

UNIVERSITY OF BENIN, BENIN CITY NIGERIA
 FACULTY OF PHYSICAL SCIENCES
 DEPARTMENT OF CHEMISTRY

 FIRST SEMESTER B.Sc (HONS) DEGREE EXAMINATION 2020/2021 SESSION-
 CHM 111 - GENERAL CHEMISTRY I

December, 2021

INSTRUCTION: Answer any ALL questions

Time Allowed: 2hrs

1. Which of the following pairs represents isotones? (a) 1H and 2H (b) ^{40}Ar and ^{39}K (c) ^{14}C and ^{16}O (d) ^{22}Ne and ^{21}Na (e) ^{37}Cl and ^{35}Cl
2. The europium nucleus has a charge of +63. How many electrons are there in Eu^{+1} ion? (a) 66 (b) 63 (c) 62 (d) 61 (e) 63
3. From the following hydrides; LiH, BeH₂, B₂H₆, NH₃, H₂O and HF, which of them will be basic in water? (a) 3 (b) B₂H₆ and HF (c) H₂O (d) H₂O and HF (e) HF
4. A certain mass of a gas has a volume of 241m³ at 18 °C and 100400 Nm⁻² pressure. What would its volume be at S.T.P.? (a) 1180 m³ (b) 224.04 m³ (c) 234.00 m³ (d) 230.05 m³ (e) 180.10 m³
5. The mole fraction of oxygen in the atmosphere is 0.2094. Calculate the partial pressure of oxygen in air when the atmospheric pressure is 760 Torr. (a) 1120 Torr (b) 760 Torr (c) 520 Torr (d) 159 Torr (e) 219 Torr
6. Calculate the density of butane C₄H₁₀ at a pressure of 117.4 Pa and a temperature of 125 °C ($R = 8.314 \text{ Pa mol}^{-1} \text{ K}^{-1}$). (a) 2.06 g/L (b) 4.20 g/L (c) 3.08 g/L (d) 5.00 g/L (e) 3.15 g/L
7. What is the total number of orbitals associated with the principal quantum number n = 3? (a) 3 (b) 9 (c) 4 (d) 8 (e) 7
8. Calculate the energy required to remove the electron from a hydrogen atom in its ground state ($E = -2.178 \times 10^{-18} \text{ J}$). (a) $2.178 \times 10^{-18} \text{ J}$ (b) $-2.178 \times 10^{-18} \text{ J}$ (c) $2.178 \times 10^{-18} \text{ J}$ (d) $-3.178 \times 10^{-18} \text{ J}$ (e) $3.178 \times 10^{-18} \text{ J}$
9. The simplest formula of a compound containing 50% of element X and 50% of element Y (atomic mass X = 10g/mol, Y= 20 g/mol) is: (a) XY (b) X₂Y₃ (c) X₂Y (d) XY₂ (e) XY₃
10. Which one of the following statements about s orbitals is incorrect?
 (a) they are found in all principal energy levels (b) they are spherical in shape
 (c) they can only hold one electron (d) the maximum number of s orbitals in any principal quantum number is 1 (e) none of the above.
11. What particle would be produced when plutonium-242 decays to uranium-238? (a) gamma (b) alpha (c) positron (d) beta (e) negatron
12. What is the binding energy for $^{11}_5B$ nucleus, if its mass defect is 0.0818 fmamu?
 (a) 1.7×10^{-5} erg/nucleus (b) 1.2×10^{-4} erg/nucleus (c) 3.7×10^{-5} erg/nucleus (d) 3.2×10^{-4} erg/nucleus (e) 4.5×10^{-5} erg/nucleus
13. Which of the following equations represent the industrial production of hydrogen at elevated temperature?
 (a) $3Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + 3H_2_{(g)}$ (b) $2Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + 3H_2_{(g)}$
 (c) $3Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + 2H_2_{(g)}$ (d) $3Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + 4H_2_{(g)}$
 (e) $3Fe_{(s)} + 3H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + H_2_{(g)}$
14. What is the number of electrons and neutrons present in silver (I) ion? ($^{108}_{47}Ag$) (a) 47 and 51 (b) 46 and 60 (c) 46 and 61 (d) 47 and 62 (e) 47 and 60
15. 20 ml. of a gas at 17°C is cooled to -13°C at constant pressure. Determine the new volume of the gas (a) 280 mL (b) 290 mL (c) 260 mL (d) 270 mL (e) 300 mL
16. The following are natural radioactive decay series except (a) Polonium series (b) Uranium series (c) Thorium series (d) Actinium series (e) All of the above
17. Which of the following properties increases down the group of the alkali metals? (a) ionization energy (b) atomic number (%) electronegativity (d) melting point (c) all of the above
18. The half-life of Rn is 3.825 days. Calculate the activity of Rn (atomic weight of Rn= 222) (a) 6.51×10^{-12} g Curie (b) 6.51×10^{-6} g Curie (c) 5.32×10^{-12} g Curie (d) 5.32×10^{-6} g Curie (e) 4.51×10^{-4} g Curie
19. The reaction of sodium with oxygen results in the formation of (a) oxides (b) peroxides (c) superoxides (d) sesquioxides (d) none of the above



20. How much time would it take for a sample of cobalt-60 to disintegrate to the extent that only 2% remains? (The disintegration constant = 0.13 yr^{-1}) (a) 10 years (b) 5 years (c) 15 years (d) 30 years (e) 45 years
21. Calculate the percentage by mass of chlorine in DDT $\text{C}_{11}\text{H}_9\text{Cl}_5$ ($\text{H}=1.0$; $\text{C}=12.0$; $\text{Cl}=35.5$) (a) 2.56% (b) 38.68% (c) 44.00% (d) 46.56% (e) 50.00%
22. The electronic configuration for an element in the halogen group should always end with (a) $ns^2 np^6$ (b) $ns^2 np^5$ (c) $ns^2 np^4$ (d) $ns^2 np^2$ (e) none of the above
23. What is the maximum number of electrons in an atom that have these quantum numbers; $n = 5$, $m_s = +1/2$ (a) 6 (b) 8 (c) 10 (d) 25 (e) 32
24. If it takes 1.25 minutes for 0.010 mol of He to effuse, how long will it take the same amount ethane gas (C_2H_6) to effuse? ($\text{H}=1.0$; $\text{C}=12.0$; $\text{He}=4.0$) (a) 1.72 mins (b) 2.74 mins (c) 3.43 mins (d) 3.88 mins (e) 4.33 mins
25. What is the geometry of the molecule XeF_4 ? (a) trigonal planar (b) tetrahedral (c) square planar (d) trigonal bipyramidal (e) trigonal pyramid
26. Calculate the half-life of radium-226, if 1g of it emits 3.7×10^{10} alpha particles per second (a) 1000 years (b) 200 years (c) 1843 years (d) 1583 years (e) none of the above
27. The following properties generally increases across a period except? (a) electron affinity (b) ionization energy (c) atomic radius (d) electronegativity (e) all of the above
28. Which of the following equation depicts the formation of phosphide from alkali metals? (a) $12\text{Na} + \text{N}_3 \rightarrow 3\text{Na}_4\text{N}$ (b) $6\text{Ca} + \text{P}_3 \rightarrow 3\text{Ca}_2\text{P}$ (c) $12\text{Ca} + \text{Na} \rightarrow 4\text{Ca}_3\text{N}$ (d) $12\text{Na} + \text{P}_3 \rightarrow 6\text{Na}_2\text{P}$ (e) $12\text{Na} + \text{Pa} \rightarrow 4\text{Na}_3\text{P}$
29. Complete and balance the following nuclear equation by selecting the missing particle
$${}_{98}^{252}\text{Cr} + {}_{5}^{10}\text{B} \rightarrow {}_0^1n + ??$$
 (a) ${}_{103}^{261}\text{Lr}$ (b) ${}_{103}^{229}\text{Lr}$ (c) ${}_{93}^{241}\text{Np}$ (d) ${}_{93}^{239}\text{Np}$ (e) none of the above
30. If a gas diffuses at a rate of one-half as fast as O_2 gas, find the molecular mass of the gas. (a) 158 (b) 148 (c) 138 (d) 128 (e) 118
31. What is the amount of pressure exerted by 200g of Xe gas in a vessel of volume 1.0 dm^3 at 25°C if it behaves as an ideal gas? [$\text{Xe} = 131.295 \text{ g/mol}$] (a) 37.24 atm (b) 30.54 atm (c) 25.65 atm (d) 28.51 atm (e) 10.21 atm
32. What amount of pressure (in bar) would be exerted by 35g of Ar gas contained in a 1.5 dm^3 vessel at 35°C if it behaves as an ideal gas? [$\text{Ar} = 39.948 \text{ g/mol}$] (a) 18.70 (b) 13.95 (c) 20.75 (d) 10.51 (e) 11.30
33. Hydrogen economy refers to (a) the different methods of producing H_2 (b) the industrial production of H_2 (c) the chemical reactions of H_2 (d) the cheap and easy method of producing and storing H_2 (e) all of the above.
34. Which of the following is the correct mathematical relation for Charle's law at constant pressure? (a) $V \propto T$ (b) $v \propto t$ (c) $v = kt$ (d) $V \propto P$ (e) none of the above.
35. 50 mL of gas A effuse through a pin-hole in 1146 seconds. The same volume of CO_2 under identical conditions effuses in 115 seconds. Calculate the molecular mass of A. (a) 59 (b) 61 (c) 108 (d) 71 (e) 84
36. A compound containing boron and hydrogen consists of 6.444 g of B and 1.803 g of H. The molar mass of the compound is about 30g. What is its molecular formula? (a) BH_3 (b) B_2H_6 (c) B_3H_6 (d) B_2H_4 (e) B_3H_5
37. How many atoms are bonded to the central atom in a molecule that has an octahedral geometry? (a) 4 (b) 5 (c) 6 (d) 7 (e) 8
38. An atom is indivisible, was proposed by _____ (a) Einstein (b) Lavoisier (c) Dalton (d) Proust (e) none of the above
39. The atomic mass of calcium is 40. Calculate the number of moles in 16g of calcium (a) 0.40 mole (b) 4.00 moles (c) 0.25 moles (d) 6.40 moles (e) 1.20 moles
40. Principal, azimuthal and magnetic quantum numbers are respectively related to (a) size, shape and orientation (b) shape, size and orientation (c) size, orientation and shape (d) orientation, size and shape (e) none of the above.
41. For azimuthal quantum number $l=3$, the maximum number of electrons will be (a) 2 (b) 6 (c) 0 (d) 14 (e) 18
42. A Compound containing 69.5% oxygen and 30.5% nitrogen has a molecular mass of 92g/mol. What is the formula of the compound? (a) N_2O (b) NO_2 (c) N_2O_5 (d) N_2O_4 (e) N_3O_4
43. In a given atom, no two electrons can have the same values for all four quantum number. This is achieved following _____ (a) Hund's rule (b) Aufbau's principle (c) Uncertainty principle (d) Pauli's exclusive principle (e) all of the above
44. If the values of l are 0, 1, 2, and 3, what is the corresponding value of n? (a) 2 (b) 3 (c) 4 (d) 5 (e) 6

45. The number of unpaired electrons in a given energy level must be maximum. This statement is accredited to who? (a) Dalton (b) Aufbau (c) Hund (d) Bohr (e) Pauli
46. The correct ground state electronic configuration for a chromium atom is [At. No. = 24] (a) $[\text{Ar}]3\text{d}^5 4\text{s}^1$ (b) $[\text{Ar}]3\text{d}^4 4\text{s}^2$ (c) $[\text{Ar}]3\text{d}^6 4\text{s}^0$ (d) $[\text{Ar}]3\text{d}^5 4\text{s}^0$ (e) $[\text{Ar}]3\text{d}^5 4\text{s}^2$
47. According to Aufbau's principle, the energies of 3p, 3d, 4s and 4p orbitals are in the order (a) $3\text{p} < 3\text{d} < 4\text{s} < 4\text{p}$ (b) $3\text{p} < 4\text{s} < 3\text{d} < 4\text{p}$ (c) $3\text{d} < 3\text{p} < 4\text{s} < 4\text{p}$ (d) $3\text{d} < 3\text{p} < 4\text{p} < 4\text{s}$ (e) $3\text{p} < 4\text{p} < 3\text{d} < 4\text{s}$
48. What mass of F is in 24.5g of tin (I) fluoride? [At. Mass: F = 19.0; Sn = 118.7] (a) 9.57g (b) 9.75g (c) 5.97 g (d) 5.79 g (e) 7.59 g
49. Vanillin has the following composition by mass: carbon 63.2%, hydrogen 5.26%, and oxygen 31.6%. What is the empirical formula of Vanillin? [H = 1.0 g/mol, C = 12.0 g/mol, O = 16 g/mol]. (a) $\text{C}_8\text{H}_7\text{O}_3$ (b) $\text{C}_3\text{H}_3\text{O}$ (c) $\text{C}_8\text{H}_8\text{O}_3$, (d) CHO (e) $\text{C}_4\text{H}_4\text{O}_7$
50. Find the wavelength of a line in Balmer series associated with a drop of the electron from the fourth orbit. [Rydberg constant = 109,678 cm⁻¹] (a) 456nm (b) 565nm (c) 656nm (d) 670nm (e) 760nm
51. Predict the geometry and hybridization of the central atom in SCl_6 . (a) octahedral, sp^3d (b) square planar, sp^3d^2 (c) octahedral, sp^3d^2 (d) square planar, sp^3d (e) trigonal bipyramidal, sp^3d
52. Calculate the average atomic mass Ar for a naturally occurring chlorine if the distribution of isotopes is Cl-35 (75.77%) and Cl-37 (24.23%). Accurate masses for Cl-25 and Cl-37 are 34.97 and 36.97. (a) 34.55 (b) 33.55 (c) 35.35 (d) 35.45 (e) 35.01
53. Give the number of protons, neutrons and electrons in $^{200}_{80}\text{Hg}$. (a) 80, 80, 119 (b) 119, 80, 80 (c) 80, 120, 80 (d) 120, 80, 80 (e) 120, 120, 80
54. Predict the electronic configuration for Ti^{3+} [$^{48}_{22}\text{Ti}$]. (a) $[\text{Ar}]3\text{d}^1$ (b) $[\text{Ar}]3\text{d}^3$ (c) $[\text{Ar}]3\text{d}^4$ (d) $[\text{Kr}]4\text{d}^{10} 5\text{s}^2$ (e) $[\text{Kr}]4\text{d}^9$
55. A trigonal bipyramidal molecule has how many hybrid orbitals? (a) 6 (b) 5 (c) 4 (d) 3 (e) 2
56. Express 0.975 bar in atmosphere. (a) 0.872 (b) 0.862 (c) 0.972 (d) 0.962 (e) 0.772
57. A sample of 225mg of neon occupies 3.00 dm³ at 122K. If it behaves as an ideal gas, what is the amount of pressure exerted? [Ne = 20.18g/mol; R = 8.3×10^{-2} dm³ bar K⁻¹Mol⁻¹]. (a) 0.0427 bar (b) 0.0427 atm (c) 0.0247 bar (d) 0.0247 atm (e) 0.0742 bar
58. State to which period and group of the periodic table, the element with the electronic configuration $1\text{s}^2 2\text{s}^2 2\text{p}^6 3\text{s}^2 3\text{p}^6$ belongs. (a) period 2, group VIIA (b) period 2, group VIIIA (c) period 3, group VIIA (d) period 3, group VIA (e) period 3, group VIA
59. Express 108kPa in torr. (a) 710 (b) 810 (c) 910 (d) 610 (e) 510
60. Which scientist determined the charge of an electron? (a) R. Millikan (b) J. Dalton (c) J.J Thompson (d) W. Rontgen (e) E. Rutherford
61. Predict the geometry and bond angle of a molecule with a Sp^3d^2 hybridized orbital on the central atom. (a) trigonal planar, 120° (b) tetrahedral, 109.5° (c) square planar, 90° (d) octahedral, 90° (e) octahedral, 120°
62. What is the total number of electrons allowed in an "L" shell (a) 36 (b) 18 (c) 8 (d) 6 (e) 2
63. Calculate the volume occupied by 7g of nitrogen gas at 27°C and 750 mmHg pressure [N=14 g/mol] (a) 6.24 L (b) 12.48 L (c) 11.48 L (d) 7.24 L (e) 10.24 L
64. The following are examples of interstitial hydrides except? (a) TiH_{18} (b) FeH_2 (c) YbH (d) CsH (e) NiH_2
65. The arrangement of elements in the periodic table is in the order of increasing - (a) mass number (b) neutron numbers (c) proton numbers (d) molar mass (e) electron and neutron numbers
66. The half-life of ^{45}Ca is 165 days. After 1.0 year, what percentage of the original sample of ^{45}Ca remains? (a) 10.9% (b) 99.6% (c) 2.16% (d) 21.6% (e) 96.9 %
67. All the following options are examples of representative elements except? (a) Ca (b) Ga (d) Sr (d) Zr (e) Cl
68. Calculate the volume occupied by 5g of acetylene (C_2H_2) gas at 50 °C and 740 mmHg pressure, [C=12 g/mol; H= 1.0 g/mol]. (a) 3.2377 L (b) 4.2377 L (c) 5.2377 L (d) 6.2377 L (e) 7.2377 L
69. How many empty p orbitals are there in a carbon ion [C] (a) 1 (b) 2 (c) 3 (d) 4 (e) 5
70. 8g of methane gas and 2g of hydrogen gas are mixed at 760 mm Hg pressure at 273K. The total volume occupied by the mixture will be _____ [C=12 g/mol, H= 1 g/mol] (a) 11.2 L (b) 22.4L (c) 33.6 L (d) 44.8 L (e) 55. 0 L
71. Which equation represents alpha emission from $^{196}_{84}\text{Po}$? (a) $^{196}_{84}\text{Po} \rightarrow ^{192}_{82}\text{Po} + {}_2^4\text{He}$ (b) $^{196}_{84}\text{Po} + {}_2^4\text{He} \rightarrow ^{192}_{82}\text{Po}$ (c) $^{196}_{84}\text{Po} \rightarrow ^{200}_{86}\text{Rn} + {}_2^4\text{He}$ (d) $^{196}_{84}\text{Po} + {}_2^4\text{He} \rightarrow ^{200}_{86}\text{Rn}$ (e) none of the above
72. Which atomic orbital has values of n = 4, l = 2? (a) 4s (b) 4p (c) 4d (d) 4f (e) 4g



73. What is the missing particle in the bombardment reaction? $\text{Al}^{27} + ? = {}^1\text{n} + \text{P}^{30}$ (a) neutron (b) proton (c) beta (d) alpha (e) gamma
74. Which of the following is not an example of ionic hydride? (a) LiH (b) CaH₂ (c) SrH₂ (d) ZrH₂ (e) NaH
75. Of the following processes, which one does not change the atomic number? (a) gamma emission (b) alpha emission (c) positron emission (d) beta emission (e) none of the above
76. Which of the following pairs represents isobars? (a) ${}^{17}_8\text{O}$ and ${}^{18}_8\text{O}$ (b) ${}^{40}_{19}\text{K}$ and ${}^{40}_{20}\text{Ca}$ (c) ${}^{15}_7\text{N}$ and ${}^{16}_8\text{O}$ (d) ${}^{235}_{92}\text{U}$ and ${}^{238}_{92}\text{U}$ (e) none of the above
77. Which of the following elements has the lowest ionization energy; P, Na, Si, Mg, Al. (a) P (b) Mg (c) Al (d) Na (e) Si
78. Complete and balance the following nuclear equation by selecting the missing particle.

$${}_{12}^{24}\text{Mg} + {}_1^2\text{H} \rightarrow {}_2^4\text{He} + ?$$
 (a) ${}_{13}^{22}\text{Al}$ (b) ${}_{11}^{22}\text{Na}$ (c) ${}_{13}^{26}\text{Al}$ (d) ${}_{10}^{20}\text{Ne}$ (e) none of the above
79. "The total pressure of a mixture of gases (non-reacting) is equal to the sum of the partial pressure of all the gases present" is a statement of _____ (a) Graham's law of diffusion (b) Dalton's law of partial pressure (c) Avogadro's law of partial pressure (d) Ideal gas law (e) none of the above
80. An atom of _____ contains no neutron (a) hydrogen (b) deuterium (c) tritium (d) helium (e) sodium

SOLUTIONS TO CHM111 2020/2021

1. Isotones are those atoms that have equal number of neutrons e.g. ${}^14_6\text{C}$ and ${}^16_8\text{O}$ are isotones, other examples Cl-37 and K-39
Neutron No = Mass Number - Proton No
 taking Oxygen and Carbon
 Oxygen: 16 - 8 = 8 Neutrons
 Carbon: 14 - 6 = 8 Neutrons

Correct Option C

2. Eu^{3+} is a cation that has lost 3 electrons out of a total of 63 electrons hence 60 electrons are left.
NB. proton number in the nucleus equals electron number.

No Correct Option

3. NH₃ and LiH are the two basic hydrides in the list,

Correct Option A

4. $V_1 = 241\text{m}^3$,
 $T_1 = 18 + 273 = 291\text{K}$
 $P_1 = 100,400\text{Nm}^{-2}$ $V_2 = ?$
 $T_2 = 273\text{K}$
 $P_2 = 101,325\text{Nm}^{-2}$

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1} = \frac{100,400 \times 241 \times 273}{101,325 \times 291} = 224.03\text{m}^3$$

Correct Option B

5. $\text{PO}_2 = \text{XO}_2 \times \text{P}_{\text{total}}$
 $\text{PO}_2 = 0.2094 \times 760 = 159\text{Torr}$

Correct Option D

6. $M = \text{DRT}/P$
 $D = ?, R = 8.314,$
 $T = 125 + 273 = 398\text{K}$
 $M = (12 \times 4) + (1 \times 10) = 58$
 $P = 117.4$
 $\therefore D = MP/RT$

$$D = (5.8 \times 117.4)/(8.314 \times 398) = 2.057\text{g/L}$$

Correct Option A

7. The total number of orbitals present in $n = 3$ includes

1 orbital in the 3s sub shell
 3 orbitals in the 3p subshell and
 5 orbitals in the 3d subshell

Making a total of nine 9 orbitals in $n = 3$

Correct Option B

8. Hydrogen atom has only one electron, Hence, will require an equivalent ionization energy of $2.178 \times 10^{-18}\text{J}$ to knock out the electron out of the atom.

Correct Option C

9. $x : y$

50% : 50%

50/10 : 50/20

5 : 2.5

dividing by the lowest value

5/2.5 : 2.5/2.5

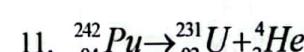
2 : 1

Empirical formula X₂Y

Correct Option C

10. An Orbital can hold a maximum of 2 electrons

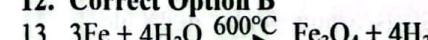
Correct Option C



Plutonium (94) will decay to yield an Alpha particle and a Uranium (92)

Correct Option B

12. **Correct Option B**



Correct Option D

14. Silver (I) ion Ag⁺ contains 46 electrons and 61 neutrons



15. ***

Correct Option C

16. The three series that undergo natural radioactive are
Thorium Series
Actinium Series'
Uranium Series.

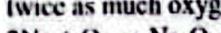
Correct Option A

17. The properties that increases down the group of alkali earth metals are, atomic number, Atomic weight, density and metallic radius.

Correct Option B

18. **Correct Option C**

19. Sodium reacts with oxygen under normal conditions to form a compound that's contains twice as much oxygen as in the oxide above.



Lithium reacts with oxygen to form Li_2O (an oxide) while, Potassium, Rubidium and Caesium reacts with oxygen to form super oxides

Correct Option B

$$\Delta_f = \Delta_o e^{kt}$$

Making t the subject of the formula

$$t = \frac{1}{-k} \ln\left(\frac{\Delta_f}{\Delta_o}\right) = \frac{1}{-0.13} \ln\left(\frac{\frac{2}{100}(\Delta_o)}{\Delta_o}\right) \approx 30 \text{ years}$$

Correct Option A

21. $\text{Cl}_4\text{H}_9\text{Cl}_3$

$$(12 \times 14) + (1 \times 9) + (35.3 \times 5)$$

$$168 + 9 + 177.5 = 354.5 \text{ g/mol}$$

$$\% \text{ Cl} = 177.7/354.5 \times 100 = 50.07\%$$

Correct Option E

22. Halogens have 7 electrons in the outermost shell, therefore, it's configuration must always end with $ns^2 np^5$

Correct Option B

23. For a principal quantum number of 5, there are 25 orbitals and only 1 electron, within each orbital we have a value of $ms = +1/2$, meaning there are 25 electrons within $n = 5$ and $ms = +1/2$

Correct Option D

24. $\text{He} = 4 \text{ g/mol } t = 1.25$

$\text{C}_2\text{H}_6 = 30 \text{ g/mol } t = x$

$$\frac{t_{\text{He}}}{t_{\text{C}_2\text{H}_6}} = \sqrt{\frac{M_{\text{He}}}{M_{\text{C}_2\text{H}_6}}} \rightarrow \frac{1.25}{x} = \sqrt{\frac{4}{30}}$$

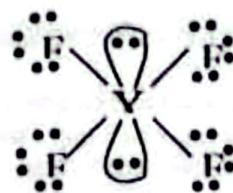
$$0.364x = 1.25$$

$$\therefore x = 3.42 \text{ minutes}$$

Correct Option C

25. The molecule XeF_4 is a non polar molecule, since the geometric structure of XeF_4 is symmetric i.e Square planar

Correct Option A



Correct Option C

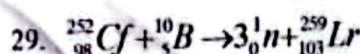
26. ***

27. Generally, electronegativity, ionization energy and electron affinity, increases across the period while atomic radii and ionic radii decreases across the period

Correct Option C

28. Phosphorus reacts with alkali earth metals to form phosphides such as Sodium phosphide $12\text{Na} + \text{P}_4 \rightarrow 4\text{Na}_3\text{P}$

Correct Option E



Correct Option E

$$30. \frac{t_x}{t_{\text{O}_2}} = \sqrt{\frac{M_x}{M_{\text{O}_2}}} \rightarrow \frac{1}{2} = \sqrt{\frac{32}{x}} \quad x = 12.8$$

Correct Option D

$$31. P = ? \quad T = 298 \text{ K} \quad R = 0.0821$$

$$V = 1 \text{ dm}^3$$

$$n = \text{mass} / \text{molar mass}$$

$$n = 200/131.295 = 1.52$$

but $PV = nRT$ (ideal gas equation)

$$P = nRT/V$$

$$P = 1.52 \times 0.821 \times 298/1 = 37.26 \text{ atm}$$

Correct Option A

$$32. P = ? \quad T = 273 + 35 = 308 \text{ K}$$

$$R = 0.0821 \quad V = 1.5 \text{ dm}^3$$

$$n = \text{mass/molar mass}$$

$$n = 35/39.948 = 0.876$$

but $PV = nRT$ (ideal gas equation)

$$P = nRT/V$$

$$P = 0.876 \times 0.821 \times 308/1.5 = 14.76 \text{ atm}$$

Closest Correct Option B

33. **Correct Option D**

34. Charles law

$$V \propto T, \text{ therefore } V = kT, k = V/T$$

Correct Option A

$$35. t_x = 146 \text{ s } M_x = ?$$

$$\text{CO}_2 = 115 \text{ s } \text{MCO}_2 = 44 \text{ g/mol}$$

$$\frac{t_x}{t_{\text{CO}_2}} = \sqrt{\frac{M_x}{M_{\text{CO}_2}}} \rightarrow \frac{146}{115} = \sqrt{\frac{x}{44}} \quad x = 70.9$$

Correct Option D

36. ***

37. Table of facts

Hybrid	Geometric	No of	Examples
--------	-----------	-------	----------



orbitals	arrangements	orbitals	
SP	Linear	2	Be in BeCl_2
SP^2	trigonal planar	3	B in BF_3
SP^3	Tetrahedral	4	C in CH_4
SP^3d	trigonal bipyramidal	5	P in PCl_5
SP^3d^2	Octahedral	6	S in SF_6

Correct Option C

38. John Dalton formulated a precise definition of the indivisible building blocks of matter called Atoms.

Correct Option C

$$39. m = 16 \text{ g} \quad M = 40 \text{ g/mol} \\ n = m/M = 16/40 = 0.4 \text{ mol}$$

Correct Option A

40. principal (n) = size
Azimuthal (L) = shape
Magnetic (m) = Orientation

Correct Option A

$$41. l = 3$$

For Azimuthal quantum number $L = 3$, the maximum number of electrons will be the total values of $m = (2 \times 3 + 1) = 7$ orbital, since, one orbital contains 2 electrons, therefore total number of electrons will be $7 \times 2 = 14$ electrons.

Correct Option D

$$42. N : O \\ 30.5/14 : 69.5/16$$

$$2.1/2.1 : 4.3/2.1$$

$$1 : 2$$

NO_2 = Empirical formula

$$(\text{NO}_2)_n = 92$$

$$n(14 + 2(16)) = 92 \text{ g/mol}$$

$$n = 92/46 = 2$$

$$\text{Molecular formula} = (\text{NO}_2)_2 = \text{N}_2\text{O}_4$$

Correct Option D

43. Pauli's Exclusion principle states that no two electrons in the same atom can have identical values for all 4 quantum numbers.

Correct Option D

44. $n = 4$, Then $L = 0, 1, 2, 3$ i.e. $L = n - 1$

Correct Option C

45. **Correct Option C**

46. The ground state configuration of gaseous neutral Chromium is $[\text{Ar}]3\text{d}^54\text{s}^1$

Correct Option A

47. $1\text{s} < 2\text{s} < 2\text{p} < 3\text{s} < 3\text{p} < 4\text{s} < 3\text{d} < 4\text{p} < 5\text{s} < 5\text{p} < 6\text{s} < 4\text{s} < 5\text{d} \dots$

Correct Option B

48. Tin(ii)fluoride SnF_2

$$\text{SnF}_2 = 118.7 + (19 \times 2) = 156.7$$

if $38 \text{ g/mol} \rightarrow 156.7 \text{ g/mol}$

$$x \text{ g} \rightarrow 24.5 \text{ g}$$

$$x = 5.94 \text{ g/mol}$$

Correct Option C

$$49. \text{C} : \text{H} : \text{O} \\ 63.2/12 : 5.26/1 : 31.6/16$$

$$5.26/1.97 : 5.26/1.97 : 1.97/1.97$$

$$2.6 : 2.6 : 1$$

Multiply all through by 3

$$8 : 8 : 3$$

$\text{C}_8\text{H}_8\text{O}_3$ (Empirical formula)

Correct Option C

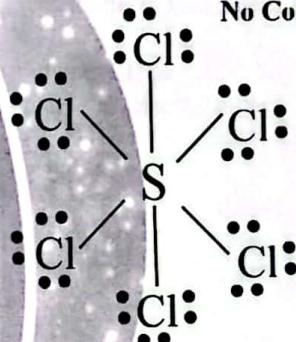
$$50. n_1 = 2 \text{ for Balmer series}$$

fourth orbital $n_2 = 4$

$$\frac{1}{\lambda} = R c \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = 109678 \left[\frac{1}{2^2} - \frac{1}{4^2} \right]$$

$$\frac{1}{\lambda} = 20564.62 \quad \therefore \lambda = 4.86 \times 10^{-5} = 486 \text{ nm}$$

51.



No Correct Option

the central atom (S) has 6 atoms attached to it.

Bonding pair plus lone pair = 6 + 0 = 6 hence, sp^3d^2 which is octahedral

Correct Option C

$$52. \text{Average atomic mass of Chlorine} =$$

$$(75.77/100)(34.97) + (24.22/100)(36.97)$$

$$\text{AAMCl} = 35.45 \text{ amu}$$

Correct Option D

$$53. {}^{200}_{80}\text{Hg}$$

Neutron = mass No. - proton No.

Neutron number = 200 - 80 = 120

Recall, proton No. electron number

Hence, number of protons, neutrons and electrons = 80, 120, 80

Correct Option C

54. Ti^{3+} has lost 3 electrons, hence has 19 electrons left. Hence, $[\text{Ar}]3\text{d}^1$

Correct Option A

55. Check the table in Question 37 above

Correct Option B

56. If 1 bar $\rightarrow 0.987 \text{ atm}$

$$\therefore 0.975 \text{ bar} \rightarrow x$$

$$x = 0.975 \times 0.987 = 0.9622 \text{ atm}$$

Correct Option D

57. mass = 225mg = 0.225g
 $n = m/M = 0.225/20.18 = 0.011$
 $V = 3.0, T = 122K, P = \dots?$
 But $PV = nRT$
 $P = nRT/V$
 $P = 0.011 \times 0.08314 \times 122/3 = 0.0376 \text{ Barr}$

No Correct Option

58. $1s^2 2s^2 2p^6 3s^2 3p^6$ period 3 group VIIA
Correct Option C

59. If $101.325 \text{ KPa} \rightarrow 760 \text{ Torr}$
 $108 \text{ KPa} \rightarrow x \text{ Torr}$
 $x = 760 \times 108/101.325 = 810.06 \text{ Torr}$
Correct Option B

60. J. J Thompson obtained the ratio of electric charge to mass for an electron to be $-1.76 \times 10^8 \text{ C/g}$. Thereafter, in a series of experiments carried out between 1908 and 1917, R. A. Millikan found the charge of an electron to be $1.60 \times 10^{-19} \text{ C}$

Correct Option A

61. sp^3d^2 has an octahedral shape with an angle of 90°

Correct Option D

62. K, L, M = 2, 8, 18

Correct Option C

63. $n = m/M = 0.25, T = 237 + 27 = 300 \text{ K}, P = 0.986, V = ?$
 but $PV = nRT$

$V = nRT/P$
 $V = 0.25 \times 0.0821 \times 300/0.986 = 6.24 \text{ L}$

Correct Option A

64. Cesium hydride (CsH) is a compound made of Cesium and Hydrogen. It is an alkali metal hydride.

Correct Option D

65. Proton number or Atomic number

Correct Option C

66. **Correct Option D**

67. The representative elements are elements where the s and p orbitals are filling. The transition elements are elements where the d orbitals (groups 3–11 on the periodic table) are filling, and the inner transition metals are the elements where the f orbitals are filling.

Zirconium, is a transition element.

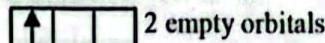
Correct Option D

68. $n = n/M = 5/26 = 0.192,$
 $T = 323 \text{ K}, P = 0.973, V = ?$
 but $PV = nRT \therefore V = nRT/P$

$V = 0.192 \times 0.0821 \times 323/0.973 = 5.237 \text{ L}$

Correct Option C

69. $C^+ = 5 \text{ electrons} = 1s^2 2s^2 2p^1$

 2 empty orbitals

Correct Option B

70. $\text{CH}_4 = 16, \text{ mass} = 8 \text{ g},$

$n = m/M = 8/16 = 0.5$

$\text{H}_2 = 2 \text{ g/mol} \text{ mass} = 2 \text{ g}$

$n = m/M = 2/2 = 1$

Total No. of moles = $0.5 + 1 = 1.5 \text{ mol}$

At $P = 1$

But $PV = nRT \therefore V = nRT/P$

$V = 1.5 \times 0.0821 \times 273/1 = 32.61 \text{ L}$

Correct Option C

71. $^{196}_{84}Po \rightarrow ^{192}_{82}Po + ^4_2He$

Correct Option A

72. $n = 4, l = 2$

$l = 0 = s$

$l = 1 = p$

$l = 2 = d$

$l = 3 = f$

Hence the orbital is a 4d orbital.

Correct Option C

73. $\text{Al}^{27} + ? = ^1n + \text{P}^{30}$

$\text{Al}^{27} + ^4_2He = ^1n + \text{P}^{30}$ Alpha emission

Correct Option D

74. Ionic hydrides are formed when molecular hydrogen combines directly with some of the alkali earth metals e.g Ca, Sr, Ba, Li etc..

Zr is not an alkali Earth metal but a transition element.

Correct Option D

75. Gamma rays' emission does not result in any change in atomic number or mass number of the nucleus.

Correct Option A

76. Isobars are atoms that have equal number of nucleons i.e. they have different atomic numbers but same mass numbers

Correct Option B

77. ionization energy is the minimum energy required to remove the most loosely bound electron of an isolated gaseous atom, positive ion, or molecule.

Ionization energy increases across the period

Correct Option D

78. $^{24}_{12}\text{Mg} + ^1_1H \rightarrow ^4_2He + ^{23}_{11}\text{Na}$

Correct Option B

79. **Correct Option B**

80. *Hydrogen has no neutron.*

Correct Option A



UNIVERSITY OF BENIN, BENIN CITY NIGERIA
FACULTY OF PHYSICAL SCIENCES
DEPARTMENT OF CHEMISTRY

FIRST SEMESTER B.Sc (HONS) DEGREE EXAMINATION 2021/2022 SESSION-
CHM 111 – GENERAL CHEMISTRY 1

MAY, 2023

INSTRUCTION: Answer any ALL questions

Time Allowed: 2hrs

91. Which of the following is NOT Correct? (a) a double bond is a δ - bond plus one π (b) a single bond is a π bond (c) a triple bond is a δ -bond plus two π - bonds (d) a triple bond is a π -bond plus 2 δ -bonds (e) a bond is formed by the overlapping of 2 atomic orbitals along the interatomic axis
92. How many moles are present in 52 g of Cr [Cr = 52g/mol] (a) 10.00 mol (b) 1.00 mol (c) 1. mol (d) 10.52 mol
93. What is the total number of orbitals associated with principal quantum number n = 3 (a) 6 (b) 12 (c) 18 (d) 9
94. How many oxygen atoms are present in 0.025mol of aspirin ($C_9H_8O_4$)
(a) 3.0×10^{22} (b) 6.0×10^{24} (c) 56.32×10^{22} (d) 6.0×10^{22}
95. How many atoms are in 32.6g of sulphur? ($S = 32.07$, $N_A = 6.02 \times 10^{23}$)
(a) 1.52×10^{24} (b) 1.12×10^{24} (c) 8.42×10^{23} (d) 6.12×10^{23} (e) 3.06×10^{23}
96. Which of the following is paramagnetic? (a) Zn (b) Ni (c) Cu (d) none of the above
97. Calculate the density of butane at a pressure of 117.4 kPa and a temperature of 125°C ($R = 8.314$ $P\text{am}^3/\text{mol/K}$) (a) 2.60 g/L (b) 2.65g (c) 2.06 g/L (d) none of the above
98. All of these are neutral oxides except (a) CO (b) N_2O (c) MgO (d) H_2O
99. The magnetic quantum number M_L is given by (a) $2l$ (b) $2l-1$ (c) $2l+1$ (d) $n-1$
100. What is the total number of electrons that can be held in all orbitals having the same principal quantum number n? (a) $2n$ (b) $2n+1$ (c) $2n^2$ (d) $2n^2+1$ (e) $2n^2-1$
101. Predict the molecular geometry of the following species: PCl_6 [$P = 15.0$; $Cl = 19.0$]
(a) Linear (b) Tetrahedral (c) Octahedral (d) Trigonal Planar
102. Using the ideal gas law, calculate the pressure in atmosphere exerted by 5g of methane enclosed in a container of 0.1L at 25°C (a) 2.55 (b) 4.80 (c) 13.8 (d) none of the above
103. The species that contains 24 protons, 26 neutrons and 22 electrons would be represented by the Symbol
(a) $^{10}_{24}V^{3+}$ (b) $^{36}_{24}Cr^{2+}$ (c) $^{50}_{24}Cr^{2+}$ (d) $^{50}_{24}Mn^{2-}$ (e) none of the above
104. Convert a pressure of 0.657atm to a pressure in mmHg
(a) 250 mmHg (b) 500 mmHg (c) 750 mmHg (d) 120 mmHg
105. How many valence electrons are in ICl_4 molecule (a) 14 (b) 21 (c) 18 (d) none of the above
106. Which of the following is FALSE?
(a) the angular momentum quantum number tells us the shape
(b) The magnetic quantum number describes orientation of the orbital
(c) the value for the electron spin quantum number is $\pm 1/2$ (d) none of the above
107. If it takes 125 minutes for 0.010mol of He to effuse, how long will it take the same amount of ethanol (C_2H_6) to effuse [$H = 1.0$; $C = 12.0$; $He = 4.0$] (a) 1.72 min (b) 2.74 min (c) 3.43 min (d) 3.88 min
108. The molar mass of oxalic acid, a toxic substance found in rhubarb leaves is 90.0 mg/mol and its empirical formula is CHO_2 . What is the molecular formula? (a) $C_2H_2O_4$ (b) $C_2H_2O_2$ (c) CHO_2 (d) $C_4H_4O_2$ (e) C_2H_2O
109. State the number of unpaired electrons in the electronic configuration of Chromium (a) 2 (b) 4 (c) 3 (d) 6
110. How many electrons can be placed into the M shell of an atom? (a) 14 (b) 16 (c) 18 (d) 20 (e) 22
111. Predict the geometry of $SnCl_2$?
(a) tetrahedral (b) trigonal planar (c) bent or angular (d) trigonal bi-pyramidal (e) circular
112. Calculate the energy required to remove the electron from a hydrogen atom in its ground state [$R_H = 2.18 \times 10^{-18}$]
(a) -4.36×10^{-18} J (b) -3.27×10^{-18} J (c) -2.18×10^{-18} J (d) 2.18×10^{-18} J (e) 4.36×10^{-18} J
113. The number of orbitals in a d-subshell ($l = 2$) is : (a) 5 (b) 3 (c) 1 (d) 7 (e) 10
114. Which of the following element is a metalloid (a) Li (b) Be (c) B (d) C
115. Given the electronic configuration of Z^2 as $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$ the atomic number of Z is (a) 24 (b) 22 (c) 18 (d) 20
116. Which of the following particles will not be deflected by charged plates?
(a) γ - particles (b) β - particles (c) α - particles (d) protons
117. Starting with a 4.00mg sample, how much ^{198}Au remains in mg after 7 days? (a) 0.66 mg (b) 1.00mg (c) 1.28mg (d) 0.35mg



118. What is the number of orbitals in a 5g subshell? (a) 1 (b) 3 (c) 5 (d) 7 (e) 9
119. What is the half-life of a radioactive nucleus that takes 15 min to decay to 90% of its original activity (a) 180 min (b) 99 min (c) 210 min (d) 5min
120. Lindane, used in insecticide has a mass composition of 24.78% C, 2.08% H and 73.14% Cl and molar mass 290.85 g/mol. What is the molecular formula of lindane?
(a) C_6H_6Cl (b) $C_6H_6Cl_6$ (C) $C_2H_2Cl_2$ (d) $C_4H_6Cl_4$ (e) $C_6H_6Cl_6$
121. Nuclides having different mass and atomic numbers but contains the same number of neutrons are called?
(a) isotopes (b) isobars (c) isotones (d) allotropes
122. Balance the following nuclear reaction $^{234}_{90}Th \rightarrow {}^0_{-1}\beta + X$ (a) $^{233}_{91}X$ (b) $^{210}_{91}X$ (c) $^{234}_{88}X$ (d) $^{234}_{91}X$
123. A substance gives on decomposition 0.6 mole of Fe and 0.90 mole of S. What is its empirical formula?
(a) Fe_2S (b) FeS (c) FeS_2 (d) FeS_3
124. How many electrons are in the p-orbital in Ru? [Z = 44] (a) 6 (b) 18 (c) 12 (d) 10
125. A nucleus of mass number 81 contains 46 neutrons in it. Write the symbol for this ion
(a) $^{81}_{36}Br$ (b) $^{81}_{36}Br^-$ (c) $^{81}_{36}Br^+$ (d) $^{81}_{35}Br^+$
126. Helium gas, He at 22°C and 1.00 atm occupied a vessel whose volume was 2.54L. Calculate the Volume this gas would occupy if it were cooled to liquid - nitrogen temperature(-197°C) (a) 0.33L (b) 0.56L (c) 0.65L (d) 1.30L
127. Calculate the wavelength in 1nanometers of the spectral line of hydrogen for which $n_2 = -6$ and $n_1 = 3$ ($R_H = 109,678 \text{ cm}^{-1}$) (a) 1737 nm (b) 1358 nm (c) 1094 nm (d) 978 nm (e) 656 nm
128. Which of the following contains the largest number of molecules? (a) 0.2 mol od H_2 (b) 8g of H_2 (c) 17g of H_2O (d) 6g of CO_2
129. Calculate the molecular formula of caffeine if this compound is 49.48% C, 5.19% H and 28.85% N and 16.48% O by mass and it has a molecular weight of 194.2 gram per mole (a) $C_{14}H_{18}N_2O_2$ (b) $C_7H_9N_2O_5$ (c) $C_8H_{10}N_4O_2$ (d) $C_9H_{11}N_4O_2$ (e) $C_{16}H_{20}N_4O_5$
130. The species $^{52}_{24}Cr^{3+}$ contains (a) 24 protons, 24 neutrons and 24 electrons (b) 24 protons, 28 neutrons and 24 electrons (c) 24 protons, 28 neutrons and 21 electrons (d) 52 protons, 52 neutrons and 21electrons (e) 21 protons, 31 neutrons and 21 electrons
131. Which of the following is paramagnetic? (a) Zn^{2+} (b) Ni^{2+} (c) Cu^+ (d) Cu (e) none of the above
132. $^{59}_{27}Cr$ has _____ unpaired electrons (a) 1 (b) 2 (c) 3 (d) 4
133. The volume of a gas at STP is 488mL. Calculate its volume at 22.5atm and 150°C (a) 33.6mL (b) 63.3mL (c) 67.2 mL (d) 50.4 mL
134. What is the angular momentum allowed for principal quantum number n = 4
(a) 0,123,4 (b) 0,1,2,3 (c) 0, 1,2,4 (d) 0,1,3,3,4
135. What is the maximum number of electrons for an n =3 shell? (a) 10 (b) 6 (c) 18 (d) 8 (e) 2
136. Caffeine contains 28.9% by mass nitrogen. If the molecular formula of caffeine is 194 then the number of nitrogen atoms present in one molecule is (a)3 (b) 4 (c) 5 (d) 6
137. What did Bohr assume about the motion of electrons?
(a) Bohr proposed that electrons travelled in straight path
(b) Bohr proposed that electrons travelled in circular paths around the nucleus
(c) Bohr proposed that both electrons and neutrons are found in the nucleus
(d) Bohr proposed that both protons and neutrons are found in the nucleus (e) none of the above
138. Which of the following contains more electrons than neutrons?
(a) $^{25}_{12}X^{2+}$ (b) $^{33}_{16}X^{2-}$ (c) $^{75}_{33}X^{3-}$ (d) $^{26}_{13}X$ (e) none of these
139. How many atoms are bonded to the central atom in a molecule that has a trigonal bi-pyramidal shape?
(a) 4 (b) 5 (c) 6 (d) 7
140. The arrangement of the elements in the periodic table is in order of their
(a) atomic weight (b) isotopic weight (c) atomic number (d) molecular weight
141. ${}^2_1H + {}^3_1H \rightarrow {}^4_2H + {}^1_0n$ is an example of
(a) nuclear fission (b) nucleus fusion (c) alpha emission (d) combination reaction
142. What is the bond angle of in a tetrahedral molecule (a) 180° (b) 120° (c) 109.5° (d) 107.3°
143. A quantity of gas weighing 7.10g at 741 torr and 44° C occupies a volume of 5.40L. What is the molar mass?
(a) 17.6 g/mol (b) 29.3 g/mol (c) 35.1g/mol (d) 52.7g/mol



144. Calculate the energy in joules of an electron in the second energy level ($n=2$) of a hydrogen atom ($R_H = -2.18 \times 10^{-18} \text{ J}$) (a) $-5.45 \times 10^{-19} \text{ J}$ (b) $-1.09 \times 10^{-10} \text{ J}$ (c) $-1.09 \times 10^{-18} \text{ J}$ (d) $-5.45 \times 10^{-18} \text{ J}$
145. What is the frequency of the photon that is emitted if an electron falls from the fourth orbit to the third energy levels in a hydrogen [$R_H = 2.18 \times 10^{-18} \text{ J}$, $\hbar = 663 \times 10^{-34} \text{ J}\cdot\text{s}$, $c = 3.00 \times 10^8 \text{ m/s}$] (a) $1.59 \times 10^{14} \text{ s}^{-1}$ (b) $2.598 \times 10^{15} \text{ s}^{-1}$ (c) $1.598 \times 10^{14} \text{ s}^{-1}$ (d) $1.34 \times 10^{21} \text{ s}^{-1}$ (e) $2.582 \times 10^{14} \text{ s}^{-1}$
146. How many unpaired electrons are there in the Mn atom? ($Z=25$) (a) 5 (b) 1 (c) 2 (d) 3
147. How many orbitals are there in the shell of $n=5$ (a) 18 (b) 21 (c) 25 (d) 22
148. Calculate the binding energy of $^{60}_{28}\text{Ni}$ in MeV per nucleon if the exact mass of this nuclide is 59.9332 amu [$^{1}_1\text{H} = 1.00728$; $^{1}_0\text{n} = 1.00867$ amu; $^{9}_0\text{e} = 0.0005486$; 1 amu = 931.5 MeV] (a) 8.70 MeV per nucleon (b) 7.80 MeV per nucleon (c) 6.98 MeV per nucleon (d) 5.25 MeV per nucleon (e) 524.81 MeV per nucleon
149. The transition metals are elements in which the differentiating electrons go into the (a) s-orbital (b) p-orbital (c) d-orbital (d) f-orbital
150. An oxide of manganese has the following composition by mass: 36.89% O and 63.2% Mn. What is the formula of the oxide? [O = 16.0, Mn = 55.0] (a) MnO (b) MnO_2 (c) MnO_3 (d) Mn_2O_2 (e) Mn_2O_7
151. The species that contains 24 protons, 26 neutrons and 23 electrons would be represented by the symbol (a) $^{50}_{24}\text{V}^{31}$ (b) $^{26}_{24}\text{Cr}^{2+}$ (c) $^{50}_{22}\text{Mn}^{2+}$ (d) $^{50}_{24}\text{V}^{+}$
152. A 200.0ml flask contains 1.03mg O_2 and 0.56mg He at 15°C. What is the total pressure? [$M_{\text{He}} = 4.0$; O = 16.0] (a) 0.0038atm (b) 0.017atm (c) 0.020atm (d) 0.040atm
153. An element with atomic number 12 is likely to have the same chemical properties as those elements in (a) Group IIB (b) Group IIA (c) Group IIIA (d) Group IVA
154. Calculate the ratio of diffusion of hydrogen to the rate of diffusion of oxygen (a) 4:1 (b) 2:1 (c) 3:1 (d) 6:1 (e) 3:2
155. What hybrid orbitals would be expected for the central atom in the following species BrF_5 (a) sp (b) sp^2 (c) sp^3 (d) sp^3d
156. How many unpaired electrons would there be in the ion Gd^{3+} ? [Z = 64] (a) 3 (b) 5 (c) 7 (d) 9 (e) 11
157. Calculate the density (in grams per litre) of ammonia gas NH_3 at 31°C and 751 mmHg. [H = 1.0; N = 14.0; R = 0.0821 L atm/K/mol] (a) 0.338 g/L (b) 0.57 g/L (c) 0.675 g/L (d) 0.765 g/L
158. Which of these is an acidic oxide? (a) SO_2 (b) CaO (c) MgO (d) Na_2O
159. Electron affinity is the (a) energy released when an electron is added to an isolated atom in gaseous state (b) energy absorbed when an electron is added to an isolated atom in the gaseous state (c) energy to take out an electron from an isolated gaseous atom (d) power of an atom to attract an electron to its self
160. How many molecules are present in one gram of hydrogen gas? (a) 6.02×10^{23} (b) 3.01×10^{23} (c) 5×10^{23} (d) 1.5×10^{23}
161. A certain compound on analysis yielded 2.0g carbon, 0.34g hydrogen and 2.67g oxygen. If the relative molecular mass of the compound is 60, calculate its molecular formula (a) CH_2O (b) $\text{C}_2\text{H}_6\text{O}_2$ (c) $\text{C}_2\text{O}_2\text{H}_4$ (d) CHO_2
162. Group II elements of the periodic table are also referred to as? (a) halogens (b) alkali metals (c) metalloids (d) alkaline earth metals
163. The ground state electronic configuration of ^{80}Hg is (a) $[\text{Ar}]6s^24f^{14}5d^{10}$ (b) $[\text{Kr}]6s^24f^{14}5d^{10}$ (c) $[\text{Xe}]6s^24f^{14}5d^{10}$ (d) $[\text{Xe}]6s^24f^{14}6p^64d^{10}$ (e) $[\text{Rn}]6s^24f^{14}5d^{10}$
164. Magnesium occurs instantly as a mixture of three isotopes: 78.99% Mg (mass 23.99 amu) 10.00% Mg (mass = 24.99 amu) and 11.01% Mg (mass = 25.98 amu) what is the atomic mass of magnesium (a) 26.31 g/mol (b) 24.62 g/mol (c) 24.31 g/mol (d) 26.62 g/mol (e) 23.41 g/mol
165. A compound having the empirical formula $\text{C}_2\text{H}_3\text{Cl}$ has a molecular mass of about 190. Its molecular formula is (a) $\text{C}_2\text{H}_3\text{Cl}$ (b) $\text{C}_6\text{H}_9\text{Cl}_3$ (c) $\text{C}_6\text{H}_{12}\text{Cl}_3$ (d) $\text{C}_4\text{H}_6\text{Cl}_2$
166. What are the quantum numbers of the electron that is lost by an atom of copper when it forms the ion Cu^+ ? ($Z=29$) (a) $n=3$, $l=2$, $m_l=-2$, $m_s=+\frac{1}{2}$ (b) $n=3$, $l=2$, $m_l=0$, $m_s=-\frac{1}{2}$ (c) $n=4$, $l=0$, $m_l=0$, $m_s=+\frac{1}{2}$ (d) $n=4$, $l=0$, $m_l=0$, $m_s=+\frac{1}{2}$ (e) $n=4$, $l=2$, $m_l=1$, $m_s=-\frac{1}{2}$
167. A gas of unknown identity diffuses at the rate of 16.0 ml. per second in a diffusion apparatus in which a second gas whose molecular weight is 28.0 diffuses at the rate of 24.2 ml per second. Calculate the molecular weight of the first gas. (a) 46.50 g/mol (b) 65.04 g/mol (c) 64.05 g/mol (d) 12.24 g/mol
168. The density of water is 1.0 g at 4°C. How many molecules are present in 2.5 ml? (a) 8.56×10^{22} (b) 3.28×10^{22} (c) 2.38×10^{22} (d) 6.02×10^{23}



169. What is the number of orbitals in a 5g subshell? (a) 9 (b) 1 (c) 3 (d) 5

170. How many grams of Zn are there in 0.250 ml of Zn | Zn = 65.39g | (a) 16.35g (b) 12.12g (c) 20105 (d) 18.21g

SOLUTIONS TO CHM111, 2021/2022

1. Option D is the most appropriate option, A pi bond is a single bond formed alongside with an existing sigma bond as double and triple bonds, triple bonds are made up of 1 sigma bonds and 2 pi bonds.

Correct Option D

2. Cr = 52g/mol

$$\text{Moles} = \frac{\text{Given Mass}}{\text{Molar Mass}} = \frac{52}{52} = 1.00\text{mol}$$

Correct Option B

3. There are a total of 9 orbitals in n = 3 shell (M shell)

- 1 orbital in the 3s subshell
- 3 orbitals in the 3p subshell
- 5 orbitals in the 3d subshell
- Making a total of 9 orbitals

Correct Option D

4. First, we need to calculate the percentage by mass of oxygen in Asprine, then obtain the mass of Asprine present in 0.025mol, then, use such mass to obtain the mass of oxygen present and finally find out how many atoms of oxygen are present in such amount.

Asprine = C₉H₈O₄ = 180g/mol

$$\%O_2 \text{ in Asprine} = \frac{4(O)}{9C + 8H + 4(O)} \times 100$$

$$\%O_2 \text{ in Asprine} = \frac{4(16)}{9(12) + 8(1) + 4(16)} \times 100 = 35\%$$

$$\text{But, No. of mol in Asprine} = \frac{X}{\text{molar Mass}}$$

$$\therefore \frac{X}{\text{molar Mass}} = 0.025\text{mols} \rightarrow X = 4.5\text{g}$$

The mass of oxygen present in 4.5g of

Asprine will be

$$4.5\text{g} \times 35\% = 1.5975\text{g of oxygen}$$

$$\text{No of moles O}_2 = 1.5975/2(16) = 0.049\text{mol}$$

So applying Avogadro's law

If 1 mole of oxygen contains 6.02×10^{23} atoms

Then 0.049moles will contain how many?

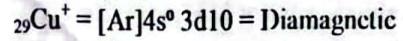
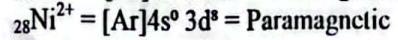
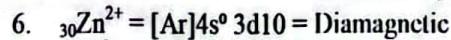
$$0.049 \times 6.02 \times 10^{23} = 3.0 \times 10^{22} \text{ atoms of oxygen}$$

Correct Option A

$$5. \text{ Moles} = \frac{\text{Given Mass}}{\text{Molar Mass}} = \frac{32.6}{32.07} = 1.0165\text{mol}$$

Now, number of atoms present in 1.0165mol of Sulphur will be $1.0165 \times 6.02 \times 10^{23} = 6.119 \times 10^{23}$ atoms of Sulphur.

Correct Option D



NB: Cu^{2+} is Paramagnetic | Ar|4s⁰ 3d⁹

Para magnetism occurs in an element as a result of unpaired electrons in the last orbitals of that element while diamagnetism occurs as a result of completely paired electrons in the last orbital.

Correct Option B

Recall Density is mass over volume.

To calculate the density of butane, first we can calculate the volume occupied by butane under the given conditions by comparing it at STP, then from there, obtain the density of butane.

At STP, butane will occupy

$$V_1 = 22.4 \times 10^{-3}\text{m}^3, P_1 = 1.01325 \times 10^5\text{Pa}$$

$$T_1 = 273\text{K}, P_2 = 117,400\text{Pa}$$

$$T_2 = 125^\circ\text{C} = 398\text{K}, V_2 = ?$$

$$\text{But, } \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \therefore V_2 = \frac{P_1 V_1 T_2}{T_1 P_2}$$

$$V_2 = \frac{1.01325 \times 10^5 \times 22.4 \times 10^{-3} \times 398}{273 \times 117,400}$$

$$V_2 = 0.0281\text{m}^3 = 28.1\text{Liters}$$

But Butane is C₄H₁₀ = 4(12) + 10(1) = 58g/mol

∴ Density = mass/volume = 58g/28.1L = 2.06g/L

Correct Option C

8. Neutral oxides are those oxides that do not show either acidic or basic properties, hence do not form salts when reacted with

acids or bases. Common examples include, CO , N_2O , NO , H_2O , SO_3 , P_2O_5 , Cl_2O_7 , SrO , N_2O_5 etc

MgO is a basic oxide and can easily form a salt.

Correct Option C

9. The principal Quantum number tells us the maximum number of electrons can be accommodated in all orbitals and it's given by $2n^2$

Correct Option C

10. The magnetic Quantum number tells us the number of orbitals present in the subshell of an atom and it's given by $2L + 1$

Correct Option C

11. PCl_6^-

Hybrid orbitals = No of lone pair + No of surrounding atoms = 0 + 6 = 6
 (Octahedral) SP^3d^2

Correct Option C

12. Mass of CH_4 = 5g

Molar mass = $12 + 4 = 16\text{g/mol}$

Number of moles = $5/16 = 0.3125 \text{ mol}$

But $PV = nRT$ where, $V = 1\text{L}$, $R = 0.082$,

$T = 25^\circ\text{C} = 298\text{K}$, $n = 0.3125$, and $P = ?$

$$P = \frac{nRT}{V} = \frac{0.082 \times 0.3125 \times 298}{1} = 7.63\text{ atm}$$

Correct Option E

13. $^{50}_{24}\text{Cr}^{2+}$

Contains 24 protons, 22 electrons and 26 neutrons.

Correct Option C

14. If 1 atm contains 760mmHg

0.657atm will contain how many?

$$0.657 \times 760\text{mmHg} = 499.32 = 500\text{mmHg}$$

Correct Option B

15. Valence electrons are the number of electrons found in the outermost shell of an atom or compound.



Iodine has 7 valence electrons

Cl has also 7 valence electrons in each atom of Cl.

Hence total number of valence electrons in ICl_4^- = $7 + 4(7) = 35$ valence electrons.

Correct Option E

16. All statements are correct

Correct Option D

17. Note the question is quite wrongly set. The question used ethanol as C_2H_6 which ought

to be ethane, however, let us assume the examiners had ethane in mind.

Hint: First calculate the mass of helium present in 0.01mol, also calculate the mass of ethane present in the same 0.01mol. then apply Grahams Law of effusion

Mole of He = given mass/molar mass = 0.1

Mass of He = $4 \times 0.01 = 0.04\text{g}$

Mole of C_2H_6 = given mass/molar mass = 0.1

Mass of C_2H_6 = $30 \times 0.01 = 0.3\text{g}$

$$t_{\text{C}_2\text{H}_6} = \frac{t_{\text{He}} \sqrt{M_{\text{C}_2\text{H}_6}}}{\sqrt{M_{\text{He}}}} = \frac{1.25 \sqrt{0.3}}{\sqrt{0.04}} = 3.42 \text{ min}$$

Correct Option C

18. Oxalic acid has the formula $\text{C}_2\text{H}_2\text{O}_4$, which you could just shade the right option and work away.

However, let's follow due process

Molar mass = 90mg/mol

Empirical formula (EF) = CHO_2

Molecular formula (MF) = (EF) n = molar mass

$(\text{CHO}_2)_n = 90$

$$[12 + 1 + 2(16)]n = 90$$

$$45n = 90 \therefore n = 2$$

$$\text{MF} = (\text{EF})n = (\text{CHO}_2)_n = (\text{CHO}_2)_2 = \text{C}_2\text{H}_2\text{O}_4 \quad \text{QED}$$

Correct Option A

19. $^{24}\text{Cr} = [\text{Ar}] 4s^1 3d^5$

Cr , has 6 unpaired electrons, 1 from the s orbital and 5 from the d orbital.

Correct Option D

20. M shell is $n = 3$

Hence number of electrons = $2n^2 = 2(3)^2 = 18e^-$

Correct Option C

21. SnCl_2

Has a V-shaped or Angular or bent shape

Correct Option C

22. IE = $E_z - E_n$

That is the energy required to remove a particular electron from a given energy level to a position at infinity. Note. E at infinity = 0, z = atomic No.



$$J.E = 0 - E_n = -\frac{R_H z^2}{n^2} =$$

$$J.E = -\frac{(-2.18 \times 10^{-18})(1)^2}{(1)^2} = 2.18 \times 10^{-18} J$$

Correct Option D

23. The number of orbitals in a d-subshell is 5.

Correct Option A

24. There are 7 metalloids in the periodic table of elements which are, *Boron, Silicon, Germanium, Astatine, Antimony, Tellurium and Polonium*

Correct Option C

25. First find the number of electrons present in

$$Z^+ = 2 + 2 + 6 + 2 + 6 + 2 + 1 = 21 \text{ electrons}$$

Since Z^+ lost 1 electron, then the initial number of electrons in Z will be $21 + 1 = 22$ electrons.

Correct Option B

26. Gamma particles do not experience deflection in both electric and magnetic fields.

Correct Option A

27. $N_i = 4\text{mg}$, $t = 7\text{days}$, $N_f = ?$

NB the half-life of Au is 2.7 days (though not given, you are expected to know)

$$\frac{N_i}{N_f} = e^{\lambda t} \quad \therefore N_f = \frac{N_i}{e^{\lambda t}} = \frac{4}{e^{\frac{0.693}{2.7} \times 7}} = 0.66\text{mg}$$

Correct Option A

28. $5g = 9$ orbitals

Correct Option E

29. Let the initial Amount be A, then amount left after 15minutes = $90\%A$

$$\text{but}, \frac{N_i}{N_f} = e^{\lambda t} \quad \lambda = \frac{0.693}{T_{\frac{1}{2}}} \quad \therefore \frac{N_i}{N_f} = e^{\frac{0.693}{T_{\frac{1}{2}} t}}$$

making $T_{\frac{1}{2}}$ the subject of formula

$$T_{\frac{1}{2}} = \frac{0.693t}{\ln\left(\frac{N_i}{N_f}\right)} = \frac{0.693(15)}{\ln\left(\frac{A}{90A/100}\right)} = 98.66 = 99 \text{ min}$$

Correct Option B

30. $C = 24\%$, $H = 2.08\%$, $\text{Cl} = 73.14\%$

Molar mass = 290.85g/mol

Molecular formula = ?

Calculating the Empirical formula

C :	H :	Cl
24 :	2.08 :	73.14
24/12	2.08/1	73.14/35.5
2	2.08	2.06
2/2	2.08/2	2.06/2
1	1.04	1.03
1 :	1 :	1

Empirical formula = $\text{C}_1\text{H}_1\text{Cl}_1 = \text{CHCl}$

$\text{MF} = (\text{EF})n = \text{molar mass}$

$$(\text{CHCl})_n = 290.85$$

$$(12 + 1 + 35.5)n = 290.85$$

$$48.5n = 290.85 \quad \therefore n = 5.99 = 6$$

$$\text{MF} = (\text{CHCl})_6 = \text{C}_6\text{H}_6\text{Cl}_6$$

Correct Option E

31. Isotones are elements with same number of neutrons

NB, same number of electrons =
isoelectronic

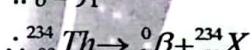
Same number of protons = *isotopes*

Same atomic mass = *isobars*

Correct Option C



$$234 = 0 + a, \quad \therefore a = 234 \quad \text{Also } 90 = -1 + b, \\ \therefore b = 91$$



Correct Option D

$$33. \text{Fe : S} \\ 0.6 : 0.9 \\ 0.6/0.6 \quad 0.9/0.6 \\ 1 : 1.5$$

At this point it will be wrong to approximate 1.5 = 2,

Moreover, the molecular formula FeS_2 doesn't exist in chemistry. Hence the wisest thing to do is to multiply all through by a factor of 2,

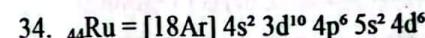
$$1 : 1.5$$

$$2(1) : 2(1.5)$$

$$2 : 3$$

Hence, $\text{EF} = \text{Fe}_2\text{S}_3$.

No correct Option



Hence there are 6 electrons in the p-orbital of Ruthenium.

Correct Option A

35. Mass number = 81, Neutron number = 46
 Atomic number = ?

But mass number = proton + neutron
 81 = protons + 46

Hence protons = 35 = Atomic number

Bromine, which eventually is a halogen and in its ionic state will gain an electron to become Br^-

Hence the symbol will be Br

Correct Option B

36. The above question is based on Charles Law, since the pressure is kept constant (1atm) in both conditions

Hence $V_1 = 2.54\text{L}$, $T_1 = 22^\circ\text{C} = 295\text{K}$, $T_2 = -197^\circ\text{C} = 76\text{K}$ and $V_2 = ?$

$$V_2 = \frac{V_1 T_2}{T_1} = \frac{2.54 \times 76}{295} = 0.664\text{L}$$

Correct Option C

37. $R_H = 109,678/\text{cm}$

To convert to meters we multiply by 100

$R_H = 109,678 \times 10^3/\text{m}$ also $n_1 = 3$ and $n_2 = 6$

$$\frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = 109,678 \times 10^3 \left[\frac{1}{3^2} - \frac{1}{6^2} \right]$$

$$\frac{1}{\lambda} = 913,983.33 \quad \therefore \lambda = \frac{1}{913,983.33} = 1094\text{nm}$$

Correct Option C

38. According to Avogadro's Law,

1 mol of a substance contains 6.02×10^{23} molecules

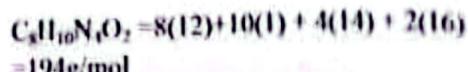
Hence, 0.2 mol of H_2 will contain $0.2 \times 6.02 \times 10^{23}$ molecules

- 8g of H_2 contains = $8/2 = 4$ moles
- 17g of water contains = $17/18 = 0.9$ moles
- 6g of CO_2 Contains $6/44 = 0.13$ moles

Hence H_2 has the highest number of moles and automatically with the highest number of molecules $4 \times 6.02 \times 10^{23} = 2.4 \times 10^{24}$ molecules

Correct Option B

39. Shortcut: once molar mass is given, just calculate the molar masses of the options to get the one that tallies with the question.


Correct Option C

40. $^{52}_{21}\text{Cr}^{+1}$ has 21 electrons, 24 protons and 28 Neutrons

Correct Option C

41. $\text{Zn}^{2+} = [\text{Ar}] 4s^0 3d^{10}$
 $\text{Ni}^{2+} = [\text{Ar}] 4s^0 3d^8$
 $\text{Cu}^+ = [\text{Ar}] 4s^0 3d^{10}$
 $\text{Cu} = [\text{Ar}] 4s^1 3d^{10}$

Nickel is the only element above with an incomplete d-orbital hence, Paramagnetic

Correct Option B

42. $_{27}\text{Co} = [\text{Ar}] 4s^2 3d^7$
 3 electrons are remaining to completely fill the last d-orbital, hence has 3 unpaired electrons.

Correct Option C

43. Using the ideal gas equation...
 $V_1 = 488\text{mL}$ $T_1 = 273\text{K}$ (STP) $P_1 = 1\text{atm}$ (STP)

$P_2 = 22.5\text{atm}$, $T_2 = 150^\circ\text{C} = 423\text{K}$ and $V_2 = ?$

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1} = \frac{1 \times 488 \times 423}{22.5 \times 273} = 33.6\text{mL}$$

Correct Option A

44. For an angular momentum quantum number, the possible values ranges from 0 to $n-1$. Hence if $n=4$

The angular momentum quantum number will be 0, 1, 2 and 3

Correct Option B

45. The maximum number of electrons in a given shell is obtained from the formula $2n^2$. Hence when $n=3$, max electrons will be $2(3)^2 = 18$ electrons.

Correct Option C

46. First there is a mistake in the question, the word "molecular formula should be molecular mass". Generally, caffeine has a molecular mass of 194.1g/mol with a molecular formula $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$.

Now if 28.9% of caffeine mass is Nitrogen And caffeine has a mass of 194g/mol. Then the mass of caffeine will be 28.9% of 194 = 56.066g

hence the number of moles of N_2 in caffeine will be $56.066/14 = 4\text{mol}$

Correct Option B

47. Correct Option B

48. $^{25}_{12}X^{2+}$ = 10 electrons and 13 neutrons

$^{25}_{16}X^{2-}$ = 18 electrons and 17 neutrons

$^{25}_{13}X^{3-}$ = 36 electrons and 137 neutrons

$^{25}_{13}X^-$ = 13 electrons and 13 neutrons

$\therefore {}_{16}^{25}X^{2-}$ contains more electrons than neutrons.

Correct Option B

49. 5 atoms are bonded to the central atom of a molecule with a trigonal pyramidal geometry.

Correct Option B

50. Atomic number

Option B

51. Nuclear fusion is the joining together of two or more nuclei to form a heavier nucleus.

Correct Option B

52. 109.5° e.g. CH_4

Option C

53. Using the ideal gas equation

$$PV = nRT$$

$$P = 741 \text{ Torr} = 0.97 \text{ atm} (\text{since } 1 \text{ atm} = 760 \text{ Torr})$$

$$V = 5.4 \text{ L}, R = 0.082 \text{ atm L/mol K}$$

$$T = 44^\circ\text{C} = 317 \text{ K}$$

$$\therefore n = \frac{PV}{RT} = \frac{0.97 \times 5.4}{0.082 \times 298} = 0.202 \text{ mol}$$

But n = given mass/molar mass

$$\therefore \text{molar mass} = n/\text{mass} = 0.202/7.1 =$$

$$35.23 \text{ g/mol}$$

Correct Option C

54. The energy of a H_2 electron is given by

$$E/n = -13.6 \text{ eV}/n^2 = -13.6/2^2 = -3.4 \text{ eV}$$

But 1eV contains $1.602 \times 10^{-19} \text{ J}$

Therefore -3.4 eV will contain

$$-3.4 \times 1.602 \times 10^{-19} \text{ J} = -5.45 \times 10^{-19} \text{ J}$$

Correct Option A

55. The frequency of an emitted photon is given by

$$E = hf, \text{ hence, } f = E/h, \text{ taking } n_1 = 4 \text{ and } n_2 = 3$$

$$E = -13.6 \left[\frac{1}{n_2^2} - \frac{1}{n_1^2} \right] = -13.6 \left[\frac{1}{3^2} - \frac{1}{4^2} \right] = -0.66 \text{ eV}$$

Ignore the negative sign, it only indicates that the electron is falling from a higher energy level to a lower energy level.

To obtain the energy in joules we have

$$E = 0.66 \times 1.602 \times 10^{-19} \text{ J} = 1.057 \times 10^{-19} \text{ J}$$

$$f = \frac{E}{h} = \frac{1.057 \times 10^{-19}}{6.63 \times 10^{-34}} = 1.59 \times 10^{14} \text{ Hz}$$

Correct Option A

56. $Mn = [\text{Ar}] 4s^2 3d^5$

The d-orbital is deficient of 5 electrons, hence has 5 unpaired electrons.

Correct Option A

57. $n = 5$ (O shell), $l = 4$ i.e. 0, 1, 2, 3 and 4

s Contains 1 orbital, p Contains 3 orbitals

d Contains 5 orbitals, f Contains 7 orbitals

g Contains 9 orbitals

Total number of orbitals = 25

Correct Option C

58. $M_{\text{nucleus}} = 49.9332 \text{ amu}, M_{\text{proton}} =$

1.00728 amu

$M_{\text{neutron}} = 1.00867 \text{ amu}, M_{\text{electron}} =$

0.0005486 amu

$$B.E = \Delta m \times 931.5 \text{ MeV}$$

$$\text{But } \Delta m = M_{\text{nuc}} - (M_p + M_n) = M_{\text{nuc}} - (28M_p + 32M_n)$$

$$\Delta m = 59.9332 - (28 \times 1.00728 + 28 \times 1.00867)$$

$$\Delta m = -0.5564$$

NB ignore the sign, the negative sign only shows that heat is released in the process.

$$\Delta m = 0.5564$$

$$\therefore B.E = 0.5564 \times 931.5 \text{ MeV} = 518.36 \text{ MeV}$$

per nucleus.

Now the B.E per nucleon will be

$$B.E/\text{nucleons}$$

And Ni has 60 nucleons, Hence

$$B.E/\text{nucleon} = 518.36/60 = 8.64 \text{ MeV}$$

Correct Option A

59. Correct Option C

60. O : Mn

36.8% : 63.2%

$36.8/16 : 63.2/55$

2.3 : 1.15

$2.3/1.15 : 1.15/1.15$

2 : 1

Hence EF = MnO_2

Correct Option B

61. Protons = 24, Neutrons = 26, Electrons = 23



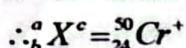
$$a = \text{proton number} = 24$$

$$b = \text{mass number} = p + n = 24 + 26 = 50$$

c = oxidation number

Since 23 electrons are left out of 24 protons, in the element, it therefore implies that the element lost 1 electron, hence positively charged

X = Cr = atomic number 24



No Correct Option

62. Total pressure of the system will be

$$P_T = \frac{n_T RT}{V}$$

$$n_T = n_{O_2} + n_{H_2}$$

$$n_{O_2} = \text{mass/MM} = 1.03 \times 10^{-3} / 32 = 0.032 \times 10^{-3} \text{ mol}$$

$$n_{H_2} = \text{mass/MM} = 0.56 \times 10^{-3} / 4 = 0.14 \times 10^{-3} \text{ mol}$$

$$n_T = 0.032 \times 10^{-3} + 0.14 \times 10^{-3} = 0.172 \times 10^{-3} \text{ mol}$$

$$T = 15^\circ\text{C} = 288\text{K}$$

$$V = 200 \times 10^{-3} \text{ L}$$

$$R = 0.082 \text{ atm L/mol/K}$$

$$P_T = \frac{0.172 \times 10^{-3} \times 0.082 \times 288}{200 \times 10^{-3}} = 0.02 \text{ atm}$$

Correct Option C

63. Atomic number 12 = Mg which is a group 2A element of the periodic table.

Correct Option B

64. Rate of diffusion is inversely proportional to the square root of the molar mass (Grahams Law of diffusion)

$$\frac{R_{H_2}}{R_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}} = \sqrt{\frac{32}{2}} = \frac{4}{1} \therefore 4:1$$

Correct Option A

65. BCl_4

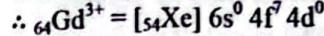
Hybrid orbitals = No of lone pairs + No of surrounding atoms = 1 + 5 = 6

Hence, Sp^3d^2 = square pyramidal geometry, since it has one lone pair and 5 bonds.

No Correct Option

66. ${}_{64}^{Gd^{3+}}$ Gadolinium belongs to the lanthanide series of the periodic table of elements aka f-block element, but however, is one of the 12 elements that obeys aufbau principle, its expected configuration is ${}_{64}^{Gd} = [{}_{54}^{Xe}] 6s^2 4f^8$ but actually has the configuration ${}_{64}^{Gd} = [{}_{54}^{Xe}] 6s^2 4f^7 5d^1$

Now, since Gd^{3+} lost 3 electrons, hence 61 electrons are left out of 64.



Hence has 7 unpaired electrons and 2 vacant orbitals in its 2 and d-orbital

Correct Option C

67. Using the ideal gas equation...

$$PV = nRT \text{ since } n = m/mm$$

$$PV = \frac{m}{MM} RT$$

Also Density = mass/volume

Now, making mass/volume the subject of the form in the ideal gas equation above we have ...

$$\frac{m}{V} = \frac{P \times MM}{RT} = \text{Density}$$

$$P = 751 \text{ mmHg} = 751/760 = 0.988 \text{ atm}$$

$$R = 0.082 \text{ atm L/mol/K}$$

$$T = 31^\circ\text{C} = 304\text{K}$$

$$D = \frac{0.988 \times 17}{0.082 \times 304} = 0.67 \text{ g/L}$$

Correct Option C

68. SO_2 is the only acidic oxide in the options also called acid anhydride because it dissolves in water to form a weak acid H_2SO_3 , the rest are however, basic oxides

Correct Option A

69. Electron Affinity is the energy released (not absorbed), when an electron is added to the neutral atom of negatively charged ion. The process is usually exothermic.

There are however, two types of electron affinity, which are First and second Electron affinity, the first is the adding of an electron to a neutral atom (gaseous state). While the second involves the adding of electron to a negatively charged ion.

NB, energy is only absorbed when an electron is removed from a neutral atom (Ionization energy) and it's endothermic in nature.

Correct Option A

70. 1g of H_2 contains 1/2 moles

∴ the amount of molecules present in 0.5mol of H_2 will be $0.5 \times 6.02 \times 10^{23} = 3.01 \times 10^{23}$ molecules.

Correct Option B

71. C : 2	H : 0.34	O : 2.76
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$$\begin{array}{ll} 2/12 : & 0.34/1 \\ 2.76/16 & \\ 1.6667 : & 0.34 : \\ 0.1725 & \\ 1.6667/1.6667 : & 0.34/1.6667 : \\ 0.1725/1.6667 & \end{array}$$

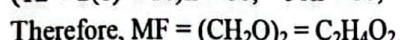
$$1 : 2 : 1$$



But Molecular formula = $(\text{EF})n$ = molar mass

$$(\text{CH}_2\text{O})n = 60$$

$$(12 + 2(1) + 16)n = 60, \quad 30n = 60, \quad n = 2$$



Correct Option C

72. Alkaline Earth metals, this is because their oxides and hydroxides are soluble in water (Hence alkaline), as for the terminology "Earth metals" this is because their oxides are found in the earth crust.

Correct Option D

73. Ground state configuration simply means the arrangements of electrons around the nucleus of the atom, starting from the lowest energy level to its final energy level.



NB mercury has a completely filled d-orbital, hence not considered to be a transition metal, based on IUPAC's definition of transition elements.

Correct Option C

74. The atomic mass of an element is simply the algebraic sum of the product of it's % abundance and atomic mass units

$$^{27}\text{Mg} = 78.99\% \text{ of } 23.99 = 18.95$$

$$^{25}\text{Mg} = 10\% \text{ of } 24.99 = 2.499$$

$$^{23}\text{Mg} = 11.01\% \text{ of } 25.98 = 2.86$$

$$\text{Atomic mass of Mg} = 18.95 + 2.499 + 2.86$$

$$= 24.31\text{g/mol}$$

Correct Option C

75. $\text{MF} = (\text{EF})n$ = molar mass
 $(\text{C}_2\text{H}_3\text{Cl})n = 190$
 $[2(12) + 3(1) + 35.3]n = 190$
 $62.5n = 190 \quad \therefore n = 3$
 $\text{MF} = (\text{C}_2\text{H}_3\text{Cl})_3 = \text{C}_6\text{H}_9\text{Cl}_3$

Correct Option B

76. $^{29}\text{Cu}^+ = 28$ electrons
 $\text{Cu}^+ = [_{18}\text{Ar}] 4s^0 3d^{10}$
 $n = 3, L = 2, M_L = 2, M_s = -\frac{1}{2}$

No Correct Option

77. $R_1 = 16\text{mL/s}$ $R_2 = 24.2\text{mL/s}$, $M_2 = 28$, $M_1 = ?$

$$\frac{R_1}{R_2} = \sqrt{\frac{M_2}{M_1}} \quad \therefore M_1 = \frac{M_2}{\left(\frac{R_1}{R_2}\right)^2}$$

$$M_1 = \frac{28}{\left(\frac{16}{24.2}\right)^2} = 64.05\text{g/mol}$$

Correct Option C

78. First the question is wrongly set, density is measured in g/L not "g". However, the density of water at 4°C is maximum, 1g/mL (Anomalous Behavior of water)

$$D = 1\text{g/mL}, V = 2.5\text{mL}, m = ?$$

$$\text{But } D = m/V \quad m = DV = 1 \times 2.5 = 2.5\text{g}$$

$$\text{Moles of water} = \text{mass/MM} = 2.5/18 = 0.1388\text{mols}$$

Therefore, the number of moles will be

$$0.1388 \times 6.02 \times 10^{23} = 8.36 \times 10^{22}$$

molecules

Correct Option A

79. A 5g subshell has 9 orbitals, with 18 Electrons max.

Correct Option A

80. ***

UNIVERSITY OF BENIN, BENIN CITY NIGERIA
FACULTY OF PHYSICAL SCIENCES
DEPARTMENT OF CHEMISTRY

FIRST SEMESTER B.Sc (HONS) DEGREE EXAMINATION 2022/2023 SESSION-
CHM 111 – GENERAL CHEMISTRY 1 **JANUARY, 2024**

INSTRUCTION: Answer any ALL questions

Time Allowed: 3hrs

1. The density of a gaseous organic compound is 3.38 g/L at 40°C and 1.97 atm. What is its molar mass? ($R = 0.0821 \text{ L atm/K mol}$) (a) 22.05 g/mol (b) 26.46 g/mol (c) 33.2 g/mol (d) 44.10 g/mol (e) 66.15 g/mol
2. Which molecule contains an sp-hybridized orbital? (a) HCO_2H (b) HNO_3 (c) HNO_2 (d) HCN
3. A Compound was analyzed in the laboratory and found to contain 69.949% iron and 30.06% oxygen. What is the molecular formula of the compound (a) FeO (b) Fe(OH)_2 (c) FeO_3 (d) none of the above
4. An atmosphere consists of 79 mole % N_2 , 17 mole $^{16}\text{O}_2$ and 4 mole % $^{18}\text{O}_2$. The pressure of the mixture is 0.75 atm. Calculate the partial pressure of $^{18}\text{O}_2$ (a) 0.30 atm (b) 0.33 atm (c) 0.03 atm (d) 0.040 atm (e) 0.06 atm
5. A 1.00 liter sample of gas at 1.10 atm is compressed to 0.80L at constant temperature. The final pressure of the gas is (a) 4.30 atm (b) 2.55 atm (c) 2.68 atm (d) 1.38 atm (e) 3.18 atm
6. The empirical formula of a compound is CH_2O . Its molecular weight is 120. The molecular formula of the compound is (a) CH_2O (b) $\text{C}_2\text{H}_3\text{O}_2$ (c) $\text{C}_3\text{H}_5\text{O}_3$ (d) $\text{C}_4\text{H}_8\text{O}_4$.
7. How many moles are in 41.6g of ammonium carbonate? ($\text{O} = 12$, $\text{N} = 14$) (a) 0.433 mol (b) 0.033 mol (c) 1.724 mol (d) 0.466mol
8. All the following are group (VIA) elements except (a) selenium (b) potassium (c) bismuth (d) tellurium
9. The maximum number of electrons that can be accommodated in a subshell for which $l = 3$ is (a) 2 (b) 10 (c) 6 (d) 14 (e) 8
10. Calculate the number of neutrons in ^{233}Pa [$\text{Pa} = 91.0$] (a) 91 (b) 142 (c) 146 (d) 233 (e) 239
11. Calculate the density of carbon dioxide (CO_2) in grams per litre (g/L) at 752 mmHg and 55°C ($C = 12.01, O = 16.00$) (a) 1.62 g/L (b) 2.86 g/L (c) 28.62 g/L (d) 26.82 g/L (e) none of the above
12. Estimate the pressure (in atm) inside a television picture tube given that its volume is 5.0L, its temperature is 25°C and it contains 0.01mg of nitrogen gas. Molar mass of nitrogen gas is 28.02 g/mol (a) 1.7×10^{-5} atm (b) 1.7×10^{-6} atm (c) 1.6×10^{-5} atm (d) 1.4×10^{-6} (e) 1.6×10^{-6}
13. Which of the following overlap will result in the formation of a pi bond? (a) overlap of two s- orbitals (b) overlap of two p-orbitals along their axis (c) sideways overlap of two p-orbitals (d) overlap of one s and one p-orbital
14. What is the geometric structure of PCl_5 ? (a) tetrahedral (b) octahedral (c) trigonal planar (d) none of the above
15. The percentage by weight of Zn in white vitriol $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ ($\text{Zn} = 65$, $\text{S} = 32.0$, $\text{O} = 6$ $\text{H} = 1$) is approximately (a) 23 (b) 33 (c) 43 (d) 13
16. $^{59}_{27}\text{Co}$ has _____ unpaired electrons (a) 1 (b) 2 (c) 3 (d) 4 (e) 5
17. The arrangement of five electron pairs is (a) linear (b) trigonal planar (c) trigonal bipyramidal (d) bent (e) octahedral
18. 3g of CH_4 and 2g of hydrogen are mixed and kept at 760 mmHg at 273K. The total volume occupied by the mixture will be? (a) 1.2L (b) 22.4L (c) 33.6L (d) 44.8L
19. 25.8L of a gas has a pressure of 690torr and a temperature of 17°C. What will be the volume if the pressure is changed to 1.85atm and the temperature to 345K (a) 25.8L (b) 23.5L (c) 15.1L (d) 21.5L
20. Which oxide of nitrogen is solid at room temperature (a) NO_2 (b) N_2O (c) N_2O_5 (d) N_2O_4
21. The europium nucleus has a charge of +63. How many electrons are there in Eu^{3+} ion? (a) 66 (b) 63 (c) 62 (d) 61 (e) 60
22. How many σ and π bonds are in a C_6H_6 molecule if the carbons are bonded in hexagonal (six – member ring)? (a) 6, 6 (b) 3, 6 (c) 6, 3 (d) 9, 6 (e) 12, 3
23. 2.65L of an ideal gas at 25°C and 1.00atm is warmed and compressed until the final temperature is 75°C and the final pressure is 2.00 atm. What is the final volume? (a) 1.05L. (b) 2L (c) 1.55L (d) 1.75L (e) 1.50L
24. State the number of unpaired electrons in the electronic configuration of chromium [$\text{Cr} = 24$] (a) 2 (b) 4 (c) 3 (d) 6
25. At 38°C the partial pressure of nitrogen (0.5 liters, 14 mol/g) and neon (0.8L, 20 mole/g) enclosed in a gas tube are 1.2atm and 2atm respectively. Estimate the total mass of the gases (a) 3.321 g (b) 1.124g (c) 1.534 g (d) 2.892g (e) none of the above
26. Given the following sets of quantum numbers for n, l, m, m_s . Which one of these set is not a possible set for an electron in an atom?

	n	l	m	m_s
(a)	3	1	-1	0
(b)	3	2	2	$-\frac{1}{2}$
(c)	4	3	2	$+\frac{1}{2}$
(d)	4	3	-2	$-\frac{1}{2}$

27. A compound has a molar mass of 90.0 g/mol and its percent composition is 2.22% H, 26.7% C, and 71.1% O. What is its molecular formula? (a) $\text{H}_2\text{C}_2\text{O}_4$ (b) CH_2O_2 (c) $\text{C}_2\text{H}_4\text{O}_2$ (d) none of the above



28. How many pi - and sigma bonds are in the molecule $\text{CH}_3\text{-CH}=\text{CH-C}\equiv\text{C-H}$? (a) 4 sigma bonds, 2-pi bonds (b) 10 sigma bonds, 3 pi bonds (c) 6 sigma bonds, 3 pi bonds (d) 11 sigma bonds, 3 pi bonds (e) 7 sigma bonds, 2 pi bonds
29. How many molecules are present in one gram of hydrogen gas? (a) 6.02×10^{23} (b) 3.01×10^{23} (c) 5×10^{23} (d) 1.5×10^{23}
30. The species that contains 24 protons, 26 neutrons and 22 electrons would be represented by the symbol y
(a) $^{50}_{24}\text{Cr}^{2+}$ (b) $^{56}_{24}\text{Cr}^{2+}$ (c) $^{50}_{30}\text{Cr}^{2+}$ (d) $^{50}_{22}\text{Mn}^{2-}$ (e) $^{24}_{22}\text{Cr}^{2+}$
31. What is the maximum number of electrons that can occupy a 3p subshell; 2s subshell and 2p subshells
(a) 3, 1, 3 (b) 6, 3, 6 (c) 6, 2, 6 (d) 2, 6, 2
32. A sample of chlorine gas is confined in a 5.0L container at 228torr and 27°C. How many moles of gas are in the sample?
(a) 61mol (b) 6.01mol (c) 0.061mol (d) 0.82mol (e) 0.082mol
33. If it takes 1.25 minutes for 0.010 mol of He to effuse, how long will it take the same amount of ethanol (C_2H_6 to effuse [H = 1.0, C = 12.0, He = 4.0] (a) 1.72 min (b) 2.74 min (c) 3.43 min (d) 3.88 min
34. What is the hybrid orbital of the central atom in SF_4 ?
(a) tetrahedral (b) trigonal bipyramidal (c) trigonal planar (d) octahedral (e) linear
35. The half-life of sulphur-35 is 88 days. If 8g of sulphur-35 exist on day one, what fraction will remain after 264 days?
(a) 0.5g (b) 4g (c) 0g (d) 1.0g
36. What is X in the following nuclear reaction equation: $^{58}_{28}\text{Ni} + ^1\text{H} \rightarrow ^{55}_{27}\text{Co} + X$
(a) ^3_2He (b) ^3_1H (c) ^4_2He (d) ^1_0H (e) ^2_0H
37. Calculate the percentage of nitrogen by mass in $\text{Ca}(\text{NO}_3)_2$ (a) 27.5% (b) 17.35% (c) 17.1% (d) 27.30%
38. Caffeine contains 48.5% carbon, 5.15% hydrogen, 28.9% nitrogen and 16.5% oxygen by mass. What is the empirical formula of caffeine if its molar mass is about 195g/mol. What is its molecular formula
(a) $\text{C}_8\text{H}_{10}\text{N}_2\text{O}_4$ (b) $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$ (c) $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$ (d) $\text{C}_6\text{H}_{10}\text{N}_8\text{O}_2$
39. How old is a fossil bone whose ^{14}C is 15% that of a living bone? [$t_{1/2} = 5.73 \times 10^3$ years]
(a) 25,400 years (b) 15,600 years (c) 380 years (d) 480 years
40. What mass of oxygen is combined with 4.13×10^{24} atoms of sulfur in Na_2SO_4 ? [Na = 23, O = 16, S = 32]
(a) 224.5g (b) 439g (c) 156g (d) none of the above
41. What type of hybrid orbital is involved in the bonding of carbon atom in $\text{H}_2\text{C}-\text{CH}_2$
(a) sp (b) sp^3 (c) sp^3d (d) sp^2 (e) none of the above
42. A mixture of gases contains 4.46 moles of neon (Ne), 0.74 mole of argon (Ar) and 2.15 moles of Xenon (Xe). Calculate the partial pressure of neon (Ne). If the total pressure is 2.00 atm at a certain temperature
(a) 0.2atm (b) 0.586atm (c) 1.21atm (d) 5.86atm (e) 12.82atm
43. Which of the following molecules contains a central atom that does not obey the octet rule
(a) PBr_3 (b) AlI_3 (c) PF_3 (d) SiCl_4 (e) CH_4
44. Which of the following element is a metalloid (a) Li (b) Be (c) B (d) C (e) none of the above
45. The electronic configuration for an element in the halogen group should always end with
(a) ns^2 (b) $\text{ns}^2 \text{np}^6$ (c) $\text{ns}^2 \text{np}^4$ (d) $\text{ns}^2 \text{np}^2$ (e) ns^2
46. How many paired electrons are there in an atom of Sodium and Oxygen?
(a) 2 and 3 (b) 3 and 4 (c) 6 and 2 (d) 5 and 3 (e) 4 and 4
47. Determine the hybridization state of Al atom in AlI_3 molecule (a) sp^1 (b) sp (c) spd (d) sp^3d^2 (e) sp^2
48. Which species does not contain an sp^3 -hybridized atom? (a) BH_3 (b) BH_4^- (c) NH_3 (d) NH_4^+
49. What is the wavelength (in nanometers) of a photon emitted during a transition from $n_i = 5$ state to a $n_f = 2$ state in the hydrogen atom (a) 4.34 nm (b) 434 nm (c) 520nm (d) 5.20nm
50. what shape do you expect from a molecule having central atom with two bonding electrons and two non-bonding electron
(a) tetrahedral (b) trigonal planar (c) bent (d) linear (e) octahedral
51. 50 ml of gas A effuses through a pinhole in 146 seconds. The same volume of CO_2 under identical conditions effuses in 115 seconds. Calculate the molecular mass of A (a) 360 (b) 71.0 (c) 128 (d) 135.0 (e) 142.0
52. The correct ground state electronic configuration of chromium atom (Atomic number = 24) is
(a) [Ar] $3\text{d}^5 4\text{s}^1$ (b) [Ar] $3\text{d}^4 4\text{s}^2$ (c) [Ar] $3\text{d}^4 4\text{s}^1$ (d) [Ar] $3\text{d}^6 4\text{s}^2$
53. What is the mass of 1g of calcium (Ca = 40.1g) (a) 6.66×10^{-23} g (b) 155.88g (c) 40.1g (d) 0.025g
54. Given $R = 0.08205\text{L atm/mol deg}$ and molar mass of Fluorine is 38.00. What is the density of Fluorine gas in g/L in a sample that exerts a pressure of 95 torr at 0°C? (1 atm = 760 torr) (a) 1.6 g/L (b) 0.21 g/L (c) 0.10g (d) 1.11 g/L (e) 0.11 g/L
55. You have 207ml of chlorine trifluoride gas at 699 mmHg and 45°C. What is the mass (in g) of the sample
(a) 67.49g (b) 0.6749g (c) 34.82g (d) 42.08 g (e) 6.74g
56. A gas of unknown identity diffuses at the rate of 160mL per second in a diffusion apparatus in which a second gas whose molecular weight is 28.0 diffuses at a rate of 24.2 mL per second. Calculate the molecular weight of the first gas? (a) 46.50 g/mol (b) 64.05 g/mol (c) 45.60 g/mol (d) 66.00 g/mol (e) 65.05g/mol
57. Which of these elements can't form peroxides (a) Li (b) Na (c) Ca (d) Ba (e) none of the above
58. A compound made of two elements A and B are found to contain 25% A (atomic mass 12.5) and 75% B (atomic mass 37.5). The simplest formula of the compound is (a) AB (b) AB_2 (c) AB_3 (d) A_3B
59. Arrange the following elements in order of increasing electronegativity, Li, Be, O, F, N, C (a) $\text{Li} < \text{Be} < \text{O} < \text{F} < \text{N} < \text{C}$ (b) $\text{Be} < \text{O} < \text{F} < \text{Li} < \text{C}$ (c) $\text{Li} < \text{Be} < \text{C} < \text{N} < \text{O} < \text{F}$ (d) $\text{F} < \text{O} < \text{N} < \text{C} < \text{Be} < \text{Li}$ (e) none of the above

60. What is the maximum number of electrons for an $n = 3$ shell? (a) 10 (b) 6 (c) 18 (d) 8 (e) 2
61. Atomic weight of a metal M is 56. The empirical formula of its oxide containing 70% of M is
 (a) MO_2 (b) M_2O , (c) M_3O_2 (d) MO_4
62. What is the total number of orbitals associated with principal quantum number $n = 3$ (a) 6 (b) 12 (C) 18 (d) 9
63. What is the F-B-B bond angle of a planar BF_3 molecule (a) 180° (b) 109° (c) 107° (d) 104° (c) 120°
64. Which of the following configuration represents an alkaline earth element?
 (a) $[\text{Ar}] 4s^1 3d^5$ (b) $[\text{Ar}] 4s^2 3d^1$ (c) $[\text{Xe}] 5s^2 5d^1$ (d) $[\text{Rn}] 7s^2$
65. In the following nuclear equation: $^{27}_{13}\text{Al} + X \rightarrow ^{30}_{15}\text{P} + ^1_0\text{n}$ X is
 (a) an alpha particle (b) a beta particle (c) a proton (d) a positron (e) tritium
66. A metal forms two different oxides A and B when heated in a stream of hydrogen gas, 7.10g of A gives 5.62g of the metal while 6.04g of B gives 4.34g of metal. Which option agrees with the law of definite proportions
 (a) 40% (b) 50% (c) 30% (a) 80% (c) 70%
67. The density of water is 1.0g at 4°C . How many molecules are present in 2.5ml?
 (a) 8.36×10^{22} (b) 3.28×10^{22} (c) 2.38×10^{22} (d) 6.02×10^{23}
68. Which of the following contains more electrons than neutrons?
 (a) $^{25}_{12}\text{X}^{2+}$ (b) $^{33}_{16}\text{X}^{2-}$ (c) $^{75}_{33}\text{Cr}^{3-}$ (d) $^{26}_{13}\text{X}$ (e) none of the above
69. Calculate the percentage of oxygen in CaSO_4 [Ca = 40.08g S = 32.06g, O = 16g]
 (a) 16% (b) 11.75% (c) 29.44% (d) 47.019%
70. Which of the following does not have sp^2 hybridization? (a) C_6H_6 (b) C_2H_4 (c) BeCl_3 (d) C_2H_2 (e) BCl_3
71. Which of the following contains the largest number of molecules?
 (a) 0.2 mol H_2 (b) 8.0g H_2 (c) 17g of H_2O (d) 6g of CO_2
72. The H-O-H bond angle in the H_2O molecule increased from the predicted 90° to 104.5° because
 (a) H_2O is sp^2 hybridized (b) the OH bonds and H atoms occupy the same sphere
 (c) There is an overcrowding between the OH and the H bonds (d) H_2O is sp^3 hybridized
 (c) The O-H bonds need to spread apart to avoid the overcrowding of the H atoms into the same space
73. Which of the following is correct of the H-N-H bond angle in NH_3 molecule
 (a) 109.5° (b) 104.5° (c) 90° (d) 180° (e) 107.3°
74. An electron having the following set of quantum numbers $n = 4$, $L = 2$, $m = 0$, $s = \frac{1}{2}$ would be classified as a
 (a) 3d electron (b) 4d electron (c) 3p electron (d) 4p electron (e) 4s electron
75. If 10.0g of sodium and 20.0g of chlorine are mixed, they react to form 25.4g of sodium chloride. Calculate the mass of chlorine that does not react (a) 4.6g (b) 2.3g (c) 1.15g (d) None of the above
76. A compound contains 85.7% carbon and 14.3% hydrogen and has a molar mass of 98 g/mol. What is the molecular formula? (a) C_2H_4 (b) C_6H_{12} (c) C_2H_{14} (d) C_7H_8
77. The volume occupied by 0.5 mole CO_2 at a pressure of 150KPa and at 19°C will be?
 (a) 8.09 dm^3 (b) 8.89 dm^3 (c) 9.09 dm^3 (d) 8.13 dm^3
78. Determine the empirical formula of a compound containing 29.09% Na, 40.559% S, and 30.36% O.
 (a) $\text{Na}_2\text{S}_2\text{O}_3$ (b) Na_2SO_4 (c) NaSO (d) none of the above
79. Elements in the periodic table are arranged on what basis?
 (a) Boiling point (b) atomic number (c) atomic mass (d) chemical symbols (e) none of the above
80. When there is a gamma decay process, the mass number of a radionuclide is:
 (a) Reduced by two (b) increased by one (c) not changed (d) increased by two (e) reduced by one
81. Which of the central atoms in the following molecules is not sp^2 hybridized (a) C_6H_6 (b) C_2H_4 (c) BeCl_2 (d) C_2H_2 (c) BF_3
82. A sample of an ideal gas occupies a volume of 2L at 27°C If the temperature is increased to 327°C at constant temperature, the new volume of the gas is (a) 3L (b) 6L (c) 4L (d) 8L (e) 4.5L
83. Which of the following sets of quantum numbers is unacceptable?
 (a) $[1, 0, \frac{1}{2}, -\frac{1}{2}]$ (b) $[3, 0, 0, +\frac{1}{2}]$ (c) $[3, 2, 1, -\frac{1}{2}]$ (d) $[4, 3, -2, +\frac{1}{2}]$ (e) $[1, 0, 0, +\frac{1}{2}]$
84. The volume occupied by 4.4g of CO_2 at STP is (a) 22. 2L (b) 2.24L (c) 0.224 L. (d) 0.1L.
85. The stability and inertness possessed by nitrogen existing as a diatomic gas can approximately be attributed to (a) two lone pair of electrons (b) completely filled p-orbital (c) partially filled p- orbital (d) Three unpaired electrons
86. A piece of charcoal from the ruins of a settlement in Japan was found to have $^{14}\text{C}/^{12}\text{C}$ ratio that was 0.617 times that found in living organisms. How old is this piece of charcoal given that $t_{1/2}$ for C is 5770 years
 (a) 4730 years (b) 4033 years (c) 4030 years (d) 4300 years
87. Which of the following is NOT a possible value for the quantum number for an electron in a 3p-orbital?
 (a) $(3, 2, 1, \frac{1}{2})$ (b) $(3, 1, 0, -\frac{1}{2})$ (c) $(3, 1, -1, -\frac{1}{2})$ (d) $(3, 1 + 1, -\frac{1}{2})$
88. The number of molecules is 4.25g ammonia is approximately (a) 1.0×10^{23} (b) 1.5×10^{23} (c) 2.0×10^{23} (d) 3.5×10^{23}
89. Which of the following metals react slowly with steam? (a) strontium (b) barium (c) magnesium (d) beryllium
90. If a gaseous compound composed of carbon and hydrogen diffuses through a pinhole 0.1826 times as fast hydrogen. What is the correct formula of the compound? (a) CH_2 (b) C_2H_4 (c) C_2H_6 (d) C_2H_5 (e) none of above



SOLUTIONS TO CHM111, 2022/2023

1. $PV = nRT$, but $n = M/M_m$, and Density M/V
 $\therefore M_m = DRT/P$

$D = 3.35 \text{ g/L}$, $T = 40 + 237 = 313 \text{ K}$, $R = 0.0821 \text{ L}$

1.97 atm

$$M_m = \frac{DRT}{P} = \frac{3.38 \times 0.0821 \times 313}{1.97} = 44.1 \text{ g/mol}$$

Correct Option D

2. HClN

$$\text{No. of Hybrid} = \frac{\text{No. of Lone pair}}{\text{Surrounding Atoms}} +$$

$\text{NOL} = 0 + 2 = 2$

SP - Linear in shape

NB,

- $\text{HNO}_2 = \text{SP}^2$ bent shape or v-shape
- $\text{HNO}_3 = \text{SP}^2$ Trigonal Planar
- $\text{HCO}_2\text{H} = \text{HCOOH} = \text{SP}^2$ Trigonal Planar

Correct Option D

3. $\text{Fe} : \text{O}$

$69.94 : 30.06$

$69.94/55.8 : 30.06/16$

$1.25 : 1.88$

$1 : 1.5$

Multiplying all through by 2

$2 : 3$

Fe_2O_3

Correct Option D

4. $\text{N} = 79\%$, $^{16}\text{O} = 17\%$, $^{18}\text{O} = 4\%$, $P_T = 0.75 \text{ atm}$

$$P_{O_{16}} = \frac{n_{O_{16}}}{n_N + n_{O_{16}} + n_{O_{18}}} \times P_T$$

$$P_{O_{16}} = \frac{4}{7.9 + 17 + 4} \times 0.75 = 0.03125 = 0.031 \text{ atm}$$

Correct Option C

5. $V_1 = 1 \text{ L}$, $P_1 = 1.1 \text{ atm}$, $V_2 = 0.8 \text{ L}$, $P_2 = ?$

$P_1 V_1 = P_2 V_2$

$$P_2 = P_1 V_1 / V_2 = 1.1 \times 1 / 0.8 = 1.378 \text{ atm}$$

Correct Option D

i. Short cut to calculate molecular formula, since the molecular weight is given (120g/mol). Simply find the molar mass of the options and pick the one with molar mass equal to the given molar mass of 120g/mol.

(a) $\text{CH}_3\text{O} = 12 + 2(1) + 16 = 30 \text{ g/mol}$

(b) $\text{C}_2\text{H}_3\text{O}_2 = 2(12) + 3(1) + 2(16) = 59 \text{ g/mol}$

(c) $\text{C}_3\text{H}_6\text{O}_3 = 3(12) + 3(1) + 3(16) = 90 \text{ g/mol}$

(d) $\text{C}_4\text{H}_8\text{O}_4 = 4(12) + 8(1) + 4(16) = 120 \text{ g/mol}$

Correct Option D

7. Ammonium Carbonate formula $(\text{NH}_4)\text{CO}_3$

Molar mass $(\text{NH}_4)\text{CO}_3 = 2(14) + 8(1) + 12 + 3(16)$

3(16)

Molar mass $(\text{NH}_4)\text{CO}_3 = 96 \text{ g/mol}$

No. Of Moles $M/M_m = 41.6/96 = 0.433 \text{ mol}$

Correct Option A

8. Potassium is a Group IA element not Group VIA

Correct Option B

9. Max number of electrons when $L = 3$ is 14, since it belongs to the f-orbital with 7 subshells.

Correct Option D

10. $^{233}_{91}\text{Pa}$

Number of neutrons Mass No. - Proton No.

Number of neutrons $233 - 91 = 142$ Neutrons

Correct Option B

11. Using the ideal gas equation...

$PV = nRT$

D Mm × P/RT

$\text{CO}_2 = 12 + 2(16) = 44 \text{ g/mol}$

R 0.0821, T 25 + 273 = 328 K, P 752mmHg, now we have to convert pressure to ATM since R is in ATM. $\therefore P = 752/760 = 0.989 \text{ atm}$

$$D = \frac{MmP}{RT} = \frac{44 \times 0.989}{0.0821 \times 328} = 1.615 \text{ g/L}$$

Correct Option A

12. $V = 5 \text{ L}$, $P = ?$, $T = 25 + 273 = 298 \text{ K}$

$M = 0.01 \text{ mg} = 0.01 \times 10^{-3} \text{ g}$, $Mm = 28.02$, $R = 0.0821$

$PV = nRT$

$$P = \frac{MRT}{MmV} = \frac{0.01 \times 10^{-3} \times 0.0821 \times 298}{28.02 \times 5} = 1.745 \times 10^{-6} \text{ atm}$$

Correct Option B

13. Pi bonds are formed by side ways overlap of orbitals while Sigma bonds are formed by head-on overlap of orbitals.

Correct Option C

14. PCl_5

$$\text{No. of Hybrid} = \frac{\text{No. of Lone pair}}{\text{Surrounding Atoms}} +$$

$\text{NOH} = 0 + 5 = 5$

Hence, Trigonal Bipyramidal

Correct Option D

$$15. \% \text{Zn} = \frac{\text{Zn}}{\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}} \times 100$$

Zn = 65 g

$\text{ZnSO}_4 \cdot 7\text{H}_2\text{O} = 65 + 32 + 4(16) + 14(1) + 16$

191 g/mol

$$\% \text{Zn} = \frac{65}{191} \times 100 = 34\%$$

No Correct Option

However, since the question is asking for an appropriate value, Option B is the best Approximate.

Correct Option B

16. Co | ^{18}Ar | $4s^2 3d^7$

Cobalt has (10 - 7) = 3 unpaired electrons on its d-orbital

Correct Option C

17. 5 electron pairs simply implies 5 Hybrid Orbitals, hence Trigonal Bipyramidal

Correct Option C

18. $P = 760 \text{ mmHg}$, 1 atm , $T = 273 \text{ K}$, $V_T = ?$, $n = ?$

But Molar mass of $\text{CH}_4 = 12 + 4 = 16 \text{ g/mol}$

No. Of moles $3/16 = 0.1875 \text{ mol}$

Molar mass of $\text{H}_2 = 2(1) = 2 \text{ g/mol}$

No. Of mols $2/2 = 1 \text{ mol}$

$n_T = 0.1875 + 1 = 1.1875 \text{ mol}$

$PV_T = n_T RT$

$$V_T = \frac{n_T RT}{P} = \frac{01.1875 \times 0.0821 \times 273}{1atm} = 26.6L$$

No Correct Option

19. Using ideal gas equation...

$$\frac{PV_1}{T_1} = \frac{PV_2}{T_2} \therefore V_2 = \frac{PVT_2}{T_1 P_2}$$

$$P_1 = 690\text{ Torr} = 690/760 = 0.9079\text{ atm}$$

$$P_2 = 1.85\text{ atm}, T_1 = 17 + 273 = 290\text{ K},$$

$$T_2 = 345\text{ K}, V_1 = 25.8\text{ L}, V_2 = ?$$

$$V_2 = \frac{345 \times 0.9079 \times 25.8}{1.85 \times 290} = 115.1\text{ Liters}$$

Correct Option C

20. N_2O_5 is a solid at room temperature; it's white in colour and formed by the dehydration of HNO_3 by P_2O_5 .

Correct Option C

21. Eu^{3+} (lost $3e^-$ from its neutral atom). Note. Its neutral atom contains 63 protons and 63 electrons, hence loses $3e^-$, will be left with $60e^-$ while the proton number remains same as 63.

Correct Option E

22. Every Benzene ring has 3 pi and 12 sigma bonds
NB. Every carbon atom on a benzene ring is SP^2 hybridized.

Correct Option E

23. Using the ideal gas equation....

$$V_1 = 2.65\text{ L}, T_1 = 25 + 273 = 298\text{ K}, P_1 = 1, P_2 = 2\text{ atm}, \\ T_2 = 75 + 273\text{ K} = 348\text{ K}, V_2 = ?$$

$$\frac{PV_1}{T_1} = \frac{PV_2}{T_2} \therefore V_2 = \frac{PVT_2}{T_1 P_2} = \frac{1 \times 2.65 \times 348}{2 \times 298} \approx 1.55\text{ L}$$

Correct Option C

$$24. {}_{24}\text{Cr} = [{}_{18}\text{Ar}] 4s^1 3d^5$$

Therefore, Cr has 5 unpaired electrons in its d-orbital and 1 unpaired electron in its s-orbital, hence making a total of 6 unpaired electrons.
NB.

The configuration of Cr does not obey Aufbau and Hunds rule of multiplicity. (There are 11 other elements like Cr, that do not obey the principles in the periodic table, meet us at Quintessence for undiluted teachings).

Correct Option D

$$25. T = 38 + 273 = 311\text{ K}, \text{Vol of N}_2 = 0.5\text{ L},$$

$$\text{Vol of Ne} = 0.8\text{ L}, V_T = 0.5 + 0.8 = 1.3\text{ L}$$

$$P_{N_2} = 1.2\text{ atm}, P_{Ne} = 2\text{ atm}, M_m \text{ of N}_2 = 14,$$

$$M_m \text{ of Ne} = 20, M_m \text{ of } = 14 + 20 = 34\text{ g/mol}$$

$$P_T = 1.2 + 2 = 3.2\text{ atm}$$

$$\text{But } PV = nRT, n = M_T/M_m$$

$$M_T = \frac{P_T V_T M_m}{RT} = \frac{3.2 \times 1.3 \times 34}{0.0821 \times 311} = 5.54\text{ g}$$

Correct Option E

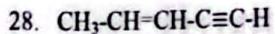
26. The set $n = 3, l = 1, m = -1, M_s = 0$ is not a possible set for an electron. No electron has a zero spin, it's either $+\frac{1}{2}$ or $-\frac{1}{2}$

Correct Option A

27. Since the molar mass is 90g/mol, $\text{H}_2\text{C}_2\text{O}_4$ is the correct Option since it's molar mass is also 90g/mol.

$$\text{H}_2\text{C}_2\text{O}_4 = 2(1) + 2(12) + 4(16) = 90\text{ g/mol}$$

Correct Option A



No. of pi bonds = 3

No. of Sigma bonds = 10

Correct Option B

29. 1g of H_2 contains how many moles?

$$n = 1/2 = 0.5 \text{ moles of H}_2$$

But 1mol of H_2 contains 6.02×10^{23} moles

0.5 mole will contain...

$$X = 0.5 \times 6.02 \times 10^{23} = 3.01 \times 10^{23} \text{ molecules of H}_2$$

Correct Option B

30. Let x be the specie ${}_b^a X^c$

$$a = \text{atomic mass} = P + N = 24 + 26 = 50$$

$$b = \text{number of protons} = 24$$

c = No. Of lost or gain e- = +2, this is because, a total of 22e- are left in the presence of 24 protons, hence lost 2.

$${}_b^a X^c = {}^{50}_{24} X^{2+} \equiv {}^{50}_{24} Cr^{2+}$$

Correct Option A

31. P-orbital has $6e^-$ max

S-orbital has $2e^-$ max

Hence, 3P, 2S, 2P = 6, 2, 6

Correct Option C

$$32. V = 0.5\text{ L}, T = 27 + 273 = 300\text{ K},$$

$$P = 228\text{ Torr} = 228/760 = 0.3\text{ atm}, R = 0.0821, n = ?$$

$$\text{But } PV = nRT$$

$$n = \frac{PV}{RT} = \frac{0.3 \times 0.5}{0.0821 \times 300} = 6.09 \times 10^{-3} = 0.0061\text{ mol}$$

Correct Option C

33. Note the question is quite wrongly set. The question used ethanol as C_2H_6 which ought to be ethane, however, let us assume the examiners had ethane in mind.

Hint: First calculate the mass of helium present in 0.01mol, also calculate the mass of ethane present in the same 0.01mol. then apply Grahams Law of effusion

$$\text{Mole of He} = \text{given mass/molar mass} = 0.1$$

$$\text{Mass of He} = 4 \times 0.01 = 0.04\text{ g}$$

$$\text{Mole of } \text{C}_2\text{H}_6 = \text{given mass/molar mass} = 0.1$$

$$\text{Mass of He} = 30 \times 0.01 = 0.3\text{ g}$$

$$t_{C_2H_6} = \frac{t_{He} \sqrt{M_{C_2H_6}}}{\sqrt{M_{He}}} = \frac{1.25 \sqrt{0.3}}{\sqrt{0.04}} = 3.42 \text{ min}$$

Correct Option C

$$34. \frac{\text{No. of Hybrid}}{\text{No. of lone pair}} = \frac{\text{No. of}}{\text{Surrounding Atoms}}$$

$$\text{SF}_4 = 1 + 4 = 5 \quad \text{HENCE, } SP^3d$$

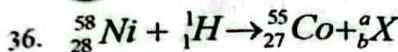
Trigonal Bipyramidal aka See-saw or saw-horse

Correct Option B

$$35. T_{1/2} = 88\text{ days}, t = 264\text{ days}, N_i = 8\text{ g}, N_f = ?$$

$$\frac{N_i}{N_f} = 2^n \quad \therefore N_f = \frac{N_i}{2^{t/T_{1/2}}} = \frac{8}{2^{264/88}} = 1\text{ g}$$

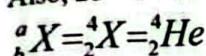
Correct Option D



a = ? b = ?

But $58 + 1 = 55 + a$, Hence a = 4

Also, $28 + 1 = 27 + b$, Hence b = 2



Correct Option C

37. $\%N = \frac{2N}{Ca(NO_3)_2} \times 100$

$Ca(NO_3)_2 = 40 + 2(14) + 6(16) = 164\text{g/mol}$

$$\%N = \frac{2(14)}{164} \times 100 = 17.07 \cong 17.1\%$$

Correct Option C

38. Applying the short cut stated earlier...

$$C_8H_{10}N_4O_2 = 8(12) + 10(1) + 4(14) + 2(16)$$

$$C_8H_{10}N_4O_2 = 195\text{g/mol}$$

Correct Option C

39. $\frac{N_i}{N_f} = 2^n$

$N_i = 100\%$, $N_f = 15\%$

$100/15 = 2n$

6.667 = $2n$ applying "ln" on both sides

$$\ln(6.667) = n \ln 2 \quad \therefore n = \ln 6.667 / \ln 2 = 2.737$$

But, $n = t/T_{1/2}$

$$t = n \times T_{1/2} = 2.737 \times 5.73 \times 103 = 15,683\text{yrs}$$

Correct Option B

40. If 4.13×10^{24} atoms of S are there in Na_2SO_4

$\therefore 4 \times (4.13 \times 10^{24})$ atoms of O₂ are present in Na_2SO_4

$\therefore 1.652 \times 10^{25}$ atoms of O₂ are present in Na_2SO_4

But if 1mol of O₂ contains 6.02×10^{23} atoms of O₂

Then, x moles of O₂ will be contained in 1.652×10^{25} atoms

$$x = \frac{1.652 \times 10^{25}}{6.02 \times 10^{23}} = 27.44 \text{ mol of } O_2$$

$\therefore 27.44$ moles of O₂ got combined with 4.13×10^{24} atoms of Sulphur.

Now mass of O₂ will be...

$$n = \text{mass/Mm} \quad \therefore \text{Mass} = n \times Mm = 27.44 \times 16 = 439\text{g}$$

Correct Option B

41. SP² hybridization

Correct Option D

42. $P_{Ne} = \frac{n_{Ne}}{n_T} \times P_T$

$n_{Ne} = 4.46$, $n_{Ar} = 0.74$, $n_{Xe} = 2.15$,

$$n_T = 0.46 + 0.74 + 2.15 = 7.35$$
, $P_T = 2\text{atm}$

$$P_{Ne} = \frac{4.46}{7.35} \times 2 = 1.21\text{atm}$$

Correct Option C

43. The octate rule simply states that, after bonding, the central atom of an element is *expected to have 8 electrons in its outermost shell*. Exceptions to this rule are, hydrogen, Lithium and Beryllium. Other exceptions are hyper valence elements like Sulphur and phosphorus, this is because when they are completely filled after bonding, will have more than 8 electrons in their outermost shell e.g PCl₅, PBr₅, these

elements will have 10 electrons in their outermost shell after complete bonding hence disobeys the octate rule of configuration.

Correct Option A

44. Boron is the only metalloid in the options; there are 7 metalloid in the periodic table of elements.

Correct Option C

45. Halogen configurations ends with ns² np⁵

Correct Option B

46. Na = 1s² 2s² 2P⁶ 3s¹

Sodium has a total of 5 paired electrons (in the 1s, 2s and 2p), but one unpaired electron in its 3s orbital.

O = 1s² 2s² 2P⁴

Oxygen has 3 paired electrons (1s and 2s) and one paired electron (2p⁴)

Correct Option D

47.
$$\frac{\text{No. of Hybrid}}{\text{No. of Lone pair}} = \frac{\text{No. of}}{\text{Surrounding Atoms}}$$

All₃ = 0 + 3 = 3

Correct Option E

48. BH₃ = SP², BH₄⁻ = SP³, NH₃ = SP³, NH₄⁺ = SP³

Correct Option A

49. n₁ = 5 and n₂ = 2

$$\frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = 1.097 \times 10^{-7} \left[\frac{1}{2^2} - \frac{1}{5^2} \right]$$

$$\frac{1}{\lambda} = 2.3 \times 10^{-8} \quad \therefore \lambda = \frac{1}{2.3 \times 10^{-8}} = 4.34 \times 10^7 \text{ m}$$

To convert $4.34 \times 10^7 \text{ m}$ to nano meter, we simply divide by 10^9 (1 billion)

$$\lambda = 4.34 \times 10^7 / 10^9 = 4.34 \times 10^{-2} \text{ nm} = 434 \text{ nm}$$

Correct Option B

50. Number of bond pair = 2

No. Of unpaired = 2

Hence, bent shape or V-shape

Correct Option C

51. At constant volume, $\frac{t_A}{t_B} = \sqrt{\frac{M_A}{M_B}}$

$$t_A = 146\text{s}, t_B = 115\text{s}, M_A = ?, M_B = CO_2 = 12 + 2(16) = 44\text{g/mol}$$

$$\sqrt{M_B} = \frac{t_B \sqrt{M_A}}{t_A} = \frac{146 \times \sqrt{44}}{115} = 8.42$$

But $\sqrt{M_B} = 8.42$

Squaring both sides

$$M_B = (8.42)^2 = 70.91 = 71\text{g/mol}$$

Correct Option B

52. ${}^{24}Cr = [{}^{18}Ar] 4s^1 3d^5$

Correct Option A

53. 1 mole of Calcium is equivalent to 1g of calcium, Hence

If 1mole of Calcium weights 40.1g, therefore, 1g of calcium will also weigh 40.1g.

In that same line, 2g of calcium (equivalent to 2moles of calcium) will weigh $2 \times 40.1\text{g} = 80.2\text{g}$ of Calcium.

Correct Option C

54. Note the unit of R = 0.08205 Latm/mol/"deg."



Ignore the degree sign and convert your temperature to kelvin, this is because the value of R as 0.08205 is calculated in Kelvin not degree Celsius, hence.

$$M_m = 38, P = 95/760 = 0.125 \text{ atm}, \\ R = 0.08205, T = 0 + 273 = 273 \text{ K}$$

$$D = \frac{M_m \times P}{RT} = \frac{38 \times 0.125}{0.08205 \times 273} = 0.21 \text{ g/L}$$

Correct Option B

$$55. PV = nRT, \text{ where } n = M/M_m$$

$$T = 45 + 273 = 318 \text{ K}, P = 699/760 = 0.919 \text{ atm},$$

$$V = 207 \text{ mL}, 207 \times 10^{-3} \text{ L}, R = 0.0821,$$

$$M_m = \text{ClF}_3 = 35.5 + 3(19) = 92.5 \text{ g/mol}$$

$$M = \frac{PV/M_m}{RT} = \frac{0.919 \times 207 \times 10^{-3} \times 92.5}{0.0821 \times 318} = 0.674 \text{ g}$$

Correct Option B

56. The rate of diff or effusion of a gas is inversely proportional to its molar mass, hence

$$R_A/\sqrt{M_A} = R_B/\sqrt{M_B}$$

$$R_A = 16 \text{ mL/s}, R_B = 24.2 \text{ mL/s}, M_B = 28 \text{ g/mol}, M_A = ?$$

$$\sqrt{M_A} = \frac{R_B \sqrt{M_B}}{R_A} = \frac{24.2 \times \sqrt{28}}{16} = 8.003 \text{ g/mol}$$

$$\sqrt{M_A} = 8.003 \text{ g/mol}$$

Squaring both sides

$$M_A = (8.003)^2 = 64.05 \text{ g/mol}$$

Correct Option B

57. Li, cannot form a peroxide, however, Na and potassium does, Cs, Rb and Fr forms superoxides

Correct Option A

$$58. A : B$$

$$25 : 75$$

$$25/12.5 : 75/37.5$$

$$2 : 2$$

Therefore, Empirical formula = $A_2B_2 = AB$

Correct Option A

59. Electronegativity increases across the period but decreases down the group. Hence across periods 3, the increasing order will be Li < Be < C < N < O < F

Correct Option C

60. The max number of electrons in a given shell is given by $2n^2$, so when n = 3, then $2(3)^2 = 18$ electrons max

Correct Option C

$$61. M : O$$

$$70 : 30$$

$$70/56 : 30/16$$

$$1.25 : 1.875$$

$$1.25/1.25 : 1.875/1.25$$

$$1 : 1.5$$

$$2 : 3$$

Therefore, Empirical formula = M_2O_3

Correct Option B

62. The total number of orbitals in n = 3 will be,

I. 0 S 1 orbital

II. 1 P 3 orbital

III. 2 d 5 orbital

Total orbitals I + 3 + 5 = 9 orbitals

Correct Option D

63. BF_3 is SP^2 , bond angle is 120° . Trigonal pyramidal

Correct Option E

64. Alkaline Earth metals are members of Group IA of the periodic table, with their s-orbital completely filled with 2 electrons, hence

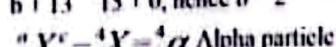
$_{16}\text{Rn}$ 7s² is an alkaline Earth metal.

Correct Option D



a + 27 = 30 + 1, hence a = 4

b + 13 = 15 + 0, hence b = 2



Correct Option A

66. *** No network...

67. Water has a density of 1g/ml. at 4°C , this implies that water weights 1g for every 1ml.vol volume of water.

So at 2.5mL, water will weight x

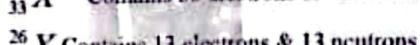
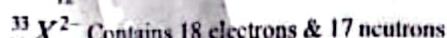
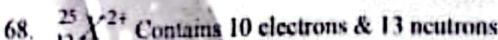
$$X = 2.5/1 = 2.5 \text{ g}$$

No. of moles of water will be $2.5/18 = 0.1388 \text{ mol}$

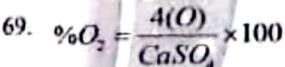
Now the number of molecules in 0.1388 mol will be

$$0.1388 \times 6.02 \times 10^{23} = 8.36 \times 10^{22} \text{ molecules}$$

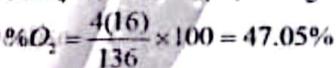
Correct Option A



Correct Option B



$$\text{CaSO}_4 = 40 + 32 + 4(16) = 136 \text{ g/mol}$$



Correct Option D

$\text{C}_6\text{H}_5 = \text{SP}^2$ hybridized

$\text{C}_2\text{H}_4 = \text{SP}^2$ hybridized

BeCl_3 = Wrong molecular formula (should be BeCl_2)

$\text{C}_2\text{H}_2 = \text{SP}$ hybridized

$\text{BCl}_3 = \text{SP}^2$ hybridized

Correct Option D

71. The element or compound with the highest number of moles has the highest number of molecules, hence we capitalize on looking for the element or compound with the highest number of moles.

$$\text{H}_2 = 0.2 \text{ mol}$$

$$8 \text{ g of H}_2 = 8/2 = 4 \text{ mol}$$

$$17 \text{ g of H}_2\text{O} = 17/18 = 0.94 \text{ mol}$$

$$6 \text{ g of C} = 6/12 = 0.5 \text{ mol}$$

$\therefore 8 \text{ g of H}_2$ has the highest number of molecules.

Correct Option B

72. The best among all options is D, water is SP^3 hybridized. However, the major reason for the increase in bond angle from 90° to 104.5° is due to the presence of lone pairs of electrons.

Correct Option D

73. NH_3 molecule has a bind angle of 107.3°



Correct Option E

74. n = 4, l = 2, m = 0, Ms = $\frac{1}{2}$

n = energy level = 4

l = 2 (d-orbital)

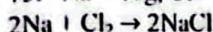
M = 0 (found in the middle subshell)

Ms = $\frac{1}{2}$ (electron spins clockwise)

Hence 4d electron

Correct Option B

75. Na = 10g, Cl = 20g, NaCl = 25.4g



If 2(23)g of Na needs 2(35.5)g of Cl to react completely.

Then 10g of Na will need x

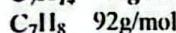
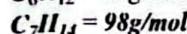
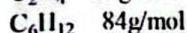
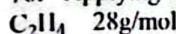
$$X = 2(35.5) \times 10/2(23) = 15.43\text{g of Cl}_2$$

So 10g of Na will only need 15.45g of Cl₂, but 20g of Cl₂ is available, hence, the unreacted Cl₂ gas will be

$$20\text{g} - 15.43\text{g} = 4.56\text{g of Cl}_2$$

Correct Option A

76. Applying the short cut formula discussed earlier..



Hence C₇H₁₄ is the right Empirical formula for a molar mass of 98g/mol.

Correct Option C

77. PV = nRT

n = 0.5mol, R = 8.314KPa dm³/mol/k

P = 150KPa, T = 19 + 273 = 292K, V = ?

$$V = \frac{nRT}{P} = \frac{0.5 \times 8.314 \times 292}{150} = 8.09\text{dm}^3$$

Correct Option A

78. Na : S : O

29.09 : 40.55 : 30.36

29.09/23 : 40.55/32 : 30.36/16

1.26 : 1.26 : 1.89

1.26/1.26 : 1.26/1.26 : 1.89/1.26

1 : 1 : 1.5

2 : 2 : 3

Empirical formula = Na₂S₂O₃

Correct Option A

79. Elements in the periodic table are arranged based on their atomic numbers (Modern Periodic Law)

Correct Option B

80. In every beta decay, the mass number always remains constant while the charge decreases by a unit.

Correct Option C

81. C₆H₆ SP² hybridized

C₂H₄ SP² hybridized

BeCl₂ = SP hybridized

C₂H₂ = SP hybridized

BF₃ SP² hybridized

Options C & D are Correct

82. According to Charle's Law,

V₁T₂ = V₂T₁

V₁ = 2L, V₂ = ?, T₁ = 27 + 273 = 300k,

T₂ = 327 + 273 = 600k

V₂ = V₁T₂/T₁ = 2 × 600/300 = 4L

Correct Option C

83. | n, l, m, Ms | = | 1, 0, $\frac{1}{2}$, $-\frac{1}{2}$ |, this is an unacceptable set of quantum numbers, because the magnetic quantum number, can never be a fraction but rather always whole numbers.

Correct Option A

84. First we need to calculate the number of moles in 4.4g of CO₂, then compare it's volume at STP.

4.4g of CO₂ contains $4.4/44 = 0.1$ mol of CO₂

But if 1 mol of CO₂ occupies 22.4dm³ at STP

Then, 0.1 mole will occupy ? X

$$X = 0.1 \times 22.4/1 = 2.24\text{L}$$

Correct Option B

85. Nitrogen has partially filled p-orbital, hence inert and stable.

Correct Option C

86. ¹⁴C/¹²C in ruins = 0.617

Let ¹⁴C/¹²C in living organisms = 1

Hence N_i = 1, N_f = 0.617, n = ?

$$N_i = N_f 2^n$$

$$1 = 0.617 2^n$$

$$1/0.617 = 2^n \therefore 1.62 = 2^n$$

$$\ln(1.62) = \ln(2)$$

$$n = \ln(1.62)/\ln 2 = 0.6967$$

$$\text{But } n = t/T_{1/2}$$

$$t = n \times T_{1/2} = 0.6967 \times 5770 = 4,019 \text{ yrs.}$$

No Correct Option

87. For an electron in 3p Quantum

n = 3, l = 2, i.e 0, 1, 2 for the p-orbital l = 1

m = 2L + 1 = 2(1) + 1 = 3 subshells (-1, 0, 1)

Ms = $\frac{1}{2}$ or $-\frac{1}{2}$

Hence, [n, l, m, Ms] = [3, 1, (-1, 0 or 1), ($\frac{1}{2}$ or $-\frac{1}{2}$)]

Hence option B is wrong

Correct Option B

88. 4.25g of NH₃, Mass = 4.25g, molar mass = 14 + 3 = 17g/mol

No. Of moles = 4.25/17 = 0.25mol of NH₃

If 1mol of NH₃ contains 6.02×10^{23} molecules of NH₃,

Then, 0.25 moles will contain x ?

$$X = 0.25 \times 6.02 \times 10^{23} = 1.55 \times 10^{23} \text{ molecules of NH}_3$$

Correct Option B

89. Beryllium does not react with cold water or steam at all; Magnesium reacts very slowly with cold water and moderately with steam or boiling water. As for Barium, strontium and Calcium, they react with cold water or steam to form hydroxides.

Correct Option C

90. Let the hydrocarbon be x,

$$R_x \sqrt{M_x} = R_{11} \sqrt{M_{11}}$$

$$R_x = 0.1826 \times R_{11}, R_{11} = 1, M_{11} = 2, M_x = ?$$

$$\sqrt{M_x} = \frac{R_{11} \sqrt{M_{11}}}{R_x} = \frac{1 \times \sqrt{2}}{0.1826(1)} = 59.9 \cong 600 \text{ g/mol}$$

Since the gasouse hydrocarbon has a molecular mass of 60g/mol, Hence it should be C₄H₁₂ (Methane Propane)

Correct Option E

Adumbrated by Juliben PhD Ed. 2024

Answer: (E)

34. We use Snell's Law: $n_1 \sin \theta_1 = n_2 \sin \theta_2$, where n_1 and n_2 are the refractive indices of the liquid and air, respectively, and θ_1 and θ_2 are the angles of incidence and refraction.

The critical angle (θ_c) is given as 52.7° . At the critical angle, the angle of refraction is 90° . Therefore, $n_1 \sin \theta_c = n_2 \sin 90^\circ = n_2$.

We are given $\theta_1 = 40^\circ$. We need to find θ_2 . we can use the critical angle to find the ratio n_1/n_2 .

$$n_1/n_2 = 1/\sin(52.7^\circ)$$

Applying Snell's Law:

$$(n_1/n_2) \sin(40^\circ) = \sin(\theta_2)$$

$$\sin(\theta_2) = (1/\sin(52.7^\circ)) \sin(40^\circ) \approx 0.626$$

$$\theta_2 = \sin^{-1}(0.626) \approx 38.8^\circ$$

Answer: (E)

35. First, Identifying the eye defect shown in the diagram.

The diagram shows that the light rays converge behind the retina, which is characteristic of myopia (shortsightedness)

Identify the type of lens used to correct myopia. A diverging/concave lens is used to correct myopia.

Answer: (D)

36. Calculating the linear density (μ) of the wire.

$$\mu = \text{mass}/\text{length} = 0.01/0.5 = 0.02 \text{ kg/m}$$

Calculating the speed (v) of the wave on the wire

$$v = \sqrt{T/\mu} = \sqrt{(800/0.02)} = 200 \text{ m/s}$$

$$f = v / (2L) = 200 \text{ Hz}$$

Answer: (B)

37. Calculating the linear density (μ) of the wire

$$\mu = \text{mass}/\text{length} = 1 \text{ kg} / 550 \text{ m} = 1/550 \text{ kg/m}$$

Calculating the speed (v) of the wave on the wire

$$v = \sqrt{T/\mu} = \sqrt{(45/(1/550))} = \sqrt{(45 \times 550)} = 158.11 \text{ m/s}$$

Calculating the time (t) for the pulse to travel there and back, $t = 2L/v = (2 \times 550) / 158.11 \approx 6.96 \text{ s}$.

The closest answer is 6.96 s, but this is not among the options. Recalculating:

$$v = \sqrt{(45/(1/550))} \approx 158.11 \text{ m/s.}$$

$$t = (2 \times 550)/158.11 \text{ m/s} \approx 6.96 \text{ s.}$$

Answer: (E)

38. Bulk modulus and the density of the medium

Answer: (D)

39. Calculating the linear density (μ) of the string.

$$\mu = \text{mass}/\text{length} = 0.01 \text{ kg} / 5 \text{ m} = 0.002 \text{ kg/m}$$

Calculate the speed (v) of the transverse wave.

$$v = \sqrt{T/\mu} = \sqrt{(10/0.002)} = \sqrt{5000} \text{ m/s} \approx 70.7 \text{ m/s}$$

Answer: (C)

40. Calculating the speed (v) of the longitudinal wave.

$$v = f\lambda = 250 \times 8.00 = 2000 \text{ m/s}$$

Calculating the bulk modulus (B)

$$v = \sqrt{B/\rho}, \text{ so } B = v^2\rho = (2000)^2 \times 900 = 3.6 \times 10^9 \text{ Pa}$$

Answer: (B)

**DEPARTMENT OF CHEMISTRY
FACULTY OF PHYSICAL SCIENCES
UNIVERSITY OF BENIN, BENIN CITY**

BSC. DEGREE EXAMINATION, SECOND SEMESTER, 2023/2024 SESSION

COURSE: CHM101: GENERAL CHEMISTRY I

CREDIT: 2 TIME ALLOWED 2HOURS

DATE: SEPTEMBER 2024.

INSTRUCTIONS:

- Answer all Questions
- There are five (5) options for each question, shade the correct option with HB PENCIL
- Fill in your personal details in the space provided on top of the answer sheet with HB pencil
- Shade your OPTION TYPE correctly
- No cell phones (handset) is allowed in the examination hall

1. The following are decomposable trioxocarbonate (IV) except: (A) CaCO_3 (B) Na_2CO_3 (C) $\text{Pb}(\text{CO}_3)_2$ (D) Li_2CO_3 (E) MgCO_3
2. The following changes will affect a system in equilibrium except:
(A) concentration (B) volume (C) catalyst (D) Pressure (E) temperature ✓
3. What is the vapour pressure of a solution containing 1.00 g sulfanilamide ($\text{C}_6\text{H}_5\text{N}_2\text{O}_2\text{S}$) dissolved in 10.0 g of acetone at 39.5°C , if the vapour pressure of pure acetone at this temperature is 400 mmHg? [At. wt.(g/mol); C=12.01, H=1.008, N=14.01, O=16.00, S=32.06]. (A) 296 mmHg (B) 342 mmHg (C) 388 mmHg (D) 398 mmHg (E) 400 mmHg
4. Which of the following properties increases across a period?
(A) Atomic radius (B) Electropositivity (C) Ionization energy (D) Electron affinity (E) Electronegativity ✓
5. The rate of effusion of an unknown gas was determined to be 2.92 times greater than that of NH_3 . What is the approximate molecular mass of the unknown gas? [H=1.0 g/mol; N = 14.0 g/mol]
(A) 1.56 g/mol (B) 1.99 g/mol (C) 2.92 g/mol (D) 2.98 g/mol (E) 3.22 g/mol
6. A mixture of He and Ne gases is collected over water at 28°C and 745 mmHg. If the partial pressure of He is 368 mmHg, what is the partial pressure of Ne? [Vapour pressure of water at 28°C = 28.3 mmHg]
(A) 523 mmHg (B) 493 mmHg (C) 349 mmHg (D) 218 mmHg (E) 175 mmHg



7. Which of the following is true? (A) Rb_2O is a basic oxide (B) B_2O_3 is a basic oxide (C) As_2O_5 is a basic oxide (D) Rb_2O is an amphoteric oxide (E) B_2O_3 is an acidic oxide
8. What is the geometry of the molecule XeF_4 ?
(A) Trigonal planar (B) Tetrahedral (C) Trigonal bipyramidal (D) Trigonal pyramidal (E) Octahedral
9. An element with atomic number 12 is likely to have the same chemical properties as those elements in: (A) Group IA (B) Group IIA (C) Group IIIA (D) Group IVA (E) Group VA
10. An element with atomic number 38 belong to period (A) 2 (B) 3 (C) 4 (D) 5 (E) 6
11. In the reaction $^{234}_{90}\text{Th} \rightarrow {}_x^y\text{Pa} + \beta^- + \gamma$ and x respectively are
(A) 234 and 91 (B) 235 and 90 (C) 233 and 89 (D) 230 and 86 (E) 228 and 98
12. The atomic radius of Be, Mg and Ca are 1.13\AA , 1.60\AA and 1.97\AA respectively. This graduation in atomic radius is due to the fact that: (A) electronegativity decreases from Be to Mg to Ca (B) metallicity decreases from Be to Mg to Ca (C) the elements are all in the same period (D) the number of electronic shells increases for Be to Mg to Ca (E) none of the above.
13. How many oxygen atoms are in $0.25 \text{ mol } \text{Ca}(\text{NO}_3)_2$? [$N_A = 6.02 \times 10^{23}$]
(A) 4.52×10^{23} atoms (B) 9.03×10^{23} atoms (C) 3.01×10^{23} atoms (D) 1.20×10^{24} atoms (E) 1.81×10^{24} atoms
14. The following properties decreases down group in the periodic table except:
(A) Electron affinity (B) Atomic radius (C) Ionization energy (D) Electronegativity (E) None of the above
15. Calculate the percent by mass of silicon in the mineral beryl, $\text{Be}_3\text{Al}_2(\text{SiO}_4)_4$ [At. wt. (g/mol): Be=9.0; O=16.0; Al=27.0; Si=28.0]. (A) 17.50% (B) 28.00% (C) 35.00% (D) 52.50% (E) 70.00%
16. A sample of apple cider has a pH of 3.15. What is the hydroxide ion concentration of this solution?
(A) $7.14 \times 10^{-4} \text{ M}$ (B) $4.20 \times 10^{-11} \text{ M}$ (C) $2.80 \times 10^{-11} \text{ M}$ (D) $1.40 \times 10^{-11} \text{ M}$ (E) $7.14 \times 10^{-12} \text{ M}$
17. Calculate the concentration of acetic acid, $\text{C}_2\text{H}_4\text{O}_2$, whose pH is 2.68.
(A) 0.65 M (B) 0.52M (C) 0.44M (D) 0.36M (E) 0.26 M
18. Which of these solutions is not a buffer system?
(A) $\text{NaClO}_4/\text{HClO}_4$ (B) $\text{KH}_2\text{PO}_4/\text{H}_3\text{PO}_4$ (C) $\text{C}_5\text{H}_5\text{N}/\text{C}_3\text{H}_5\text{NHCl}$ (D) $\text{Na}_2\text{CO}_3/\text{NaHCO}_3$ (E) KF/HF
19. The following are examples of amphoteric oxides except: (A) Al_2O_3 (B) Se_2O_3 (C) BeO (D) Fe_2O_3 (E) Sc_2O_3
20. Which of the following solution is the most acidic? (A) 0.10M CH_3COOH ; $K_a = 1.8 \times 10^{-5}$ (B) 0.10M HCOOH ; $K_a = 1.8 \times 10^{-4}$ (C) 0.10M $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$; $K_a = 1.4 \times 10^{-3}$ (D) 0.10M CH_3COOH ; $K_a = 5.1 \times 10^{-2}$ (E) All the above.
21. Which of the following is the hardest synthetic substance after diamond? (A) Al_2O_3 (B) BC_4 (C) AlO_3 (D) B_4C (E) C_6H_6
22. The products formed in the thermal decomposition of magnesium trixonitrate (V) are: (A) Magnesium, oxygen and nitrogen (IV) oxide (B) Magnesium oxide, nitrogen (IV) oxide and oxygen (C) Magnesium oxide, nitrogen (II) oxide and oxygen (D) Magnesium, nitrogen and oxygen (E) Magnesium oxide and nitrogen
23. A solution made by dissolving 0.320g of a new compound in 25.0 g of water has a freezing point of -0.201°C . Calculate the molecular weight of the new compound. [$\text{Kr of H}_2\text{O} = 1.86^\circ\text{C/m}$]. (A) 107 g (B) 119 g (C) 126 g (D) 179 g (E) 238 g
24. Calculate the osmotic pressure (in atm) of an aqueous solution containing 10 g of urea in 500 cm^3 of solution at 12°C [molar mass of urea = 60.0]. (A) 14.56 (B) 12.74 (C) 10.92 (D) 8.27 (E) 7.28
25. 1 mol of HI was placed in a 1 dm^3 reaction vessel at 698 K. At equilibrium, the vessel contained 0.12 mol of H_2 , 0.12 mol of I_2 and 0.88 mol HI. Calculate the K_c at this temperature. (A) 38.75 (B) 46.27 (C) 50.23 (D) 53.78 (E) 73.58
26. For the reaction: $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightarrow 2\text{NH}_{3(g)}$ the value of K_p at 500°C is 1.50×10^5 , calculate the value of K_c .
(A) 0.0604 (B) 0.0755 (C) 0.0906 (D) 0.1208 (E) 0.1812
27. Calculate the binding energy of Ni in MeV per nucleon if the exact mass of this nuclide is 59.9332 amu [${}^1_{1p} = 1.00728 \text{ amu}$; ${}^1_{0n} = 1.00867 \text{ amu}$; ${}^1_{-1e} = 0.0005486$; 1 amu = 931.5 MeV]. (A) 8.70 (B) 7.80 (C) 6.98 (D) 5.25 (E) 524.81
28. A bone taken from a garbage pile buried under a hillside had $^{14}\text{C}/^{12}\text{C}$ ratio 0.477 times the ratio in a living organism. What is the age of the bone? [$^{14}\text{C}: t_{1/2} = 5730 \text{ yr}$]. (A) 2500 yr (B) 3010 yr (C) 4400 yr (D) 5220 yr (E) 6100 yr
29. Naturally occurring magnesium is 78.99% ^{24}Mg atoms (23.98504 amu); 10.0% ^{25}Mg atoms (24.98584 amu) and 11.01% ^{26}Mg atoms (25.98259 amu). Calculate the average atomic mass of Mg.
(A) 23.9858 amu (B) 24.3050 amu (C) 25.8668 amu (D) 23.9478 amu (E) 24.9859 amu
30. What pressure is exerted by a mixture of 5.00 g of hydrogen gas and 7.00 g of nitrogen gas at 273 K in a 10 L vessel? [$\text{H} = 1 \text{ g/mol}$; $\text{N} = 14 \text{ g/mol}$] (A) 11.47 atm (B) 12.33 atm (C) 6.72 atm (D) 6.16 atm (E) 11.74 atm
31. What is the bond angle in methane? (A) 104.5° (B) 109.5° (C) 180° (D) 120° (E) 90°
32. Calculate the density in g/L of nitrogen gas at S.T.P. ($\text{N} = 14 \text{ g/mol}$). (A) 1.25 (B) 0.63 (C) 0.57 (D) 3.45 (E) 0.89
33. How much time would it take for a sample of cobalt-60 to disintegrate to the extent that only 2.0% remains? The disintegration constant λ is 0.13 yr^{-1} . (A) 10 years (B) 20 years (C) 30 years (D) 40 years (E) 45 years
34. The following are examples of interstitial hydrides except: (A) SrH_2 (B) TiH_2 (C) MoH_2 (D) CdH_2 (E) LaH_2
35. Calculate the pH of buffer solution composed of 0.12 M benzoic acid and 0.20M sodium benzoate [$K_a = 6.5 \times 10^{-5}$].
(A) 2.68 (B) 3.31 (C) 4.41 (D) 5.36 (E) 6.82
36. Hydrogen gas is usually produced industrially by the action of steam on _____ (A) Zn (B) Na (C) K (D) Fe (E) Ca
37. The element with the smallest atomic size in the second period is: (A) Li (B) Ne (C) N (D) F (E) Mg
38. An overall equation for the degradation of glucose is $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$. If 98 g of glucose is consumed by a person over a certain period, what is the mass of carbon (IV) oxide produced?
(A) $3.16 \times 10^{-3} \text{ g}$ (B) $1.42 \times 10^3 \text{ g}$ (C) $1.52 \times 10^3 \text{ g}$ (D) $3.16 \times 10^3 \text{ g}$ (E) $5.75 \times 10^3 \text{ g}$



39. A common preparation of oxygen gas is the thermal decomposition of KClO_3 . Assuming complete decomposition takes place, calculate the amount of oxygen gas in grams that can be obtained from 46.0 g of KClO_3 :
(A) 16.0 g (B) 16.55 g (C) 18.35 g (D) 18.00 g (E) 5.00 g
40. Arrange the following in order of increasing acid strength: HCl, HBr, HF, HI, HClO_4 (A) $\text{HCl} < \text{HBr} < \text{HF} < \text{HI} < \text{HClO}_4$, (B) $\text{HF} < \text{HCl} < \text{HBr} < \text{HI} < \text{HClO}_4$, (C) $\text{HF} < \text{HCl} < \text{HBr} < \text{HClO}_4 < \text{HI}$ (D) $\text{HF} < \text{HCl} < \text{HClO}_4 < \text{HBr} < \text{HI}$ (E) $\text{HClO}_4 < \text{HI} < \text{HBr} < \text{HCl} < \text{HF}$
41. List all the possible subshells and orbitals associated with the principal quantum number n, if $n = 5$.
(A) 4s, 4p, 4d, 4f (B) 4s, 4p, 4d, 4f, 4g (C) 5s, 5p, 5d, 5f, 5g (D) 6s, 6p, 6d, 6f, 6g, 6h (E) none of the above
42. What is the total number of electrons that can be held in all orbitals of an atom having a principal quantum n?
(A) $2n^2$ (B) s, p, d, f (C) n, l, m, m, (D) 0,1,2,3 (E) none of the above.
43. Arrange the following atoms in order of decreasing atomic radius Na, Al, P, Cl, Mg (A) $\text{Na} > \text{Mg} > \text{P} > \text{Al} > \text{Cl}$ (B) $\text{Na} > \text{Mg} > \text{Al} > \text{P} > \text{Cl}$ (C) $\text{Cl} > \text{P} > \text{Al} > \text{Na} > \text{Mg}$ (D) $\text{Na} > \text{Al} > \text{P} > \text{Cl} > \text{Mg}$ (E) $\text{Mg} > \text{Na} > \text{P} > \text{Cl} > \text{Al}$
44. Calculate the pH of a buffer system containing 1.0 M CH_3COOH and 1.0 M CH_3COONa
(A) 5.02×10^1 (B) 3.40×10^2 (C) 4.74 (D) 0.302 (E) 3.02×10^2
45. What is the hybridization around the central atom of the molecule BCl_3 ? (A) sp (B) sp^2 (C) sp^3 (D) sp^3d (E) sp^3d^2
46. A sample of oxygen occupies 47.2 litres under a pressure of 1240 torr at 25°C . What volume would it occupy at 25°C and 730 torr? (A) 27.8 L (B) 29.3 L (C) 32.2 L (D) 47.8 L (E) 80.2 L
47. A sample of nitrogen occupies 5.50 litres under a pressure of 900 torr at 25°C . At what temperature will it occupy 10.0 litres at the same pressure? (A) 32°C (B) -109°C (C) 154°C (D) 269°C (E) 370°C
48. What pressure (in atm) would be exerted by 76g of fluorine gas in a 1.50 litre vessel at -37°C ?
(A) 26 (B) 41 (C) 19,400 (D) 84 (E) 50
49. The phenomenon of forming completely new set of atomic orbitals by intermixing them is known as
(a) allocation (B) hybridization (C) chemical bond formation (D) electron configuration (E) promotion
50. Calculate the volume occupied by 9g of nitrogen gas at 37°C and 750 mmHg pressure ($N=14\text{g/mol}$).
(A) 16.58L (B) 8.29 L (C) 0.01 L (D) 0.99 L (E) 1.98 L
51. What is the pH of 0.0001M HCl solution? (A) 1 (B) 2 (C) 3 (D) 4 (E) 5
52. The volume of a sample of nitrogen is 6L at 35°C and 740 torr. What volume will it occupy at S.T.P?
(A) 6.59L (B) 5.46 L (C) 6.95 L (D) 5.67 L (E) 5.18 L
53. The periodic classification of the elements is an arrangement of the elements in order of increasing
(A) atomic weight (B) isotopic weight (C) atomic number (D) atomic masses (E) All of the above
54. The empirical formula for an oxide of nitrogen containing 30.4% of nitrogen is:
(A) N_2O_2 (B) NO (C) NO_2 (D) N_2O (E) N_2O_3
55. Element X and Y have an electron configuration of $1s^22s^22p^6$ and $1s^22s^22p^63s^23p^1$ respectively. When they combine, the formula of the compound formed is (A) XY (B) YX (C) X_2Y_3 (D) Y_2X_3 (E) Y_4X_3
56. To which block in the periodic table does Cu belong? (A) s (B) p (C) d (D) f (E) g
57. What is the oxidation number of chromium in Cr_2O_3 (A) +3 (B) +6 (C) +5 (D) +4 (E) -3
58. Estimate the solubility of SrF_2 in mol/L in a mineral (K_{sp} of $\text{SrF}_2 = 2.5 \times 10^{-9}$)
(A) 8.0×10^{-4} (B) 7.0×10^{-4} (C) 8.5×10^{-4} (D) 7.5×10^{-4} (E) 6.0×10^{-4}
59. What is the molality of a 0.5M H_2SO_4 solution with a density of 1.18 g/mol?
(A) 0.442 (B) 0.340 (C) 0.560 (D) 0.470 (E) 0.617
60. Determine the mass of carbon (IV) oxide produced on burning 182g of ethyne ($C = 12$, $O = 16$, $H = 1$).
(A) 600g (B) 606 g (C) 616 g (D) 645 g (e) 654 g
61. Calculate the number of neutrons in $^{235}_{92}\text{Pa}$. (A) 91 (B) 142 (C) 146 (D) 233 (E) 239
62. The europium nucleus has a charge of +63. How many electrons are there in Eu^{3+} ion? (A) 66 (B) 63 (C) 62 (D) 61 (E) 60
63. A nucleus of mass number 81 contains 46 neutrons. An atomic ion of this element has 36 electrons in it. Write the symbol of this ion (A) $^{81}_{36}\text{Br}^-$ (B) $^{81}_{36}\text{Br}^+$ (C) $^{81}_{36}\text{Br}^0$ (D) $^{81}_{35}\text{Br}^+$ (E) $^{81}_{35}\text{Br}^-$
64. Which of the following physical properties decreases from left to right of the periodic table? (I) Atomic radius (II) Ionization energy (III) Electropositivity (IV) Electronegativity (A) I and II (B) I, II and IV (C) III and IV (D) I and III (E) II and III
65. How many moles of ethane (C_2H_6) are present in 0.334 g of C_2H_6 ?
(A) 0.0111 mol (B) 0.0222 mol (C) 0.0333 mol (D) 0.0444 mol (E) 0.0555 mol
66. What is the mass in grams of a single atom of the element Se? [$\text{Se} = 79.0$; $N_A = 6.02 \times 10^{23}$].
(A) 7.874×10^{-23} g/atom (B) 1.312×10^{-22} g/atom (C) 1.312×10^{-21} g/atom (D) 2.625×10^{-22} g/atom (E) 7.874×10^{-22} g/atom
67. How many electrons are in the p-orbitals of Ru? [$^{101}_{44}\text{Ru}$] (A) 6 (B) 10 (C) 12 (D) 15 (E) 18
68. Calculate the energy required to remove the electron from a hydrogen atom in its ground state [$RH = -2.179 \times 10^{-19}$ J]
(A) -4.36×10^{-18} J (B) -3.27×10^{-18} J (C) -2.18×10^{-18} J (D) 2.18×10^{-18} J (E) 4.36×10^{-18} J
69. How many orbitals are there in the shell with $n = 5$? (A) 18 (B) 21 (C) 22 (D) 25 (E) 28
70. What value of angular momentum is allowed for principal quantum number $n = 4$?
(A) 0,1,2,3,4 (B) 0,1,2,3 (C) 0,1,2,4 (D) 0,1,2,3,4,5, (E) 0,1,2,3,4,5,6
71. What is the number of orbitals in a 5g subshell? (A) 1 (B) 3 (C) 5 (D) 7 (E) 9
72. How many moles of hydrogen gas are in 27.0g hydrogen? [$\text{H} = 1.008$] (A) 46.74 (B) 20.25 (C) 27.25 (D) 19.25 (E) 13.40
73. What mass of HNO_3 is contained in 350 mL of 0.3 M of the acid? [Molar mass of $\text{HNO}_3 = 63.0$]



- (A) 5.281 g (B) 6.615 g (C) 15.251 g (D) 22.145 g (E) 453.000 g
74. ****(question not clearly visible)*
75. ****(question not clearly visible)*
76. What is the bond angle in a square planar molecule? (A) 180° (B) 120° (C) 109.5° (D) 107.3° (E) 90°
77. A chemical specie that can donate a lone pair of electrons to another chemical specie to form a dative bond is referred as a/an: (A) Bronsted-Lowry acid (B) Arrhenius acid (C) Lewis acid (D) Bronsted-Lowry base (E) ****(option not visible)*
78. Identify the conjugate base in the following reactions: $\text{N}_2\text{H}_4 + \text{NH}_4^+ \leftrightarrow \text{N}_2\text{H}_5^+ + \text{NH}_3$,
(A) N_2H_4 (B) N_2H_3 (C) NH_4^+ (D) NH_3 (E) NH_4^+ and NH_3
79. The volume of oxygen collected at 26°C over water and at an atmospheric pressure of 771 mmHg is 300 mL. Calculate the mass (g) of oxygen gas obtained. The pressure of water vapour at 26°C is 25 mmHg.
(A) 0.18 g (B) 2.86 g (C) 1.76 g (D) 0.18 g (E) 11.5 g
80. Identify the reducing agent in the given reaction: $\text{Zn} + \text{l}_2 \rightarrow \text{ZnI}_2$ (A) Zn (B) I₂ (C) Zn and I₂ (D) Zn (E) Znl
81. How many unpaired electrons are there in the Mn atom? [$^{55}_{25}\text{Mn}$] (A) 1 (B) 2 (C) 3 (D) 4 (E) 5
82. Calculate the pH of Pepsi cola if the H_3O^+ ion concentration in this solution is 0.00342M.
(A) 2.46 (B) 4.37 (D) 5.24 (E) 6.22
83. A moth repellent made from chlorine, carbon and hydrogen has a composition 49.1% C; 2.7%H, and 48.2% Cl. Its molecular weight is 147amu. What is the molecular formula? [At. mass (g/mol): H= 1.0; C = 12.0; Cl = 35.5].
(A) $\text{C}_6\text{H}_5\text{Cl}$ (B) $\text{C}_6\text{H}_4\text{Cl}_2$ (C) $\text{C}_6\text{H}_3\text{Cl}_3$ (D) $\text{C}_6\text{H}_2\text{Cl}_4$ (E) $\text{C}_5\text{H}_2\text{Cl}_2$
84. Calculate the mass of nitrogen in 30.0 g of the amino acid glycine, $\text{CH}_2(\text{NH}_2)\text{COOH}$. [At. mass (g/mol): H= 1.0; C=12.0; N=14.0; O=16.0]. (A) 5.60 g (B) 6.50 g (C) 7.70 g (D) 8.70 g (E) 11.20 g
85. What is the molarity of a solution that contains 6.3 g of NaOH in 30 mL of water?
(A) 0.115 M (B) 0.250 M 0.344 M (D) 0.424 M (E) 0.525 M
86. How many grams of AgNO_3 are needed to prepare 1L of 0.2 M AgNO_3 solution? [At. mass (g/mol): Ag = 10^8 ; N=14.0; O = 16.0]. (A) 15.0 g (B) 28.0 g (C) 34.0 g (D) 40.0 g (E) 37.0 g
87. Commercial nitric acid has a density of 1.42 g/cm³ and mass percent of solute of 70%. Calculate the molarity of HNO_3 .
(A) 12.0 M (B) 15.0 M (C) 16.0 M (D) 17.0 M (E) 18.0 M
88. Which of the following set of quantum numbers are not allowed in the hydrogen atom?
(A) n = 2, l=1, m_l = 1, m_s = + $\frac{1}{2}$ (B) n = 1, l=1, m_l = 0 (C) n = 8, l=7, m_l = -6 (D) n = 1, l=0, m_l = 0 (E) none of the above
89. How many atoms are bonded to the central atom in a molecule that has a trigonal bipyramidal shape?
(A) 3 (B) 4 (C) 6 (D) 7 (E) 8
90. Predict the molecular geometry of the following specie: PCl_6^-
(A) Linear (B) Tetrahedral (C) Trigonal biplanar (D) Square planar (E) Octahedral
91. What is the oxidation number of Cr in the compound HgCr_2O_7 ? (A) +1 (B) +2 (C) +4 (D) +5 (E) +6
92. Which of the following reaction is a disproportionation reaction? (A) $3\text{K}_2\text{MnO}_4 + 4\text{HCl} \rightarrow 2\text{KMnO}_4 + \text{MnO}_2 + 4\text{KCl} + 2\text{H}_2\text{O}$ (B) $\text{K}_2\text{Cr}_2\text{O}_7 + 14\text{HCl} \rightarrow 2\text{CrCl}_3 + 3\text{Cl}_2 + 2\text{KCl} + 7\text{H}_2\text{O}$ (C) $2\text{KMnO}_4 + 3\text{KNO}_2 + \text{H}_2\text{O} \rightarrow 2\text{MnO}_2 + 3\text{KNO}_3 + 2\text{KOH}$ (D) $\text{KIO}_3 + \text{Cl}_2 + 2\text{KOH} \rightarrow \text{KIO}_4 + 2\text{KCl} + \text{H}_2\text{O}$ (E) none of the above
93. What is the empirical formula of a compound composed of 43.7% phosphorus and 56.3% oxygen be weight? [$^{31}_{15}\text{P}$, $^{16}_8\text{O}$]
(A) PO_2 (B) P_2O_3 (C) P_3O_5 (D) P_3O (E) P_2O_5
94. Zn (Zn) is a silvery metal that is used to form brass (with copper) and plate iron to prevent corrosion. How many grams of Zn are there in 0.456 mol of Zn? $^{65}_{30}\text{Zn}$ (A) 29.64 g (B) 23.30 g (C) 13.68g (D) 10.63 g (E) 15.64 g
95. Which quantum number describes the shape of the orbital occupied by an electron? (A) principal quantum number (B) azimuthal quantum number (C) magnetic quantum number (D) spin quantum number (E) all of the above
96. NaHSO_4 is an example of: (A) normal salt (B) acid salt (C) basic salt (D) double salt (E) complex salt
97. Arrange the following in order on increasing acidity: NH_3 , CH_4 , H_2O , HF. (A) $\text{NH}_3 < \text{CH}_4 < \text{H}_2\text{O} < \text{HF}$ (B) $\text{CH}_4 < \text{NH}_3 < \text{H}_2\text{O} < \text{HF}$ (C) $\text{HF} < \text{H}_2\text{O} < \text{NH}_3 < \text{CH}_4$ (D) $\text{HF} < \text{H}_2\text{O} < \text{CH}_4 < \text{NH}_3$ (E) $\text{H}_2\text{O} < \text{HF} < \text{NH}_3 < \text{CH}_4$
98. Identify the Lewis acid in the equation: $\text{Ag}^+ + 2\text{NH}_3 \leftrightarrow [\text{Ag}(\text{NH}_3)_2]^+$
(A) $[\text{Ag}(\text{NH}_3)_2]^+$ (B) $(\text{NH}_3)_2$ (C) Ag^+ (D) NH_3 (E) none of the above
99. What is the degeneracy of the d-orbital? (A) 1 (B) 2 (C) 3 (D) 5 (E) 7
100. The following are examples of covalent hydrides except: (A) NH_3 (B) CH_4 (C) PH_3 (D) SeH_2 (E) TaH_2

Solutions to CHM 101 2023/2024

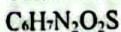
1. Trioxocarbonates (IV) are carbonates, with the general formula M_2CO_3 or MCO_3 , where M represents a metal cation. These generally decompose upon heating, however, the stability of the metal affects the decomposition process, metals with the least stability becomes easily than those with high stability; thence Lithium is the least stable.
2. Le Chatelier's principle states that if a change of condition is applied to a system in equilibrium, the system will shift in a direction that relieves the stress. Changes in concentration, pressure, volume, and temperature can all shift the equilibrium position. A catalyst speeds up the rate of both the forward and reverse reactions equally, thus it does not affect the equilibrium position.

Correct Option D



Answer: (C)

3. Calculate the molar mass of sulfanilamide



$$(6 \times 12.01) + (7 \times 1.008) + (2 \times 14.01) + (2 \times 16.00) + 32.06 = 172.2 \text{ g/mol}$$

Calculating the moles of sulfanilamide:

$$\text{Mol} = 1.00 \text{ g}/172.2 \text{ g/mol} = 0.00581 \text{ mol}$$

Calculating the moles of acetone:

$$\text{Mol} = 10.0 \text{ g} / 58.08 \text{ g/mol} = 0.172 \text{ mol}$$

Calculating the mole fraction of acetone:

$$0.172 \text{ mol} / (0.172 \text{ mol} + 0.00581 \text{ mol}) = 0.967$$

Apply Raoult's Law:

Vapour pressure of solution = mole fraction of acetone

× vapour pressure of pure acetone

$$V_p = 0.967 \times 400 \text{ mmHg} = 387 \text{ mmHg}$$

Answer: (C)

4. Across a period (left to right), the effective nuclear charge increases, pulling electrons closer to the nucleus.

Atomic radius decreases across a period.

Electropositivity (ability to lose electrons) decreases across a period.

Ionization energy (energy required to remove an electron) increases across a period.

Electron affinity (ability to gain an electron) generally increases across a period (with some exceptions)

Electronegativity (ability to attract electrons) increases across a period.

Answer: (C)

5. Graham's Law of Effusion: $\text{Rate}_1/\text{Rate}_2 = \sqrt{(M_2/M_1)}$ where M represents molar mass.

Let the unknown gas be denoted by X.

$$\text{Rate}_x/\text{Rate}_{\text{NH}_3} = 2.92$$

Molar mass of $\text{NH}_3 = 17 \text{ g/mol}$

$$2.92 = \sqrt{(17/M_x)}$$

Square both sides: $8.53 = 17/M_x$

$$M_x = 17/8.53 \approx 2 \text{ g/mol}$$

Answer: (B)

6. Total pressure = Partial pressure of He + Partial pressure of Ne + Partial pressure of water

$$745 = 368 + \text{Partial pressure of Ne} + 28.3 \text{ mmHg}$$

$$\text{Partial pressure of Ne} = 745 - 368 - 28.3 = 348.7 \text{ mmHg}$$

Answer: (C)

7. Rb_2O is a basic oxide (Group 1 oxides are basic)

B_2O_3 is an acidic oxide (Group 13 oxides are generally acidic)

As_2O_3 is an amphoteric oxide (shows both acidic and basic properties)

Answer: (A)

8. Xe has 8 valence electrons.

4 electrons are used for bonding with 4 F atoms.

4 electrons remain as lone pairs.

The molecule has a square planar geometry (AX_4E_2)

Answer: (E)

9. Chemical properties of element with atomic number 12: Atomic number 12 is Magnesium (Mg)

Mg belongs to Group IIA (alkaline earth metals)

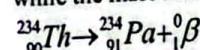
Answer: (B)

10. Atomic number 38 is Strontium (Sr)

Strontium is in the 5th period of the periodic table.

Answer: (D)

11. The beta decay increases the atomic number by 1 while the mass number remains the same.



Answer: (A)

12. The elements Be, Mg, and Ca are all in Group 2 (alkaline earth metals) of the periodic table. As you go down a group, the number of electron shells increases. This leads to a larger atomic radius.

Answer: (D)

13. ***

14. Electron affinity, atomic radius, and electronegativity generally decrease down a group. Ionization energy also generally decreases down a group.

Answer: (B)

15. Calculating the percent by mass of silicon in the mineral beryl, $\text{Be}_3\text{Al}_2(\text{SiO}_3)_6$.

$$\text{Calculate the molar mass of beryl: } (3 \times 9.0) + (2 \times 27.0) + (6 \times 28.0) + (18 \times 16.0) = 537 \text{ g/mol}$$

Calculating the mass of silicon in one mole of beryl:

$$6 \times 28.0 \text{ g/mol} = 168 \text{ g/mol}$$

Calculating the percent by mass of silicon:

$$(168/537) \times 100\% = 31.28\% \text{ (Approximates to 35%)}$$

Answer: (C)

16. Using the relationship between pH and pOH: $\text{pH} + \text{pOH} = 14$

$$\text{Calculating pOH: } \text{pOH} = 14 - 3.15 = 10.85$$

Calculating the hydroxide ion concentration:

$$[\text{OH}^-] = 10^{-10.85} \text{ M} \approx 1.41 \times 10^{-11} \text{ M}$$

Answer: (D)

17. Acetic acid is a weak acid. We need the K_a value for acetic acid (approximately 1.8×10^{-5})

Using the equation for the dissociation of a weak acid:

$$\text{Ka} = [\text{H}^+][\text{A}^-]/[\text{HA}] \text{ (where HA is acetic acid)}$$

Since $\text{pH} = 2.68$, $[\text{H}^+] = 10^{-2.68} \text{ M} \approx 2.09 \times 10^{-3} \text{ M}$.

For a weak acid, $[\text{H}^+] \approx [\text{A}^-]$

Substitute into the Ka equation and solve for $[\text{HA}]$:

$$1.8 \times 10^{-5} = (2.09 \times 10^{-3})^2/[\text{HA}]$$

$$[\text{HA}] \approx 0.24 \text{ M} \text{ (This is closest to 0.26M)}$$

Answer: (E)

18. A buffer system requires a weak acid and its conjugate base (or a weak base and its conjugate acid)

HClO_4 is a strong acid, not a weak acid. Therefore, $\text{NaClO}_4/\text{HClO}_4$ is not a buffer system.

Answer: (A)

19. Amphoteric oxides react with both acids and bases. Let's examine the options:

- Al_2O_3 : Reacts with both acids and bases, thus amphoteric.
- Se_2O_3 : Selenium trioxide is acidic.
- BeO : Beryllium oxide is amphoteric.
- Fe_2O_3 : Iron(III) oxide is primarily basic, though it can show some amphoteric behavior under specific conditions. However, compared to the others, it's less amphoteric.
- Sc_2O_3 : Scandium(III) oxide is primarily basic.

Answer: (B)

20. Acidity is determined by the K_a value. A higher K_a indicates a stronger acid.

Answer: (D)

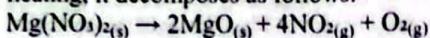


21. Cubic boron nitride (c-BN) is known for its hardness, second only to diamond. While the formulas provided don't directly represent c-BN, B₄C (boron carbide) is a very hard material.

Answer: (D)

22. The products formed in the thermal decomposition of magnesium trioxonitrate (V) are:

Magnesium trioxonitrate (V) is Mg(NO₃)₂. Upon heating, it decomposes as follows:



Answer: (B)

23. $\Delta T_f = K_f \times m$

where ΔT_f is the freezing point depression, K_f is the cryoscopic constant of water (1.86 °C/m), and m is the molality.

Calculating molality: $0.201 \text{ }^\circ\text{C} = 1.86 \times m$

$$\Rightarrow m = 0.108 \text{ mol/kg}$$

Calculating moles of solute: $0.108 \times 0.025 = 0.0027 \text{ mol}$

Calculate molar mass: $0.320 / 0.0027 \approx 118.5 \text{ g/mol}$

Answer: (B)

24. $\pi = MRT$

where π is osmotic pressure, M is molarity, R is the ideal gas constant (0.0821 L·atm/mol·K), and T is temperature in Kelvin.

Calculating molarity: $(10 \text{ g} / 60 \text{ g/mol}) / 0.5 \text{ L} = 0.333 \text{ M}$

Converting temperature to Kelvin:

$$12 \text{ }^\circ\text{C} + 273.15 = 285.15 \text{ K}$$

Calculating osmotic pressure:

$$\pi = (0.333)(0.0821)(285.15) \approx 7.78 \text{ atm}$$

Answer: (E)

25. Calculating the K_c at this temperature.

$$K_c = [\text{H}_2][\text{I}_2]/[\text{HI}]^2 = (0.12)(0.12)/(0.88)^2 \approx 0.0187$$

This value is not among the options

26. $K_p = K_c(RT)^{\Delta n}$

where Δn is the change in moles of gas (2 - 4 = -2), R is the ideal gas constant (0.0821 L·atm/mol·K), and T is temperature in Kelvin (773.15 K)

$$K_c = K_p/(RT)^{(-2)}$$

$$K_c = (1.50 \times 10^{-5}) / (0.0821 \times 773.15)^{(-2)} \approx 0.0755$$

Answer: (B)

27. Calculating the mass defect:

$$M = (28 \times 1.00728 + 32 \times 1.00867) - 59.9332 \approx 0.552 \text{ amu}$$

Converting mass defect to energy:

$$E = 0.552 \text{ amu} \times 931.5 \text{ MeV/amu} \approx 514.6 \text{ MeV}$$

Calculating binding energy per nucleon:

$$B = 514.6 \text{ MeV} / 60 \text{ nucleons} \approx 8.58 \text{ MeV/nucleon}$$

Answer: (A)

28. The formula for radioactive decay is: $N(t) = N_0 e^{-\lambda t}$

where $N(t)$ is the amount remaining at time t , N_0 is the initial amount, λ is the decay constant, and t is time. The half-life ($t_{1/2}$) is related to λ by

$$\lambda = \ln(2)/t_{1/2}.$$

$$0.477 = e^{-\lambda t} \Rightarrow \ln(0.477) = -\lambda t, \quad \lambda = \ln(2)/5730 \text{ yr}$$

Solving for t : $t = -\ln(0.477) / (\ln(2)/5730 \text{ yr}) \approx 6100 \text{ yr}$

Answer: (E)

29. Average atomic mass = $(0.7899 \times 23.98504 \text{ amu}) + (0.100 \times 24.98584 \text{ amu}) + (0.1101 \times 25.98259 \text{ amu})$

Calculating the result:

$$\text{Average atomic mass} \approx 18.9478 \text{ amu} + 2.4986 \text{ amu} + 2.8590 \text{ amu} \approx 24.3054 \text{ amu.}$$

Answer: (B)

30. Calculating the moles of each gas:

Moles of H₂ = 5.00 g / (2.02 g/mol) ≈ 2.475 mol;

Moles of N₂ = 7.00 g / (28.02 g/mol) ≈ 0.250 mol

Calculating the total moles:

$$\text{Total moles} = 2.475 \text{ mol} + 0.250 \text{ mol} = 2.725 \text{ mol}$$

Using the ideal gas law: $PV = nRT$

$$\text{Solving for P: } P = nRT/V$$

$$P = (2.725 \times 0.0821 \times 273) / 10 \text{ L} \approx 6.16 \text{ atm}$$

Answer: (D)

31. 109.5° (Tetrahedral geometry)

Answer: (B)

32. At STP, 1 mole of any gas occupies 22.4 L.

The molar mass of N₂ is 28 g/mol.

$$\text{Density} = \text{mass/volume} = (28) / (22.4) \approx 1.25 \text{ g/L}$$

Answer: (A)

33. The decay equation is $N(t) = N_0 e^{-\lambda t}$. We are given that $N(t)/N_0 = 0.02$ and $\lambda = 0.13 \text{ yr}^{-1}$.

$$0.02 = e^{-0.13t}$$

$$\ln(0.02) = -0.13t$$

$$t = -\ln(0.02)/0.13 \approx 30 \text{ years}$$

Answer: (C)

34. Interstitial hydrides are formed when small atoms (like H) occupy the interstitial sites in the metal lattice. Cd is not a transition metal and doesn't readily form interstitial hydrides.

Answer: (D)

35. Using the Henderson-Hasselbalch equation:

$$\text{pH} = \text{pKa} + \log([\text{A}^-]/[\text{HA}]),$$

where [A⁻] is the concentration of sodium benzoate (0.20 M) and [HA] is the concentration of benzoic acid (0.12 M)

$$\text{pKa} = -\log(K_a) = -\log(6.5 \times 10^{-5}) \approx 4.19$$

$$\text{pH} = 4.19 + \log(0.20/0.12) \approx 4.19 + 0.22 \approx 4.41$$

Answer: (C)

36. Fe (Steam reforming of methane is more common industrially, but Fe is used in some processes)

Answer: (D)

37. Atomic size decreases across a period.

Answer: (B)

38. Find the moles of glucose:

$$\text{Moles of glucose} = 98 / (180) \approx 0.544 \text{ mol}$$

From the stoichiometry,

1 mol of glucose produces 6 mol of CO₂.

$$\text{Moles of CO}_2 = 0.544 \text{ mol} \times 6 = 3.264 \text{ mol}$$

$$\text{Mass of CO}_2 = 3.264 \times (44) \approx 143.78 \approx 1.42 \times 10^3 \text{ g}$$

Answer: (B)

39. $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$

Calculating the molar mass of KClO₃:

$$\text{K} (39.1) + \text{Cl} (35.5) + 3\text{O} (3 \times 16) = 122.6 \text{ g/mol}$$

Calculating the moles of KClO₃:

$$\text{Moles} = \text{mass} / \text{molar mass} = 46.0 / 122.6 = 0.375 \text{ mol}$$

Use stoichiometry to find the moles of O₂ produced: From the balanced equation, 2 moles of KClO₃ produce 3 moles of O₂.

Therefore, 0.375 mol of KClO₃ produces $(3/2) \times 0.375 \text{ mol} = 0.5625 \text{ mol of O}_2$.

Calculating the mass of O₂ produced:

$$\text{Molar mass of O}_2 = 2 \times 16 = 32 \text{ g/mol}$$

$$\text{Mass} = \text{moles} \times \text{molar mass} = 0.5625 \times 32 = 18 \text{ g}$$

Answer: (C)

40. The order of increasing acid strength among hydrohalic acids is HF < HCl < HBr < HI.

Perchloric acid (HClO₄) is a very strong acid.



- Answer: (C)
41. For $n=5$, the possible subshells are 5s, 5p, 5d, 5f, and 5g.
Answer: (C)
42. The maximum number of electrons in a shell with principal quantum number n is $2n^2$.
Answer: (A)
43. Atomic radius decreases across a period and increases down a group. $\text{Na} > \text{Mg} > \text{Al} > \text{P} > \text{Cl}$
Answer: (B)
44. The Henderson-Hasselbalch equation is used to calculate the pH of a buffer solution:

$$\text{pH} = \text{pKa} + \log([\text{A}^-]/[\text{HA}]),$$
 where $[\text{A}^-]$ is the concentration of the conjugate base (CH_3COONa) and $[\text{HA}]$ is the concentration of the weak acid (CH_3COOH).
 The pKa of acetic acid (CH_3COOH) is 4.74.
 Substitute the given values into the equation:

$$\text{pH} = 4.74 + \log(1.0/1.0) = 4.74 + \log(1) = 4.74 + 0 = 4.74$$

Answer: (C)
45. Boron (B) is the central atom in BCl_3 . It has 3 valence electrons. Hence, three hybrid orbitals are formed from one "s" orbital and two p orbitals, resulting in sp^2 hybridization.
Answer: (B)
46. Use Boyle's Law: $P_1V_1 = P_2V_2$
 Converting pressure to the same units:
 $1240 \text{ torr} = 1.63 \text{ atm}; 730 \text{ torr} = 0.96 \text{ atm}$
 Substituting values: $(1.63)(47.2) = (0.96)(V_2)$
 Solving for V_2 : $V_2 = [(1.63)(47.2)] / (0.96) = 80.2 \text{ L}$
Answer: (E)
47. Use Charles's Law: $V_1/T_1 = V_2/T_2$
 Converting temperatures to Kelvin:
 $25 + 273.15 = 298.15 \text{ K}$
 Substituting values: $(5.50) / (298.15) = (10.0) / T_2$
 Solving for T_2 : $T_2 = (10.0 \times 298.15) / 5.50 = 542 \text{ K}$
 Converting back to Celsius: $542 \text{ K} - 273.15 = 269^\circ \text{C}$
Answer: (D)
48. Use the Ideal Gas Law: $PV = nRT$.
 Converting temperature to Kelvin:
 $-37^\circ \text{C} + 273.15 = 236.15 \text{ K}$.
 Finding moles of F_2 : $76 / 38 = 2 \text{ mol}$ (molar mass of $\text{F}_2 = 38$). $R = 0.0821 \text{ L} \cdot \text{atm/mol} \cdot \text{K}$
 Substitute values: $P(1.50) = (2)(0.0821)(236.15)$
 Solving for P :
 $P = [(2)(0.0821)(236.15)] / (1.50) \approx 26 \text{ atm}$
Answer: (A)
49. Answer: (B) hybridization
50. Using the Ideal Gas Law: $PV = nRT$.
 Converting temperature to Kelvin:
 $37^\circ \text{C} + 273.15 = 310.15 \text{ K}$.
 Converting pressure to atm:
 $750 \text{ mmHg} \times (1 \text{ atm} / 760 \text{ mmHg}) \approx 0.987 \text{ atm}$
 Find moles of N_2 : $9 / (28) \approx 0.321 \text{ mol}$ (molar mass of $\text{N}_2 = 28 \text{ g/mol}$). $R = 0.0821 \text{ L} \cdot \text{atm/mol} \cdot \text{K}$
 Substituting values:
 $(0.987)V = (0.321)(0.0821)(310.15)$, $V \approx 8.29 \text{ L}$
Answer: (B)
51. $\text{pH} = -\log[\text{H}^+]$. $[\text{H}^+] = 0.0001 \text{ M} = 1 \times 10^{-4} \text{ M}$
 $\text{pH} = -\log(1 \times 10^{-4}) = 4$
Answer: (D)
52. Using the Combined Gas Law: $(P_1V_1)/T_1 = (P_2V_2)/T_2$.

Converting temperatures to Kelvin:

$$35^\circ \text{C} + 273.15 = 308.15 \text{ K}; 0^\circ \text{C} + 273.15 = 273.15 \text{ K}$$

Converting pressures to atm:

$$740 \text{ torr} \times (1 \text{ atm} / 760 \text{ torr}) \approx 0.974 \text{ atm};$$

Substituting values:

$$(0.974 \times 6) / 308.15 = (1 \times V_2) / 273.15 \text{ K}$$

Solving for V_2 : $V_2 \approx 5.46 \text{ L}$

Answer: (B)

53. Answer: (C) atomic number

54. Assume 100g of the oxide. This means there are 30.4g of N and 69.6g of O.

Converting grams to moles:

$$30.4 \text{ g N} / (14 \text{ g/mol}) \approx 2.17 \text{ mol N};$$

$$69.6 \text{ g O} / (16 \text{ g/mol}) \approx 4.35 \text{ mol O}$$

Finding the mole ratio:

$$2.17 / 2.17 \approx 1 : 4.35 / 2.17 \approx 2$$

The empirical formula is NO_2

Answer: (C)

55. 3 Y atoms (losing 3 electrons each) will combine with 2 X atoms (gaining 2 electrons each)

Answer: (C)

56. The element with atomic number 29 is Copper (Cu). Copper is a transition metal, and transition metals belong to the d-block in the periodic table.

Answer: (C)

57. Answer: (B) +6

58. Answer: (C)

59. Answer: (A) 0.442

60. Answer: (C) 616 g

61. Number of neutrons = mass number - atomic number
 $N = 233 - 91 = 142$

Answer: (B)

62. Europium (Eu) has an atomic number of 63, meaning it has 63 electrons in its neutral state.

Eu^{3+} has lost 3 electrons.

Number of electrons in $\text{Eu}^{3+} = 63 - 3 = 60$

Answer: (E)

63. Number of protons = mass number - number of neutrons = $81 - 46 = 35$

Since the ion has 36 electrons and 35 protons, it has a charge of -1

The element with atomic number 35 is Bromine (Br)

Answer: (E)

64. Atomic radius decreases across a period. Ionization energy increases across a period. Electropositivity (metallic character) decreases across a period.

Electronegativity increases across a period.

Answer: (D)

65. Molar mass of ethane = 30 g/mol

Moles of ethane = $0.334 \text{ g} / 30 \text{ g/mol} \approx 0.0111 \text{ mol}$

Answer: (A)

66. The molar mass of Se is 79.0 g/mol.

Mass of one atom = molar mass / Avogadro's number
 $M \text{ of 1 atom} = (79.0) / (6.02 \times 10^{23}) = 1.312 \times 10^{-22} \text{ g/atom}$

Answer: (C)

67. The electron configuration of Ru ($Z=44$) is $[\text{Kr}]4d^7 5s^1$. The number of electrons in p orbitals is determined by the p subshells that are filled. The [Kr] core has filled 2p, 3p subshells. The number of electrons in the 2p and 3p orbitals is $6 + 6 = 12$.

Answer: (C)



68. The energy of the electron in the ground state of hydrogen is given by $E = -R_H/n^2$, where R_H is the Rydberg constant (2.18×10^{-19} J) and $n=1$ for the ground state.
 $E = - (2.18 \times 10^{-19}) / 1^2 = -2.18 \times 10^{-19}$ J
The energy required to remove the electron is the negative of this value.
- Answer: (D)
69. The number of orbitals in a shell with principal quantum number n is n^2 .
For $n = 5$, the number of orbitals is $5^2 = 25$.
- Answer: (D)
70. The allowed values of the angular momentum quantum number (l) are integers from 0 to $n-1$.
For $n = 4$, the allowed values of l are 0, 1, 2, and 3.
- Answer: (B)
71. For a given value of l , the number of orbitals is $2l + 1$.
For a 5g subshell, $l = 4$.
Number of orbitals = $2(4) + 1 = 9$.
- Answer: (E)
72. The molar mass of hydrogen (H_2) is $2 \times 1.008 = 2.016$
Moles = mass / molar mass = $27.0 / 2.016 = 13.40$ mol
- Answer: (E)
73. Moles of HNO_3 = Molarity × Volume (in Liters)
 $M = 0.3 \text{ M} \times 0.350 \text{ L} = 0.105 \text{ mol}$
Mass of HNO_3 = moles × molar mass
 $M = 0.105 \text{ mol} \times 63.0 \text{ g/mol} = 6.615 \text{ g}$
- Answer: (B)
74. ***
75. ***
76. A square planar molecule has a central atom with four ligands arranged in a square.
The bond angles between the ligands are 90° .
- Answer: (E)
77. A Lewis base is a species that can donate a lone pair of electrons.
- Answer: (D)
78. Answer: (D)
79. This question seems incomplete. The volume of oxygen collected is needed to solve for the mass of oxygen.
80. The reducing agent is the species that is oxidized. Zn
- Answer: (A)
81. The electron configuration of Mn (atomic number 25) is $[Ar] 3d^5 4s^2$.
There are five unpaired electrons in the 3d orbitals.
- Answer: (E)
82. $pH = -\log_{10}[H_3O^+]$
 $pH = -\log_{10}(0.00342)$
 $pH \approx 2.46$
- Answer: (A)
83. Determining the empirical formula.
Assume 100g of the compound.
This gives 49.1g C, 2.7g H, and 48.2g Cl.
Converting grams to moles:
Moles of C = $49.1 \text{ g} / 12.0 \text{ g/mol} \approx 4.09 \text{ mol}$
Moles of H = $2.7 \text{ g} / 1.0 \text{ g/mol} \approx 2.7 \text{ mol}$
Moles of Cl = $48.2 \text{ g} / 35.5 \text{ g/mol} \approx 1.36 \text{ mol}$
Dividing by the smallest number of moles to get the empirical formula ratio:
C: $4.09 / 1.36 \approx 3$
H: $2.7 / 1.36 \approx 2$

- Cl: $1.36 / 1.36 \approx 1$
∴ Empirical formula: C_3H_2Cl
Finding the empirical formula mass:
 $(312) + (21) + 35.5 = 75.5 \text{ g/mol}$
Determine the ratio between the molecular weight and the empirical formula mass: $147 / 75.5 \approx 2$
Multiply the empirical formula by this ratio to get the molecular formula: $2 \times C_3H_2Cl = C_6H_4Cl_2$
- Answer: (B)
84. Calculating the molar mass of glycine:
 $12.0 + 2(1.0) + 14.0 + 12.0 + 2(16.0) = 75.0 \text{ g/mol}$
Calculating the moles of glycine: $30.0 / 75.0 = 0.4 \text{ mol}$
Calculating the moles of nitrogen:
 $0.4 \text{ mol glycine} \times 1 \text{ mol N} / 1 \text{ mol glycine} = 0.4 \text{ mol N}$
Calculating the mass of nitrogen:
 $0.4 \text{ mol N} \times 14.0 \text{ g/mol} = 5.6 \text{ g}$
- Answer: (A)
85. Calculate the moles of NaOH: $6.3 / 40.0 = 0.1575 \text{ mol}$
Convert mL to L: $30 \text{ mL} \times (1 \text{ L} / 1000 \text{ mL}) = 0.030 \text{ L}$
Calculate the molarity: $0.1575 \text{ mol} / 0.030 \text{ L} = 5.25 \text{ M}$
- Answer: (E) closest
86. Calculate the molar mass of $AgNO_3$:
Molar mass of $AgNO_3 = 107.9 + 14.0 + 3 \times 16.0 = 169.9$
Use the formula: moles = molarity × volume (in liters)
Moles of $AgNO_3 = 0.2 \text{ mol/L} \times 1 \text{ L} = 0.2 \text{ mol}$
Calculating the mass of $AgNO_3$:
Mass = moles × molar mass = $0.2 \times 169.9 \approx 34.0 \text{ g}$
- Answer: (C)
87. Assume 100 g of solution. This contains 70 g HNO_3 and 30 g of water.
Calculate the volume of the solution.
Volume = mass/density = $100 \text{ g} / (1.42 \text{ g/cm}^3) = 70.42 \text{ cm}^3 = 0.07042 \text{ L}$
Calculating the moles of HNO_3 :
Molar mass of $HNO_3 = 1.01 + 14.0 + 3 \times 16.0 = 63.01$
Moles of $HNO_3 = 70 / 63.01 = 1.111 \text{ mol}$
Calculating the molarity:
Molarity = moles / volume = $1.111 / 0.07042 \approx 16.0 \text{ M}$
- Answer: (C)
88. m_l (magnetic quantum No.) can range from -1 to +1.
(A) $n=2, l=1, m_l=0$ is allowed.
(B) $n=1, l=1$ is not allowed (l cannot be equal to n).
(C) $n=8, l=7, m_l=-6$ is allowed.
(D) $n=1, l=0, m_l=0$ is allowed.
- Answer: (B)
89. A trigonal bipyramidal shape has 5 atoms bonded to the central atom.
- Answer: (A)
90. PCl_6^- has a central phosphorus atom surrounded by six chlorine atoms. This results in an octahedral geometry.
- Answer: (E)
91. $(+2) + 2x + 7(-2) = 0$
 $2x = 12, x = +6$
- Answer: (E)
92. A disproportionation reaction involves an element undergoing both oxidation and reduction. In (A), manganese changes oxidation states.
- Answer: (A)
93. Assume 100g of the compound. This contains 43.7g P and 56.3g O
Converting grams to moles:
Moles of P = $43.7 \text{ g} / 31 \text{ g/mol} = 1.41 \text{ mol}$



Moles of O = $56.3\text{g} / 16 \text{ g/mol} = 3.52 \text{ mol}$

Finding the mole ratio:

P : O = $1.41:3.52 \approx 1:2.5 \approx 2:5$ P₂O₅

Answer: (E)

94. Using the formula: mass = moles × molar mass

Molar mass of Zn = 65 g/mol

Mass of Zn = $0.456 \text{ mol} \times 65 \text{ g/mol} = 29.64 \text{ g}$

Answer: (A)

95. The azimuthal quantum number (l) describes the shape of an atomic orbital.

Answer: (B)

96. NaHSO₄ contains the bisulfate ion (HSO₄⁻), which is an acidic ion. Therefore, NaHSO₄ is an acid salt.

Answer: (B)

97. Acidity increases with the ability to donate a proton. The order of increasing acidity is

Answer: (E)

CH₄ < NH₃ < H₂O < HF. HF is the strongest acid in this group of acids, H₂O is weakly acidic, NH₃ is weakly basic, and CH₄ is neither acidic nor basic.

Answer: (A)

98. A Lewis acid is an electron-pair acceptor.

In the reaction $\text{Ag}^+ + 2\text{NH}_3 \rightleftharpoons [\text{Ag}(\text{NH}_3)_2]^+$, the silver ion (Ag⁺) accepts electron pairs from the ammonia molecules (NH₃)

Answer: (D)

99. The d-orbital has five degenerate orbitals (d_{xy}, d_{yz}, d_{xz}, d_{x²-y²}, d_{z²}). Degeneracy refers to orbitals having the same energy level (5).

Answer: (D)

100. Covalent hydrides are formed by the sharing of electrons between a hydrogen atom and a nonmetal atom. Transition metal hydrides, like TiH, are typically metallic hydrides, involving different bonding characteristics.

Answer: (E)

COURSE CODE: CHM101B GENERAL CHEMISTRY I (2 credits).

FIRST SEMESTERI EXAMINATIONS 2022/2023 ACADEMIC SESSION, MARCH, 2024

CHM 101B- GENERAL CHEMISTRY (2 Credits)

1. What is the pH of 0.001M solution of HCl?
(a) 3 (b) 5 (c) 7 (d) 10
2. A buffer is made from equal concentrations of a weak acid and its conjugate base. Doubling the volume of the buffer solution by adding water has what effect on its pH? (a) It has little effect (b) it significantly neutralizes the pH (c) It significantly decreases the pH (d) It changes the pH asymptotically to the pKa of the acid (e) it changes the pH asymptotically to the pKb of the conjugate base.
3. Which of the given compounds do not belong to Lewis acid (a) AlCl₃ (b) C₅H₅N (C) ZnCl₂ (d) FeCl₃ (e) none of the above
4. Calculate the hydronium ion concentration of a solution containing 0.2 mol of CH₃COOH in 1L solution. K_a = 1.8 × 10⁻⁵
(a) 1.89 × 10⁻³ (b) 1.8 × 10⁻⁵ (c) 1.4 × 10⁻⁵ (d) 1.8 × 10⁻⁶
5. Calculate the molality of a solution that contains 51.2 g of naphthalene, C₁₀H₈, in 500 ml of carbon tetrachloride. The density of CCl₄ is 1.60g/mL.
(a) 0.250m (b) 0.500m (c) 0.750m (d) 0.840m (e) 1.69
6. A 2.82g of glucose (mol mass = 180g/mol) are dissolved in 180g of water. Calculate the mole fraction of water (a) 0.5223 (b) 0.0093 (c) 0.9907 (d) 1.243
7. In which case is the solution of BaSO₄ over-saturated? (a) [Ba²⁺].[SO₄²⁻] = K_{sp} (b) [Ba].[SO₄] = K_{sp}
(c) [Ba²⁺].[SO₄²⁻] > K_{sp} (d) [Ba²⁺].[SO₄²⁻] = K_{sp}
(e) [Ba²⁺].[SO₄²⁻] < K_{sp}
8. A stock solution of potassium dichromate K₂Cr₂O₇ is made by dissolving 89.3g of the compound in 1.0Lof solution. How many milliliters of this solution is required to prepare 1.00L of 0.100 M K₂Cr₂O₇? (a) 110ml b) 165ml (c) 274ml (d) 329ml (e) 494ml
9. Consider the following equilibrium: PCl_{5(g)} ⇌ PCl_{3(g)} + Cl_{2(g)}. A 1.00L flask contains 0.0200 mol PCl₅, 0.0500mol PCl₃ and 0.0500mol Cl₂ at equilibrium. The value of K_{eq} is (a) 0.125 (b) 2.50 (c) 5.00 (d) 8.00
10. Calculate the change in boiling point of water if 1.5g glycerin C₃H₈O₃ is dissolved in 47.8g of water (K_b for water = 0.512 °C/m) (a) 0.174 °C (b) 0.170 °C (c) 117°C (d) 0.147 °C

Type B Time: 3hours

11. For which of the following reactions is the numerical value of K_c and K_p the same? (a) N₂ + 3H₂ → 2NH₃ (b) 2SO₂ + O₂ → 2SO₃ (c) H₂ + Cl₂ → 2HCl (d) N₂O₄ → 2NO₂
12. The K_{sp} for PbI₂ is 8.7 × 10⁻⁹. What is the molar solubility of PbI₂? (a) 1.3 × 10⁻³ (b) 8.7 × 10⁻³ (c) 9.3 × 10⁻³ (d) 1 × 10⁻⁹
13. Consider the following equilibrium: 2NO_{2(g)} ⇌ N₂O_{4(g)} + Energy. The equilibrium will shift to the left is as a result of (a) adding a catalyst (b) increasing the volume (c) removing some N₂O₄ (d) decreasing the temperature.
14. What is the molality of a solution labeled "8.6% glucose (C₆H₁₂O₆) by weight?" (a) 0.26m (b) 0.34m (c) 0.44m (d) 0.52m (e) 0.67m
15. What is the equilibrium partial pressure of PCl₃ in a 3.00L vessel that was changed with 0.123 atm of PCl₅. K_{eq}= 0.0121. PCl_{5(g)} ⇌ PCl_{3(g)} + Cl_{2(g)} (a) 0.123 atm (b) 0.011 atm (c) 0.0380 atm (d) 0.0900 atm
16. How many grams of AgNO₃ are required to prepare 10g of 2% solution? (a) 10 (b) 20 (c) 0.2 (d) 0.1
17. What is the molarity of a solution containing 9.8g of H₂SO₄ in 200 mL solution? (a) 0.50 (b) 0.75 (c) 1.00 (d) 0.25 (e) 0.1019
18. Calculate the pH of NaOH with concentration 0.5 mol/L if the resulting solution is diluted 10 fold (a) 12.0 (b) 12.7 (c) 13.4 (d) 11.6
19. Which of the following equations depicts a disproportionation reaction?
(a) MnO₂ + HCl → MnCl₂ + Cl₂ + H₂O (b) FeCl₂ + Cl₂ → FeCl₃ (c) S + KOH → KSO₃ + K₂S + H₂O (d) Au₂O₃ → Au + O₂ (e) HCl + Cr₂O₃ → CrCl₃ + Cl₂ + H₂O
20. Calculate the number of moles of calcium chloride CaCl₂ that can be obtained from 25g of limestone CaCO₃ on reacting with HCl [Ca = 40, C=12, O=16, H=1, Cl=35.5] (a) 0.20 mole (b) 0.30 mole (c) 0.25 mole (d) 0.35 mole
21. Calculate the freezing point of a solution that contains 2g of methyl alcohol CH₃OH in 50g of water K_f=1.86 (a) 1.25 °C (b) -2.32°C (c) 2.32°C (d) -1.25°C
22. What is the oxidation number of Cr in the compound HgCr₂O₇? (a) +1 (b) +2 (c) +4 (d) +5 (e) +6



23. Calculate the molarity of a solution prepared by dissolving 15g of solid NaOH in enough water to make 2.5 L of solution
(a) 0.15 M (b) 0.375 M (c) 0.075 (d) 0.188 M
24. What is the molality of a solution prepared by dissolving 15g of I₂ in 150g of CCl₄ [C=12, I=127, Cl=35.5] (a) 0.64 m (b) 0.53 m (c) 0.78 m (d) 0.394 m
25. Which of the following is classified as a conjugate acid-base pair? (a) HCl/NaOH (b) H₃O⁺/H₂O (c) O₂/H₂O (d) H⁺/Cl⁻ (e) NaCl/NaOH
26. Which of the following is the strongest acid? (a) HClO₂ (b) HClO (c) HClO₃ (d) HClO₄ (e) chlorous acid
27. Which of the following substance is a Lewis acid? (a) NH₃ (b) BCl₃ (c) H₂O (d) OH⁻
28. A solution contains 6.00% (by mass) NaBr (sodium bromide). The density of the solution is 1.046g/cm. What is the molarity of NaBr? [Na= 23.0, Br = 80.0] (a) 0.310 M (b) 0.513 (c) 0.610 M (a) 0.765M (e) 0.920 M
29. Colligative properties depend on: (a) nature of the solvent (b) number of solute and solvent molecules (c) percent of ionization (d) nature of solute (e) temperature
30. What volume of a 0.1M solution of NaHCO₃ contains 0.350g of NaHCO₃? Na = 23.0, O = 16.0; C = 12.0; H=1] (a) 17.4 mL (b) 20.9 mL (c) 38.3 mL (d) 41.7 mL (e) 59.1 mL
31. What is the molarity of a solution containing 5.6g of KOH in 400 mL solution? (a) 1.0 (b) 0.75 (c) 0.10 (d) 0.25 (e) 0.50
32. Calculate the mole fraction of NaCl in 40% wt NaCl solution (a) 0.684 (b) 4.017 (c) 3.333 (d) 1.70 no answer
33. What is the oxidation number of phosphorus in the compound ammonium phosphate? (a) +1 (b) +4 (c) +3 (d) +2 (e) +5
34. When equal volumes of four 0.1mol/dm³ solutions are arranged in order of increasing pH, what is the correct order?
(a) CHCOOH < HNO₃ < CH₃CH₂NH₂ < KOH
(b) HNO₃ < CH₃COOH < CH₃CH₂NH₂ < KOH
(c) CH₃CH₂NH₂ < HNO₃ < CH₃COOH < KOH
(d) KOH < CH₃CH₂NH₂ < CH₃COOH < HNO₃
35. What mass of CO₂ Could be formed by the reaction of 16.0g of CH₄ with 48.0g of O₂? (a) 44g (b) 1.5 g (c) 33g (d) 16g
36. What mass of AgNO₃ (169.9 g/mol) is needed to convert 2.33g of Na₂CO₃ (106 g/mol) to AgCO₃? [Ag= 107.9g/mol] (a) 0.047g (b) 6.06g (c) 3.47 (d) 7.47
37. Calculate the mass percent of NaCl If 1.75g of NaCl is dissolved in 5.85g of water (a) 23.0% (b) 32.0% (c) 55.0% (d) 68.0% (e) 77.0 9%
38. Which of the following is not a Bronsted-Lowry base? (a) H₂O (b) NH₃ (c) OH⁻ (d) OH⁻
39. What osmotic pressure would the 1.25 m sucrose solution exhibit at 25°C if the density of the solution is 1.34g/ml? (a) 28.6 atm (b) 15 atm (c) 14.3 atm (d) 1.675 atm
40. At 25°C for 3O_{2(g)} ↔ 2O_{3(g)} Kc = 2.9 × 10⁻⁵⁹, If at equilibrium, the concentration of O₂ is 0.04M, what is the concentration of O₃? (a) 1.92 × 10⁻⁶³ M (b) 4.3 × 10⁻³² M (c) 2.3 × 10⁻³¹ M (d) 1.2 × 10²¹M
41. What is the molality of a 0.50M H₂SO₄ solution that has a density of 1.18 g/mol? (a) 0.442 (b) 0.340 (c) 0.560 (d) 0.470
42. Calculate the mole fraction of HCl in a solution of hydrochloric acid in water containing 36 percent HCl by weight (a) 0.182 (b) 0.218 (c) 0.500 (d) 0.782 (e) 0.827
43. Calculate the molarity of concentrated hydrochloric acid if this solution is 37.7% HCl by mass and its density is 1.19g/ml (H=1.0; Cl=35.5] (a) 11.8 M (b) 12.3 M (c) 13.3 M (d) 15.2 M (e) 16.2
44. What is the pH of 0.4 M NH₃ solution? K_a = 1.8 × 10⁻⁵ (a) 0.45 (b) 0.55 (c) 3.27 (d) 11.43 no answer
45. Calculate the pH of a solution containing 0.1 M H₃BO₃ and 0.18M NaHBO₃ (a) 5.46 (b) 9.39 (c) 74 (d) 12.5
46. Which of the given species is a Lewis base? (a) CO₂ (b) Ca²⁺ (c) F⁻ (d) CH₄ (e) H⁺
47. Which base is the weakest electrolyte? (a) NaOH (b) Ca(OH)₂ (c) Mg(OH)₂ (d) Ba(OH)₂ (e) KOH
48. Ethylene oxide C₂H₄O is made by the oxidation of ethylene C₂H₄. In a pilot study, 10.6g ethylene gave 9.91g of ethylene oxide. What is the percentage yield of ethylene oxide? [H = 1.0, 12.0; O = 16.0] (a) 37.19% (b) 44.63% (c) 59.50% (d) 67.00% (e) 74.39%
49. Consider the following equilibrium: H_{2(g)} + I_{2(g)} ↔ 2HI_(g). At equilibrium [H₂]= 0.00220 mol/L, [I₂]= 0.00220 mol/L and [HI]=0.0156mol/L. The value of K_{eq} is (a) 3.10 × 10⁴ (b) 1.99 × 10⁻² (c) 5.03 × 10¹ (d) 3.22 × 10³
50. Calculate the pH of buffer composed of 0.12 M benzoic acid and 0.2 M solution sodium benzoate (Ka = 6.5 × 10⁻⁵) (a) 4.00 (b) 4.41 (C) 4.67 (d) 4.33
51. How many grams of Na are contained in 25g of Na₂SO₄? [Na=23, C=32, O=16] (a) 2.10 Na (b) 7.08 Na (c) 8.10 Na (d) None of the above
52. Which of the following reactions is a disproportionation reaction
(a) Zn + CuSO₄ ZnSO₄ + Cu (b) 2Na + 2H₂O → 2NaOH + H₂
(c) Cl₂ + 2NaOH → NaClO + NaCl + H₂O
(d) NaH → 2Na + H₂
53. Which of the following does not act as a Bronsted acid? (a) NH₄⁺
(b) CH₃COO⁻ (c) HCO₃⁻ (d) HSO₃⁻
54. What is the concentration of hydroxide ion in a solution if pOH = 9? (a) 10⁻⁷ (b) 10⁻³ (c) 10⁻⁹ (a) 10⁻⁵ (e) 10⁻¹¹
55. 2.82g of glucose C₆H₁₂O₆ are dissolved in 30g of water. Calculate the mole fraction of glucose (a) 0.0093 (b) 0.0930 (c) 0.9079 (d) 0.9907 (e) 0.3900
56. A sample of limestone CaCO₃ weighing 438 is treated with oxalic acid H₂C₂O₄ to give calcium oxalate CaC₂O₄,
CaCO_{3(s)} + H₂C₂O₄ → CaC₂O_{4(s)} + H₂O + CO_{2(g)}.
The mass of the calcium oxalate produced is 472 mg. What is the percentage of calcium carbonate in this limestone ? [Ca=40; O= 16.0; C= 12; H=1.0] (a) 88.7% (b) 84.2% (c) 78.3% (d) 69.6% (e) 92.4%
57. Which of the following is NOT a redox reaction?
(a) 2Cr₂O₇²⁻ + 2H⁺ → Cr₂O₇²⁻ + H₂O
(b) Cr₂O₇²⁻ + 6Fe²⁺ + 14H⁺ → 6Fe³⁺ + 2Cr³⁺ + 7H₂O
(c) 2IO₃⁻ + 12H⁺ + 10I⁻ → I₂ + 6H₂O
(d) 2MnO₄⁻ + 6H⁺ + 5NO₂⁻ → 2Mn²⁺ + 5NO₃⁻ + 3H₂O
58. For the reaction ZnO_(s) + CO_(g) → Zn_(s) + CO_{2(g)} what is the maximum amount of zinc that can be obtained from 75g of zinc oxide and 50.0g of carbon monoxide? [Zn=64.5; O=16.0; C= 12.0] (a) 30.1g (b) 45.2g (c) 52.7g (d) 60.3g (e) 62.5g
59. The transformation Cr³⁺ → CrO₄²⁻ is via
(a) the process of oxidation in basic solution
(b) the process of reduction in acidic solution
(c) the process of reduction in basic solution
(d) the process of oxidation in acidic solution
60. A 0.500g mixture of Cu₂O and CuO contains 0.425g Cu. What is the mass of CuO in the mixture [O=16.0; Cu = 63.55]
(a) 0.18g (b) 0.21g (c) 0.28g (d) 0.32g (e) 0.42g
61. A 1.37 M solution of citric acid (H₃C₆H₅O₇) in water has a density of 1.10g/cm³. Calculate the molality of citric acid
(a) 1.37 m (b) 1.60 m (c) 2.30 m (d) 2.70 m (e) 3.00 m
62. What volume of 0.120M CuSO₄ is required to give 0.150mol of copper (ii) sulphate (vi) CuSO₄? [O=16; S= 32; Cu = 63.55] (a) 12.5 mL (b) 125.00 mL (c) 625 mL (d) 750 mL (e) 1.25 L
63. Calculate the concentration of sodium benzoate that must be present in a 0.20 solution of benzoic acid HC₇H₅O₂ to produce a pH of 4.0 (Ka = 6.5 × 10⁻⁵) (a) 0.10 M (b) 0.12 M (c) 0.13 M (d) 0.14 M
64. Calculate the vapour pressure lowering of water when 5.67g of glucose C₆H₁₂O₆ is dissolved in 25.2g of water at 25 °C is 23.8 mmHg. What is the vapour pressure of the solution? (a) 23.3 mmHg (b) 0.524 mmHg (c) 23.8 mmHg (d) 24 mmHg (e) 22.3 mmHg
65. A solution is prepared by dissolving 0.131g of a substance in 25.4g of water. The molality of the solution is determined by freezing point depression to 0.056m, what is the molecular weight of the substance? (a) 95 amu (b) 96 amu (c) 106 amu (d) 92 amu



66. In a study of hydrogen halide decomposition, a researcher fills an evacuated 2.00 L flask with 0.200 mol of HI gas and allows the reaction to proceed at 453°C. At equilibrium $[HF] = 0.078\text{M}$. Calculate K_c . $2\text{HI}_{(g)} \leftrightarrow \text{H}_2_{(g)} + \text{I}_2_{(g)}$ (a) 0.30 (b) 0.02 (c) 0.4 (d) 0.04 (e) 0.20
67. Which of the following reaction is a disproportionation reaction?
(a) $3\text{K}_2\text{MnO}_4 + 4\text{HCl} \rightarrow 2\text{KMnO}_4 + \text{MnO}_2 + 4\text{KCl} + 2\text{H}_2\text{O}$
(b) $\text{K}_2\text{Cr}_2\text{O}_7 + 14\text{HCl} \rightarrow 2\text{CrCl}_3 + 3\text{Cl}_2 + 2\text{KCl} + 7\text{H}_2\text{O}$ (c) $2\text{KMnO}_4 + 3\text{KNO}_3 + \text{H}_2\text{O} \rightarrow 2\text{MnO}_2 + 3\text{KNO}_3 + 2\text{KOH}$ (d) $\text{KIO}_3 + \text{Cl}_2 + 2\text{KOH} \rightarrow \text{KIO}_4 + 2\text{KCl} + \text{H}_2\text{O}$
68. Hydrazine (N_2H_4) and dinitrogen tetraoxide (N_2O_4) ignite on contact to form nitrogen and water vapour. How many grams of nitrogen gas form when 1.00×10^2 g of N_2H_4 and 2.00×10^2 g of N_2O_4 are mixed [$N=14.00$, $H=1.008$] (a) 141g N₂ (b) 151g N₂ (c) 136g N₂ (d) 131g N
69. How many kilograms of oxygen are required to form 2.80 kg of copper (i) oxide? [O=16; Cu=63.5] (a) 2.15 kg O₂ (b) 0.960 kg O₂ (c) 1.96 kg O₂ (d) 1.98 kg O₂ (e) 0.810 kg O₂
70. When steel is placed in a solution of CuSO_4 , the steel becomes coated with copper and the characteristic blue colour of the solution fades as the following reaction proceeds: $\text{Fe}_{(s)} + \text{Cu}^{2+} \rightarrow \text{Cu}_{(s)} + \text{Fe}^{2+}$ for this reaction. It can be said that: (a) Fe is the oxidizing agent (b) Fe is reduced (c) Cu^{2+} loses electrons (d) Cu^{2+} is an oxidizing agent (e) Fe gains electrons
71. In acidic solution ClO_3^- reacts with I_2 to form IO_3^- and Cl^- . The oxidizing agent is (a) ClO_3^- (b) I_2 (c) Cl^- (d) IO_3^- (e) none of the above
72. In the balanced equation for the reaction of CrO_4^{2-} and HSnO_2^{2-} in a basic medium, the coefficients for CrO_4^{2-} and HSnO_2^{2-} are respectively (a) 1 and 3 (b) 1 and 2 (c) 2 and 1 (d) 2 and 3
73. Calculate the percentage of magnesium in magnesium nitrate, $\text{Mg}(\text{NO}_3)_2$. Given that the formula weight of magnesium nitrate is 148.33 (a) 12.5% (b) 16.39% (c) 11.259% (d) 18.359%
74. What is the correct solubility product expression for Ag_3PO_4 ? (a) $K_{sp} = [3\text{Ag}^+]^3[\text{PO}_4^{3-}]$ (b) $K_{sp} = [\text{Ag}^+]^3[\text{PO}_4^{3-}]$ (c) $K_{sp} = 3[\text{Ag}^+][\text{PO}_4^{3-}]$ (d) $K_{sp} = 3[3\text{Ag}^+][\text{PO}_4^{3-}]$ (e) $K_{sp} = [\text{Ag}^+][\text{PO}_4^{3-}]$
75. All of the following is the effect of colligative properties except (a) lowering of vapour pressure of the solvent (b) elevation of boiling point of the solvent (C) depression of the freezing point of the solvent (d) exhibition of solvent pressure (e) osmotic pressure
76. Calculate the change in the boiling point of water if 1.5 g of glycerin $\text{C}_3\text{H}_8\text{O}_3$ is dissolved in 47.8 g of water? (K_b for water = $0.512^\circ\text{C}/\text{m}$) (a) 0.174°C (b) 0.170°C (c) 0.117°C (d) 0.147°C
77. Which among the following will you consider the strongest base: (a) $\text{ClCH}_2\text{CH}_2\text{NH}_2$ (b) $\text{BrCH}_2\text{CH}_2\text{NH}_2$ (c) $\text{FCH}_2\text{CH}_2\text{NH}_2$ (d) $\text{ICH}_2\text{CH}_2\text{NH}_2$
78. Which one of the following aqueous solutions will have the highest pH value (a) NaCl (b) KNO_3 (c) ZnCl_2 (d) Na_2CO_3
79. A solution of AlCl_3 in H_2O is (a) acidic (b) basic (c) neutral (d) normal
80. Calculate the H_3O^+ concentration of a solution containing 0.2 mol of $\text{HC}_2\text{H}_5\text{O}_2$ in 1000 mL of solution; a, 1.8×10^{-5} (a) 1.89×10^{-3} (b) 4.0×10^{-2} (c) 5.0×10^{-3} (d) 2.67×10^{-2}
81. Which of the following is a buffer? (a) $\text{NaOH} + \text{CH}_3\text{COONa}$ (b) $\text{NaOH} + \text{Na}_2\text{SO}_4$ (c) $\text{Fe}_2\text{SO}_4 + \text{H}_2\text{SO}_4$ (d) $\text{NaCN} + \text{HCN}$
82. A research chemist adds a measured amount of HCl gas to pure water at 25°C and obtains a solution with $[\text{H}_3\text{O}^+] = 3.0 \times 10^{-11}\text{M}$. Calculate $[\text{OH}^-]$ (a) 6.01 M (b) $46.56 \times 10^{11}\text{M}$ (C) $6.01 \times 10^{-11}\text{M}$ (d) $3.3 \times 10^{-11}\text{M}$
83. Propanoic acid ($\text{CH}_3\text{CH}_2\text{COOH}$), which we simplify as HPr, is an organic acid whose salts are used to retard mold growth in foods.
84. What is the $[\text{H}_3\text{O}^+]$ of 0.1M HPr? $K_a = 1.3 \times 10^{-5}\text{M}$ (a) $1 \times 10^{-3}\text{M}$ (b) $3.0 \times 10^{-4}\text{M}$ (c) $1.39 \times 10^{-4}\text{M}$ (d) $2.5 \times 10^{-3}\text{M}$
85. Dimethylamine ($\text{CH}_3)_2\text{NH}$, a key intermediate in detergent manufacture has a K_b of 3.9×10^{-4} . What is the pH of 1.5M ($\text{CH}_3)_2\text{NH}$? (a) 12.48 (b) 10.58 (c) 11.65 (d) 15.06
86. 100 kg of antifreeze ethylene glycol ($\text{C}_2\text{H}_6\text{O}_2$) is added to a car radiator, which contains 4450g of water. What is the boiling point of the solution? (a) 97°C (b) 101.85°C (c) 90°C (d) 100°C
87. A chemical reaction $A \leftrightarrow B$ is said to be in equilibrium when (a) complete conversion of A to B has taken place (b) conversion of A to B is only 50% complete (c) only 10% conversion of A to B has taken place (d) the rate of transformation of B to A is just equal to the rate of transformation of B to A in the system
88. According to Le Chatelier's principle, adding heat to a solid and liquid in equilibrium will cause the (a) amount of solid to decrease (b) amount of liquid to decrease (c) temperature to rise (d) temperature to fall
89. Which of the following statements is correct? (a) all Arrhenius acids are Bronsted-Lowry acids (b) Bronsted-Lowry are Arrhenius bases (c) all Arrhenius bases do not contain Bronsted-Lowry bases (d) All Bronsted-Lowry acids are not Lewis acid (e) an acid base reaction is a proton acceptor
90. Calculate the volume of 0.30 M HNO_3 Solution required to supply 2.0 mole of HNO_3 (a) 6.7 L (b) 7.0 (c) 5.6 L (d) 4.9 L
91. If glycine exist in this form $\text{NH}_3\text{CH}_2\text{COO}^-$ its conjugate base would be (a) $\text{NH}_3\text{CH}_2\text{COOH}$ (b) $\text{NH}_2\text{CH}_2\text{COO}^-$ (c) $\text{NH}_3\text{CH}_2\text{COO}^-$ (d) $\text{NH}_2\text{CH}_2\text{COOH}$
92. Calculate the mass of NaOH present in 5.0 ml. of a 1.0% (m/v) NaOH solution. (a) 0.050g (b) 0.10g (c) 0.50g (d) 1.0 g
93. Acrylic acid has the composition 50% C; 5.6% H and 44.4% O. What is its empirical formula? [H=1.0; C=12.0; O=16.0] (a) $\text{C}_2\text{H}_2\text{O}_4$ (b) $\text{C}_2\text{H}_6\text{O}_4$ (c) $\text{C}_3\text{H}_2\text{O}$ (d) $\text{C}_3\text{H}_6\text{O}_2$ (e) C_3HO_2
94. A white powder is analysed and found to have empirical formula of P_2O_5 . The compound has molar mass of 283.83. What is the molecular formula of the compound? [P=31.0; O=16.0] (a) P_2O_5 (b) P_4O_8 (c) P_4O_{10} (d) P_5O_{10} (e) P_{10}O_4
95. What is the vapour pressure lowering caused by the addition of 100g of sucrose (molar mass =342) to 1000g of water if the vapour pressure of pure water at 25°C is 23.8 mmHg (a) 0.92 mmHg (b) 55.5 mmHg (c) 0.125 mmHg (d) 1.25 mmHg no answer
96. Considering 0.1M aqueous solutions of each of the following, which solution has the lowest pH (a) Na_2CO_3 (b) Na_3PO_4 (c) Na_2S (d) NaCl (e) CH_3COONa
97. Identify the reducing agent in the given reaction $\text{Zn} + \text{I}_2 \rightarrow \text{ZnI}_2$ (a) Zn (b) I₂ (c) ZnI₂ (d) none of the above
98. What is the molarity of K^+ in a solution that contains 63.3 mg/L of $\text{K}_3\text{Fe}(\text{CN})_6$. Molar mass of salt = 329.3 g/mol (a) $6.22 \times 10^{-3}\text{M}$ (b) $5.77 \times 10^{-4}\text{M}$ (c) $6.22 \times 10^{-4}\text{M}$ (d) $3.26 \times 10^{-4}\text{M}$
99. In which of the reaction is a metal not oxidized (a) $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{Na}_2\text{H} + \text{H}_2$ (b) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$ (c) $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ (d) $\text{Pb} + \text{Cu}^{2+} \rightarrow \text{Pb}^{2+} + \text{Cu}$
100. Which among the following arrangements is correct in the increasing order of acid strength: HF, HCl, HI, HBr (a) HCl > HBr > HI > HF (b) HF > HCl > HBr > HI (c) HI > HBr > HCl > HF (d) HBr > HCl > HF > HI
101. What is the oxidation state of the underlined element Ba_2XeO_6 ? (a) +5 (b) +8 (c) +3 (d) 0

UNIVERSITY OF BENIN, BENIN CITY NIGERIA
 FACULTY OF PHYSICAL SCIENCES
 DEPARTMENT OF CHEMISTRY

 FIRST SEMESTER B.Sc (HONS) DEGREE EXAMINATION 2020/2021 SESSION-
 CHM 111 - GENERAL CHEMISTRY I

December, 2021

INSTRUCTION: Answer any ALL questions

Time Allowed: 2hrs

1. Which of the following pairs represents isotones? (a) 1H and 2H (b) ^{40}Ar and ^{39}K (c) ^{14}C and ^{16}O (d) ^{22}Ne and ^{21}Na (e) ^{37}Cl and ^{35}Cl
2. The europium nucleus has a charge of +63. How many electrons are there in Eu^{+1} ion? (a) 66 (b) 63 (c) 62 (d) 61 (e) 63
3. From the following hydrides; LiH, BeH₂, B₂H₆, NH₃, H₂O and HF, which of them will be basic in water? (a) 3 (b) B₂H₆ and HF (c) H₂O (d) H₂O and HF (e) HF
4. A certain mass of a gas has a volume of 241m³ at 18 °C and 100400 Nm⁻² pressure. What would its volume be at S.T.P.? (a) 1180 m³ (b) 224.04 m³ (c) 234.00 m³ (d) 230.05 m³ (e) 180.10 m³
5. The mole fraction of oxygen in the atmosphere is 0.2094. Calculate the partial pressure of oxygen in air when the atmospheric pressure is 760 Torr. (a) 1120 Torr (b) 760 Torr (c) 520 Torr (d) 159 Torr (e) 219 Torr
6. Calculate the density of butane C₄H₁₀ at a pressure of 117.4 Pa and a temperature of 125 °C ($R = 8.314 \text{ Pa mol}^{-1} \text{ K}^{-1}$). (a) 2.06 g/L (b) 4.20 g/L (c) 3.08 g/L (d) 5.00 g/L (e) 3.15 g/L
7. What is the total number of orbitals associated with the principal quantum number n = 3? (a) 3 (b) 9 (c) 4 (d) 8 (e) 7
8. Calculate the energy required to remove the electron from a hydrogen atom in its ground state ($E = -2.178 \times 10^{-18} \text{ J}$). (a) $2.178 \times 10^{-18} \text{ J}$ (b) $-2.178 \times 10^{-18} \text{ J}$ (c) $2.178 \times 10^{-18} \text{ J}$ (d) $-3.178 \times 10^{-18} \text{ J}$ (e) $3.178 \times 10^{-18} \text{ J}$
9. The simplest formula of a compound containing 50% of element X and 50% of element Y (atomic mass X = 10g/mol, Y= 20 g/mol) is: (a) XY (b) X₂Y₃ (c) X₂Y (d) XY₂ (e) XY₃
10. Which one of the following statements about s orbitals is incorrect?
 (a) they are found in all principal energy levels (b) they are spherical in shape
 (c) they can only hold one electron (d) the maximum number of s orbitals in any principal quantum number is 1 (e) none of the above.
11. What particle would be produced when plutonium-242 decays to uranium-238? (a) gamma (b) alpha (c) positron (d) beta (e) negatron
12. What is the binding energy for $^{11}_5B$ nucleus, if its mass defect is 0.0818 fmamu?
 (a) 1.7×10^{-5} erg/nucleus (b) 1.2×10^{-4} erg/nucleus (c) 3.7×10^{-5} erg/nucleus (d) 3.2×10^{-4} erg/nucleus (e) 4.5×10^{-5} erg/nucleus
13. Which of the following equations represent the industrial production of hydrogen at elevated temperature?
 (a) $3Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + 3H_2_{(g)}$ (b) $2Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + 3H_2_{(g)}$
 (c) $3Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + 2H_2_{(g)}$ (d) $3Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + 4H_2_{(g)}$
 (e) $3Fe_{(s)} + 3H_2O_{(l)} \rightarrow Fe_3O_4_{(s)} + H_2_{(g)}$
14. What is the number of electrons and neutrons present in silver (I) ion? ($^{108}_{47}Ag$) (a) 47 and 51 (b) 46 and 60 (c) 46 and 61 (d) 47 and 62 (e) 47 and 60
15. 20 ml. of a gas at 17°C is cooled to -13°C at constant pressure. Determine the new volume of the gas (a) 280 mL (b) 290 mL (c) 260 mL (d) 270 mL (e) 300 mL
16. The following are natural radioactive decay series except (a) Polonium series (b) Uranium series (c) Thorium series (d) Actinium series (e) All of the above
17. Which of the following properties increases down the group of the alkali metals? (a) ionization energy (b) atomic number (%) electronegativity (d) melting point (c) all of the above
18. The half-life of Rn is 3.825 days. Calculate the activity of Rn (atomic weight of Rn= 222) (a) 6.51×10^{-12} g Curie (b) 6.51×10^{-6} g Curie (c) 5.32×10^{-12} g Curie (d) 5.32×10^{-6} g Curie (e) 4.51×10^{-4} g Curie
19. The reaction of sodium with oxygen results in the formation of (a) oxides (b) peroxides (c) superoxides (d) sesquioxides (d) none of the above



20. How much time would it take for a sample of cobalt-60 to disintegrate to the extent that only 2% remains? (The disintegration constant = 0.13 yr^{-1}) (a) 10 years (b) 5 years (c) 15 years (d) 30 years (e) 45 years
21. Calculate the percentage by mass of chlorine in DDT $\text{C}_{11}\text{H}_9\text{Cl}_5$ ($\text{H}=1.0$; $\text{C}=12.0$; $\text{Cl}=35.5$) (a) 2.56% (b) 38.68% (c) 44.00% (d) 46.56% (e) 50.00%
22. The electronic configuration for an element in the halogen group should always end with (a) $ns^2 np^6$ (b) $ns^2 np^5$ (c) $ns^2 np^4$ (d) $ns^2 np^2$ (e) none of the above
23. What is the maximum number of electrons in an atom that have these quantum numbers; $n = 5$, $m_s = +1/2$ (a) 6 (b) 8 (c) 10 (d) 25 (e) 32
24. If it takes 1.25 minutes for 0.010 mol of He to effuse, how long will it take the same amount ethane gas (C_2H_6) to effuse? ($\text{H}=1.0$; $\text{C}=12.0$; $\text{He}=4.0$) (a) 1.72 mins (b) 2.74 mins (c) 3.43 mins (d) 3.88 mins (e) 4.33 mins
25. What is the geometry of the molecule XeF_4 ? (a) trigonal planar (b) tetrahedral (c) square planar (d) trigonal bipyramidal (e) trigonal pyramid
26. Calculate the half-life of radium-226, if 1g of it emits 3.7×10^{10} alpha particles per second (a) 1000 years (b) 200 years (c) 1843 years (d) 1583 years (e) none of the above
27. The following properties generally increases across a period except? (a) electron affinity (b) ionization energy (c) atomic radius (d) electronegativity (e) all of the above
28. Which of the following equation depicts the formation of phosphide from alkali metals? (a) $12\text{Na} + \text{N}_3 \rightarrow 3\text{Na}_4\text{N}$ (b) $6\text{Ca} + \text{P}_3 \rightarrow 3\text{Ca}_2\text{P}$ (c) $12\text{Ca} + \text{Na} \rightarrow 4\text{Ca}_3\text{N}$ (d) $12\text{Na} + \text{P}_3 \rightarrow 6\text{Na}_2\text{P}$ (e) $12\text{Na} + \text{Pa} \rightarrow 4\text{Na}_3\text{P}$
29. Complete and balance the following nuclear equation by selecting the missing particle
$${}_{98}^{252}\text{Cr} + {}_{5}^{10}\text{B} \rightarrow {}_0^1n + ??$$
 (a) ${}_{103}^{261}\text{Lr}$ (b) ${}_{103}^{229}\text{Lr}$ (c) ${}_{93}^{241}\text{Np}$ (d) ${}_{93}^{239}\text{Np}$ (e) none of the above
30. If a gas diffuses at a rate of one-half as fast as O_2 gas, find the molecular mass of the gas. (a) 158 (b) 148 (c) 138 (d) 128 (e) 118
31. What is the amount of pressure exerted by 200g of Xe gas in a vessel of volume 1.0 dm^3 at 25°C if it behaves as an ideal gas? [$\text{Xe} = 131.295 \text{ g/mol}$] (a) 37.24 atm (b) 30.54 atm (c) 25.65 atm (d) 28.51 atm (e) 10.21 atm
32. What amount of pressure (in bar) would be exerted by 35g of Ar gas contained in a 1.5 dm^3 vessel at 35°C if it behaves as an ideal gas? [$\text{Ar} = 39.948 \text{ g/mol}$] (a) 18.70 (b) 13.95 (c) 20.75 (d) 10.51 (e) 11.30
33. Hydrogen economy refers to (a) the different methods of producing H_2 (b) the industrial production of H_2 (c) the chemical reactions of H_2 (d) the cheap and easy method of producing and storing H_2 (e) all of the above.
34. Which of the following is the correct mathematical relation for Charle's law at constant pressure? (a) $V \propto T$ (b) $v \propto t$ (c) $v = kt$ (d) $V \propto P$ (e) none of the above.
35. 50 mL of gas A effuse through a pin-hole in 1146 seconds. The same volume of CO_2 under identical conditions effuses in 115 seconds. Calculate the molecular mass of A. (a) 59 (b) 61 (c) 108 (d) 71 (e) 84
36. A compound containing boron and hydrogen consists of 6.444 g of B and 1.803 g of H. The molar mass of the compound is about 30g. What is its molecular formula? (a) BH_3 (b) B_2H_6 (c) B_3H_6 (d) B_2H_4 (e) B_3H_5
37. How many atoms are bonded to the central atom in a molecule that has an octahedral geometry? (a) 4 (b) 5 (c) 6 (d) 7 (e) 8
38. An atom is indivisible, was proposed by _____ (a) Einstein (b) Lavoisier (c) Dalton (d) Proust (e) none of the above
39. The atomic mass of calcium is 40. Calculate the number of moles in 16g of calcium (a) 0.40 mole (b) 4.00 moles (c) 0.25 moles (d) 6.40 moles (e) 1.20 moles
40. Principal, azimuthal and magnetic quantum numbers are respectively related to (a) size, shape and orientation (b) shape, size and orientation (c) size, orientation and shape (d) orientation, size and shape (e) none of the above.
41. For azimuthal quantum number $l=3$, the maximum number of electrons will be (a) 2 (b) 6 (c) 0 (d) 14 (e) 18
42. A Compound containing 69.5% oxygen and 30.5% nitrogen has a molecular mass of 92g/mol. What is the formula of the compound? (a) N_2O (b) NO_2 (c) N_2O_5 (d) N_2O_4 (e) N_3O_4
43. In a given atom, no two electrons can have the same values for all four quantum number. This is achieved following _____ (a) Hund's rule (b) Aufbau's principle (c) Uncertainty principle (d) Pauli's exclusive principle (e) all of the above
44. If the values of l are 0, 1, 2, and 3, what is the corresponding value of n? (a) 2 (b) 3 (c) 4 (d) 5 (e) 6

45. The number of unpaired electrons in a given energy level must be maximum. This statement is accredited to who? (a) Dalton (b) Aufbau (c) Hund (d) Bohr (e) Pauli
46. The correct ground state electronic configuration for a chromium atom is [At. No. = 24] (a) $[\text{Ar}]3\text{d}^5 4\text{s}^1$ (b) $[\text{Ar}]3\text{d}^4 4\text{s}^2$ (c) $[\text{Ar}]3\text{d}^6 4\text{s}^0$ (d) $[\text{Ar}]3\text{d}^5 4\text{s}^0$ (e) $[\text{Ar}]3\text{d}^5 4\text{s}^2$
47. According to Aufbau's principle, the energies of 3p, 3d, 4s and 4p orbitals are in the order (a) $3\text{p} < 3\text{d} < 4\text{s} < 4\text{p}$ (b) $3\text{p} < 4\text{s} < 3\text{d} < 4\text{p}$ (c) $3\text{d} < 3\text{p} < 4\text{s} < 4\text{p}$ (d) $3\text{d} < 3\text{p} < 4\text{p} < 4\text{s}$ (e) $3\text{p} < 4\text{p} < 3\text{d} < 4\text{s}$
48. What mass of F is in 24.5g of tin (I) fluoride? [At. Mass: F = 19.0; Sn = 118.7] (a) 9.57g (b) 9.75g (c) 5.97 g (d) 5.79 g (e) 7.59 g
49. Vanillin has the following composition by mass: carbon 63.2%, hydrogen 5.26%, and oxygen 31.6%. What is the empirical formula of Vanillin? [H = 1.0 g/mol, C = 12.0 g/mol, O = 16 g/mol]. (a) $\text{C}_8\text{H}_7\text{O}_3$ (b) $\text{C}_3\text{H}_3\text{O}$ (c) $\text{C}_8\text{H}_8\text{O}_3$, (d) CHO (e) $\text{C}_4\text{H}_4\text{O}_7$
50. Find the wavelength of a line in Balmer series associated with a drop of the electron from the fourth orbit. [Rydberg constant = 109,678 cm⁻¹] (a) 456nm (b) 565nm (c) 656nm (d) 670nm (e) 760nm
51. Predict the geometry and hybridization of the central atom in SCl_6 . (a) octahedral, sp^3d (b) square planar, sp^3d^2 (c) octahedral, sp^3d^2 (d) square planar, sp^3d (e) trigonal bipyramidal, sp^3d
52. Calculate the average atomic mass Ar for a naturally occurring chlorine if the distribution of isotopes is Cl-35 (75.77%) and Cl-37 (24.23%). Accurate masses for Cl-25 and Cl-37 are 34.97 and 36.97. (a) 34.55 (b) 33.55 (c) 35.35 (d) 35.45 (e) 35.01
53. Give the number of protons, neutrons and electrons in $^{200}_{80}\text{Hg}$. (a) 80, 80, 119 (b) 119, 80, 80 (c) 80, 120, 80 (d) 120, 80, 80 (e) 120, 120, 80
54. Predict the electronic configuration for Ti^{3+} [$^{48}_{22}\text{Ti}$]. (a) $[\text{Ar}]3\text{d}^1$ (b) $[\text{Ar}]3\text{d}^3$ (c) $[\text{Ar}]3\text{d}^4$ (d) $[\text{Kr}]4\text{d}^{10} 5\text{s}^2$ (e) $[\text{Kr}]4\text{d}^9$
55. A trigonal bipyramidal molecule has how many hybrid orbitals? (a) 6 (b) 5 (c) 4 (d) 3 (e) 2
56. Express 0.975 bar in atmosphere. (a) 0.872 (b) 0.862 (c) 0.972 (d) 0.962 (e) 0.772
57. A sample of 225mg of neon occupies 3.00 dm³ at 122K. If it behaves as an ideal gas, what is the amount of pressure exerted? [Ne = 20.18g/mol; R = 8.3×10^{-2} dm³ bar K⁻¹Mol⁻¹]. (a) 0.0427 bar (b) 0.0427 atm (c) 0.0247 bar (d) 0.0247 atm (e) 0.0742 bar
58. State to which period and group of the periodic table, the element with the electronic configuration $1\text{s}^2 2\text{s}^2 2\text{p}^6 3\text{s}^2 3\text{p}^6$ belongs. (a) period 2, group VIIA (b) period 2, group VIIIA (c) period 3, group VIIA (d) period 3, group VIA (e) period 3, group VIA
59. Express 108kPa in torr. (a) 710 (b) 810 (c) 910 (d) 610 (e) 510
60. Which scientist determined the charge of an electron? (a) R. Millikan (b) J. Dalton (c) J.J Thompson (d) W. Rontgen (e) E. Rutherford
61. Predict the geometry and bond angle of a molecule with a Sp^3d^2 hybridized orbital on the central atom. (a) trigonal planar, 120° (b) tetrahedral, 109.5° (c) square planar, 90° (d) octahedral, 90° (e) octahedral, 120°
62. What is the total number of electrons allowed in an "L" shell (a) 36 (b) 18 (c) 8 (d) 6 (e) 2
63. Calculate the volume occupied by 7g of nitrogen gas at 27°C and 750 mmHg pressure [N=14 g/mol] (a) 6.24 L (b) 12.48 L (c) 11.48 L (d) 7.24 L (e) 10.24 L
64. The following are examples of interstitial hydrides except? (a) TiH_{18} (b) FeH_2 (c) YbH (d) CsH (e) NiH_2
65. The arrangement of elements in the periodic table is in the order of increasing - (a) mass number (b) neutron numbers (c) proton numbers (d) molar mass (e) electron and neutron numbers
66. The half-life of ^{45}Ca is 165 days. After 1.0 year, what percentage of the original sample of ^{45}Ca remains? (a) 10.9% (b) 99.6% (c) 2.16% (d) 21.6% (e) 96.9 %
67. All the following options are examples of representative elements except? (a) Ca (b) Ga (d) Sr (d) Zr (e) Cl
68. Calculate the volume occupied by 5g of acetylene (C_2H_2) gas at 50 °C and 740 mmHg pressure, [C=12 g/mol; H= 1.0 g/mol]. (a) 3.2377 L (b) 4.2377 L (c) 5.2377 L (d) 6.2377 L (e) 7.2377 L
69. How many empty p orbitals are there in a carbon ion [C] (a) 1 (b) 2 (c) 3 (d) 4 (e) 5
70. 8g of methane gas and 2g of hydrogen gas are mixed at 760 mm Hg pressure at 273K. The total volume occupied by the mixture will be _____ [C=12 g/mol, H= 1 g/mol] (a) 11.2 L (b) 22.4L (c) 33.6 L (d) 44.8 L (e) 55. 0 L
71. Which equation represents alpha emission from $^{196}_{84}\text{Po}$? (a) $^{196}_{84}\text{Po} \rightarrow ^{192}_{82}\text{Po} + {}_2^4\text{He}$ (b) $^{196}_{84}\text{Po} + {}_2^4\text{He} \rightarrow ^{192}_{82}\text{Po}$ (c) $^{196}_{84}\text{Po} \rightarrow ^{200}_{86}\text{Rn} + {}_2^4\text{He}$ (d) $^{196}_{84}\text{Po} + {}_2^4\text{He} \rightarrow ^{200}_{86}\text{Rn}$ (e) none of the above
72. Which atomic orbital has values of n = 4, l = 2? (a) 4s (b) 4p (c) 4d (d) 4f (e) 4g



73. What is the missing particle in the bombardment reaction? $\text{Al}^{27} + ? = {}^1\text{n} + \text{P}^{30}$ (a) neutron (b) proton (c) beta (d) alpha (e) gamma
74. Which of the following is not an example of ionic hydride? (a) LiH (b) CaH₂ (c) SrH₂ (d) ZrH₂ (e) NaH
75. Of the following processes, which one does not change the atomic number? (a) gamma emission (b) alpha emission (c) positron emission (d) beta emission (e) none of the above
76. Which of the following pairs represents isobars? (a) ${}^{17}_8\text{O}$ and ${}^{18}_8\text{O}$ (b) ${}^{40}_{19}\text{K}$ and ${}^{40}_{20}\text{Ca}$ (c) ${}^{15}_7\text{N}$ and ${}^{16}_8\text{O}$ (d) ${}^{235}_{92}\text{U}$ and ${}^{238}_{92}\text{U}$ (e) none of the above
77. Which of the following elements has the lowest ionization energy; P, Na, Si, Mg, Al. (a) P (b) Mg (c) Al (d) Na (e) Si
78. Complete and balance the following nuclear equation by selecting the missing particle.

$${}_{12}^{24}\text{Mg} + {}_1^2\text{H} \rightarrow {}_2^4\text{He} + ?$$
 (a) ${}_{13}^{22}\text{Al}$ (b) ${}_{11}^{22}\text{Na}$ (c) ${}_{13}^{26}\text{Al}$ (d) ${}_{10}^{20}\text{Ne}$ (e) none of the above
79. "The total pressure of a mixture of gases (non-reacting) is equal to the sum of the partial pressure of all the gases present" is a statement of _____ (a) Graham's law of diffusion (b) Dalton's law of partial pressure (c) Avogadro's law of partial pressure (d) Ideal gas law (e) none of the above
80. An atom of _____ contains no neutron (a) hydrogen (b) deuterium (c) tritium (d) helium (e) sodium

SOLUTIONS TO CHM111 2020/2021

1. Isotones are those atoms that have equal number of neutrons e.g. ${}^14_6\text{C}$ and ${}^16_8\text{O}$ are isotones, other examples Cl-37 and K-39
Neutron No = Mass Number - Proton No
 taking Oxygen and Carbon
 Oxygen: 16 - 8 = 8 Neutrons
 Carbon: 14 - 6 = 8 Neutrons

Correct Option C

2. Eu^{3+} is a cation that has lost 3 electrons out of a total of 63 electrons hence 60 electrons are left.
NB. proton number in the nucleus equals electron number.

No Correct Option

3. NH₃ and LiH are the two basic hydrides in the list,

Correct Option A

4. $V_1 = 241\text{m}^3$,
 $T_1 = 18 + 273 = 291\text{K}$
 $P_1 = 100,400\text{Nm}^{-2}$ $V_2 = ?$
 $T_2 = 273\text{K}$
 $P_2 = 101,325\text{Nm}^{-2}$

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1} = \frac{100,400 \times 241 \times 273}{101,325 \times 291} = 224.03\text{m}^3$$

Correct Option B

5. $\text{PO}_2 = \text{XO}_2 \times \text{P}_{\text{total}}$
 $\text{PO}_2 = 0.2094 \times 760 = 159\text{Torr}$

Correct Option D

6. $M = \text{DRT}/P$
 $D = ?, R = 8.314,$
 $T = 125 + 273 = 398\text{K}$
 $M = (12 \times 4) + (1 \times 10) = 58$
 $P = 117.4$
 $\therefore D = MP/RT$

$$D = (5.8 \times 117.4)/(8.314 \times 398) = 2.057\text{g/L}$$

Correct Option A

7. The total number of orbitals present in $n = 3$ includes

1 orbital in the 3s sub shell
 3 orbitals in the 3p subshell and
 5 orbitals in the 3d subshell

Making a total of nine 9 orbitals in $n = 3$

Correct Option B

8. Hydrogen atom has only one electron, Hence, will require an equivalent ionization energy of $2.178 \times 10^{-18}\text{J}$ to knock out the electron out of the atom.

Correct Option C

9. $x : y$

50% : 50%

50/10 : 50/20

5 : 2.5

dividing by the lowest value

5/2.5 : 2.5/2.5

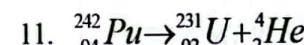
2 : 1

Empirical formula X₂Y

Correct Option C

10. An Orbital can hold a maximum of 2 electrons

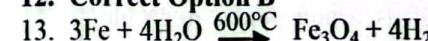
Correct Option C



Plutonium (94) will decay to yield an Alpha particle and a Uranium (92)

Correct Option B

12. **Correct Option B**



Correct Option D

14. Silver (I) ion Ag⁺ contains 46 electrons and 61 neutrons



15. ***

Correct Option C

16. The three series that undergo natural radioactive are
Thorium Series
Actinium Series'
Uranium Series.

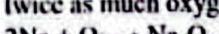
Correct Option A

17. The properties that increases down the group of alkali earth metals are, atomic number, Atomic weight, density and metallic radius.

Correct Option B

18. **Correct Option C**

19. Sodium reacts with oxygen under normal conditions to form a compound that's contains twice as much oxygen as in the oxide above.



Lithium reacts with oxygen to form Li_2O (an oxide) while, Potassium, Rubidium and Caesium reacts with oxygen to form super oxides

Correct Option B

$$\Delta_f = \Delta_o e^{kt}$$

Making t the subject of the formula

$$t = \frac{1}{-k} \ln\left(\frac{\Delta_f}{\Delta_o}\right) = \frac{1}{-0.13} \ln\left(\frac{\frac{2}{100}(\Delta_o)}{\Delta_o}\right) \approx 30 \text{ years}$$

Correct Option A

21. $\text{Cl}_4\text{H}_9\text{Cl}_3$

$$(12 \times 14) + (1 \times 9) + (35.3 \times 5)$$

$$168 + 9 + 177.5 = 354.5 \text{ g/mol}$$

$$\% \text{ Cl} = 177.7/354.5 \times 100 = 50.07\%$$

Correct Option E

22. Halogens have 7 electrons in the outermost shell, therefore, it's configuration must always end with $ns^2 np^5$

Correct Option B

23. For a principal quantum number of 5, there are 25 orbitals and only 1 electron, within each orbital we have a value of $ms = +1/2$, meaning there are 25 electrons within $n = 5$ and $ms = +1/2$

Correct Option D

24. $\text{He} = 4 \text{ g/mol } t = 1.25$

$\text{C}_2\text{H}_6 = 30 \text{ g/mol } t = x$

$$\frac{t_{\text{He}}}{t_{\text{C}_2\text{H}_6}} = \sqrt{\frac{M_{\text{He}}}{M_{\text{C}_2\text{H}_6}}} \rightarrow \frac{1.25}{x} = \sqrt{\frac{4}{30}}$$

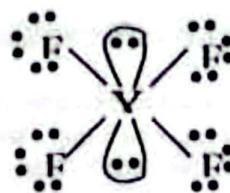
$$0.364x = 1.25$$

$$\therefore x = 3.42 \text{ minutes}$$

Correct Option C

25. The molecule XeF_4 is a non polar molecule, since the geometric structure of XeF_4 is symmetric i.e Square planar

Correct Option A



Correct Option C

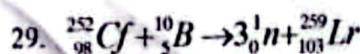
26. ***

27. Generally, electronegativity, ionization energy and electron affinity, increases across the period while atomic radii and ionic radii decreases across the period

Correct Option C

28. Phosphorus reacts with alkali earth metals to form phosphides such as Sodium phosphide $12\text{Na} + \text{P}_4 \rightarrow 4\text{Na}_3\text{P}$

Correct Option E



Correct Option E

$$30. \frac{t_x}{t_{\text{O}_2}} = \sqrt{\frac{M_x}{M_{\text{O}_2}}} \rightarrow \frac{1}{2} = \sqrt{\frac{32}{x}} \quad x = 12.8$$

Correct Option D

$$31. P = ? \quad T = 298 \text{ K} \quad R = 0.0821$$

$$V = 1 \text{ dm}^3$$

$$n = \text{mass} / \text{molar mass}$$

$$n = 200/131.295 = 1.52$$

but $PV = nRT$ (ideal gas equation)

$$P = nRT/V$$

$$P = 1.52 \times 0.821 \times 298/1 = 37.26 \text{ atm}$$

Correct Option A

$$32. P = ? \quad T = 273 + 35 = 308 \text{ K}$$

$$R = 0.0821 \quad V = 1.5 \text{ dm}^3$$

$$n = \text{mass/molar mass}$$

$$n = 35/39.948 = 0.876$$

but $PV = nRT$ (ideal gas equation)

$$P = nRT/V$$

$$P = 0.876 \times 0.821 \times 308/1.5 = 14.76 \text{ atm}$$

Closest Correct Option B

33. **Correct Option D**

34. Charles law

$$V \propto T, \text{ therefore } V = kT, k = V/T$$

Correct Option A

$$35. t_x = 146 \text{ s } M_x = ?$$

$$\text{CO}_2 = 115 \text{ s } \text{MCO}_2 = 44 \text{ g/mol}$$

$$\frac{t_x}{t_{\text{CO}_2}} = \sqrt{\frac{M_x}{M_{\text{CO}_2}}} \rightarrow \frac{146}{115} = \sqrt{\frac{x}{44}} \quad x = 70.9$$

Correct Option D

36. ***

37. Table of facts

Hybrid	Geometric	No of	Examples
--------	-----------	-------	----------



orbitals	arrangements	orbitals	
SP	Linear	2	Be in BeCl_2
SP^2	trigonal planar	3	B in BF_3
SP^3	Tetrahedral	4	C in CH_4
SP^3d	trigonal bipyramidal	5	P in PCl_5
SP^3d^2	Octahedral	6	S in SF_6

Correct Option C

38. John Dalton formulated a precise definition of the indivisible building blocks of matter called Atoms.

Correct Option C

$$39. m = 16 \text{ g} \quad M = 40 \text{ g/mol}$$

$$n = m/M = 16/40 = 0.4 \text{ mol}$$

Correct Option A

40. principal (n) = size
Azimuthal (L) = shape
Magnetic (m) = Orientation

Correct Option A

$$41. l = 3$$

For Azimuthal quantum number $L = 3$, the maximum number of electrons will be the total values of $m = (2 \times 3 + 1) = 7$ orbital, since, one orbital contains 2 electrons, therefore total number of electrons will be $7 \times 2 = 14$ electrons.

Correct Option D

$$42. N : O$$

$$30.5/14 : 69.5/16$$

$$2.1/2.1 : 4.3/2.1$$

$N\text{O}_2$ = Empirical formula

$(\text{NO}_2)_n = 92$

$$n(14 + 2(16)) = 92 \text{ g/mol}$$

$$n = 92/46 = 2$$

Molecular formula = $(\text{NO}_2)_2 = \text{N}_2\text{O}_4$

Correct Option D

43. Pauli's Exclusion principle states that no two electrons in the same atom can have identical values for all 4 quantum numbers.

Correct Option D

44. $n = 4$, Then $L = 0, 1, 2, 3$ i.e. $L = n - 1$

Correct Option C

45. **Correct Option C**

46. The ground state configuration of gaseous neutral Chromium is $[\text{Ar}]3\text{d}^54\text{s}^1$

Correct Option A

47. $1\text{s} < 2\text{s} < 2\text{p} < 3\text{s} < 3\text{p} < 4\text{s} < 3\text{d} < 4\text{p} < 5\text{s} < 5\text{p} < 6\text{s} < 4\text{s} < 5\text{d} \dots$

Correct Option B

48. Tin(ii)fluoride SnF_2

$$\text{SnF}_2 = 118.7 + (19 \times 2) = 156.7$$

if $38 \text{ g/mol} \rightarrow 156.7 \text{ g/mol}$

$$x \text{ g} \rightarrow 24.5 \text{ g}$$

$$x = 5.94 \text{ g/mol}$$

Correct Option C

$$49. \text{C} : \text{H} : \text{O}$$

$$63.2/12 : 5.26/1 : 31.6/16$$

$$5.26/1.97 : 5.26/1.97 : 1.97/1.97$$

$$2.6 : 2.6 : 1$$

Multiply all through by 3

$$8 : 8 : 3$$

$\text{C}_8\text{H}_8\text{O}_3$ (Empirical formula)

Correct Option C

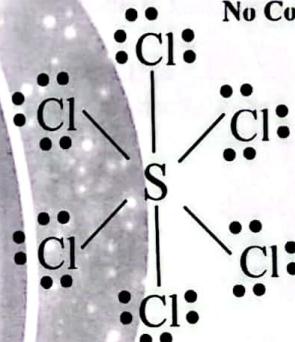
$$50. n_1 = 2 \text{ for Balmer series}$$

fourth orbital $n_2 = 4$

$$\frac{1}{\lambda} = R c \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = 109678 \left[\frac{1}{2^2} - \frac{1}{4^2} \right]$$

$$\frac{1}{\lambda} = 20564.62 \quad \therefore \lambda = 4.86 \times 10^{-5} = 486 \text{ nm}$$

51.



No Correct Option

the central atom (S) has 6 atoms attached to it.

Bonding pair plus lone pair = $6 + 0 = 6$ hence, sp^3d^2 which is octahedral

Correct Option C

$$52. \text{Average atomic mass of Chlorine} =$$

$$(75.77/100)(34.97) + (24.22/100)(36.97)$$

$$\text{AAMCl} = 35.45 \text{ amu}$$

Correct Option D

$$53. {}^{200}_{80}\text{Hg}$$

Neutron = mass No. - proton No.

Neutron number = $200 - 80 = 120$

Recall, proton No. electron number

Hence, number of protons, neutrons and electrons = 80, 120, 80

Correct Option C

54. Ti^{3+} has lost 3 electrons, hence has 19 electrons left. Hence, $[\text{Ar}]3\text{d}^1$

Correct Option A

55. Check the table in Question 37 above

Correct Option B

56. If 1 bar $\rightarrow 0.987 \text{ atm}$

$$\therefore 0.975 \text{ bar} \rightarrow x$$

$$x = 0.975 \times 0.987 = 0.9622 \text{ atm}$$

Correct Option D

57. mass = $225\text{mg} = 0.225\text{g}$
 $n = m/M = 0.225/20.18 = 0.011$
 $V = 3.0, T = 122\text{K}, P = \dots?$
 But $PV = nRT$
 $P = nRT/V$
 $P = 0.011 \times 0.08314 \times 122/3 = 0.0376 \text{ Barr}$

No Correct Option

58. $1s^2 2s^2 2p^6 3s^2 3p^6$ period 3 group VIIA
Correct Option C

59. If $101.325\text{KPa} \rightarrow 760\text{Torr}$
 $108\text{KPa} \rightarrow x \text{ Torr}$
 $x = 760 \times 108/101.325 = 810.06 \text{ Torr}$
Correct Option B

60. J. J Thompson obtained the ratio of electric charge to mass for an electron to be $-1.76 \times 10^8 \text{ C/g}$. Thereafter, in a series of experiments carried out between 1908 and 1917. R. A. Millikan found the charge of an electron to be $1.60 \times 10^{-19}\text{C}$

Correct Option A

61. sp^3d^2 has an octahedral shape with an angle of 90°

Correct Option D

62. K, L, M = 2, 8, 18

Correct Option C

63. $n = m/M = 0.25, T = 237 + 27 = 300\text{K}, P = 0.986, V = ?$
 but $PV = nRT$

$V = nRT/P$
 $V = 0.25 \times 0.0821 \times 300/0.986 = 6.24\text{L}$

Correct Option A

64. Cesium hydride (CsH) is a compound made of Cesium and Hydrogen. it is an alkali metal hydride.

Correct Option D

65. Proton number or Atomic number

Correct Option C

66. **Correct Option D**

67. The representative elements are elements where the s and p orbitals are filling. The transition elements are elements where the d orbitals (groups 3–11 on the periodic table) are filling, and the inner transition metals are the elements where the f orbitals are filling.

Zirconium, is a transition element.

Correct Option D

68. $n = n/M = 5/26 = 0.192,$
 $T = 323\text{K}, P = 0.973, V = ?$
 but $PV = nRT \therefore V = nRT/P$

$V = 0.192 \times 0.0821 \times 323/0.973 = 5.237\text{L}$

Correct Option C

69. $C^+ = 5 \text{ electrons} = 1s^2 2s^2 2p^1$



2 empty orbitals

Correct Option B

70. $\text{CH}_4 = 16, \text{ mass} = 8\text{g},$

$n = m/M = 8/16 = 0.5$

$\text{H}_2 = 2\text{g/mol} \text{ mass} = 2\text{g}$

$n = m/M = 2/2 = 1$

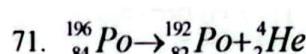
Total No. of moles = $0.5 + 1 = 1.5 \text{ mol}$

At $P = 1$

But $PV = nRT \therefore V = nRT/P$

$V = 1.5 \times 0.0821 \times 273/1 = 32.61\text{L}$

Correct Option C



Correct Option A

72. $n = 4, l = 2$

$l = 0 = s$

$l = 1 = p$

$l = 2 = d$

$l = 3 = f$

Hence the orbital is a 4d orbital.

Correct Option C

73. $\text{Al}^{27} + ? = ^1n + \text{P}^{30}$

$\text{Al}^{27} + ^4_2He = ^1n + \text{P}^{30}$ Alpha emission

Correct Option D

74. Ionic hydrides are formed when molecular hydrogen combines directly with some of the alkali earth metals e.g Ca, Sr, Ba, Li etc..

Zr is not an alkali Earth metal but a transition element.

Correct Option D

75. Gamma rays' emission does not result in any change in atomic number or mass number of the nucleus.

Correct Option A

76. Isobars are atoms that have equal number of nucleons i.e they have different atomic numbers but same mass numbers

Correct Option B

77. ionization energy is the minimum energy required to remove the most loosely bound electron of an isolated gaseous atom, positive ion, or molecule.

Ionization energy increases across the period

Correct Option D



Correct Option B

79. **Correct Option B**

80. *Hydrogen has no neutron.*

Correct Option A