කො/විශාඛා විද්‍යාලය කොළඹ - 05
Co/Visakha Vidyalaya, Colombo - 05

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2023
General Certificate of Education (Adv. Level) Examination, 2023

රසායන විද්‍යාව I **Chemistry I** 13- ශ්‍රේණිය Grade -13	තුන්වන වාර පරීක්ෂණය - නොවැම්බර් 2023 **Third Term Test - 2023 November** 02 E I	පැය 02 යි. *02 hours*

* This paper consists of 10 pages. (Periodic table is provided.)
* Answer all the questions.
* Use of calculators is **not allowed**.
* Write your **index number** in the space provided in the answer sheet.
* Follow the instructions given on the back of the answer sheet carefully.
* In each questions 1 to 50, pick one of the answer sheet with a cross (x) in accordance with the instructions given on the back of the answer sheet.

Universal gas constant, R	$= 8.314 \, J \, mol^{-1} K^{-1}$
Avogadro constant N_A	$= 6.022 \times 10^{23} \, mol^{-1}$
Plank's constant h	$= 6.626 \times 10^{-34} \, Js$
Velocity of light C	$= 3 \times 10^{8} \, ms^{-1}$

(1) Consider following discoveries relavent to build atomic structure.

   (I) Radioactivity and existence of three types of radiation were discovered by Henri Becquerel and Ernest Rutherford respectively.

   (II) Atomic nuclear model and proton were discovered by J.J. Thomson and Ernest Rutherford respectively.

   (III) Properties of cathode rays and positive rays and atomic number were discovered by J.J. Thomson and Jeffrey Moseley respectively.

   Which of the above statements I, II or III is/ are correct?

   (1) Only I   (2) Only I and II   (3) Only I and III

   (4) Only II and III   (5) All I, II and III

(2) Shapes of BF_4^-, ClO_3^- and $XeOF_2$ are respectively.

   (1) tetrahedral, trigonal planer, T- shape
   (2) tetrahedral, tetrahedral, T- shape
   (3) tetrahedral, tetrahedral, trigonal bipyramidal
   (4) Trigonal planer, trigonal pyramidal, T- shape
   (5) Trigonal planer, tetrahedral, T-shape

(3) Which of the following species is **not** an ionic compound?

   (1) $KMnO_4$ (2) Hg_2Cl_2 (3) $BeCl_2$

   (4) $LiAlH_4$ (5) CH_3COONa

(4)

$$HC=CH_2$$
$$HOC-\underset{\underset{CH_3}{|}}{C}-CH_2CH_2-\overset{\overset{O}{\|}}{C}-NH_2 .$$
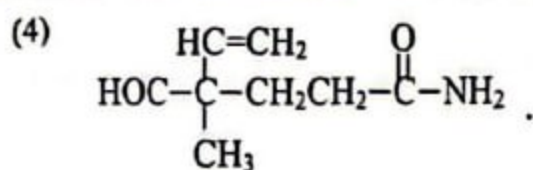
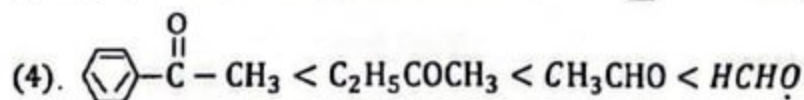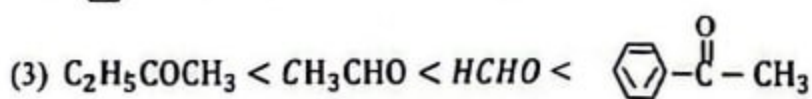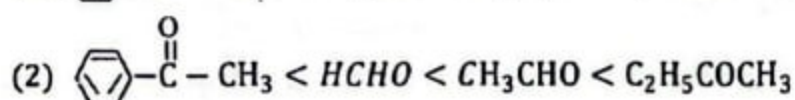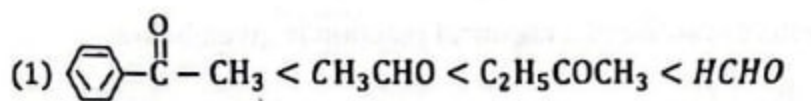What is the IUPAC name of above organic compound?

(1) 5-oxo-4-methyl-4-enalhexamide

(2) 4-methyl-4- formyl-5- hexenamide

(3) 4-formyl-4 -methyl-6- hexenamide

(4) 4- formyl -4- methyl-5- hexenamide ,

(5) 4-methyl-4 -enyl-5- oxopentanamide

(5) Toxic or hazardous organic compounds which persistent are called POP's (Persistent Organic pollutants). Which of the following **does not** belong to this group?

(1) Dioxin

(2) Furan

(3) Chloroform

(4) PCB (Poly Chlorinated Biphenyls)

(5) PAH (Poly Aromatic Hydrocarbon)

(6) Salt Na_2S reacts completely with volume of V cm^3 of $0.5 moldm^{-3}$ HNO_3 to give SO_2 gas and $NaNO_2$. The resultant solution was reacted with $80.00 cm^3$ of 0.1 $moldm^{-3}$ $KMnO_4$ in acidic medium. During this purple colour gets decolourized without evolving a gas. What is the value of V. Consider $SO_2(g)$ is insoluble in water.

(1) 10   (2) í5   (3) 25   (4) 40   (5) 45

(7) A is a water insoluble inorganic salt. A gets dissolved in conc. HCl to give yellow colour solution B and colourless gas C. When solution B was diluted with water, its colour changes. When gas C was passed into solution B, it gets decolourized.

(1) $CuCO_3$ (2) $NiCO_3$ (3) $CuSO_4$ (4) $NiSO_3$ (5) $CuSO_3$

(8) At temperature 895°C $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ is at equilibrium. Which of the following is correct regarding ΔH and ΔS of forward reaction.

(1) $\Delta H = \Delta S = 0$

(2) $\Delta H > 0, \Delta S < 0$

(3) $\Delta H < 0, \Delta S > 0$

(4) $\Delta H > 0, \Delta S > 0$

(5) $\Delta H < 0, \Delta S < 0$

(9) Which of the following statement is correct regarding variation of properties of alkali metals descending the group?

(1) Hardness increases

(2) First ionization energy decreases and second ionization energy increases.

(3) Reactivity increases

(4) Reducing property decreases.

(5) Melting point increases.

(10) A mixture of CH_4 and C_3H_8 had stored in a rigid container at 600 mmHg pressure and at T°C temperature. When this gas mixture is burnt in air, the pressure of $CO_2(g)$ at that temperature and volume is 750 mmHg. Molar fraction of CH_4 and C_3H_8 is respectively (At this temperature H_2O is a liquid)

(1) $\frac{1}{11}$ and $\frac{2}{11}$

(2) $\frac{7}{8}$ and $\frac{1}{8}$

(3) $\frac{7}{12}$ and $\frac{5}{12}$

(4) $\frac{8}{9}$ and $\frac{1}{9}$

(5) $\frac{1}{4}$ and $\frac{3}{4}$

(11)

(1

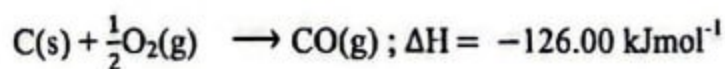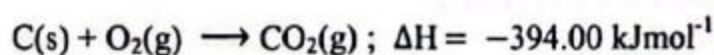(11) Following is a dynamic equilibrium which exists in closed rigid container.

$$CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$$

At 960°C partial pressures of $CH_4(g)$, $H_2S(g)$, $CS_2(g)$ and $H_2(g)$ are 6.0atm, 12.0 atm, 3.0 atm and 2.0 atm respectively. At 960°C Ar gas was introduced to above equilibrium until total pressure of system becomes 46 atm. Which of the following statement is **incorrect** regarding this system? (Ar = 40 Ne =20)

(1) Value of Kp is $5.6 \times 10^{-2} atm^2$

(2) Forward reaction rate does not get increased due to addition of Ar gas.

(3) Equilibrium partial pressures of initial gases remain constant.

(4) Molar fraction of initial gases get changed.

(5) When Ne gas is added instead of Ar, value of Kp is $11.2 \times 10^{-2} atm^2$

(12) Which of the following correctly gives the increasing order of rate of nucleophilic addition reactions of given organic compounds?

(1) $\langle \bigcirc \rangle - \overset{\overset{O}{\parallel}}{C} - CH_3 < CH_3CHO < C_2H_5COCH_3 < HCHO$

(2) $\langle \bigcirc \rangle - \overset{\overset{O}{\parallel}}{C} - CH_3 < HCHO < CH_3CHO < C_2H_5COCH_3$

(3) $C_2H_5COCH_3 < CH_3CHO < HCHO < \langle \bigcirc \rangle - \overset{\overset{O}{\parallel}}{C} - CH_3$

(4). $\langle \bigcirc \rangle - \overset{\overset{O}{\parallel}}{C} - CH_3 < C_2H_5COCH_3 < CH_3CHO < HCHO$

(5) $HCHO < CH_3CHO < C_2H_5COCH_3 < \langle \bigcirc \rangle - \overset{\overset{O}{\parallel}}{C} - CH_3$
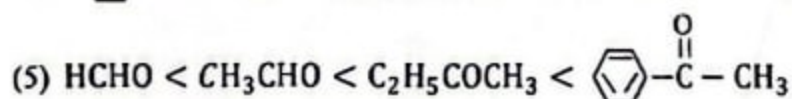
(13) At 25°C and at 1atm pressure 24.00 g Carbon react with Oxygen to form a gas mixture of CO and CO_2 . If the released energy during this is 600.00 kJ , the mass of O_2 reacted is, (C=12, O= 16)
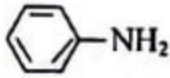
$$C(s) + O_2(g) \longrightarrow CO_2(g); \Delta H = -394.00 \text{ kJmol}^{-1}$$

$$C(s) + \frac{1}{2}O_2(g) \longrightarrow CO(g); \Delta H = -126.00 \text{ kJmol}^{-1}$$
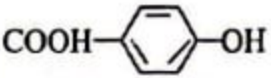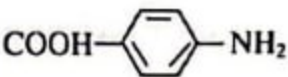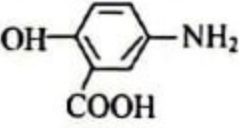
(1) 13. 19g   (2) 26.38g   (3) 39.57g   (4) 52.77g   (5) 65.96 g

(14) Consider following statement regarding compound X and Y given below.

	X	Y
(i)	Soluble in dil. HCl	Soluble in dil. HCl
(ii)	Insoluble in dil. NaOH	Soluble in dil. NaOH
(iii)	Releases a colourless gas with NaNO₂/ dil. HCl	Releases a colourless gas with NaNO₂/ dil. HCl

According to that X and Y can be

	X	Y
(1)	⬡—NH₂	COOH—⬡—OH
(2)	COOH—⬡—NH₂	OH—⬡(—NH₂)(COOH)
(3)	CH₃CH₂OH	CH₃CH₂COOH
(4)	⬡—NH₂	⬡(COOH)(—NH₂)(OH)
(5)	⬡—NH₂	NH₂—⬡—CH₂OH

(15) Reaction mechanism and relevant energy profile of a chemical reaction is given below.

Step I $\quad X_{(g)} + Y_{(g)} \longrightarrow P_{(g)} + Q_{(g)}$
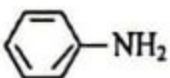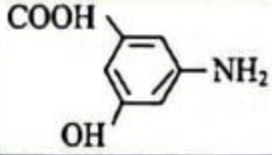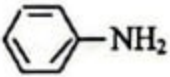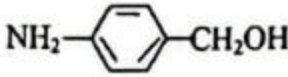
Step II $\quad Q_{(g)} + Z_{(g)} \longrightarrow Y_{(g)} + P_{(g)}$
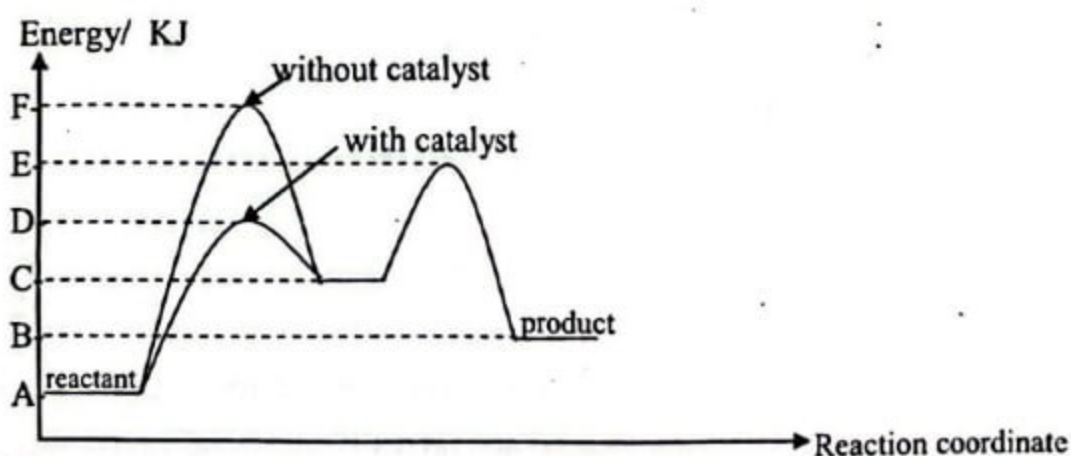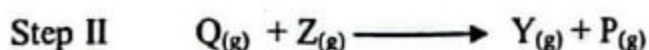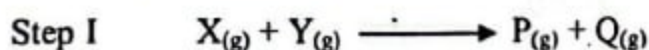
Which of the following statement is **incorrect** regarding above reaction mechanism?

(1) Energy barrier in step I had been reduced from F to D by Y

(2) Q exists in a equal value of energy as C.

(3) A, B and D give the energy of molecular species with stable bonds.

(4) Rate of net reaction is determined by step I.

(5) Enthalpy change of reaction is (B-A).

(16) Which of the following statement is correct regarding the element Nitrogen and its compounds?

(1) Nitrogen gas is stable since it has a stable electronic configuration.

(2) Water solubility of Nitrogen can be increased by increasing temperature.

(3) Out of second period elements, the highest range of oxidation state is only for Nitrogen

(4) Pure Nitric acid is pale yellow in colour.

(5) Li, Mg and Al metals can react with Nitrogen gas when heated to form corresponding Nitride.

(17) Consider following reaction that occurs at TK temperature.
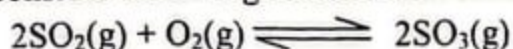
$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad K_p = 7 \times 10^2 Pa^{-1}$$
$$\Delta G_R^\theta = -141.6 \text{ kJmol}^{-1}$$

At TK temperature partial pressures of $SO_2(g)$, $O_2(g)$ and $SO_3(g)$ are $0.5 \times 10^5 Pa$, 0.01×10^5 Pa, 0.1×10^5 Pa respectively. Which of the following graph represents this situation.

| (1) | (2) | (3) | (4) | (5) |
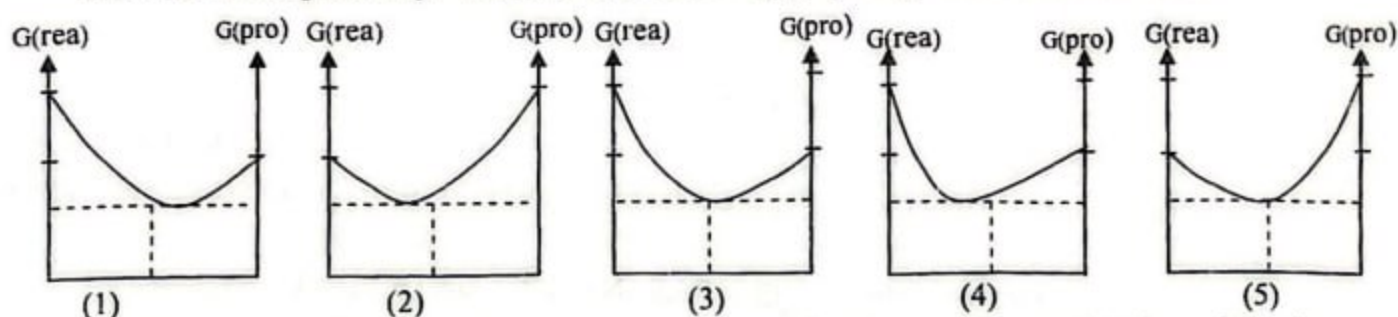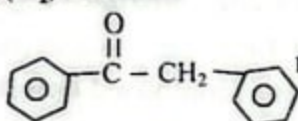
(18) Given below is a diagram which used to convert Cu plate with metallic impurities into pure metal by electrolysis.
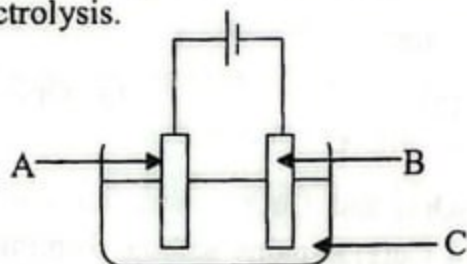
Which of the following statement is **false** with regard to this?
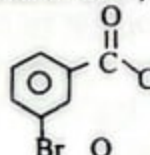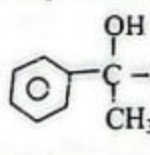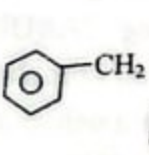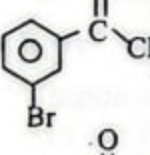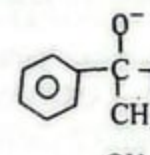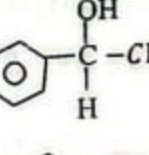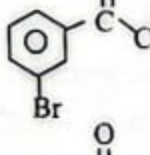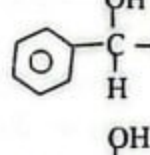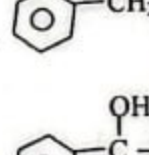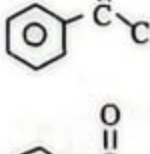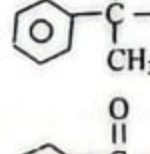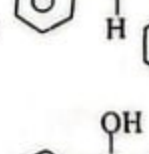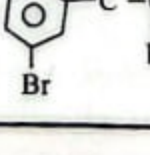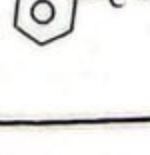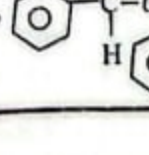
(1) A is a Cu plate with impurities
(2) B is a pure Cu metal plate.
(3) C is a CuSO$_4$(aq) solution
(4) B is a Ag metal plate
(5) C is a AgNO$_3$(aq) solution

(19) When compound

reacts with following reagents, structures of given products are as in following table.

Reagent	Products
(1) Br$_2$/ anhydrous FeBr$_3$	P
(2) (i) CH$_3$MgBr (ii) H$^+$/H$_2$O	Q
(3) (i) LiAlH$_4$ / dry ether (ii) H$^+$ /H$_2$O	R

Structures of P, Q and R are respectively.

(20) Consider following elementary reaction.

$P(g) + Q(g) \longrightarrow S(g)$
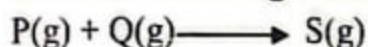
Rate constant is $1.6 \times 10^{-4} \, mol^{-1} dm^3 s^{-1}$

8 mol of P and Q are mixed in a rigid container with volume $2 \, dm^3$. When time is t at 300K reaction rate is $0.64 \times 10^{-3} \, mol^{-1} dm^3 s^{-1}$. Pressure of the container at this situation is, (in Pa),

(1) 149.652×10^2 (2) 99.768×10^2 (3) 99.768×10^5

(4) 149.652×10^5 (5) 99.00×10^5

(21) Solution X was prepared by mixing equal volumes of $0.5 \, moldm^{-3}$ CH_3COOH and $0.5 \, moldm^-$ CH_3COONa solutions. Under which of the following condition, $1 \, dm^3$ of above solution can act as buffer.

$K_a, CH_3COOH = 1.8 \times 10^{-5} \, moldm^{-3}$ ($Cl = 35.5$, $Na = 23$, $O = 16$, $H = 1$)

(a) During addition of 8.0g of NaOH
(b) During addition of 0.02 mol HCl
(c) During addition of $5 \, cm^3$ of distilled water.

(1) Only (a) (2) Only (b) (3) Only (c)

(4) Only (a) and (d) (5) All (a), (b), (c)

(22) Mass of 8.8 g of $Cu(s)$ converts to $Cu_2O(s)$ and $CuO(s)$ with 1:1 molar ratio under limited amount of oxygen gas. Here some amount of $Cu(s)$ remains without forming oxide. If the obtained total mass of solid mixture is 10g, what is the mass of $Cu(s)$ which does not convert to oxide? ($Cu = 64$, $O = 16$)

(1) 1.60 g (2) 2.40 g (3) 3.80 g (4) 5.34 g (5) 7.20 g

(23) Which of the following statement is **false** regarding alternative gases introduced instead of CFC gas which responsible for ozone layer depletion?

(1) In HCFC, C-H bond dissocociates and gets decomposed before reaching ozone layer.
(2) HFC does not form $\overset{\cdot}{C}l$ radicals at upper atmosphere.
(3) Due to double bond in HFO, it reacts faster in the lower atmosphere.
(4) Out of HFC and HCFC, HCFC has higher GWP value.
(5) HCFC, HFC and CFC contributes to global warming.

(24) Which of the following statement is **false** regarding Al metal?

(1) It is the most abundant metal in the Earth crust.
(2) Solution of Al^{3+} (aq) gives a white precipitate with NH_4OH and gets dissolved in excess NH_4OH by forming $[Al(OH)_4]^-$
(3) Since $AlCl_3$ does not complete octet, it acts as a Lewis acid.
(4) Alumina is used as a dehydrating agent.
(5) Out of group 13 elements, Al has the highest 3rd ionization energy.

(25) 25°C dissociation constants of ethanoic and methanoic acids are $1.75 \times 10^{-5} \, moldm^{-3}$ and $1.77 \times 10^{-4} \, moldm^{-3}$ respectively. In an aqueous solution. which concentrations of ethanoic and methanoic acid are respectively $0.1 \, moldm^{-3}$ and $0.2 \, moldm^{-3}$, what is the pH?

(1) 1.77 (2) 17.5 (3) 2.22 (4) 3.54 (5) 6.24

(26) At 298K standard Galvanic cell was constructed using standard silver electrode and standard silver-silver chloride electrode. Which of the following gives the correct cell notation at that,

$E^\theta Ag/Ag^+ = +0.80V$

$E^\theta \, AgCl^-/Ag = +0.22V$

(1) $Ag(s) \mid Ag^+(aq, 1moldm^{-3}) \vdots Cl^-(aq, 1moldm^{-3}) \mid AgCl(s) \mid Ag(s)$
(2) $Ag(s) \mid Ag^+(aq, 1moldm^{-3}) \mid\mid Cl^-(aq, 1moldm^{-3}) \mid AgCl(s) \mid Ag(s)$
(3) $Ag(s) \mid AgCl(s) \mid Cl^-(aq, 1moldm^{-3}) \mid\mid Ag^+(aq, 1moldm^{-3} \mid Ag(s)$
(4) $Ag(s) \mid AgCl(s) \mid Cl^-(aq, 1moldm^{-3}) , Ag^+(aq, 1moldm^{-3}) \mid Ag(s)$
(5) $Ag(s) \mid AgCl(s) \mid Cl^-(aq, 1moldm^{-3}) \mid Ag^+(aq, 1moldm^{-3}) \mid Ag(s)$

(27) When 1.56g of tri valent metal X was reacted with 31.25 cm^3 of 2 moldm^{-3} H$_2$SO$_4$ acid. metal sulfate, Hydrogen sulfide and water are formed. When the resultant solution was reacted with 0.5 moldm^{-3} NaOH, required volume was 25cm^3. What is the relative atomic mass of X. (Assume :- The formed salt of X does not react with NaOH and H$_2$S is water insoluble under this condition)

    (1) 27.00   (2) 44.95   (3) 52.00   (4) 55.84   (5) 69.72

(28) Which of the following statement is **False** regarding DOW process?

    (1) When CaO is obtained in first step from decomposition of limestone, CaCO$_3$ exits as an impurity.

    (2) In 2nd step Mg(OH)$_2$ precipitates since its K$_{sp}$ value is less than K$_{sp}$ value of Ca(OH)$_2$

    (3) At 3rd step, with the reaction of conc. HCl, MgCl$_2$ as well as CaCl$_2$ are formed.

    (4) At 4th step, temperature of cell is maintained at higher value than 700°C since melting point of MgCl$_2$ is 714°C.

    (5) At 4th step molten Mg is removed from steel cathode of the cell.

(29) Amount of 1 mol of N$_2$O$_4$ was allowed to decompose according to following reaction in 1dm^3 flask at T°C.

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$$

When the system attains dynamic equilibrium dissociated amount of N$_2$O$_4$ is x mol. At T°C , K$_c$ of this equilibrium reaction is,

    (1) $\dfrac{2x}{(1-x)}$ (2) $\dfrac{2x^2}{(1-x)}$ (3) $\dfrac{4x^2}{(1-x)}$ (4) $\dfrac{2x}{(1-x)^2}$ (5) $\dfrac{4x}{(1-x)}$

(30) Distribution coefficient of organic compound between ether and water is 4. Mass of 0.5g of organic compound was dissolved in 25cm^3 of water. This was extracted twice using 25cm^3 of ether. What is the total mass of organic compound that can be extracted into whole ether layer.

    (1) 0.28g   (2) 0.38g   (3) 0.40g   (4) 0.48g   (5) 0.58g

• **Instructions for question no. 31 to 40.**

For each of the questions 31 to 40, four responses (a), (b), (c) and (d) are given. One or more of these is/are correct. Select the correct response / responses. In according to instructions 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 response 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 or combination of responses is correct

(31) When separate aqueous solutions are provided, which of the following pair / pairs can be distinguished by passing H$_2$S gas in basic medium?

    (a) Zn^{2+} , Ni^{2+} (b) Mg^{2+} , Zn^{2+} (c) Cu^{2+} , Bi^{3+} (d) Ni^{2+} , Cu^{2+}

(32) Which of the following statement is/are true regarding compound

$$\text{Ph}-\overset{\overset{\displaystyle O}{\|}}{C}-C \equiv C - H$$
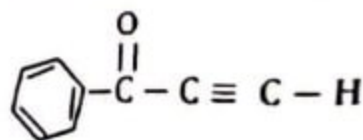
(a) Reacts with CH_3MgBr to give

$$\text{Ph}-\overset{\overset{\displaystyle OMgBr}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-C \equiv C - H$$

(b) Under goes electrophilic substitution reactions.

(c) Under goes acid /base reaction with $NaNH_2$.

(d) When subjected to nitration, ortho nitro para substituted product is given as major **product.**

(33) Which of the following statement/s is/are true regarding ionization energy of elements till atomic number 20?

(a) In group 16 elements, 2nd ionization energy is greater than that of in group 15 elements.

(b) In a given period 1st ionization energy of inert element is always high.

(c) In group 13 elements, 1st ionization energy is greater than that of in group 2 elements.

(d) With the increasing of effective nuclear charge, ionization energy gradually decreases.

(34) At temperature TK ,pH variation of titrating $20.00 cm^3$ of $1.0 \, moldm^{-3}$ H_2SO_4 acid with $1.0 \, moldm^{-3}$ NaOH is given below

At temperature TK,

$$K_{a_1} \, H_2SO_3 = 1.4 \times 10^{-2} \, moldm^{-3}$$
$$K_{a_2} \, H_2SO_3 = 6.5 \times 10^{-6} \, moldm^{-3}$$
$$K_w = 1 \times 10^{-14} \, mol^2 dm^{-6}$$

Indicator ranges : Phenolphthalein 8.3 -10.0

Methyl orange 3.1 - 4.4
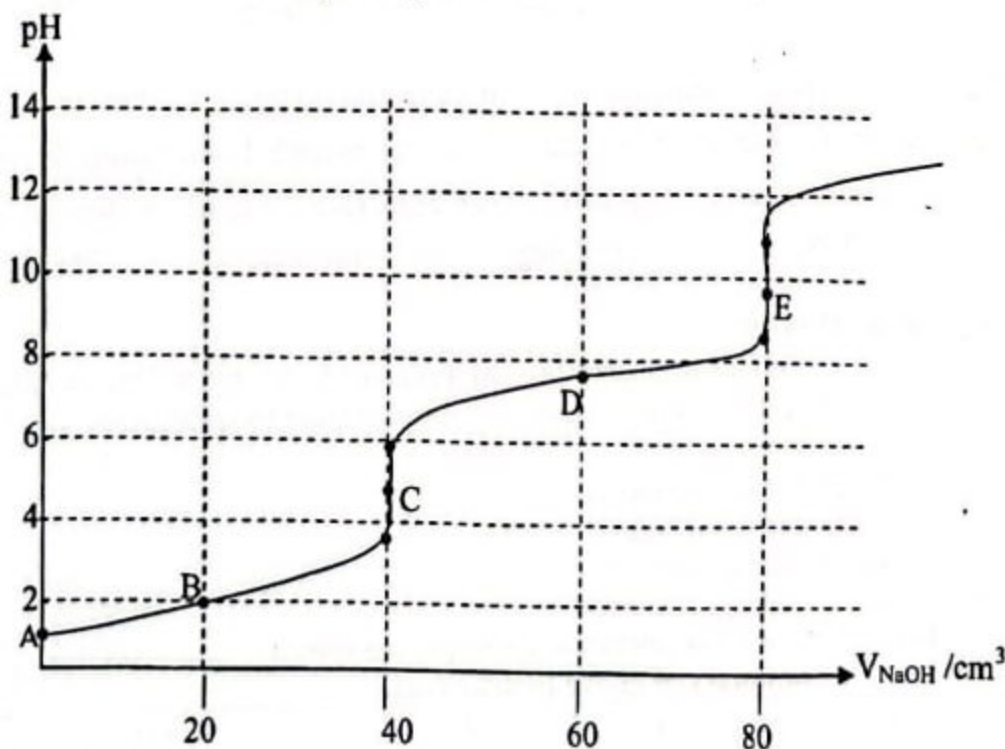
Which of the following statement/s is/ are correct regarding this titration?

(a) There are two equivalence points and two buffer phases.

(b) At point C, solution has only HSO_3^- and H_3O^+.

(c) Methyl orange can be used to determine 2nd equivalence point

(d) Point E corresponds to 2nd equivalence point.

(35) Which of the following factor/s that affect/s electrode potential of chlorine gas electrode.
    (a) Area of Pt plate
    (b) $Cl^-(aq)$ concentration in solution
    (c) Pressure of chlorine gas
    (d) volume of solution

(36) Standard formation enthalpy (ΔH_f^θ) and standard entropy (S^θ) of certain substances are given below;

	ΔH_f^θ / kJmol^{-1}	S^θ / Jmol^{-1}K^{-1}
CO_2(g)	-393	213.7
H_2(g)	0	130.7
CH_3OH(l)	-239	126.8
H_2O(l)	-285	69.9

Which of the following statement/s is /are correct regarding the following reaction?

$$CO_2(g) + 3H_2(g) \longrightarrow CH_3OH(l) + H_2O(l)$$

    (a) This reaction is a non spontaneous reaction at 25°C
    (b) Standard enthalpy change of this reaction is -132 kJmol^{-1}
    (c) Standard entropy change of this reaction is -409 Jmol^{-1} K^{-1}
    (d) This reaction is a spontaneous reaction at 100°C

(37) Which of the following statement/s is/ are **False** regarding Nitrogen containing organic compounds.
    (a) Aniline is more basic than ammonia
    (b) Basicity of methyl amine is less than basicity of aniline.
    (c) Amides are less basic than methyl amine.
    (d) Stability of alkyl ammonium ion with respect to amine, is higher than stability of alkyl oxonium ion with respect to alcohol.

(38) A student states Boyle's law is "when all other factors are constant, pressure of a gas is inversely proportional to its volume." According to this which of the following statement/s is/ are correct.
    (a) All other factors mean, amount of gas and temperature.
    (b) When pressure of ideal gas gets doubled, volume is exactly half.
    (c) When pressure of ideal gas gets doubled, its thermodynamic temperature is doubled.
    (d) When mass of gas sample increases, pressure decreases.

(39) Given below graph is drawn based on data obtained from an experiment to determine kinetics of reaction between HCl and $CaCO_3$ by initial rate method.
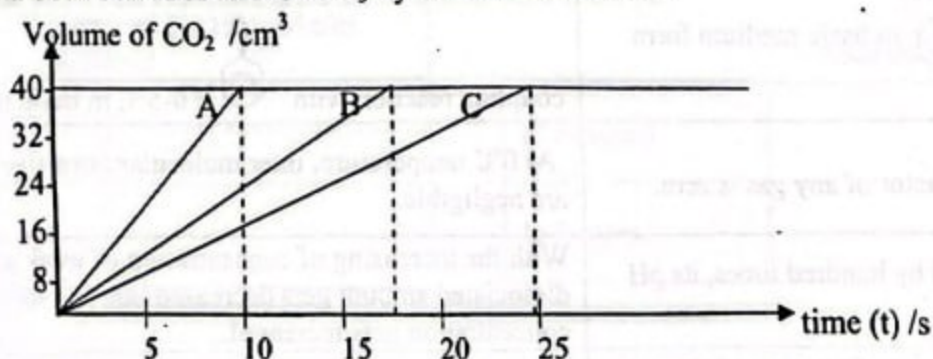
Which of the following statement/s is/are true regarding this reaction?
    (a) Initial rate is maximum at C state.
    (b) Initial rate $\alpha \frac{1}{t}$
    (c) Descending order of concentration of HCl solutions that used is experiment is $[HCl]_A > [HCl]_B > [HCl]_C$
    (d) By varying HCl concentration, method of measuring initial rate can be used to find out order of the reaction but not the rate constant.

(40) Which of the following is/are correct regarding the variation of physical properties of some compounds?

    (a) The variation of boiling points of H_2O, C_2H_5OH and CH_3-O-CH_3 is
        $CH_3-O-CH_3 < C_2H_5OH < H_2O$

    (b) Though the relative molecular masses are atmost equal in CH_4, NH_3 and H_2O the variation of saturated vapour pressures is $H_2O < NH_3 < CH_4$.

    (c) The melting points of F_2, Cl_2 and Br_2 is $Br_2 < Cl_2 < F_2$.

    (d) The variation of melting points of HCHO, H_2O_2 and HCOOH is HCHO $< H_2O_2 <$ HCOOH.

- **Instructions for question no. 41 to 50.**

    In question no. **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 appropriatly 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

	1st Statement	2nd Statement
41.	Solid compounds of NH_4NO_2 and $(NH_4)_2Cr_2O_7$ can be distinguished by thermal decomposition.	NH_4NO_2 and $(NH_4)_2Cr_2O_7$ decompose to give $N_2(g)$
42.	Electro motive force is the maximum voltage that can be obtained from Galvanic cell	To measure electro motive force of Galvanic cell, voltmeter can be used
43.	If rate of reaction $A \rightarrow B + C$ is $R = K[A]$, its half-life depends on initial concentration of A.	Half life of a first order reaction is given by, $t_{1/2} = \dfrac{k}{0.693}$
44.	Gibbs free energy is a state function	Both enthalpy and entropy are state functions with different SI units.
45.	When dill HCl is added to a mixture of acetaldehyde and aqueous NaCN solution, a Nucleophilic addition reaction takes place.	Due to polarization nature of carbonyl group characteristic reaction type of aldehyde is Nucleophilic addition.
46.	Dizanium salts with [OH-phenol] in basic medium form orange colour azo dye.	Dizanium ion acts an electrophile and under goes coupling reaction with [OH-phenol] at 0-5°C in basic medium
47.	At 0°C , compressibility factor of any gas is zero.	At 0°C temperature, inter molecular attractive forces are negligible.
48.	When weak acid is diluted by hundred times, its pH gets increased by one unit.	With the increasing of concentration of weak acid , dissociated amount gets decreased but H^+ ion concentration gets increased.
49.	To find out equivalence point of titration of strong acid and strong base with concentrations 0.1 moldm^{-3}, bromothymol blue (6.0-7.5)can be used.	During titration of strong acid and strong base, with the increasing of acid concentration, At equivalence point pH is steam higher than 7.0.
50.	During steam distillation of essential oil, solution boils at a lower temperature than 100°C and than boiling point of essential oil.	During steam distillation, when mixture boils, sum of saturated vapour pressures of water vapour and essential oil, is equal to external atmospheric pressure.

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අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2023
General Certificate of Education (Adv. Level) Examination, 2023

රසායන විද්‍යාව II Chemistry II	13 ශ්‍රේණිය , 3 වන වාර පරීක්ෂණය 2023 නොවැම්බර් Grade 13 . 3rd Term Test 2023 November
පැය තුනයි Three Hours	02 E II	අමතර කියවීම් කාලය - මිනිත්තු 10 යි. Additional Reading Time - 10 minutes

Name:...Class :..

Part A – Structured Essay (Pages 02 – 09)

* Use of calculators is not allowed.
* Answer all the questions.
* Write your answer in the space provided below each question.
* Please note that the space provided is sufficient for the answer and that extensive answers are not expected.

In answering questions 4 and 8, you may represent alkyl groups in a condensed manner.

Example :

$$H - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - \text{ may be shown as } CH_3\,CH_2 -$$
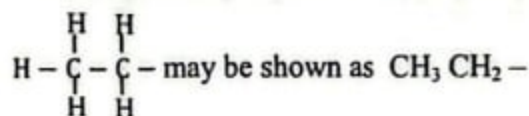
Part B and Part C – Essay (Pages 10 - 17)

* Answer four questions selecting not more than two questions from each part.
* At the end of the time allocated for this paper, the answers to three parts A, B and C together so that part A is on top and hand them over to the supervisor.
* You are permitted to remove only Part B and C of the question paper from the Examination Hall.

Universal gas constant R	=8.314 J mol⁻¹ K⁻¹	$=8.314 \text{ J mol}^{-1} \text{ K}^{-1}$
Avogadro constant	N_A	$= 6.022 \times 10^{23} \text{ mol}^{-1}$
Plank's constant	h	$= 6.626 \times 10^{-34} \text{ JS}$
Velocity of light	C	$= 3 \times 10^8 \text{ m S}^{-1}$
Faraday constant	F	$= 96500 \text{ Cmol}^{-1}$

For Examiner's Use only

Part	question numbers	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
C	8	
	9	
	10	
Total		
Percentage		

	Final marks
In numbers	
In Letters	

Part A - structured Essay

* Answer all four questions. Each carries 100 marks.

1. (a) Mention whether the following statements are true or false on dotted lines.

   (i) The energy is either released or absorbed by atoms only in discrete quantities of some minimum energy. ....

   (ii) The correct increasing order of boiling points is $C_3H_8 < CH_3CH_2OCH_3 < CH_3COCH_3 < CH_3CH_2OH$ ....

   (iii) The condensed electronic configuration of cobalt in $[Co(NH_3)_6](NO_3)_3$ is $[Ar]3d^7$. ....

   (iv) The first ionization energies of 3d series elements, increase with increasing of atomic number ....

   (v) All $S-O$ bond lengths in $S_2O_3^{2-}$ are equal ....

   (vi) The set of quantum number for the last electron of As is $n = 4$; $l = 1$, $m_l = 0$ and $m_s = +\frac{1}{2}$ ....

   (24 marks)

   (b) (i) The skeleton of a molecule containing only hydrogen, carbon, nitrogen and oxygen is give below. Draw the most acceptable Lewis dot-dash structure for this molecule.

$$H - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - \overset{1}{N} - \overset{2}{\underset{|}{N}} - O$$
with H and O above.
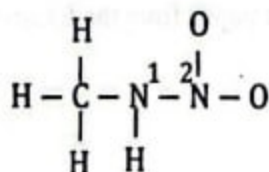
   (ii) Give (I) shapes around N^1 and N^2 atoms and (II) oxidation numbers of the atoms in the structure drawn in above (i).

   (I) shapes : N^1 .... N^2 ....

   (II) oxidation number : N^1 .... N^2 ....

   (iii) A Lewis structure for the CH_2N_2 is given below. Draw most acceptable Lewis dot-dash structure (resonance structure) for CH_2N_2.

$$\overset{H}{\underset{CH_3}{\diagdown}} C - N - N$$
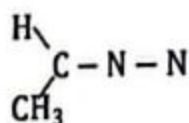
(iv) Complete the given table based on the Lewis dot dash structure and its labelled skeleton given below.

$$\begin{array}{cc} & H \quad :\ddot{O}-H \quad :O: \\ & | \quad\quad | \quad\quad || \\ H- & C - C - N - C - \ddot{O} - H \\ & | \quad | \quad | \\ & H \quad C \quad H \\ & \quad\; ||| \\ & \quad\; C \\ & \quad\; | \\ & \quad\; H \end{array}$$

$$\begin{array}{cc} & H \quad O-H \quad O^8 \\ & | \quad\quad | \quad\quad | \\ H- & {}^6C - {}^3C - N^2 - C^1 - O_7 - H \\ & | \quad | \\ & H \quad {}^4C \\ & \quad\;\; | \\ & \quad\; {}^5C \\ & \quad\; | \\ & \quad\; H \end{array}$$
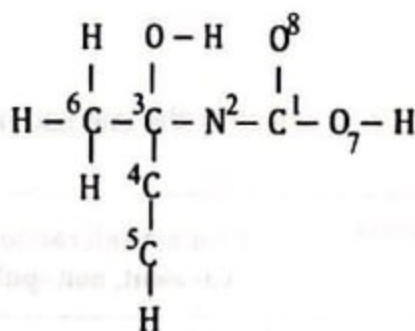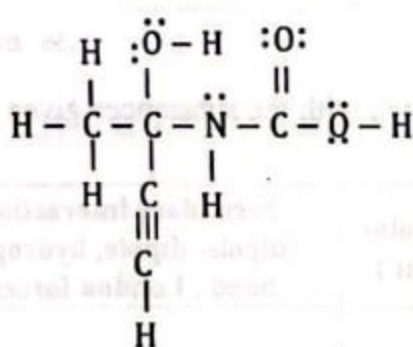
·	C^1	N^2	C^4	C^6
(I) The number of VSEPR pairs around the atom				
(II) electron pair geometry around the atom.				
(III) Shape around the atom.				
(IV) Hybridization of the atom				

Parts (v) to (viii) are based on the Lewis dot dash structure given in part (iv) above. Labelling of atoms is as in part (iv)

(v) Identify the atomic / hybrid orbitals involved in the formation of σ bonds between the two atoms given below.

(I) $C^1- O^7$ C^1............................. O^7.............................

(II) $C^1- N^2$ C^1............................. N^2.............................

(III) $N^2 - C^3$ N^2............................. C^3.............................

(IV) $C^3 - C^4$ C^3............................. C^4.............................

(V) $C^4 - C^5$ C^4............................. C^5.............................

(VI) $C^3 - C^6$ C^3............................. C^6.............................

(vi) Identify the atomic orbitals involved in the formation of π bonds between the atoms given below.

(I) $C^1- O^8$ C^1............................. O^8.............................

(II) $C^4- C^5$ C^4............................. C^5.............................

          C^4............................. C^5.............................

(vii) State the approximate bond angles around C^1, N^2, C^3 and C^4.

C^1............................. N^2............................. C^3............................. C^4.............................

(viii) Arrange the atoms C^1, N^2, C^3 and C^4 in the increasing order of their electronegativity.

.... < .... < .... < ....

(56 marks)

(c) Fill in the blanks by selecting the interactions that match with the substances given in the table.

	Substance	Primary interaction (ionic, polar covalent, non -polar covalent)	Secondary interaction (dipole- dipole, hydrogen bond , London forces)
(i)	$CCl_4(l)$		
(ii)	$Ne(g)$		
(iii)	$CH_3OH(l)$		
(iv)	$HF(l)$		
(v)	$BaS(s)$		

(20 marks)

2. (a) A is an element of s- block and B is an element of p- block. The atomic numbers of these are less than 20. Both A and B are soluble in dil. HCl and form the compound C and D respectively by evolving a colourless and odourless gas E. When diluted NaOH is added dropwisely to aqueous solutions of C and D, they form white precipitates F and G respectively. A and B do not react with water at room temperature.

    (i) Identify the elements A and B.

        A - .... B - ....

    (ii) Write down the chemical formulae of C, D and E.

        C - .... D - ....

        E- ....

    (iii) Write down the balanced chemical equation for the reactions of A and B with dil. HCl.

        A - ....

        B - ....

    (iv) Write down chemical formulae of F, G and H.

        F - .... G - ....

        H - ....

    (v) Mention another chemical test to distinguish C and D.

....

....

....

....

100

(vi) Write down the balanced chemical equation for the dissolution of G in excess NaOH.

....

(vii) State an important use of each element A and B.

A - ....

B - ....

(54 marks)

(b) R is an element of p- block. It forms two hydrides, S and T. The boiling point of T is greater than the boiling point of S. When SO_2 gas is bubbled through T and S, they form the compounds U and V respectively. When aqueous $BaCl_2$ is added to these two, W and X, White precipates are formed. Out of these only Wdissolves in diluted HNO_3.

(i) Identify element R. Write down the name and fomula of two allotropes of it.

R - ....

Names of the allotrope	Formula

(ii) Write down chemical formulae of T and S

T - ....   S- ....

(iii) State the reasons to have higher boiling point for S than T.

....

....

(iv) Write down balanced chemical equations for following reactions.

T + SO_2 - ....

S + SO_2 - ....

(v) Write down chemical formulae of W and X.

W- ....   X - ....

(vi) How to distinguish U and V using aqueous $CuSO_4(aq)$ solution.

....

....

(vii) Write down a balanced chemical equation for a disproponation reaction of S.

....

(46 marks)

100

3. (a) Showing a nucleophilic substitution, bromoalkanes form alcohols in the presence of aqueous NaOH.

$$R\,Br_{(aq)} + OH^-_{(aq)} \longrightarrow R - OH_{(aq)} + Br^-_{(aq)}$$

The chemical kinetic data obtained in an experiment conducted by student that used to find the orders of reactants relevant to above reaction are given below. In all instances, very high constant concentration for NaOH is maintained by him.

Experiment	Time (s)	Concentration of RBr $(moldm^{-3})$
1	0	0. 100
2	30	0.065
3	60	0.042
4	90	0.028
5	120	0.019
6	150	0.014

(i) Using the above data, plot a graph for variation of time with concentration of RBr as appropriate.
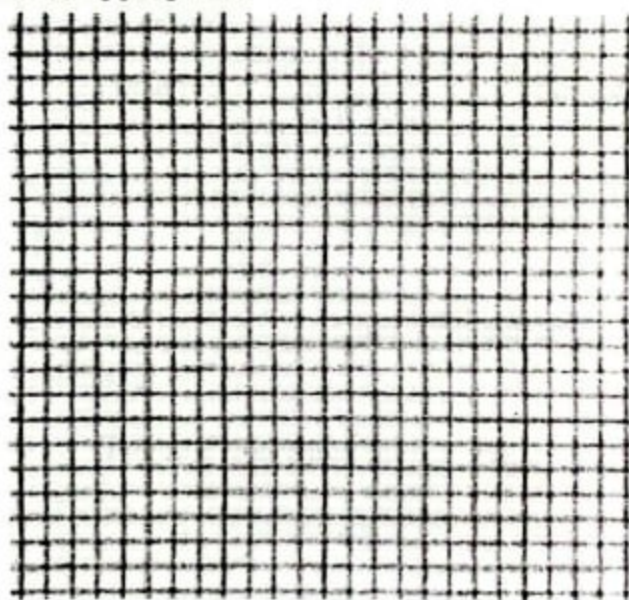
(ii) Using the graph, deduce the order with respect to concentration of RBr.

....

....

(iii) Thus write down the rate expression for above reaction.

....

(iv) If the graph plotted with different concentrations of OH^- against rate of reaction keeping constant concentration for RBr, in above experiment, draw the shape of it.

rate/ $moldm^{-3}\,s^{-1}$

$[OH^-]$ / $moldm^{-3}$

(v) Considering the orders of each reactant, suggest a mechanism for the reaction between RBr and OH^- .

....

....

....

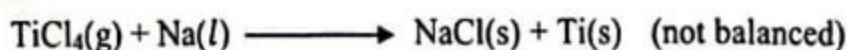...

(40 marks)

(b) The extraction of titanium from rutile is carried out in two steps. In first step, $TiCl_4$ is produced and in second step, titanium is extracted from $TiCl_4$ as given below.

$$TiCl_4(g) + Na(l) \longrightarrow NaCl(s) + Ti(s) \quad \text{(not balanced)}$$

Answer the following questions using below given data.

	$TiCl_4(g)$	Na(l)	NaCl(s)	Ti(s)
ΔH_f^θ / kJmol^{-1}	-720	$+3$	$+411$	0
S^θ / Jmol$^{-1}K^{-1}$	354	58.0	72	31.0

(i) Why the standard enthalpy change for Na(l) is not zero according to the above table.

....

....

(ii) Calculate ΔH^θ relevant to above reaction.

....

....

....

(iii) Calculate ΔS^θ relevant to above reaction.

....

....

....

....

(iv) Calculate the temperature that reaction get spontaneous.

....

....

....

....

(v) What is the role of Na in the reaction?

....

(vi) Mention the assumptions that you made in above (iv)

....

....
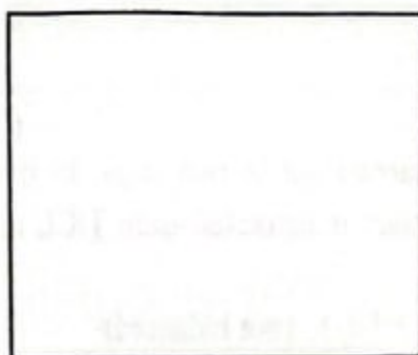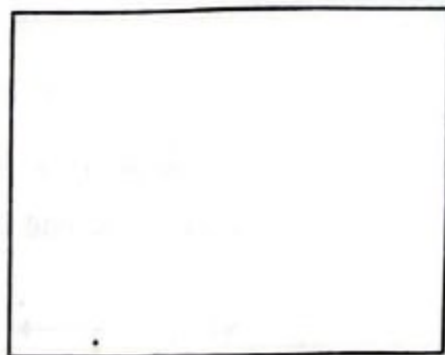
(60 marks) 100

4. (a) A, B, C and D are four isomers having the molecular formula $C_4H_{11}N$. When these are reacted with $NaNO_2 / $ dil. HCl E, F, G and H are formed evolving N_2 gas. When these products are heated with conc. H_2SO_4 I, J, K and L are formed, respectively. Only J shows geometric isomerism.
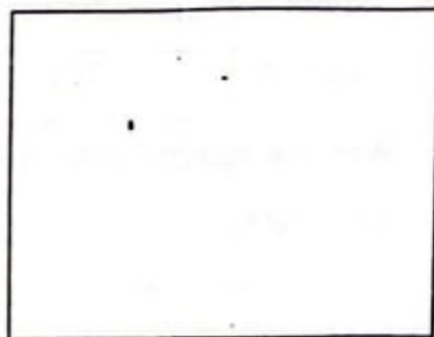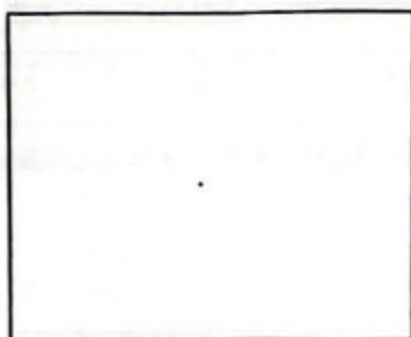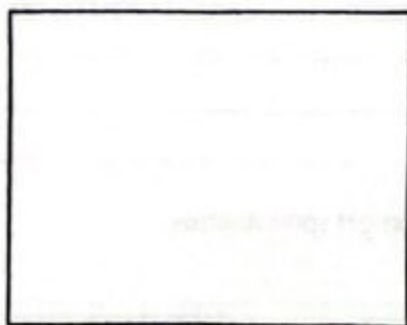
(i) Draw structures of B and F.

B

F

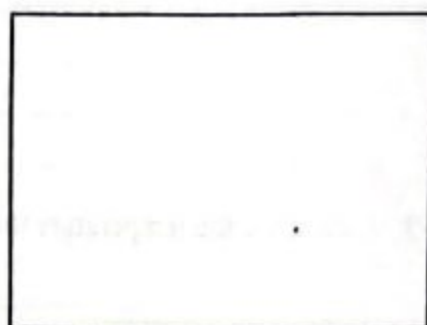(ii) Draw the structures of isomers of J.

(iii) Compounds I, J, K and L are subjected to the following reaction sequence separately.

I, J, K and L $\xrightarrow{Br_2/ CCl_4}$ Products $\xrightarrow[KOH]{alcoholic}$ Products $\xrightarrow{Cu_2Cl_2/ NH_3}$ product
$\qquad\qquad\qquad\qquad$ (I) $\qquad\qquad\qquad$ (II) $\qquad\qquad\qquad\qquad$ (III)

At product (III) state ; only I gives reddish brown precipitate. J.K and L does not give such precipitate. Draw the structures of A and E.

A

E
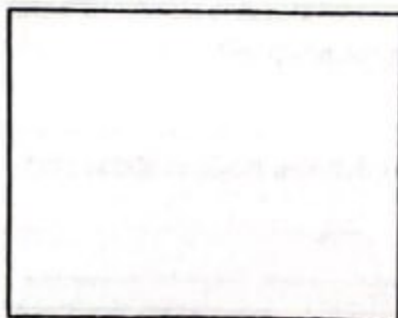
(iv) Draw the structure of reddish brown precipitate that gives by I.

(v) When Lucas reagent ($ZnCl_2$/ conc. HCl) is added to G and H separately, H gives instant turbidity. G does not give turbidity at room temperature. Draw the structures of C, D, G and H.
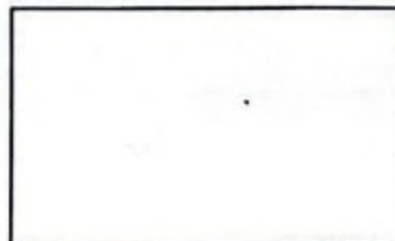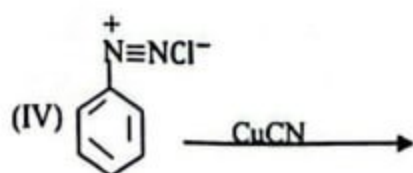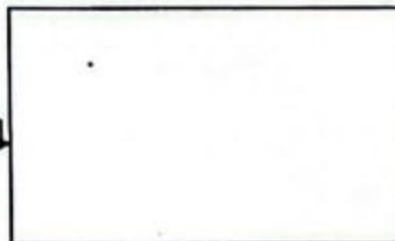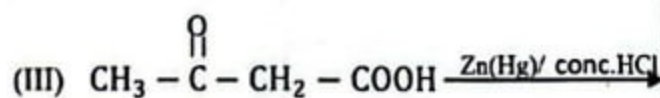

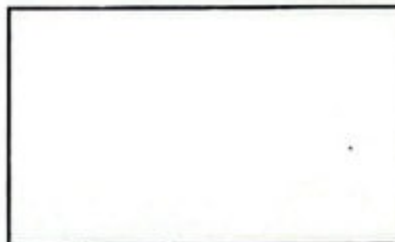C   D   G   H

(72 marks)

(b) (i) Draw the main products for each of the reaction I - IV in given boxes.

(I) $\xrightarrow{Br_2 / CCl_4}$ [ ]

(II) $\xrightarrow{HBr}$ [ ]

(III) $CH_3 - \overset{\overset{O}{\|}}{C} - CH_2 - COOH \xrightarrow{Zn(Hg)/ \ conc.HCl}$ [ ]

(IV) $\xrightarrow{CuCN}$ [ ]
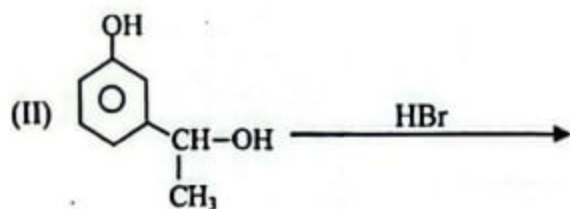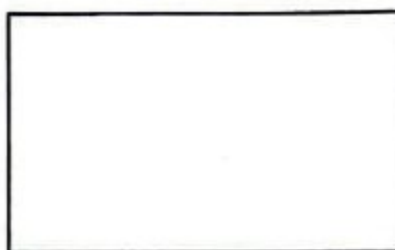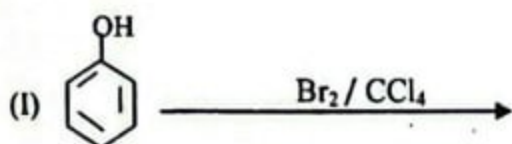
(ii) For reaction I and II, select the type of reaction from parenthesis and write the symbol. (A_E- Electrophilic addition , A_N -Nucleophilic addition, S_E -Electrophilic substitution, S_N - Nucleophilic substitution)

I - [ ]   II - [ ]

(28 marks)

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Visakha Vidyalaya , Colombo –05

100

කො/විශාඛා විද්‍යාලය, කොළඹ - 05
Co/Visakha Vidyalaya - Colombo - 05

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය 2023
General Certificate of Education (Adv. Level) Examination, 2023

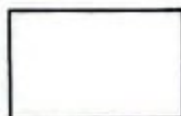|	
රසායන විද්‍යාව **II**	13 ශ්‍රේණිය, Grade13
Chemistry **II**	තුන්වන වාර පරීක්ෂණය - නොවැම්බර් 2023
	Grade 13 - 3ʳᵈ Term Test - 2023 November

02 E II

* Universal gas constant R = 8.314 $Jmol^{-1}K^{-1}$
* Avogadro's constant N_A = 6.022 x 10^{23} mol^{-1}

Part B - Essay

- Answer two questions only. (Each carries 150 marks)

5. (a) At 27°C the pressure exerted by $X_{(g)}$ which is the only gas contains in 1 dm³ rigid closed vessel is 3×10^5 Pa. At 127°C, the system attains the following dynamic equilibrium.

$$2X_{(g)} \rightleftharpoons Y_{(g)} + 2Z_{(g)} \quad\text{---- (1)}$$

$$Y_{(g)} \rightleftharpoons A_{(g)} + B_{(g)} \quad\text{---- (2)}$$
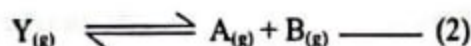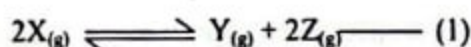
At 127°C , the equilibrium constant of above two equilibriums are same and 50% of X has dissociated.

(i) At 127°C , calculate partial pressure of X before initiating the reaction.

(ii) Find the partial pressure of each substance in the system at equilibrium.

(iii) Calculate the mole fraction of Y(g) at equilibrium.

(iv) Find the initial number of males of X(g) at 127°C.

(v) Calculate the equilibrium constants, K_p and K_c for above reactions.

(vi) The relationship between equilibrium constant and Gibb's free energy is given by;
$\Delta G = \Delta G^\theta + 2.303\ RT \log K_c$ Using this , calculate ΔG^θ for above reaction.

(80 marks)

(b) (i) The concentration of 0.5 dm³ NH_3 solution is 0.1 moldm⁻³. If $K_b(NH_3(aq)) = 1\times10^{-5}$ moldm⁻³ Calculate the pH of this solution. ($K_w = 1\times10^{-14}$ mol²dm⁻⁶)

(ii) When 0.5 dm³ of $AgNO_3(aq)$ was added to above solution and then attained to following equilibrium, 0.4 mol of $[Ag(NH_3)_2]^+_{(aq)}$ was formed.

$$Ag^+_{(aq)} + 2\,NH_3(aq) \rightleftharpoons [Ag(NH_3)_2]^+_{(aq)}$$

The equilibrium constant, $K_c = 2\times10^5$ mol⁻²dm⁶ . Find Ag^+ ion concentration at equilibrium. Write down an assumption that you made during above calculation. (Consider during addition of $AgNO_3$, volume of solution does not change)

(iii) When 2×10^{-4} mol of water solutble solid, MCl_2 is added to above (ii) solution, it dissolves completely. The 4.8×10^{-5} mol of $M(OH)_2$ gets precipitated. Then the precipitation of AgCl is begun. Calculate the OH^- ion concentrations of the solution separately, after dissolving MCl_2.

(iv) Calculate solubility product (K_{sp}) of $AgCl_{(s)}$

$K_{sp}[M(OH)_2] = 12 \times 10^{-12} \ mol^2 dm^{-6}$

(70 marks)

6. (a) At temperature TK, mixing $100cm^3$ of $NH_3(aq)$, $50cm^3$ of $CHCl_3$ and 0.75 g of solid $Co(NO_3)_2$ together and shaking well the mixture is allowed to attain equilibrium. After attaining the equilibrium, $25cm^3$ of aqueous layer was titrated with $1.0 \ moldm^{-3}$ HCl using suitable indicator. The burette reading was $4.5cm^3$. A $25cm^3$ of $CHCl_3$ layer was titrated with $0.5 \ moldm^{-3}$ HCl using suitable indicator. The burette reading was $1.5cm^3$ (The partition coefficient of NH_3 between $CHCl_3$ and H_2O is two. At TK, the solubility of NH_3 in $CHCl_3$ is higher than the solubility in water).

(i) What is the concentration of NH_3 in $CHCl_3$ layer.

(ii) What is the concentration of initial NH_3 solution.

(iii) What is the colour of initial aqueous layer.

(iv) Determine by calculation the molecular formula of the species that gave the particular colour.

(v) Write an assumption that you made in the calculation. (55 marks)

(b) At same temperature T/K, it was prepared $100cm^3$ solution, dissolving another 9.4 g of S; that has $100 \ gmol^{-1}$ molar mass, in water. The compound S is extracted using two $50cm^3$ protions of $CHCl_3$. The partition coefficient for the distribution of S between water and chloroform is 10.

S is more soluble in $CHCl_3$ than H_2O.

(i) What is the mass that can extract to the $CHCl_3$ layer?

(ii) What is the mass that can extract to the $CHCl_3$ layer after the second extraction.

(iii) The extracted amount of S into total volume of $100 \ cm^3$ of $CHCl_3$ by using $50cm^3$ of each in above two instances, is separated is pure form. For that , a student is constructed a distillation set up.

Density of chloroform $=1.49 \ gcm^{-3}$
Molecular mass of $CHCl_3 = 119.5 \ gcm^{-3}$
$CHCl_{3(boiling \ point)} < S_{(boiling \ point)}$

(I) Write down an assumption that uses.

(II) Based on the assumption in above (I), what is the law that used to extract S.

(III) Calculate the molar fractions of $CHCl_3$ and S in $100cm^3$ solution.

(IV) At constant pressure, according to the above (II) assumption at low pressure conditions the solution boils at temperature T_1.

$P^0 CHCl_3 = 0.25 \times 10^5 Pa$ $P^0 S = 0.15 \times 10^5 \ Pa$

(A) Find the composition of first distillate in $100cm^3$.

(B) Using above data, plot a graph for boiling point -composition variation of mixture of $CHCl_3$ and S at constant pressure. Mark the followings in drawn graph.

boiling points of pure solutions, temperature T_1, compositions for extraction, composition of first extraction.
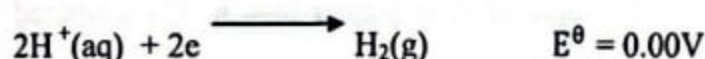
(55 marks)

(c) A 0.1 $moldm^{-3}$ weak acid, HA is titrated with $25cm^3$ of 0.1 $moldm^{-3}$ NaOH. Find the pH value at following instances. $K_a=1.5\times10^{-5}/mol\ dm^{-3}$; $K_w=1\times10^{-2}\ mol^2\ dm^{-6}$.

    (i)   Initial solution

    (ii)   at equivalence point

(4.0 marks)

7. (a) (i) A galvanic electrochemical cell was constructed at 25°C based on the following half reactions.

$$Cu^{2+}(aq) + 2e \longrightarrow Cu(s) \qquad E^\theta = +0.34V$$

$$2H^+(aq) + 2e \longrightarrow H_2(g) \qquad E^\theta = 0.00V$$

  (I)   Write down balanced chemical equations for anodic and cathodic half reactions of the cell.

  (II)   Write the balanced chemical equation for cell reaction of the cell.

  (III) The cell was operated for a duration of 96.5 s passing 300mA current. What is the mass of the discharged substance at the cathode?

       (H = 1 O = 16   Cu = 64   F = 96500C mol^{-1})

(ii) The electrode potential depends on the concentration of a solution. The variation of potential of Cu electrode with ion concentration is given by the following equation.

$$E = E^\theta + \frac{0.059}{2} \log [Cu^{2+}(aq)]$$

  (I)   Calculate the electrode potential of the cell when the concentration of the solution of Cu^{2+} is 0.5 $moldm^{-3}$.

  (II)   Considering above (I) value, sketch a graph to show the variation of electrode potential with log value of concentration of Cu^{2+}.
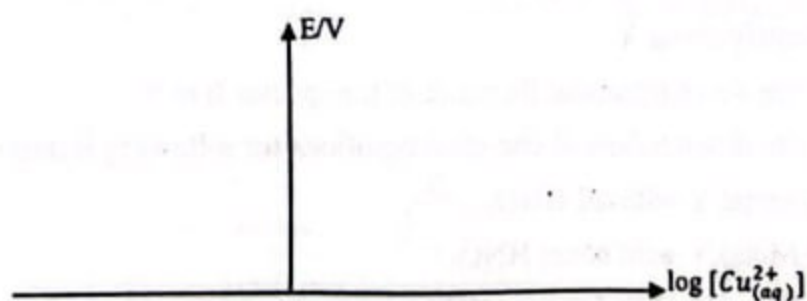
(iii) Consider the following galvanic cell constructed with two Cu electrodes.

Answer the following questions based on the above (ii) calculation and graph.

(I) Identify anode and cathode.

(II) Write down balanced chemical reactions, for anodic and cathodic half reactions.

(III) Calculate the electromotive force of the cell.

(IV) To increase the electromotive force of the cell, how should be changed the concentration of $Cu_{(aq)}^{2+}$ at electrode C.

(V) State a chemical substance that can be used for A.

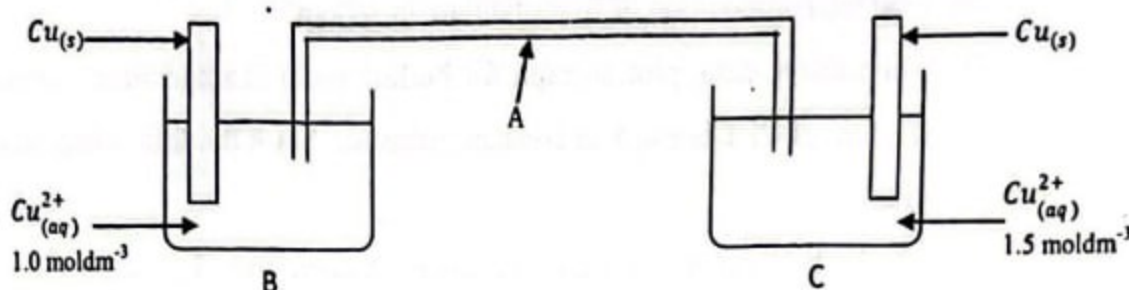(74 marks)

(b) (i) X is an d-block element that belongs to 4th period. There are two abundant oxidation states of X as m and n. The value of m is greater than n. The coloured substances A_1 and A_2 are formed by the X^{n+} and X^{m+} ions in aqueous solution. When diluted NH_3 is added to these coloured substances, the coloured precipitates A_3 and A_4 are formed respectively. When H_2O_2 is added to green colour precipitate A_3, it converts to brown colour precipitate A_4.

(I) Identify element X.

(II) Write down electron configurations of X^{n+} and X^{m+} ion.

(III) Write down chemical formulae for substances A_1 to A_4.

(IV) Write down the balanced chemical equation relevant to conversion A_3 to A_4 by H_2O_2.

(V) Write down IUPAC names of A_1 and A_2.

(ii) Y is a d-block element belongs to 4th period. When element Y reacts with dil HNO_3 and conc. HNO_3 , it forms coloured solution D and two gases B and C respectively. When dil NH_3 is added to D, coloured precipitate E is formed. When it is dissolved in excess NH_3 blue coloured solution F is formed. When H_2S gas is passed through D, it forms a black precipitate both in acid and basic medium.

(I) Identify metal Y.

(II) Write down chemical formulae of the species B to F.

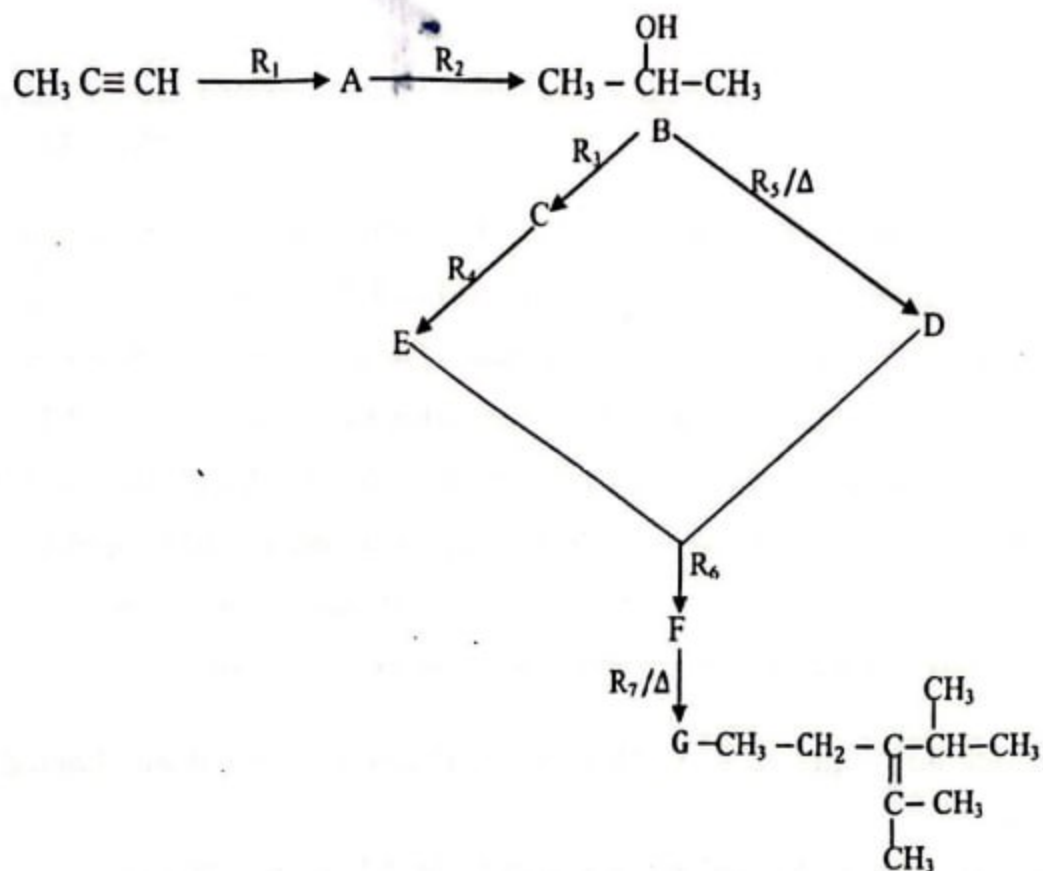(III) Write down balanced chemical equations for following instances.

A) metal Y with dil HNO_3

B) Metal Y with conc. HNO_3

C) Solution D and excess NH_3.

(76 marks)

Part C - Essay

• **Answer two questions only. (Each carries 150 marks)**

8. (a) Given below is a reaction scheme for the synthesis of compound G using $CH_3C \equiv CH$.

$$CH_3 C \equiv CH \xrightarrow{R_1} A \xrightarrow{R_2} CH_3 - \overset{\overset{\displaystyle OH}{|}}{CH} - CH_3$$

(structure labelled B)

Reaction scheme diamond:

B → (R₃) → C → (R₄) → E
B → (R₅/Δ) → D
E → F, D → F (via R₆)
F → (R₇/Δ) → G

$$G - CH_3 - CH_2 - \underset{\underset{\displaystyle CH_3}{\overset{\displaystyle \parallel}{C-CH_3}}}{\overset{\overset{\displaystyle CH_3}{|}}{C}} - CH - CH_3$$

(i) Write the structure of compounds A, C, D, E and F and reagents R_1, R_2, R_3, R_4, R_5 and R_7.

The following chemical substances can be used in singly or combindly as reagents.

chemical substances
dry ether, CH_3CH_2COOH, conc. H_2SO_4, Mg, H_2, PCl_5, Pd/BaSO₄ / quinolene catalyst , dil. H_2SO_4

(ii) The compound B was reacted with PCC. The product obtained is reacted with dil NaOH to form compound X. Draw the structure of X.

(85 marks)

(b) (i) Show how the following conversion could be carried out in not more than four steps.

$$CH_3 CH_2 - \overset{\overset{\displaystyle O}{\parallel}}{C} - H \longrightarrow CH_3 - C \equiv C - CH_3$$

(ii) Show how the following conversion could be carried out in not more than five steps.

$$CH_2 - \overset{\overset{\displaystyle O}{\parallel}}{C} - NH_2 \text{ (on benzene ring)} \longrightarrow \overset{\overset{\displaystyle Br}{|}}{CH} - CH_3 \text{ (on benzene ring)}$$
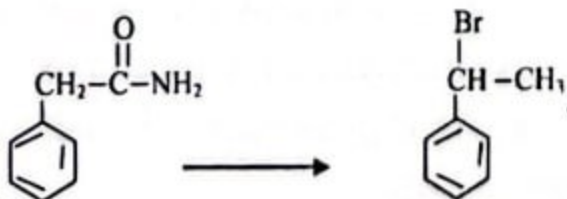
(c) (i) Write the mechanism of following reaction.

$$\text{benzene} \xrightarrow[\underset{\underset{CH_3}{|}}{CH_3-CH-Cl}]{\text{anhydrous } AlCl_3}$$
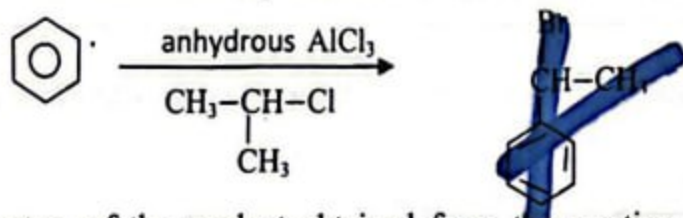
(ii) Draw the structure of the product obtained from the reaction of benzaldehyde with above reactant.   **(65 marks)**

9. (a) When the white compound, A is reacted with dil. H_2SO_4 it gives a colourless gas. B and colourless solution C. When gas B is reacted with acidified $K_2Cr_2O_7$ solution, it gives turbid green coloured solution. Then when the solution is filtered and obtained residue is thoughrouly heated in air, colourless gas E, is evolved. When this gas is reacted with B, residue D is again formed and colourless amphiprotic, F. Increasing the pH value of F by bubbling a gas that converts the colour of Nestle's regent into brown and then, added dropwisely to solution C. Then, the white precipitate H was obtained and, then precipitate is dissolved in excess F and coloureless solution, I was obtained.

   (i)   Identifying the species A, B, C, D, E, F, G, H and I , write down chemical formulae.

   (ii) Write down balanced chemical ionic equations for the following reactions.

      (I)   between A and dil H_2SO_4
      (II)   between B and acidified $K_2Cr_2O_7$
      (III) When D is burnt in air
      (IV)   To explain the observations when adding F which increased pH value to solution C dropwisely.

   (75 marks)

   (b) Below is an experiment carried out to determine the composition of glycerol $(C_3H_8O_3)$ which is an active ingredient containing in sunscreen lotion, X that used for skin protection from sun bunns in ppm by back titration.

   It is allowed to react $25.00 cm^3$ of aqueous solution of X with $50.0 cm^3$ of $0.02 mol dn^{-3}$ $KMnO_4$ (excess) in acidic conditions. The glycerol contained in X oxidizes to CO_2 and H_2O by $KMnO_4$. After adding $25.00 cm^3$ (excess) of $0.05 mol dn^{-3}$ oxalic acid $(H_2C_2O_4)$ to the remained solution after the reaction , the remained $KMnO_4$ is reduced.

   After this reaction , when they remained oxalic acid is titrated again with above $KMnO_4$ solution, the used volume is $10.00 cm^3$

      (i) Write down all the balanced ionic equations during this analytical process.

      (ii) Calculate the composition of glycerol contains in X in ppm. (C=12 , O = 16, H=1) Consider that chemical formulae of glycerol and oxalic acid are $C_3H_8O_3$ and $H_2C_2O_4$ respectively. (1ppm = 1mg dm^{-3})

   (75 marks)

10. (a) The following flow chart shows production processes of important compounds P_5, P_8 and P_9.

P_5 - Show cleansing properties.

P_8 - Producing alkalinity, to enhance the cleansing action.

P_9 - To produce nitric acid.

(R) - raw materials   /P\ - Product   [M] - Methodology / production process

(△) - product / raw material
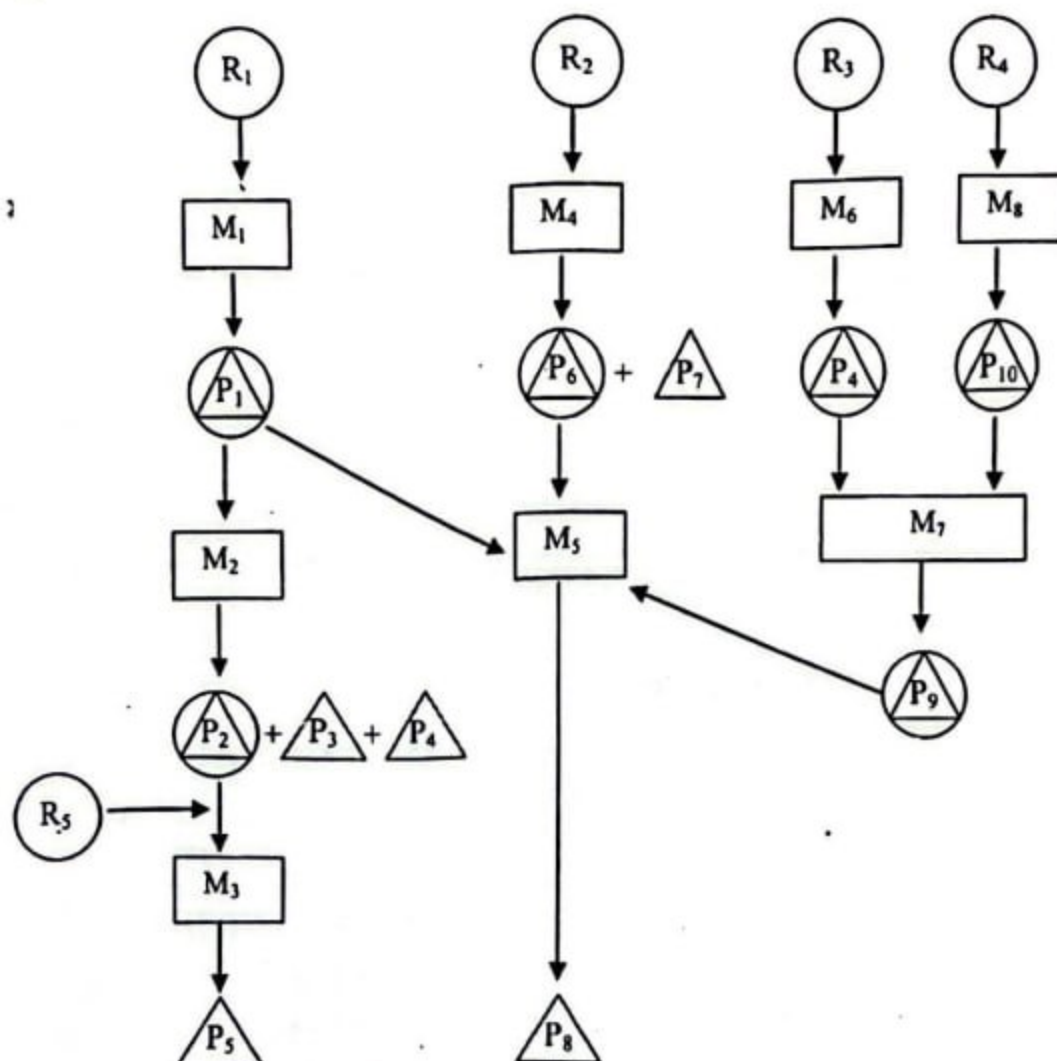
(i) Write down using names of raw materials R_1 - R_5.

(ii) Identify the products M_1 - M_7

(iii) State the products P_1 - P_5

(iv) Write down four main steps along with balanced chemical equations included in process M_3.

(v) What are the physio - chemical principles that uses in production process M_2 and M_5? Write down relevant balanced chemical equations.

(vi) Give one use for each product P_2, P_3 and P_7 (Except given in flow chart and question.)   (75 marks)

(b) Following questions are based on acid rains and global warming.

(i) State two main gaseous pollutants for each that contribute to acid rains and global warming.

(ii) Mention seperately natural way and human activity for each releasement of above (i) to environment.

(iii) Write down the balanced chemical equations for decreasing of pH value of rain water by pollutants in above (i).

(iv) Write two ways in which variation in the pH value of water effects aquatic life.

(v) Explain two activities that can be done to minimize acid rains a not global warming.

(60 marks)

(c) Polyethylene terephthalate (PET) and nylon 6,6 are condensation polymers.

(i) What are condensation polymers?

(ii) Draw the structures of two monomers that uses in production of PET.

(iii) Draw the repeating unit of nylon 6,6.

(iv) Give an example of application of three dimensional polymer and explain why the relevant polymer is suitable for that application.

(15 marks)

***

Periodic Table

	1																	2
1	H																	He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	La-Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	Ac-Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr