අධ්‍යාපන,උසස් අධ්‍යාපන සහ වෘත්තිය අධ්‍යාපන අමාත්‍යාංශය
கல்வி, உயர்கல்வி மற்றும் தொழிற்கல்வி அமைச்சு
Ministry of Education, Higher Education and Vocational Education

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය **2026** උපකාරක ප්‍රශ්න පත්‍රය
General Certificate of Education (Adv. Level) Exam, 2026 Support Seminar Paper

රසායන විද්‍යාව I Chemistry I	**02**	**E**	**I**	**13** ශ්‍රේණිය **Grade 13**	*පැය දෙකයි* ***Two hour***

Universal gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$	Plank constant	$h = 6.626 \times 10^{-34}\ J\ s$
Avogadro constant	$N_A = 6.022 \times 10^{23}\ mol^{-1}$	speed of light	$c = 3 \times 10^{8}\ m\ s^{-1}$

Instructions: –

- *This question paper has **10** pages.*
- *A periodic table is provided and can be detached if necessary*
- *Answer **all** questions.*
- ***Use of calculators is not allowed**.*
- *Write your **Index number** in the space provided in the answer sheet.*
- *Follow the other instructions given on the back of the answer sheet carefully.*
- *In each of the questions **1** to **50**, pick one of the from the answers (1), (2), (3), (4), (5) which is **correct** or **most appropriate** and **mark your response on the answer sheet with a cross (x) in accordance with the instructions given on the back of the answer sheet.***

1. Which of the following elements has the **highest** first ionization energy?

   (1) N (2) F (3) Mg (4) S (5) P

2. The maximum number of electrons that can exsist in an atom with the atomic number 29, that have quantum numbers $l = 0$ and $m_s = +½$ is?

   (1) 1 (2) 3 (3) 4 (4) 7 (5) 8

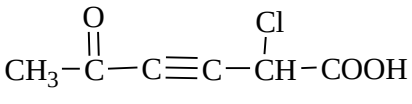
3. The shape and the electron pair geometry of IF_4^+ are respectively

   (1) Tetrahedral , Tetrahedral
   (2) Tetrahedral, Trigonal bipyramidal
   (3) Trigonal bipyramidal, Seesaw
   (4) Seesaw, Trigonal bipyramidal
   (5) Trigonal bipyramidal, T shape

4. Which answer correctly states the increasing order of electronegativity of the central atom in the compounds H_2O, NO_4^{3-}, NH_4^+, CH_4 and HCN

   (1) $CH_4 < NH_4^+ < NO_4^{3-} < H_2O < HCN$
   (2) $CH_4 < NH_4^+ < HCN < NO_4^{3-} < H_2O$
   (3) $HCN < H_2O < NO_4^{3-} < NH_4^+ < CH_4$
   (4) $HCN < CH_4 < NO_4^{3-} < NH_4^+ < H_2O$
   (5) $CH_4 < HCN < NH_4^+ < NO_4^{3-} < H_2O$

5. What is the IUPAC name of the compound given below?



   (1) 1–chloro–4–oxopent–3–ynoic acid
   (2) 5–chloro–6–hydroxyhex–3–yn–2,6–dione
   (3) 2–chloro–5–oxohex–3–ynoicacid
   (4) 2–chloro–5–oxohex–3–yneoic acid
   (5) 2–chloro–5–oxohex–3–ynoic acid

6. Which answer **correctly** states the variation of boiling points?

(1) $CH_3CH(CH_3)_2 < CH_3CH_2CH_2CH_3 < CH_3CH_2CHO < CH_3COCH_3$
(2) $CH_3CH_2CH_3 < CH_3CH_2OH < CH_3CH_2Cl < CH_3COOH$
(3) $CH_3CH_2CH_3 < CH_3OH < CH_3CH_2OH < CH_3CH_2CH_2CH_3$
(4) $CH_3CH_2Cl < CH_3CHO < CH_3CH_2OH < CH_3CH_2CH_3$
(5) $CH_3–O–CH_3 < CH_3CH_2OH < CH_3COCH_3 < CH_3CH_2CH_3$

7. The solubility of sparingly soluble ionic compound $M(OH)_3(s)$ in water at 298 K is 1.0×10^{-5} mol dm^{-3}. The solubility of $M(OH)_3(s)$ in mol dm^{-3} in a solution where pH = 8.0, is,
(1) 1×10^{-23} (2) 2.7×10^{-5} (3) 1×10^{-4}
(4) 2.7×10^{-3} (5) 1×10^{-2}

8. Consider the following reaction.

$$H_3C-C\equiv C-H \xrightarrow[\text{dry ether}]{H_3CMgBr} A \xrightarrow[\text{ii. } H_3O^+]{\text{i.}CH_3COCH_3} B$$

The results A and B obtained here can be respectively

(1) $H_3C-C\equiv C-CH_3$, $H_3C-\underset{\displaystyle CH_3}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-C\equiv C-CH_3$
(2) $H_3C-C\equiv C\,MgBr$, $H_3C-\underset{\displaystyle CH_3}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-C\equiv C-CH_3$
(3) $H_3C-C\equiv C\,MgBr$, $H_3C-\underset{\displaystyle H}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-C\equiv C-CH_3$
(4) $H_3C-\underset{\displaystyle MgBr}{\underset{|}{C}}=CHCH_3$, $H_3C-\underset{\displaystyle CH_3}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH-CH_3$
(5) $H_3C-\underset{\displaystyle MgBr}{\underset{|}{C}}=CH_2$, $H_3C-\underset{\displaystyle CH_3}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-CH_2-C\equiv CH$

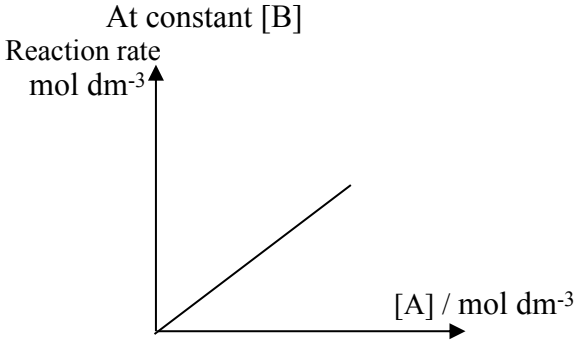
9. When 0.428 g of KIO_3 and 0.83 g of KI, are dissolved in 100.00 cm^3 of 0.001 mol dm^{-3} H_2SO_4, and the resulting I_2 is titrated with a 0.050 mol dm^{-3} $Na_2S_2O_3$ solution using starch as the indicator, the expected endpoint volume (cm^3) is (K – 39, I – 127, O – 16, H – 1)
(1) 10.00 (2) 20.00 (3) 24.00 (4) 30.00 (5) 40.00

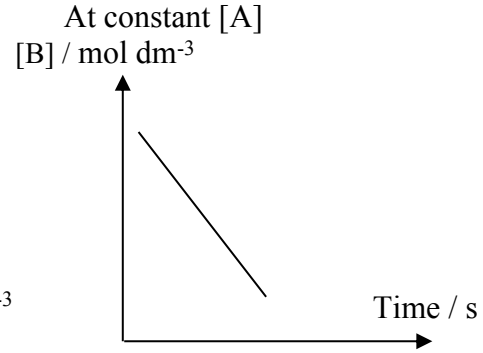
10. The **false** statement about the reaction $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br$ is,

(1) This is a nucleophilic addition reaction.
(2) During the reaction it forms the $R-\overset{+}{O}(H)-H$ intermediate
(3) OH^- ion is formed as a by product of the reaction.
(4) The Br^- ion behaves as a nucleophile.
(5) This reaction occurs in two steps.

11. A large amount of a trivalent metal, M, was reacted completely with 50 cm^3 of a certain HNO_3 solution. The metal nitrate, NH_4OH, and water were formed. After the reaction was complete, when an excess NaOH was added to the solution at room temperature, a gas was evolved. The evolved gas was absorbed in to 100.00 cm^3 of 0.20 mol dm^{-3} HCl. And this solution was then titrated with 1.00 mol dm^{-3} NaOH, the burette reading was 10.00 cm^3. What is the concentration of the HNO_3 solution used in (mol dm^{-3})?
(1) 0.02 (2) 0.10 (3) 0.20 (4) 1.00 (5) 2.00

12. The kinetic data obtained at constant temperature for the reaction of A+ B → 2D are represented by the graphs below.





Which of the following statement is correct about the reaction given according to the above graphs?

(1) This reaction is a bimolecular elementary reaction.
(2) At a constant concentration of A, doubling the concentration of B doubles the rate of the reaction.
(3) The half-life ($t_{½}$) of B does not depend on the initial concentration.
(4) The rate law for this reaction is given by k[A][B]. (k = rate constant)
(5) This reaction is a multistep reaction.

13. When 25.00 cm^3 of a 0.25 mol dm^{-3} NH_4Cl solution and 25.00 cm^3 of a 0.20 mol dm^{-3} NaOH solution are mixed at 298 K, the pH of the resulting solution is, ($K_{b(NH_3)}$ =1.8 x 10^{-5} mol dm^{-3} , note that none of the products leave the system).

(1) 4.14 (2) 5.26 (3) 5.60 (4) 9.85 (5)10.60

14. At a given temperature, $YZ_2(g)$ and $Z_2(g)$ are added in a 2:1 molar ratio into a rigid closed vessel. Then the following reaction takes place.

$$2YZ_2(g) + Z_2(g) \rightleftharpoons 2YZ_3(g)$$

At equilibrium, if the total pressure of the system is P and the mole fraction of $YZ_3(g)$ is X, the value of the equilibrium constant (K_p) is given by,

(1) $\frac{(2X)^2.P}{(2-2X)^2(1-X)}$ (2) $\frac{(XP)^2}{2(1-X)^3}$ (3) $\frac{9X^2}{4(1-X)^3.P}$ (4) $\frac{27X^2}{4(1-X)^3.P}$ (5) $\frac{2X^2}{27(1-X)^3.P}$

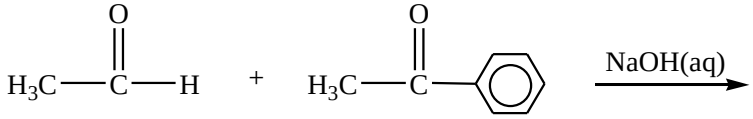
15. A weak monobasic acid, HX, is soluble in water as well as in a nonpolar organic solvent, B. A solution prepared by dissolving 0.12 moles of HX in 100.00 cm^3 of water was added to a separating funnel with 50.00 cm^3 of the organic solvent B was mixed thoroughly , and the system was allowed to reach the equlibrium. The pH of the aqueous phase of the equilibrium system at 25 ^{0}C is 3. The dissociation constant of HX at 25 ^{0}C is 1 x 10^{-6} mol dm^{-3}. The distribution coefficient of HX between water and B is,

(1) 1.0 (2) 2.5 (3) 3.5 (4) 4.0 (5) 4.5

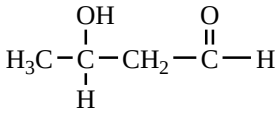
16. The solubility products of AgCl(s) and Ag_2CrO_4 (s) at 25 ^{0}C are 1 x 10^{-10} mol^2 dm^{-6} and 4 x10^{-12} mol^3 dm^{-9} respectively. Which of the following statements is **correct** at 25 ^{0}C?

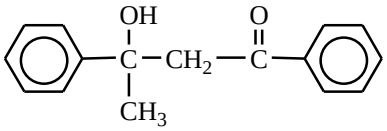
(1) The solubility of Ag_2CrO_4 (s) is less than that of AgCl(s).
(2) When 50.00 cm^3 of 1.0 x 10^{-5} mol dm^{-3} NaCl (aq) solution and 50.00 cm^3 of 1.0 x 10^{-5} mol dm^{-3} $AgNO_3$ (aq) solution are mixed, a precipitate forms.
(3) When a 0.1 mol dm^{-3} $NaNO_3$ (aq) solution is added to a saturated solution of AgCl, the solubility of AgCl decreases.
(4) When NH_3(aq) is added to the equilibrium system AgCl(s) $\rightleftharpoons Ag^+(aq) + Cl^-(aq)$, the precipitation of AgCl(s) increases.
(5) When NaCl(aq) is added to the equilibrium system $Ag_2CrO_4(s) \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)$, the yellow color of the solution increases.

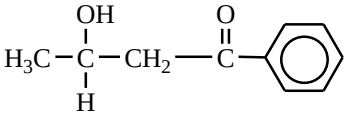
17. Consider the following reaction.

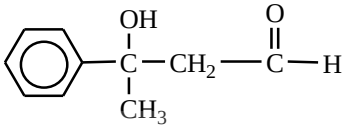


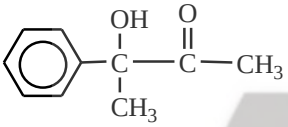
Which of the following cannot be a main product of this reaction

(1) 

(2) 

(3) 

(4) 

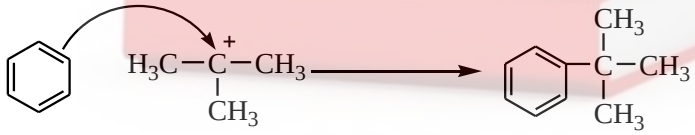
(5) 

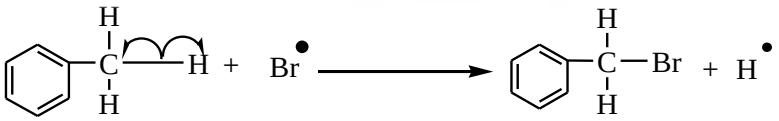
18. When 50.00 cm^3 of an aqueous $BaCl_2$ solution is added to an excess of $AgNO_3$ (aq) solution, the dry mass of the precipitate obtained is 2.87 mg. If the density of the initial aqueous $BaCl_2$ solution is 1.20 g cm^{-3}, the Ba^{2+}(aq) composition of the initial $BaCl_2$ solution in ppm is,
(1ppm = 1 mg kg^{-1}, Ba = 137, Ag = 108, Cl = 35.5, N – 14, O – 16)
(1) 11.4 (2) 22.8 (3) 27.4 (4) 34.7 (5) 45.7

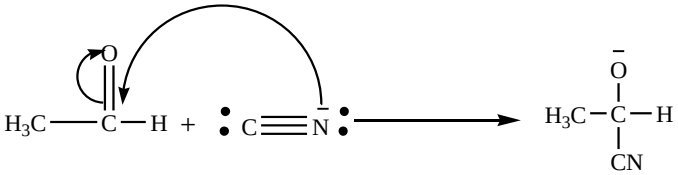
19. The standard enthalpy of combustion of C_2H_5OH(l) is -1360 kJ mol^{-1} and the standard enthalpy of vaporization of H_2O(l) and C_2H_5OH(l) are +44.0 kJ mol^{-1} and +42.0 kJ mol^{-1} respectively. The standard bond dissociation enthalpies of the bonds C – C (g), C – H (g), O – H (g), C = O (g) and O = O (g) are +350 kJ mol^{-1}, +415 kJ mol^{-1},+460 kJ mol^{-1},+800 kJ mol^{-1} and +495 kJ mol^{-1} respectively. The standard bond dissociation enthalpy of the C – O (g) bond is
(1) 232 (2) 240 (3) 320 (4) 340 (5) 497

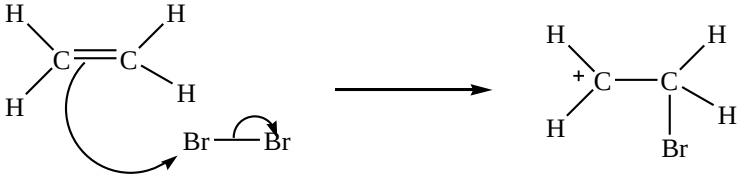
20. Which of the following mechanistic steps is correct?

(1) 

(2) 

(3) 

(4) 

(5) 

21. The details for the following solvent mixtures are as follows.

Very dilute glucose solution	Methanol and ethanol mixture	A solution made by dissolving ethanol in water
Solution A	Solution B	Solution C

The strength of the attractive forces in solutions A, B and C is as follows.

Solution A =>

Glucose – Glucose attraction force = Water – Water attractive force = Glucose – Water attractive force

Solution B =>

Methanol – Methanol attractive force = Ethanol – ethanol attractive force = Methanol – ethanol attractive force

Solution C =>

Water – Water attractive force > Ethanol – ethanol attractive force

Which of the following sttements is **correct** regarding the application of Raoult's law to the above solutions is:

(1) Since solution A contains only water as a volatile liquid, Raoult's law cannot be applied.
(2) When ethanol is added to solution C, a solution that obeys Raoult's law is formed.
(3) When further methanol is added to solution B, a solution that obeys Raoult's law is not formed.
(4) Solutions A and B obey Raoult's law.
(5) Solution C shows a slight negative deviation from Raoult's law.

22. Which of the following is **most accurate** about the experiment conducted to determine the effect of reactant concentration on the rate of the reaction between $Na_2S_2O_3$ and acid?
(1) Here, the time taken to obtain a constant volume of SO_2 is measured.
(2) The acid concentration is always maintained at a low level relative to the $S_2O_3^{2-}$ concentration.
(3) The amount of sulfur obtained in a constant time is measured here.
(4) In this experiment, it is not necessary to know the concentration of $Na_2S_2O_3$ at the beginning of the reaction.
(5) The rate of the reaction between $Na_2S_2O_3$ and acids can be found from this.

23. The reaction $\frac{1}{2}H_2(g) + AgCl(s) \rightarrow H^+(aq) + Cl^-(aq) + Ag(s)$ takes place in a galvanic cell. The correct IUPAC notation of this cell which operates under the standard conditions is,
(1) Ag(s) | AgCl (s) | KCl (aq,1.0 mol dm^{-3}) | $AgNO_3$ (aq,1.0 mol dm^{-3}) | Ag(s)
(2) Pt(s) | H_2 (g,1atm) | HCl (aq,1.0 mol dm^{-3}) ⋮ $AgNO_3$ (aq,1.0 mol dm^{-3}) | Ag(s)
(3) Pt (s) | H_2 (g,1atm) | HCl (aq,1.0 mol dm^{-3}) | AgCl (s) | Ag(s)
(4) Pt(s) | ½ H_2 (g,1atm) | HCl (aq,1.0 mol dm^{-3}) | AgCl (s) | Ag(s)
(5) Ag(s) | AgCl(s) | HCl (aq,1.0 mol dm^{-3}) | H_2 (g,1atm) | Pt(s)

24. For the equilibrium system $A_2(g) + B_2(g) \rightleftharpoons A_2B_2(g)$in a rigid closed vessel of volume 1 dm^3 at 25 ^0C, $K_C = 3 \times 10^{18}$ mol^{-1} dm^3. Initially, 0.2 mol of $A_2(g)$ and 0.15 mol of $B_2(g)$ were added to the vessel and allowed to equilibrate. What is the concentration of $B_2(g)$ in mol dm^{-3} at equilibrium?
(1) 1×10^{-18} (2) 1×10^{-15} (3) 1×10^{-12} (4) 1×10^{-10} (5) 1×10^{-8}

25. Which of the following statements is **false** regarding iron extraction?
(1) CO gas acts as the main oxidizing agent in the furnace.
(2) Liquid iron flowing out of the blast furnace contains 3% - 4% organic impurities.
(3) The CaO formed in the furnace forms slag.
(4) If too much air is supplied to the furnace, CO will be converted into CO_2, which is a disadvantage.
(5) At low temperatures, the stability of CO_2 is less and the stability of CO is high.

26. Which of the following statements is true regarding the chemistry of halogens?
(1) The bond energy of halogens decreases as $F_2 > Cl_2 > Br_2 > I_2$.
(2) The acidity of hydrogen halides decreases as HF > HCl > HBr > HI.
(3) The energy released when an electron is added to halogens decreases as F > Cl > Br > I.
(4) The oxidizing properties of halogens decrease as F > Cl > Br > I.
(5) The acidity of oxo acids of chlorine decreases as $HOCl > HClO_2 > HClO_3 > HClO_4$

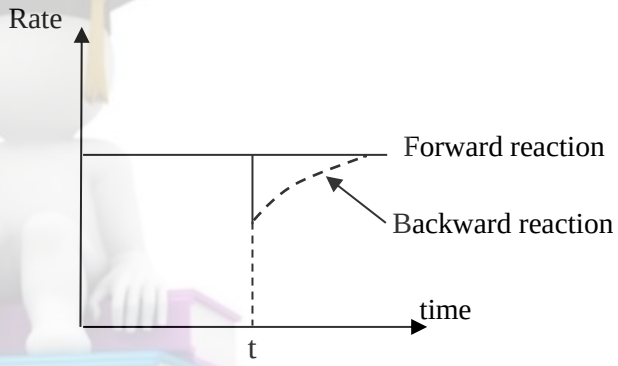
27. At what temperature in ^0C does the root mean square speed of an ideal gas at a temperature of 127 ^0C increase by 50%?
(1) 127 (2) 327 (3) 400 (4) 627 (5) 900

28. Which of the following correctly gives the variation of the base strength of the following species in aqueous medium.
(a) CH_3COO^- (b) $CH_3 - C \equiv C^-$ (c) $C_2H_5O^-$ (d) ^-OH (e) $C_6H_5O^-$
(1) a < b < c < e < d (2) b < a < e < c < d (3) b < c < d < e < a
(4) c < d < e < a < b (5) a < e < d < c < b

29. A small amount of solid PbI_2 was added to a beaker containing distilled water and mixed well. Most of the PbI_2 settled to the bottom of the beaker, while a very small amount dissolved in the water, resulting in the following equilibrium.

$$PbI_2(s) \rightleftharpoons Pb^{2+}(aq) + 2I^-(aq)$$

The forward and backward reaction rates were studied for this process.

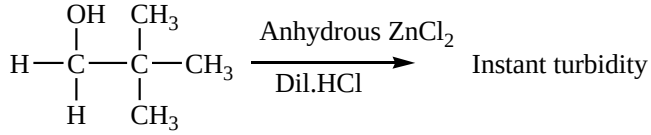


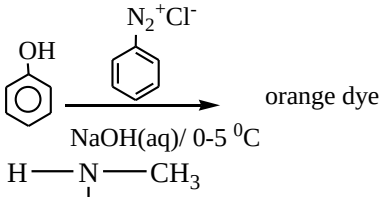
The change that has occurred at time t is
(1) The beaker was cooled suddenly.
(2) Addition of a small amount of $Pb(NO_3)_2$ solid to the beaker.
(3) Addition of a small amount of KI solid to the beaker.
(4) Addition of a small amount of water to the beaker.
(5) Removal of a small amount of PbI_2 solid from the beaker.

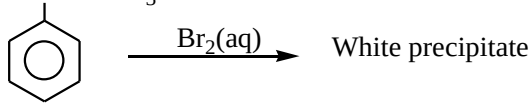
30. Which of the following is false about the reagents and observations that can be used to identify the organic compounds given below?

(1) 

(2) 

(3) 

(4) 

(5) 

- For each 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 (b) and (c) are correct
(4) If only (b) and (c) are correct
(5) If **any other** number or combination responses is correct

Summary of the above instructions

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

31. The **true** statement/statement regarding the reaction of carboxylic acids with alcohols to form esters is
(a) In this reaction, concentrated H_2SO_4 acts as a catalyst.
(b) This is a nucleophilic substitution reaction.
(c) A tetrahedral intermediate is formed in this reaction.
(d) At the beginning of the reaction, a water molecule is removed from the acid and alcohol.

32. The **true** statement/statement regarding the production of NaOH using the membrane cells is
(a) The anode of the membrane cell is made up of nickel metal.
(b) Only positive ions can pass through the polymeric membrane of the membrane cell.
(c) H_2 gas is released near the cathode of the cell.
(d) Seawater is constantly introduced into the anode chamber of the cell.

33. Cu(s) oxidizes dilute HNO_3 acid to NO(g). Cu(s) oxidizes concentrated HNO_3 acid to NO_2(g). The balanced chemical equations and electromotive force of the cell corresponding to the above reactions are as follows.

Cell 1 $3Cu(s)+2NO_3^-(aq)+8H^+(aq)\rightarrow 3Cu^{2+}(aq)+2NO(g)+4H_2O(l)\ \ E^0=+0.62V$

Cell 2 $Cu(s)+2NO_3^-(aq)+4H^+(aq)\rightarrow Cu^{2+}(aq)+2NO_2(g)+2H_2O(l)\ \ E^0=+0.45V$

Select the **false** statement/statement from the following statements.
(a) The cathode reaction is the same in both cells.
(b) $Cu^{2+}(aq)+2e\rightleftharpoons Cu(s)$ is a half-cell belonging to both cells.
(c) The pH of the electrolyte increases during the cell reaction.
(d) Reduction of concentrated HNO_3 by Cu is eaier than that of dilute HNO_3.

34. Select the **false** statement/statement regarding the reactions of phenol.
(a) Phenol reacts with Na(s) as well as NaOH(aq) to give sodium phenate ion.
(b) Phenol is nitrated at 20 ^{0}C with dilute nitric acid to give 2,4–dinitrophenol.
(c) Phenol undergoes nucleophilic substitution reaction with PCl_5.
(d) Phenol reacts with Br_2(aq) to give a white precipitate of 2,4,6–tribromophenol.

35. Select the **true** statement/statement regarding air pollution.
(a) HCFCs damage the ozone layer.
(b) HFCs damage the ozone layer.
(c) HFCs do not contribute to global warming.
(d) The gas that contributes the most to global warming is CO_2.

36. The following reaction is carried out at 25 ^{0}C separately under constant pressure and constant volume conditions $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$ Select the **true** statement/statement regarding the above processes.
(a) Under constant pressure and constant volume conditions, the amount of heat transferred during a reaction does not change.
(b) At constant pressure, the entropy increases during a reaction.
(c) The standard enthalpy of formation of $Cl^-(aq)$ has no effect on the standard enthalpy change of the reaction.
(d) If there is no heat loss, the amount of heat transferred under constant volume conditions is equal to the enthalpy change of the reaction.

37. Select the **true** statement/statement regarding the elements of group 16.
(a) H_2O_2 is a planar molecule.
(b) H_2S cannot act as an oxidizing agent.
(c) $S_2O_3^{2-}$ on acts as an oxidizing agent.
(d) The bond angle of H_2S is less than the bond angle of H_2O.

38. The following equilibrium occurs in a rigid closed container at a given temperature.

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)\ ;\ \Delta H<0$$

The answer(s) that **correctly** state the response of an equilibrium system to the various changes applied to this system and the effect on the equilibrium constant are

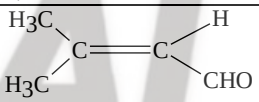
	Changes	Response of the equilibrium system	Effect on the equilibrium constant
(a)	Reducing the volume at constant temperature	The reaction proceeds forward	Does not change
(b)	Raising the temperature	The reaction proceeds backward	Equilibrium constant decreases
(c)	Adding a catalyst	The reaction proceeds forward	Equilibrium constant increases
(d)	Adding a small amount of Ar gas, an inert gas	The reaction proceeds forward	Does not change

39. Which of the following statements is/are **true** about 3d elements?
(a) The complex $[Co(NH_3)_6]^{2+}(aq)$ turns brown when exposed to air.
(b) Mn has the lowest melting point among the 3d elements.
(c) Fe^{3+} ions form a yellow complex with excess of aqueous NH_3.
(d) Co^{2+} ions form a blue complex with concentrated HCl.

40. Which of the following statements regarding water quality parameters is/are **true**?
(a) The hardness of natural water is mainly due to the dissolution of Ca^{2+} and Mg^{2+} ions in water.
(b) Adding Na_2CO_3 only removes the permanent hardness present in water.
(c) The BOD value of water decreases due to the dissolved organic matter in water.
(d) The conductivity of water is used as a water quality parameter.

- In question Nos; **41** to **50**, two statements are given in respect of each question. From the table given below, select the response, out of the responses (1), (2), (3), (4) and (5) that **best** fits the two statements and mark appropriately on your answer sheet.

Response	First statement	Second statement
(1)	True	True and correctly explains the first statement
(2)	True	True and does **not** explain the first statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First statement	Second statement
(41)	A yellowish solution is formed, when a solution of H_2O_2 in the presence of NaOH(aq) is added to an aqueous solution of Cr^{3+},	Cr^{3+} is oxidizes to CrO_4^{2-} in this reaction
(42)	The formation of a solution mixture that exhibits a negative deviation from Raoult's law is not spontaneous.	Reactions in which ΔH is zero cannot be spontaneous.
(43)	Hydrolysis of NCl_3 produces NH_3, while hydrolysis of CCl_4 produces CH_4.	During the hydrolysis of both NCl_3 and CCl_4 the lone pair of electrons on oxygen is taken by the chlorine atom.
(44)	At low temperatures, a real gas never behaves as an ideal gas.	The intermolecular attractions becomes stronger in a real gas when the temperature is decreased due to the decrease of the kinetic energy of molecules
(45)	Amides are oxidized to primary amines by 1. $LiAlH_4$ /dry ether, 2. H^+/H_2O .	Amides are readily hydrolyzed in alkaline media at room temperature.
(46)	The compound  does not exhibit diastereomerism.	This compound has two non-superimposable structures with the same molecular formula and the same structural formula.
(47)	The DOW process requires limestone or dolomite as a raw material for the extraction of Mg.	Dolomite contains Mg.
(48)	The OH^- ion is the nucleophile in the reaction between CH_3COCl and NaOH(aq).	Acid chlorides undergo nucleophilic addition reactions.
(49)	The solubility of $PbI_2(s)$ increases when the pH of a saturated solution is lowered.	The I^- anion is the conjugate base of the strong acid HI.
(50)	Teflon-coated vessels can be heated to high temperatures.	Teflon is a thermoplastic polymer.

1												13	14	15	16	17	18
1 H 1.008	2																2 He 4.0026
3 Li 6.94	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.630	33 As 74.922	34 Se 78.97	35 Br 79.904	36 Kr 83.798
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.95	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71 *	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 #	104 Rf (265)	105 Db (268)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)

* Lanthanide series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
# Actinide series	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

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கல்வி, உயர்கல்வி மற்றும் தொழிற்கல்வி அமைச்சு
Ministry of Education, Higher Education and Vocational Education

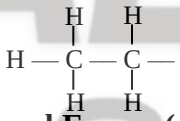
අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය **2026** උපකාරක තක්සේරුව
General Certificate of Education (Adv. Level) Exam, 2026 Supportive Assessment

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

Index No: – .....

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		

Final mark

In Numbers	
In Letters	

Marks

Paper 1	
Paper 2	
Total Marks	
Final Mark	%

[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) Since CH_2Cl_2 and CCl_4 molecules are nonpolar, only London forces are formed when CH_2Cl_2 and CCl_4 are mixed. .....

(ii) Although the shapes around the carbon atom in H_2CO_3, HCO_3^- and CO_3^{2-} are similar, the bond angles are different. .....

(iii) The energy released when a sulfur atom gains its first electron is greater than that of an oxygen atom. .....

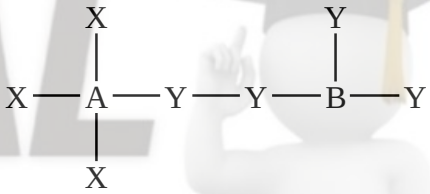
(iv) The secondary interaction strength of hydrogen halides increases in the order HCl < HBr < HF. .....

(v) XeF_4 is a nonpolar molecule with a planar tetrahedral shape. .....

(vi) Despite having the same shape, SCl_6 is more stable than SF_6. .....

(24 Marks)

(b) The skeleton structure of the molecule AX_3BY_4 is given below.



A, B and Y are three elements in the second period of the periodic table that complete an octet of electrons. Their electronegativities are in increasing order A < B < Y. X is an element that can only exist in the +1 or -1 oxidation state, which does not complete an octet of electrons. The atomic radius of A, B, X and Y varies in the order X < Y < B < A.

i) Identify the elements A, B, X and Y in the above molecule.

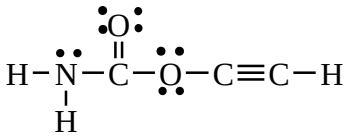
A …….. B …….. X …….. Y……..

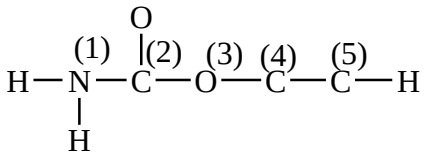
ii) Draw the most stable Lewis dot-line structure for the AX_3BY_4 molecule using the correct symbols of the elements identified above.

iii) Draw 3 Lewis dot-line structures (resonance structures) other than the structure drawn in B(i) above. State their stability (stable / less stable / unstable) under the relevant structures.

Do not write anything in this column

(iv) Complete the table based on the Lewis dot-line structure given below.





		N^1	C^2	O^3	C^4
I	Number of VSEPR pairs around the atom				
II	Electron pair geometry around the atom				
III	Shape around the atom				
IV	Hybridization of the atom				
V	Oxidation number of the atom				

- Parts (v) to (vii) are based on the Lewis dot-line structure given in (iv) above. The atom labeling is the same as in part (iv).

(v) Identify the atomic/hybrid orbitals that participate in the formation of σ bonds between the two atoms shown below.

I	$H - N^1$	H	……	N^1	……
II	$N^1 - C^2$	N^1	……	C^2	……
III	$C^2 - O^3$	C^2	……	O^3	……
IV	$O^3 - C^4$	O^3	……	C^4	……
V	$C^5 - H$	C^5	……	H	……

(vi) Identify the atomic/hybrid orbitals that participate in the formation of π bonds between the two atoms shown below.

I	$C^2 - O$	C^2	……	O	……
II	$C^4 - C^5$	C^4	……	C^5	……
		C^4	……	C^5	……

(vii) Draw a sketch of the Lewis structure of C(i) above, showing the approximate bond angles.

(viii) Arrange the electronegativity values of the N^1, C^2, O^3 and C^4 atoms in the above structure in ascending order.

…….. < …….. <…….. <……..

(60 Marks)

Do not write anything in this column

(c) i. The wavelength of the first line of the Lyman series in the hydrogen emission spectrum is 122 nm. If the ionization energy of hydrogen is 1312 kJ mol^{-1}, calculate the energy of the electron when its quantum number is n = 2.

ii. The kinetic energy of a particle with a mass of 6.626×10^{-24} g is 3.313×10^{-23} J. Calculate the de Broglie wavelength of that particle.

100

(16 Marks)

02. (a) Six unlabeled beakers contain the following solids. They are labeled A, B, C, D, E, and F (not in order).

$BiCl_3$, ZnO, Na_2CrO_4, $AlCl_3$, NH_4NO_2, $(NH_4)_2CO_3$

The observations made during several chemical tests conducted on these compounds are given below.

Beaker	Observation
A	It is a white solid insoluble in water. It turns yellow when heated. The solid is soluble in both dilute HCl and dilute NaOH.
B	When dissolved in water, it forms a viscous solution. When the solution is acidified and H_2S is passed through it, a black precipitate is obtained.
C	Thermally decomposes without leaving a residue. The evolved gas turns Nessler reagent brown.
D	A water–soluble colored solid. When dilute HCl is added, an orange colour solution is obtained.
E	A water–soluble solid. It decomposes thermally without leaving a residue when heated. The evolved gas reacts with heated Mg strips to form a white precipitate.
F	Soluble in water. When a solution of NaOH is gradually added, a white precipitate forms, which then dissolves in the presence of more NaOH.

I. Identify the compounds A, B, C, D, E and F

A …….. B …….. C ……. D …….. E ……..…….. F ……..

II Write the balanced equations for the following reactions.

i. Reaction of A with aqueous NaOH

……..

ii. Reaction of B with water

……..

iii. Thermal decomposition of C

……..

iv. Reaction of D with dil HCl

……..

v. Thermal decomposition of E

……..

vi. Reaction of F with excess NaOH

……..

(54 Marks)

Do not write anything in this column

(b) X is a second period element. It forms two oxides, one of which is neutral. The other oxide cannot be liquefied at atmospheric pressure. Y is also a second period element. It forms two neutral oxides. The hydride of Y is alkaline.

i. Identify X and Y elements..

X = ……. Y = …….

ii. Draw the Lewis dot-line structures of the two oxides of X.

iii. Write the oxidation number of X in the oxides.

……..

iv. Write a laboratory experiment to identify the oxide with the highest oxidation number of X and state the observations.

……..

……..

v. Write the balanced chemical equations for the experiment in part (iv) above.

……..

……..

vi. Write the chemical formula of the hydride of Y……..

vii. Write a laboratory experiment to identify the hydride of Y and state the observations.

……..

……..

……..

viii. Write the chemical formulas of two common oxoacids formed by Y.

……..

ix. Write the chemical formula of the oxide of Y with the oxidation number +3 and state its IUPAC name.

……..

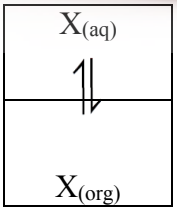
(46 Marks)

100

03. (a)

S_1 aqueous phase 250 cm^3

S_2 organic phase 100 cm^3



At 25 °C, solute X is distributed between the S_1 and S_2 phases and reached dynamic equilibrium.

At 25 °C, $K_D = \frac{[X]_{H_2O}}{[X]_{Org}} = 4$

X and $KMnO_4$ react in an acidic medium in a molar ratio of 5:2. When 50.00 cm^3 of solution S_1 was taken and titrated with a 0.1 mol dm^{-3} $KMnO_4$ solution in acidic medium, the burette reading at the endpoint was 12.0 cm^3.

i. Calculate the concentration of X in S_1 solution.

Do not write anything in this column

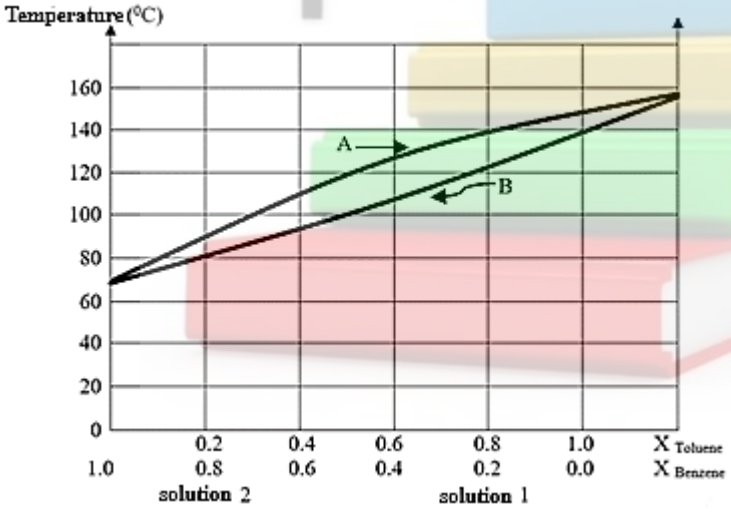
ii. Calculate the concentration of X in S_2 solution.

iii. Calculate the volume of 0.1 mol dm^{-3} $KMnO_4$ required for titration with 25.0 cm^3 of S_2 solution in acidic medium.

iv. After adding 50.0 cm^3 of organic solvent to 50.0 cm^3 of solution S_1 at 25 ^oC, calculate the concentration of X in aqueous phase X in the equilibrium system.

(50 Marks)

(b) Answer the questions using the boiling point composition curve given below at a certain pressure. The liquid-vapor equilibrium exists in the area between the two curves on the graph.



i. State what is represented by curves A and B.

A –:
.....

B –:
.....

ii. The vapor of solution 1 at a temperature of 120 ^0C is cooled to 80 ^0C to obtain solution 2.

I. In solution 2, find the composition of the liquid phase.

II. In solution 2, find the composition of the gas phase.

Do not write anything in this column

III. Briefly describe how the composition of a solution changes when it is cooled.

……..
……..
……..
……..

IV. Name the industrial process, in which the principle of (III) above is used to separate volatile solvents from each other.

……..

V. The saturated vapor pressure of toluene at 80 ^{0}C is 38.6 kPa. If the equilibrium vapor pressure of S_2 solution at 80 ^{0}C is 18 kPa, calculate the saturated vapor pressure of benzene at 80 ^{0}C.

VI. What is the composition of a solution in which the partial pressures of benzene and toluene are equal at 80 ^{0}C?

100

(50 Marks)

04. (a) A, B, C and D are structural isomers of each other with the molecular formula $C_5H_{12}O$. None of these are optically active. Compounds A, B and C, respectively, are oxidized to give compounds E, F and G, all of which give a silver mirror with ammonical $AgNO_3$. Compound D does not oxidize in PCC. Dehydration of A, C in concentrated H_2SO_4 gives H and I, respectively. The compound with the longest carbon chain is H. B does not dehydrate in concentrated H_2SO_4. Identify compounds A, B, C, D, E, F, G, H and I and write their structural formulas in the boxes below.

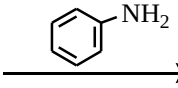
A B C

D E F

G H I **(45 Marks)**

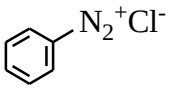
Do not write anything in this column

(b) i. Write the structure of the product/products obtained in the following reactions.

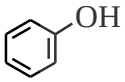
I. $H_3C-\overset{\overset{O}{\|}}{C}-H$ $\xrightarrow{\quad}$ 

II. $H_3C-CH=CH_2$ $\xrightarrow{Conc.H_2SO_4}$

III. $H_3C-CH=CH_2$ $\xrightarrow[\text{Peroxide}]{HBr}$

IV.  $\xrightarrow[\triangle]{H_3PO_2 / H_2O}$

V. $H_3C-\overset{\overset{O}{\|}}{C}-Cl$ $\xrightarrow{NaOH(aq)}$

VI.  $\xrightarrow{Br_2}$

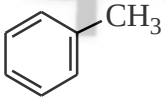
(30 Marks)

ii. Write one example of each of the following types of reactions from each of the reactions in (i) above. (Write the number I/II/III/IV/V/VI in the blank).

A. Electrophilic addition ……

B. Electrophilic substitution ……. **(09 Marks)**

(c) Draw the structure of the main product K given below and write the mechanism for this reaction.

 $\xrightarrow[Conc.H_2SO_4]{Conc.HNO_3}$ K

(16 Marks)

100

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AL

අධ්‍යාපන,උසස් අධ්‍යාපන සහ වෘත්තිය අධ්‍යාපන අමාත්‍යාංශය
கல்வி, உயர்கல்வி மற்றும் தொழிற்கல்வி அமைச்சு
Ministry of Education, Higher Education and Vocational Education

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය **2026** උපකාරක තක්සේරුව
General Certificate of Education (Adv. Level) Exam, 2026 Supportive Assessment

රසායන විද්‍යාව II Chemistry II	**02**	**E**	**II**	**13** ශ්‍රේණිය **Grade 13**

Universal gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$	Plank constant	$h = 6.626 \times 10^{-34}\ J\ s$
Avogadro constant	$N_A = 6.022 \times 10^{23}\ mol^{-1}$	speed of light	$c = 3 \times 10^{8}\ m\ s^{-1}$

Part B – Essay

Answer only **two** questions. (Each question carries **150** marks).

5) (a) Consider the following equilibrium occurring in a 1.0 dm^3 closed rigid container.

$$A(g) \rightleftharpoons B(g) + x\ C(g)\ ;$$

When 0.60 mol of A(g) was placed in the above vessel at a temperature of 400 K, the above equilibrium occurred within 10 minutes. The total pressure at equilibrium was found to be 4×10^6 Pa and the concentration of B at equilibrium was 0.3 mol dm^{-3}.

i. Calculate the value of x

ii. Calculate the value of equilibrium constants K_C and K_P at 400 K

iii. After 15 minutes from the beginning, 0.2 mol of A(g) and 0.2 mol of C(g) were added simultaneously to the above equilibrium system at 400 K. Calculate Q_C (reaction quotient) and state the direction in which the reaction is shifed with reasons.

The system will reach the equilibrium after 10 minutes of adding A(g) and C(g).

iv. The Kc value for the equilibrium in (i) above at 500 K was 0.5 $mol^2\ dm^{-6}$. Therefore, explain whether the above reaction is exothermic or exothermic.

v. Plot the variation of the concentrations of gases A(g), B(g) and C(g) in the system for 35 minutes after the start of the reaction. **(80 Marks)**

(b) i. What is meant by the rate of a reaction?

ii. Write 4 factors that affect the rate of a reaction.

iii. What is meant by the initial rate, instantaneous rate (rate at a certain point in time) and average rate of a reaction.

iv. The reaction $A(g) + 2\ B(g) \rightarrow AB_2(g)$ occurs at 100 ^{0}C. 1 mol each of A(g) and B(g) was added to a 2.0 dm^3 rigid vessel at 27 ^{0}C and the temperature was raised rapidly to 328.35 ^{0}C. After 5 seconds the total pressure of the system was 4.5×10^6 Pa. Calculate the average rate of consumption of A(g) and B(g) and formation of AB_2(g). (RT = 5000 J mol^{-1} at 328.35 ^{0}C)

v. In another experiment, 2 mol of A(g) and 1 mol of B(g) were added to the rigid vessel and the identical vessel of part (iv) above at 328.35 ^{0}C. After 5 seconds, the total pressure of the system was 6.5×10^6 Pa. Calculate the order with respect to A considering the average rate of the reaction.

vi. In another experiment, 2 mol each of A(g) and B(g) were added to the rigid vessel of same kind mentioned in part (iv) above at 328.35 ^{0}C. If the average rate in 5 seconds of the reaction was found to be 0.04 mol $dm^{-3}s^{-1}$ (assuming the average rate is equal to the initial rate), find the order with respect to B and rate expression for the reaction.

vii. In part (iv) above calculate the total pressure of the system after 5 seconds.

viii. Plot a graph showing how the concentration of A(g) changes with time when the concentration of B(g) is kept constant in part (vi) above **(70 Marks)**

6) (a)

i. The dissociation constant of a weak acid HA is Ka and its initial concentration is C mol dm^{-3} and the dissociation rate is α. Derive the relationship between K_a, C and α.

ii. Derive an expression for the pH of the solution in terms of K_a, α and C.

iii. If the pH of the weak acid at 298 K is 3.3 and the initial concentration is 0.10 mol dm^{-3}, calculate the dissociation constant of the acid.

iv. Calculate the pH of the final solution when 25.00 cm^3 of the solution mentioned in part (iii) above is mixed with 25.00 cm^3 of 0.050 mol dm^{-3} NaOH solution. State assumptions if any during the calculation.

v. Calculate the pH value when 50.0 cm^3 of 0.05 mol dm^{-3} NaOH solution is added to 25.0 cm^3 of the solution mentioned in part (iii) above.

vi. Sketch a graph of the pH versus volume of NaOH added as NaOH is gradually added to the solution in part (iii) above.

(80 Marks)

(b) The solubility of a saturated solution of $M(OH)_2$, which is sparingly soluble in water, is 2.0×10^{-4} mol dm^{-3} at 298 K.

i. Calculate the solubility product (K_{SP}) of $M(OH)_2$ at 298 K.

ii. Calculate the solubility of $M(OH)_2$ in a 0.02 mol dm^{-3} MCl_2(aq) solution at 298 K. (Assume that MCl_2 is completely ionized in water)

iii. Explain the change in solubility in part (ii) above.

iv. Write an expression for the equilibrium exist in an aqueous solution of a weak monoacidic base, B.

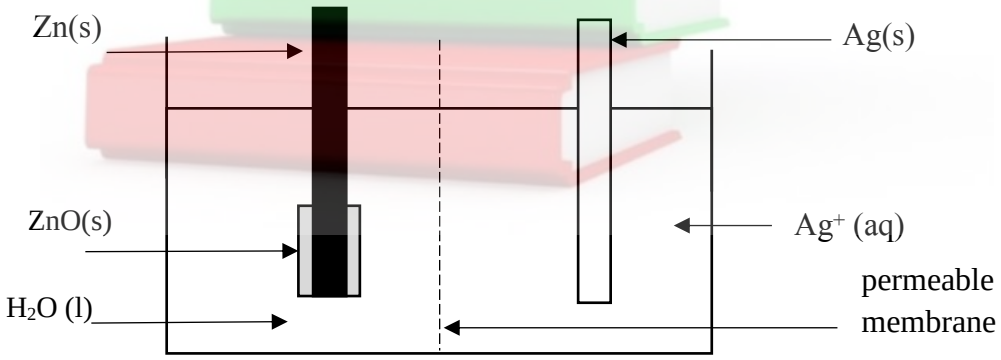
v. The pH of a solution containing 0.1 mol dm^{-3} of B(aq) at 298 K is 10.7. Calculate the dissociation constant of B(aq) at 298 K.

vi. Calculate the maximum pH value that must be maintained in a solution where the concentration of MCl_2(aq) of 8.0×10^{-2} mol dm^{-3} at 298 K to prevent the precipitation of $M(OH)_2$.

vii. Calculate the concentration of B(aq) that must be present to maintain the pH in part (vi) above.

(70 Marks)

7) (a)



When the above Galvanic cell is operated, the following reaction occurs.

$$Zn(s) + H_2O(l) + 2Ag^+(aq) \rightarrow ZnO(s) + 2H^+(aq) + 2\ Ag(s)$$

Answer the following questions regarding this cell.

i. Identify the anode and cathode of the cell.

ii. Write the balanced equations for the anode reaction and the cathode reaction of the cell.

iii. Write the formula of a solution containing Ag^+ ions suitable for the electrolysis of the above cell.

iv. State whether the conductivity of the solution decreases or increases during the operation of the above cell and briefly explain the answer.

v. State whether the e.m.f of the cell changes or not if a salt bridge is used instead of a permeable membrane and briefly explain the answer.

vi. Calculate the change in mass of the silver electrode when a constant current of 1.0 A passes through the cell for one hour. ($1F = 96500\ C\ mol^{-1}$, $Ag = 108$)

vii. The following reaction occurs in a lead storage battery when a current passes through the cell.

$Pb(s) + PbO_2(s) + 2H^+(aq) + 2\ HSO_4^-\ (aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

a. Write the anode reaction and the cathode reaction of the cell.
b. State the electrolyte used in the cell.
c. Briefly explain why it is called a secondary cell.

(75 Marks)

(b)

A, B, C and D are four complexes of Mn. Each of these complexes has two or three ligands in the valence shell with octahedral geometry. The molecular formulas of A, B, C, D are given below (not in order).

$MnBrC_3N_3H_6O_3$, $MnBrC_3N_3H_4O_2$, $MnBr_2C_2N_2H_8O_4$, $MnBr_3CNH_8O_4$

When 1 mol of each of compounds A, B, C and D react separately with excess of aqueous $AgNO_3$, 2 mol of AgBr are produced. From each of A and B while 1 mol AgBr formed by D. C does not form a precipitate with $AgNO_3$.

The oxidation state of Mn is the same in all four complexes. The molar mass of A is higher than that of B.

1. Write the types of ligands bonded to the central atom of each of the compounds A, B, C, D separately.
2. What is the oxidation number of Mn?
3. Write the structural formulas of the compounds A, B, C, D.

(45 Marks)

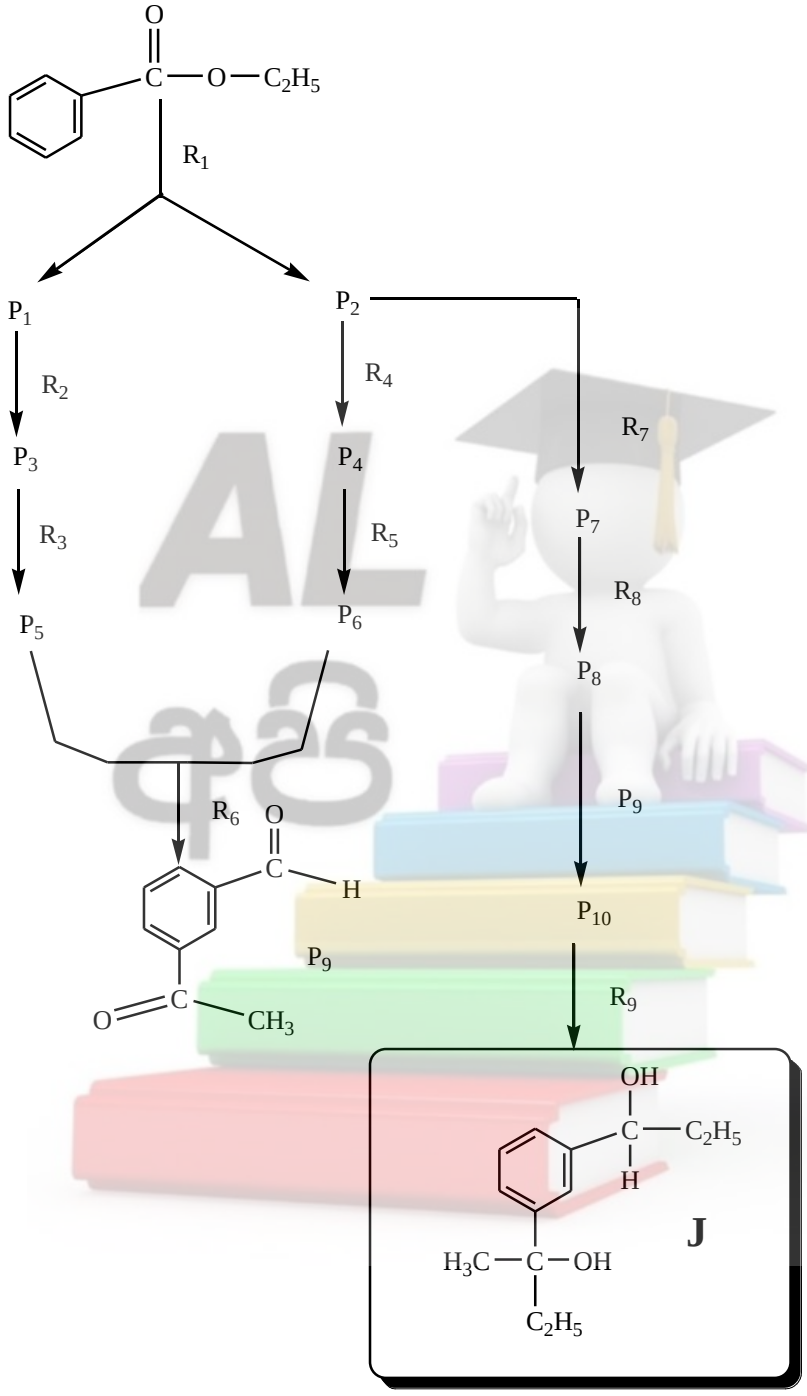
II. An aqueous solution contains Zn^{2+}, Cu^{2+} and Ni^{2+} ions as their nitrates. Describe the experiments you would perform to show the presence of each cation and the observations you would make.

You can use concentrated HNO_3, $NH_3(aq)$, $NaOH(aq)$, $H_2S(g)$, dimethylglyoxime (DMG) and water only. **(30 Marks)**

Part C – Essay

Answer only **two** questions. (Each question carries **150** marks).

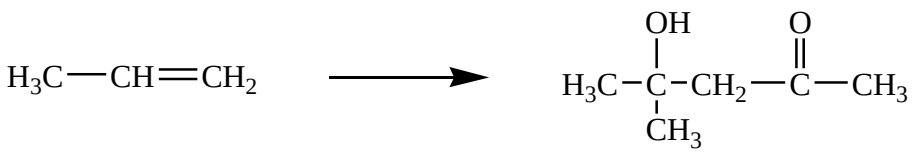
08.(a) Given below is a reaction scheme for the preparation of the compound **J** from the given starting compound.



(75 Marks)

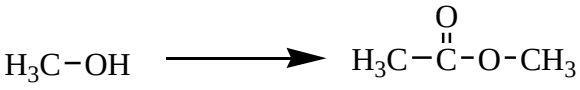
1. Write the structures P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8 ,P_{10} and reagents R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9

(b) I) Show how you would carry out the conversion in not more than **three** steps.

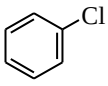


(24 Marks)

II) Show how you would carry out the conversion in not more than **six** steps.



(36 Marks)

(c) Explain the reasons why vinyl halides and aryl halides do not undergo nucleophilic substitution reactions, taking the compounds $H_2C=CHCl$ and  as exmples **(14 Marks)**

9. (a) X is a colored aqueous solution containing 4 cations and 2 anions. The information obtained during an analytical procedure used to identify the cations and anions is shown in the flowchart below. Write the answers considering the substances/conditions represented by the symbols in the box.

****The flowchart for the question 9 (a) is given on the next page.***

i. Identify the 4 cations and 2 anions present in the aqueous solution X. (No need to give reasons).
ii. Write the chemical formulas of the precipitates A, B, C, D, E, F and G.
iii. Write the formulas of the complex ions present in the solution Y, indicate their colors and write their IUPAC names.
iv. Identify the gas P.
v. Write the balanced ionic reaction between the gas P and the acidic $KMnO_4$.
vi. Which cation present in the solution Y reacts with excess KI under acidic conditions? Write the balanced ionic reaction that occurs.
vii. Write the formulae of the chemical species present in the solution Z.

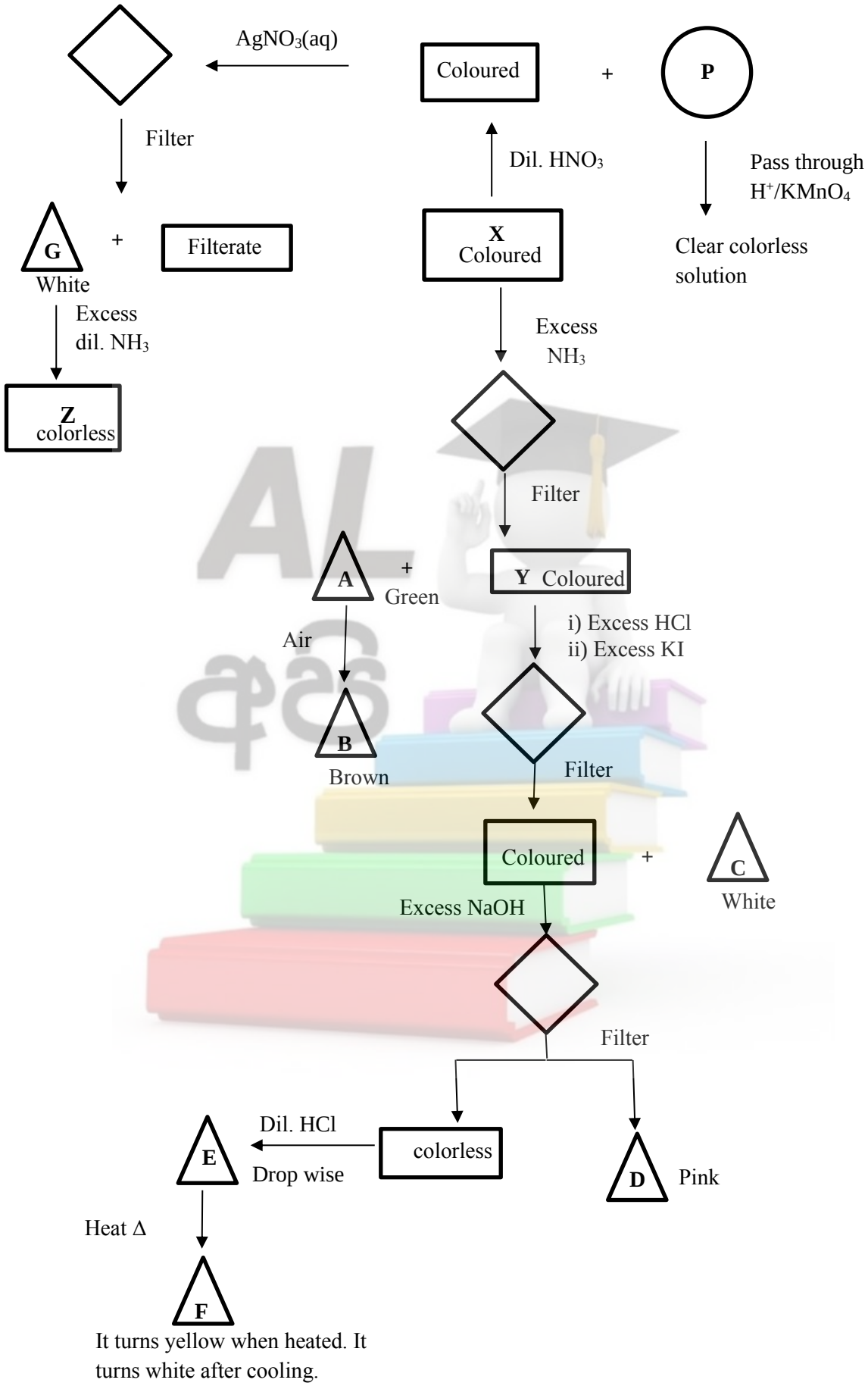
(75 Marks)

(b)

A solution of $Fe(NO_2)_2$ and FeC_2O_4 in the molar ratio of 1:2 was titrated with 0.10 mol dm^{-3} acidic $KMnO_4$ solution. The burette volume obtained at the end point was 22.0 cm^3. (Assume that NO_2^- ions do not react with the acid and are not removed from the medium.)

1. Write the balanced ionic equation for the reaction between $Fe(NO_2)_2$ and acidic $KMnO_4$.
2. Write the balanced ionic equation for the reaction between FeC_2O_4 and acidic $KMnO_4$.
3. Calculate the molar concentration of NO_2^- ions in the solution.

(75 Marks)


$AgNO_3(aq)$
Coloured
+
P
Filter
Dil. HNO_3
Pass through
$H^+/KMnO_4$
G
White
+
Filterate
X
Coloured
Clear colorless solution
Excess
dil. NH_3
Excess
NH_3
Z
colorless
Filter
A
Green
+
Y Coloured
Air
i) Excess HCl
ii) Excess KI
B
Brown
Filter
Coloured
+
C
White
Excess NaOH
Filter
Dil. HCl
colorless
E
Drop wise
D
Pink
Heat Δ
F
It turns yellow when heated. It turns white after cooling.

10. (a)

(i) In the production of iron, three naturally occurring raw materials are brought into contact with a stream of hot compressed air in a blast furnace.

I. Name the raw materials used to maintain a high temperature in the blast furnace and as a reductant. Write the balanced equations for the task mentioned.

II. In iron production, CO gas is formed at the bottom of the blast furnace, but hematite contained in the ore is reduced at the top part of the blast furnace. Briefly explain this statement.

III. Write the balanced chemical equations for the reduction of hematite by CO.

(ii) The following questions are based on the production of sulfuric acid by the contact process.

I. What are the raw materials used in the production of sulfuric acid?

II. Write two strategies used to increase the efficiency of sulfuric acid production.

(iii) The following questions are based on the production of nitric acid by Oswald's process.

I. Write the reactions that occur in the three basic steps in the production of nitric acid with the relevant conditions.

II. Explain the occurrence of the second reaction above under the given conditions using ΔH, ΔS and ΔG.

III. Write two uses of nitric acid.

IV. Write two physicochemical principles used in the production of nitric acid.

V. State one instant in which each of the physicochemical principles mentioned in (IV) above are applied.

(50 Marks)

(b)

i. Write three environmental factors that affect the decrease in dissolved O_2 (DO) in water in reservoirs.

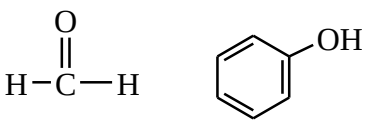
ii. Mention three other parameters that can be used to measure water quality apart from dissolved O_2.

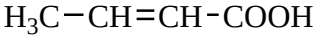
iii. The final results of a test conducted to determine dissolved oxygen (DO) content in a contaminated water sample are shown below.
50.0 cm^3 of the water sample is titrated with 0.01 mol dm^{-3} $Na_2S_2O_3(aq)$ according to the Winkler method. The burette reading is 4.0 cm^3.

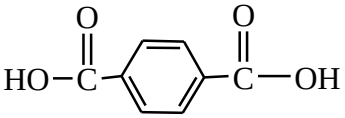
(a) Write the balanced ionic equations for the reactions that occur in the Winkler method.
(b) Hence obtain the stoichiometry between $S_2O_3^{2-}$: O_2.
(c) Calculate the amount of dissolved oxygen in the water sample in ppm

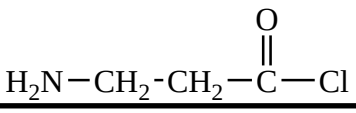
(50 Marks)

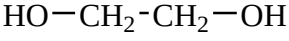
(c) Consider the compounds given below which are used in the polymer industry











i. Write the repeat units of two polymers that can be prepared using only one of the above compounds.
ii. To which type does each polymer in (i) above belong according to the method of production?
iii. Write the repeat units of two polymers that can be prepared using only two of the above compounds
iv. To which category (Thermoplastic / Thermosetting) the polymers mentioned by you in (i) and (iii) above belong?
v. Mention 2 uses of each of the two polymers mentioned in (iii) above.

(50 Marks)

1																	18
1 H 1.008	2											13	14	15	16	17	2 He 4.0026
3 Li 6.94	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.630	33 As 74.922	34 Se 78.97	35 Br 79.904	36 Kr 83.798
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.95	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71 *	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 #	104 Rf (265)	105 Db (268)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)

* Lanthanide series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
# Actinide series	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

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