



Anula Vidyalaya
Grade 13
Diagnostic Test – 2020 September
Chemistry I

Enu

Time : 2 hour

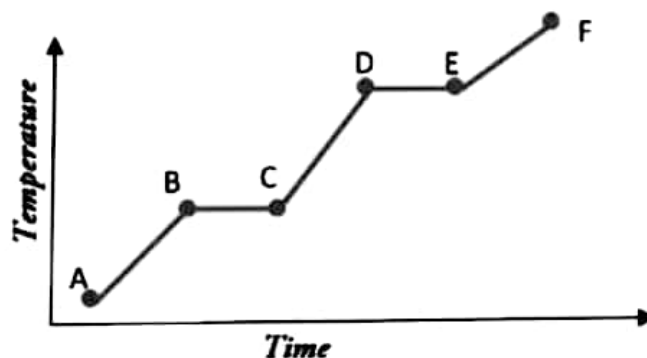
Universal Gas constant	R	=	8.314 J K ⁻¹ mol ⁻¹
Avogadro's constant	N _A	=	6.022 x 10 ²³ mol ⁻¹
Plank's constant	h	=	6.626 x 10 ⁻³⁴ Js
Velocity of light	C	=	3 x 10 ⁸ ms ⁻¹

Answer all the questions.

- 1) The metal that forms the most stable cation in water is,
1) Fe 2) Al 3) Na 4) K 5) Mg
- 2) What could be the charge of the octahedral complex formed by the contact of the Cu²⁺ ion with the H₂N-CH₂-COO⁻ binary ligand?
1) -4 2) -2 3) +2 4) -1 5) +1
- 3) Two liquids P and Q form Ideal solutions. The mole content of P in the vapour phase is 50% when the mole of P is in the solution at equilibrium is 25%. The ratio of pure saturated vapour pressures of P and Q is,
1) $\frac{P_P^0}{P_Q^0} = \frac{3}{1}$ 2) $\frac{P_P^0}{P_Q^0} = \frac{1}{3}$ 3) $\frac{P_P^0}{P_Q^0} = \frac{1}{2}$ 4) $\frac{P_P^0}{P_Q^0} = \frac{1}{4}$ 5) $\frac{P_P^0}{P_Q^0} = \frac{3}{4}$
- 4) The maximum number of electrons that can be quantum numbers n = 3, l = 2 and m_s = -1/2,
1) 1 2) 3 3) 6 4) 5 5) 10
- 5) A drinking water sample is highly contaminated with the carcinogenic chloroform (CHCl₃). The level of contamination is 15 ppm (by mass). The concentration of CHCl₃ in that water sample is (H = 1, C = 12, Cl = 35.5),
1) 15 x 10⁻⁴ moldm⁻³ 2) 1.5 x 10⁻⁴ moldm⁻³ 3) 1.266 x 10⁻⁴ moldm⁻³
4) 1.266 x 10⁻³ moldm⁻³ 5) 9.99 x 10⁻³ moldm⁻³
- 6) The IUPAC name of Na₂[Fe(CN)₅(NO)] is,
1) Sodium pentacyanonitrosylferrate(II) 2) Sodium pentacyanonitrosylferrate(III)
3) Sodium pentacyanonitrosyliron(III) 4) Sodium nitrosylpentacyanidoferrate(II)
5) Sodium nitrosylpentacyanidoferrate(III)
- 7) A white inorganic salt was dissolved in dilute HCl. When this solution was alkalized with excess NaOH, a colorless clear solution was obtained. There was no precipitate formed when one part of this solution treated with H₂S. When the remainder of the solution was treated with aqueous Ba(NO₃)₂, a white precipitate was obtained. This salt is,
1) ZnCl₂ 2) MgSO₄ 3) ZnSO₄ 4) Al₂(SO₄)₃ 5) SrSO₄

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- 8) A mixture containing 0.36g of NaBr and KBr by mass was dissolved in water, diluted with HNO_3 and aqueous AgNO_3 , and quantitatively analyzed. If 0.6g of AgBr was given here, the percentage of KBr in the mixture is, (Ag = 108, Br = 80, K = 39, Na = 23).
 1) 6.13% 2) 30.63% 3) 33.33% 4) 38.75% 5) 61.25%
- 9) Heat decomposition of the compound that gives both acidic oxide and alkaline oxide is,
 1) NaHCO_3 2) MgCO_3 3) NH_4NO_3 4) KNO_3 5) KClO_3
- 10) A system with a pure liquid is supplied with energy at a uniform rate. Its temperature varies with time as in the following.



Closest to the B – C line is,

- 1) Heat change that occurs during fusion 2) Heat transfer during evaporation
 3) Specific heat capacity of the gas 4) Specific heat capacity of the solid
 5) The melting point of the solid
- 11) Which of the following is a three-dimensional polymer that, contains benzene in every repeating unit but not a thermoplastic?
 1) Urea formaldehyde 2) Polystyrene 3) Nylon 4) Bakelite 5) Terylene
- 12) The $\text{NO}_{2(g)}$ dissociation rate of the reaction $4\text{NO}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{N}_2\text{O}_{5(g)}$ is $0.048 \text{ moldm}^{-3}\text{s}^{-1}$. The rate with respect to $\text{N}_2\text{O}_{5(g)}$ is,
 1) $0.024 \text{ moldm}^{-3}\text{s}^{-1}$ 2) $0.048 \text{ moldm}^{-3}\text{s}^{-1}$ 3) $-0.012 \text{ moldm}^{-3}\text{s}^{-1}$
 4) $-0.024 \text{ moldm}^{-3}\text{s}^{-1}$ 5) $0.012 \text{ moldm}^{-3}\text{s}^{-1}$
- 13) A mixture of salts MgCO_3 and CaCO_3 was heated to 1000°C until a constant mass was obtained. The volume of exhaust gas was collected and the volume of air under pressure $7 \times 10^4 \text{ Pa}$ was 83.14 dm^3 . When the starting mixture was dissolved in water and an additional volume of $(\text{NH}_4)_2\text{C}_2\text{O}_4$ was added to it, the mass of precipitated CaC_2O_4 was 25.6g. What was the mass of MgCO_3 in the starting mixture? (Ca = 40, Mg = 24, C = 12, O = 16)
 1) 84g 2) 42g 3) 21g 4) 16.8g 5) 8.4g
- 14) Which of the following statements about aluminium chloride is true?
 1) Aqueous AlCl_3 reacts as a Lewis acid.
 2) Anhydrous AlCl_3 is a compound that exhibits covalent properties.
 3) It precipitates with aqueous ammonia and the precipitate does not dissolve in excess sodium hydroxide.
 4) The acidic nature of an aqueous solution of AlCl_3 cannot be observed with litmus paper.
 5) The only observation obtained when Na_2CO_3 is added to an aqueous solution of AlCl_3 is the release of a gas.

- 15) An organic compound called A reacts with the ammoniacal AgNO_3 and does not reduce Ag^+ ions. And A with $\text{ZnCl}_2 / \text{HCl}$ forms a water insoluble compound instantly. The most possible statement regarding A is,
- 1) A is an aldehyde and has a of tertiary carbon atoms attached to a OH group.
 - 2) A can be an alcohol and has a triple bond in the carbon chain.
 - 3) A is an aldehyde and has a terminal triple bond in the carbon chain.
 - 4) A is an alcohol and has a terminal triple bond in the carbon chain.
 - 5) A is a tertiary alkyl halide and has a non-terminal triple bond in the carbon chain.

- 16) $\text{H}_3\text{C}-\overset{\text{CHO}}{\underset{|}{\text{C}}}\text{H}-\text{CH}=\text{CH}-\overset{\text{CHO}}{\underset{|}{\text{C}}}\text{H}-\text{CH}_3$ The IUPAC name of the organic compound is,

- 1) 5-formyl-2-methylhex-3-enal
 - 2) 2,5-dimethylhex-3-ene-1,6-dial
 - 3) 2,5-diformylhex-3-ene
 - 4) 2,5-dimethylhex-1,6-dione
 - 5) 2,5-dimethyl-6-oxohex-3-enal
- 17) The dichromate of a metal called M has one Cr atom per M atom. Here the percentage of M by mass of fluoride is 85.04%. What is the R.A.M of M? (F = 19)
- 1) 108
 - 2) 36
 - 3) 54
 - 4) 162
 - 5) 216
- 18) Which of the following sets of quantum numbers is incorrect?
- 1) $n = 6, l = 1, m_l = -1$
 - 2) $n = 4, l = 2, m_l = 1$
 - 3) $n = 3, l = 2, m_l = 3$
 - 4) $n = 2, l = 0, m_l = 0$
 - 5) $n = 2, l = 1, m_l = 0$

- 19) The mole ratio between NaNO_3 and KNO_3 in a mixture of solid nitrates is 4:1. The O_2 formed when a known mass of this mixture is heated, takes volume of 112 cm^3 at standard temperature and pressure. The mass of the heated nitrate mixture is (Na = 23, N = 14, O = 16, K = 39, the molecular volume of a gas at standard temperature and pressure is 22.4 moldm^{-3}).

- 1) 441 mg
- 2) 820 mg
- 3) 850 mg
- 4) 882 mg
- 5) 900 mg

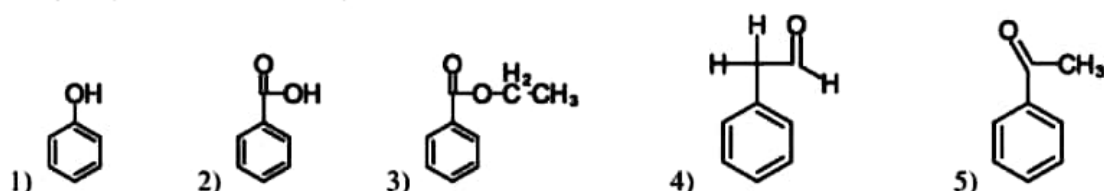
- 20) The true statement on nylon is,

- 1) A synthetic, condensation and thermoplastic polymer.
- 2) Natural condensation Polymer.
- 3) $-\text{CONH}_2$ linkages are present in the polymer.
- 4) A synthetic, addition and thermoplastic polymer.
- 5) formed by the condensation of a diamine with a dihydric alcohol.

- 21) $\text{Ca}(\text{OH})_2$ is slightly soluble in water. Its K_{sp} value at 25°C is 1.28×10^{-8} . The pH of a saturated solution of $\text{Ca}(\text{OH})_2$ at 25°C is,

- 1) 12.34
- 2) 12.14
- 3) 12.04
- 4) 11.84
- 5) 11.04

- 22) The organic compound X reacts with dilute NaOH . But does not emit a gas with Na_2CO_3 . This gives a colored precipitate with the Brady's reagent and decolorizes an acidic KMnO_4 solution. X could be,



23) Consider the solubility of $\text{MgSO}_{4(s)}$ in water at room temperature. The following data are given.

$$\Delta G^\circ [\text{MgSO}_{4(s)}] = -279 \text{ kJmol}^{-1}$$

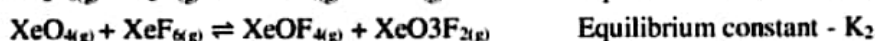
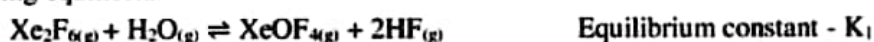
$$\Delta G^\circ [\text{Mg}^{2+}_{(aq)}] = -109 \text{ kJmol}^{-1}$$

$$\Delta G^\circ [\text{SO}_4^{2-}_{(aq)}] = -178 \text{ kJmol}^{-1}$$

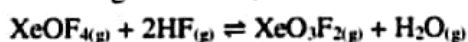
Which of the following statement is true?

- 1) $\text{MgSO}_{4(s)}$ has a negative ΔG° value in the water-solubility reaction and dissolves well in water.
- 2) $\text{MgSO}_{4(s)}$ has a negative ΔG° value in the water-solubility reaction and is insoluble in water.
- 3) $\text{MgSO}_{4(s)}$ has a positive value of ΔG° in the water-solubility reaction and dissolves well in water.
- 4) $\text{MgSO}_{4(s)}$ has a positive value of ΔG° in the water-solubility reaction and is insoluble in water.
- 5) Since the ΔG° value of $\text{MgSO}_{4(s)}$ water dissolution reaction is a small negative value, nothing can be said about water polarity.

24) Consider the following equilibria.



The equilibrium constant of the following reaction is,



1) $\frac{K_1}{K_2^2}$

2) $K_1 - K_2$

3) $\frac{K_1}{K_2}$

4) $\frac{K_2}{K_1}$

5) $\frac{K_1^2}{K_2}$

25) After electrolysis of the aqueous solution of CuSO_4 using M metal electrodes, the mass of the cathode increased by 0.65g and the mass of the anode decreased by 0.18g after some time. The metal used for the electrodes could be ($\text{Cu} = 63.5$, $\text{Fe} = 56$, $\text{Al} = 27$, $\text{Zn} = 65$, $\text{Mg} = 24$).

1) Cu

2) Fe

3) Mg

4) Al

5) Zn

26) A cell is made using X and Y standard electrodes. The electrodes to be applied for X and Y as that then an electric current flows from Y to X through the external circuit, are,

	1)	2)	3)	4)	5)
X	$\text{Cl}_2 / \text{Cl}^-$	F_2 / F^-	$\text{Cu}^{2+} / \text{Cu}$	$\text{Zn}^{2+} / \text{Zn}$	$\text{Fe}^{3+} / \text{Fe}^{2+}$
Y	H^+ / H_2	$\text{Cl}_2 / \text{Cl}^-$	H^+ / H_2	$\text{Cu}^{2+} / \text{Cu}$	I_2 / I^-

27) False statement regarding hydrocarbons is,

- 1) Some hydrocarbons with $\text{C} = \text{C}$ bonds do not show electrophilic addition under normal conditions.
- 2) The result of the addition of HBr on 2-butene is always a stereo isomer.
- 3) When H_2 is added to an alkene, the hybridization of some of the C atoms in the alkene changes.
- 4) When the catalyst is Hg^{2+} , most alkynes react with H_2SO_4 to produce ketones.
- 5) When a non-polar molecule is added to an alkene, the oxidation numbers of the C atoms do not change.

28) Which of the following statement about the s block and its compounds is true?

- 1) Down the group, the solubility of second group hydroxides decreases.
- 2) On heating, KNO_3 decomposes to form gases NO_2 and O_2 .
- 3) Down the group, the solubility of second group sulphates decreases.
- 4) All the elements in group two react with cold water to give H_2 gas.
- 5) All first group elements bicarbonate could be decomposed to the respective oxides by heating.

29) The true statement regarding the reactions having in a closed system is,

- 1) The randomness of the environment increases when a spontaneous exothermic reaction occurs.
- 2) When the enthalpy change is positive but the entropy change is negative, the reaction is spontaneous at high temperatures.
- 3) Any reaction with a negative value of ΔG^0 is spontaneous at any temperature.
- 4) A heat-absorbing reaction occurs spontaneously only at high temperatures.
- 5) A reaction with negative ΔG^0 and positive ΔS^0 can reach dynamic equilibrium.

30) Which of the following could be used to obtain a buffer solution with a pH less than 7 by partially neutralizing it with NaOH at 25°C?

- | | | |
|---|--|----------------------------------|
| 1) 0.01 mol dm ⁻³ CH ₃ COOH | 2) 0.1 mol dm ⁻³ HI | 3) 0.01 mol dm ⁻³ HCl |
| 4) 0.001 mol dm ⁻³ HClO ₄ | 5) 0.1 mol dm ⁻³ H ₂ SO ₄ | |

❖ For each of the question 31 to 40, one or more responses out of the four responses (a), (b), (c) and (d) given is /are correct. Select the correct response /responses. In accordance with the instruction given on your answer sheet, mark

- 1) if only (a) and (b) are correct.
- 2) if only (b) and (c) are correct.
- 3) if only (c) and (d) are correct.
- 4) if only (d) and (a) are correct.
- 5) if any other number or combination of responses is correct.

Summary of above Instructions

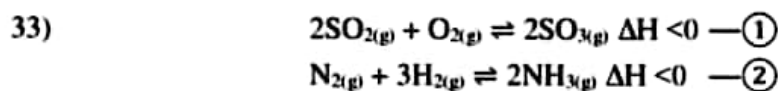
(1)	(2)	(3)	(4)	(5)
Only (a) and (b) are correct.	Only (b) and (c) are correct.	Only (c) and (d) are correct.	Only (d) and (a) are correct.	Any other number of combination of responses is correct.

31) Solutions of NaIO₃ and Cu(NO₃)₂ having the concentration of each as 0.002 mol dm⁻³ are mixed in equal proportions. If the K_{sp} of Cu(IO₃)₂ is 6.4 × 10⁻⁸ mol³dm⁻⁹, which of the following statement/statements is/are true?

- a) Precipitation of Cu(IO₃)₂ occurs.
- b) Cu(IO₃)₂ is precipitated when the concentration of IO₃⁻ ions is 0.006 mol dm⁻³ or higher than that.
- c) Cu(IO₃)₂ begins to precipitate when the IO₃⁻ ion concentration is 0.008 mol dm⁻³ or higher..
- d) The concentration of Cu²⁺ in the solution is 10⁻¹ mol dm⁻³.

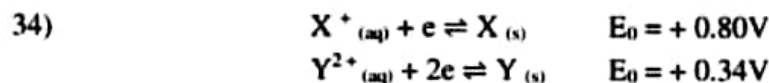
32) In the equilibrium system A_{2(g)} + B_{2(g)} ⇌ 2AB_(g), the activation energy of the forward reaction is 108 kJ and of the backward reaction is 230 kJ. The true statement about this equilibrium system is/are,

- a) Decrease of the temperature increases the equilibrium constant.
- b) The forward reaction is exothermic.
- c) Reduction of the volume of the vessel at a constant temperature does not change the rate of the reaction.
- d) Once when B₂ is removed from the system, the backward reaction rate increases.



Consider the above (1) and (2) reversal equilibrium reactions. Accordingly, the true statement/statements is/are,

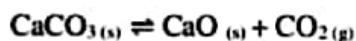
- As the temperature of both equilibrium systems increases, the reactions rates increase.
- For the second equilibrium reaction, $K_C = K_P(RT)$.
- The K_P values increase when the reactants amounts of the two systems increase.
- It would be the same amount of both SO_3 and NH_3 are given when equal moles of reactants are used.



Which of the following statements / statements is/are incorrect regarding the electrochemical cell constructed using X and Y electrodes under standard conditions?

- The $\text{X}^+(\text{aq}) / \text{X}(\text{s})$ electrode is the anode.
- The mass of the metal Y decreases with time.
- Oxidation occurs at the $\text{Y}^{2+}(\text{aq}) / \text{Y}(\text{s})$ electrode.
- The anions move toward the $\text{Y}^{2+}(\text{aq}) / \text{Y}(\text{s})$ electrode.

35) Consider the equilibrium system below



Which of the following could take place when $\text{CaO}(\text{s})$ is added to the system?

- Increasing of the CaCO_3 mass in the system.
- The equilibrium point shifts to left.
- No change in $\text{CO}_2(\text{g})$ concentration.
- The partial pressure of $\text{CO}_2(\text{g})$ does not change.

36) The true statement/statements about $\text{CH}_3\text{-COOC}_2\text{H}_5$ is/are,

- It gives an alcohol having 4 carbon atoms with CH_3MgBr .
- It gives 2 alcohols with $\text{LiAlH}_4 / \text{H}_2\text{O}$.
- Forms $\text{CH}_3\text{-COOH}$ with aqueous NaOH .
- Reacts with dilute HBr to form $\text{C}_2\text{H}_5\text{Br}$.

37) $[\text{Ni}(\text{H}_2\text{O})_4(\text{NH}_3)_2]\text{SO}_4$ Consider the complex compound formed by a metal in d block. Which of the following statements / statement is true in this regard?

- There are ionic, dative and polar covalent bonds in it.
- The oxidation number of Ni in this complex compound is +4.
- Tetraaquadiamminenickel(II) sulphate refers to the IUPAC name.
- When excess amount of dilute ammonia is added to this complex compound, the solution turns blue.

38) Which of the following is/are insoluble in water but soluble in concentrated HCl ,

- BaSO_4
- CoCl_2
- BiOCl
- PbCl_2

39) The true statement/statements about SO_2 is/are,

- The SO_2 molecule is angular in shape.
- SO_2 reacts as a bleach under wet conditions, and its bleaching action is a reducing process.
- A weak acid is given when SO_2 dissolves in water.
- The acidity of SO_2 is higher than that of SO_3 .

40) Which of the following industrial processes/processes use lime stones at least in one step in the manufacturing process?

- In the manufacturing of bleaching powder
- In the production of nitric acid by the Oswald method
- In the production of ammonia by the Haber method
- In the manufacturing of urea fertilizer

❖ In question numbers from 41 to 50, two statements are given in respect of each question.

From the table given below, select the response, out of the responses (1),(2),(3),(4) and (5) that best fits the two statements and mark appropriately on your answer sheet.

Response	First statement	Second statement
1)	True	True and correctly explains the first statement
2)	True	True, but does not explain the first statement correctly.
3)	True	False
4)	False	True
5)	False	False

	First Statement	Second Statement
41	As the pressure of an ideal gas increases at a given temperature, its square mean velocity increases.	The pressure of an ideal gas at a given temperature is directly proportional to its root mean square speed.
42	O ₂ gas could be used to distinguish chemically between NO and SO ₂ gases.	NO is not a colorless gas.
43	NH ₃ is oxidized by air in the presence of a heated Cu metal catalyst.	NH ₃ gas is oxidized by O ₂ to N ₂ and H ₂ O when Cu metal is present.
44	All bicarbonates in the first group of s block remain solid at room temperature.	Solid carbonates are formed during thermal decomposition of all bicarbonates.
45	If an element goes under oxidation and reduction during a chemical reaction, it is a disproportionation reaction.	H is disproportionated in the reaction between CaH ₂ and H ₂ O.
46	In the production of NaOH using the membrane cell system, a small electric current is sent through the cell at a greater potential difference.	"Low power consumption" is one of the advantages of the NaOH manufacturing process using the membrane cell.
47	In the reaction between KMnO ₄ and H ₂ C ₂ O ₄ , the Mn ²⁺ ion acts as a self-catalyst.	A catalyst changes the reaction mechanism of a reaction.
48	A poor fuel gas mixture with excess air (lean mixture) produces exhaust fumes with a low CO amount but a high amount nitric oxide.	The composition of the exhaust fumes can be controlled by tuning the engine.

49	As water vapor condenses in a closed system, the entropy of the surrounding environment increases.	The mobility of the particles of the surrounding environment increases by the heat liberated from the system.
50	A solid bromide and a chloride could not be distinguished separately by heating with conc: HNO_3 .	Although Br^- turns Br_2 in the presence of conc: HNO_3 , Cl^- does not turn to Cl_2 .

Periodic Table

	1																	2
1	H																	He
2	3	4											5	6	7	8	9	10
	Li	Be											B	C	N	O	F	Ne
3	11	12											13	14	15	16	17	18
	Na	Mg											Al	Si	P	S	Cl	Ar
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	55	56	La-	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	87	88	Ac-	104	105	106	107	108	109	110	111	112	113	...				
	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub	Uut					
	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71			
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103			
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			



Anula Vidyalaya
Grade 13
Diagnostic Test – 2020 September
Chemistry II

Enu

Time : 3 hours

Part A – Structured Essays

Answer all the questions.

- * A periodic table is provided
- * Use of calculators is not allowed.

Part A – Structured Essay (pages 2 – 11)

- * Answer all the questions on the question paper itself.

Part B and Part C Essay (pages 12 – 19)

- * Answer four questions selecting two questions from each part. Use the papers supplied for this purpose.

- | |
|---|
| <ul style="list-style-type: none">* Universal gas constant $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$* Avogadro constant $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$ |
|---|

part	Q. No.	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
C	8	
	9	
	10	
Total		
Percentage		

Final Marks

Enu

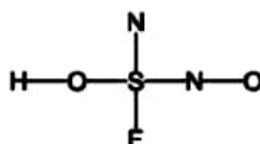
Answer all four questions.

1)

- a) Identify the element that exhibits the following properties using only the elements give in parenthesis. (Na, Mg, Al, Si, P, N, O, S, F and Cl)
- The element that makes up the strongest alkaline hydride is _____
 - The element that forms the strongest acidic oxide is _____
 - The element that does not react with acids but reacts with bases and releases H_2 is _____
 - The element that forms the strongest basic hydride is _____
 - The element that shows the highest composition in the atmosphere (out of the element in this category) is _____
 - The element that forms strongest metallic bonding is _____
 - The element forms a molecule with a crown shape is _____
 - The element used to make the Grignards' Reagent is _____

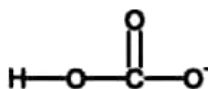
b)

- i) Following states the skeletal structure of the HSO_2N_2F molecule.



Draw the stable Lewis structure for this molecule.

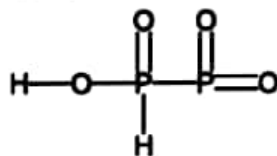
- ii) HCO_3^- ion exhibits buffer action. Its Lewis structure is given below.



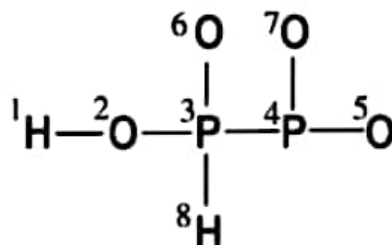
Draw 2 other acceptable structures (resonance structures) for this ion. Name the most unstable structure among them.

- iii) Draw the resonance hybrid for HCO_3^- ion (N.B.; do not use unstable structures for this).

iv) Consider the Lewis structure below.



Each atom in this molecule is numbered as follows.

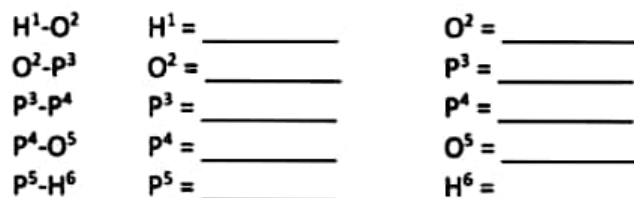


From the numbered atoms, provide the information about them which were asked below. Write those information in the table below.

1. Number of repulsion units around the atom.
2. The electron pairs geometry around the atom.
3. The shape around the atom
4. The hybridization of the atom

	O ²	P ³	P ⁴	O ⁵
1. Number of repulsion units				
2. electron pairs geometry				
3. shape				
4. hybridization				

v) Consider the molecule mentioned in question iv) above. (The numbering of the respective atoms is the same.) Specify the type of atomic / molecular orbital that participates in each atom to form sigma bonds between the two atoms below.



vi) Indicate the approximate possible values for the bond angles between the atoms below.

- (1) H¹O²P³ = _____
- (2) O²P³P⁴ = _____
- (3) P³P⁴O⁵ = _____

c)

- i) The quantum numbers of three consecutive electrons in an element are as follows.

n	l	m_l	m_s
	0		$+\frac{1}{2}$
			$+\frac{1}{2}$
3			$+\frac{1}{2}$

Complete this note with the appropriate symbols.

- ii) Adjust the species listed in ascending order according to the property in parentheses.

1. N_2O , N_2O_3 , N_2O_5 (Acidic character)

_____ < _____ < _____

2. $AgCl$, $AgBr$, AgI (Covalent Features)

_____ < _____ < _____

3. NO_2^+ , NO , NO_2^- (Electronegativity of N)

_____ < _____ < _____

4. O_2 , O_2^{2-} , O_3 (O-O bond length)

_____ < _____ < _____

2)

- a) A is a metal. It gives a reddish flame in flame test. A reacts with nitrogen gas to form a metal nitride B when heated. But no other element in the same group that A belonging to the periodic table reacts with nitrogen in this way. A reacts with cold water and hot water to form metal hydroxide and releases gas C. However, in the reaction with steam, the metal produces oxide, not hydroxide. Where C is also formed. The element that shows the maximum radius of the period to which A belongs in the periodic table is A.

- i) Identify A.

- ii) Write the electron configuration in the ground state of the element.

- iii) Identify the B and C compounds and write their chemical formulae.

B = _____ C = _____

- iv) What are the products formed when the compound B reacts with water?

- v) Note the group to which A belongs in the periodic table. Indicate whether the following features increase or decrease as you go down that group.

- The rate of reaction with water _____
- Alkalinity of metal oxide _____

3. Thermal stability of metal hydroxide _____

4. The melting point of the element _____

Give reasons for your 4th answer..

vi) Give 2 examples to show that element A behaves differently from other elements in the group to which it belongs.

(1) _____

(2) _____

vii) Indicate another element that gives colors close to A in the flame test.

viii) State one use of A.

ix) Chemically there is another element that behaves almost identically to A but does not belong to the same group of A. What is it?

x) What color does the element you mentioned in (ix) above give to the flame test?

xi) Write the balanced chemical equation to show the thermal decomposition of nitrate of

b) The 5 unlabeled bottles contain NaCl, NaOH, Na₂S₂O₃, Na₂CrO₄ and NaHCO₃ separately. In a test to identify these, a small amount of each solution was taken and named A, B, C, D and E (not orderly) and a small amount of aqueous AgNO₃ solution was added to it. The observations received are as follows.

test tube	Observation when AgNO ₃ solution was added
A	A white precipitate is obtained. It is insoluble in dilute acids but soluble in dilute NH ₃ .
B	Gives a brown precipitate.
C	Gives a brick red precipitate.
D	A light yellow precipitate is obtained. Gas bubbles are released.
E	Gives a white precipitate. It turns black over time or when heated

3)

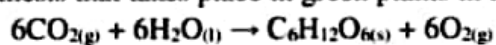
a)

i) Define the standard formation enthalpy of glucose.

ii) Consider the standard enthalpy and standard entropy data below given at 25°C.

Compound	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	$\Delta S^\ominus / \text{JK}^{-1} \text{mol}^{-1}$
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$	-1268	212
$\text{CO}_2(\text{g})$	-394	214
$\text{H}_2\text{O}(\text{l})$	-286	70
$\text{O}_2(\text{g})$	0	205

Note the photosynthesis that takes place in green plants in the presence of sunlight.



(1) Calculate the following at 25°C for the above reaction using the data given above.

(a) Enthalpy change

(b) Entropy change

(c) Gibbs' free energy change

(2) State your ideas on the spontaneity of the reaction above.

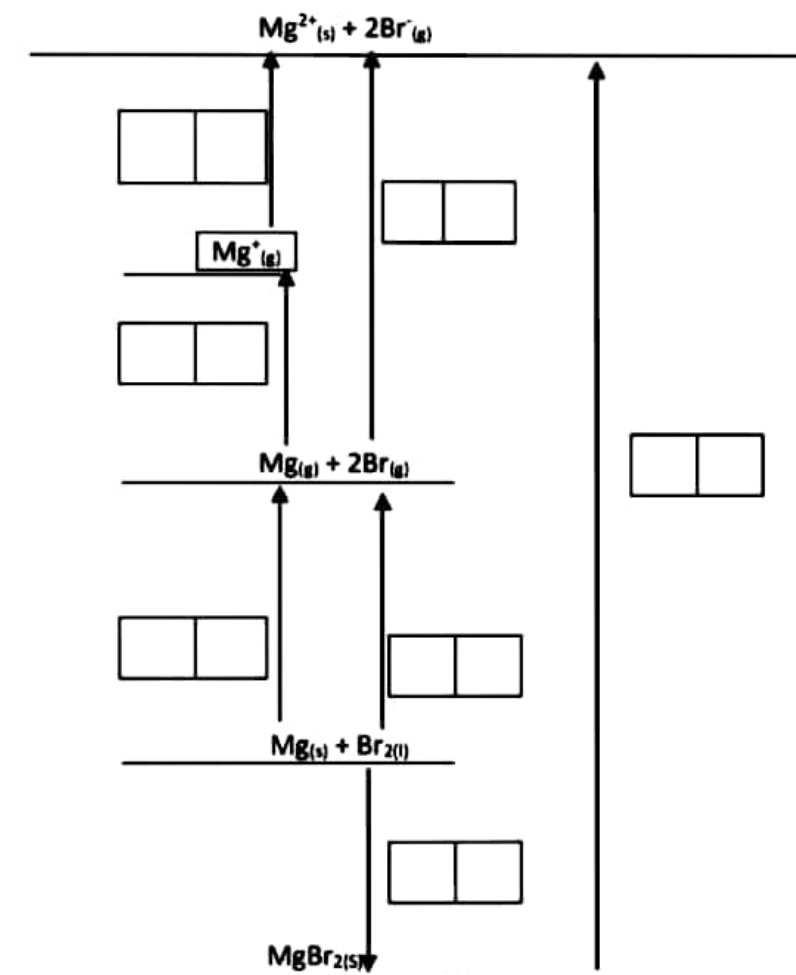
(3) If the above reaction is not spontaneous, calculate the temperature at which it occurs.

(4) Mention the assumptions you made in the calculation above (3)..

b)

(i) Define standard lattice dissociation enthalpy.

(ii) The following is the Bone-Haber cycle for finding the lattice dissociation enthalpy of $\text{MgBr}_{2(s)}$. Indicate the accepted symbols for each of these enthalpy variations and their +/- nature in the boxes in front of the arrows. Note that all changes are considered in the standard case. With the size of the enthalpy change the sign should also be indicated.



(iii) Calculate the standard enthalpy change of dissolution of $\text{MgBr}_{2(s)}$ using the standard enthalpy data below.

- (2) The standard lattice enthalpy change of $\text{MgBr}_{2(s)} = 2400 \text{ kJmol}^{-1}$
- (3) Standard hydration enthalpy of $\text{Mg}^{2+}_{(g)} = -1891 \text{ kJmol}^{-1}$
- (4) Standard hydration enthalpy of $\text{Br}^-_{(g)} = -351 \text{ kJmol}^{-1}$

- c) Determine the characteristics of ΔS in the following reactions and indicate whether the temperature should increase (\uparrow) or decrease (\downarrow) for the reaction to occur spontaneously. **Enu**

reaction	ΔH	ΔS	ΔG	T
$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$	+	—	-	—
$H_2O_{(l)} \rightarrow H_{2(g)} + \frac{1}{2}O_{2(g)}$	-	—	-	—

4)

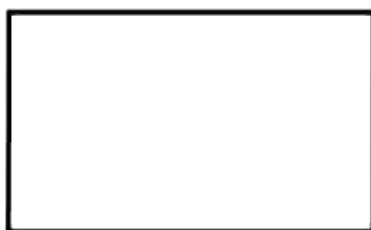
a)

- i) In a hydrocarbon with 4 carbon atoms, 2 C atoms show sp^2 hybridization and 2 C atoms sp^3 hybridization. All carbon atoms are in the same plane. There are three isomers A, B and C and only A shows the diastereomerism.

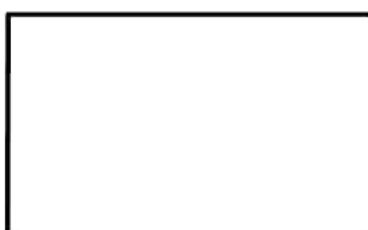
When A, B and C are hydrated, D is obtained from A and B, and the resultant product of C which is named as E gives an immediate turbidity with the Lucas reagent.

The product formed by the oxidation of D gives the product F reacting with 2,4 DNP.

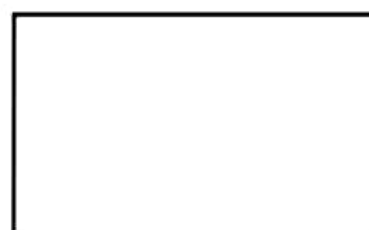
Draw structural formulae from A to F.



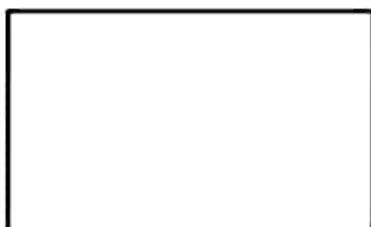
A



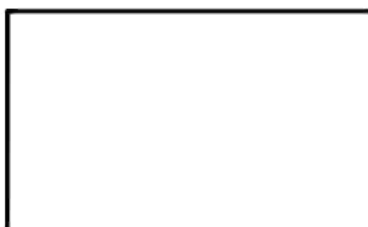
B



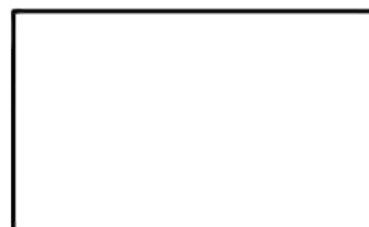
C



D



E



F


- ii) Write down the mechanism for the reaction below.



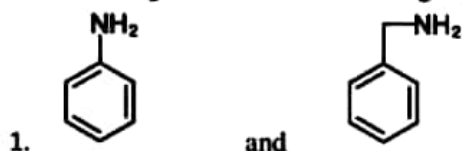
b)

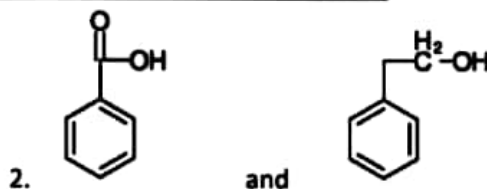
i. Complete the table below.

(Type of reaction - nucleophilic substitution S_N , electrophilic substitution S_E , nucleophilic addition A_N , electrophilic addition A_E , other M_O)

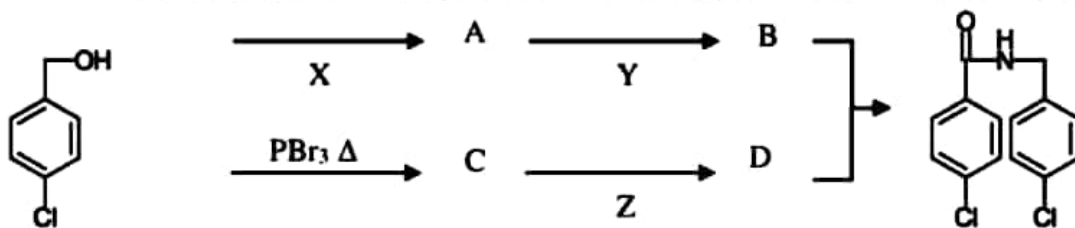
Reactant	Reagent	Major Product	Type of the reaction
CH_3COOH	I. $LiAlH_4/\text{ether}$ II. H^+/H_2O		
	Br_2/CCl_4	$H_3C-\overset{H}{\underset{Br}{C}}-\overset{H}{\underset{Br}{C}}-H_2$	
	CH_3Cl Anhydrous $AlCl_3$		
CH_4	Cl_2 Scattered sunlight		
	Conc: NH_3	$CH_3CH_2NH_2$	

ii. Propose a method to distinguish between following organic compounds.





c) Write down the reactants and products related to the synthesis of the organic compound below.



A

B

C

D

X

Y

Z



Grade 13
Diagnostic Test – 2020 September
Chemistry II

Part B – Essay

Answer 2 questions only

5)

- a) The following equilibrium was reached when a sample of NO_2 gas was heated to 601K in a closed vessel.

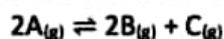


At equilibrium, the initial pressure of the system was found to be 1.40×10^5 Pa and the partial pressure of $\text{NO}_{(g)}$ was 4.0×10^4 Pa. At 601K, $\text{RT} = 5 \times 10^3 \text{ J mol}^{-1}$.

- Calculate the partial pressures of $\text{NO}_{2(g)}$ and $\text{O}_{2(g)}$.
- Calculate the equilibrium Concentrations of $\text{NO}_{2(g)}$, $\text{NO}_{(g)}$ and $\text{O}_{2(g)}$ at equilibrium.
- Calculate the equilibrium constant K_c for the above equilibrium.
- Explain whether the brown color decreases / increases as the pressure in the above system increases.

(7.5 Marks)

- b) The following equilibrium was achieved when 0.2 moles of gas A were inserted into a closed rigid vessel with a volume of 5.0 dm^3 and heated to 127°C .



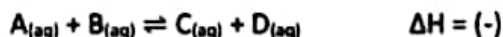
If 20% of the gas A at the equilibrium transformed in to products, calculate the following.

- Molecular amounts of equilibrium $\text{A}_{(g)}$, $\text{B}_{(g)}$ and $\text{C}_{(g)}$
- K_c of the system
- K_p of the system
- Total pressure in the system
- If 10% of the gas A is formed at 127°C , predict the direction in which the K_c and equilibrium point of the system will follow.

(7.5 Marks)

6)

- a) The method of initial rates was used to study the chemical kinetics of the following reaction at 25°C .



Here the time taken for a concentration change ($\Delta C_{D(aq)}$) of $\text{D}_{(aq)}$ to occur is measured and shown in the table below.

Test	Initial $[A_{(aq)}]/\text{mol dm}^{-3}$	Initial $[B_{(aq)}]/\text{mol dm}^{-3}$	$\Delta C_{D(aq)}/\text{mol dm}^{-3}$	Time/ s
1	0.010	0.02	0.010	100
2	0.030	0.02	0.180	200
3	0.010	0.04	0.060	300

- i) Define initial speed.
- ii) Calculate the initial velocities of each test.
- iii) Calculate x , y and K if the order of the reaction with respect to $A_{(aq)}$ and $B_{(aq)}$ are x and y respectively, and the rate constant of the reaction at 25°C is K .
- iv) Write down the rate equation for the reaction.
- v) How does the rate of the above reaction change when the concentration of B (aq) is kept constant and the concentration of A (aq) is tripled?
- vi) Catalyst E has been found to increase the rate of the above reaction. Note the presence of E and the absence of E in the energy profile of the above reaction. Name the axes and curves.

(7.5 Marks)

b)

- i) Define the Solubility product of $\text{Ca}(\text{OH})_{2(s)}$.
- ii) Derive an expression for the Solubility product of $\text{Ca}(\text{OH})_{2(s)}$.
- iii) The Solubility product of $\text{MgCO}_{3(s)}$ at 25°C is $3 \times 10^{-8} \text{ mol}^2 \text{ dm}^{-6}$. Calculate the Mg^{2+} concentration of a saturated $\text{MgCO}_{3(s)}$ solution at 25°C .
- iv) The Solubility product of $\text{CaCO}_{3(s)}$ at 25°C is $3 \times 10^{-9} \text{ mol}^2 \text{ dm}^{-6}$. Calculate the concentrations of Mg^{2+} and Ca^{2+} separately in an aqueous solution saturated with both $\text{MgCO}_{3(s)}$ and $\text{CaCO}_{3(s)}$ at this temperature.

(7.5 Marks)

7)

a)

- i) Write an expression for the Raoult's law relating to solvent A in a binary ideal solution made up of mixed solvents A and B .
- ii) Two liquids A and B with boiling points T_A and T_B , respectively, combine to form an ideal solution. A and B form a solution X at a ratio of 2: 3 moles, respectively, and the total pressure results by the solution at equilibrium is $2.8 \times 10^4 \text{ Pa}$. The total vapor pressure of another solution called Y , a co-molecular mixture of A and B , is $3 \times 10^4 \text{ Pa}$. Calculate the molar fraction of A at the vapor phase that is at equilibrium with the X solution.
- iii) Draw the temperature-composition phase diagram for the above system.
- iv) If the Y solution is distilled,
 1. Mark the boiling point of Y , T_1 in the phase diagram above.
 2. Mark the composition of the vapor phase X_1 at T_1 temperature.
 3. If the above two liquids A and B are not miscible, what can you say about the boiling point of the mixture?
 4. Write an expression for the partition coefficient K_D between water and CCl_4 .
 5. Write 2 requirements for K_D to be valid.

b) $\text{NH}_3(\text{aq})$, forms a complex of $[\text{Cu}(\text{NH}_3)_n]^{2+}$ in a solution of $\text{CuSO}_4(\text{aq})$. 100 cm^3 of 0.75 mol dm^{-3} CuSO_4 in concentrated NH_3 was shaken with 100 cm^3 of CCl_4 solution and allowed to reach the equilibrium. When the equilibrium system was separated and the aqueous layer was titrated against 2 mol dm^{-3} HCl solution, 162.5 cm^3 of HCl solution was consumed. When the remaining CCl_4 layer was taken and titrated with a 0.1 mol dm^{-3} HCl solution, a volume of 10 cm^3 was consumed. The partition coefficient of NH_3 between water and CCl_4 is 25. Calculate the following.

1. Total number of moles of NH_3 in the aqueous layer.
2. Number of free NH_3 moles in the aqueous layer.
3. Find the value of n .

c) A chemical cell is formed using Sn and Al.

$$E^\ominus \text{Sn}^{2+}(\text{aq})/\text{Sn}(\text{s}) = -0.14 \text{ V}$$

$$E^\ominus \text{Al}^{3+}(\text{aq})/\text{Al}(\text{s}) = -1.66 \text{ V}$$

- i. Write the cell reaction of the cell.
- ii. Find out the electromotive force of the cell.
- iii. State what happens to the electromotive force of the cell when,
 - iv. the Al^{3+} concentration is elevated,
 - v. the temperature rises,
 - vi. the surface area increases of Al is increased.

Answer two questions only.

8)

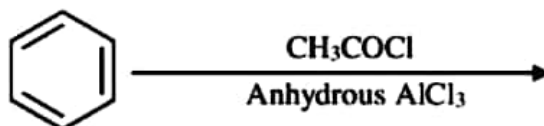
a)

i) Explain the following scientifically.

1. Amines are more alkaline than alcohols.

2. The organic compound CH_3CHO exhibits nucleophilic addition reactions.

ii) Write down the mechanism for the following reaction.

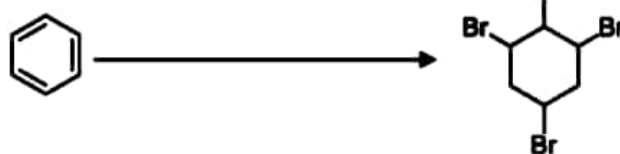


b) State how you would try the following conversion using the given compound as the only organic compound.

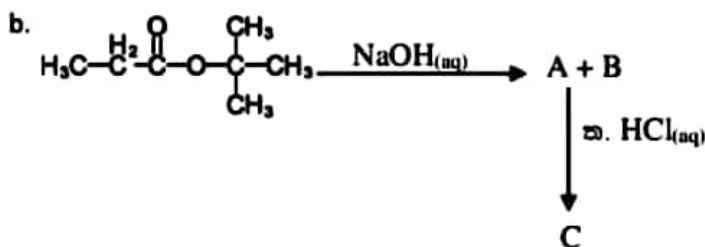
(NB: Must be no more than five steps.)



viii.



c)

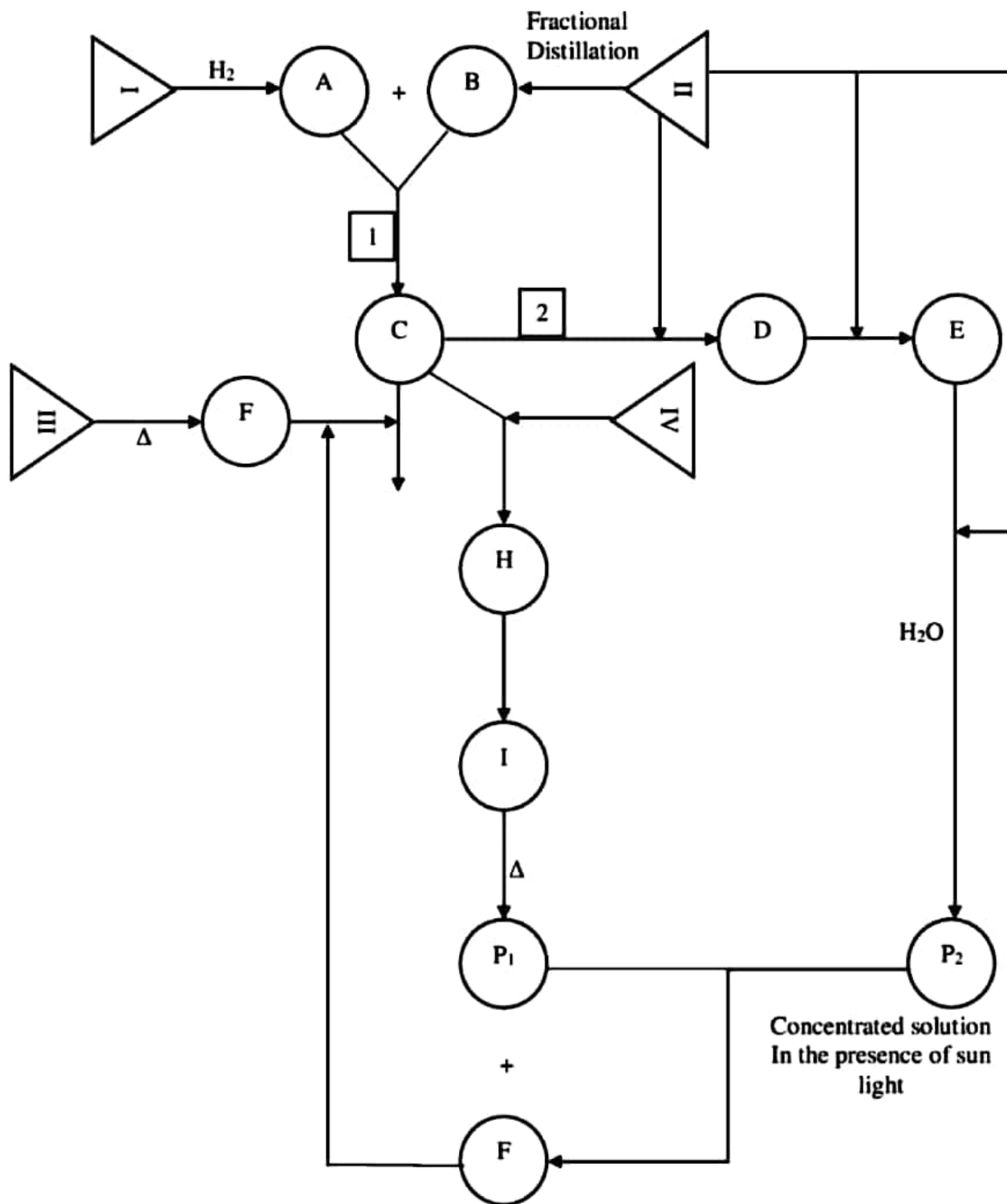


i. Draw structures A, B and C in related to the above reaction.

ii. Write tests to identify B and C.

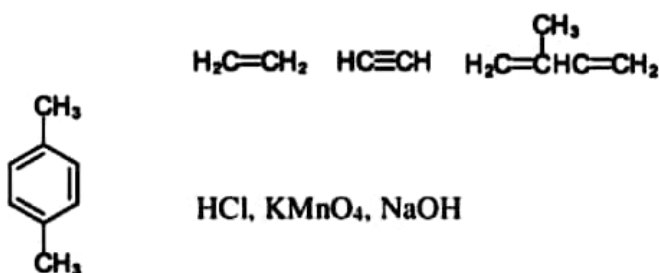
9)

a) The following is a flow chart that can be used industrially to manufacture P_2 and P_3 products. Answer the following questions in that note.



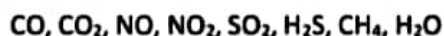
- i) Identify the products P_2 and P_3 .
- ii) Write the names of the natural raw materials suit for triangles I, II, III, IV.
- iii) Write the chemical formulae of A, B, C, D, E, F, H and I given in circles.
- iv) Mention the reaction conditions for 1, 2.
- v) Write balanced chemical equations for the reactions related to the P_2 product formation and the reactions related to its recycling of its by-products.
- vi) Give I and P_2 a benefit each.
- vii) Write a use of P_3 .
- viii) Write down 4 environmental issues that occur during the production of the P_3 .
- ix) Write the balanced chemical equation for yellowing the P_3 solution when exposed to sunlight

b)



Use these compounds and reagents appropriately and answer the following questions.

- i) Indicate how a thermoplastic, condensation polymer is formed by giving a reaction and state its 'repeating unit'.
 - ii) Draw the structure of the most elastic polymer and its repeating unit.
 - iii) Draw the structure of an addition polymer that can be produced from the above compounds and the structure of its repeating unit.
 - iv) How do you distinguish between bakelite and PVC polymer?
- c) Answer the following questions using the following species:



State following

- i) Two species that contribute to acid rain,
- ii) Two species that contribute to global warming,
- iii) Two species that not possible in vehicle exhaust fumes,
- iv) Write two species that contribute to photo-chemical smog.

10)

- a) The following is data from a laboratory test to find the standard neutralizing enthalpy of an acid. Here the acid and the base are reacted in an equivalent volume of thermal insulation.

1. 2M HCl 50 cm³ 2M NaOH 50 cm³
Temperature of 2M HCl was 25°C

2M NaOH

The maximum temperature obtained when mixing the solution is 38.5°C

2. 2M CH₃COOH 50 cm³ 2M NaOH 50 cm³

The temperature of the 2M CH₃COOH solution was 25°C

The temperature of the 2M NaOH solution was 25°C

The maximum temperature obtained when mixing the solution is 37.5°C

- i) Write balanced chemical equations for the above reactions.
 - ii) Calculate the heat changes in reactions 1 and 2 above.
(Density of water 1 gcm⁻³, specific heat capacity of water 4.2 Jg⁻¹K⁻¹)
 - iii) Write 3 assumptions made here.
 - iv) Calculate the neutralization enthalpy for an acid mole of 1 and 2.
 - v) Explain with reason whether the values obtained in the calculation of (iv) are equal or not.
- b) The following procedure was used to calculate the concentrations of SO₃²⁻ and SO₄²⁻ ions contained in the waste water. 50 cm³ of the wastewater sample was reacted with 150 cm³ of 0.1 moldm⁻³ I₂ (dissolved in KI) solution. The total volume of the solution was 200 cm³. 25 cm³ of the above solution was titrated with 0.1 moldm⁻³ Na₂S₂O₃ solution to react with the remaining I₂. The burette reading was 25 cm³.

Another 25 cm³ of the above solution was acidified with dilute HNO₃ and reacted with excess aqueous **Error! Not a valid link.**. The resulting white precipitate after drying was 0.466 g. (Ba = 137, S = 32, O = 16)

- i) Write balanced chemical equations for all of the above reactions.
- ii) Calculate the concentration of SO₃²⁻ ions in the wastewater.
- iii) Calculate the concentration of SO₄²⁻ ions contained in the wastewater.

