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තෙවන වාර පරීක්ෂණය - 12 ශ්‍රේණිය - 2024
 Third Term Test - Grade 12 - 2024

Examination No.:

CHEMISTRY - I**Time : 2 hours****Instructions:**

- Periodic Table is provided.
- Answer **all** the questions.
- 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.
- This paper consists of **09** pages.
- **Use of calculators is not allowed.**

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

- (01) consider the following discoveries made with regard to the electron
- The charge of the electron.
 - The electron moving about the nucleus of an atom behaves like a wave.
- The scientists who discovered the above stated I and II respectively are,
- (1) J. J. Thomson, Louise De Broglie.
 - (2) Robert Millikan, Max Plank.
 - (3) J. J. Thomson, Max Plank.
 - (4) Ernest Rutherford, Albert Einstein
 - (5) Robert Millikan, Louise De Broglie.
- (02) Which of the following electrons is represented by the set of quantum numbers $n = 3, l = 1, m_l = 0, m_s = +\frac{1}{2}$?
- (1) 3p
 - (2) 2p
 - (3) 3d
 - (4) 3s
 - (5) 2p
- (03) From the list of the electron transitions given below, identify the emitted electromagnetic radiation in the hydrogen spectrum that has the lowest wave length.
- (1) $n = 2 \rightarrow n = 4$
 - (2) $n = 7 \rightarrow n = 3$
 - (3) $n = 8 \rightarrow n = 5$
 - (4) $n = 2 \rightarrow n = 1$
 - (5) $n = 1 \rightarrow n = 2$
- (04) Consider the oxidation number of the underlined element. The increasing order of the oxidation numbers of those species is,
- (1) $\underline{\text{ClO}}_4, \underline{\text{ClO}}_3, \underline{\text{ClO}}_2$
 - (2) $\underline{\text{MnO}}_4, \underline{\text{MnO}}_2, \underline{\text{Mn}}^{2+}$
 - (3) $\underline{\text{Cr}}_2\text{O}_7^{2-}, [\underline{\text{Cr}}(\text{H}_2\text{O})_6]\text{Cl}_2, \text{CrCl}_3$
 - (4) $\text{Na}_2\underline{\text{S}}, \underline{\text{S}}\text{Cl}_2, \underline{\text{S}}\text{O}_4^{2-}$
 - (5) $\underline{\text{N}}_2\text{O}_3, \underline{\text{NO}}_3^-, \underline{\text{NO}}_2$
- (05) A compound contains 72% of carbon, 12% of hydrogen and 16 % of oxygen. The ratio of C : H present in the empirical formula of this compound is,
- (1) 1 : 1
 - (2) 1 : 2
 - (3) 1 : 6
 - (4) 6 : 1
 - (5) 2 : 1



- (06) The increasing order of the O - N - O bond angle of the species NO_2^- , NO_2 , NO_2^+
- (1) $\text{NO}_2 < \text{NO}_2^- < \text{NO}_2^+$ (2) $\text{NO}_2^- < \text{NO}_2 < \text{NO}_2^+$ (3) $\text{NO}_2^- < \text{NO}_2 < \text{NO}_2^+$
 (4) $\text{NO}_2^+ < \text{NO}_2^- < \text{NO}_2$ (5) $\text{NO}_2^- < \text{NO}_2^+ < \text{NO}_2$
- (07) The oxidation number and the coordination number of the central metal ion of $[\text{Fe}(\text{SCN})(\text{H}_2\text{O})_5]\text{Cl}_2$ are respectively,
- (1) +3, 2 (2) +3, 5 (3) +2, 6 (4) +2, 2 (5) +3, 6

- (08) The density of Ne gas is highest at,

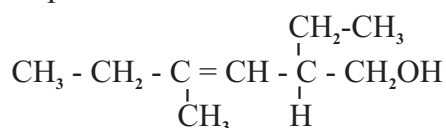
temperature	pressure (Pa)
(1) 0 °C	1 x 10 ⁵
(2) 0 °C	2 x 10 ⁵
(3) 273 °C	1 x 10 ⁵
(4) 273 °C	2 x 10 ⁵
(5) 298 K	1 x 10 ⁵

- (09) Consider the data given below.

Element	Standard enthalpy of combustion / kJ mol ⁻¹
C(S, graphite)	- 393
C(S, diamond)	- 395

Calculate the standard enthalpy of the reaction ($\Delta H^\circ_{\text{rxn}}$) for $\text{C}(\text{S, graphite}) \rightarrow \text{C}(\text{S, diamond})$

- (1) -2 (2) +788 (3) -788 (4) +2 (5) 0
- (10) When the colourless compound X is heated strongly, a colourful gas is liberated. X gives yellowish green flame to the flame test. X could be,
- (1) $\text{Ba}(\text{NO}_3)_2$ (2) $\text{Cu}(\text{NO}_3)_2$ (3) $\text{Ba}(\text{NO}_2)_2$ (4) $\text{Mg}(\text{NO}_3)_2$ (5) CuBr_2
- (11) The non polar molecule is,
- (1) CHCl_3 (2) CO (3) SF_6 (4) SF_4 (5) H_2O
- (12) The false statement regarding Barium (Ba) and its compound is,
- (1) When water is added to the residue obtained in the combustion of Ba metal in air, a clear solution is obtained.
 (2) Among the hydroxide of the group to which Ba belongs $\text{Ba}(\text{OH})_2$ shows the highest basicity.
 (3) Among the carbonates of the group of Ba, BaCO_3 shows the highest thermal stability.
 (4) In the combustion of Ba in excess O_2 , a super oxide is obtained.
 (5) Among the elements in the group of Ba, the element that reacts with water the fastest is Ba.
- (13) What is the IUPAC name of the following compound.



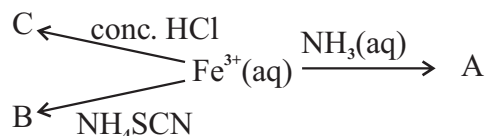
- (1) 2 - ethyl - 4 - methylhex - 3 - en - 1 - ol (2) 5 - ethyl - 4 - methylhex - 3 - en - 1 - ol
 (3) 3 - methyl - 5 - ethylhex - 3 - en - 6 - ol (4) 2 - ethyl - 4 - methylhex - 3 - ene - 1 - ol
 (5) 4 - ethyl - 3 - methylhex - 3 - ene - 6 - ol

- (14) A gaseous hydrocarbon contains hydrogen about 14%. The volume of 0.042 g of that gas at STP is 13.44 cm^3 . The molecular formula of the hydrocarbon is,
 (1) C_5H_{12} (2) C_5H_{10} (3) C_4H_8 (4) C_4H_{10} (5) C_5H_8
- (15) The energy of a mole of photon of an electro magnetic radiation is 203 kJ mol^{-1} . The wave length of that radiation (in nm) is,
 (1) 459 (2) 589 (3) 671 (4) 781 (5) 856
- (16) Consider the following facts about 3 compounds A, B and C,
 A - An amphoteric oxide
 B - An electron deficient compound
 C - A strong oxidizing agent
 The most suitable set of compounds for A, B and C are respectively,
 (1) Al_2O_3 , BeCl_2 , $\text{K}_2\text{C}_2\text{O}_4$ (2) BeO , AlCl_3 , KMnO_4 (3) K_2O , AlCl_3 , $\text{K}_2\text{Cr}_2\text{O}_7$
 (4) ZnO , BeCl_2 , $\text{K}_2\text{C}_2\text{O}_4$ (5) MgO , AlCl_3 , KMnO_4
- (17) Which of the following reaction steps is a chain propagation step in the chlorination of methane (CH_4) ?
 (1) $\text{Cl}_2 \rightarrow 2\dot{\text{Cl}}$ (2) $\dot{\text{C}}\text{H}_3 + \dot{\text{C}}\text{H}_3 \rightarrow \text{C}_2\text{H}_6$ (3) $\dot{\text{C}}\text{H}_3 + \dot{\text{Cl}} \rightarrow \text{CH}_3\dot{\text{Cl}}$
 (4) $\dot{\text{C}}\text{HCl}_2 + \dot{\text{H}} \rightarrow \text{CH}_2\text{Cl}_2$ (5) $\dot{\text{C}}\text{H}_2\text{Cl} + \text{Cl}-\text{Cl} \rightarrow \text{CH}_2\text{Cl}_2 + \dot{\text{Cl}}$
- (18) Which of the following statement is false with regard to NH_3 gas and ammonium salts ?
 (1) Ammonia dissolves easily in water forming a weak basic solution.
 (2) Ammonium salts react with $\text{Ba}(\text{OH})_2$ liberating $\text{NH}_3(\text{g})$.
 (3) Ammonium salts decompose at the presence of heat easily liberating NH_3 gas.
 (4) Ammonia reacts with metals as an oxidizing agent under dry conditions.
 (5) The compound that formed in the reaction between Cl_2 gas and excess ammonia is used as a disinfectant for water.
- (19) The reaction between potassium superoxide (KO_2) and CO_2 is given below.

$$4\text{KO}_2(\text{s}) + 2\text{CO}_2(\text{g}) \rightarrow 2\text{K}_2\text{CO}_3(\text{s}) + 3\text{O}_2(\text{g})$$
 2.84g of $\text{KO}_2(\text{s})$ and 7.76g of $\text{CO}_2(\text{g})$ is allowed to react each other. The limiting reagent and the mass of O_2 formed respectively are, (K = 39, C = 12, O = 16)
 (1) KO_2 and 0.48 g (2) KO_2 and 4.8 g (3) CO_2 and 0.24 g
 (4) CO_2 and 0.96 g (5) KO_2 and 0.96 g
- (20) Temperature of $\text{O}_2(\text{g})$, which has the same root mean square velocity as He (g) gas which remains at 300 K is,
 (1) 1200 K (2) 2400 K (3) 12000 K (4) 2400°C (5) 1000 K
- (21) Which of the following statements is false with regard to the elements of group 18 and Xe ?
 (1) The boiling point of Xe is greater than He.
 (2) XeO_3 is trigonal planer shape and the oxidation number of Xe is +6
 (3) XeF_2 molecule is non polar.
 (4) All element have a positive value for the election gain enthalpy.
 (5) Xe reacts with F_2 since the ionization energy is decreasing down the group.

- (22) The standard enthalpy of formation of H_2O is -242 kJ mol^{-1} . Bond dissociation enthalpy of $\text{H}_2(\text{g})$ and $\text{O}_2(\text{g})$ are $+436 \text{ kJ mol}^{-1}$ and $+496 \text{ kJ mol}^{-1}$ respectively. The mean bond dissociation enthalpy of the O - H bond of $\text{H}_2\text{O}(\text{g})$ (in kJ mol^{-1}) is,
- (1) +587 (2) +463 (3) -463 (4) +926 (5) -926
- (23) Which of the following reactions does not give a black coloured precipitate or compound ?
- (1) Passing H_2S through a lead acetate $\text{Pb}(\text{CH}_3\text{COO})_2$ solution.
 (2) Adding a lead $\text{Pb}(\text{NO}_3)_2$ solution to a $\text{Na}_2\text{S}_2\text{O}_3$ solution and heating.
 (3) The reaction between conc H_2SO_4 and sucrose.
 (4) Adding a BaCl_2 solution to a K_2SO_4 solution.
 (5) Passing H_2S gas through an aqueous solution of Cu^{2+} in acidic medium
- (24) 50 cm^3 of a $\text{H}_2\text{O}_2(\text{aq})$ solution acidified with dil H_2SO_4 and allowed to react with excess KI solution. To react completely with the liberated I_2 here 20 cm^3 of 0.01 mol dm^{-3} $\text{Na}_2\text{S}_2\text{O}_3$ solution is required. The concentration of H_2O_2 (in mol dm^{-3}) is,
- (1) 0.02 (2) 0.068 (3) 0.2 (4) 0.002 (5) 0.032
- (25) At 298 K the equal masses of $\text{CH}_4(\text{g})$ and $\text{O}_2(\text{g})$ exist in a closed rigid vessel. The ratio between the partial pressure of $\text{O}_2(\text{g})$ (P_{O_2}) and the total pressure (P_{T}) of the vessel is,
- (1) 1 : 2 (2) 1 : 3 (3) 2 : 3 (4) 3 : 1 (5) 1 : 5
- (26) Which of the following statement is true with regard to the reaction, $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$ $\Delta H^\circ = -198 \text{ kJ mol}^{-1}$
- (1) When 2mol of SO_3 is formed a heat of 396 kJ mol^{-1} is liberated to the environment.
 (2) This reaction is spontaneous at low temperatures.
 (3) The entropy change of this reaction takes a positive value.
 (4) When a mole of $\text{SO}_2(\text{g})$ is reacting, an energy of 99 kJ is absorbed from the environment.
 (5) This reaction is spontaneous in all temperatures.
- (27) Which of the following statement is correct ?
- (1) The bond angle of NF_3 is greater than the bond angle of NH_3 .
 (2) The density of graphite is greater than the density of diamond.
 (3) H_2O_2 is a uniplanar molecule.
 (4) The bond between C and O of CO has a tripple bond nature.
 (5) AlCl_3 Forms a dimer in gaseous state and the hybridization of Al of it is sp^2 .
- (28) When the inorganic compound X is heated with excess NaOH it liberates a gas with a pungent smell. It was heated until the gas liberation stopped. when Al dust was added to that mixture and heated, the above gas was liberated again. The compound X could be,
- (1) NH_4NO_3 (2) $(\text{NH}_4)_2\text{CO}_3$ (3) NaNO_3 (4) $(\text{NH}_4)_2\text{SO}_4$ (5) Na_2SO_3

- (29) A $\text{Fe}^{3+}(\text{aq})$ solution undergoes the following reactions.

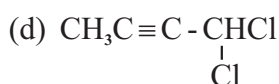
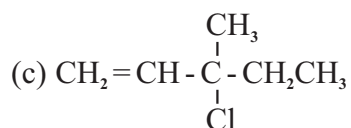
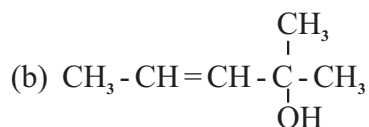
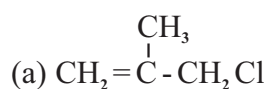


The colours of the complex ions A, B and C respectively are,

- (1) reddish brown, red, green (2) reddish brown, red, yellow (3) green, red, yellow
 (4) green, red, blue (5) reddish brown, blue, yellow.
- (30) The chemical equation which represents the standard enthalpy of atomization of Bromine ($\text{Br}_2(l)$) is,
- (1) $\frac{1}{2}\text{Br}_2(\text{g}) \rightarrow \text{Br}(\text{g})$ (2) $\text{Br}_2(l) \rightarrow \text{Br}_2(\text{g})$ (3) $\frac{1}{2}\text{Br}_2(l) \rightarrow \text{Br}(\text{g})$
 (4) $\text{Br}_2(l) \rightarrow 2\text{Br}(\text{g})$ (5) $\frac{1}{2}\text{Br}_2(l) \rightarrow \frac{1}{2}\text{Br}(\text{g})$

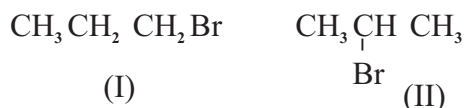
For each of the questions 31 to 40, one or more responses out of the four responses (a), (b), (c) and (d) given is/are correct. Select the correct response/responses in accordance with the instructions given on your answer sheet, mark.

- (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.
- (31) Which of the following set/s of compounds that contain(s) the carbon atoms of the same hybridization state ?
 (a) H_2CO , C_2H_2 (b) HCN , CO_2 (c) CH_4 , C_2H_4 (d) C_2H_6 , H_2CO
- (32) The extensive property/properties is/are,
 (a) mass (b) temperature (c) refractive index (d) heat capacity
- (33) Which of the following compound /compounds gives/give two acids by reacting with water ?
 (a) N_2O_3 (b) PCl_5 (excess water) (c) NO_2 (d) SCl_2
- (34) Which of the following compound/s show(s) stereo isomerism ?



- (35) Which of the following statement/s is/are true regarding Hydrogen halides ?
- (a) The bond lengths of Hydrogen halides are increasing down the group 17.
 - (b) The boiling point of Hydrogen halides decreasing down the group 17.
 - (c) The acidic strength of Hydrogen halides is increasing down the group 17.
 - (d) $\text{AgNO}_{3(\text{aq})}$ and $\text{NH}_{3(\text{aq})}$ can be used to distinguish between Hydrogen halides each other.
- (36) Which of the following enthalpy change/s is / are always negative value ?
- (a) The enthalpy of atomization
 - (b) The enthalpy of combustion.
 - (c) The enthalpy of evaporation.
 - (d) The enthalpy of hydration.

- (37) The following 2 products formed in the reaction between $\text{CH}_3\text{CH}=\text{CH}_2$ and HBr



Which of the following statement/s is/are true ?

- (a) According to Markovnikov's law, the main product is I.
 - (b) The main product is II.
 - (c) A more stable intermediate carbo cation is formed in the formation of product II.
 - (d) Both I and II products are formed in the same amount
- (38) Which of the following statement/s is/are false regarding transition elements ?
- (a) V_2O_5 is used as a catalyst in the process of H_2SO_4 production.
 - (b) Aqueous $\text{Zn}^{2+}(\text{aq})$ and $\text{Sc}^{3+}(\text{aq})$ ions are colourless.
 - (c) Only transition elements have the ability to form the coordination complex ions.
 - (d) All the coordination complexes formed by transition metal ions are colourful.
- (39) The composition of $\text{Na}^+(\text{aq})$ ions present in an aqueous solution of Na_2CO_3 is 46 ppm. The density of this solution is 1gcm^{-3} . Which of the following statements/s is/ are correct ?
- (a) The concentration of $\text{Na}^+(\text{aq})$ is $1 \times 10^{-4}\text{mol dm}^{-3}$
 - (b) The concentration of $\text{SO}_4^{2-}(\text{aq})$ is $1 \times 10^{-4}\text{mol dm}^{-3}$
 - (c) The concentration of SO_4^{2-} is 96ppm.
 - (d) The concentration of Na_2CO_3 is $1 \times 10^{-4}\text{mol dm}^{-3}$
- (40) Which of the following pairs of solutions give (s) the colourful precipitate/s when mixed ?
- (a) Na_2CO_3 and H_2SO_4
 - (b) NaI and AgNO_3
 - (c) BaCl_2 and K_2CrO_4
 - (d) CaCl_2 and $\text{K}_2\text{C}_2\text{O}_4$

● **Instruction for questions 41 -50.**

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
False	False	5

First statement	Second statement
(41) Acidified $K_2C_2O_4$ can be used to determine the concentration of a $KMnO_4$ solution.	$K_2C_2O_4$ is a primary standard.
(42) The boiling point of H_2O_2 is greater than that of H_2O	H bonds are present among the molecule of H_2O_2 and H_2O
(43) The boiling point of pentane (C_5H_{12}) is greater than 2-methylbutane	pentane and 2-methylbutane are chain isomers.
(44) Diamond is an allotropic form of carbon that does not conduct electricity.	The hybridization of C present in diamond is sp^3
(45) The atomic spectrum of hydrogen is a line spectrum.	Each line of the spectrum corresponds to an energy level of H atom.
(46) The shape of BF_3 and NH_3 is trigonal planer.	Both BF_3 and NH_3 are hetero atomic molecules.
(47) All C-O bond lengths of HCO_3^- are equal.	There are 3 stable resonance structures for HCO_3^-
(48) The acidity of the oxoacids of Cl varies as $HOCl < HClO_2 < HClO_3 < HClO_4$.	When the oxidation number of chlorine is increasing the acidic strength is increasing.
(49) H_2S reacts only as a reducing agent.	The oxidation number of S atom of H_2S is - 2
(50) The pressure of an ideal gas that contains in a rigid vessel is decreasing when the temperature is decreasing.	When the temperature is increasing the distance among the molecules is increasing.

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විසම් පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව Provincial Department of Education - NWP
 විසම් පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව Provincial Department of Education - NWP
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තෙවන වාර පරීක්ෂණය - 12 ශ්‍රේණිය - 2024
 Third Term Test - Grade 12 - 2024

Index No.:

CHEMISTRY - II

Time 03 hours

Extra reading time 10 minutes

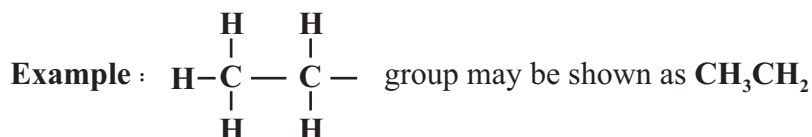
Use **additional reading time** to go through the question paper, select the questions **and** decide on the questions that you give priority in answering.

- A Periodic Table is provided on page 15.

- Use of calculators is not allowed.

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

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



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 :	



Structured Essay**Part -A**

- Answer all four questions on this paper itself.

(01) (a) You are provided with the following list of compounds.

Note - A compound should be used only once.



Which one of the above compounds,

- (i) is thermally stable
- (ii) the solid compound that is soluble in warm water though insoluble in cold water is
- (iii) gives a colour change when it is heated in the presence of water
- (iv) forms a dimer in the gaseous state.
- (v) is soluble in dil HCl and dil NaOH though insoluble in cold water.
- (vi) liberates a colourful gas when dil HCl is added.

(1a. 4 x 6 = 24 marks)

(b) (i) Draw the most acceptable Lewis structure for the ion $(\text{CN}_3\text{H}_6)^+$

(ii) Draw another two Lewis structures (resonance structures) for the Lewis structure drawn in part (i) above.



(iii) Based on the Lewis structure and the labelled skeleton given below, fill in the table.



	¹ C	² C	³ C	⁴ N	⁵ O
(I) Electronpair geometry.					
(II) shape					
(III) oxidation number					

- Parts (iv) and (v) are based on the Lewis structure given in part (iii) above. Labeling of atoms is as in part (iii).

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

- | | | |
|---------------------------------------|------------------------|------------------------|
| (I) H - ¹ C | H - | ¹ C - |
| (II) ¹ C - ² C | ¹ C - | ² C - |
| (III) ² C - ³ C | ² C - | ³ C - |
| (IV) ³ C - ⁴ N | ³ C - | ⁴ N - |
| (V) ³ C - ⁵ O | ³ C - | ⁵ O - |

(v) Arrange the atoms ¹C, ²C, ³C, ⁵O, ⁴N in the increasing order of electro negativity.

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(1b. 52 marks)

(c) Arrange the followings in the increasing order of the property indicated in parenthesis.

(i) $\text{Cl}_2, \text{Ar}, \text{Al}, \text{Si}$ (melting point)

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(ii) $\text{CO}, \text{H}_2\text{CO}, \text{CH}_3\text{OH}, \text{HCO}_3^-$ (Oxidation number of carbon)

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(iii) $\text{MgCl}_2, \text{MgBr}_2, \text{MgI}_2, \text{MgF}_2$ (ionic nature)

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(vi) $\text{B}, \text{O}, \text{F}, \text{N}$ (Second ionization energy)

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(1c. 24 marks)

(02)(a) X is an element that belongs to S block in the periodic table. The atomic number of X is less than 20. The first ionization energy of X is not the highest value of the group. X gives a white precipitate X_1 by burning with a bright white flame when it is burnt in air. X does not react with cold water. X reacts with hot water and gives a whitish precipitate X_2 that is insoluble in water and liberates the gas X_3 . The stable compound X_4 is formed when X is heated with N_2 gas. X_2 is formed and colourless gas X_5 with a pungent smell is liberated when X_4 is reacted with water. The gas X_5 turns red litmus blue.

(i) Identify X and the species X_1 to X_5 .

X = X_3 -

X_1 = X_4 -

X_2 = X_5 -

(ii) Write the electron configuration of X.

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(iii) Write the balanced chemical equation for the following reactions.

(I) between X and N_2 -

(II) between X and hot water -

(III) between X_4 and water -

(iv) Write a simple test to distinguish the gas X_5 . Write the observations of it.

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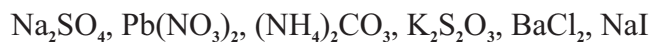
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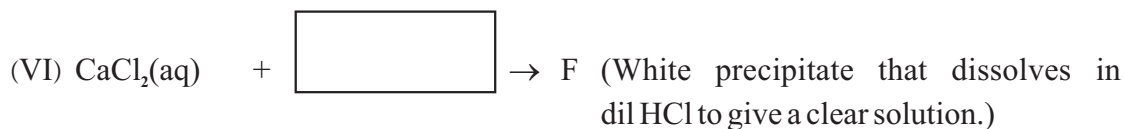
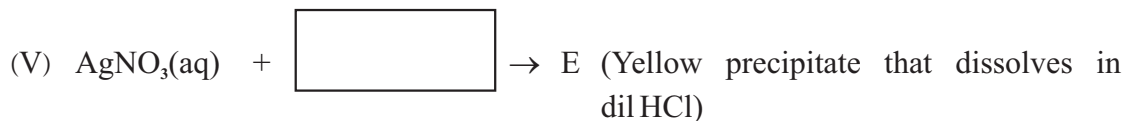
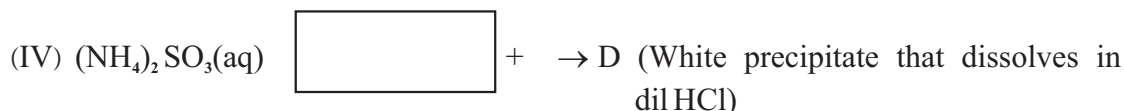
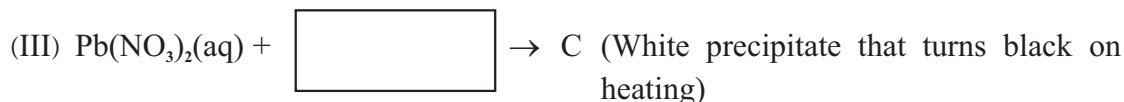
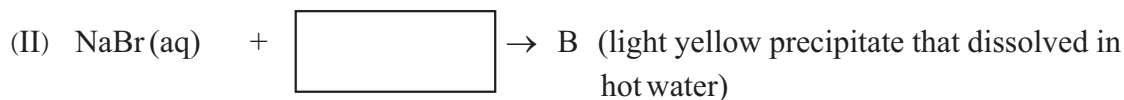
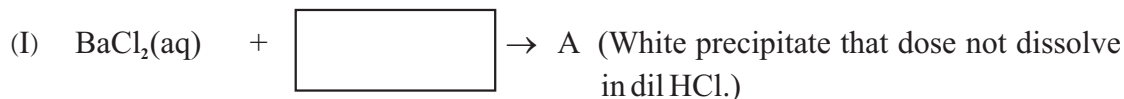
(2a. 55marks)

- (b) (i) Complete the reactions given below by selecting the appropriate solution from the given list and write in the box.

List of solutions (not in order)



Note : A solution should be used only once.



- (ii) Write the chemical formulae of the precipitates A to F.

A- D-

B- E-

C- F-

- (iii) Write the balanced chemical equations for the dissolution of precipitates D and F in b(i) above.

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- (iv) Write the balanced chemical equation to the chemical changes occurred when the precipitate C is heating.

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(2b. 45 marks)



- (03) (a) (i) Define the standard enthalpy of combustion of propane ($\text{CH}_3\text{CH}_2\text{CH}_3$)(g)

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- (ii) The following test was carried out to determine the standard enthalpy of combustion of propane. The mass of a cylinder of propane was measured and connected to a burner. Then a beaker that contains 400cm^3 of water was heated by that burner. The burner was turned off, when water was reached the maximum temperature of 85°C . and the mass of the cylinder was measured again.

- Initial mass of the cylinder = 1500 g
- Final mass of the cylinder = 1497.8 g
- Density of water = 27°C
- Specific heat capacity of water = $4.2\text{ J g}^{-1}\text{ }^\circ\text{C}^{-1}$

Using the above data calculate the amount of heat released in the combustion.

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- (iii) Calculate the standard enthalpy of combustion of propane.

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- (iv) The theoretical value of the standard enthalpy of combustion is -2220 kJ mol^{-1} . Write two reason for the difference between this theoretical value and the calculated value in (iii) above.

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- (b) Two flasks A and B are connected by a thin tube with a negligible volume. The volume of flask A is two times the volume of B. Initially when the tap is closed the flask A contains 0.6 mol of He and B contains 0.3 mol of H_2 . The pressure inside the flask A is $5 \times 10^4\text{ Pa}$ and the temperature of both flask is 300 K. Then the tap is opened and only the flask A is immersed in a vessel of 400 K. The flask B is kept at 300 K.

- (i) Calculate the initial pressure of the flask B.

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- (ii) Calculate the volume of the flask A and B.

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- (iii) Calculate the partial pressures of each gas when the tap is opened and the temperature is increased.

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- (iv) Calculate the total pressure of the combined vessels.

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- (v) State assumptions made in your calculations.

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- (c) Show that the reaction, $\text{CO(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$ is exothermic and spontaneous at 300K.

The standard enthalpy change of the reaction is $-0.094 \text{ kJ mol}^{-1} \text{ K}^{-1}$. The standard Gibbs energy values of $\text{CO}_2\text{(g)}$, $\text{O}_2\text{(g)}$ and CO(g) are $-394.4 \text{ kJ mol}^{-1}$, 0 kJ mol^{-1} and $137.2 \text{ kJ mol}^{-1}$ respectively.

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- (04) (a) P, Q and R are three isomers having the molecular formula C_6H_{12} . P shows diastereoisomerism, but Q and R do not show it. R shows enantiomerism. Q has only one directly bonded hydrogen to the sp^2 hybridized carbons. P, Q and R isomers react with HBr to give S, T and U respectively. S, T and U isomers react with C_2H_5OH / KOH and undergo catalytic hydrogenation. The both S and T isomers give the product V and U gives the product W. V and W are two position isomers.

Draw the structure of P, Q, R, S, T, U, V and W in the boxes given below.



P



Q



R



S



T



U

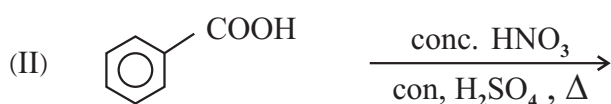


V



W

- (b) (i) Draw the structures of the products A, B, C, D and E of the following reactions (I - V), in the given boxes.





C



D



E

- (ii) (I) Write a test to distinguish between the organic starting compounds of I and IV reactions above.

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- (II) Writing A_E, A_N, S_E, S_N, E or O in the appropriate box classify each of the reactions (I - V) above as,

Electrophilic addition (A_E),

Nucleophilic addition (A_N),

Electrophilic substitution (S_E),

Nucleophilic substitution (S_N)

Elimination (E)

Any other reaction (O)

Reaction I.

Reaction II.

Reaction III.

Reaction IV.

Reaction V.

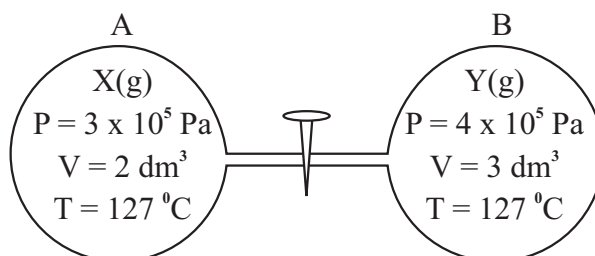
Part - B - Essay

● Answer the two question only.

- (05) (a) (i) Write van der waals equation that describes the behavior of real gases and identify all the terms in it.
- (ii) Show that the kinetic energy of a mole of an ideal gas, $KE = \frac{3}{2} RT$ using ideal gas equation and kinetic molecular equation.
- (iii) A rigid vessel contains 0.3 mol of N_2 gas, 0.4 mol of N_2O_3 gas and 0.2 mol of He at $27^\circ C$ and 3×10^5 Pa. N_2O_3 is thermally decomposed completely to its constituent elements by heating the system to the temperature of $327^\circ C$. By keeping the resultant gaseous system at $327^\circ C$, a sufficient amount of Mg powder is added to that system to react completely. water is added to the solid product obtained in this reaction, and the system is cooled again to $27^\circ C$. Assume that all these gases do not dissolve in water and the volume of solids are negligible relative to the volume of gases.
- (I) Write the balanced chemical equation for the reactions of the above procedure.
- (II) Calculate the mass of Mg required for the complete reaction ($Mg = 24$)
- (III) Calculate the pressure of the system at $27^\circ C$

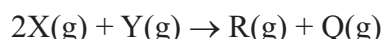
(5a. 75 marks)

- (b) Two bulbs A and B contain $X_{(g)}$ and $Y_{(g)}$ respectively. $X_{(g)}$ and $Y_{(g)}$ behave ideally and data of the initial state is given below.



Two bulbs are connected by a thin tube with a negligible volume and the tap is closed.

- (i) Calculate the initial moles of $X(g)$ and $Y(g)$.
- (ii) Calculate the total pressure of the system when the tap is opened.
- (iii) Calculate the partial pressure of $Y(g)$ when the tap is opened.
- (iv) Calculate the mole fraction of $X(g)$ when the tap is opened.
- (v) Assume that the following reaction is taken place when the temperature of the bulbs is measured to $227^\circ C$.



- (I) The total gas moles of the final system.
- (II) The total gas moles of A.
- (III) The pressure inside A.

(5b. 75 marks)



(06) (a) Define the following standard enthalpy changes. Give an example each by writing the balanced chemical reactions.

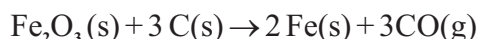
- Standard enthalpy of sublimation.
- Standard enthalpy of atomization.
- Standard enthalpy of first electron gain.

(6a. 30 marks)

(b) Consider the following reactions. thermodynamic data supplied are not for the standard state.

	ΔH (kJ mol ⁻¹)	ΔS (J K ⁻¹ mol ⁻¹)
$2\text{Fe(s)} + \frac{3}{2} \text{O}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s})$	-824	-274
$\text{C(s)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO(g)}$	-110	10

- (i) Calculate ΔH and ΔS for the reaction,



State giving reasons whether the sign of ΔS agrees with the reaction taking place.

- (ii) By means of a suitable calculations, predict whether the reaction given in part (i) above is spontaneous at 27°C.

(6b. 45 marks)

(c) Considering the thermodynamic data given below, construct a Born Haber cycle and use it to calculate the standard lattice dissociation enthalpy of MgBr₂ solid.

Standard enthalpy of formation of MgBr₂(s) = -524 kJ mol⁻¹

Standard enthalpies of first and second ionization of Mg (g) respectively
= 738 kJ mol⁻¹ and 1451 kJ mol⁻¹

Standard enthalpy of sublimation of Mg(s) = 146 kJ mol⁻¹

Standard enthalpy of evaporation of Br₂(l) = 31 kJ mol⁻¹

Standard enthalpy of bond dissociation of Br₂(g) = 193 kJ mol⁻¹

Standard enthalpy of electron gain of Br(g) = -325 kJ mol⁻¹

(6c. 75 marks)

(07) (a) 3 d block element M Forms an ion M²⁺. The highest oxidation number of M equals to the group number of M. M forms the aqueous complex P with water (P=[M(H₂O)₆]²⁺). P was subjected to the following reactions.

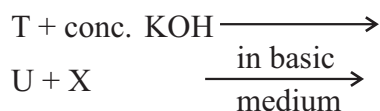
- ★ P forms the yellow coloured complex Q with conc HCl.
- ★ P forms the solid R with NaOH
- ★ R is also formed in the presence of excess NH₃.

The oxo anion T that is derived from the highest oxidation number of M acts as a strong oxidizing agent.

When T is slightly acidified with dil H₂SO₄ and a conc. KOH solution is added, U is formed.

When U is reacted with X in basic medium the solid compound S is formed. X is a covalent compound formed by two elements of first and second periods.

- (i) Identify the metal M.
- (ii) Write the electron configuration of M^{2+} ion.
- (iii) Write the chemical formulae and colours of P, R, S, T and U.
- (iv) Identify X.
- (v) Write IUPAC names of P and Q.
- (vi) Write the balanced ionic equation for the following reaction.



- (b) The solid X contains FeSO_4 , CuSO_3 an inert substance. The following procedure is carried out to determine the mass percentages of FeSO_4 and CuSO_3 in X.

5g of the solid X dissolved in a sample of dil H_2SO_4 and treated with 200 cm^3 0.1 mol dm^{-3} KMnO_4 . The ions Fe^{3+} , Mn^{2+} , SO_4^{2-} and Cu^{2+} are obtained as products in this reaction. The amount of KMnO_4 present in excess is titrated with 0.3 mol dm^{-3} Fe^{2+} solution. The consumed volume of Fe^{2+} is 100 cm^3 . Do not consider the effect of conversion of SO_3^{2-} ions to $\text{SO}_2(\text{g})$ in acidic medium.

(Fe = 56, S = 32, O = 16, Cu = 63.5)

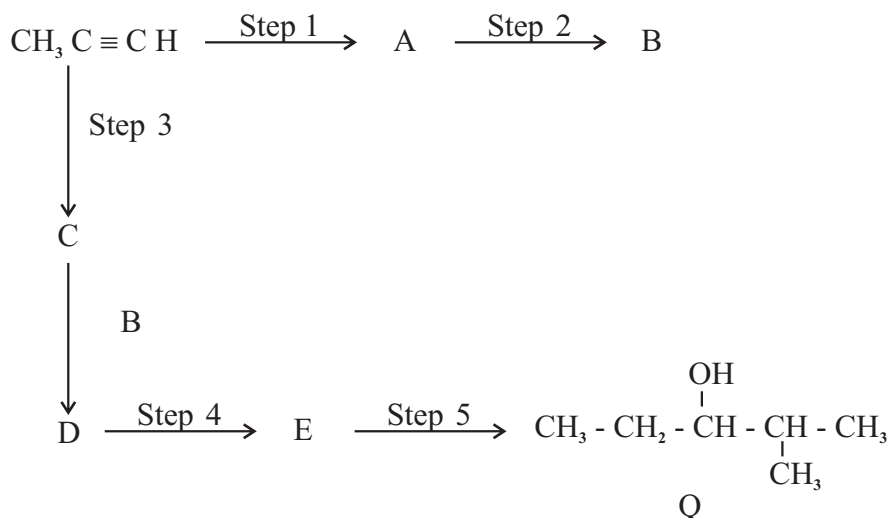
- (i) Write the balanced reaction between FeSO_3 and KMnO_4
- (ii) Write the balanced reaction between CuSO_3 and KMnO_4
- (iii) Calculate the mass percentage of FeSO_3 and CuSO_3

Part - C - Essay

- Answer two question only.

- (08) (a) (i) Given below is a reaction scheme for the synthesis of compound Q using $\text{CH}_3\text{C}\equiv\text{CH}$ as the organic starting compound.

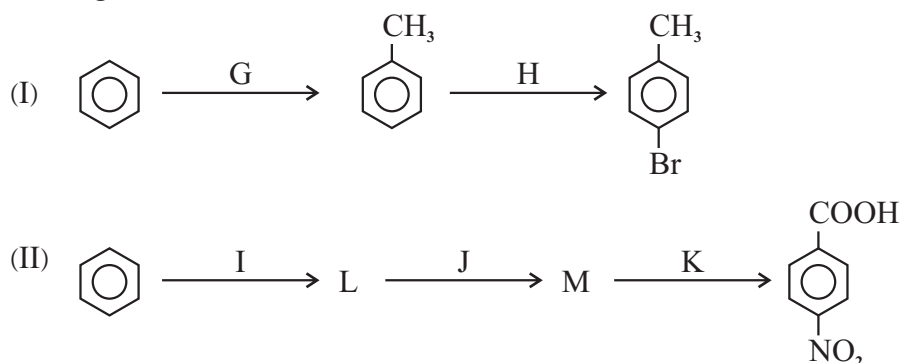
Complete the reaction scheme by drawing the structures of compounds A, B, C, D and E and writing the appropriate reagent for steps 1 - 5, select only from those given in the list.



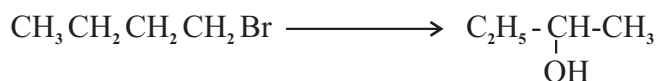
List of Reagents.

$\text{dil H}_2\text{SO}_4$, H_2 , HBr , NaNH_2 , $\text{Pd} - \text{BaSO}_4 / \text{Quinoline}$

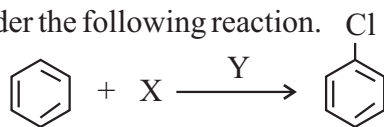
- (ii) Consider the following conversions. Draw the structures of the compounds L and M. Give the reagents G, H, I, J and K.



- (b) (i) Show how you would carry out the following conversion in not more than three (03) steps.



- (ii) Consider the following reaction.



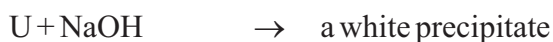
- (I) Identify the chemical compounds X and Y required to take place the reaction.

- (II) Write the mechanism of the reaction.

- (09) (a) Solid substances labeled as P, Q, R, S, T and U are AgNO_3 , $\text{Al}(\text{NO}_3)_3$, $\text{Pb}(\text{NO}_3)_2$, BaCl_2 , ZnCl_2 , and CaCO_3 (not in order.) The following tests are carried out and observations are given below.

	Tests	Observations
(1)	Compounds are dissolved separately in water	Only compound P does not dissolve in water.
(2)	$\text{Na}_2\text{S}_2\text{O}_3$ is added to the solution of Q, R, S, T and U	The white precipitates are Formed in the solutions of Q and R. The precipitates obtained by Q is turned black on standing.
(3)	$\text{Dil H}_2\text{SO}_4$ is added to the solution of S, T, U	A white precipitate that dissolves in dil HNO_3 is obtained by S.
(4)	NaOH is added dropwise to the solution of T and U.	gelatinous white precipitate is obtained by T and U.
(5)	Excess NH_3 is added to the white precipitate obtained in 4 above.	Only the precipitate obtained by T is completely dissolved.

- (i) Identify P, Q, R, S, T and U.
- (ii) Write the products obtained when the precipitate formed by R at the presence of $\text{Na}_2\text{S}_2\text{O}_3$ is heated.
- (iii) Write the balanced chemical equation for the reactions of U with NaOH.



- (iv) Write the balanced chemical equation for the reaction relevant to the dissolution of the precipitate that obtained when T is reacted with NaOH in aqueous NH_3 .
- (b) $\text{K}_2\text{Cr}_2\text{O}_7$ is a primary standard substance. 4.704 g of $\text{K}_2\text{Cr}_2\text{O}_7$ is dissolved completely in 500cm^3 of water. 25cm^3 of this solution is measured to the titration flask and it is acidified. An excess KI is added to it and titrated with a $\text{Na}_2\text{S}_2\text{O}_3$ solution. The volume of $\text{Na}_2\text{S}_2\text{O}_3$ at the end point is obtained as 24cm^3 at the presence of starch as the indicator.
- (i) Write 2 properties of a primary standard substance.
- (ii) Write the balanced chemical equation for the reaction occurred in the above titration.
- (iii) Calculate the concentration of $\text{Na}_2\text{S}_2\text{O}_3$ ($\text{K} = 39, \text{Cr} = 52, \text{O} = 16$)

- (10) (a) A and B are coordination compounds contain complex ions with an octahedral geometry. The atomic composition of the species in the coordination compounds is $\text{CoN}_5\text{H}_{12}\text{Cl}_2\text{O}_2$. All hydrogen of the compounds exists only as NH_3 . Compound A does not give a white precipitate with aqueous AgNO_3 . Compound B forms a white precipitate with aqueous AgNO_3 and it is soluble in dil NH_3 .
- (i) Write the structural formulae of A and B.
- (ii) Write the oxidation number of Co in A and B.
- (iii) Write the electron configuration of Co in the complex anion.
- (iv) All NH_3 present in A is replaced by the ligand $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$. Then the molecular geometry around M does not change. Draw the structure of the new complex ion obtained.
- (b) A certain contaminated water sample contains a mixture of FeSO_3 and FeSO_4 . The following procedure was used to determine the concentration of FeSO_3 and FeSO_4 .

Procedure 01 :

A solution is prepared by mixing 50 cm^3 of water with excess 0.6 mol dm^{-3} H_2O_2 solution (Solution A)

Procedure 02 :

25 cm^3 of 0.04 mol dm^{-3} KMnO_4 solution is consumed to react completely with 50 cm^3 of solution A.

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						

