බස්නාහිර පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව
மேல் மாகாணக் கல்வித் திணைக்களம்
Department of Education - Western Province

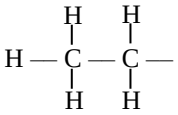
අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය **2025** නොවැම්බර් උපකාරක ප්‍රශ්න පත්‍රය
General Certificate of Education (Adv. Level) Exam, November 2025 Supportive Seminar Paper

රසායන විද්‍යාව II Chemistry II	**02**	**E**	**II**	**13 ශ්‍රේණිය** **Grade 13**	**පැය තුනයි** ***Three hours***

Index number : – .....

Extra reading time
10 minutes

- Periodic table is provided.
- **Use of calculators is not allowed**.
- Universal gas constant $R = 8.314\ JK^{-1}\ mol^{-1}$
- Avagadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$
- **In answering the paper, you may represent alkyl groups in a condensed manner.**

Example : –  group can be represented as CH_3CH_2 –

❑ PART A – Structured Essay (pages 02 – 09)

- *Answer **all** the questions on the question paper itself.*
- *Write your answers 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 and PART C - Essay (pages 10 – 18)

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

For Examiner's Use Only

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

Total

In Numbers	
In Letters	

Code Numbers

Marking Examiner 1	
Marking Examiner 2	
Checked by :	
Supervised by :	

[see page two

Do not write anything in this column

Part A - Structure and essay

Answer **all four** questions in this paper. (Each question carries **100** marks.)

01. (a) Write on the dotted lines, whether the following statements are **true** or **false**.

(i) Among all the elements in the periodic table, F has the most negative electron-gaining energy **False**

(ii) Li salts give crimson-red for the flame test **True**

(iii) The decomposition of $(NH_4)_2CO_3$ produces a white powder **False**

(iv) HCOONa(aq) is act as a buffer solution **False**

(v) $Cl_2BrO_2^+$ ion is tetrahedral in shape **True**

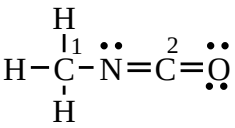
(vi) As the nuclear charge of isoelectronic ions increases, the ionic radius decreases **True**

*** If (T or F) or (√ or X) written instead of True or false in word deduct 1 mark each**

(4x6=24 marks)

24

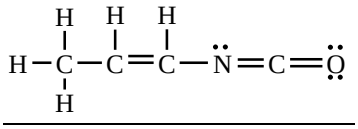
(b) (i) State the shape around the atoms marked C^1, N, and C^2 in the structure shown below and their valence in the table.



Atom	Shape around the atom	Valence
C^1	**Tetrahedral**	**4**
N	**Bent / V shape/ Angular**	**3**
C^2	**Linear**	**4**

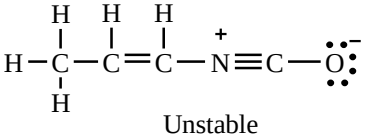
If + or – written for valance no marks **(1x6 = 6 marks)**

(ii) Draw the most acceptable Lewis dot–dash structure for molecule C_4H_5NO. Its template is shown below.

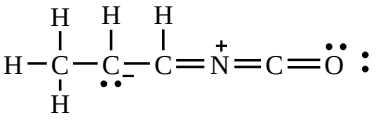


(iii) Draw two more Lewis dot-cross (resonance) structures that can be drawn for the stable Lewis structure drawn in (ii) above.

Identify whether the structures you drew are **unstable** or **stable** and indicate that under each structure.



Unstable



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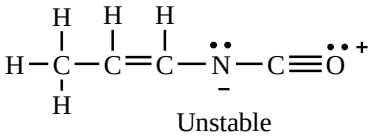

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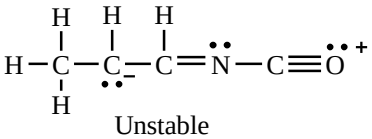

Unstable

Any 2 structures (2+1) x 2 = 6

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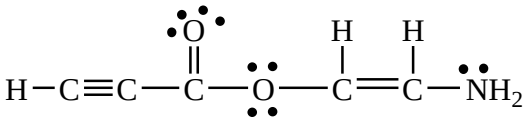
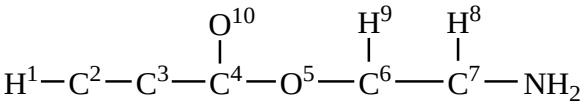
(iv) Complete the given table based on the following Lewis dot-cross structure and its labeled skeleton.





		C^2	C^4	O^5	N
I	Number of VSEPR pairs around the atom	**2**	**3**	**4**	**4**
II	Electron pair geometry around the atom	**Linear**	**Trigonal planner**	**Tetrahedral**	**Tetrahedral**
III	shape around the atom	**Linear**	**Trigonal planner**	**Bent / V shape/ Angular**	**Pyramidal**
IV	Hybridization of the atom	**sp**	**sp^2**	**sp^3**	**sp^3**
V	The oxidation number of the atom	**-1**	**+3**	**-2**	**-3**

(1x20 = 20 marks)

- Parts (v) to (viii), based on the Lewis dotted line structure given in part (iv) above. Atom labeling is the same as in part (iv).

(v) Identify the atomic/bond orbitals involved in the formation of σ bonds between the following two atoms.

I	$H^1 - C^2$	H^1	**1s**	C^2	sp
II	$C^2 - C^3$	C^2	sp	C^3	sp
III	$C^3 - C^4$	C^3	sp	C^4	sp^2
IV	$C^4 - O^5$	C^4	sp^2	O^5	sp^3
V	$O^5 - C^6$	O^5	sp^3	C^6	sp^2
VI	C^7 - N	C^7	sp^2	N	sp^3

*** no marks for s only**

*** No marks for sp_2 or sp_3 deduct maximum 5 marks from total for wrong representation of the symbol** **(1x12 = 12 marks)**

(vi) Identify the atomic/bond orbitals involved in the formation of π bonds between the following two atoms.

I	$C^2 - C^3$	C^2	2p	C^3	2p
		C^2	2p	C^3	2p
II	$C^4 - O^{10}$	C^4	2p	O^{10}	2p
III	$C^6 - C^7$	C^6	2p	C^7	2p

(1x8 = 8 marks)

(vii) State the approximate bond angles around the C^2, C^4, O^5 and N atoms.

C^2 **180^0** , C^4 **$120^0 \pm 1$** , O^5 **$104^0 \pm 1$**, N **$107^0 \pm 1$** **(1x4 = 4 marks)**

(viii) Arrange the O^5, C^2 C^6 and N atoms in order of increasing electronegativity.

$C^6 < C^2 < N < O^5$

(4 marks)

64

Do not write anything in this column

(c) The Rydberg equation gives the wavelength of light emitted when electrons move between energy levels in an atom. The Rydberg equation for hydrogen is shown below.

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

λ = Wave length of the photon n_1 = Initial energy level
n_2 = Final energy level R_H = Rydberg constant
$R_H = 1.097 \times 10^7\ m^{-1}$

(i) Find the wavelength in nano meters of the photon emitted when an electron moves from the fourth energy level to the second energy level in a Hydrogen atom.

Clue -: $(1.097\times10^7 \times 0.1875)^{-1} = 4.86 \times 10^{-7}$

$$\frac{1}{\lambda} = 1.097\times10^7\left[\frac{1}{2^2} - \frac{1}{4^2}\right] \quad (4\ marks)$$

$$\lambda = \left(1.097\times10^7 \times 0.1875\right)^{-1} = 486\ nm \quad (2\ marks)$$

(ii) An electron in the Hydrogen atom falls from a certain energy level to another certain energy level by emitting a radiation with wavelength (λ) = 1.025×10^{-7} m. This transition falls into Lyman series, Find the initial energy level of the electron.

Clue -: $(1.025)^{-1} = 0.9756,\ \left(\frac{0.9756}{1.097}\right) = 0.889,\ (9)^{-1} = 0.111$

$$\frac{1}{1.025\times10^{-7}} = 1.097\times10^7\left[\frac{1}{1} - \frac{1}{n^2}\right] \quad (4\ marks)$$

$$0.889 = \left(1 - \frac{1}{n^2}\right) \Rightarrow \frac{1}{n^2} = 0.111$$

$$n^2 = 9 \therefore n = 3 \quad (2\ marks)$$

12
100
100

02. (a) X, Y and Z are three elements belonging to p block which are non-gaseous at room temperature and, having atomic number **less than 20**, existing as allotropic forms in nature Only a common allotropic form (A) of element X conducts electricity. Only chlorides of elements Y and Z undergo hydrolysis, and chloride of Z hydrolyzes to give a cloudy solution and a gas (B) with a pungent smell that decolorizes the color of an acidified $K_2Cr_2O_7$ solution. Element Z undergoes disproportionation when reacted with dilute NaOH. Element Y reacts with dilute NaOH to give a colorless gas with a pyramidal shape and a sodium salt in which the ratio of H, Y and O atoms is 2:1:2 respectively.

(i) Identify the elements X, Y and Z

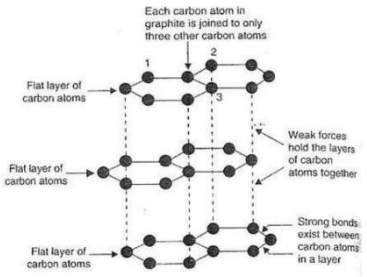
X – **C** Y – **P** Z – **S** **(5x3 = 15 marks)**

(ii) Identify the allotropic form A and name another common allotropic form of element X

A – **graphite** Allotropic form – **diamond / buck minster fullerene**
(3x2 = 6 marks)

(iii) Draw a sketch for the atomic arrangement of A and explain why A conducts electricity with the aid of its atomic structure.

Each carbon atom in **graphite is sp² hybridized**. Three of its four valence electrons form σ (sigma) bonds with neighboring carbon atoms in the same plane.
The fourth electron remains in a p orbital, which overlaps with neighboring p orbitals above and below the plane to form a delocalized π-electron cloud.
These delocalized electrons are free to move across the layers.
Therefore, graphite conducts electricity parallel to the layers due to the mobility of delocalized π-electrons.



(2 marks for diagram 2 marks for reason = 4 marks)

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(iv) Write the balanced chemical equations for the hydrolysis of chlorides of elements Y and Z.

Y- With less amount of water **$PCl_5 + H_2O \rightarrow POCl_3 + 2\ HCl$** **(3 marks)**

Y- With excess amount of water **$PCl_5 + 4\ H_2O \rightarrow H_3PO_4 + 5\ HCl$** **(3 marks)**

Z- **$SCl_2 + 2\ H_2O \rightarrow S + SO_2 + 4HCl$** **(3 marks)**

(v) Write the balanced chemical equations for the reaction between B gas and acidified $K_2Cr_2O_7$ solution

$H_2SO_4 + 3\ SO_2 + K_2Cr_2O_7 \rightarrow Cr_2(SO_4)_3 + K_2SO_4 + H_2O$ **(5 marks)**

(vi) Write the balanced chemical equations for the reaction between dil.NaOH solution and element Y and Z

Y- **$3\ H_2O + 3\ NaOH + 4P \rightarrow 3\ NaH_2PO_2 + PH_3$** **(3 marks)**
{ $P \rightarrow PH_3$, $P \rightarrow H_2PO_2^-$ disproportionation}

Z- **$6\ NaOH + 3S \rightarrow 2\ Na_2S + Na_2S_2O_3 + 3\ H_2O$** **(3 marks)**

45

(b) The experiments and their observations on salt **A** are shown in the table below

	Experiment	Observation
I	$BaCl_2$ (aq) was added to the aqueous solution containing salt **A**	Obtained the white precipitate **B**, which is insoluble in HNO_3
II	NaOH (aq) was added to the aqueous solution containing **A**	A white precipitate, **C**, was formed which turned blackish brown precipitate **D** when kept in air
III	H_2S (g) was added to the alkalized aqueous solution containing **A**.	Obtained a pinkish **E** precipitate, which is soluble in dilute HNO_3.

(i) Identify the compounds A, B, C, D, and E.

A – **$MnSO_4$** B – **$BaSO_4$** C – **$Mn(OH)_2$**
D – **MnO_2** E – **MnS** **(4x5=20 marks)**

(ii) Salt A is used for a common test for quantitative analysis under alkaline conditions. What is the relevant test and the purpose of performing the test?

Test – **Winkler test** **(3 marks)**

Purpose – **detect dissolved Oxygen in a water sample** **(2 marks)**

(iii) Write balanced chemical equations for each reaction **I** to **III** above

I **$MnSO_4 + BaCl_2 \rightarrow MnCl_2 + BaSO_4 \downarrow$** **(5 marks)**

II Obtaining a white precipitate **$MnSO_4 + 2\ NaOH \rightarrow Na_2SO_4 + Mn(OH)_2$** **(5 marks)**

Turned blackish brown when kept in air **$2\ Mn(OH)_2 + O_2 \rightarrow 2\ MnO_2 + 2\ H_2O$** **(5 marks)**

III Obtaining a pinkish precipitate **$MnSO_4 + H_2S \rightarrow MnS + H_2SO_4$** **(5 marks)**

(iv) Give the chemical formulae of five oxides of metal **A** and write the nature of each of the oxides as basic, weakly basic, amphoteric, weakly acidic and acidic

oxide	nature of oxide
MnO	**Basic**
Mn_2O_3	**weakly basic**
MnO_2	**amphoteric**

oxides	nature of oxide
MnO_3	**weakly acidic**
Mn_2O_7	**acidic**

(1x10= 10 marks)

55

100
100

Do not write anything in this column

03. (a) Dissolve 5 g of a solid sample containing NaOH and Na_2CO_3 in pure hot water to make a 100 cm^3 solution. 25.00 cm^3 of that solution was titrated with 1.0 $moldm^{-3}$ HCl solution with phenolphthalein as an indicator and the burette reading was observed as 20.00 cm^3 . Another volume of 25.00 cm^3 of the above solution was titrated with 1.0 $moldm^{-3}$ HCl solution using methyl orange as an indicator and obtained burette reading was 25.00 cm^3 .

(i) Write the balanced chemical equations for the reaction that take place in the first titration.

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
$Na_2CO_3(aq) + HCl(aq) \rightarrow NaHCO_3(aq) + H_2O(l)$ **(4x2=8 marks)**

(ii) Write all the balanced equations for the reactions taking place in the second titration

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
$Na_2CO_3(aq) + HCl(aq) \rightarrow NaHCO_3(aq) + H_2O(l)$
$NaHCO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$ **(4x3=12 marks)**

(iii) What is the difference between the two burette readings in two titrations?

5 cm^3 **(5 marks)**

(iv) What can you calculate from the volume of HCl in question (iii) above

The $NaHCO_3(aq)$ amount **(5 marks)**

(v) Calculate the mass percentages of NaOH and Na_2CO_3 present in the mixture

Let x be the moles of NaOH and y be the moles of Na_2CO_3

$for 25cm^3$

$$x + y = \frac{1}{1000} \times 20$$

$$x + 2y = \frac{1}{1000} \times 20$$

$$\therefore y = \frac{5}{1000}, x = \frac{15}{1000} (5 marks)$$

$for 100cm^3$

$$y = \frac{20}{1000}, x = \frac{60}{1000}$$

$mass\%of\ NaOH$

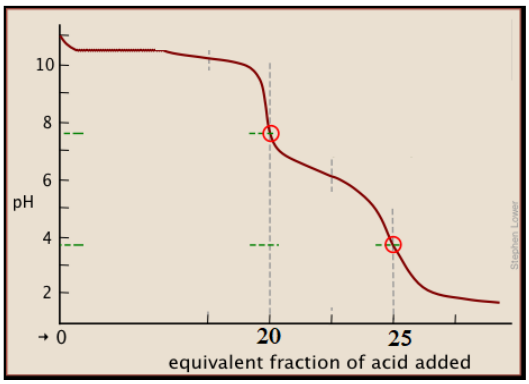
$$\frac{60}{1000} \times 40 \times \frac{100}{5} = 48\% (5 marks)$$

$mass\%of\ Na_2CO_3$

$$\frac{20}{1000} \times 84 \times \frac{100}{5} = 34.4\%$$

$(5 marks)$

(vi) Sketch graph for the change in pH of the solution with the volume of HCl in the titration



First eq point between pH 8-10 = 1 mark
2nd eq point less t han pH 7 = 1 mark
Correct two axis = 1x2 = 2 marks
Shape of the curve = 1 mark

(5 marks)

50

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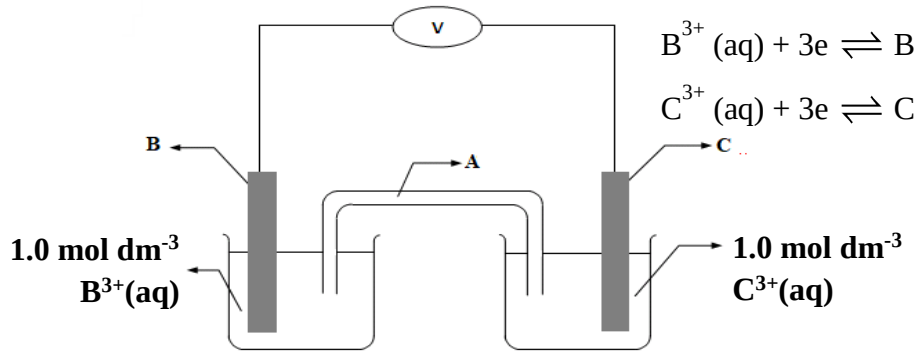
(b) Following diagram shows a galvanic cell kept at 25 ^{o}C and 1 atm pressure consist of half cells B and C. The relevant reduction potential values are given. Answer the questions given below.



B^{3+} (aq) + 3e $\rightleftharpoons$ B (s) E^{o} = – 0.20 V

C^{3+} (aq) + 3e $\rightleftharpoons$ C (s) E^{o} = – 0.40 V

(i) Identify the component A and state two primary functions of A .

A – **Salt bridge** **(3 marks)**

Primary functions of A

- ✳ **Maintains electrical neutrality**
- ✳ **Prevents polarization of the cell**
- ✳ **Completes the circuit**
- ✳ **Minimize the liquid junction potential** **(any two 2x2 = 4 marks)**

(ii) Among the following chemicals, identify the most suitable chemical to be used for A. Mention reasons for rejection of each other chemicals. Comment on the conductivity of cation and anion your chosen chemical. (Note that the chloride salts of B and C are used to construct half-cells B and C).

List of chemicals –: $AgNO_3$ (aq) / CH_3COOH(aq) / KNO_3 (aq) / $NaNO_3$(aq)

Salt	Suitable / not suitable	reason
$AgNO_3$ (aq)	**Not Suitable**	**AgCl will precipitate**
CH_3COOH(aq)	**Not Suitable**	**Weak electrolyte so increases the liquid junction potential**
KNO_3 (aq)	**Suitable**	**ok**
$NaNO_3$(aq)	**Not Suitable**	**Mobility of cataion and anion are considerably different**

*** If student has taken $NaNO_3$ also suitable without knowing the mobility of ions then consider it as correct** **(2x4 = 8 marks)**

(iii) Identify the cathode and the anode of the above cell.

Anode – **C(s)**

Cathode – **B(s)** **(4x2 = 8 marks)**

(iv) Determine the direction of the current flow in the cell if the both ends are connected from a conducting wire.

From C to B **(2 marks)**

(v) Calculate the electromotive force of the cell.

$$E^{\theta}_{Cell} = E^{\theta}_{Cathode} - E^{\theta}_{anode} \qquad (5\,Marks)$$

$$E^{\theta}_{Cell} = (-0.2V) - (-0.4V) = +0.2V \qquad (5\,Marks)$$

Do not write anything in this column

(vi) The relationship between Gibbs free energy and standard cell potential (E^0_{cell}) is given by the following equation.

$\Delta G^0 = - nFE^0_{cell}$

n = number of moles of electrons participating
F = Faraday constant (96500 C)

Calculate ΔG^0 for the cell using the above relationship

$\Delta G^0 = - nFE^0_{cell}$

$\Delta G^0 = -3 mol \times 96500\ C\ mol^{-1} 0.2V$ $(3+1=4 Marks)$

$= -57.9 kJ\ mol^{-1} (3 Marks)$

(vii) Complete the following table by using the terms **positive, negative spontaneous** and **non – spontaneous**

	Sign of E^0_{cell}	Spontaneity of the reaction
Galvanic cell	**Positive**	**Spontaneous**
Electrolytic cell	**Negative**	**Non – Spontaneous**

*** no marks if the student uses symbols + or -** **(1x4 = 4 marks)**

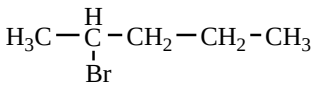
50

100

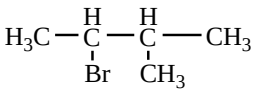
100

04. (a) A, B, and C are structural isomers with the formula $C_5H_{11}Br$. All three isomers show optical isomerism. A, B, C give D, E, F respectively as main products when reacted with alcoholic KOH. Only D shows diastereomerism. E and F give the same compound G when reacted with HBr. Compound G is a structural isomer of A, B, and C. Compound G is optically inactive. B and C give H and I respectively when reacted with dil.NaOH. H and I reacts with PCC to give J and K. only K decolorizes the colour of $H^+/KMnO_4$ solution to give compound L.

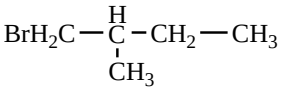
(i) Identify the structures of A, B, C, D, E, F, G, H, I, J, K and L and draw them in the corresponding boxes given below.



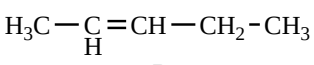
A



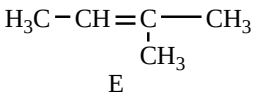
B



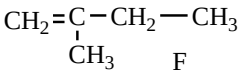
C



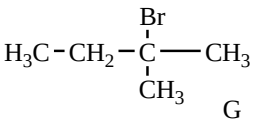
D



E



F



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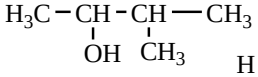
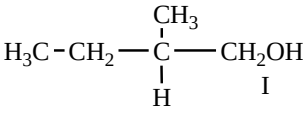
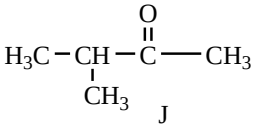


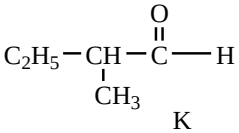
H



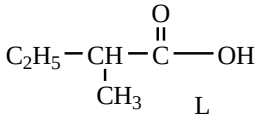
I



J



K



L

(4x12=48 Marks)

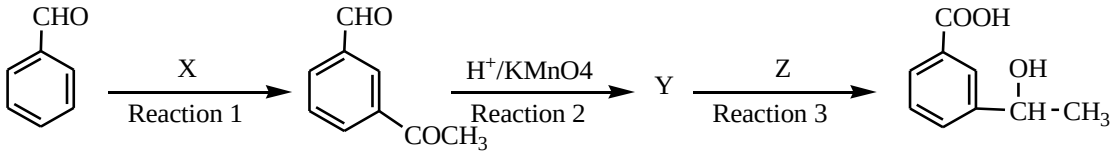
50

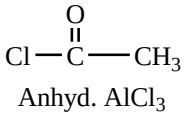
(ii) What is the colour change you observed on the reaction of K with $H^+/KMnO_4$

Purple → Colour **(2 marks)**

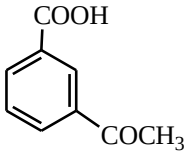
Do not write anything in this column

(b) Write the structure of Y and the reaction conditions of X and Z in the appropriate boxes with respect to the following conversion.





X



Y

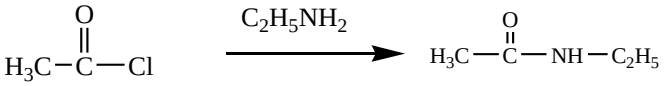
$NaBH_4$
CH_3OH

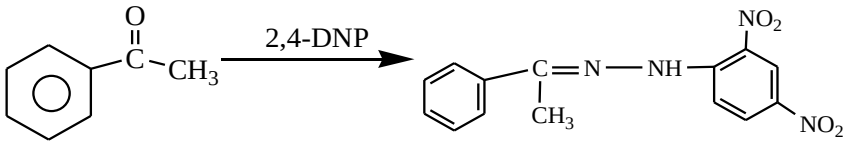
Z

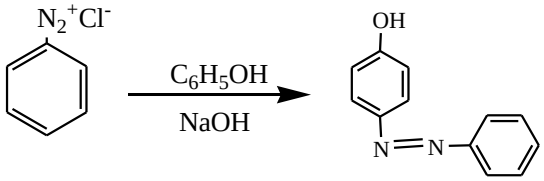
12

(4x3=12 marks)

(c) Draw the products given in each reaction below in the corresponding box.

1. 

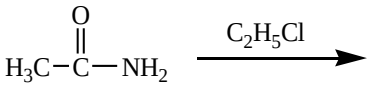
2. 

3. 

15

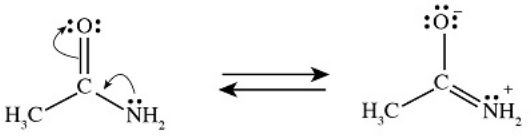
(5x3=15 marks)

(c) State whether the following reaction takes place. If so then give the product. If the reaction does not happens then give the reasons.



No **(2 marks)**

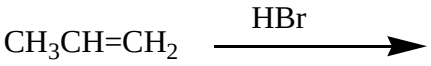
The <u>lone pair on nitrogen in ethanamide is involved in resonance with the carbonyl group,</u> <u>making it unavailable for reaction with ethyl chloride.</u> Hence, ethanamide does not react with ethyl chloride. **(2x2 = 4 marks)**



(**(2 marks)**

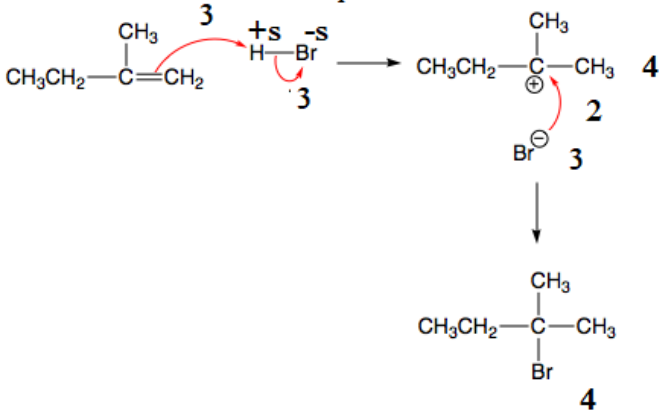
8

(d) Write the product obtained in the following reaction and write its mechanism.



Do not write anything in this column

1 for polarization



20

(20 marks)

***

100

100