DEVI BALIKA VIDYALAYA - COLOMBO

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Final Term Test - September 2020

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13 ශ්‍රේණිය - Grade 13

රසායන විෂයය I Chemistry I	02 E I	පැය දෙකයි *Two hours Enu*

Instructions:

* Periodic Table is provided
* Answer **all** the questions.
* Use of calculators is not allowed
* Write your name in the space provided in the answer sheet.
* Follow the instructions given on the back of the answer sheet carefully.
* In each of the questions 1 to 50, pick one of the alternative (1), (2), (3), (4) ,(5) which is correct or most appropriate and mark your response on the answer sheet with a cross (x) in accordance with the instructions given on the back of the answer sheet.

Universal gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$

Avogadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

Planck's constant $h = 6.626 \times 10^{-34}\ J\ s$

Velocity of light $c = 3 \times 10^{8}\ m\ s^{-1}$

01. Consider the following statements I & II regarding the electron.

I - Negatively charged particle in cathode rays is the electron.

II - Electron can behave as a wave.

The scientists who made the above statements respectively are,

(1) Rutherford de Broglie (2) Stoney and Neils Bohr

(3) J·J Thompson and de Broglie (4) Stoney and Max Planck

(5) J·J Thompson and Max Planck

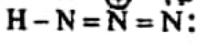
02. Number of electrons of a Ti atom in ground state which satisfy the quantum number requirements of (i) & (ii) as given below respectively are

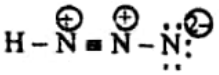
(i) $\ell = 2$ (ii) $n = 3$ and $\ell = 1$

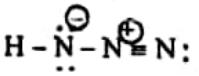
(1) 6 and 2 (2) 2 and 12 (3) 3 and 8

(4) 8 and 2 (5) 2 and 6

03. Resonance structures of molecule HN_3 are given below.

(I) 

(II) 

(III) 

Which of the following statement is incorrect regarding the above structures.

(1) All of the resonance structure are different in stability.

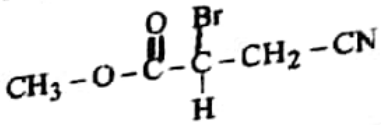
(2) Structure II is unstable.

(3) Structure II gives the least contribution to the resonance hybrid.

(4) The N – N bond length (attached to H) in the above molecule is less than bond length of a N – N single bond and greater than the bond length of a N – N double bond.

(5) $N\hat{N}N$ bond angle in each of the above structure is 180^{o}.

04. IUPAC nomenclature of the compound given below



(1) methyl 2–bromo–4–cyanopropanoate
(2) methyl 2–bromo–3–cyanopropanoate
(3) methyl 2–bromo–3–cyanopropaneoate
(4) methyl 2–bromo–3–cyanopropane oate
(5) methyl 2–bromo–3–nitrilpropanoate

05. Increasing order of the melting points of the compounds $MgCl_2$, MgI_2, NaF and NaCl is,

(1) $NaCl < MgI_2 < NaF < MgCl_2$
(2) $MgI_2 < MgCl_2 < NaCl < NaF$
(3) $MgCl_2 < NaCl < MgI_2 < NaF$
(4) $MgI_2 < NaCl < MgCl_2 < NaF$
(5) $NaCl < NaF < MgI_2 < MgCl_2$

06. Which of the following molecules / ions have the same shape?

(A) BrF_5 (B) F_4ClO^- (C) ICl_4^- (D) ClF_3 (E) $XeOF_4$

(1) A and C
(2) C and D
(3) A, B and E
(4) C, D and E
(5) B and C

07. Which of the following statement/s is/are correct regarding compound but – 3 – yn – 2 – one

(A) forms a silver mirror with tollens reagent.
(B) decolourizes acidic $KMnO_4$.
(C) decolourizes Br_2 water.
(D) the product formed by the reaction with H_2, Pd, $BaSO_4$ and quinoline, shows enantiomerism.

(1) Only A
(2) A , B and C
(3) B and C
(4) C and D
(5) A, C and D

08. 5.05 g of a solid sample containing only $NaNO_3$ and $MgCO_3$ was heated until a constant mass of the residue is observed. Released gaseous mixture was passed through conc. KOH solution. Volume of the gaseous mixture was reduced by 1120 cm^3 at STP. Mass percentage of $NaNO_3$ in the mixture is, (Na - 23, N - 14, O - 16, Mg - 24, C - 12)

(1) 16.8%
(2) 34.32%
(3) 49%
(4) 75%
(5) 83.16%

09. Consider the following elementary reaction.

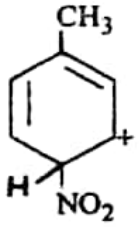
$AB_{(g)} + BC_{(g)} \rightleftharpoons AB_2C_{(g)}$

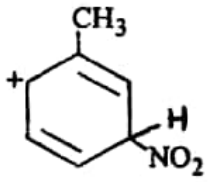
Standard enthalpy of formation AB $= -200\ kJ\ mol^{-1}$
Standard enthalpy of formation BC $= -600\ kJ\ mol^{-1}$
Standard enthalpy of formation AB_2C $= -1200\ kJ\ mol^{-1}$
Activation energy of the forward reaction $= 200\ kJ\ mol^{-1}$

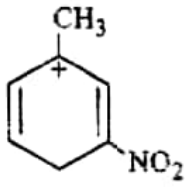
According to the above data activation energy of the reaction $AB_2C_{(g)} \longrightarrow AB_{(g)} + BC_{(g)}$ is

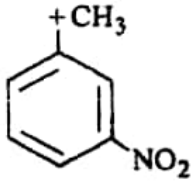
(1) 900 $kJ\ mol^{-1}$
(2) 1100 $kJ\ mol^{-1}$
(3) 800 $kJ\ mol^{-1}$
(4) 1300 $kJ\ mol^{-1}$
(5) 600 $kJ\ mol^{-1}$

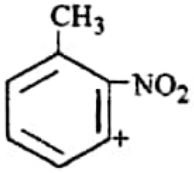
10. Intermediate formed during the nitration of Toluene is,

(1) 

(2) 

(3) 

(4) 

(5) 

11. Increasing order of the C – O bond length in CO, CO_2, HCO_3^- and CO_3^{2-} is;

(1) $HCO_3^- < CO_3^{2-} < CO_2 < CO$ (2) $CO < CO_2 < CO_3^{2-} < HCO_3^-$

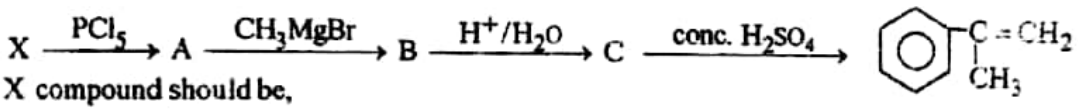
(3) $HCO_3^- < CO < CO_2 < CO_3^{2-}$ (4) $CO < CO_2 < HCO_3^- < CO_3^{2-}$

(5) $CO_2 < CO < CO_3^{2-} < HCO_3^-$

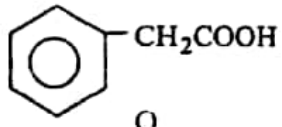
12. Molar solubility of $Ca(OH)_2$ at 25°C is x mol dm^{-3}. $CaCl_2$ powder is added to 1000.0 cm^3 of a saturated $Ca(OH)_2$ solution which is prepared by dissolving $Ca(OH)_2$ powder. Mass of $CaCl_2$ that should be added in order to reduce the concentration of OH^- to the above solution to x. (Molar mass of $CaCl_2$ is M)

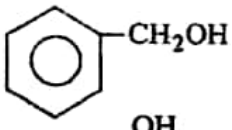
(1) $\frac{3}{2}x$ M (2) $2x$ M (3) $3x$ M (4) $\frac{7}{2}x$ M (5) $4x$ M

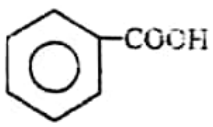
13. Consider the following reaction scheme is

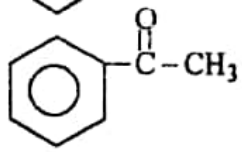


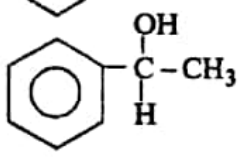
X compound should be,

(1) 

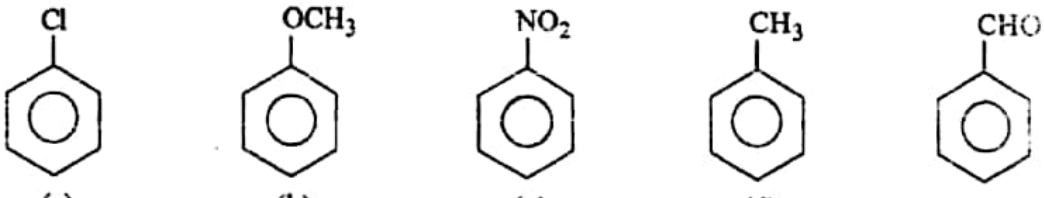
(2) 

(3) 

(4) 

(5) 

14. The acending order of the reactivity towards bromination of the given compounds,



(a) (b) (c) (d) (e)

(1) d < b < a < c < e (2) c < a < e < d < b (3) c < e < a < b < d

(4) c < e < a < d < b (5) e < c < a < d < b

15. 19.3 mA current was passed through 1 dm^3 of 0.1 mol dm^{-3} NaCl solution at 25 °C. Time required for the pH of solution to become 12 is, ($1F = 96500\ C\ mol^{-1}$)

(1) 1×10^4 s (2) 2×10^4 s (3) 3×10^4 s

(4) 4×10^4 s (5) 5×10^4 s

16. The following equilibrium exists at 1200 K,

$$CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$$

Which of the following is correct regarding the of ΔH and ΔS values of the forward reaction of the equilibrium given above?

(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) $\Delta H < 0\ ;\ \Delta S < 0$

17. Which of the following statement is correct;

(1) Half life of a zeroth order reaction is independent of the initial concentration of the reactant.
(2) A catalyst increases the rate of a reaction by lowering the activation energy of the reaction.
(3) As order of a reaction with respect to a reactant can be zero, molecularity can also be zero.
(4) The rate equation of the overall reaction could include the intermediate.
(5) The overall order of a reaction is not always equal to the molecularity of the rate determining step.

18. Gas X_3 decomposes as follows $X_{3(g)} \longrightarrow 3\ X_{(g)}$

When 10% of X_3 gas in a rigid vessel at a constant temperature is decomposed, percentage increase of pressure is

(1) 10% (2) 20% (3) 30% (4) 40% (5) 50%

19.

$$X_{(g)} + 2Y_{(g)} \rightleftharpoons Z_{(g)}$$

1 mol of X and 2 mol of Y were placed in a rigid vessel at TK.

At equilibrium x mol of $X_{(g)}$ has converted to Z. If units of equilibrium constant K_c is mol dm^{-3}. The total pressure of the system is correctly given by,

(1) $P = \dfrac{\sqrt{X}(3-2x)(RT)}{2\sqrt{K_c}(1-x)^{3/2}}$ (2) $P = \dfrac{x(3-2x)}{2(RT)\sqrt{K_c}(1-x)^2}$

(3) $P = \dfrac{2\sqrt{x}(3-2x)(RT)}{\sqrt{K_c}(1-x)^{3/2}}$ (4) $P = \dfrac{2\sqrt{x}(3-2x)}{(RT)\sqrt{K_c}(1-x)^{3/2}}$

(5) $P = \dfrac{\sqrt{x}\ (3-2x)\ (RT)}{2\sqrt{K_c}(1-x)^3}$

20. The reaction $A \longrightarrow B + C$ is an elementary reaction. n_0 moles of A was kept in a vessel of V volume at temperature T. After time t, the total pressure of the system was P. The instantaneous rate at time t is correctly given, by (k is the rate constant and R is the universal gas constant)

(1) $R = k\left(\frac{n_0}{V}\right)$ (2) $R = k\left(\frac{n_0}{V^2}\right)\frac{RT}{P}$ (3) $R = k\left(2n_0 - \frac{PV}{RT}\right)\frac{1}{V}$

(4) $R = k\left(P - \frac{n_0 RT}{V}\right)\times\frac{1}{V}$ (5) $R = k\left(n_0 - \frac{PV}{RT}\right)\times\frac{1}{V}$

21. $25.00\ cm^3$ of $0.2\ mol\ dm^{-3}$ NH_4OH solution is titrated with $0.05\ mol\ dm^{-3}$ HCl solution. pOH of the solution when $25.00\ cm^3$ of HCl is added to the titration flask.

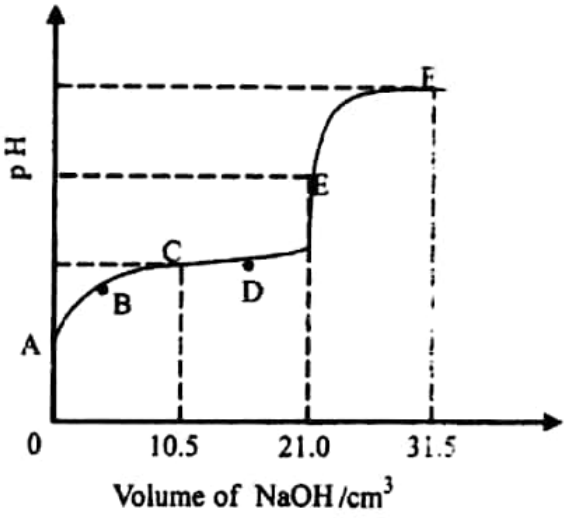
(K_b of $NH_3 = 1 \times 10^{-5}\ mol\ dm^{-3}$)

(1) 4 (2) 4.85 (3) 4.52 (4) 4.25 (5) 4.35

22. $25.00\ cm^3$ of a given HCl solution is added to a titration flask. Then KI and KIO_3 in excess are added to the above solution and titrated with $0.1\ mol\ dm^{-3}$ $Na_2S_2O_3$ solution. Volume of $Na_2S_2O_3$ required is $50.00\ cm^3$. Concentration of HCl solution in $mol\ dm^{-3}$ is,

(1) 0.2 (2) 0.15 (3) 0.1 (4) 0.25 (5) 0.3

23. $20.00\ cm^3$ of an unknown monobasic weak acid HA is titrated with $0.1\ mol\ dm^{-3}$ NaOH solution. Variation of the pH against the added volume of shown in the graph given below.



pH range that the solution shows a buffer action is,

(1) AB (2) BC
(3) CD (4) DE
(5) BD

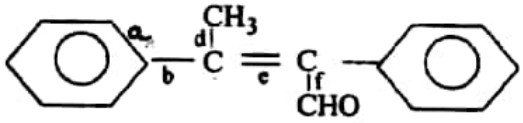
24. $5\ dm^3$ gaseous sample of SO_2 is passed through $100\ cm^3$ of excess, H_2O_2 solution. $25.00\ cm^3$ of the resultant solution is titrated with $1\ mol\ dm^{-3}$ NaOH solution. Required volume is $25.00\ cm^3$ If the density of the gaseous sample is $1.6\ g\ cm^3$ composition of SO_2 in the sample in ppm is (S=32; O=16)

(1) 200 (2) 400 (3) 600 (4) 800 (5) 1000

25. $25.00\ cm^3$ of a solution containing SO_3^{2-} and $C_2O_4^{2-}$ is titrated with $0.4\ mol\ dm^{-3}$ acidic $KMnO_4$ solution. Required volume of $KMnO_4$ is $30.00\ cm^3$. Resultant solution is heated and $BaCl_2$ is added in excess, to the resultant solution dry mass of the precipitate is 4.66 g . Concentrations of SO_3^{2-} and $C_2O_4^{2-}$ in the solution in $mol\ dm^{-3}$ respectively are, (Ba – 137 S – 32 O – 16)

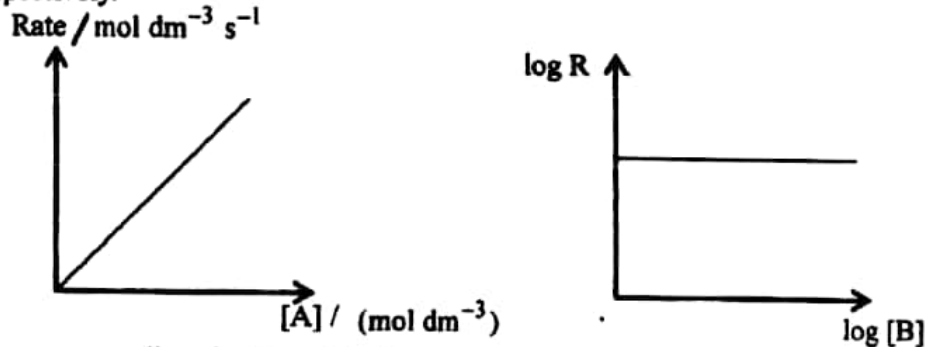
(1) 0.8, 0.4 (2) 0.6, 0.4 (3) 0.4, 0.1 (4) 0.4, 0.2 (5) 0.8, 0.2

26. The statement/s regarding the compound given below.



(1) All carbon atoms lie in the same plane.
(2) Since all C - H bonds are sigma (σ) bonds, they are similar in length.
(3) The C - C bond length increases in the order e < a < b < d < f
(4) All CCC bond angles are equal

27. An experiment is carried out to find the order with respect to each reactant A and B of the reaction $A + B \longrightarrow C$. The following graphs were plotted by keeping th concentrations of B and A constant (in excess) respectively.



Incorrect statement regarding above reaction is,
(1) Order with respect to A is 1.
(2) Units of rate constant relevant to the rate law of the above reaction is s^{-1}.
(3) Reaction should take place via a multi step mechanism.
(4) The activation energy of the step were B is involved is greater than the activation energy of the RDS.
(5) B is participated in a fast step of the reaction mechanism.

28. Which of the following statement is incorrect.
(1) Concentrated H_2SO_4 reacts with KCl, KBr and KI and forms HCl, Br_2 and I_2 respectively.
(2) Even though concentrated H_2SO_4 is a dehydrating agent concentrated HNO_3 is not.
(3) Concentrated HNO_3 can act as a base.
(4) Even though concentrated HNO_3 acts as an acidizing agent, it cannot act as a reducing agent.
(5) Sulfur undergoes disproportionation when reacted with concentrated H_2SO_4.

29. Which of the following statement is false regarding polymers?
(1) NH_3 is used to prevent the coagulation of rubber latex.
(2) ebonite is a product of rubber which does not show elastic properties.
(3) In the production of plastics to increase the flexibility plasticizers are added.
(4) Elasticity of trans polyisoprene is less.
(5) When PVC is stretched beyond the **elastic limit** its shape is not changed.

30. Which of the following would takes place if the Pt wire in the standard O2 electrode is replaced by a zinc rod.

$E^{\circlearrowleft}_{Zn^{2+}/Zn} = -0.76\ V$ $E^{\circlearrowleft}_{O_2/OH^-} = -0.40\ V$ $E^{\circlearrowleft}_{Pt^{2+}/Pt} = 1.20\ V$

(1) As Pt is used to facilitate the reaction between O_2 and OH^- by the adsorption of gas molecules, no change occurs due to the replacement of Pt by Zn .
(2) No reaction takes place.
(3) pH of the solution increases.
(4) Mass of the zinc rod increases.
(5) A gas formed.

- For each of the questions **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 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 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 or combination of responses is correct

31. Which of the following statement/s is/are correct regarding colours of complexes formed by metal cations of d block.

(a) Aqueous solutions of Ti^{3+}, V^{2+}, Cr^{3+} and Mn^{3+} are purple in colour.
(b) Aqueous solutions of Fe^{2+}, Ni^{2+}, V^{3+} are green in colour.
(c) Ammine complexes of Cr^{3+}, Co^{2+}, Co^{3+} are yellow in colour.
(d) Chloro complexes of Mn^{2+}, Fe^{2+}, Ni^{2+} and Cu^{2+} are yellow brown in colour.

32. Which of the following statement/s is/are correct regarding a solution prepared by mixing equal volumes of CH_3COCH_3 and $CHCl_3$.

(a) Mixture shows a positive deviation from Raoults Law.
(b) Attraction forces between homogeneous molecules is less than that of heterogeneous molecules.
(c) H-bonds are formed when CH_3COCH_3 and $CHCl_3$ are mixed.
(d) In all compositions of the two solutions, boilding point of the mixture will be between the boiling points of the two liquids.

33. Which of the following statements is/are true regarding elements of compounds of s block.

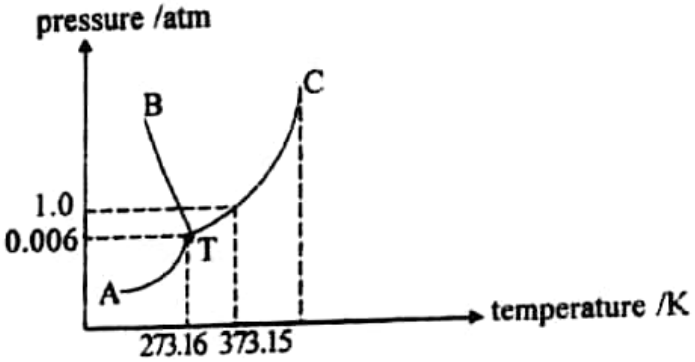
(a) The basicity of oxides of block elements, increases down the group.
(b) Thermal stability of group 1 carbonates increase down the group.
(c) Solubility of carbonates of group 2 increases, due to the increase of the radius of cations down the group.
(d) Ionic nature of chlorides of group 2 increases down the group due to the increase in the radius of cations down the group.

34. Which of the following statement/s is/are true regarding Aniline?
(a) It is more basic than para-nitro aniline .
(b) Basicity of it is less than that of amides.
(c) It acts as a nucleophile.
(d) It forms N_2 gas by reacting with $NaNO_2$ and dil HCl at room temperature

35. Which of the following statement/s is/are true regarding compounds formed by elements of p block.
(a) Melting point of graphite is greater than that of diamond.
(b) When chlorides of group 5 elements are hydrolysed, HCl is always formed.
(c) Dipole moment of H_2O is greater than that of H_2S
(d) Vapours of Br_2 and I_2, show different colours in aqueous solutions and in organic solvents.

36. Which of the following statement/s is/are incorrect regarding turbidity.
(a) Turbidity is a parameter for quality of effluent water.
(b) Presence of very soft colloidal particles is a cause for the turbidity.
(c) Turbidity is caused by dissolved matter.
(d) Turbidity is determined by measuring the amount of detraction in water.

37. A phase diagram of pure water is given below .



correct statement regarding the above phase diagram is,
(a) When pressure is increased in the mixture at triple point at a constant temperature, only liquid H_2O remains.
(b) Curve TC shows the temperature and pressure at which ice and water vapour are in equilibrium.
(c) When temperature of the mixture at triple point is increased at constant pressure, only water vapour will remain.
(d) When temperature of the mixture at point A is reduced at constant pressure frost is formed.

38. Which of the following statement/s is/are correct regarding 3–butenal?
(a) The product formed by the reaction between $NaBH_4$ and the above compound, shows diasteriomerism.
(b) The product formed when the above compound is reacted with HBr followed by alcoholic KOH , shows diasteriomerism.
(c) The product formed when the above compound is reacted with CH_3MgBr followed by hydrolysis, shows enantiomerism.
(d) The product formed, when Br_2 / CCl_4 is reacted with the above compound, shows enantiomerism.

39. Which of the following statement/s is/are correct,
   (a) Viniger is formed by the oxidation of acetic acid which is formed by the bacterial action on todd.
   (b) Ethanol is produced from fermented coconut toddy and molasses which is a byproduct in the production of sugar from sugar cane.
   (c) Water insoluble and soluble volatile liquids are known as essential oils.
   (d) Triglycerides in plant oils are converted to bio diesel by transesterification in the presence of NaOH catalyst.

40. $2C_{(s)} + O_{2(g)} \rightleftharpoons 2\,CO_{(g)}\ \Delta H_1 = -221\ kJ\ mol^{-1}$

$O_{2(g)} + C_{(g)} \rightleftharpoons CO_{2(g)}\ \Delta H_2 = -393\ kJ\ mol^{-1}$

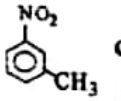
Which of the following should be done in order to increase the yield of $CO_{(g)}$ of the equilibrium given below which takes place in a rigid vessel. $C_{(s)} + CO_{2(g)} \rightleftharpoons 2\,CO_{(g)}$

   (a) Increasing the temperature of the system.
   (b) Addition of $CO_{2(g)}$.
   (c) Decreasing the temperature of the system.
   (d) Addition of $C_{(s)}$

- In question Nos. **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.	$AlCl_3$, is more covalent than $MgCl_2$	Charge / radius ratio of Al^{3+} is greater than that of Mg^{2+}
42.	CH_3NH_2 react with the grignand reagent in the presence of dry ether	Grignard reagent is a good neucleophile
43.	Yield can be increased by the addition of $BaCl_2$ in the production of caustic soda.	The efficiency of the production of NaOH is increased by the addition of $BaCl_2$, as it removes SO_4^{2-} ions.
44.	Mass and the chemical properties of a catalyst is unchanged in a reaction even if physical state of the catalyst is changed.	Catalysts never involve to the reaction.

45.	Boiling point of CH_3Cl is greater than that that of CCl_4	CH_3Cl has dipole - dipole attractions and CCl_4 has London forces.
46.	When dil.HCl is added dropwise to an aqueous solution containing $PbCO_3$ precipitate, it dissolves forming a clear solution.	If anion of a sparingly soluble salt is a conjugate base of a strong acid, solubility of the salt increases in an acidic medium.
47.	When the temperature of an equilibrium reaction, where the forward reaction is exothermic, is increased, the rate of the reverse reaction is increased.	When the temperature of an equilibrium reaction, where the forward reaction is exothermic, is increased, the rate constants of both forward and backward reactions increase.
48.	 can be synthesized by undergoing alkylation on nitrobenzene	NO_2^- group is a meta directing group.
49.	It is important for the electrolytes used in the salt bridge to have equal mobilities.	A liquid junction potential arises when the mobility of ions in the electrolytic solution of the salt bridge are different to each other.
50.	Arsenicosis is an effect arises due to the addition Arsenic to water.	Arsenic is a heavy metal.

* * *

දේවි බාලිකා විද්‍යාලය - කොළඹ

DEVI BALIKA VIDYALAYA - COLOMBO

13 වන ශ්‍රේණිය අවසාන වාර පරීක්ෂණය - 2020 සැප්තැම්බර්

Grade 13 Final Term Test September 2020

රසායන විද්‍යාව II Chemistry II	02 E II	පැය තුනයි *Three hours*

Name : ..... Grade : ..... Index No. : .....

* *Use of calculators is not allowed*

Part A : Structured Essay (Page 2 - 10)

* *Answer all questions on the question paper itself.*
* *Write your answer in the space provided for each question. Please note that the space provided is sufficient for the answer and the extensive answers are not expected.*

Part B - Essay (Page 11 - 17)

* *Answer two questions Use the papers supplied for this purpose.*
* *At the end of the time allotted for this paper, tie the answers of the Parts A and B together so that Part A is on top and hand them over to the Supervisor.*
* *You are permitted to remove only Part B of the question paper from the Examination Hall.*

* *Universal gas constant*	R	=	$8.314\ JK^{-1}\ mol^{-1}$
* *Avogadro constant*	N_A	=	$6.022 \times 10^{23}\ mol^{-1}$
* *Planck's constant*	h	=	$6.626 \times 10^{-34}\ Js$
* *Speed of light*	c	=	$3 \times 10^{8}\ ms^{-1}$

For Examiner's Use Only

Part	Question No	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
C	8	
	9	
	10	
Total		
Percentage		

Final Marks

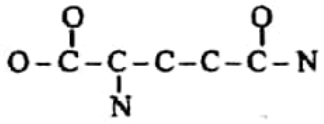
Paper I	
Paper II	
Total	
Percentage	

Part A - Structured Essay

Answer all four questions on this paper itself. (Each question carries 10 marks)

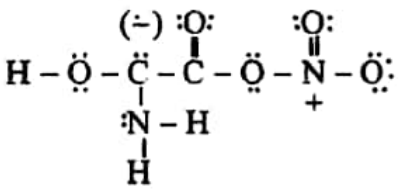
01. a) i) Glutamine is an amino acid with molecular formular $H_{10}N_2C_5O_3$. Draw the most acceptable Lewis structure for glutamine. The skeleton is given below.

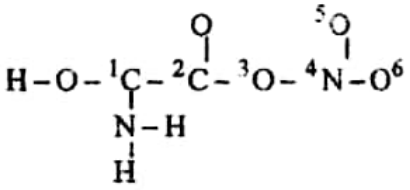
Note : Two H atoms are connected to each. N atom



ii) Draw another three Lewis structures (resonance structures) for the above molecule.

iii) Consider the following hypothetical Lewis structure. Atoms are numbered as follows.





Based on the Lewis structure given above, state the following regarding the C, N and O atoms given in the table below.

I. VSEPR pairs around the atom.

II. electron pair geometry around the atom.

III. shape around the atom.

IV. hybridization of the atom.

V. formal charge of the atom.

VI. oxidation number of the atom.

	^1C	^2C	^3O	^4N
I. VSEPR pairs				
II. electron pair geometry				
III. shape				
IV. hybridization				
V. formal charge				
VI. oxidation number				

iv) Identify the atomic/ hybrid orbitals involved in the formation of the following & bonds in the Lewis structure given in part (iii) above.

I. $O - {}^1C$ O ..... ^1C .....

II. $^1C - {}^2C$ ^1C ..... ^2C .....

III. $^2C - {}^3O$ ^2C ..... ^3O .....

IV. $^3O - {}^4N$ ^3O ..... ^4N .....

V. $^4N - {}^5O$ ^4N ..... ^5O .....

VI. $^4N - {}^6O$ ^4N ..... ^6O .....

(5.5 mark)

b) i) The set of quantum numbers (n, ℓ, m_ℓ, m_s) of the last electron being filled in each of the atoms A, B, C, D and E are given below. Given that the electron under consideration is the only electron in the sub-shell, write their electronic configuration.

Atom	Set of quantum numbers	Complete electronic configuration	Period it belongs to	Block, it belongs to
A	$3, 2, -1, +\frac{1}{2}$			
B	$3, 0, 0, -\frac{1}{2}$			
C	$4, 0, 0, +\frac{1}{2}$			
D	$3, 1, -1, -\frac{1}{2}$			
E	$2, 0, 0, +\frac{1}{2}$			

ii) Answer the questions from I to VI below considering the atoms A, B, C, D and E in part b (i) above.

I. The element with highest atomic radius. .....

II. the element that forms an oxide and a nitride when burnt in air .....

III. the element that can form compounds that can act as Lewis acids.....

IV. element with highest melting point .....

V. element that forms a soluble salt that is readily available .....

VI. element with highest electronegativity .....

(4.5 marks)

02 a) X and Y are two elements belonging to the p - block. X is a gas while Y is a solid. Both elements X and Y show allotropic forms. Hydride of X has a higher boiling point than the hydride of Y and is non toxic. The hydride of Y shows weak acidic properties in aqueous solution.

i) Identify X and Y.

X - ..... Y - .....

ii) Draw Lewis structures of the allotropes of X.

iii) Indicate the relative magnitudes of the following regarding the hydrides of X and Y.

I. boiling point ☐ > ☐

II. bond length ☐ > ☐

III. bond angle ☐ > ☐

iv) The hydride of X is an amphoprotic compound.

I. What is meant by amphoteric ?

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.....

II. Write balanced chemical equations to show the amphoprotic properties of the hydride of X.

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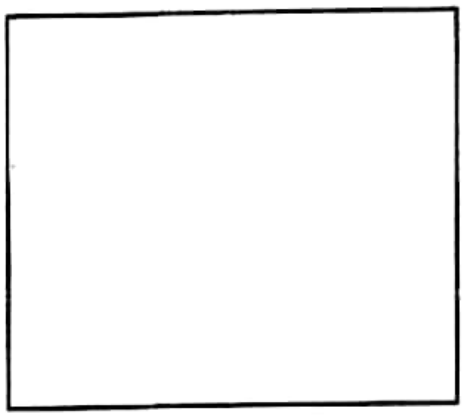
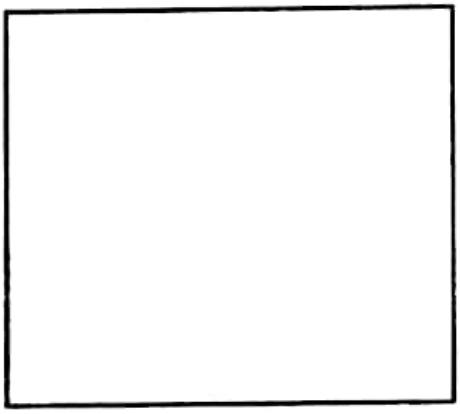
.....

v) Name the crystalline allotropic forms of Y and draw their structures.





vi) A light blue colour, viscose liquid compound formed by X can act as an oxidizing agent as well as a reducing agent. Write the following for the compound.

I. reduction half reaction

.....

II. oxidation half reaction

.....

III. disproportionation reaction

.....

vii) Write balanced chemical equations for the following.

I. Na and excess H_2S

.....

II. H_2S and SO_2

.....

III. S and hot concentrated H_2SO_4

.....

IV. Decomposition of $H_2S_2O_3$

.....

viii) You are provided with aqueous solutions of four different anions formed by Y. A dilute acid was used to distinguish the four different anions provided in seperate test tubes. The re results of the test is given below. Identify the four anions and give one test each to confirm the anion.

Test tube Number	Observation	Anion	Confirmation test
1.	A gas was evolved. A colourless clear solution was formed.		
2.	A gas was evolved. A turbid solution was formed.		
3.	A gas was formed. A turbid solution was formed when the gas was passed through an acidified $K_2Cr_2O_7$ solution		
4	No change		

(7.5 marks)

b) i) Test tubes labelled A, B, C, D and E contain solids of Mg_3N_2, $AlCl_3$, $CuSO_4$, $BiCl_3$ and PbI_2 (Not in order). The following observations were made when water was added to each of the test tubes. Identify the salts and explain the observation.

		Observation	Salt	Explanation
I.	A	White precipitate		
II.	B	Light blue solution		
III.	C	Colourless solution		
IV.	D	Evolution of a gas		
V.	E	Coloured precipitate		

ii) Write the balanced chemical equation for the reaction taking place in A.

.....

iii) Identify the species responsible for the colour in B and C

B - ..... C - .....

iv) Give a test to identify the gas evolved in D

.....

.....

(2.5 marks)

03. a) i) Write chemical equations for the thermochemical

I. Standard atomization enthalpy of chlorine. $\Delta H^{\ominus}_{at} = 121\ kJ\ mol^{-1}$

.....

II. Standard enthalpy of combustion of $H_2O(\ell)$. $\Delta H^{\ominus}_{C} = -285 kJ\ mol^{-1}$

.....

III. Standard enthalpy of formation of $NO_{2(g)}$ $\Delta H^{\ominus}_{f} = 33.0\ kJ\ mol^{-1}$

.....

IV. Standard lattice enthalpy of $AlCl_3(s)$ $\Delta H^{\ominus}_{LE} = -5440\ kJ\ mol^{-1}$

.....

ii) The industrial preparation of NH_3 is done by the Haber process. The relevant reaction is given below.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2\ NH_{3(g)}$$

I. Using the data given below calculate $\Delta H^{\ominus}_{r}$ for the above reaction at 25°C

Compound	Standard enthalpy of formation $kJ\ mol^{-1}$	Standard Entropy $J\ K^{-1} mol^{-1}$
$N_{2(g)}$	0	192
$H_{2(g)}$	0	131
$NH_{3(g)}$	- 46	195

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II. Given that $\Delta G^{\ominus}_{r} = 2.303\ RT \log K$, calculate the equilibrium constant (K) for the above reaction.

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.....

III. For the above reaction to be spontaneous what should be the value of K.

.....

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.....

b) i) State the Nernst distibution law.

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ii) State three requirements that should be satisfied in order to apply the Nernst distribution law.

.....

.....

.....

.....

iii) Explain why the Nernst distribution law can not be applied directly for the distribution of CH_3COOH between $CHCl_3$ and H_2O

.....

.....

(iv) 10.0 cm^3 of 1.0 mol dm^{-3} aqueous NH_3 solution was added to a flask containing 50.00 cm^3 of $CHCl_3$ and 40.00 cm^3 of H_2O and shaken well. 10.0 cm^3 of 0.08 mol dm^{-3} H_2SO_4 solution was required to react completly with 10.00 cm^3 of the aqueous layer. Find the distribution coefficient of NH_3 between $CHCl_3$ and H_2O.

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(5. 0 marks)

04. a). A, B, C and D are four compounds containing a benzene ring with molecular formula C_8H_9NO. A, B and C are disubstituted benzene compounds where as D is a monosubstituted benzene com pound. A and D do not form precipitates with the Bradys' reagent where as B and C form precipitates with the Bradys' reagent. B does not undergo self condensation in basic medium where as C does. When A, B, C and D are reacted with $NaNO_2$/ dilute HCl, E, F, G and H are formed respectively. Only E and H are carboxylic acids while F and G are not. H does not declorize acidified $KMnO_4$. E F and G form carboxylic acids I, J and K respectively when reacted with acidified $KMnO_4$. I is a monomer used to form a certain polymer I and K are para substituted compounds. I, and J are dicarboxylic acids and isomers of each other.

i) Identify A, B, C, D, E, F, G and H

A	B	C
D	E	F
G	H	

ii) Draw structures of I and J

I	J

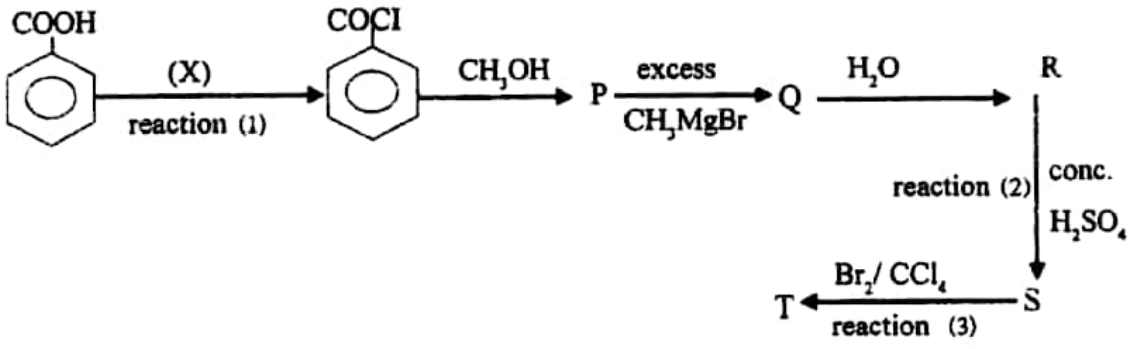
iii) Arrange I and J in increasing order of their boiling points and acidity.

boiling point - .....

acidity - .....

(5.0 marks)

b) Consider the following reaction scheme.



i) Identify reagent X

.....

ii) Draw structures of P, Q, R, S and T in the boxes given below.

P	Q	R

S	T

iii) Write the type of reactions of (1), (2) and (3)

Reaction (1) - .....

Reaction (2) - .....

Reaction (3) - .....

iv) Write the mechanism of reaction (3)

.....

.....

.....

.....

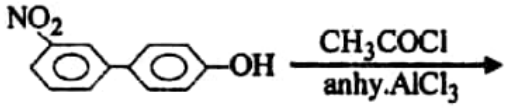
.....

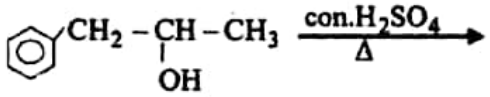
(3.0 marks)

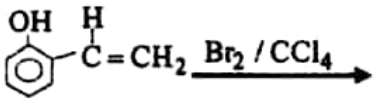
c) Complete the following reactions.

i). $CH_3-C\equiv C-H \xrightarrow[(2)\ H_3O^+]{(1)\ \text{C}_6\text{H}_5\text{MgBr}}$

ii). $CH_3-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-OH \xrightarrow[\text{conc.HCl}]{Zn(Hg)}$

iii). 

iv). 

v). 

(2.0 marks)

c) 100 cm^3 of each 0.01 $moldm^{-3}$ and 0.04 $moldm^{-3}$ acetic acid solutions are added seperately to two systems at equilibrium as in 5 (a) above at 27°C

A suitable catalyst is added to each of the system and the concentration of acetic and is determined after 10 s.

The results are tabulated below.

Test	Initial CH_3COOH concentration mol dm^{-3}	Concentration of CH_3COOH after 10 s. mol dm^{-3}	Initial Rate mol dm^{-3} s^{-1}
1	0.01	0.0001	
2	0.04	0.0004	

Assuming that the X (as mentioned earlier) does not evaporate, answer the following questions.

i) Write the rate law for the reaction between acetic acid and methanol.

ii) State one method that can be used to stop the equilibrium reaction taking place.

iii) State a method that can be used to determine the acetic acid concentration.

iv) Using the above data calculate the initial rate for each test.

vi) Calculate the order with respect to acetic acid.

v) Find the rate constant. (6.0 marks)

06. a) 30.00 cm^3 of 0.2 $moldm^{-3}$ NaOH solution taken into a titration flask and titrated against a monoprotic weak acid HA of concentration 0.3 $moldm^{-3}$. The dissociation constant of the weak acid is Ka.

i) Find the initial pH of the NaOH solution in the titration flask.

ii) If the burette reading at the equivalence point is V, find the value of V.

iii) If the pH at the equivalence point is 9 find Ka of the weak acid.

iv) Find the pH of the solution in the titration flask when the burette reading is $V/2$ and 2 V.

v) Suggest a suitable indicator for the above titration.

(5.0 marks)

b) i) The concentrations of HCl and H_2S in an aqueous solution is 0.1 mol dm^{-3} each.

Calculate the HS^- concentration and S^{2-} concentration in this solution.

ii) 0.01 moles of the solid salts $M(NO_3)_2$ and $X(NO_3)_2$ were added seperately to 100.0 cm^3 portions of the above solution given in (i) and shaken well. Show by means of a calculation whether MS and XS will preciptate or not.

$H_2S_{(aq)} \rightleftharpoons H^+_{(aq)} + HS^-_{(aq)}$ $\quad Ka_1 = 9 \times 10^{-8}$ mol dm^{-3}

$HS^-_{(aq)} \rightleftharpoons H^+_{(aq)} + S^{2-}_{(aq)}$ $\quad Ka_2 = 1 \times 10^{-19}$ mol dm^{-3}

$K_{sp}(MS) = 1.6 \times 10^{-20}$ mol^2 dm^{-6} $\quad K_{sp}(XS) = 6 \times 10^{-16}$ mol^2 dm^{-6}

(5.0 marks)

c) A certain amount of CaF(s) was added to 500.0 cm^3 of a 0.5 mol dm^{-3} HCl solution. When this was thoroughly mixed, part of the solid dissolved.

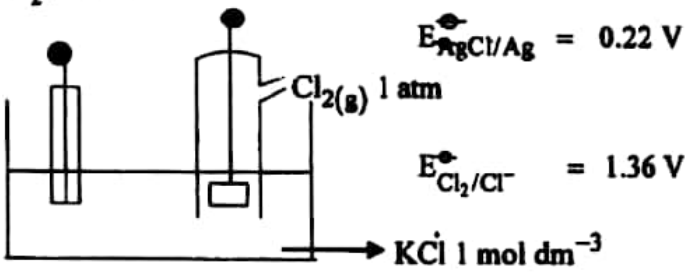
The remaining $CaF_2(s)$ was removed by filtration. The filtrate did not contain any HCl. The pH of the filtrate was found to be 4. Ka $(HA) = 1 \times 10^{-5}$ mol dm^{-3}

i) Find the concentration of F^- in the filtrate.

ii) Calculate the Ksp of CaF_2

iii) Find the mass of CaF_2 dissolved. (Ca - 40 , F-19) (5.0 marks)

07. a) Consider the following electrochemical cell constructed by connecting a standard Ag – AgCl electrode and a standard Cl_2 electrode.



i) Write the reduction half reaction and the oxidation half reaction of the above cell.

ii) Construct the cell reaction.

iii) Calculate the electromotive force of the cell.

iv) Give the standard cell notation of the above electrochemical cell.

v) "The electromotive force of the above cell can be increased by reducing the temperature." Giving reasons explain whether or not you will agree to the above statement.

vi) It was found that the mass of the Ag/ AgCl electrode has increased by 0.71 g after a current had being drawn for 30 minutes. Find the current drawn from the cell.

vii) What would you expect if a potential of 2.5 V was connected externally to the above cell.

(IF = 96500 c) (Ag - 108, Cl - 35.5) (7.5 marks)

b) Magnetite is a natural mineral used to extract iron. Its formula is Fe_3O_4. When Fe_3O_4 is dissolved in dilute HCl it hydrates and formes coordination compounds.

A, B and C are aqueous solutions containing octahedral coordination compounds of Fe. H_2O and Cl^- are ligands of these coordination compounds.

The compounds in the above solutions were analyzed as follows. 0.1 mol dm^{-3} solutions of each of the above solutions were prepared and excess $Pb(NO_3)_2$ was added to each of it. The mass of the precipitate formed are as follows.

Mass of the precipitate formed from A - 1.390 g

Mass of the precipitate formed from B - 2.78 g

Mass of the precipitate formed from C - 4.17 g

(Pb - 207, Cl - 35.5 , Fe 56)

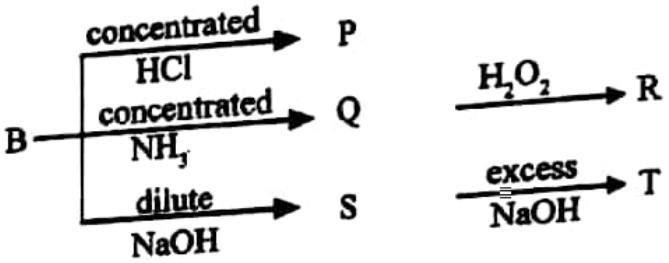
i) State the oxidation number of iron in Fe_3O_4

ii) Deduce the structures of coordination compounds in the corresponding solutions. (4.0 marks)

iii) Write the IUPAC names of the compounds.

c) i) Explain why elements of the d block tend to form complexes.

ii) Element A forms a complex ion B in aqueous medium. The chemical formula of B is, $[A(H_2O)_n]^{m+}$ B undergoes the following reactions.



I. Identify metal A

II Write the oxidation state of A in complex B

III. State the values of m and n

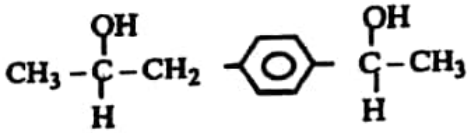
IV State the coordination number of B

III. Write the formula Ω of P, Q, R, S and T (3.5 marks)

Part C

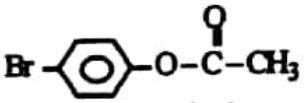
* Answer two questions only. (Each question carries 15 marks.)

08. a) Using $C_6H_5CO_2C_2H_5$ as the only organic starting material show how you would synthesize the following compound in not more than seven (7) steps.



(6.0 mark)

b) Using $C_6H_5NHCOOH_3$ as the only organic starting material show how you would synthesize the following compound in not more than six steps.



(6.0 mark)

c) i) Write the products formed when ethylamine reacts with

I) CH_3CHO II) CH_3COCl

ii) Write the mechanism for the reaction taking place between ethylamine and compound (II) above.

(3.0 mark)

09. a) An aquous solution contains CO_3^{2-} , SO_4^{2-} and CrO_4^{2-} ions. The following procedure was carried out for the quantitative analysis of the anions present in the above solution.

I. To 100 cm^3 of the above solution $BaCl_2$ is added in excess. Mass of the precipitate obtained is 15.79 g. 100 cm^3 of dil HCl is added to the precipitate & the solution is filtered again. Mass of the residue is 9.32 g

25.00cm^3 of the above filtrate is transferred to a titration flask and KI is added in excess. Resultant solution is titrated with $Na_2S_2O_3$ solution. Required volume of $Na_2S_2O_3$ is 25.00 cm^3

II. 3.21 g of KIO_3 was dissolved in water and a 250.00cm^3 solution was prepared. 20cm^3 of dilute H_2SO_4 and excess KI was added to 25.00cm^3 of the above solution and titrated against the $Na_2S_2O_3$ solution used in procedure (I) above. The volume of $Na_2S_2O_3$ consumed was 30.00 cm^3

i) Write balanced chemical equations for all the reactions taking place in the above procedure.

ii) Find the concentration of CO_3^{2-} , SO_4^{2-} and CrO_4^{2-} in the initial solution..

(Ba - 137, S - 32 , O - 16 , Cr - 52 , C - 12 K - 39 , I - 127)

(8.0 mark)

b) Solution A contains four metal cations. The folllowing tests were carried out to identify these cations.

	Test	Observation
1.	dil HCl is added to the solution A.	A white precipitate (P) is formed.
2.	P is filtered & H_2S is passed through the filtrate.	A black precipitate is formed. (Q)
3.	Q is filtered & to the filtrate (R) obtained, NH_4Cl and NH_4OH is added.	No precipitate formed & a colourless solution (S) was observed.
4.	H_2S gas is bubbled through solution (S)	A black precipitate is formed.

The following tests were carried out on precipitates P, Q, T and filtrate R

	Test	Observation
5.	dil NH_3 is added to the precipitate P.	Part of the precipitate dissolved forming. a colourless solution. (X)
6.	H_2O_2 is added to the precipitate Q	Precipitate turned white
7.	To a fresh portion of filtrate (R) conc. HNO_3 is added & boiled. Then solution is neutralized and shaken well after the addition of KI and $CHCl_3$	$CHCl_3$ layer turned purple.
8.	Conc HCl is added to the precipitate (T)	Blue colour solution (Y) was formed.

i). Identify the four cations in the solution A

ii). Identify the chemical species in precipitates. P. Q, T and solutions X and Y

iii). Write balanced chemical equations for the reactions taking place in 6 and 7 experiments.

(7.0 mark)

10. a) Copy the following table and fill it according to the relevant industry.

	Industry	Raw material	One use	Special conditions	Net reactions relevant to the process
1.	NH_3				
2.	HNO_3				
3.	H_2SO_4				
4.	Extraction of iron				
5.	Bio diesel				

(4.0 marks)

b) Answer the following questions based on the production of TiO_2

i) Name two minerals containing Titanium.

ii) State the name of the process of the production of TiO_2

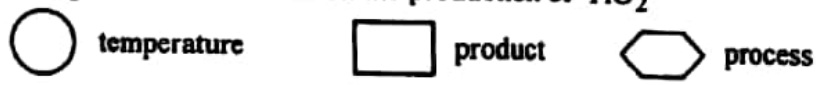
iii) What are the raw material used.

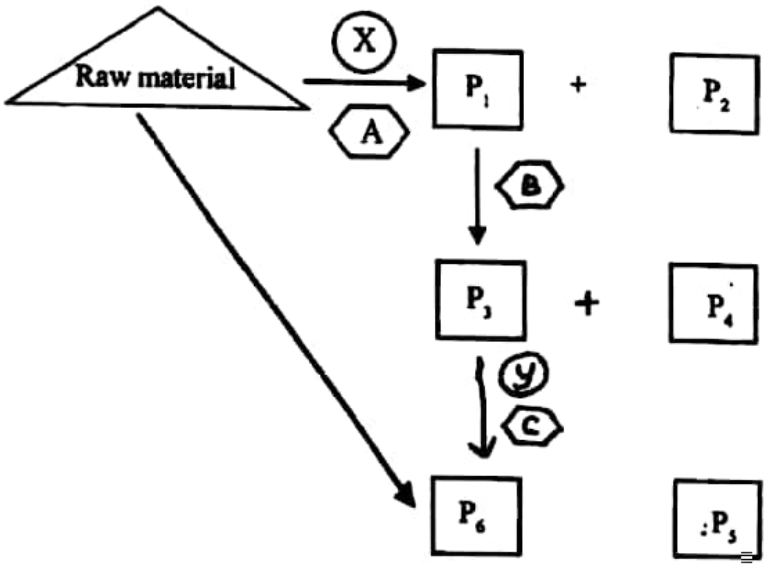
iv) Production of TiO_2 consists of two steps. Name the 2 steps.

v) Write 2 uses of TiO_2

vi) Write the net reaction taking place in the production of TiO_2

The following flow chart is based on the production of TiO_2





vii) Identify the comditions x, y the process A, B, C and the products P_1 - P_6 (3.5 marks)

c) i) I) Name the environmental pollutant released in the production of Mg.

II) Mention 2 ways that the above pollutant is formed during the process and write balanced chemical equations for these reactions.

III) Write one environmental issue caused by the above pollutant.

ii) I) Using relevant balanced chemical equations show how the depletion of the ozone layer is caused by freon 12 $(C F_2 Cl_2)$

II) H F C (Hydrofluoro carbons) is an alternative coolant which prevents the depletion of ozone layer, but it is

responsible for global warming Explain this statement.

III) Write 2 alternative compounds

iii) I) Mention four water quality parameters for of effuluent water.

II) What is meant by 'eutrophication'.

III) Mention 2 ions responsible for eutrophication.

IV) Write a human activities responsible for eutrophication.

V) Write 2 environmental issues caused by the above process.

(7.5 marks)

The Periodic Table

1	1 H																2 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 Uun	111 Uuu	112 Uub	113 Uut					

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