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Provincial Department of Education - NWP

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Third Term Test - Grade 12 - 2023

Index No.: .....

CHEMISTRY - I

Time 02 hours

Instructions:

- *Periodic Table is provided.*
- *This paper consists of **09** pages.*
- *Answer **all** the questions.*
- ***Use of calculators is not allowed.***
- *Write your **Index Number** in the space provided in the answer sheet.*
- *Follow the instructions given on the back of the answer sheet, carefully.*
- *In each of the questions **1** to **50.** pick one of the alternatives from* (1), (2), (3), (4), (5) *which is **correct** or **most appropriate** and **mark your response on the answer sheet with a cross** (x) **with the instructions given on the back of the answer sheet.***

Universal gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$ Planck's constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

Avogadro constant $h = 6.626 \times 10^{-34}\ J\ s$ Velocity of light $C = 3 \times 10^{8}\ m\ s^{-1}$

(01) The emission of three types of radiation by the radioactive elements was first shown by,

(1) Henri Becquerel (2) Marie curie (3) J.J. Thomson

(4) Ernest Rutherford (5) Robert Millikan

(02) The atom which is having 2 halfly filled sub energy levels is,

(1) Cr (2) Al (3) K (4) Mn (5) P

(03) The total number of resonance structures can be drawn for the molecule N_2O is,

(1) 1 (2) 2 (3) 3 (4) 4 (5) 5

(04) Consider the following compounds the highest boiling point is shown by,

(1) CH_3Cl (2) CCl_4 (3) CH_4 (4) Xe (5) CH_3F

(05) Select the species which doesnot have a similar configuration as the titanium ion present in TiO_2 molecule,

(1) Sc^{3+} (2) Mn^{+7} (3) Fe^{+2} (4) Cr^{+6} (5) Ar

(06) The density of the HNO_2 solution which is named as A is $1.2gcm^3$ and the percentage purity of that solution is 21%. The required volume of A to prepare $250cm^3$ of $0.8moldm^{-3}$ $HNO_{3(aq)}$ solution is,

(1) $0.50dm^3$ (2) $5dm^3$ (3) $40cm^3$ (4) $500cm^3$ (5) $50cm^3$

(07) Which of the following statements is true regarding the s block elements?

(1) All of them react with water and liberate $H_{2(g)}$ at room temperature.

(2) All group 1 elements react with $N_{2(g)}$ present in air.

(3) All group 1 elements react with $H_{2(g)}$ and form solid ionic metal hydrides.

(4) When $Li_{(s)}$ is heating in air, a mixture of Li_2O, Li_3N and Li_2O_2 is formed.

(5) All s block elements give a colour to the flame of the flame test.

(08) Which is false regarding the SO_4^{2-} and SO_3^{2-} ions?

(1) The hybridization of the central atom is equal.

(2) The bond angle of SO_3^{2-} is less than that of the bond angle of SO_4^{2-}.

(3) Although the oxidation number of the central atom is different, the charge is the same.

(4) The shape of the both ions is the same.

(5) The electronegativity of the central atom of SO_4^{2-} ion is high.

(09) Consider the nuclear reaction ${}^{9}_{4}Be + {}^{4}_{2}\alpha \rightarrow {}^{14}_{6}C + X$. X is,

(1) a γ ray (2) a β particle (3) a proton

(4) an electron (5) a neutron

(10) The correct increasing order of the first ionization energy of the following elements is,

(1) Na < Be < P < N (2) Na < Mg < Al < S (3) Li < Na < K < Rb

(4) Be < B < N < O (5) B < C < N < P

(11) Under standard conditions when 18.56 g of $C_4H_{10\,(g)}$ is combusted, the amount of heat released is 960 KJ. The standard enthalpy of combustion of $C_4H_{10(g)}$ (in $KJmol^{-1}$) is,

(1) -3000 (2) 3000 (3) +2890 (4) -3072 (5) -3010

(12) The true statement is,

(1) Only energy is exchanged through an isolated system.

(2) State functions depends only on the initial state and the final state.

(3) To define the state of a system the measurable macroscopic properties of the system and also the microscopic properties can be used.

(4) Many spontaneous reactions are reversible.

(5) Under constant temperature and pressure the amount of heat supplied to the system and liberated from the system is known as the enthalpy change (ΔH).

(13) Which of the following processes is not exothermic?

(1) $O_{(g)} + e \rightarrow O^-_{(g)}$ (2) $Na^+_{(g)} + e \rightarrow Na^+_{(aq)}$ (3) $Na^+_{(g)} + Cl^-_{(g)} \rightarrow NaCl_{(s)}$

(4) $MgCl_{2(s)} \rightarrow Mg^{2+}_{(g)} + 2Cl^-_{(g)}$ (5) $CH_{2(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2HO_{(l)}$

(14) Upon the themal decomposition NH_3 gas is liberated by,

(1) $(NH_4)_2CrO_4$ (2) NH_4NO_3 (3) NH_4Cl (4) NH_4NO_2 (5) $Mg(NO_3)_2$

(15) Which of the following compounds shows the least water solubility?

(1) $Mg(OH)_2$ (2) $Ba(OH)_2$ (3) $NaNO_3$ (4) $(NH_4)_2CO_3$ (5) $CaCl_2$

(16) Consider the following reactions,

$$2Fe_{(s)} + \frac{3}{2} O_{2(g)} \rightarrow Fe_2O_{3(g)}, \Delta H^{\theta} = -822\ KJmol^{-1}$$

$$C_{(s,graphite)} + \frac{1}{2} O_{2(g)} \rightarrow CO_{(g)}, \Delta H^{\theta} = -111\ KJmol^{-1}$$

The standard enthalpy of the following reaction ($KJmol^{-1}$) is,

$$3C_{(s,graphite)} + Fe_2O_{3(s)} \rightarrow 2Fe_{(g)} + 3CO_{(g)}$$

(1) -711 (2) +489 (3) -489 (4) 711 (5) 1153

(17) The composition of dry air is 75% of $N_{2\ (g)}$ and 25% of O_2 by volume. Atmospheric pressure is 1×10^5 Pa,

(1) The partial pressure of $O_{2(g)}$ (P_{o_2}) is 2.5×10^5 Pa.

(2) The mole fraction of $O_{2(g)}$ (X_{o_2}) is ¼.

(3) The mass fraction of $N_{2(g)}$ is 0.75.

(4) The partial pressure of $N_{2(g)}$ (P_{N_2}) is 7.5×10^5 Pa.

(5) The mean molar mass of the gas mixture is 30 $gmol^{-1}$.

- Use the following data for the question No. 18 and 19.

$200cm^3$ of 0.2 $moldm^{-3}$ $BaCl_2$ Solution and $300cm^3$ of 0.1 $moldm^{-3}$ K_2CrO_4 Solution and mixed together. The formed precipitate here is washed and dried.

K = 39, Cr = 52, Ba = 137, Cl = 35.5, O = 16

(18) The mass obtained (in g) is,

(1) 7.6 (2) 7.89 (3) 10.12 (4) 76 (5) 101.2

(19) The false statement regarding the above reaction is,

(1) The stoichiometry between $BaCl_{2(aq)}$ and $K_2CrO_{4(aq)}$ is 1 : 1

(2) The limiting reagent of the reaction is $BaCl_2$.

(3) The formed precipitate is yellow in colour.

(4) The composition of the remaining $Cl^-_{(aq)}$ ion in the solution is 120 ppm.

(5) The concentration of the remaining $K^+_{(aq)}$ ion is 0.16 $moldm^{-3}$.

(20) Which of the following elements form a Peroxide when it is heated with excess O_2?

(1) Mg (2) Na (3) Li (4) Ca (5) C

(21) At 500K and 1 x 10^5 Pa pressure gas A exists in a vessel of vdm^3 volume. At the same temperature and 4 x 10^4 Pa pressure gas B exists in a vessels of 2vdm^3 volume. Both A and B gases are passed in to a vessel of 4vdm^3 volume at 500K. The pressure inside the vessel (in Pa) is, (The temperature is constant)

(1) 4.5×10^5 (2) 2.25×10^5 (3) 1.66×10^5 (4) 4.5×10^4 (5) 1.66×10^4

(22) According to the kinetic molecular theory of gases,

(1) At a given temperature the gases with a high mass, move slowly.

(2) The kinetic energy of a gas depends only on temperature.

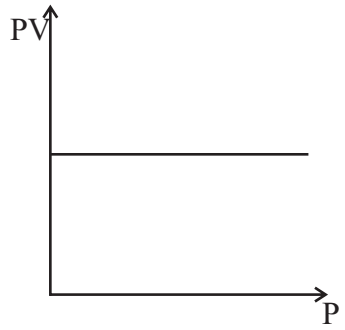
(3) A pressure exerts inside the vessel, when gas molecules collide each other.

(4) All particles of inside the vessel have the same speed.

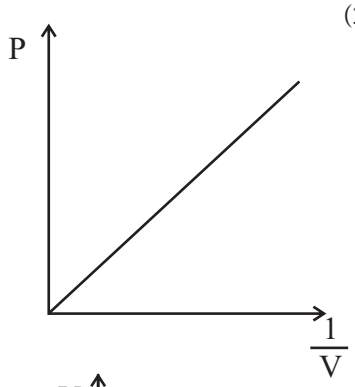
(5) The mass and the volume of a gas particle is negligible relative to the total mass of the particles and the volume of the vessel.

(23) Which is group is incorrect for an ideal gas,

(1)



(2)



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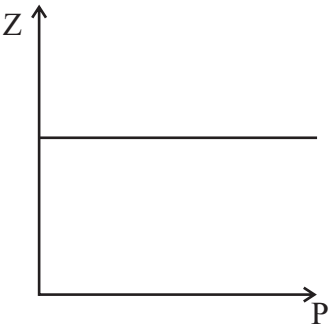

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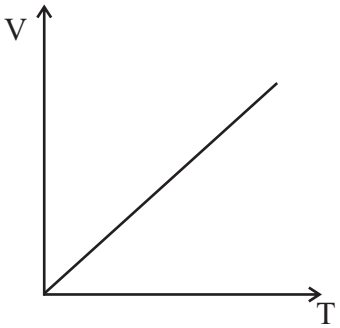
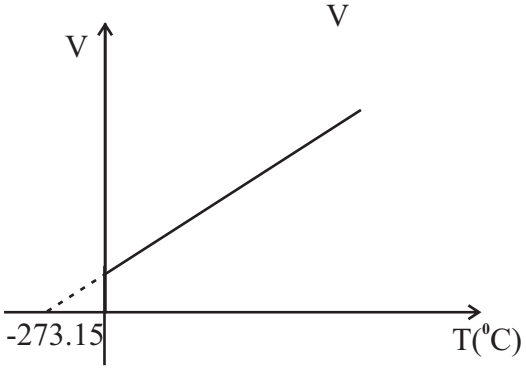


(5)



(24) If any reaction is spontaneous only at the high temperature, which of the following states is correct?

	ΔG	ΔH	ΔS
(1)	(+)	(+)	(+)
(2)	(-)	(-)	(-)
(3)	(+)	(-)	(+)
(4)	(+)	(-)	(+)
(5)	(-)	(+)	(+)

(25) The false statement regarding Ozone (O_3) is,

(1) O_3 is an allotropic form of Oxygen.

(2) O_3 molecule is nonpolar.

(3) O_3 is a strong Oxidizing agent than O_2.

(4) The number of resonance structures can be drawn for O_3 molecule is 2.

(5) O_3 is very good antiseptic substance than Cl_2.

(26) Consider the following reaction,

$$CH_2 = CH_{2\,(g)} + H_{2\,(g)} \rightarrow CH_3CH_{3\,(g)}$$

Calculate the standard enthalpy of the above reacion using the following standard bond dissociation enthalpy values in KJ mol^{-1}.

Bond	Standard bond dissociation enthalpy / KJ mol^{-1}.
C = C	+ 612
C - C	+ 348
C - H	+ 412
H - H	+ 486

(1) +124 (2) -124 (3) +288 (4) -288 (5) +127

(27) Select the chemical equation, which does not explain the given process correctly,

(1) Standard enthalpy of formation of $Na_2O_{(s)}$	$2Na_{(s)} + ½O_{2(g)} \rightarrow Na_2O_{(s)}$
(2) The bond dissociation enthalpy of $Cl_{2(g)}$	$Cl_{2(g)} \rightarrow 2Cl_{(g)}$
(3) The atomization enthalpy of $I_{2(s)}$	$I_{2(s)} \rightarrow I_{2(g)}$
(4) The standard enthalpy of combustion of $CO_{(g)}$	$CO_{(g)} + ½O_{2(g)} \rightarrow CO_{2(g)}$
(5) The standard lattice dissociation enthalpy of $MgCl_{2(s)}$	$MgCl_{2(s)} \rightarrow Mg^{2+}_{(g)} + 2Cl^-_{(g)}$

(28) When 4g of a solid mixture which contains only Na_2CO_3 and $CaCO_3$ is heated to obtain a constant mass. 450cm^3 of CO_2 gas is obtained at 27^{0}C and 1 atm. The mass percentage of Na_2CO_3 in the sample is, (Consider that the volume of 1 mol of CO_2 gas at this temperature and pressure is 25 dm^3.)

(Na = 23, Ca = 40, C = 12, O - 16)

(1) 55% (2) 45% (3) 60% (4) 50% (5) 63%

(29) $O_{(g)} + e \rightarrow O^-_{(g)}$, $\Delta H^\theta = -142$ KJmol^{-1}

$O_{(g)} + 2e \rightarrow O^{2-}_{(g)}$, $\Delta H^\theta = +702$ KJmol^{-1}

The second electron gain enthalpy of Oxygen gas (KJmol^{-1}) is,

(1) +844 (2) -844 (3) 560 (4) -560 (5) +986

(30) The compound A which is formed by a s block element gives red colour to the flame in the flame test. When A is subjected to the thermal decomposition a colour ful gas is liberated. A would be,

(1) Li_2CO_3 (2) $NaNO_3$ (3) $SrCO_3$ (4) $Ca(HCO_3)_2$ (5) $LiNO_3$

- **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 of 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	d Only (a) and (d) are correct	Any other number or combination of responses is correct

(31) The common properties for both allotropic forms of C, graphite and diamond are,

(a) The existance of demoralized electron.
(b) The existance of convalent bonds among carbon-carbon atoms.
(c) Exist as homo atomic lattices.
(d) Carbon - carbon bond lengths are equal.

(32) Which of the following pairs of solutions form precipitates by mixing,

(a) $MgCl_2$ and NaOH (b) Na_2CO_3 and $MgSO_4$
(c) $Ba(OH)_2$ and KCl (d) $Mg(NO_3)_2$ and Na_2SO_4

(33) Extensive properties are,

(a) Temperature (b) mass (c) volume (d) molar mass

(34) Which is / are the process / es with a positive entropy ?

(a) $N_{2(g)} + H_{2(g)} \rightarrow 2NH_{3(g)}$ (b) $Br_{2(l)} \rightarrow Br_{2(g)}$
(c) $NaCl_{(s)} + aq \rightarrow NaCl_{(aq)}$ (d) $Cl^-_{(g)} + aq \rightarrow Cl^-_{(aq)}$

(35) Select the true statement / statements regarding the following molecules,

CO_2, BF_3, NH_3, CH_4, XeF_4, SF_6

(a) All molecules obey the Octet rule.
(b) Both NH_3 and CH_4 molecules are iso - electronic.
(c) All molecules are non polar.
(d) Except 2 molecules, the central atom of the rest of the molecules, does not more lone pair of electrons.

(36) All s-block elements are,

(a) metals.
(b) when going down the group, melting point is decreasing.
(c) When heated in air, oxides are formed.
(d) All those oxides are basic.

(37) H_2O_2 reacts as an reducing agent with,

(a) $Na_2Cr_2O_7$ (b) SO_2 (c) $FeSO_4$ (d) KI

(38) Which of the following statement / statements is/are true regarding Cl_2?

(a) Cl_2 gas is strong reducing agent.

(b) H undergoes a disproportionation reaction with bases.

(c) The acidity of the Oxoacids of Cl varies as $HOCl < HClO_2 < HClO_3 < HClO_4$.

(d) Bond dissociation enthalpy of Cl - Cl is less than that of F - F.

(39) The element A belongs to s block when A is heated in air a white precipitate is obtained when water is added to it a gas is liberated. That gas turns the fitter paper dipped in Nestler reagent to brown colour. A would be,

(a) Mg (b) Na (c) Li (d) K

(40) The root mean square speed ($\sqrt{\overline{C^2}}$) of He and Ne,

(a) Depends only on the temperature (T).

(b) It is increasing when the temperature is increasing.

(c) when the temperature is constant, the root mean square speed of He is greater than that of Ne.

(d) When temperature is constant, ($\sqrt{\overline{C^2}}$) of He and Ne are equal.

- **In question numbers 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.**

1st statement	2nd statement	Response
True	True and 1st is explained correctly	1
True	True and 1st is not explained correctly	2
True	False	3
False	True	4

1st statement	2nd statement
(41) H_2O_2 molecule is non polar.	H_2O_2 molecule is linear.
(42) Mn and Cr are transition elements, belong to d - block.	The valence electrons of those atoms fill to d orbitals.

(43) The enthalpy change of an endothermic reaction is always a (+)ve value.	for a system, which take place such a reaction the energy of the final state is always greater than the energy of its initial state.
(44) All p block elements are non metals.	p block consists of the elements, belong to all states, solid, liquid and gas.
(45) Most of the compounds formed by Al, are identified as electron deficient compounds.	The electron octet is not completed in the compounds formed by Al.
(46) When going down the group 2, the thermal decomposition temperature of the carbonates in increasing.	Down the group, the radius of the cation is increasing.
(47) Van der waals equation can be applied for a gas which behaves ideally.	The amendments for the deviations shown by the real gases, are includes in van der waals equation.
(48) One N-H bond of the NH^{+}_{4} ion is longer than the other N-H bonds.	All N-H bonds present in NH^{+}_{4} ion are not covalent.
(49) Standard enthalpy of formation of any element is equal to the standard enthalpy of combustion of that compound.	The standard enthalpy of formation of a pure element, exists in the naturally occurring form is zero.
(50) In aqueous solutions, HF is a weak acid than HCl.	H-F bond length is greater than that of H-Cl bond length.

The Periodic Table / ආවර්තිතා වගුව

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 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

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

12 ශ්‍රේණිය GRADE 12 රසායන විද්‍යාව CHEMISTRY

The Periodic Table / ආවර්තිතා වගුව

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 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

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

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Provincial Department of Education - NWP

තෙවන වාර පරීක්ෂණය - 12 ශ්‍රේණිය - 2023

Third Term Test - Grade 12 - 2023

Index No.: .....

CHEMISTRY – II

Time 03 hours

Extra reading time 10 minutes

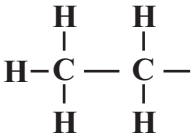
Use **additional reading time** to go through the question paper, select the questions **and** decide on the questions that you give priority in answering.

- A Periodic Table is provided on page 15.
- **Use of calculators is not allowed.**

  Universal gas constant $\mathbf{R = 8.314\ J\ K^{-1}\ mol^{-1}}$ Planck's constant $\mathbf{N_A = 6.022 \times 10^{23}\ mol^{-1}}$

  Avogadro constant $\mathbf{h = 6.626 \times 10^{-34}\ J\ s}$ Velocity of light $\mathbf{C = 3 \times 10^{8}\ m\ s^{-1}}$

- **In answering this paper, you may represent alkyl groups in a condensed manner.**

Example :  group may be shown as $\mathbf{CH_3CH_2}$

PART A - Structured Essay (page 02 - 08)

- Answer all the 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 that extensive answers are not expected.

PART B and PART C - Essay (page 09 - 14)

- 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 :	

Structure Essay

Part - A

- **Answer the following questions.**

(01) (A) Arrange the following species to the ascending order of the mentioned properties within brackets.

(i) S, Cr, Mn, Fe (number of unpaired electrons)

.....

(ii) Mg, Al, P, Si (Second ionization energy)

.....

(iii) H_3O^+, H_2O, $^-NH_2$, N^+H_4 (bond angles)

.....

(iv) Ca^{2+}, K^+, Al^{3+}, Mg^{2+} (cationic radius)

.....

(v) CO, HCO^-_2, HCO^-_3, CO (C-O bond length)

.....

(B) (i) The skeletal structure of $(HNO_2CN)^+$ is given below. Draw the most acceptable lewis structure.

.....

.....

.....

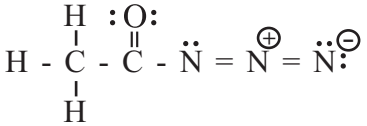
(ii) Sketch the shape of the lewis structure drawn in part (i) above. Mention the bond angles.

.....

.....

.....

(iii) A Lewis slot - clash structure for the azyl azide CH_2CON_2 is given below. Draw 4 more Lewis structures for the compound. Mention the stability of the drawn 4 structure as stable, less stable and unstable.



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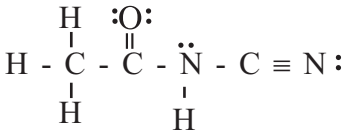
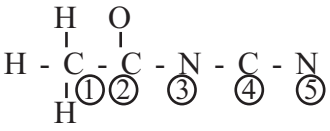
(iv) Fill in the following table considering the lewis structure and the labeled structure given below.





		C_1	C_2	N_3	C_4	N_5
I)	VSEPR pairs around the atom.					
II)	Electron pair geometry aroun the atom.					
III)	Shape around the atom.					
IV)	Hybridization of the atom.					

The part (v) to (vii) is based on the Lewis dot-dash structure given in part (iv) above. The labelling of atoms is the same as in part (iv).

(v) Identify the atomic / hybridized orbitals participated for the formation of σ bonds between the given atoms below.

I) $H - C^1$ H ..... C^1 .....

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

III) $C^2 - O$ C^2 ..... O .....

IV) $C^2 - N^3$ C^2 ..... N^3 .....

V) $N^3 - C^4$ N^3 ..... C^4 .....

VI) $C^4 - N^5$ C^4 ..... N^5 .....

(vi) Identify the atomic orbitals, participated for the formation of the bonds between the following atoms.

I) C^2 - O C^2 ..... O .....

II) C^4 - N^5 C^4 ..... N^5 .....

III) C^4 - N^5 C^4 ..... N^5 .....

(vii) Arrange the N^3, C^4 and N^5 atoms to the increasing order of their electro negativity.

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(02) (a) The element X belongs to the s block. The fist ionization energy of this is the highest in the group X does not reacts with cold water. X reacts with steam by liberating the gas A.

Also X liberates the gas A by reacting with HCl. The resultant solution B here does not give any colour to the flame. X forms covalent compound C by reacting with A at high temperatures. C reacts with water to form the precipitate D and evolve the gas A.

(i) Identify the species A to D by giving the chemical symbols / formulae.

A ..... B ..... C ..... D .....

(ii) Write the balance chemical equations for the above mentioned reaction.

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(iii) Write a general reaction for the thermal decomposition of carbonates of the group which consists the element X.

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(iv) Arrange the carbonates of the group of the element X to the increasing order of the thermal stability. Explain your answer using the polarization of ions.

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(b) P, Q and R are 3 consecutive elements belong to the same group and their atomic numbers are less than 20. P reacts strongly with water to produce H_2 gas and its carbonate is thermally stable. The compound formed by reacting P with water, reacts with R to liberate H_2 gas. Carbonate of Q liberates CO_2 upon heating and Q liberates H_2 gas by reacting with hot water.

(i) Identify the P, Q, R elements and write their chemical symbols.

P ..... Q ..... R .....

(ii) Compare the following properties of P and Q elements.

Atomic radius		<	
Metallic bond strength		<	
Reactivity		<	
Polarizing power		<	

(iii) Write the balanced chemical equation for the reaction of the element R with the hydroxide of P in aqueous medium.

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(iv) What is the gas liberated in the thermal decomposition of the nitrate of P ?

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(v) Write the balanced chemical equations for all the reactions taken place when Q is combusted in atmosphere.

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(vi) Write balanced, chemical equations for all reactions occurred when the product obtained in above (v) with water.

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(vii) How to identify the gas liberated there?

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(03) (a) At 300k and 3.0×10^5 Nm^{-2} a vessel of $2.0m^3$ contains gas X. At 300 K and 5.0×10^5 Nm^{-2} a vessel of $3.0m^3$ contains gas Y. Both vessels are connected through a thin tube allow both gases to mix each other completely. When both gases mixing, they do not react each other. Assume that the volume of the thin tube is negligible.

(i) Calculate the total pressure of the connected vessels.

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(ii) Calculate the mole fraction of gas X in the mixture.

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(iii) Calculate the partial pressure of gas Y, present in the mixture.

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(iv) By keeping the total volume of the two vessels constants, calculate the partial pressure of the gas X, inside the connected vessels, when the temperature of the gas mixture is increased up to 350K.

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(v) Write two important assumptions you made here?

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(b) Consider the following equation at 300k, and the data given in the table.

$$Cr_2O_{3\,(s)} + 3H_{2\,(g)} \rightarrow 3H_2O_{(g)} + 2Cr_{(s)}$$

	standard enthalpy of formation / $KJmol^{-1}$	standard entropy / $JK^{-1}\ mol^{-1}$
$H_{2\,(g)}$	0	131
$H_2O_{(g)}$	-242	189
$Cr_2O_{2\,(s)}$	822	90
$Cr_{(s)}$	0	27

(i) Calculate the enthalpy change of the reaction.

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(ii) Calculate the standard entropy change of the reaction.

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(iii) Predict the spontaneity of the reaction.

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(iv) Write an important assumption, you made here.

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(c) (i) Z is a metallic element in acidic medium $C_2O_4^{2-}$ ions are converted to CO_2 by ZO_4^- ion. During this reaction ZO_4^- ions convert to ZO^+ ions. Write the balanced half ionic reactions.

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(ii) Mention the stoichiometry between $C_2O_4^{2-}$ and ZO_4^-.

$C_2O_4^{2-} : ZO_4^-$ = ...

(04) (a) Following experiments and observations are relevent to the identification of A, B, C, D and E compounds given below. The compounds given below are not in order.

BaS, $Na_2S_2O_3$, NH_4NO_2, $(NH_4)_2CO_3$, $Mg(NO_3)_2$

Experiments	Observations
A. Adding dil HCl to solid compound.	A brown colour gas is liberated.
B. Lead acetate is added to the solid compound and the resultant solution is heated.	White precipitate is obtained and it turns black upon heating. A colourless gas is liberated.
C. Heating the solid compound.	A white colour powder is obtained. A brown colour gas and a colourless gas are liberated.
D. Heating the solid compound.	A gas which turns red litmus blue and another gas which turns lime water milky and water vapors are obtained.
E. Adding dil H_2SO_4 to the solid compound.	A white precipitate is obtained which is insoluble in dil HCl. A gas with a pungent odour is obtained.

(i) Write the chemical formulae of the compound A to E.

A - .....

B - .....

C - .....

D - .....

E - .....

(ii) Name the gases evolved in identification of the compounds in part (i) above.

A - .....

B - .....

C - .....

D - .....

E - .....

(b) 2.0 g of a an alloy consists of Cu and Zn is dissolved completely in conc. HNO_3 and diluted up to 250 cm^3. 25cm^3 of that solution is mixed with an excess $KI_{(aq)}$ solution. When that solution is titrated with 0.1 $moldm^{-3}$ $Na_2S_2O_3$ solution, the consumed volume is 30cm^3.

(Cu = 63.5, Zn = 65.3)

(i) Write balanced chemical equations for all reaction taken place in the above process.

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(ii) Calculate the mass percentage of Cu in the alloy.

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(c) Water of a tube well contains Fe^{2+} ions as the only species, can be Oxidized. To oxidize Fe^{2+} ions present in 20cm^3 of the tube well water to Fe^{3+} of 8cm^3 0.001 mol dm^{-3} $KMnO_4$ is consumed.

(i) Build the balanced ionic equation for the reaction between Fe^{2+} and MnO_4^- in acidic medium.

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(ii) Calculate the composition (ppm) of Fe^{2+} ions in water of the tube well.

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Part B - Essay

- **Answer two questions only.**

(05) (a) Define the following enthalpies.

(i) Standard enthalpy of bond dissociation. (ΔH_D^θ)

(ii) Standard enthalpy of hydration. (ΔH^θ_{hyd})

(iii) Standard enthalpy of sublimation. (ΔH^θ_S)

(iv) Standard enthalpy of atomization. (ΔH^θ_{atm})

(v) Standard enthalpy of lattice dissociation. (ΔH^θ_L)

(b) (i) Draw a Born-Haber cycle to calculate the standard enthalpy of lattice dissociation of $BaBr_2$ using the following data.

Standard enthalpy of sublimation of $Ba_{(s)}$	- 174.4 KJ mol^{-1}
Standard first ionization enthalpy of $Ba_{(g)}$	+ 502 KJ mol^{-1}
Standard second ionization enthalpy of $Ba_{(g)}$	+ 966 KJ mol^{-1}
Standard enthalpy of atoroization of $Br_{2(l)}$	+ 244.2 KJ mol^{-1}
Standard first electron gain enthalpy of $Br_{(g)}$	- 344 KJ mol^{-1}
Standard enthalpy of formation of $BaBr_{2(s)}$	- 755 KJ mol^{-1}

(ii) Hence calculate the standard enthalpy of lattice dissociation of $BaBr_{2(s)}$.

(c) Methanol and gasoline (C_8H_{18}) are used as fuels.

(i) Write the balanced chemical equations for the combustion of liquid methanol and gasoline.

(ii) Calculate the energy change occurred in the combustion per 1g of methanol and gasoline.

	$CO_{2(g)}$	$H_2O_{(l)}$	$CH_3OH_{(l)}$	$C_8H_{18(l)}$
ΔH^θ_f / KJmol^{-1}	- 394	-286	-239	-269

(iii) Considering the answer of part (ii) above, suggest the most suitable compound as a fuel. Give reasons.

(06) (a) (i) Write the kinetic molecular equation for ideal gases. Introduce the terms of it.

(ii) Derive the following expression to find the root mean square speed of an ideal gas using molecular kinetic equation and ideal gas equation.

$$\sqrt{\overline{C^2}} = \sqrt{\frac{3RT}{M}}$$

(iii) Prove that the root mean square speed of a gas depends on the molar mass of the gas using the root mean square speed of H_2 and O_2 at 25^0C. (Assume that H_2 and O_2 gases behave ideally at that temperature)

(iv) At a constant temperature, plot the variation occurred in the Maxwell - Baltzmann distribution curve of gas particles of group 18 elements with the molar mass of the gas.

(b) At 400K A_2 and B_2 gases exists in the molar ratio of 1.4 in a rigid vessel. A_2 and B_2 do not react each other. The total pressure of the vessel is 8×10^4 Pa.

(i) Calculate the partial pressure of A_2 and B_2 gases.

(ii) To the some vessel 0.4 mol of He gas is inserted and the temperature is decreased up to 300 K. Then the total pressure inside the vessel is 1×10^5 Pa. Calculate the partial pressures of A_2 and B_2 gases at this second state.

(iii) Calculate the partial pressure of He gas.

(iv) Calculate the number of moles of A_2 and B_2 gases inside in vessel at the beginning.

(c) (i) What is known as "molar volume" at standard temperature and pressure.

(ii) Derive an expression for the compressibility factor (Z) by using the molar volume of a real gas (V_m) and the molar volume of an ideal gas. (V^0_m)

(iii) The readings are given below of a practical experiment carried out to determine the molar volume of Oxygen gas using $KMnO_4$ in the laboratory. Calculate the molar volume of O_2 gas in $dm^3\ mol^{-1}$ using those.

Readings :	laboratory pressure	=	750 mmHg
	laboratory temperature	=	27^0C
	mass of O_2 gas evolved	=	0.7 g
	volume of the collected O_2 gas	=	546 cm^3
	vapour pressure of water at 27^0C	=	26.7 mmHg

(07) (a) A, B, C and D are four coordinate complexes of Fe. There are 3 Cl atoms bonded through ionic bonds or covalent bonds. The number of water molecules are varied inside the coordinate sphere. The charge of the coordinate sphere is +3, +2, +1 and 0 respectively. The oxidation state of Fe is the same in A, B, C and D.

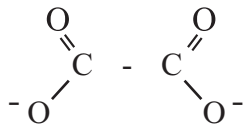
(i) Write the Oxidation number in the coordinate complexes.

(ii) Write the complex structures as A, B, C and D.

(iii) Write an experiment to distinguish between A and D. Write the observations.

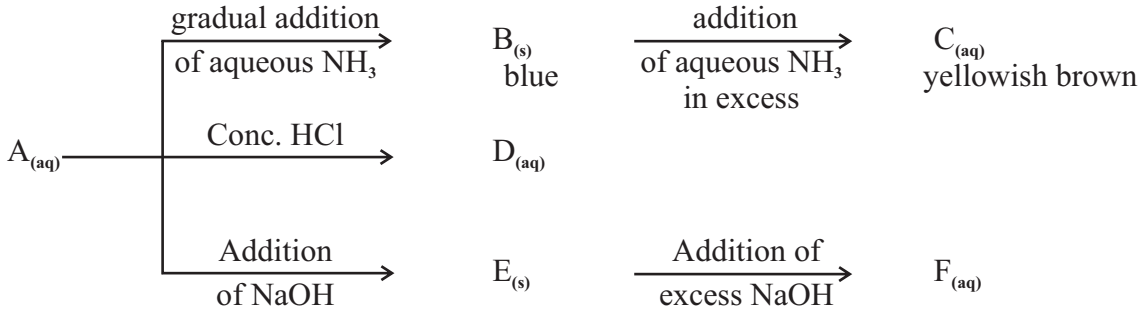
(iv) Write the IUPAC name of A.

(v) By the negatively charged Oxygen atoms in the Oxalate ion cordinate bonds. Can be formed by with the metal cations. Draw the structure of the Octahedral complex formed by M^{2+} ions with Oxalate ions.



(b) 3d metal ion M forms the aqueous complex $[M(H_2O)_n]^{m+}$ Which is named as A.

A Undergoes the following reactions.



(i) Determine the values of n and m.

(ii) Write the electron configuration of M cation.

(iii) Mention A, B and C complexes.

(iv) Mention D, E and F complexes and their colours.

(v) Write the IUPAC names of A, C and D.

(vi) What are the observations when H_2O_2 is added to the solution? Mention the chemical species.

Part C - Essay

- **Answer two questions only.**

(08) (a) Standardizing $Na_2S_2O_3$ solution which is used for titration using the primary standard solution KIO_3 and KI.

- $Na_2S_2O_3 . 5H_2O$ solid substance is dissolved in water and prepared $500cm^3$ of the solution. A small amount of Na_2CO_3 and $CHCl_3$ is added to the solution.
- 2.14 g of pure dry KIO_3 is measured and dissolved in a $250cm^3$ volumetric flask and distilled water is added up to the volume mark.
- $25cm^3$ of the above solution is measured to a titration flask and excess KI (about 1g) is added and acidified with 1 $moldm^{-3}$ H_2SO_4.
- Carrying out the titration using $Na_2S_2O_3$ solution inside the burette.
- At the beginning of the titration the solution of the flask is dull brown and when it turns to light yellow (hay colour) $2cm^3$ of starch is added as the indicator.
- Burette readings of 3 titration are given below.

First titration	$26.8\ cm^3$
Second titration	$25.5\ cm^3$
Third titration	$24.5\ cm^3$

(i) Write three properties of primary standard substance.

(ii) What are the reasons for the addition of Na_2CO_3 and $CHCl_3$?

(iii) Mention the chemical species which causes to turn the solution dull brown.

(iv) What is the reason for the addition of the indicator during the titration, without adding initially. Mention the colour change at the end point.

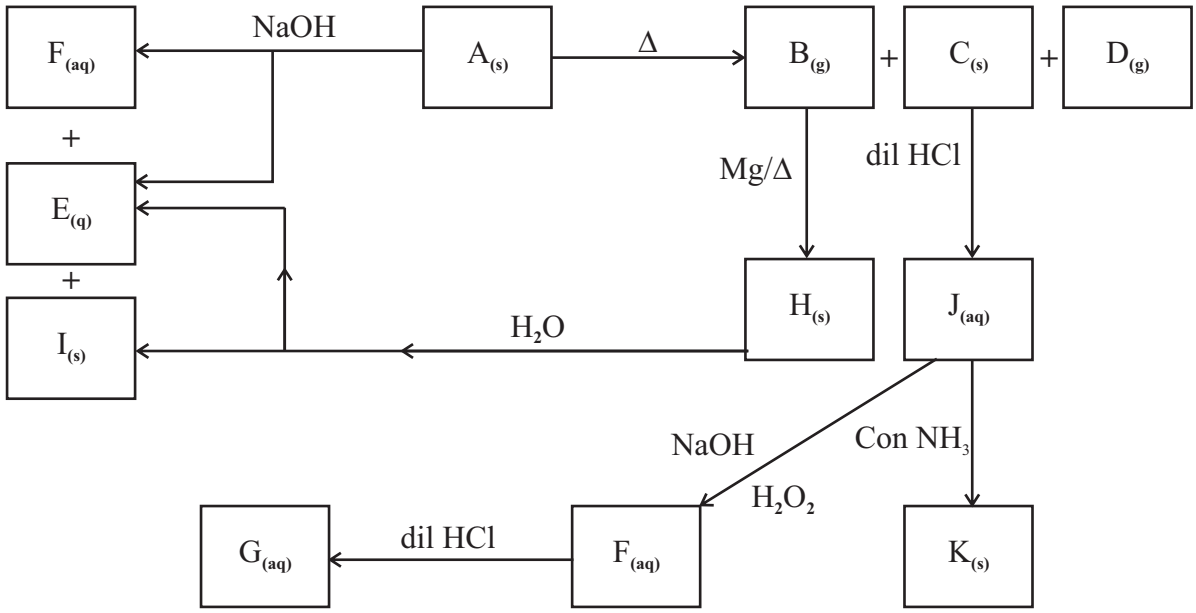
(v) Write the reason to carry out the titration 3 times.

(vi) Write balanced ionic equations for all reactions in the titration.

(vii) Calculate $Na_2S_2O_3$ concentration.

(b) 10 cm^3 of a H_2O_2 solution is allowed to react with excess dil H_2SO_4 acidified by KI solution. To react with the liberated I_2 here, 40 cm^3 of 0.1 mol dm^{-3} $Na_2S_2O_3$ solution is consumed. Express the strength of the H_2O_2 solution by volume. (If the complete decomposition of 1 dm^3 of H_2O_2 produces 10 dm^3 O_2 at standard temperature and pressure strength is called "volume 10")

(09) (a) The following diagram is relevant to the reactions of he inorganic salt A.



- D turns anhydrous $CuSO_4$ to blue colour.
- Gas E tuns red litmus blue.
- J is a green colour coordinate complex, containing a 3d metal cation.

Answer there following questions using the above diagrams and the data given.

(i) Write chemical formulae of A, B, C, D, E, F, G, H, I and K.

(ii) Mention the chemical formulae and colour of J, F and G.

(iii) Write the balanced chemical equations relevant to the following changes.

J $\rightarrow$ K

J $\rightarrow$ F

F $\rightarrow$ G

H $\rightarrow$ I + E

(b) The iron bullets contains metal Fe and other impurities. To determine the percentage of iron inside the bullets, the following procedure was carried out.

(i) 2g of iron bullets were powdered and allowed to oxdize completely by O_2. After obtaining constant mass it is was weighed as 3g. This oxide mixture consists of Fe_2O_3 and Fe_3O_4. Those oxides ware dissolved completely in dil H_2SO_4 and excess KI was added. This solution was diluted up to 100cm^3 by adding distilled water. (solution S)

(ii) $20cm^3$ of the above solution S is measured to a titration flask and titrated with 0.5 mol dm^{-3} $Na_2S_2O_3$. The consumed volume was $11cm^3$.

(iii) $50cm^3$ of the above solution S was measured, and titrated with 0.25 mol dm^{-3} $KMnO_4$. The consumed volume was $12.80cm^3$.

1) Write the balance chemical equations for the reactions taken place in above I, II and III states.

2) Calculate the percentage of Fe in bullets.

(10) (a) When 0.025 mol of $Na_2CO_{3\,(s)}$ is added to 25 cm^3 of HCl solution at room temperature, it is observed that the temperature of the solution is increased by 7^0C. The specific heat capacity of the final solution is 5000 J $kg^{-1}K^{-1}$ and its density is 1000 kgm^{-3}.

(i) Calculate the heat emitted during the above reaction.

(ii) Calculate the enthalpy of naturalization when a mole of HCl is reacted.

(iii) Mention an important assumption used for this calculation.

(iv) Under the same conditions of above reaction, when the following reaction is carried out the enthalpy change occurred is - 25.5 kjmol^{-1}.

$$NaHCO_{3(s)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$

Calculate the enthalpy change of the following reaction under the same conditions.

$$2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + H_2O_{(l)} + CO_{2(g)}$$

(b) The amount of Cu^{2+} ions in a solution can be determined by adding excess I^-. The liberated I_2 there, is titrated by a standard sodium thiosulfate solution.

$$Cu^{2+}_{(aq)} + I^-_{(aq)} \rightarrow CuI_{(s)}\ I_{2(aq)}$$

$$I_{2(aq)} + Na_2S_2O_{3(aq)} \rightarrow Na_2S_4O_6 + NaI_{(aq)}$$

In a certain experiment, 2.5 g of hydrated copper sulfate ($CuSO_4 . 5H_2O$) is dissolved in $100cm^3$ of water.

$20cm^3$ of that solution is measured to a titration flask and excess KI solid is added. To react completely with the liberated I_2 18.2 cm^3 $Na_2S_4O_3$ solution is required. Calculate the percentage purity of the hydrated $CuSO_4$.

(H = 1, O = 16, S = 32, Cu = 64)

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