually the volume occupied by one (1) mole of any gas at standard condition (***STP- 0 ^{0}C and 1 atm (760 torr)),*** which is equal to **22.4 Liters.** The given substance, $\mathbf{CH_4}$ is a gas and the condition is at standard conditions, the required unit liters may be obtained using the **22.4 L** constant. Using the relationship ***1 mole CH_4 = 22.4 L*** and applying dimensional analysis the solution would be:

$$\boldsymbol{V} = 40\ g \times \frac{1\ mol}{16\ g} \times \frac{22.4\ Li}{1\ mol} = \mathbf{56\ Li}$$

The answer is **C**.

54. From the given balanced equation, ***1 mole of ammonium nitrate*** produces ***2 moles of water***. So the conversion will be as follows:

mass ammonium nitrate → mole ammonium nitrate → mole water

$$mol\ H_2O = 100\ g\ NH_4NO_3 \times \frac{1\ mol}{80\ g} \times \frac{2\ mol\ H_2O}{1\ mol\ NH_4NO_3}$$

$$= \mathbf{2.50\ mol\ H_2O}$$

The answer is **B**.

55. From the given balanced equation, ***4 moles of NH_3*** produces ***4 moles of NO***. So the conversion will be as follows:

mass NO → mole NO → mole NH_3 → mass NH_3

$$\boldsymbol{mass\ NH_3} = 50\ g\ NO \times \frac{1\ mol}{30\ g} \times \frac{4\ mol\ NO}{4\ mol\ NH_3} \times \frac{17\ g\ NH_3}{1\ mol\ NH_3}$$

$$= \mathbf{28\ g\ NH_3}$$

The answer is **C**.

56. From the given balanced equation, ***5 moles of O_2*** produces ***6 moles of H_2O***. So the conversion will be as follows:

mole O_2 → mole H_2O → molecules H_2O

$$\boldsymbol{molecules\ H_2O} = 10\ mol\ O_2 \times \frac{6\ mol\ H_2O}{5\ mol\ O_2} \times \frac{6.02 \times 10^{23}}{1\ mol\ H_2O}$$

$$= \mathbf{7.22 \times 10^{24}\ molecules}$$

The answer is **D**.

57. Again, ***5 moles of O_2*** produces ***6 moles of H_2O***. So the conversion will be as follows:

mole H_2O → mole O_2

$$\boldsymbol{mol\ O_2} = 18\ mol\ H_2O \times \frac{5\ mol\ O_2}{6\ mol\ H_2O} = \mathbf{15\ mol\ O_2}$$

The answer is **A**.

58. ***LIMITING REACTANT OR REAGENT*** *is the substance that limits the amount of products that can be formed. It is the substance which determines the amount of product and is always used up in the reaction.*

EXCESS REACTANT OR REAGENT *is the reagent that is more than enough to react with a limiting reactant or reagent.*

Given in the problem are 10 moles of NH_3 and 10 moles O_2 and what is asked is which substance is the **limiting reactant**. It is clear from the balanced equation that for every 4 moles of NH_3, 5 moles of O_2 will react.

Thus, for ***10 moles of NH_3***: $$\boldsymbol{mol\ O_2} = 10\ mol\ NH_3 \times \frac{5\ mol\ O_2}{4\ mol\ NH_3} = \mathbf{12.5\ mol\ O_2}$$

and for ***10 moles of O_2***: $$\boldsymbol{mol\ NH_3} = 10\ mol\ O_2 \times \frac{4\ mol\ NH_3}{5\ mol\ O_2} = \mathbf{8\ mol\ O_2}$$

The results of the computations reveal that ***10 moles of NH_3 need 12.5 moles of O_2.*** And ***10 moles of O_2 need only 8 moles of NH_3.*** Thus, **the limiting reactant is O_2** while ***the excess reactant is NH_3.***

The answer is **D**.

59. We need first to know which between the reactants is the limiting reagent. In the balanced equation, 1 mole of C_3H_8 will react with 5 moles of O_2.

Now given 15 g C_3H_8, let's compute the mass of O_2 that would react completely with the given mass of C_3H_8:

$$\boldsymbol{mass\ O_2} = 15\ g\ C_3H_8 \times \frac{1\ mol}{44\ g} \times \frac{5\ mol\ O_2}{1\ mol\ C_3H_8} \times \frac{32\ g\ O_2}{1\ mol\ O_2} = \textbf{55 g (too large, thus } \boldsymbol{O_2} \textbf{ is the limiting reagent)}$$

So that means all the 10 g of O_2 shall react. So, we can now solve for the mass of CO_2 formed:

$$\boldsymbol{mass\ CO_2} = 10\ g\ O_2 \times \frac{1\ mol}{32\ g} \times \frac{3\ mol\ CO_2}{5\ mol\ O_2} \times \frac{44\ g\ CO_2}{1\ mol\ CO_2}$$

mass CO_2 = 8 g

The answer is **B**.

60. ***THEORETICAL YIELD*** *the calculated amount of product using the balanced chemical equation.*
ACTUAL YIELD *the actual amount of product obtained.*

The actual yield is usually lesser in amount than the theoretical yield. It is always provided in the problem.

The percent yield of the reaction is thus expressed as

$$\boldsymbol{Percent\ Yield} = \frac{\boldsymbol{Actual\ Yield}}{\boldsymbol{Theoretical\ Yield}} \times \mathbf{100}$$

Given ***9 moles of Cl_2***, based on the balanced chemical equation, the ***theoretical yield*** should be:

$$\boldsymbol{mol\ HCl} = \mathbf{9\ mol\ Cl_2} \times \frac{\mathbf{2\ mol\ HCl}}{\mathbf{1\ mol\ Cl_2}} = \mathbf{18\ mol}$$

Since the ***actual yield is 15 mol***,

$$\boldsymbol{Percent\ Yield} = \frac{\mathbf{15\ mol}}{\mathbf{18\ mol}} \times \mathbf{100} = \mathbf{83\%}$$

The answer is **D**.

61. The properties of a gas may be described using the following variables: ***volume***, ***temperature***, ***pressure*** and ***amount in terms of no. of moles***. Relating any of these variables with another comprise what is known as the ***gas laws***. The following are the different gas laws:

- ***BOYLE'S LAW*** *states that for any given mass of gas, the volume varies inversely with pressure at constant temperature. The law is also expressed as* $PV = k = constant$ *and the general formula is*
$$P_1V_1 = P_2V_2.$$
- ***CHARLES' LAW*** *states that for any given mass of gas, the volume varies directly with the absolute temperature, as pressure remains constant. It is expressed mathematically as* $V = kT$ *and its general formula is*
$$V_1T_2 = V_2T_1.$$
- ***GAY-LUSSAC'S LAW*** *at constant volume, the pressure and absolute temperature of a gas vary directly. Mathematically, it is expressed as* $P = kT$ *and its general formula is* $P_1T_2 = P_2T_1.$
- ***COMBINED GAS LAW*** *For a given mass of gas the product of the pressure and volume divided by its absolute temperature is a constant. This can be expressed as* $PV / T = k$
The general formula for this law is
$$P_1V_1\,T_2 = P_2V_2\,T_1$$
- ***AVOGADRO'S LAW*** *states that equal volumes of all gases at the same temperature and pressure contain the same number of moles (molecules), n. This is expressed mathematically as* $V = kn$
- ***IDEAL GAS EQUATION*** *describes the relationship between pressure (P), volume (V), number of moles (n) and absolute temperature (T_K) for an ideal gas. It is Boyle's Law, Charles' Law, and Avogadro's Law combined into one mathematical statement*
$$V \alpha \frac{nT}{P}$$

The answer is **A**.

62. Using ***IDEAL GAS EQUATION***

For a given mass of gas the product of the pressure and volume divided by its absolute temperature is a constant. This can be expressed as $PV / T = k$ ***or*** $P_1V_1\,T_2 = P_2V_2\,T_1$

If $P_2 = P_1/3$ and $T_2 = 5T_1$, then

$$P_1V_1\,(5T_1) = (P_1/3)V_2\,T_1$$

Solving for V_2 (after cancelling P_1 and T_1):

$$V_2 = (5)(3)V_1 = 15V_1 = \mathbf{15(30) = 450\ mL}$$

The answer is **D**.

63. Using ***BOYLE'S LAW*** *(for any given mass of gas, the volume varies inversely with pressure at constant temperature. The law is also expressed as* $PV = k = constant)$ $P_1V_1 = P_2V_2.$

Solving for P_2,

$$P_2 = P_1V_1/V_2 = (725)(5)/9 = \mathbf{403\ torr}$$

The answer is **C**.

64. Using ***CHARLES' LAW*** *(for any given mass of gas, the volume varies directly with the absolute temperature, as pressure remains constant. It is expressed mathematically as* $V = kT)$ $V_1T_2 = V_2T_1.$

Solving for V_2, $V_2 = V_1T_2/T_1$
Now, T_1 and T_2 must be in ***Kelvin scale***:
$T_1 = 35℃ + 273 = 308\ K$
$T_2 = 2(35℃) + 273 = 70℃ + 273 = 343\ K$
Thus, $V_2 = (3)(343)/308 = \mathbf{3.3\ L = 3{,}300\ mL}$

The answer is **D**.

65. Using ***GAY-LUSSAC'S LAW*** *(at constant volume, the pressure and absolute temperature of a gas vary directly. Mathematically, it is expressed as* $P = kT)$ $P_1T_2 = P_2T_1.$

Since $P_2 = 3P_1$, $P_1T_2 = 3P_1T_1.$
Solving for T_2, $T_2 = 3T_1$

T_1 must be in ***Kelvin scale***: $T_1 = 50℃ + 273 = 323\ K$
$T_2 = 3(323) = 969$
In ***Celcius scale***, $\mathbf{T_2 = 969 - 273 = 696°C}$

The answer is **C**.

66. Using ***IDEAL GAS EQUATION***

$$PV = nRT$$

Solving for V, $V = nRT/P$

$n = 0.012\ mol$
$T = 30℃ = 303\ K$
$P = 2\ atm$
$R = 0.0821\ atm\text{-}L/mol\text{-}K$

$V = (0.012)(0.0821)(303)/2 =$ **0.149 L or 149 mL**

The answer is **D**.

67. Using ***Dalton's Law of Partial Pressures***

For a mixture of gases in a container,

$$P_{Total} = P_1 + P_2 + P_3 + \ldots$$

P_1 represents the "***partial pressure***", or the contribution by that gas.

Since CO_2 is ***20% by volume*** and the ***total pressure*** is ***1 atm***,

$P(CO_2)$ = 1 atm x 760 torr x 20% = 152 torr

The answer is **B**.

CHEMISTRY TIP:

Tips for solving problems:

- When given the density of a gas, assume a volume of 1 Liter.
- When given the molar mass of a gas, assume there is 1 mole of gas present.
- When doing stoichiometry problems, remember that the ideal gas law applies ONLY to gases. Don't attempt to calculate the number of moles of a solid or liquid using PV=nRT!.

68. The ***ideal gas equation*** can also be applied to compute the ***molecular weight*** of a gas sample. From the ***ideal gas equation*** (***PV = nRT***), the ***n*** (*moles*) can be computed. Once the ***no. of moles*** is determined, the ***molar mass*** is then computed using the formula ***molar mass = mass/mole***

This problem involves calculating the ***molar mass*** of a ***0.58 g*** sample of gas in a ***250 mL*** container at ***24^0C*** and ***743 mm Hg***.

(computation of the no. of moles) $n = PV/RT$
$P = 743\ mm\ Hg = 0.98\ atm$
$V = 250\ mL = 0.25\ L$
$T = 24℃ = 297\ K$
$R = 0.0821\ atm\text{-}L/mol\text{-}K$

substituting the values
$n = (0.98)(0.25)/(0.0821)(297) = 0.01\ mol$

(computation of molar mass)
$Molar\ mass = mass / mole$
Molar mass = 0.58/ 0.01 = 58 g/mol

The answer is **B**.

69. **GRAHAM'S LAW OF EFFUSION (DIFFUSION)**

at constant conditions of temperature and pressure, the rate of Effusion (diffusion) of a gas is inversely proportional to the square root of its density/mass. Thus if two different gases are present and under identical conditions then,

$$\frac{rate\ of\ gas_1}{rate\ of\ gas_2} = \sqrt{\frac{density\ of\ gas_2}{density\ of\ gas_1}} = \sqrt{\frac{M_2}{M_1}}$$

where M_1 = *mass or molecular weight of gas 1*
M_2 = *mass or molecular weight of gas 2*

Diffusion refers to the ability of gas particles to spread out spontaneously while ***effusion*** is the passage of a gas through a small opening into a vacuum. ***Graham's Law*** therefore implies that ***the lighter the gas (lower molecular weight) the faster is the diffusion.*** To solve this particular problem, the Graham's law formula is applied. Since the gases being compared are HCl and NH_3, their molar masses are incorporated in the formula as follows:

$$\frac{rate\ of\ HCl}{rate\ of\ NH_3} = \sqrt{\frac{17}{36}} \approx \frac{\mathbf{1}}{\mathbf{1.5}}$$

The answer is **B**.

70. Except for **choice letter C** which is ***Graham's Law of Diffusion***, every statement is a postulate in the ***Kinetic Molecular Theory of Gases***.

The answer is **C**.

71. ***Solutions*** are ***homogenous mixtures*** composed of a ***solute*** and ***solvent***. The **proportion of components within a solution may vary** and since substances in a solution are physically combined, then the ***component substances are also physically separated***. The parts of a solution are as follows:

- ***Solute is also known as the dissolved substance which is usually present in lesser amount.***
- ***Solvent is the dissolving medium which is present in larger amount.***

The answer is **C**.

72. The ***molarity*** (***M***) of a solution is calculated by ***dividing*** the ***moles of solute*** by ***the volume of solution*** expressed in ***Liters***. In the problem, the ***solute*** (***HNO_3***) is expressed in ***% by mass*** and must first be converted to ***grams*** then to ***moles***. Similarly, the ***volume of solution*** in ***Li*** must first be derived from the ***solution density***.

Solution:

$$M = \frac{moles\ HNO_3}{Li\ HNO_3\ solution}$$

Assume ***volume*** of HNO_3 solution = ***1 Li***

Thus, ***mass*** of HNO_3 solution = ***1.42 kg***.

mass of solute HNO_3=1.42 kg x0.69=0.9798 kg or ***979.8 g***

$$moles\ HNO_3 = 979.8g \times \frac{1\ mole}{63\ g} = \mathbf{15.6\ moles}$$

$$M = \frac{15.6\ mol\ HNO_3}{1\ Li\ HNO_3\ solution} = \mathbf{15.6\ M}$$

The answer is **D**.

73. ***Dilution*** involves the addition of solvent to lessen the concentration of a solution. Most solutions prepared in the laboratory are expressed in ***molar concentration*** or ***molarity***. Since the process of dilution involves lessening concentration, it means that two concentrations are involved – the ***initial*** (*more concentrated*) and the ***final concentration*** (*dilute*). In molarity they are expressed as ***M_1*** (***initial concentration***) and ***M_2*** (***dilute solution***).

Dilution only involves ***addition of solvent***, therefore the ***solute amount*** (in ***moles***, ***n***) in both initial and final (*dilute*) concentrations ***remain constant*** or stated in another way ***$n_1 = n_2$***.

If n_{solute} = M V (in liters) (*molarity formula*)
and $n_1 = n_2$ (*during dilution*)

substituting $M_1V_1 = M_2V_2$
(***DILUTION FORMULA***)

where ***M_1*** = ***higher molar concentration***
M_2 = ***lower (dilute concentration)***
V_1 = ***volume of initial concentration***
V_2 = ***volume of dilute concentration***

Analyzing the data in the problem,

Given: 6 M HCl (***M_1***)
500 mL of 1 M HCl
(***V_2***) (***M_2***)

Unknown: ***V1***

$$V_1 = \frac{M_2V_2}{M_1} = \frac{(1\ M)(500\ mL)}{6\ M} = \mathbf{83\ mL}$$

The answer is **A**.

74. ***B is FALSE*** since dilution is a process of adding more ***solvent*** (*not solute*) to lessen concentration.

C is FALSE because aqueous solutions are solutions dissolved in water, *not in alcohol.*

D is FALSE since it is ***solubility***, *not concentration*, that refers to the amount of solute that dissolve in a given amount of solvent at a specific temperature.

The **ONLY TRUE** statement is the **first one**.

The answer is **A**.

75. The ***mole fraction*** of a solution is actually the ***ratio of the mole of the solute or solvent and the mole of solution***. It is computed by dividing the moles of the solute or solvent by the mole of the solution. The mole of the solution is the sum of the moles of the solute and solvent. In this particular problem, both the solute and solvent are expressed in grams and has to be converted to moles. And since the problem requires only the mole fraction of the solute, the formula would include only the mole of solute divided by the mole of the solution.

$$mole\ solute\ (CH_3OH) = 1.2\ g \times \frac{1\ mol}{32\ g}$$
$$= 0.0375\ mol$$

$$mole\ solvent\ (H_2O) = 16.8\ g \times \frac{1\ mol}{18\ g}$$
$$= 0.9333\ mol$$

$mole\ solution =$
$mole\ solute + mole\ solvent = 0.0375\ \text{mol} + 0.9333\ \text{mol} = 0.9708\ \text{mol}$

$$mole\ fraction = \frac{moles\ CH_3OH}{moles\ solution} = \frac{0.0375}{0.9708}$$
$$\approx \mathbf{0.04}$$

The answer is **A**.

76. An ***alloy*** is a ***homogeneous mixture or solid solution of two or more metals***. ***Amalgam*** is an ***alloy*** of ***mercury*** and ***silver*** used in ***dental fillings***.

Brine is a ***solution*** of ***salt and liquid*** with an extremely high salinity content.

An **emulsion** is a ***suspension of small globules of one liquid in a second liquid*** with which the first will not mix.

The answer is **D**.

CHEMISTRY TIP:

Molarity is the *most common concentration* used in laboratories. And since the process of **dilution** involves *lessening concentration*, it follows that two concentrations are involved – the **initial** (*more concentrated*) and the **final concentration** (*dilute*).

77. ***Molal concentration*** or ***molality*** is the concentration expressed in ***moles solute per kilogram of the solvent***. To find the ***molality*** of a certain solution, ***moles of solute is divided by the mass of the solvent in kilograms***. In this particular problem, the ***solute*** which is NH_3 is expressed in ***% mass*** and thus needs to be converted first to ***grams*** then to ***moles*** before computing the ***molality***. In the case of H_2O which is expressed in ***% mass***, the ***% mass*** is converted to ***grams*** (or ***kilograms***). Let there be ***100 g*** of the ***solution***. Thus,

$mole\ solute(NH_3) = 100g \times 0.33 \times \frac{1\ mol}{17\ g} = 1.94\ mol$

$$kg\ solvent(H_2O) = 100g \times 0.67 \times \frac{1\ kg}{1000\ g}$$
$$= 0.067kg$$

$$molality = \frac{moles\ solute}{kg\ solvent} = \frac{1.94\ mol}{0.067\ kg} = \mathbf{29.0}$$

The answer is **B**.

78. $\%\ mass = \frac{mass\ solute}{mass\ solution} \times 100$

$$mass\ solute = \frac{\%\ mass}{100} \times mass\ solution$$

$$mass\ solute = \frac{20}{100} \times 200\ g = \mathbf{40\ g}$$

The answer is **B**.

79. **Electrolytes** are ***solutions which produce ions in solution***.

The answer is **B**.

80. $\%\ volume = \frac{volume\ solute}{volume\ solution} \times 100$

$$\%\ volume = \frac{35\ mL}{35\ mL + 80\ mL} \times 100$$

$$\%\ volume = \frac{35\ mL}{115\ mL} \times 100 = \mathbf{30}\%$$

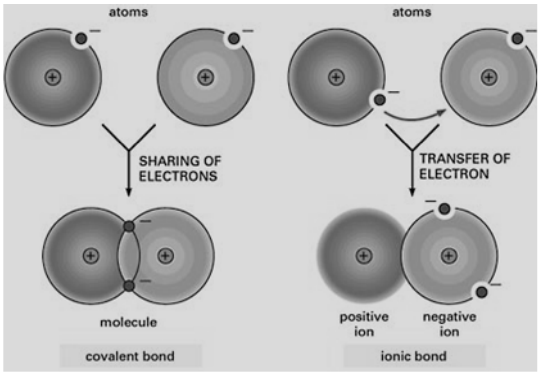
The answer is **A**.

81. **COVALENT BOND**

- *bond formed between* ***two non-metals***
- *involves* ***sharing of electrons***
- *leads to the* ***formation of a molecule***
- *common examples of molecules are water (**H_2O**), methane (**CH_4**), ammonia (**NH_3**), carbon dioxide (**CO_2**)*

IONIC BOND

- *also referred to as* ***electrovalent bond***
- *bond formed between* ***a metal and a non-metal***
- *involves* ***complete transfer of electrons***
- *leads to the* ***formation of an ionic compound/salt***
- *common example*: **NaCl**



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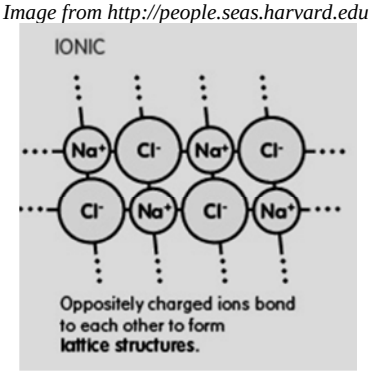


The answer is **C**.

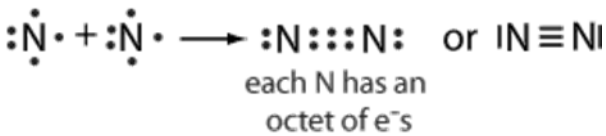
82. **Types of Solids**

Solids may be classified into ***four types*** depending upon the ***nature of bonds*** present in them.

- ***Molecular*** - the constituent particles are ***molecules***. These molecules are held together by weak forces known as ***Van der Waal's forces***. Common examples are ***dry ice***, ***wax***, ***iodine***, ***sulphur***, etc.
- ***Ionic*** - consist of positively and negatively charged ***ions*** arranged in a regular fashion throughout the solid. They form a network of positive and nagative ions in three dimension in such a way that cations and anions occupy alternate sites. These are held together by ***strong electrostatic forces***. Common examples of ionic solids are, ***salts*** like ***NaCl***, ***KNO_3***, ***LiF*** etc.
- ***Network*** - the constituent particles are atoms of the same or different kind, which are bonded to one another by a network of ***covalent bonds***. The common examples of network solids are ***diamond***, ***carborundum*** (***silicon carbide***), ***quartz*** (***SiO_2***) etc.
- ***Metallic*** - the constituent particles are positive kernels i.e., nuclei where inner electrons are dispersed in a sea of mobile valence electrons. The forces present between the constituents are metallic bonds.The examples of metallic solids are common metals such as nickel, copper and alloys.

The answer is **C**.

83. For ***diatomic nitrogen***, the ***Lewis-dot structure*** correctly predicts that there will be a **triple bond** between nitrogen atoms:



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The answer is **B**.

84. ***Choices A, C, and D*** have been mentioned in the previous items as ***characteristics of an ionic bond***. It is the ***covelent bond*** that leads to the **formation of a molecule**.

The answer is **B**.

85. **POLAR COVALENT** formed between two (2) ***different non-metals or elements*** with ***different electronegativity values***; involves ***unequal sharing*** between two dissimilar atoms as in the case of ***N*** and ***H*** in ***ammonia*** (**NH_3**).

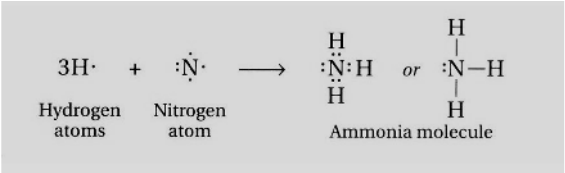


Image from http://www.gunthersclass.com

The answer is **A**.

86. **VSEPR (VALENCE SHELL ELECTRON PAIR REPULSION) THEORY** states that molecular shape is influenced by the tendency of electron pairs surrounding the central atom to minimize their mutual repulsion. This means that electron pairs try to attain maximum distance of separation in order to avoid repulsion. The farther apart are the electron pairs, the lesser is the repulsion. The shapes and corresponding angles for general types of molecules are as follows:

TYPE OF MOLECULE	SHAPE and BOND ANGLE	COMMON EXAMPLES
YZ/YZ_2	**LINEAR, 180^0**	CO_2, HCl
YZ_3	TRIGONAL PLANAR, 120^0	BF_3
YZ_4	**TETRAHEDRAL, 109.5^0**	CH_4
YZ_5	TRIGONAL BIPYRAMIDAL, 180^0, 120^0, & 90^0	PCl_5
YZ_6	OCTAHEDRAL, 90^0	SF_6
YZ_2E_2	ANGULAR / **BENT, 104.5^0**	H_2O
YZ_3E	**PYRAMIDAL, 107^0**	NH_3

The answer is **C**.

87. The ***hydrogen bond*** is really a special case of ***dipole forces.*** A ***hydrogen bond*** is the attractive force ***between the hydrogen attached to an electronegative atom of one molecule and an electronegative atom of a different molecule***. Usually the electronegative atom is ***oxygen***, ***nitrogen***, or ***fluorine***, which has a ***partial negative charge.*** The ***hydrogen*** then has the ***partial positive charge***. The **polarity of the water molecule** with the attraction of the positive and negative partial charges is the **basis for the hydrogen bonding**.Some combinations which are not hydrogen bonds include: ***hydrogen to another hydrogen*** or ***hydrogen to a carbon***.

The answer is **D**.

88. The only ***TRUE*** statement among the choices is **B**. **London forces**, named after the German physicist ***Fritz London***, are ***weak intermolecular forces*** that arise from the attractive force between transient dipoles in otherwise nonpolar molecules**. London forces** are also called **London dispersion forces**.

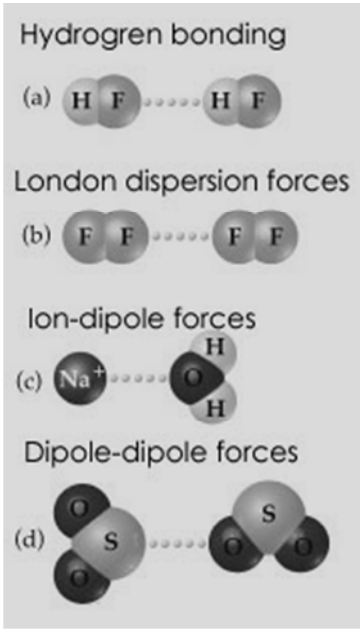


Image from http://i41.tinypic.com

The answer is **B**.

CHEMISTRY TIP:

OCTET RULE is the tendency of atoms to have *eight (8) valence electrons* to become stable.

89. ***Gases are diatomic*** when it is energetically favorable for individual atoms of the gas to chemically bind to other atoms. While most of the gas we normally encounter is ***diatomic*** (i.e. the N_2 and O_2 in our atmosphere), many gases are not diatomic.

Noble gases such as ***Helium***, ***Argon***, and **Neon** are monatomic.

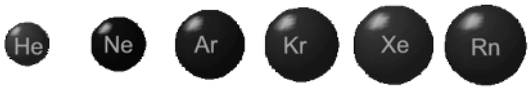


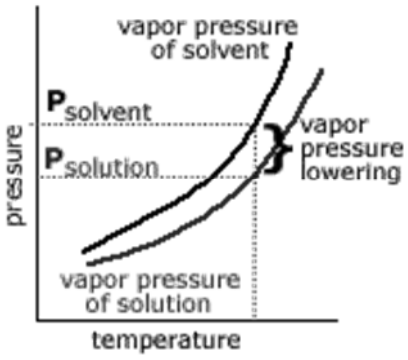
Image from http://www.decompression.org

The answer is **B**.

90. As mentioned in #86, **VSEPR (VALENCE SHELL ELECTRON PAIR REPULSION) THEORY** states that ***molecular shape is influenced by the tendency of electron pairs surrounding the central atom to minimize their mutual repulsion***. ***VSEPR*** predicts **molecular geometry**.

The answer is **B**.

91. **Colligative properties of solutions** are properties that depend upon the concentration of solute molecules or ions, but not upon the identity of the solute. **Colligative properties** include ***freezing point depression***, ***boiling point elevation***, ***vapor pressure lowering***, and ***osmotic pressure***.



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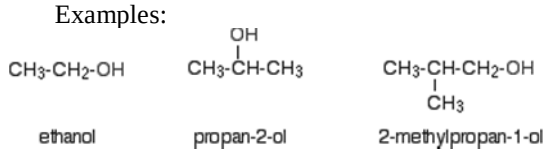
The answer is **D**.

92. **Alcohols** are compounds in which one or more hydrogen atoms in an alkane have been replaced by an ***-OH group***.

Examples:



The answer is **A**.

93. All statements are ***TRUE EXCEPT*** **choice letter C**. the ***electrode at which oxidation takes place is called the anode*** (***not the cathode***).

The answer is **C**.

94. ***Amino acids*** are ***building blocks*** of **proteins**.

The answer is **D**.

95. **Choice letter C** is ***Newton's Third Law of Motion***. The rest are ***Thermodynamic Laws***.

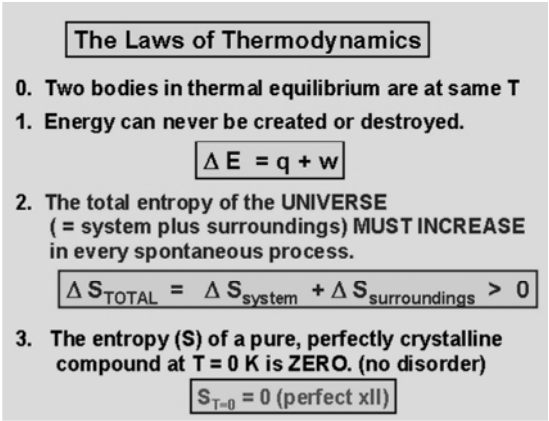


Image from http://www.chemistry.mcmaster.ca

The answer is **C**.

96. The time required to convert ***half of the original amount*** of reactant to product is the **half-life**.

The answer is **B**.

CHEMISTRY TIP:

AQUEOUS SOLUTIONS are solutions having *water* as the *solvent.*

97. **Factors Affecting Reaction Rates**

Concentration

As the concentration of the reactants increases, the reaction rate increases.

Surface Area

As the surface area of the reactants increases, the reaction rate increases.

Temperature

As the temperature of a system increases, the reaction rate increases.

Catalysts

The presence of a catalyst increases the reaction rate.

The answer is **D**.

98. The sum of the ***pH*** and ***pOH*** of a substance is always ***14***. ***Negative logarithm of pH*** equals the ***hydronium ion concentration*** while ***negative logarithm of pOH*** equals the ***hydroxide ion concentration***. Therefore, if ***pH + pOH = 14***, it means that $[H^+]\ x\ [OH^-] = 1.0\ x\ 10^{-14}$. Thus,

$$[H^+] = \frac{1 \times 10^{-14}}{[OH^-]} = \frac{1 \times 10^{-14}}{4.5 \times 10^{-8}} = 2.2 \times 10^{-7}$$

The answer is **C**.

CHEMISTRY TIP:

You must be willing to accept the academic challenge of learning **chemistry**. For some people it is *fun* and for others it is *hard work*, but no matter it takes time. It requires *persistence*, *concentration*, *discipline*, *patience* and **lots and lots of practice**.

99. Here is how the **greenhouse effect** works:
The Earth's atmosphere contains many trace (or minor) components. While the major atmospheric components (***Nitrogen and Oxygen***) absorb little or no radiation, some of the minor components are effective absorbers. Particularly effective is ***water vapor***, which absorb effectively in the ***infrared wavelength range***.

Because the atmosphere is almost transparent to sunlight, all that is absorbed at the surface results in warming and the ***emission of infrared radiation***; this radiation cannot freely escape into space because of absorption in the atmosphere by trace gases such as ***water vapor*** and ***carbon dioxide*** (CO_2). These absorbing gases and their surrounding air warm up, emitting radiation downward, towards the Earth's surface, as well as upward, towards space.

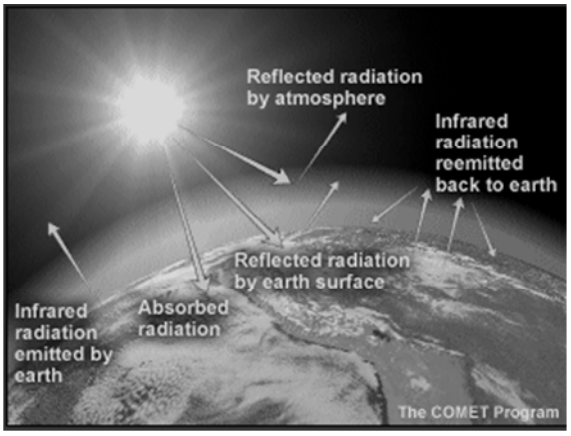


Image from http://3.bp.blogspot.com

The answer is **C**.

100. The ***Bronsted-Lowry*** definition is named for ***Johannes Bronsted*** and ***Thomas Lowry***, who independently proposed it in ***1923***. A ***Bronsted-Lowry (BL) acid*** is defined as **any substance that can donate a hydrogen ion (proton)** and a ***Bronsted-Lowry base*** is any ***substance that can accept a hydrogen ion (proton)***.

The answer is **D**.