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DEVI BALIKA VIDYALAYA– COLOMBO

13 වන ශ්‍රේණිය පළමු වාර පරීක්ෂණය - 2023 මැයි
Grade 13 - First Term Test - May 2023

රසායන විද්‍යාව I
Chemistry I

පැය දෙකයි
Two hours

Important
- This paper consist of 8 pages
- Answer all the questions
- The use of calculators is not allowed
- Write your index number in the space provided in the answer sheet
- In each of the questions 1 to 50, pick one of the alternatives (1) (2) (3) (4) (5) which is correct as most appropriate and shade its number on the answer sheet provided

Universal gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$
Avergadro's constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$
Speed of light $C = 3.0 \times 10^{8}\ m s^{-1}$
Planck's constant $h = 6.626 \times 10^{-34}\ J s$

22 A/L අපි [papers grp]

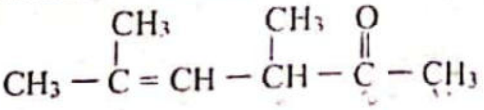
1. The scientist stated that radiation energy is quantized is.
   1) Rutherford 2) Neil Bohr 3) Albert Einstein
   4) Max Plank 5) De. Broglie

2. With respective to the quantum numbers given the lowest number of electrons given is,
   1) $n = 4$, $m_s = 1/2$ 2) $n = 3$, $l = 0$ 3) $n = 3$, $m_l = 0$
   4) $n = 2$, $m_l = 0$ 5) $n = 2$. $m_s = -1$ ml

3. The correct answer regarding the second ionization energy is,
   1) Second ionization energy of N is higher than that of O.
   2) Second ionization energy of O is higher than that of F.
   3) Second ionization energy of Na is lower than that of O.
   4) Second ionization energy of F is higher than that of Na.
   5) Second ionization energy increases in the order of $N < O < F < Ne < Na$

4. Same shape and electron pair geometry are shown by,
   1) NO_2F , HNO_2 , XeF_2 2) OCS , NO_2^+ , XeF_2 3) N_3^- , N_2O , OCS
   4) N_2O , NO_2^+ , N_3^- 5) OCS , XeF_2 , N_3^-

5. What is the IUPAC name of the following organic compound?



$$CH_3-\overset{\overset{CH_3}{|}}{C}=CH-\overset{\overset{CH_3}{|}}{CH}-\overset{\overset{O}{\|}}{C}-CH_3$$

   1) 3,5-dimethyl-2-en-hex-5-one 2) 3,5-dimethyl-4-hexene-2-one
   3) 2,4-dimethyl-2-en-hex-5-one 4) 2,4-dimethyl-2-hexeone
   5) 3,5-dimethyl-4-hexen-2-one

6. When $AgNO_3$ is added to 1.00 mol dm^{-3} KCl solution, Ag^- ion concentration (in mol dm^{-3}) in the solution when precipitation begins (Ksp, $AgCl = 1.6 \times 10^{-10}$ mol^2dm^{-6}),

1) 1.00
2) 1.6×10^{-5}
3) 1.6×10^{-10}
4) 1.2×10^{-5}
5) 0.5

7. The increasing order of melting point is,

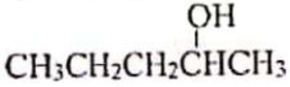
1) $CH_3OCH_3 < CH_3CH_2OH < CaO < KCl$
2) $CH_3OCH_3 < CH_3CH_2OH < KCl < CaO$
3) $CaO < KCl < CH_3OCH_3 < CH_3CH_2OH$
4) $KCl < CaO < CH_3OCH_3 < CH_3CH_2OH$
5) $CH_3OCH_3 < KCl < CaO < CH_3CH_2OH$

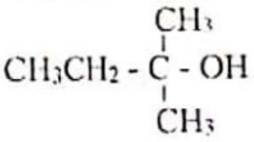
8. The false statement regarding electron gain energy is,

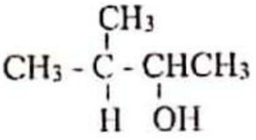
1) Even if energy is absorbed when an electron is gained by O-(g) ion, it attains a stable electron configuration.
2) Gaining an electron by O(g) is relatively easier than gaining an electron by N(g)
3) Compared to O(g), S(g) can gain an electron easily.
4) Among Be(g) and N(g), Be(g) requires a higher energy to gain an electron.
5) The energy required to gain an electron by gaseous atoms along the period from left to right decreases.

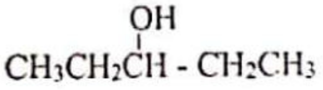
22 A/L අපි [papers grp]

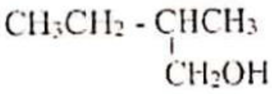
9. The organic compound X is reacted with PCC. A primary alcohol is resulted when $LiAlH_4$ is added to the above product followed by hydrolysis. X would be,

1) 
$CH_3CH_2CH_2\overset{OH}{C}HCH_3$

2) 
$CH_3CH_2-\underset{CH_3}{\overset{CH_3}{C}}-OH$

3) 
$CH_3-\underset{H}{\overset{CH_3}{C}}-\underset{OH}{C}HCH_3$

4) 
$CH_3CH_2\overset{OH}{C}H-CH_2CH_3$

5) 
$CH_3CH_2-\underset{CH_2OH}{C}HCH_3$

10. The following equilibrium exists in a rigid container at a constant temperature.

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g) \quad \Delta H > O$$

Amount of H_2 in the system can be increased by,

1) Addition of a catalyst
2) Addition of C(s)
3) Addition of He gas
4) Increasing the volume of the container
5) Decreasing the temperature

11. Consider the reaction given below

$$2A(g) \longrightarrow B(g)$$

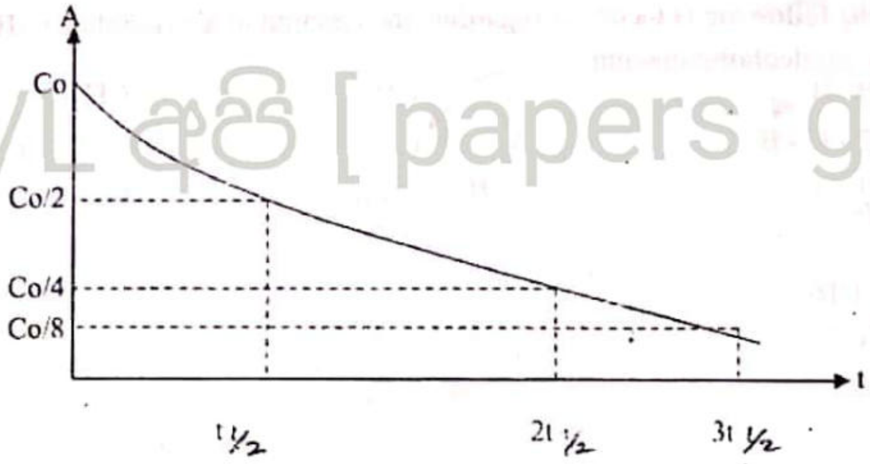
At a constant temperature, initial concentration of A is $A_0 = 0.52$ mol dm^{-3}. When concentration of A is 0.26 mol dm^{-3} rate becomes 1/4 of initial rate. Order with respect to of A is,

1) 1
2) 2
3) 3
4) 4
5) 1/2

12. When a constant number of moles of A(g) is kept in a rigid container at Tk, the initial pressure is P. With time it attains the equilibrium as $2A(g) \rightleftharpoons 2B(g) + C(g)$ and equilibrium pressure is 1.25P. The true statement regarding the above equilibrium is,
   1) Kp = 1.25 P
   2) Dissociation percentage of A is 50%
   3) Both partial pressures of A and B are equal
   4) Mole ratio between B and C in the system is 1 : 2
   5) Mole fraction of C is 1/5

13. False statement regarding haft lifetime of a reaction is. (consider half life as $t_{1/2}$, initial concentration of a reactant as Co, rate constant as k.

22 A/L අපි [papers grp]



1) In a reaction where $t_{1/2}$ = 100 s, concentration of the reactant after 300 s is $\frac{12.5Co}{100}$ then its a 1^{st} order rec,

2) If $t_{1/2}$ = Co/2k of a reaction, it is a zeroth order reaction.

3) If $t_{1/2}$ = 0.693/k of a reaction it is a first order reaction.

4) Half lite of a first order reaction is independent of both Co and temperature.

5) In an elementary reaction $A + B \rightarrow C + D$, variation of concentration of A against time when concentration of A is extremely smaller than concentration of B is shown the above graph..

14. Correct expression for the equilibrium constant of the reaction

$2NH_3(g) + \frac{5}{2}O_2(g) \rightleftharpoons 2NO(g) + 3H_2O(l)$ in terms of equilibrium constants of below reactions.

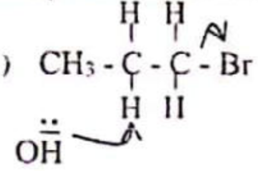
$N_2(g) + 3H_2(g) \overset{k_1}{\rightleftharpoons} 2NH_3(g)$
$N_2(g) + O_2(g) \overset{k_2}{\rightleftharpoons} 2NO(g)$
$H_2(g) + 1/2\, O_2(g) \overset{k_3}{\rightleftharpoons} H_2O(l)$

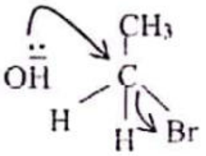
1) $\frac{k_2k_3^3}{k_1}$
2) k_2k_3
3) $\frac{k_1k_3^3}{k_2}$
4) $\frac{k_2k_1^2}{k_3}$
5) $k_1k_2k_3$

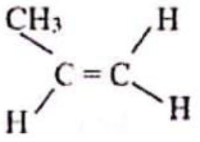
15. False statement regarding elements of s and p block is,

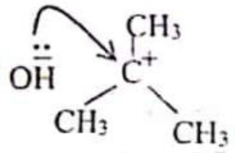
1) Corresponding hydride can be obtained by heating s block elements in H_2 gas.
2) Because of higher hydration enthalpy of Be^{2-} and Mg^{2-}, their sulphates are water soluble.
3) All the chlorides formed by p block elements of the 3rd period are acidic.
4) Chlorides bromides and iodides of metals form Cl_2, Br_2 and I_2 with con. H_2SO_4 respectively
5) Ionic properties of oxides in a given period decreases from left to right.

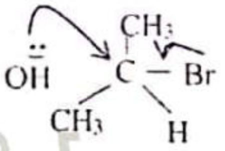
16. Which of the following is incorrect regarding the reaction of alkyl halide C_3H_7Br with strong bases in aqueous or alcoholic medium .

1) 

2) 

3) 

4) 

5) 

22 A/L අපි [papers grp]

17. Find the standard enthalphy change (kJ mol^{-1}) of the reaction $CO(g) + 2H_2(g) \longrightarrow CH_3OH(l)$ using the enthalpy data given below.

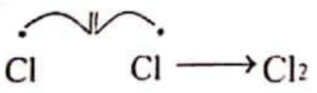
$2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$ $\Delta H^0 = -566$ kJ mol^{-1}

$CO(g) + 2H_2O(g) \longrightarrow CH_3OH(l) = -3/2\ O_2(g)$ $\Delta H^0 = 715$ kJ mol^{-1}

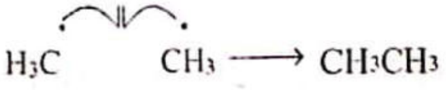
$H_2(g) + 1/2O_2(g) \longrightarrow H_2O(l)$ $\Delta H^0 = -286$ kJ mol^{-1}

1) 137 2) -140 3) 435 4) 1567 5) -1537

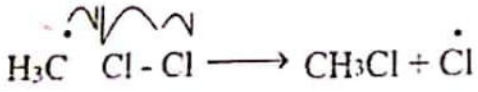
18. Which of the following is not a chain termination step of the chlorination reaction of methane?

1) 

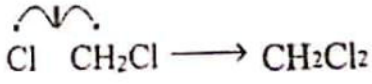
$Cl^\cdot\ \ ^\cdot Cl \longrightarrow Cl_2$

2) 

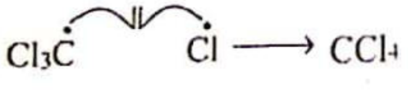
$H_3C^\cdot\ \ ^\cdot CH_3 \longrightarrow CH_3CH_3$

3) 

$H_3C^\cdot\ \ Cl-Cl \longrightarrow CH_3Cl + \dot{Cl}$

4) 

$\dot{Cl}\ \ \dot{C}H_2Cl \longrightarrow CH_2Cl_2$

5) 

$Cl_3\dot{C}\ \ \dot{Cl} \longrightarrow CCl_4$

19. pH of the resultant solution when 25 cm^3 of 3×10^{-3} mol dm^{-3} HCl and 25 cm^3 of 1×10^{-3} mol dm-3 solutions are mixed is,

1) 2 2) 2.5 3) 3 4) 3.5 5) 4

20. In the first step of industrial production of HNO_3 acid, NH_3 gas is reacted with O_2 in the presence of a catalyst.

$$4NH_3(g)+5O_2(g)\xrightarrow{cat}4NO(g)+6H_2O$$

Maximum mass of NO that can be obtained theoretically when 68g of O_2 reacts with 2.5 mol of O_2.

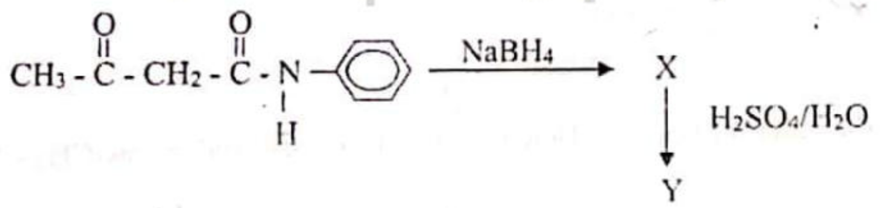
1) 60 g 2) 30 g 3) 4 g 4) 45 g 5) 32 g

21. Concentrated HCl is added in excess to 1g of an impure sample of MnO_2. Cl_2 gas released in the above process is reacted with excess KI(aq) and the resultant solution is titrated with 1 mol dm^{-3} $Na_2S_2O_3$ solution. If burette reading at the end point is 20.00 cm3, mass percentage of MnO_2 in the sample is.

1) 50% 2) 65% 3) 72% 4) 87% 5) 90% .

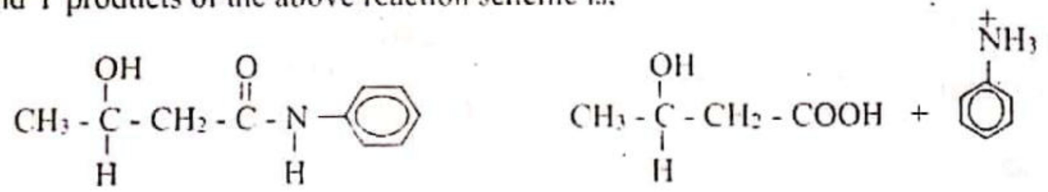
22 A/L අපි [papers grp]

22.



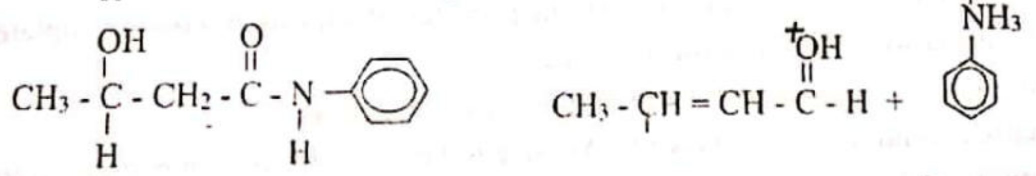
X and Y products of the above reaction scheme is.

1)

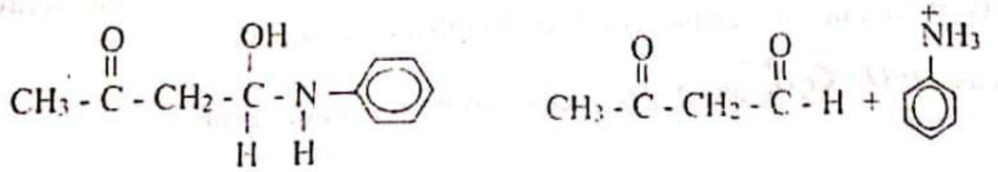


2)

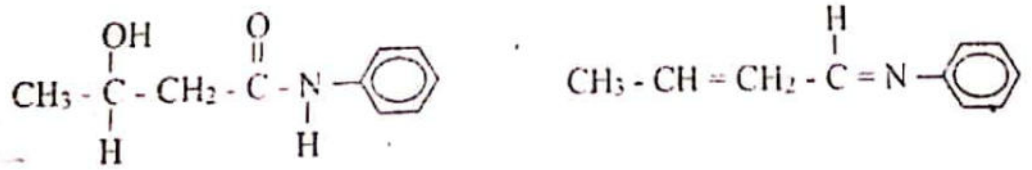
3)



4)



5)



23. Consider the following spontaneous reaction taking place in closed system

$C(s) + CO_2(g) \rightleftharpoons 2CO(g) \quad \Delta H > 0$

False statement regarding the above

1) Starting from C(s) and $CO_2(g)$ entropy of the system increases when the system reaches equilibrium.

2) Starting from C(s) and $CO_2(g)$ entropy of the surrounding d~~in~~creases when the system reaches equilibrium.

3) Molar Gibb's free energy change varies with the temperature

4) Spontaneity of the reaction increases at high temperatures.

5) Low temperatures are favorable for this reaction.

24. Which of the following statement is true regarding halogens?

a) Boiling points of halogens increase down the group as the strength of london forces increases down the group.

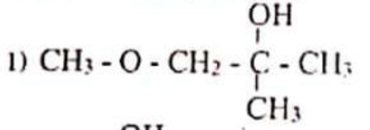
b) All the chlorides formed by elements of group 14 and 15 form strongly acidic solutions when hydrolysed.

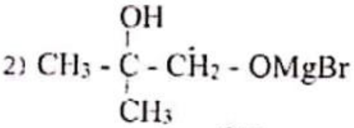
c) Among hydrogen halides HF shows the highest bond dissociation energy.

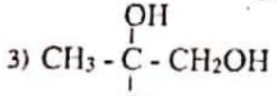
d) Reducing ability of halogens increase down the group.

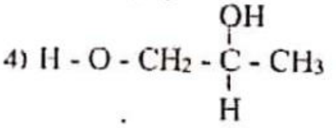
1) a , c 2) a , b , c 3) a , c , d 4) a, d 5) a , b , d

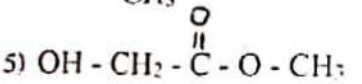
25. Major product obtained in the reaction between $HOCH_2-\overset{\overset{O}{\|}}{C}-O-C_2H_5$ and excessCH_3-MgBr followed by hydrolysis.

1)

$CH_3-O-CH_2-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$

2)

$CH_3-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2-OMgBr$

3)

$CH_3-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2OH$

4)

$H-O-CH_2-\overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}}-CH_3$

5)

$OH-CH_2-\overset{\overset{O}{\|}}{C}-O-CH_3$

26. Correct statement regarding d block elements is,

1) For a compound containing a d block element, the presence of a d cation with incompletely filled d orbitals is not compulsory for it to show a colour.

2) All the complexes with the coordination number 4 are tetrahedral.

3) Highest electrical conductivity is shown by Mn due to the presence of 5 unpaired electrons.

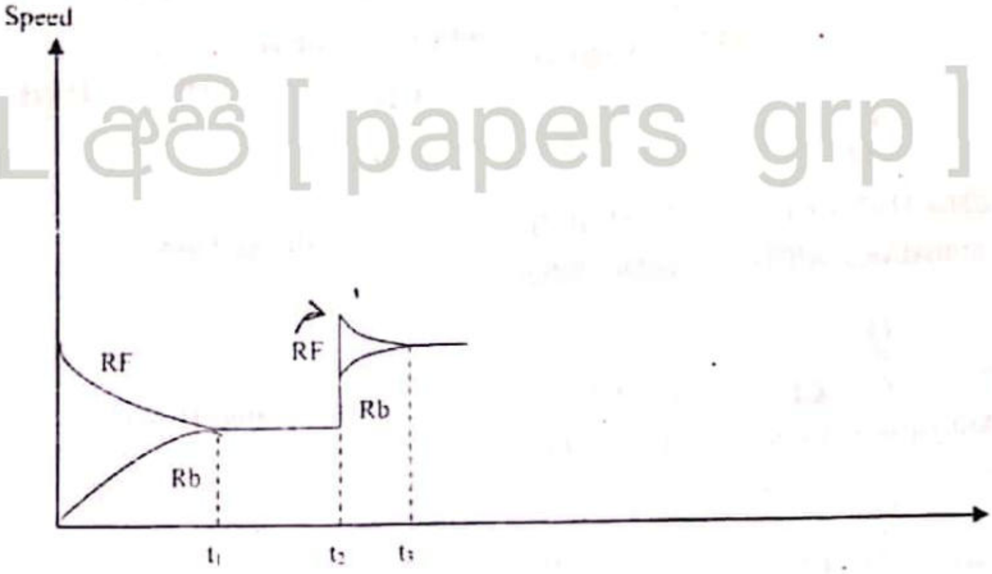
4) Electronegativity of 3d transition elements is less than that of 4s metals

5) Oxianions such as MnO_4^- , $Cr_2O_7^{2-}$ and CrO_4^{2-} act as strong reducing agents..

22 A/L අපි [papers grp]

27. The following graph shows the variation of the rate of the forward reaction (Rf) and rate of the backward reaction (Rb), with time . when a sudden change was incurred to an equilibrium system taking place in a rigid vessel.

22 A/L අපි [papers grp]



Which of the following statements are true regarding this system?

a) Reactants are added to the system at t_2 at constant temperature.

[✓ b)] A catalyst is added to the system at t_2 at constant temperature.

c) Forward reaction is endothermic.

d) Qc of the above system at t_2 is less than that of Kc under the given temperature.

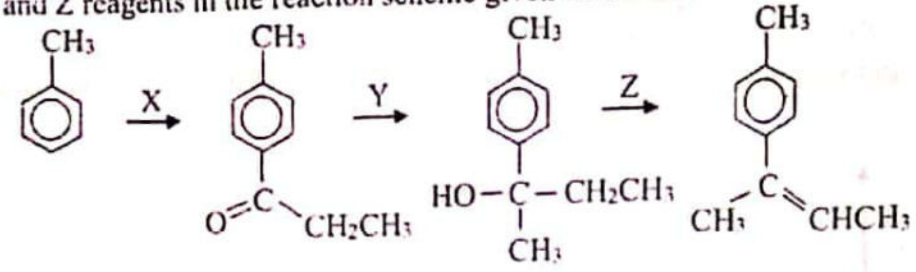
e) at t_2 Q_c of a system is lower than K_c at that temperature,

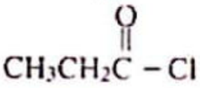
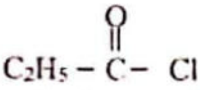
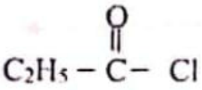
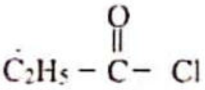
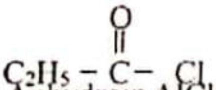
1) All statements are false
2) a and b are true
3) a . b and c are true
4) c, d and e are true
5) c and e are true

28. When H_2S is bubbled to a basic solution containing cations, a black precipitate was observed. Cations present in the mixture can be,

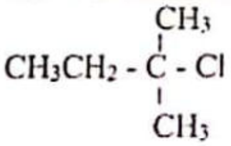
1) Co^{2+} , Ni^{2+}
2) Cu^{2+} , Pb^{2+}
3) Ni^{2+} , Zn^{2+}
4) Ba^{2+} , Ca^{2+}
5) Cr^{3+} , Al^{3+}

29. X, Y and Z reagents in the reaction scheme given below are,



	X	Y	Z
1)	 $CH_3CH_2\overset{O}{\overset{\|}{C}}-Cl$ Anhydrous $AlCl_3$	i) CH_3MgBr ii) Dry Ether	Anhydrous Al_2O_3 Δ
2)	 $C_2H_5-\overset{O}{\overset{\|}{C}}-Cl$ Anhydrous $AlCl_3$	i) $LiAlH_4$ ii) H^+/H_2O	Concentrated H_2SO_4 Δ
3)	 $C_2H_5-\overset{O}{\overset{\|}{C}}-Cl$ Anhydrous $AlCl_3$	i) CH_3MgBr ii) Dry Ether	Anhydrous Al_2O_3 Δ
4)	 $C_2H_5-\overset{O}{\overset{\|}{C}}-Cl$ Anhydrous $AlCl_3$	i) $LiAlH_4$ ii) H^+/H_2O	Anhydrous Al_2O_3 Δ
5)	 $C_2H_5-\overset{O}{\overset{\|}{C}}-Cl$ Anhydrous $AlCl_3$	i) CH_3CH_2Br ii) ~~Mg+ Dry~~ Ether H^+/H_2O	Anhydrous Al_2O_3 Δ

30. True statement regarding the following compound is,


$CH_3CH_2-\overset{CH_3}{\underset{CH_3}{C}}-Cl$

1) Undergoes nucleophilic addition
2) Reaction mechanism with CN^- takes place in two steps.
3) Substitution with $CH_3O^-Na^+$ takes place in one step
4) Does not form a precipitate with aqueous $AgNO_3$
5) Forms a product which shows stereo isomerism when reacted with aqueous bases

22 A/L අපි [papers grp]

★ **Instructions for question No 31 to 40**

For each of the questions 31 to 40, one or more 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

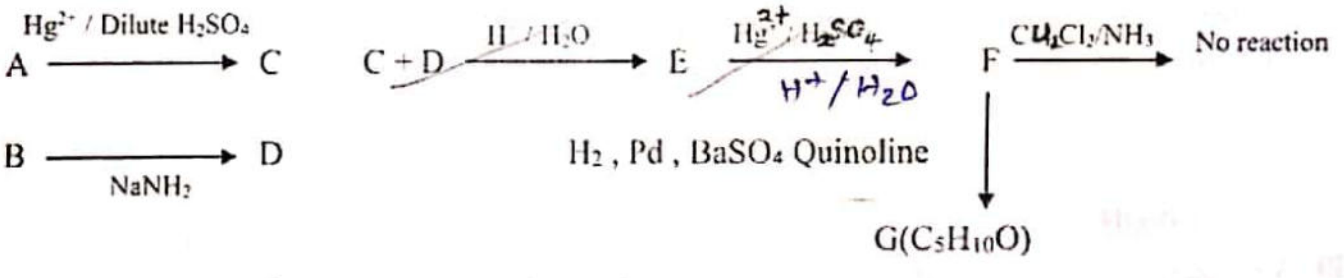
(1) if only (a) and (b) are correct
(2) if only (b) and (c) are correct
(3) if only (c) and (d) are correct
(4) if only (d) and (a) are correct
(5) if any other number or combination of responses is correct.

Summary of above information				
(1)	(2)	(3)	(4)	(5)
Only (a) and (b) correct	Only (b) and (c) correct	Only (c) and (d) correct	Only (d) and (a) correct	If any other number or combination of responses correct

31. Which of the following statement/s is/are true?
  a) Potential energy of the activated complex is high and difficult to be isolated.
  b) Rate of an exothermic reaction decreases when the temperature is increased.
  c) In a multistep reaction rate of the reaction depends on the step with the lowest activation energy.
  d) Any collision between two reactions can form products.

22 A/L අපි [papers grp]

32. A and B are terminal alkynes which show acidity. Consider the following reaction scheme for the formation of G from A and B.



Which of the following statement/s is /are true regarding the above reaction scheme?
  a) G shows both optical activity and geometrical isomerism
  b) F is optically active.
  c) G is optically active but does not show geometrical isomerism.
  d) Compound A is $CH_3 - C \equiv C - H$ while compound B is $H - C \equiv C - H$

33. Which of the following statement/s is/are true regarding chemistry of elements S and N?
  a) An aqueous solution of SO_2 shows mild oxidizing properties as well as bleaching properties.
  b) N is as non metal which shows a range of oxidation number from -3 to +5
  c) Sulfur reacts with concentrated HNO_3 forming SO_2 , SO_3 and NO_2
  d) When a strong dilute acid is added to thiosulfate it disproportionates forming S and SO_2

34. Solution S contains two salts of sodium A brown coloured gas is evolved when concentrated H_2SO_4 is added to a portion of S. When HCl is added to another portion of S. a colourless gas is evolved and when that gas is passed through a solution of $K_2Cr_2O_7$ a turbid green solution is formed. The two anions present in the solution S are.

a) S^{2-} b) SO_3^{2-} c) CO_3^{2-} d) Br^-

35. Which of the following statement/s is/are true regarding the periodic trends shown by d block elements?

a) Across a period from left to right melting points of elements increase gradually while Zn shows the lowest melting point.
b) Electronegativity values of metals from Sc to Cu are greater than that of K .
c) Due to the presence of strong metallic bonds metals from Sc to Cu show a considerably high hardness.
d) Across the period from left to right atomic volume increases and the density decreases.

36. Which of the following would take place when Sn powder and Ni powder are added to a solution containing Sn^{2+} and Ni^{2+} (1 mol dm^{-3})

$E^\theta(Sn^{2+}/Sn) = -0.14V$ $E^\theta(Ni^{2+}/Ni) = -0.23V$

a) Concentration of Ni^{2+} increases
b) Concentration of Sn^{2+} decreases
c) Ni^{2+} ions are reduced
d) Sn is oxidized

37. Which of the following complex/es is/are yellow in colour?

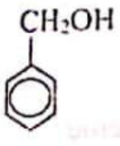
a) $[Ni(NH_3)_6]^{2+}$ b) $[MnCl_4]^{2-}$ c) $[CuCl_4]^{2-}$ d) $[CoCl_4]^{2-}$

38. False statement/s regarding entropy and enthalpy is/are,

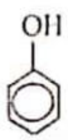
a) Absolute entropy of a compound can be zero whereas enthalpy is not.
b) Entropy of a pure solid compound cannot be a negative value.
c) Both enthalpy and entropy are state functions.
d) Entropy of any substance at absolute zero is zero.

22 A/L අපි [papers grp]

39. A -

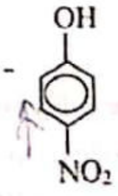


B -



C -

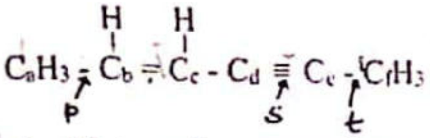
D -



Correct statement/s regarding the organic compounds given above is/are,

a) C is more acidic than D.
b) A favors nucleophilic substitution reactions than C.
c) Among the compounds given above C shows the highest tendency to undergo electrophilic substitution reactions.
d) Compound A dissolves in water and in NaOH(aq) as well

40. Correct statement/s regarding the following compound is/are.


$C_aH_3-\underset{|}{\overset{H}{C_b}}=\overset{H}{\underset{}{C_c}}-C_d\equiv C_e-C_fH_3$

a) All the carbon atoms lie on one line

b) All C - H bond lengths are equal

c) p, s and t bond lengths increase in the order of s < t < p

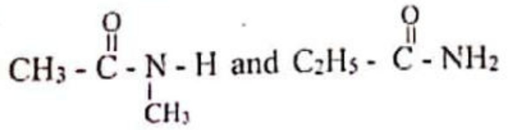
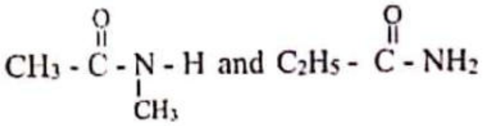
d) $C_a\hat{C}_bC_c$ bond angle and $C_b\hat{C}_cC_d$ bond angle are approximately equal

* **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), (5) that best fits the two statements given for each of the questions 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

22 A/L අපි [papers grp]

41. When H_2O_2 is added to a basic solution of Cr^{3+} ions a yellow coloured solution is formed and a gas is evolved.	H_2O_2 acts as an oxidizing agent in basic medium. ✓
42. Actual structure of all molecules is given by the resonance hybrid.	All the resonance structures equally contribute to the resonance hybrid.
43. The isomers  $CH_3-\overset{O}{\overset{\parallel}{C}}-\underset{CH_3}{\underset{\mid}{N}}-H$ and $C_2H_5-\overset{O}{\overset{\parallel}{C}}-NH_2$ have different melting points.	Both compounds  $CH_3-\overset{O}{\overset{\parallel}{C}}-\underset{CH_3}{\underset{\mid}{N}}-H$ and $C_2H_5-\overset{O}{\overset{\parallel}{C}}-NH_2$ form H- bonds
44. The solubility of a compound in the presence of a common ion is always less than the solubility in water.	The solubility of AgCl in RbCl is less than its solubility in water.
45. $A(g) \rightleftharpoons B(g)$ $\Delta H > 0$ When temperature is increased the Kp value of the above reaction increases.	In an equilibrium reaction when the temperature is increased, the rate constant of the endothermic reaction increases while the rate constant of the exothermic reaction decreases.

46. Under very low pressures compressibility factor(Z) of real gases becomes approximately equal to one.	At very low pressures inter molecular forces as well as error caused by volume is negligible.
47. The diffusion rates of two ideal gases in two identical rigid vessels at 25°C and 1 atm are equal.	The average kinetic energies of different ideal gases are equal at constant temperature.
48. The acidity of phenol is greater than the acidity of C_2H_5OH	The stability of ethanol with respect to ethoxide ion is greater than the stability of phenol with respect to the phenoxide ion.
49. The yield of a reversible reaction can be increased by the use of a catalyst.	A catalyst decreases only the activation energy of the forward reaction.
50. $C_6H_5CH_2Cl$ favours nucleophilic substitution than that of $CH_3CHClCH_3$	In nucleophilic substitution $C_6H_5CH_2Cl$ forms an intermediate primary carbocation, where as $CH_3CHClCH_3$ forms a secondary carbocation.

22 A/L අපි [papers grp]

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13 වන ශ්‍රේණිය පළමු වාර පරීක්ෂණය - 2023 මැයි
Grade 13 - First Term Test - May 2023

PART B - ESSAY

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

5. a) i) 0.4 mol of A(g) and 0.3 mol of B(g) are placed in a closed rigid container of volume 'V' and allowed to reach equilibrium at T_1K. |V|

$$2A(g) + B(g) \rightleftharpoons 2C(g)$$

Initial pressure of the container was found to be 7×10^5 Pa and the pressure at equilibrium was 6×10^5 Pa.

I) Calculate the total number of moles in the container when the equilibrium is reached.
II) Calculate the mole fraction of each gas.
III) Calculate partial pressure of each gas.
IV) Calculate K_p at T_1K

(3.5 mark)

22 A/L අපි [papers grp]

ii) A(g) and B(g) are placed in the container in (i) above at a temperature of T_2K. A and B are present in a mole ratio of 2:1. After the above equilibrium was reached at T_2K, pressure of the system was 1×10^6 Pa and mole fraction of C was 2/5.

I) Calculate partial pressures of A, B and C.
II) Calculate K_p at T_2.
III) Based on K_p values calculated at T_1 and T_2 temperature, predict whether the forward reaction of the above equilibrium is exothermic or endothermic.
IV) Calculate Q_c of the system when another container of the same volume is connected to the above system at equilibrium.
V) Predict to which direction the reaction moves based on the Q_p value calculated.

(4.0 marks)

b) In order to determine the standard enthalpy change of formation of $MgCO_3(s)$ the following experiment consisting of two step (I and II) was carried out at room temperature.

Step - 1

0.1 g Mg(s) was added to 100 cm^3 of 2 mol dm^{-3} HCl acid solution in a beaker. The maximum temperature rise was found to be 4.5 °C.

Step - II

2.1 g of $MgCO_3(g)$ was added to 100 cm^3 of 2 mol dm^{-3}. HCl sol^n

(specific heat capacity of the solution = 4.2 J g^{-1} c^{-1} , density of the solution 1 gcm^{-3} , Mg - 24 , C -12 , O-16)

i) Calculate ΔH^θ of the reaction.

$$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

ii) Heat released in the process in step II was 1.05 kJ. Calculate the ΔH^θ of the reaction

$$MgCO_3(s) + 2\,HCl(aq) \longrightarrow MgCl_2(aq) + CO_2(g) + H_2O(l)$$

iii) Using the above calculated values and the thermochemical data given below, calculate the standard enthalpy of formation of $MgCO_3(s)$

$\Delta H_f^\theta = [H_2O_{(l)}] = -286$ kJ mol^{-1} $\qquad$ $\Delta H_f^\theta = [CO_{2(g)}] = -394$ kJ mol^{-1}

iv) Using the above calculated values and the termochemical data given below, calculate ΔG^θ for the following reaction at 25°C. $MgCO_3(s) \longrightarrow MgO(s) + CO_2(g)$

	S^θ / JK^{-1} mol^{-1}	ΔH_f^θ / kJ mol^{-1}
$MgCO_{3(s)}$	66	-
$MgO_{(s)}$	27	-501
$CO_{2(g)}$	214	-394

(7.5 mark)

22 A/L අපි [papers grp]

6. a) $A(g) + B(g) \rightleftharpoons 2C(g)$; $\Delta H < 0$

K_c for the above equilibrium 25 °C is $\frac{1}{16}$

i) 0.1 mol of each A and B gases are inserted in to a syringe of 100 cm^3 and allowed to reach equilibrium at 25 °C. Calculate the concentrations of A, B and C gases at equilibrium at constant volume. Draw the variation of concentrations of A, B and C with time and label them.

ii) If volume of the equlibrium system in I above is reduced to 50 cm^3, mention now the rate of the forward reaction, reverse reaction, point of equilibrium and equilibrium constant changes with respect to the first equilibrium. Mark the new concentrations of the gases in the same graph.

iii) Maintaining the temperature and volume of the equilibrium system in i) above constant, 0.1 mol of He is added to the equilibrium system. Explain how the partial pressures of A, B, C and point of equilibrium changes.

iv) Gas C is instantly injected to the equilibrium system in i) above at constant temperature and pressure. Explain by Lechatelier's principle how this will affect the equilibrium.

v) Compare how the rate constants of forward and backward reactions and equilibrium constant change when temperature of the system in i) above is increased to 50 °C.

(9.0 marks)

b) An aqueous solution contains three cations of d block with an atomic number less than 35. The following experiments are carried out to identify these metal ions.

	Experiment	Observation
1	Excess CCl_4 and KI were added to the above solution.	Purple colour organic layer and aqueous solution (S) were formed.
2	Excess NaOH was added to a portion of S.	A coloured precipitate (T) and a solution (U) were formed.
3	T was dissolved in conc. NH_3	A deep blue solution (V) and a coloued precipitate (W) were formed.
4	Dilute HCl is added dropwise in excess to solution U.	A white precipitate formed and it dissolved forming a coloures solution.
5	Dilute HCl is added to solution V.	A green colour solution was formed.
6	W was dissolved in dilute HCl and $K_3[Fe(CN)_6]$ was added.	A deep blue solution was formed.

i) Identify the three cations in the solution.

ii) Write balanced equations for the reactions in 1 and 2

iii) Write chemical formulae of compounds T, U, V, W, X

(6.0 marks)

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7. a) i) Derive in expression for solubility product of $Ag_2CrO_4(s)$

ii) Explain how the solubility of $Ag_2CrO_4(s)$ changes in a $AgNO_3$ solution compared to the solubility in water.

iii) Explain briefly the methodology for the precipitation of cations of group II in group analysis. Explain why other cations do not precipitate under these conditions.

(4.0 marks)

b) 1 dm^3 of an aquous solution contains 0.02 mol of each $SO_4^{2-}(aq)$ and $CO_3^{2-}(aq)$ ions at 25°C. $Ba(OH)_2$ solution was added gradually to the above solution.

Assume no volume change takes place during the addition of $Ba(OH)_2$.

i) By means of a calculation show that $BaSO_4$ is precipitated first.

ii) Find the concentration of $SO_4^{2-}(aq)$ ions in the solution when $BaCO_3$ begins to precipitate.

iii) At a particular instance during the addition of $Ba(OH)_2$ concentration of SO_4^{2-} in the solution was found to be 1 x 10^{-4} mol dm^{-3}. At this instance,

I) Calculate the concentration of $Ba^{2+}(aq)$ ions and the concentration of the remaining CO_3^{2-} ions in the solution

II) Calculate the mass of $BaSO_4$ precipitated.

K_{sp} ($BaCO_3$) = 1 x 10^{-8} mol^2 dm^{-6}

K_{sp} ($BaSO_4$) = 1 x 10^{-10} mol^2 dm^{-6}

(6.0 marks)

c) i) Write 3 factors which affect the rate of a chemical reaction.

ii) $2A(g) + B(g) \longrightarrow A_2B(g)\ ;\ \Delta H < 0$

The above reaction takes place in 2 steps as given below.

Step 1 : $A(g) + B(g) \underset{k_2}{\overset{k_1}{\rightleftharpoons}} AB$ (Fast)

Step 2 : $AB + A(g) \xrightarrow{k_3} A_2B$ (Slow)

k_1 - Rate constant of the forward reaction

k_2 - Rate constant of the backward reaction

k_3 - Rate constant

I) Identify the intermediate

II) Derive the rate law for the above reaction.

III) Hence find the overall order.

IV) How would the rate of the above reaction change when 2/3 of the container in which the above reaction takes place is filled with $CCl_4(l)$. (Assume none of the chemical species dissolve in CCl_4)

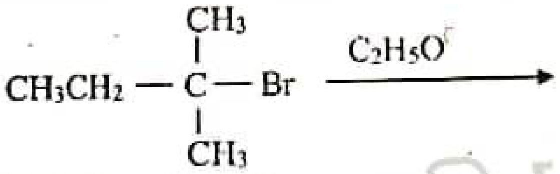
V) Draw the energy profile for the above reaction. Mark reactants,products,intermediate at the appropriate places. Draw the activated complexes at each step..

(5.0 marks)

PART C - ESSAY

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

8. a) When A is reacted with $C_2H_3O^-$ two different compounds are formed?



$$CH_3CH_2-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{C}}-Br \xrightarrow{C_2H_5O^-}$$

(A)

22 A/L අපි [papers grp]

i) Draw the structures of the two products.

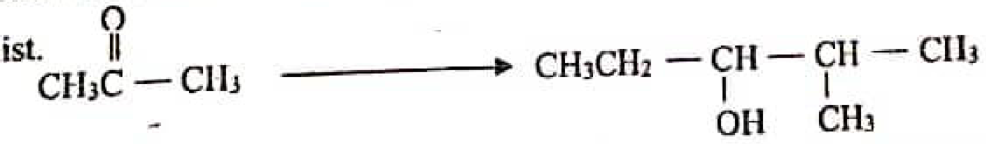
ii) Write the mechanisms for the formation of the two products seperately.

iii) State, selecting from the list below, the function of $C_2H_5O^-$

*As a nucleophile ∙As an electrophile *As a base *As an acid

(8.0 marks)

b) Show how the conversion given below. Could be carried out using only the chemicals in the list.



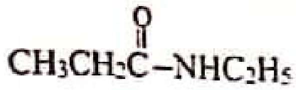
$$CH_3\overset{\overset{O}{\|}}{C}-CH_3 \longrightarrow CH_3CH_2-\underset{\underset{OH}{|}}{CH}-\underset{\underset{CH_3}{|}}{CH}-CH_3$$

List of chemical

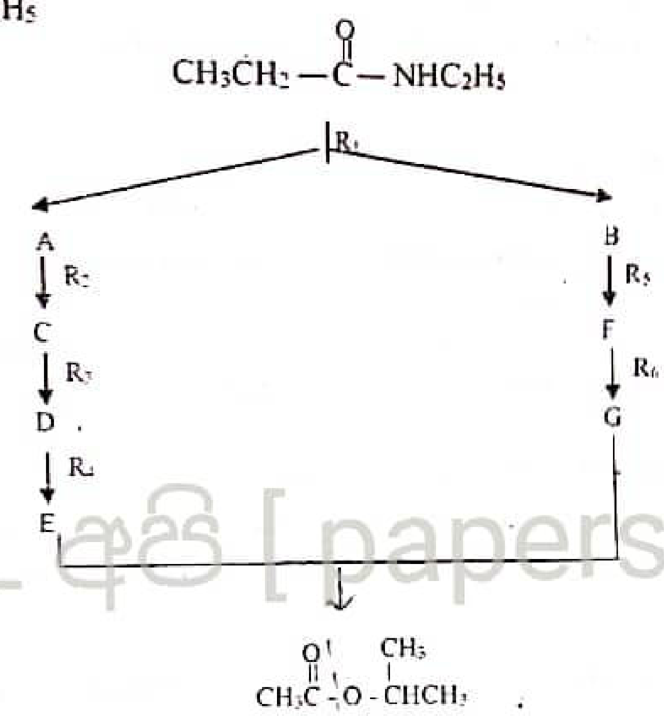
PCl_3 , Mg , dry ether , organic peroxide , HBr , NaOH , $LiAlH_4$, H^+/H_2O, PCC , concentrated H_2SO_4

~~(4.0 marks)~~

c) i) Compound P is synthesized according to the following reaction scheme by using



$CH_3CH_2\overset{O}{\overset{\|}{C}}-NHC_2H_5$



(P)

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Write reagents from R_1-R_6 and products A to G.

9. a) Aqueous solution X contains 4 metal cations. The following tests were conducted in order to identify the cations.

	Test	Observation
1	Dilute HCl was added to a portion of solution X.	No precipitate
2	H_2S gas was bubbled through the solution obtained from (1)	Black precipitate (P_1)
3	Precipitate P_1 was filtered and the filtrate was boiled until all H_2S was expelled. Concentrated HNO_3 was then added to the solution and further boiled. Afterwards the solution was allowd to cool and NH_4Cl/NH_4OH solution was added.	Green precipitate (P_2)
4	P_2 precipitate was seperated and H_2S was bubbled through the filtrate.	Light pink precipitate (P_3)
5	P_3 precipitate was seperated and the filtrate was boiled to expell H_2S. The solution was then cooled and $(NH_4)_2CO_3$ was added.	White precipitate (P_4)

The following tests were conducted for precipitates P_1 , P_2 , P_3 and P_4 .

	Test	Observation
P_1	Precipitate was dissolved in hot dilute HNO_3 and excess concentrated HCl was added. Excess H_2O was added to S_1.	Yellow solution obtained (S_1) Light blue solution obtaineed (S_2)
P_2	Excess dilute NaOH was added followed by H_2O_2 Dilute H_2SO_4 was added to S_3.	Yellow solution obtained (S_3) Orange solution obtainted (S_4)

P_3	Precipitate was dissolved in dilute HCl and excess dilute NaOH was added.	White precipitate formed which turned brown with time.
P_4	Precipitate was dissolved in concentrated HCl and 8-hydroxyquinoline solution was added.	A yellow precipitate was formed.

i) Identify the four metal cations in solution X.

ii) Write chemical formulae of precipitates P_1 , P_2 , P_3 and P_4 .

iii) Write balanced chemical equations for the reaction between P_4 and H_2O_2 in the presence of NaOH and the reaction of S_3 with dilute H_2SO_4.

iv) Write the balanced chemical equation for the reaction between dilute NaOH and the solution obtained after dissolving P_3 in dilute HCl

(7.5 marks)

b) A water sample obtained from an area with excessive industrial waste contain HCO_3^- , NO_2^- and NO_3^- ions only. The following procedure was followed to analyse the anions quantitatively.

Procedure - 1

25.00 cm^3 to the water sample was heated with Al powder and excess NaOH. The gas evolved during the reaction was absorbed into 50.00cm^3 to 0.02 mol dm^{-3} H_2SO_4 solution. 30.00 cm^3 of a 0.03 mol dm^{-3} NaOH solution was required to react with the remaining H_2SO_4 above.

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Procedure - 2

Another 25.00 cm^3 portion of the water sample was titrated against ~~0.2~~ 0.002 mol dm^{-3} acidic $KMnO_4$ solution. The volumme at the end point was 20.00cm^3.

Procedure - 3

25.00 cm^3 of the water sample was titrated against the H_2SO_4 solution used in procedure 1. The volume of H_2SO_4 required was 15.00 cm^3.

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

ii) Determine the concentration of the anions in the water sample.

(7.5 marks)

10. a) i) Draw the structure of 4-methylpentanenitrile

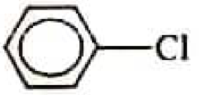
ii) Draw the structure of the tetrahedral interdiate molecule which is formed by the reaction of methylamine and acetophenone ($CH_3COC_6H_5$)

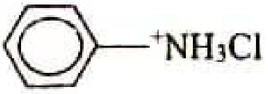
iii) Draw the structure and state the colour of the product formed by the reaction of benzene diazonium chloride with β - naphthol.

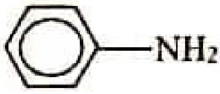
iv) Distinguish the following organic compounds.

1) $CH_2 = C(CH_3)_2$ and $CH_2 = CHCH_3$

2) $(CH_3)_2CHCOOCH_2CH_3$ and $CH_3CH_2COOCH(CH_3)_2$

3) 

and


4) 

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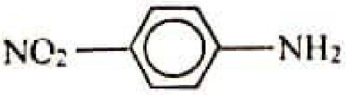
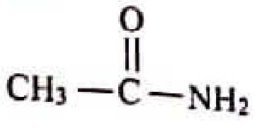


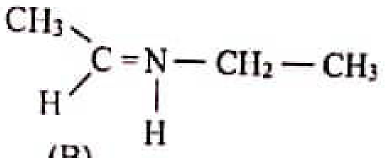
(5.0 marks)

b) Synthesize compound B by using A as the only organic compound. (Do not use more than 6 steps)



$CH_3-\overset{\overset{O}{\|}}{C}-NH_2$

(A)



(B)

(4.0 marks)

c) A solution containg Cu^{2+} and $C_2O_4^{2-}$ ions was titrated against 0.02 mol dm^{-3} acidified $KMnO_4$ solution. The volume of $KMnO_4$ required was 22.60 cm^3. The resultant solution was neutralized with Na_2CO_3, and then acidified with acetic acid. Excess KI was then added to the solution and the I_2 formed was titrated against 0.05 mol dm^{-3} $Na_2S_2O_3$ solution. The volume requied for the titration was 11.30 cm^3.

i) Write balanced ionic equations for all reactions taking place.

ii) Find the mole ratio of Cu^{2+} and $C_2O_4^{2-}$ in the solution.

(6.0 marks)

22 A/L අපි [papers grp]

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	—	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	—	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Fl	Uup	Lv	Uus	Uuo

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

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