Chemistry Olympiad Sri Lanka

& All Island Chemistry Quiz

PAPER CODE: BOX

Preliminary Selection Test – 2018

Answer ALL questions | Number of Pages 16 | Time: 2 hours & 30 minutes

Should not open the question paper until the instruction is given to start.

Composition: **50 Multiple Choice Questions and 3 Structured Questions**.

Section A: Multiple Choice Questions: Choose the best answer out of the five choices.

a. Should indicate all your answers in the answer script provided.
b. Select the best answer for each question and mark a cross using a carbon pen as shown below.

1. (a) (b) ~~(c)~~ (d) (e)

c. Mark only **one answer** to each question. Should not give more than one answer for each question.
d. Clearly write your **index number** and **paper code** (3 letters) in the answer sheet.

Section B: Structured Questions

e. For part B **use the given space** to write the answers. Do not separate the Part A & B answer scripts.

Calculators or any other electronic devices (smart watches) are not allowed.

PERIODIC TABLE OF THE ELEMENTS

1 1A																	18 8A
1 H 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 (Uut) (284)	114 Fl (289)	115 (Uup) (288)	116 Lv (293)	117 (Uus) (294)	118 (Uuo) (294)

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Gas Constant 8.314 J $mol^{-1}K^{-1}$	Avogadro Number 6.022×10^{23} mol^{-1}	0 °C = 273.15 K 1 atm = 760 mm Hg
Plank constant 6.6×10^{-34} $m^2kg\ s^{-1}$	Standard temperature and pressure: 273 K and 100 kPa	

PART A

1. Enthalpy of sublimation can be approximated by adding together _____ and _____.
   (a) Enthalpy of fusion, heat of condensation
   (b) Enthalpy of freezing (solidification), heat of condensation
   (c) Enthalpy of freezing (solidification), heat of vaporization
   (d) Enthalpy of condensation, heat of vaporization
   (e) Enthalpy of fusion, heat of vaporization

2. Which of the following has the electron configurations for sulfur (S), cadmium (Cd), hafnium (Hf), and radium (Ra) in correct order?

(a)	[Ne] $3s^2\ 3p^5$	[Kr] $5s^2\ 4d^{10}$	[Xe] $3s^2\ 3p^5$	[Rn] $6s^2$
(b)	[Ne] $3s^2\ 3p^4$	[Kr] $5s^2\ 4d^{10}$	[Xe] $6s^2\ 4f^{14}\ 5d^2$	[Rn] $7s^2$
(c)	[Ne] $3s^2\ 3p^4$	[Kr] $5s^2\ 4d^8$	[Ne] $3s^2\ 3p^5$	[Rn] $5s^2\ 4d^{10}$
(d)	[Ar] $3s^2\ 3p^5$	[Kr] $5s^2\ 4d^{10}$	[Xe] $3s^2\ 3p^5$	[Ne] $3s^2\ 3p^5$
(e)	[Ne] $3s^2\ 3p^5$	[Kr] $5s^2\ 4d^4$	[Xe] $3s^2\ 3p^5$	[Rn] $6s^2\ 4f^{14}\ 5d^2$

3. If an electron has a principal quantum number (n) of 3 and an angular momentum quantum number (l) of 2, the subshell designation is _____.
   (a) 3p
   (b) 3d
   (c) 4s
   (d) 4p
   (e) 4d

4. Quicklime (CaO) is produced by the thermal decomposition of calcium carbonate ($CaCO_3$). The volume of CO_2 at Standard Temperature and Pressure (STP) produced from the decomposition of 150 g $CaCO_3$ by the reaction is;
   (a) 3.41 L
   (b) 23.4 L
   (c) 33.6 L
   (d) 13.4 L
   (e) 11.2 L

5. Which one of the following is a valid statement of Avogadro's law?
   (a) $\frac{P}{T}$ = constant
   (b) $\frac{V}{T}$ = constant × n
   (c) PV = constant
   (d) V = constant × n
   (e) V = constant × P

6. Cathode rays are deflected away from a negatively charged plate because they are;
    (a) not particles
    (b) positively charged particles
    (c) neutral particles
    (d) emitted by all matter
    (e) negatively charged particles

7. When 1.00 L of 1.00 mol dm^{-3} $Ba(NO_3)_2$ solution at 25.0 ^oC is mixed with 1.00 L of 1.00 mol dm^{-3} Na_2SO_4 solution at 25.2 ^oC in a calorimeter, the white solid $BaSO_4$ forms, and the temperature of the mixture increases to 30.2 ^oC. Assuming that the calorimeter absorbs only a negligible quantity of heat, the specific heat capacity of the solution is 4.2 J $^oC^{-1}$ g^{-1}, and the density of the final solution is 1.0 g/mL, the enthalpy change per mole of $BaSO_4$ formed is;
    (a) 420 J mol^{-1}
    (b) 840 J mol^{-1}
    (c) 21 kJ mol^{-1}
    (d) 42 kJ mol^{-1}
    (e) 84 kJ mol^{-1}

8. The basis of the VSEPR model of molecular bonding is:
    (a) regions of electron density on an atom will organize themselves so as to maximize *s*-character
    (b) regions of electron density in the valence shell of an atom will arrange themselves so as to maximize overlap
    (c) atomic orbitals of the bonding atoms must overlap for a bond to form
    (d) hybrid orbitals will form as necessary to, as closely as possible, achieve spherical symmetry
    (e) electron pairs in the valence shell of an atom will arrange themselves so as to minimize repulsions

9. When NaCl dissolves in water, aqueous Na^+ and Cl^- ions result. The force of attraction that exists between Na^+ and H_2O is called a(n) _____ interaction.
    (a) dipole-dipole
    (b) ion-ion
    (c) hydrogen bonding
    (d) ion-dipole
    (e) London dispersion force

10. Using the data given in the following table identify the correct statement for the vaporization of PCl_3(l)

Substance	ΔH_f^0 (kJ/mol)	S^0 (J/mol K)
PCl_3 (g)	-288	317
PCl_3 (l)	-318	217

(a) spontaneous at low temperature and nonspontaneous at high temperature

(b) spontaneous at all temperatures

(c) nonspontaneous at low temperature and spontaneous at high temperature

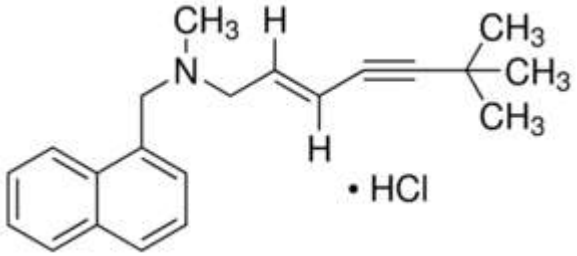
(d) nonspontaneous at all temperatures

(e) not enough information given to draw a conclusion

11. Chain isomers has the same molecular formula, but different arrangements of the carbon 'skeleton'. How many chain isomers can be drawn for hexane (C_6H_{14})?

(a) 2 (b) 3 (c) 4 (d) 5 (e) 6

12. Terbinafine is an antifungal medication used to treat fungal skin and nail infections. It is either taken orally or applied to the skin as a cream or ointment. How many pi bonds that terbinafine contains?



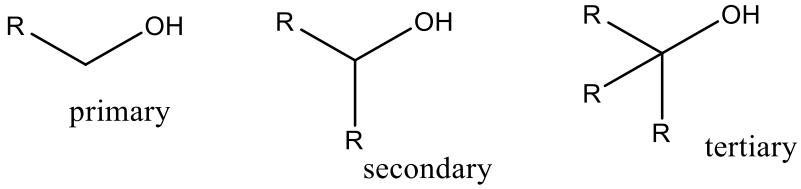
(a) 3 (b) 7 (c) 5 (d) 8 (e) 6

13. When a person breathes fresh air into the lungs, the oxygen in the air binds with hemoglobin found in red blood cells. This process allows oxygen to be moved from the lungs to rest of the body. One of the air pollutant mentioned below interferes with oxygen circulation in animals since hemoglobin prefers that molecule, over the oxygen. What is that molecule?

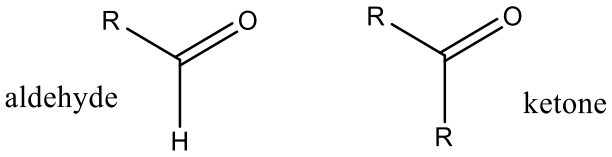
(a) Chlorofluorocarbon
(b) Carbon monoxide
(c) Carbon dioxide
(d) Hydrocarbon gas
(e) all above

14. Among the following, select the greenhouse gas pair which does not cause acid rains.
(a) SO_2 and NO_2 (b) NO_2 and CH_4 (c) CH_4 and SO_2 (d) SO_2 and CO (e) CO and CH_4

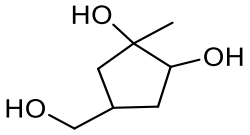
15. Primary, secondary and tertiary alcohols have formula of RCH_2OH, CHR_2OH and CR_3OH, where "R" indicates a carbon-containing group. Examples are given below.

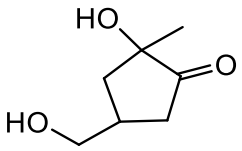


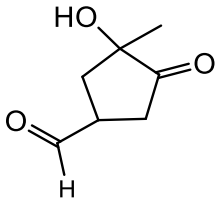
Pyridinium Chlorochromate (PCC) is an oxidizing agent. PCC readily oxidizes primary alcohols to aldehydes, and secondary alcohols to ketones. Tertiary alcohols do not undergo oxidation.



What would be the oxidation product of the following molecule when heated with PCC?



(a)


(b)


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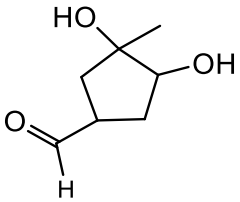
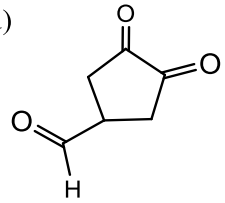
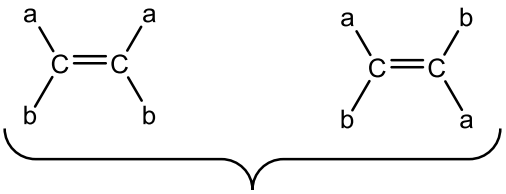


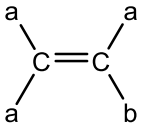
(d)


(e) None of the above

16. Compounds having similar molecular formula, but different arrangement of atoms or groups in space around the double bond are known as geometrical isomers. Geometrical isomers can be categorized as cis/trans isomers. Cis isomers have two similar atoms/groups on the same side of the double bond and trans isomers have similar atoms/groups on the opposite side of the double bond.



Cis and trans geometrical isomers



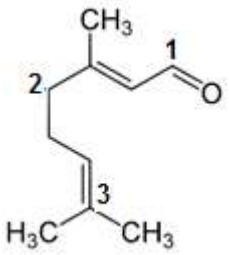
Does not exhibit geometrical isomerism

Which of the following molecular formula does not exhibit geometrical isomerism?

(a) C_4H_8 (b) C_4H_6 (c) $C_4H_6Cl_2$ (d) C_6H_{12} (e) $C_2H_2Cl_2$

17. Which of the following is lower for argon than for neon?
    (a) Polarizability
    (b) Boiling point
    (c) Melting point
    (d) First ionization energy
    (e) Heat of vaporization

18. What is the hybridization of carbon atoms 1, 2, and 3, respectively in the geramial given below?



(a) sp^2, sp^3, sp^2 (b) sp^2, sp, sp^2 (c) sp^3, sp^2, sp^3 (d) sp, sp^3, sp (e) sp, sp^2, sp

19. Which of the compounds has the lowest boiling point?

(a) HF (b) HCl (c) HBr (d) HI (e) H_2O

20. The correct balanced equation for the combustion of a hydrocarbon is
    (a) $4\ C_5H_{12} + 2\ O_2 \rightarrow 20\ CH_4 + 4\ H_2O$
    (b) $C_5H_{12} + 8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$
    (c) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
    (d) $2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$
    (e) None of the above

21. If a chemist requires 10 moles of liquid methanol (CH_3OH) for a chemical reaction, what volume should be used? The density of CH_3OH is 0.8 g cm^{-3} at 25^0C.
    (a) 0.025 L (b) 0.04 L (c) 0.25 L (d) 0.40 L (e) 2.5 L

22. For a reaction to become spontaneous Gibbs free energy (ΔG) must be negative. In order for a reaction to become **always** spontaneous what would be the conditions for enthalpy (ΔH) and entropy (ΔS). These thermodynamic parameters are related as $\Delta G = \Delta H - T\Delta S$.

    (a) ΔH positive, ΔS positive
    (b) ΔH positive, ΔS negative
    (c) ΔH negative, ΔS positive
    (d) ΔH negative, ΔS negative
    (e) none of the above

23. Raoult's law is applied to calculate partial vapour pressures of each pure substance in a mixture. Accordingly, partial vapor pressure of substance A (P_A) in a gas mixture can be expressed as

$$P_A = X_A\, P_A^0$$

    Where X_A is the mole fraction of A and and P_A^0 is the partial vapour pressure of the pure substance. The total pressure is sum of all the partial pressures.

    A liquid mixture contains 1.5 mol benzene and 0.50 mol toluene at 323 K. At a temperature of 323 K, benzene has a vapour pressure of 36.60 kPa and toluene a vapour pressure of 12.24 kPa. Calculate the partial vapour pressure of toluene at 323 K in kPa.

    (a) 1.12 (b) 3.06 (c) 8.15 (d) 9.18 (e) 12.24

24. Vapour pressure is a temperature dependent property. That means small changes in temperature cause change in vapour pressure. If the vapour pressure at temperature T_a (in Kelvin) is P_a then the vapour pressure p at a different temperature T is given by

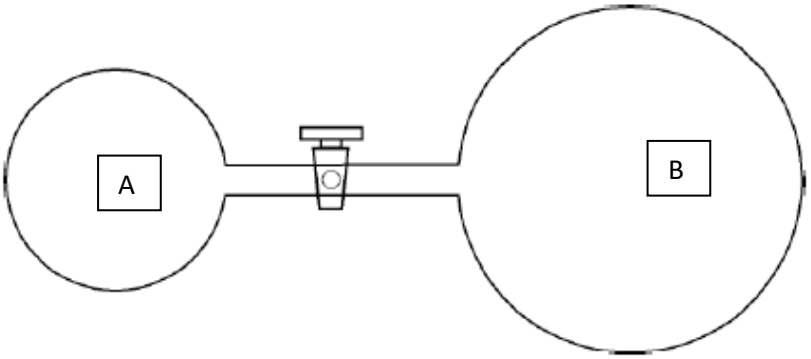
$$1 - \frac{P_a}{p} = \frac{\Delta H_{vap}}{R(T_a)^2}\,(T - T_a)$$

    where ΔH is the molar enthalpy of vaporization in kJ mol^{-1} and R is the universal gas constant.

    If at atmospheric pressure, the boiling point of a Halogen gas is 300 K determine the vapour pressure of this Halogen gas at T=290 K. ΔH_{vap}=24.94 kJ mol^{-1}.

    (a) 0.75 atm (b) 1.5 atm (c) 2.1 atom (d) 3.0 atm (e) 4.2 atm

25. As shown in figure below the vessel A with volume 1L containing Ar gas at 200 kPa and vessel B with volume 2L containing Ne gas at 150 kPa are connected through a tap of negligible volume. Initially, the tap is closed. When the tap is opened and the gases allowed to mix, what is the final pressure in the vessels?



(a) 133 kPa (b) 150 kPa (c) 167 kPa (d) 200 kPa (e) 233 kPa

26. A student mixed 4.0 g of $CaCO_3$ and 40 mL of 1.0 M HCl. What is the volume of CO_2 produced under standard temperature and pressure.

(a) $0.02\times8.314\times273$ cm^3
(b) $0.04\times8.314\times273$ cm^3
(c) $0.2\times8.314\times273$ cm^3
(d) $0.4\times8.314\times273$ cm^3
(e) $4.0\times8.314\times273$ cm^3

27. In chemistry ppm (parts per million) is used to express very low concentrations of solutions. 200 mL of aqueous NaCl solution contain 0.0040 g of NaCl. Calculate the concentration of NaCl in ppm? Consider density of water as 1.0 g/mL.

(a) 8 ppm (b) 20 ppm (c) 32 ppm (d) 80 ppm (e) 200 ppm

28. Following experiment was conducted to determine the density of the metal M. Since Metal M react with water, hence the experiment was done in a water free environment.

A 500 mL beaker was used for this experiment and the mass of the beaker was found as 284.70 g. Kerosene with density 0.75 g mL^{-1} was filled up to the lip of the beaker. Kerosene mainly consist of hydrocarbon dodecane ($C_{12}H_{26}$). Weight of the beaker with Kerosene was 684.70 g. Then the solid metal was carefully placed in the beaker and some of the Kerosene overflowed out of the beaker. The new weight of the beaker was 764.7 g. Then the metal was removed carefully without loosing any Kerosene. New weight of the beaker with kerosene was 564.7 g

What is the approximate density of the metal M in g mL^{-1}?

(a) 1.25 (b) 1.55 (c) 1.90 (d) 2.25 (e) none

29. If 2 mL of Kerosine was spilled during the removal process. What would happened to the above result (in question 28)?
    (a) Density slightly increase
    (b) Density decrease slightly
    (c) Density Remain same
    (d) Decreased by more than 10%
    (e) Cannot speculate

30. Graham's law of effusion (or diffusion) states that the rate of effusion is inversely proportional to the square root of the molar mass. According to this law Oxygen diffuses …… than Hydrogen
    (a) 0.0625 times as fast.
    (b) 0.25 times as fast.
    (c) 4 times as fast.
    (d) 8 times as fast
    (e) 16 times as fast.

31. Three balloons are filled with the same number of atoms of He, Ne, and Ar, respectively. Which of the following statements is true?
    (a) The balloons contain the same mass of gas.
    (b) All balloons have the same volume.
    (c) The densities of the three gases are the same.
    (d) The average speed of the different types of atoms is the same.
    (e) None of the above statements are true

32. 1.000 mL of 0.1000 mol L^{-1} hydrochloric acid was diluted to 100.0 mL with deionized water. 10.00 mL of this solution was diluted to 100.0 mL again using deionized water. What is the pH of the final solution? (pH is defined as $-\log[H^+]$, negative log of H^+ concentration in mol L^{-1})

    (a) 1 (b) 2 (c) 3 (d) 4 (e) 5

33. Using the kinetic theory of gasses one can determine the **average velocity** of an ideal gas in terms of molar mass (M) and absolute temperature (T). What should be the mathematical expression for average velocity? (R is the gas constant.)

    (a) $\frac{8RT}{\pi M}$ (b) $\frac{8MRT}{\pi}$ (c) $\sqrt{\frac{8R}{\pi MT}}$ (d) $\sqrt{\frac{8MRT}{\pi}}$ (e) $\sqrt{\frac{8RT}{\pi M}}$

34. At what temperature will the average velocity of He gas be equal to that of O_2 gas at 300 K? (Assume ideal gas behavior)

    (a) 300/8 K (b) 300/4 K (c) 300×4 K (d) 300×16 K (e) $\sqrt{300 \times 4}$ K

35. Accordingto the Bronsted-Lowry theory a proton (hydrogen ion) donor is an acid while proton (hydrogen ion) acceptor is a base. According to this theory which of the following compound **cannot** act as a Bronsted acid?

    (a) CH_3COOH (b) HSO_4^- (c) NH_4^+ (d) H_3O^+ (e) C_4H_{10}

36. Which of the following compounds have zero dipole moment?

(a) PF_5 (b) NH_3 (c) CH_3Cl (d) HCl (e) H_2S

37. Which of the compounds below will form a bond by overlapping of a *sp* hybrid orbital and a *p* atomic orbital?

(a) BF_3 (b) C_2H_2 (c) NH_3 (d) $BeCl_2$ (e) H_2O

38. The hybridization of central atom of H_3NO and HNO_3 respectively are

(a) sp^3 & sp^2 (b) sp^2 & sp^2 (c) sp^3 & sp^3 (d) sp^2 & sp^3 (e) sp^3d^2 & sp^2

39. Which of the following statements about the structure and stability of H_2O and H_2Te is **incorrect**?

(a) Boiling point of H_2Te is less than that of H_2O.
(b) H_2O molecules are more stable than H_2Te molecules.
(c) Acidic character of H_2Te is greater than H_2O
(d) Intermolecular forces between H_2Te is stronger than that of H_2O
(e) Covalent bonding within H_2O molecules is stronger than in H_2Te

40. Identify the molecule that does not have a permanent dipole moment?

(a) Nitrogen Dioxide (b) Nitrous Oxide (c) Ozone (d) Acetylene (e) Ammonia

41. Nitrogen monoxide, NO is a colourless gas that is produced when petrol is burned in the combustion chamber of a car engine. NO combines with oxygen (O_2) in air to form brown color NO_2 gas. What is the enthalpy change of this reaction? Standard enthalpy of formation (ΔH_f^0)of NO and NO_2 are +34 kJ mol^{-1} and +90 kJ mol^{-1} respectively.

(a) 56 kJ mol^{-1} (b) 112 kJ mol^{-1} (c) 124 kJ mol^{-1} (d) 256 kJ mol^{-1} (e) 316 kJ mol^{-1}

42. Find the correct arrangement under **decreasing** boiling points of Ar, HF, H_2, $MgCl_2$, CO

(a) HF > CO > $MgCl_2$ > Ar > H_2

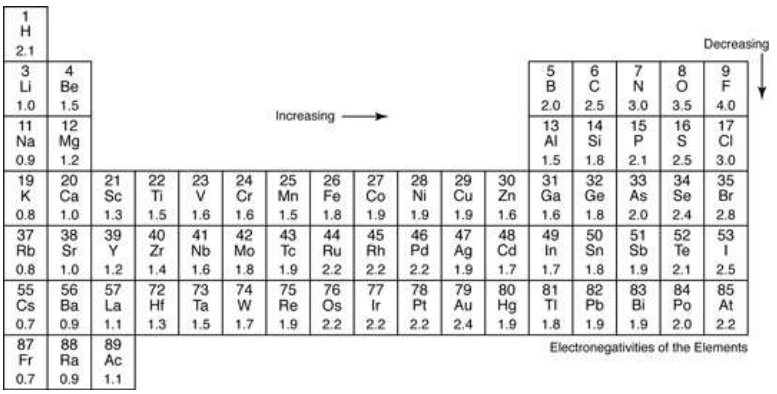
(b) H_2 > HF > $MgCl_2$ > Co > Ar

(c) $MgCl_2$ > HF> CO > Ar > H_2

(d) $MgCl_2$ > CO > HF > Ar > H_2

(e) $MgCl_2$ > HF> CO > H_2 > Ar

43. Which of the following bonds (indicated ---) are least polar. (Refer the Electronegativity values given in the periodic table)
    (a) Al --- Cl
    (b) Li --- I
    (c) P --- Br
    (d) C --- Cl
    (e) C --- I



44. Consider the following statements about HF
    (I) HF is a weak acid than other hydrogen halides due to lower H-F bond strength.
    (II) HF has a higher boiling point than other hydrogen halides because of the strong intermolecular interactions.
    (III) HF bond is more polar than other hydrogen halides because of its large electronegativity difference.

    Which of the above statements are correct?

    (a) All three (b) Only I and II (c) Only II and III (d) Only II (e) Only III

45. Density of ethanol at 175 K is 0.92 g cm^{-3}. Determine number of ethanol molecules needed to fill a cubic box with length of an edge equal to 10 nm. Molar mass of ethanol is 46 g/mol at this temperature. Avogadro number is N_A.

    (a) $2\ N_A \times 10^{-19}$

    (b) $4.1\ N_A \times 10^{-19}$

    (c) $5\ N_A \times 10^{-20}$

    (d) $2\ N_A \times 10^{-20}$

    (e) $2\ N_A \times 10^{-21}$

46. A volume of 500 mL of a 600 ppm solution of sucrose is provided to you. What volume of this solution in milliliters contain 0.15 g of sucrose?

    (a) 100 mL (b) 150 mL (c) 200 mL (d) 250 ml (e) 300 mL

47. Universal gas constant is typically given as 8.314 J mol^{-1} K^{-1} . Which of the following units gives the same value (i.e 8.314) for the universal gas constant?
    (a) atm cm^3 mol^{-1} K^{-1}
    (b) Pa cm^3 mol^{-1} K^{-1}
    (c) Pa m^3 mol^{-1} K^{-1}
    (d) kg m^2 s^{-1} mol^{-1} K^{-1}
    (e) kg m s^{-2} mol^{-1} K^{-1}

48. Choose the correct statement describing the preparation of 1 L of 3.0 % (w/v) aqueous $KHCO_3$ solution from a 0.60 M $KHCO_3$ solution provided. (Molar mass of $KHCO_3$ is 100 g/mol)

(a) Add 100 mL of $KHCO_3$ solution to a 1 L volumetric flask and top up with water

(b) Add 250 mL of $KHCO_3$ solution to a 1 L volumetric flask and top up with water

(c) Add 300 mL of $KHCO_3$ solution to a 1 L volumetric flask and top up with water

(d) Add 450 mL of $KHCO_3$ solution to a 1 L volumetric flask and top up with water

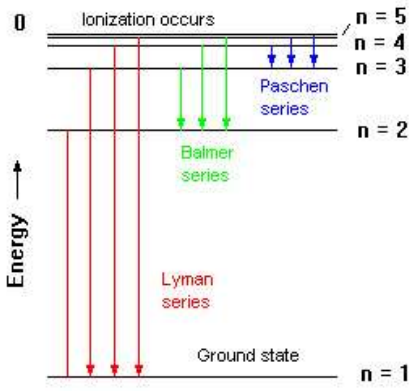
(e) Add 500 mL of $KHCO_3$ solution to a 1 L volumetric flask and top up with water

49. The Rydberg formula, which can be used to calculate the emission wavelengths of atomic Hydrogen spectrum is as follows:

$$f = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

where R is the Rydberg constant, n_1 and n_2 are the principle quantum numbers where $n_2 > n_1$, and f is the emission frequency. What is the ratio of frequencies between the first lines of Lyman, Balmer and Paschen series?

These three series are shown in the energy level diagram below.



(a) 1/2:1/6:1/12
(b) 1/2:1/3:1/4
(c) 3/4:5/36:7/144
(d) 2/3:8/56:3/88
(e) 1:14:19

50. The ability to disperse radiation is called resolving power. The resolving power of an optical spectrophotometer is given by the equation $R = \frac{\lambda}{\Delta\lambda}$ where, R = resolving power, λ = average wavelength of the two lines resolved and $\Delta\lambda$ = the difference in wavelength between the two lines. What is the resolution of a monochromator in order to observe an absorption band at 599.9 nm without interference from an absorption band at 600.1 nm.

(a) 2800
(b) 3000
(c) 6000
(d) 300
(e) 1500

PART B

Index Number ……..

Question 1

(I) $KMnO_4$ can oxidize ethanol (CH_3CH_2OH) to ethanoic acid (CH_3COOH) in acidic medium. During the reaction, MnO_4^- is reduced to Mn^{2+}.

(a) Write the balance chemical reaction using half reaction method

(b) Determine what volume of the 40% (v/v) ethanol solution is required to completely react 10.00 mL of 0.08 M $KMnO_4$ solution. (Density and molar mass of ethanol is 0.80 g/cm^3 and 46.0 g/mol respectively)

(c) What are the assumptions you considered in this calculation?

Question 2

(I) Predict the molecular shape of the following molecules/ ions using VSEPR theory and draw the Lewis structures inside respective boxes. Predict the polarity of each molecule (polar or non-polar).

XeF_2

Shape: ……

Polarity : …….

$SnCl_2$

Shape: ……

Polarity : ……

$TeCl_4$

Shape : ……

Polarity : …….

IF_5

Shape: ……

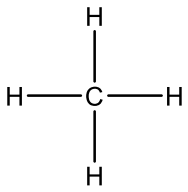
Polarity : …….

(II) Astronomers detect molecules in outer space using radio telescopes. Most of the molecules discovered in the less active regions of the space have linear structures. One of the largest linear structures detected was HC_7N. Draw the structure of this molecule?

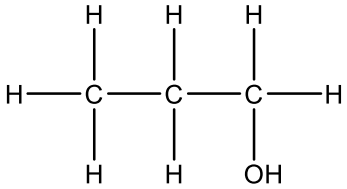
Index Number ……..

Question 3

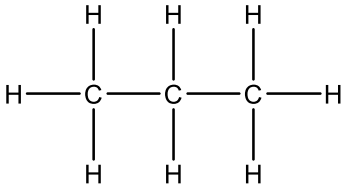
(I) Alkanes, alkenes and alcohols are three different homologous series of organic compounds. Structures of alkanes, alkenes and alcohols (**A**-**F**) are shown below.



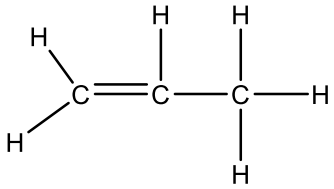
A



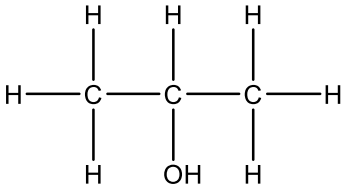
B



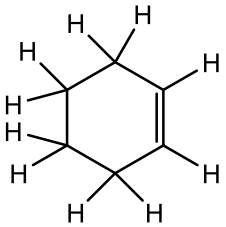
C



D



E



F

(a) Which two of these are saturated hydrocarbons?

(b) Which of these compounds are not hydrocarbons?

(c) Positional isomerism, occurs when functional groups are in different positions on the same carbon chain.

i. Which two of these compounds are positional isomers?

ii. Draw any five positional isomers of $C_5H_{11}Br$.

(d) Stereoisomers are isomeric molecules that have the same molecular formula and sequence of bonded atoms (constitution), but differ in the three-dimensional orientations of their atoms in space. For example, two stereoisomers are possible for 1,2-dimethylcyclohexane (Note that the numbers in the name determine what carbon atom the methyl groups are bonded to).

For 1,2-dimethylcyclohexane two stereoisomers are possible, one when the two methyl groups are on same sides of the ring (I) and the other when they are on the opposite side of the ring (II). Note that wedged lines ( ) denote bonds pointing out of the page and dashed lines ( ) denote bonds going into the page.

(I) (II)

Draw all of the stereoisomers possible for 1,3-dichlorocyclohexane.