අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2021(2022)
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2021(2022)
General Certificate of Education (Adv. Level) Examination, 2021(2022)

රසායන විද්‍යාව I இரசாயனவியல் I Chemistry I	02 E I	පැය දෙකයි இரண்டு மணித்தியாலம் *Two hours*

Instructions:

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

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

1. Select the correct statement with regard to particles associated with cathode rays observed in a cathode ray tube.
(1) The particles are uncharged.
(2) They travel from anode to cathode along straight lines.
(3) Their charge to mass ratio $\frac{e}{m}$ depends on the nature of gas and pressure inside the cathode ray tube.
(4) Their direction of travel is affected by magnetic and electric fields.
(5) They are not capable of ionizing the gas inside the cathode ray tube.

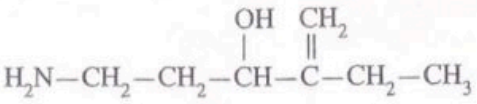
2. Which of the following statements is **incorrect** with regard to an energy level of an atom with principal quantum number (n), n = 3?
(1) There are 3 sub shells associated with it.
(2) There are 9 orbitals.
(3) There can be a maximum of 18 electrons.
(4) There can be a maximum of 10 electrons with angular momentum (azimuthal) quantum number (l), $l = 2$.
(5) There can be a maximum of 8 electrons with magnetic quantum number (m_l), $m_l = 0$.

3. The **decreasing** order of the first ionization energy of the atoms H, He, Li, Be, B and Na is,
(1) He > H > B > Be > Li > Na
(2) He > H > Be > B > Li > Na
(3) He > Be > H > Li > B > Na
(4) H > He > B > Be > Li > Na
(5) H > He > Be > B > Na > Li

4. The shapes of IF_4^+, IF_4^- and IF_5 are respectively,
(1) see-saw, square planar and square pyramidal.
(2) square planar, see-saw and square pyramidal.
(3) tetrahedral, see-saw and trigonal bipyramidal.
(4) see-saw, tetrahedral and square pyramidal.
(5) tetrahedral, square planar and trigonal bipyramidal.

[*See page two*

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



(1) 1-amino-4-ethylpent-4-en-3-ol
(2) 5-amino-2-ethylpent-1-en-3-ol
(3) 2-ethyl-3-hydroxypent-1-en-5-amine
(4) 4-ethyl-3-hydroxypent-4-en-1-amine
(5) 5-amino-2-ethyl-3-hydroxypent-1-ene

6. Which of the following statements is correct with regard to boiling points?
(1) N_2 has a higher boiling point than NO.
(2) PH_3 has a higher boiling point than NH_3.
(3) Xe has a higher boiling point than Kr.
(4) CH_3CH_2OH has a higher boiling point than $CH_3CH_2CH_2OH$.
(5) $CH_3\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_3$ has a higher boiling point than $CH_3CH_2CH_2CH_3$.

7. $M(OH)_2$ is a sparingly water soluble solid. The concentration of $M^{2+}(aq)$ in a saturated aqueous solution of $M(OH)_2$ at pH = 8.0 and at a given temperature is 1.0×10^{-6} mol dm^{-3}. The pH of a saturated aqueous solution of $M(OH)_2$ having $M^{2+}(aq)$ concentration of 1.0×10^{-4} mol dm^{-3} at this temperature is,
(1) 4.0 (2) 5.0 (3) 6.0 (4) 7.0 (5) 8.0

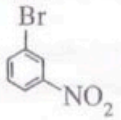
8. Select the correct statement.
(1) The electron pair geometry and shape of SF_5^+ are different from each other.
(2) The increasing order of radii of atoms/ions F^-, Mg^{2+}, Al, Cl^- and K is $F^- < Mg^{2+} < Cl^- < Al < K$.
(3) The number of resonance structures that can be drawn for nitric acid (HNO_3) is four.
(4) CO_3^{2-} has the longest C—O bond among the molecules/ions CO, CO_2, CO_3^{2-} and CH_3OH.
(5) Among the molecules CH_4, $COCl_2$ and HCN, the electronegativity of the carbon atom increases in the order $CH_4 < COCl_2 < HCN$.

9. **A** and **B** are two organic compounds containing C, H and O. When **A** and **B** were separately treated with Br_2/H_2O, only **A** gave a white precipitate. The product formed when **B** was heated with concentrated H_2SO_4 decolourised Br_2/H_2O. The organic compounds **A** and **B** are respectively,

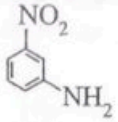
(1) C_6H_5OH, CH_3OH
(2) $C_6H_5CH_2OH$, CH_3CH_2OH
(3) C_6H_5OH, $CH_3\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_2OH$
(4) C_6H_5CHO, C_6H_5OH
(5) CH_3CHO, $CH_3\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_2OH$

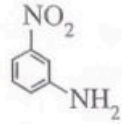
10. The elementary reaction $A(g) \rightarrow B(g) + C(g)$ occurs in a closed rigid container at constant temperature. The initial pressure of the container when only A(g) is present was measured to be $2P_0$. The pressure of the container after two half lives of A(g) would be,
(1) $\frac{P_0}{2}$ (2) $\frac{P_0}{4}$ (3) $\frac{3P_0}{4}$ (4) $\frac{3P_0}{2}$ (5) $\frac{7P_0}{2}$

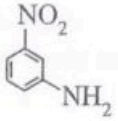
[See page three

11. A suitable method to prepare  is,

(1)  $\xrightarrow{\text{conc. } HNO_3 / \text{conc. } H_2SO_4}$

(2)  $\xrightarrow[(2)\ Br_2/FeBr_3]{(1)\ NaNO_2/\text{dilute HCl}/0-5\ ^\circ C}$

(3)  $\xrightarrow[(2)\ CuBr]{(1)\ NaNO_2/\text{dilute HCl}/0-5\ ^\circ C}$

(4)  $\xrightarrow[(2)\ CuBr]{(1)\ NaNO_2/\text{dilute HCl}/25\ ^\circ C}$

(5)  $\xrightarrow{Br_2}$

12. Which expression gives the correct volume (cm^3) of 70.0% $\left(\frac{w}{w}\%\right)$ concentrated HNO_3 acid with density 1.42 g cm^{-3} required to prepare 300 cm^3 of a 0.150 mol dm^{-3} solution of HNO_3? (Relative atomic mass: H = 1, N = 14, O = 16)

(1) $\frac{100}{1.42}\times\frac{70.0}{63}\times\frac{0.150}{1000}\times 300$

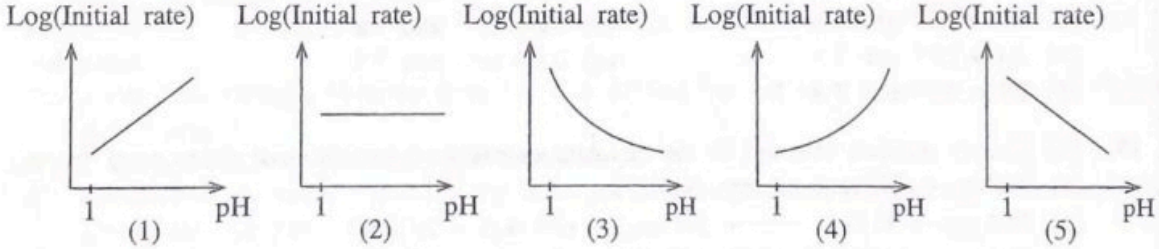
(2) $\frac{100}{1.42}\times\frac{63}{70.0}\times\frac{0.150}{1000}\times 300$

(3) $\frac{1.42}{100}\times\frac{63}{70.0}\times\frac{1000}{0.150}\times 300$

(4) $\frac{100}{1.42}\times\frac{63}{70.0}\times\frac{1000}{0.150}\times\frac{1}{300}$

(5) $\frac{1.42}{100}\times\frac{70.0}{63}\times\frac{0.150}{1000}\times 300$

13. The elementary reaction, $A(aq) + H_3O^+(aq) \rightarrow B^+(aq)$ occurs in an aqueous solution at constant temperature. Which of the following graphs correctly represents the relationship between Log(Initial rate) vs pH at a constant concentration of A(aq)?



14. An excess amount of A(g) and a small amount of B(g) are introduced into an evacuated rigid container. Then, the following elementary reactions take place at a constant temperature.

$A(g) + B(g) \rightarrow C(g)$ fast

$A(g) + C(g) \rightarrow 3D(g)$ slow

Which of the following statements is correct regarding the variation of pressure of the system with time?

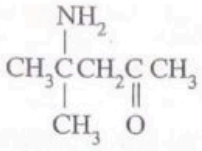
(1) Pressure remains unchanged.
(2) Pressure increases and then becomes constant.
(3) Pressure decreases and then becomes constant.
(4) Pressure decreases and returns to the initial value again.
(5) Pressure increases initially, then decreases and returns to the initial value again.

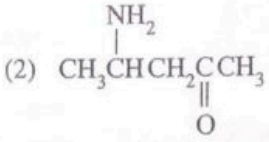
15. The solute **A** present in volume V of an aqueous solution is extracted twice using 2V volume portions of a water immiscible organic solvent. The partition coefficient of **A** between the organic solvent and water, $\frac{[A]_{(org)}}{[A]_{(aq)}} = 4.0$. The initial amount of **A** in the aqueous phase is a (mol). The amount (mol) of **A** remaining in the aqueous phase after the second extraction is,

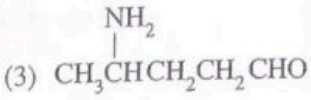
(1) $\frac{a}{2}$ (2) $\frac{a}{9}$ (3) $\frac{a}{18}$ (4) $\frac{a}{25}$ (5) $\frac{a}{81}$

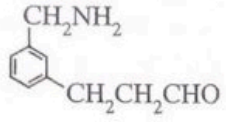
[See page four

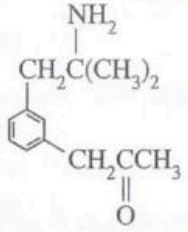
16. Compound **A** reacts with $NaNO_2$/dilute HCl to give **B**. When **B** is treated with acidified aqueous $K_2Cr_2O_7$, the solution turns green. When treated with Fehling's reagent **A** did not give a brick red precipitate. Compound **A** could be,

(1) 

(2) 

(3) 

(4) 

(5) 

17. MCl_2 is a solid which is sparingly soluble in water ($K_{sp} = 1.0 \times 10^{-8}$ mol^3 dm^{-9}). Which of the following is correct regarding a saturated aqueous solution of MCl_2?

(1) Evaporation of water from the solution increases M^{2+} and chloride ion concentrations of the solution.
(2) Chloride ion concentration of the solution can be increased by adding NaCl(s).
(3) The solution cannot be acidified by adding HCl.
(4) Chloride ion concentration of the solution cannot be increased above 1.0×10^{-4} mol dm^{-3}.
(5) Chloride ion concentration of the solution can be lowered by adding distilled water and maintaining the saturated condition.

18. When a mass of 0.0119 g of KBr is dissolved in 500.0 cm^3 of distilled water, the K^+ composition of the solution in mol dm^{-3} and ppm (mg kg^{-1}) are respectively,
(Relative atomic mass: K = 39, Br = 80; density of solution = 1.00 kg dm^{-3})

(1) 1.0×10^{-4} and 3.9
(2) 1.0×10^{-4} and 7.8
(3) 2.0×10^{-4} and 1.3
(4) 2.0×10^{-4} and 3.9
(5) 2.0×10^{-4} and 7.8

19. The correct reaction relevant to the standard enthalpy of hydration of the sodium ion is,

(1) $Na^+(g) + OH^-(aq) \longrightarrow NaOH(s)$
(2) $NaCl(g) + H_2O(l) \longrightarrow Na^+(aq) + OH^-(aq) + HCl(aq)$
(3) $Na^+(g) + H_2O(l) \longrightarrow Na^+(aq)$
(4) $Na^+(g) + H_2O(l) \longrightarrow Na^+(aq) + OH^-(aq) + H^+(aq)$
(5) $Na^+(g) + Cl^-(g) + H_2O(l) \longrightarrow Na^+(aq) + Cl^-(aq)$

20. Which of the following is **not** a step in the chlorination of methane?

(1) $Cl_2 \xrightarrow{h\nu} 2Cl^{\bullet}$
(2) $CH_4 + {}^{\bullet}Cl \longrightarrow {}^{\bullet}CH_3 + HCl$
(3) ${}^{\bullet}CH_3 + Cl_2 \longrightarrow CH_3Cl + Cl^{\bullet}$
(4) $CH_3Cl + Cl^{\bullet} \longrightarrow {}^{\bullet}CH_2Cl + HCl$
(5) ${}^{\bullet}CH_2Cl + HCl \longrightarrow CH_2Cl_2 + H^{\bullet}$

21. Which of the following statements regarding the critical temperature of a real gas is correct?

(1) It is the temperature at which the intermolecular forces can be neglected.
(2) It is the temperature corresponding to the lowest pressure at which the gas can be liquified.
(3) It is the temperature at which the gas is in equilibrium with its solid.
(4) It is the highest temperature at which the gas phase and the liquid phase are in equilibrium.
(5) It is the temperature given by the van der Waals equation at any pressure.

[*See page five*

22. In an experiment, Mg metal was made to react with excess N_2 gas and the product obtained was reacted with H_2O. The volume of the gas evolved at standard temperature (273 K) and pressure (1.0 atm) was 672 cm^3. The mass of Mg used in the experiment is,
(Assume that 1.0 mol of gas occupies a volume of 22.4 dm^3 at 273 K and 1.0 atm.
Relative atomic mass: Mg = 24)

(1) 0.24 g (2) 0.48 g (3) 0.72 g (4) 1.08 g (5) 1.50 g

23. The mean square speed of H_2 at absolute temperature T is equal to the mean square speed of N_2 at absolute temperature T'. Which of the following equations gives the correct relationship between T and T'? (Relative atomic mass: H = 1, N = 14)

(1) $T = T'$ (2) $T = 14T'$ (3) $T = \frac{T'}{4}$ (4) $T = 7T'$ (5) $T = \frac{T'}{14}$

24. A buffer solution at constant temperature contains a monobasic weak acid ($K_a = 1.00 \times 10^{-5}$ mol dm^{-3}) and its sodium salt. The concentrations of the weak acid and the sodium salt in the solution are 0.10 mol dm^{-3} each. The volume of 1.00 mol dm^{-3} weak acid that should be added to change the pH of 10.00 cm^3 of this solution by one unit, and the pH value of the solution after the addition of the weak acid are respectively,

(1) 9.00 cm^3, 4.0 (2) 9.00 cm^3, 6.0 (3) 10.00 cm^3, 4.0
(4) 10.00 cm^3, 5.0 (5) 11.00 cm^3, 4.0

25. A gaseous discharge/production that contributes to all three environmental issues, namely, global warming, acid rain and photochemical smog is,

(1) exhaust gas released from fossil fuel burning vehicles.
(2) exhaust gas released from coal power plants.
(3) gases released during repair of air conditioners and refrigerators.
(4) gases produced from the improper discharge of municipal solid waste.
(5) exhaust gas released from biofuel burning vehicles.

26. Which of the following statements is **incorrect** with regard to element Lithium (Li) and its compounds?

(1) Among the Group I elements from Li – Cs, lithium has the most negative value for electron gain energy.
(2) Lithium forms two products when heated in air.
(3) Considering the gases evolved, upon heating $LiNO_3(s)$ produces two gases whereas $Li_2CO_3(s)$ gives only one gas.
(4) Among Group I elements, lithium has the weakest metallic bonding.
(5) Lithium gives a red coloured flame in the flame test.

27. The number of moles of $KMnO_4$ that are required to react completely with one mole of $Fe(NO_2)_2$ in acidic medium is,
(**Note:** Neglect the loss of NO_2^- due to acidic conditions.)

(1) $\frac{3}{5}$ (2) $\frac{4}{5}$ (3) 1 (4) $\frac{5}{4}$ (5) $\frac{5}{3}$

28. Which of the following statements is correct regarding water and aqueous solutions at a given temperature?

(1) The solubility of a polar gas in water is lower than the solubility of a non polar gas in water.
(2) Any gas undergoes ionization in an aqueous solution.
(3) The solubility of a gas in water is proportional to its pressure.
(4) Boiling point of water decreases with increasing pressure.
(5) The temperature of the triple point of water increases with increasing pressure.

[See page six

29. Select the correct statement with regard to chromium (Cr) and its compounds.
(1) When an aqueous solution of K_2CrO_4 is treated with dilute H_2SO_4, a colour change is not observed.
(2) The electronegativity of Cr is greater than that of Co.
(3) An aqueous solution of $Cr(H_2O)_6^{2+}$ when treated with excess NaOH, followed by the addition of H_2O_2 gives a yellow coloured solution.
(4) Cr_2O_3 shows basic properties.
(5) When H_2S gas is passed into an acidic solution of $K_2Cr_2O_7$, a clear green coloured solution is observed.

30. Which of the following statements is **incorrect** regarding carboxylic acids?
(1) The product formed by the reaction of a carboxylic acid with $LiAlH_4$ gives an alcohol upon hydrolysis.
(2) Carbon dioxide is liberated when carboxylic acids are reacted with aqueous NaOH.
(3) Carboxylic acids react with PCl_5 to give acid chlorides.
(4) Methane is liberated when carboxylic acids are reacted with CH_3MgBr.
(5) Carboxylic acids are formed when aldehydes are treated with $H^+/K_2Cr_2O_7$.

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 or combination of responses is correct.

Summary of above Instructions

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

31. Which of the following give(s) 3-bromo-3-methylhexane as the major product when reacted with HBr?

(*a*) $CH_3CH_2CH_2\overset{\overset{CH_3}{|}}{C}=CHCH_3$

(*b*) $CH_3CH_2CH_2\overset{\overset{CH_3}{|}}{C}HCH=CH_2$

(*c*) $CH_3CH=\overset{\overset{CH_3}{|}}{C}HCH_2CH_3$

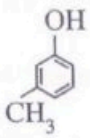
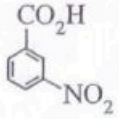
(*d*) $CH_3CH_2CH_2\overset{\overset{CH_2CH_3}{|}}{C}=CH_2$

32. Which of the following statements is/are correct regarding products related to plant sources?
(*a*) Essential oils contain complex mixtures of volatile constituents of plants.
(*b*) Biodiesel is produced from volatile plant oils.
(*c*) Methanol is not used in the production of biodiesel.
(*d*) Ethanol produced by fermentation of plant materials is regarded as a renewable energy source.

33. On which of the following factor/factors does the electrode potential of the electrode $M^{2+}(aq)/M(s)$ depend?
(*a*) Surface area of M(s)
(*b*) Concentration of $M^{2+}(aq)$
(*c*) Temperature
(*d*) Volume of $M^{2+}(aq)$ solution

[See page seven

34. Which of the following give(s) CO_2 when treated with aqueous Na_2CO_3?

(*a*)  (*b*)  (*c*)  (*d*) 

35. Which of the following statements is/are always correct regarding an aqueous solution of a weak electrolyte?

(*a*) When conducting an electric current, the fraction of the current carried by the anion is greater than the fraction of the current carried by the cation.
(*b*) The conductivity of the anion is greater than the conductivity of the cation.
(*c*) Only a small percentage of molecules of the weak electrolyte is dissociated into ions.
(*d*) The fraction of molecules of the weak electrolyte dissociated increases with dilution.

36. Which of the following statements is/are correct regarding the relationship between global environmental issues and volatile halogenated hydrocarbons?

(*a*) CFC, HCFC and HFC all three contribute to global warming.
(*b*) CFC contributes to ozone layer depletion by producing chlorine radicals in the troposphere.
(*c*) HFC contributes to ozone layer depletion by producing chlorine radicals in the stratosphere.
(*d*) Both CFC and HCFC contribute to ozone layer depletion by producing chlorine radicals in the stratosphere.

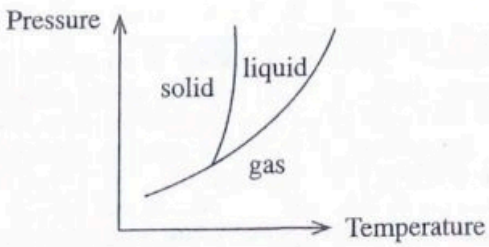
37. Which of the following statements is/are correct with regard to the two allotropes of carbon, namely, graphite and diamond?

(*a*) Carbon atoms in diamond are tetrahedrally surrounded by four other carbon atoms to give a three-dimensional lattice.
(*b*) Because graphite is composed of two-dimensional layers held together by weak van der Waals forces (secondary interactions), it acts as a good lubricant.
(*c*) Diamond is a good conductor of heat and electricity.
(*d*) Graphite has a considerably higher melting point than diamond.

38. Which of the following statements is/are correct regarding gases?

(*a*) Molecules move at different speeds in a sample of a real gas whereas all the molecules move at the same speed in a sample of an ideal gas.
(*b*) Ideal gases can be liquified at extremely high pressures.
(*c*) The Maxwell-Boltzmann speed distribution curve of an ideal gas is symmetric about the maximum point.
(*d*) The compressibility factor of a real gas depends on pressure.

39.



Which of the following statements is/are correct regarding the phase diagram of a pure substance given above?

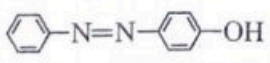
(*a*) The number of molecules in a unit volume is always higher in the gas phase than in the liquid phase.
(*b*) The liquid phase and the gas phase never co-exist at the same temperature.
(*c*) The solid phase and the gas phase never co-exist at the same pressure.
(*d*) When the system is at the triple point, the rate at which the gas is converted to the liquid is equal to the rate at which the liquid is converted to the gas.

[See page eight

40. Which of the following statements is/are correct regarding the given industrial processes?
(*a*) Sea water can be used directly as a raw material in the extraction of Mg by the Dow process.
(*b*) In the production of NaOH, the use of membrane cells is more environmentally friendly than the use of mercury cells.
(*c*) The efficiency of the Solvay process used to produce Na_2CO_3 can be increased by cooling the ammonification tower.
(*d*) Rh metal is used as a catalyst in the production of H_2SO_4 by the contact process.

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, but does **not** explain the first statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First Statement	Second statement
41.	When an acidic solution of MnO_4^- is treated with H_2O_2, it turns colourless with the evolution of O_2, whereas, an acidic solution of Fe^{2+} on treatment with H_2O_2 turns yellow-brown.	H_2O_2 can act as an oxidizing agent as well as a reducing agent in acidic medium.
42.	Energy of a gas in a closed rigid container with thermally insulated walls remains constant.	Both energy and matter of an isolated system do not exchange with the surroundings.
43.	Cl_2 gas undergoes disproportionation on reaction with water giving HOCl(aq) and HCl(aq).	HOCl has the highest oxidizing ability among the oxoacids of chlorine.
44.	When a catalyst is added, the position of equilibrium of a reversible reaction changes.	A catalyst always increases the rate of the forward reaction more than the rate of the reverse reaction.
45.	$RC{\equiv}CMgBr$ can be prepared by the reaction between $RC{\equiv}CH$ and methylmagnesium bromide.	The alkyl group of a Grignard reagent can react as a base.
46.	Reaction of HCN with any aldehyde gives a product containing a chiral carbon atom.	A carbon atom joined to four different groups is called a chiral carbon atom.
47.	The main by-product in the production of Na_2CO_3 by the Solvay process is $CaCl_2$.	CaO is used to regenerate NH_3 in the Solvay process.
48.	Benzenediazonium chloride reacts with phenol in the presence of aqueous NaOH to give the following compound. 	Diazonium ions can react as electrophiles.
49.	When strong acids are titrated with aqueous ammonia, a neutral solution is not obtained at the equivalence point.	NH_4^+ reacts with water forming H_3O^+.
50.	Atomic oxygen is an essential factor for the formation of ozone in the atmosphere.	Atomic oxygen in the atmosphere is produced only by decomposition of molecular oxygen.