නව නිර්දේශය/ புதிய பாடத்திட்டம்/*New Syllabus*

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

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

Instructions:

- *Periodic Table is provided.*
- *This paper consists of **10** 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. Who is the scientist who discovered the α, β and γ rays emitted by radioactive elements?
(1) Henri Becquerel
(2) J.J. Thompson
(3) Albert Einstein
(4) Ernest Rutherford
(5) Eugen Goldstein

2. The quantum number group that **cannot** exist in nature is,
(1) $1, 0, 0, -\frac{1}{2}$
(2) $3, 2, -2, +\frac{1}{2}$
(3) $2, 1, 0, +\frac{1}{2}$
(4) $3, 2, +3, -\frac{1}{2}$
(5) $2, 0, 0, -\frac{1}{2}$

3. In which of the following pairs is the electron geometry around the central atom is not the same?
(1) OF_2 / H_2Se
(2) SO_4^{2-} / NH_3
(3) CO_2 / NO_2^+
(4) ICl_3 / PCl_3
(5) XeF_2 / $XeOF_2$

4. How many resonance structures can be drawn for the ion given below?

$$\left[\begin{array}{c} O \\ \| \\ O-N-O-O \end{array} \right]^{(-)}$$

(1) 3   (2) 4   (3) 5   (4) 2   (5) 6

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

$$CH_3-CH-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-NH_2$$
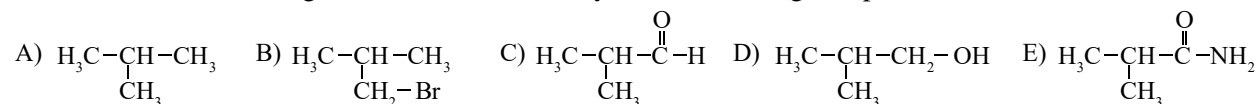$$\underset{\displaystyle CN}{|}$$
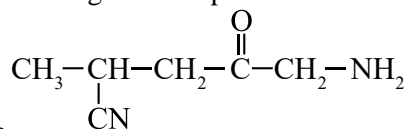
   (1) 4-cyano-1-aminopent-2-one
   (2) 5-amino-2-methyl-4-oxopentanenitrile
   (3) 1-amino-4-cyanopent-2-one
   (4) 5-amino-2-cyanopent-4-one
   (5) 2-methyl-5-amino-4-oxopentanenitrile

6. The wavelength of the yellow light emitted by Na vapour is 589nm. What is the amount of energy given by one mole of photons, and how many photons would be required to give an energy of 2.2352×10^6 kJ?
   (1) 2.032×10^5 kJ mol^{-1}, 1.099×10^7 mol
   (2) 203.2 kJ mol^{-1}, 6.618×10^{30} mol
   (3) 203.2 kJ mol^{-1}, 1.1×10^4 mol
   (4) 5.09 kJ mol^{-1}, 6.618×10^7 mol
   (5) 203.2 kJ mol^{-1}, 11×10^7 mol

7. Which response out of the following is true regarding a first order reaction?

   (1) 3 only
   (2) 2 and 3 only
   (3) 1 and 3 only
   (4) 1, 3 and 4 only
   (5) 1 and 4 only
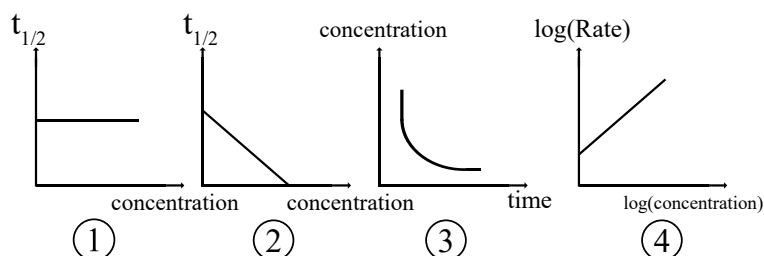
8. Which of the following is **not a method** that can be used to produce 2 mol of N_2?
   (Cu - 63.5 g mol^{-1}, Cr - 52 g mol^{-1}, molar volume of gas at standard temperature / pressure - 22.4 dm^3 mol^{-1})
   (1) Reacting 89.6 dm^3 of gaseous NH_3 with 134.4 dm^3 of gaseous Cl_2.
   (2) Combustion of 4 mol of NH_3 in air.
   (3) Oxidation of NH_3 in the presence of 381 g of red hot Cu.
   (4) Mixing and heating 1 dm^3 each of 2.0 mol dm^{-3} NH_4Cl and $NaNO_2$.
   (5) Thermal decomposition of 504 g of solid $(NH_4)_2Cr_2O_7$.

9. The total number of isomers that can be drawn for C_4H_8 is,
   (1) 2   (2) 4   (3) 5   (4) 6   (5) 7

10. 10 g of the compound X is dissolved in 100 cm^3 of water and 100 cm^3 of ether is used to extract it. What is the percentage of X remaining in the water layer after two equal, consecutive extractions? (K_D between ether and water $= 18$)
   (1) 2%   (2) 3%   (3) 1%   (4) 10%   (5) 12%

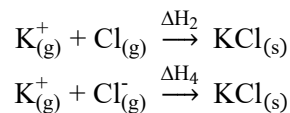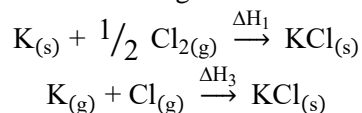**11.** What is the ascending order of water solubility of the following compounds?

A) $H_3C-\underset{\underset{CH_3}{|}}{CH}-CH_3$ B) $H_3C-\underset{\underset{CH_2-Br}{|}}{CH}-CH_3$ C) $H_3C-\underset{\underset{CH_3}{|}}{CH}-\overset{\overset{O}{\|}}{C}-H$ D) $H_3C-\underset{\underset{CH_3}{|}}{CH}-CH_2-OH$ E) $H_3C-\underset{\underset{CH_3}{|}}{CH}-\overset{\overset{O}{\|}}{C}-NH_2$

    (1) A < B < C < D < E
    (2) A < B < D < C < E
    (3) A < C < D < B < E
    (4) C < A < D < E < B
    (5) E < D < C < B < A

12. The correct answer when the compounds NaBr, KCl, NaI and KBr are arranged in **increasing order** of ionic nature is,
    (1) NaI < KBr < NaBr < KCl
    (2) NaI < NaBr < KBr < KCl
    (3) NaI < NaBr < KCl < KBr
    (4) KCl < KBr < NaBr < NaI
    (5) KCl < NaBr < KBr < NaI

13. The **correct** ascending order of these enthalpy changes is,

$$K_{(s)} + \tfrac{1}{2} Cl_{2(g)} \overset{\Delta H_1}{\longrightarrow} KCl_{(s)} \qquad\qquad K^+_{(g)} + Cl_{(g)} \overset{\Delta H_2}{\longrightarrow} KCl_{(s)}$$

$$K_{(g)} + Cl_{(g)} \overset{\Delta H_3}{\longrightarrow} KCl_{(s)} \qquad\qquad K^+_{(g)} + Cl^-_{(g)} \overset{\Delta H_4}{\longrightarrow} KCl_{(s)}$$

    (1) $\Delta H_1 < \Delta H_4 < \Delta H_3 < \Delta H_2$
    (2) $\Delta H_1 < \Delta H_3 < \Delta H_4 < \Delta H_2$
    (3) $\Delta H_1 < \Delta H_3 < \Delta H_2 < \Delta H_4$
    (4) $\Delta H_2 < \Delta H_3 < \Delta H_4 < \Delta H_1$
    (5) $\Delta H_4 < \Delta H_2 < \Delta H_3 < \Delta H_1$

14. When an aqueous, colourless salt A and aqueous, coloured salt B were mixed, a yellow-coloured solution was obtained. When excess NH_4Cl was added to B and heated, a bluish green solid was obtained. When the solid was separated and excess A was added to it, the solid dissolved, forming a bluish green precipitate. Name A and B.
    (1) NaOH, Ni(OH)$_2$
    (2) NaCl, K$_2$CrO$_4$
    (3) K$_2$CrO$_7$, NH$_4$OH
    (4) NH$_4$OH , K$_2$Cr$_2$O$_7$
    (5) NH$_4$Cl, Cu(NO$_3$)$_2$

15. At a certain T temperature, N_2O_4 dissociates as follows.
$$N_2O_{4\,(g)} \rightleftharpoons 2NO_{2\,(g)}$$
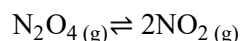
If the equilibrium constant is K_P , total pressure of the system at equilibrium is P and the degree of dissociation of N_2O_4 is α, which of the following is the **correct** expression regarding α?

    (1) $\dfrac{K_P}{2P + K_P}$
    (2) $\sqrt{\dfrac{K_P}{2P + K_P}}$
    (3) $\sqrt{\dfrac{K_P}{4P + K_P}}$
    (4) $\sqrt{\dfrac{K_P}{P + K_P}}$
    (5) $\dfrac{K_P}{(2P + K_P)^2}$

16. Consider the following reaction.

$$CH_3 - \overset{\overset{\displaystyle O}{\|}}{C} - H \quad \xrightarrow{\text{NaOH}} \quad H_3C - \underset{\underset{\displaystyle OH}{|}}{\overset{\overset{\displaystyle H}{|}}{C}} - CH_2 - CHO$$
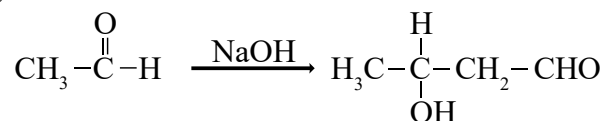
The **correct** statement is,
   (1) All Aldehydes, ketones and alcohols undergo aldol condensation as shown above.
   (2) α carbon is the carbonyl carbon, while α hydrogen is the hydrogen bound to the adjacent carbon of the carbonyl carbon.
   (3) This α hydrogen is comparatively more acidic than hydrogen in alkenes.
   (4) This condensation reaction can be applied to all aldehydes.
   (5) The product of the above aldol condensation reaction is highly stable, and its dehydration is quite difficult.

17. The pH value of the human blood is 7.4. In order to maintain this pH value, 10 cm^3 of 2 mol dm^{-3} H$_2$CO$_3$ and V cm^3 of 5 mol dm^{-3} NaHCO$_3$ is needed. In H$_2$CO$_3$, if $K_{a1} = 4.4 \times 10^{-7}$ mol dm^{-3} and $K_{a2} = 4.69 \times 10^{-12}$ mol dm^{-3}, What is the value of V.
   (1) 3.62 cm^3
   (2) 40 cm^3
   (3) 44.2 cm^3
   (4) 38.4 cm^3
   (5) 43.4 cm^3

18. P, Q and R are three consecutive elements of the same period, within the first 20 elements. Their third ionization energy varies as $Q < P < R$. The oxide derived from the highest oxidation state of R is acidic. The **correct** statement regarding P, Q and R,
   (1) P and Q are elements of the p block while R is an element of the s block.
   (2) R has the highest electronegativity after F in the periodic table.
   (3) The electron gain energy of Q has a high (+) value.
   (4) The electron affinity of Q is a (+) value.
   (5) The oxide formed by the highest oxidation state of P is a liquid.

19. The following equilibrium is formed when 2 mol of gas A is added to a 1 dm^3 vessel.

$$A_{(g)} \rightleftharpoons B_{(g)} + C_{(g)}$$
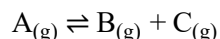
If $K_c = 1$ mol dm^{-3}, what is the concentration of B?
   (1) 2.5 mol dm^{-3} (2) 0.5 mol dm^{-3}
   (3) 2 mol dm^{-3} (4) 1 mol dm^{-3}
   (5) 0.25 mol dm^{-3}

20. Select the **incorrect** statement regarding the reactions of LiAlH$_4$ and NaBH$_4$ with organic compounds.
   (1) Here, nucleophilic addition reactions occur.
   (2) H$^-$ attacks the organic compound.
   (3) LiAlH$_4$ and NaBH$_4$ cannot be used in the presence of water or methanol.
   (4) Reaction of one ester molecule with LiAlH$_4$ and water yields 2 alcohol molecules.
   (5) NaBH$_4$ does not react with carboxylic acids or its derivatives.

21. Which of the following is **correct** regarding a system at dynamic equilibrium in a constant volume vessel?

$$Q_{(g)} + 2P_{(g)} \rightleftharpoons 2R_{(g)} \qquad \Delta H < 0$$
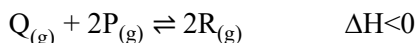
(1) The rate of the forward reaction decreases when the temperature is increased.
(2) If a part of P is removed, the rate of the forward reaction is increased.
(3) The equilibrium point does not change when an inert gas is added at constant temperature.
(4) The equilibrium constant changes when an equal amount of moles of Q and R are added, at constant temperature.
(5) When R is added to the system, the concentration of Q reduces.

22. The IUPAC name of $[Ni(NH_3)_6]\,[CoCl_4]$
(1) Hexaaminenickel(II) tetrachloridocobaltate(II)
(2) Hexamminenickel(II) ion tetracholoridocobaltate(II) ion
(3) Hexaamminenickel(II) tetrachloridocobalt(II)
(4) hexaamminenickel(II) tetrachloridocobaltate(II)
(5) hexaamminenickel(II) chloridocobaltate(III)

23. A glass bulb of volume $150 \ cm^3$ is connected to another glass bulb of volume $300 \ cm^3$, by a tube with a tap of negligible volume. The whole system is at 112 °C initially. In the system with the tap open, Xe and F are present in the ratio of 3 : 1. When the tap is closed and the smaller bulb is submerged in water at 497 °C, the percentage of change of pressure in the smaller bulb in relation to the initial pressure is, (only at temperatures above 400 °C , the reaction $Xe_{(g)} + F_{2(g)} \rightarrow XeF_{2(s)}$ occurs.)
(1) 33.33%   (2) 50%
(3) 66.66%   (4) 100%
(5) 0%

24. The chemical oxygen demand (COD) of a water sample needs to be determined. $25 \ cm^3$ of $0.1 \ mol \ dm^{-3}$ acidic $K_2Cr_2O_7$ is added to $25 \ cm^3$ of the sample. $20 \ cm^3$ of a $0.15 \ mol \ dm^{-3} \ Fe^{2+}$ solution is needed to react with the remaining $Cr_2O_7^{2-}$. Calculate the chemical oxygen demand (COD) of the water sample in $mg \ dm^{-3}$
(1) $3.84 \ mg \ dm^{-3}$ (2) $3840 \ mg \ dm^{-3}$
(3) $96 \ mg \ dm^{-3}$ (4) $120 \ mg \ dm^{-3}$
(5) $1920 \ mg \ dm^{-3}$

25. Correct statement,
(a) A catalyst reduces the activation energy of a reaction.
(b) The order of a reaction can be changed by a catalyst.
(c) When a reaction occurs, the reactant concentration and reaction constant gradually reduces.
(d) When a catalyst is added to a system at equilibrium, the equilibrium point does not change.

(1) a , d   (2) d only.
(3) b , d   (4) a , b , d
(5) a , c

26. An aqueous KI solution is electrolyzed, using Cu electrodes as depicted below. The **correct** statement is,
    (1) $Cu(OH)_2$ is formed at the cathode initially.
    (2) KOH is not formed near the cathode.
    (3) A blue colour precipitate may form near the anode.
    (4) O_2 is liberated at the anode initially.
    (5) There is no chance of a white precipitate forming at the anode.
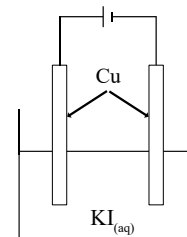
27. The lowest temperature that the reaction $\frac{1}{2} A_2 B_{(s)} \longrightarrow A_{(s)} + \frac{1}{2} B_{(g)}$ can occur in is,

    ($\Delta H = 190.6$ kJ mol^{-1}, $\Delta S = 400$ J mol^{-1} K^{-1})
   (1) 476.5 °C   (2) 47.65 °C
    (3) 203.5 °C   (4) 20.35 °C
    (5) 4765 °C

28. The reaction rate for a certain concentration of the reactants of the single step reaction $2A + B \longrightarrow 3C$ is 8×10^{-3} mol dm^{-3} s^{-1}. What is the rate of reaction when the concentrations of the reactants are doubled? (mol dm^{-3} s^{-1})
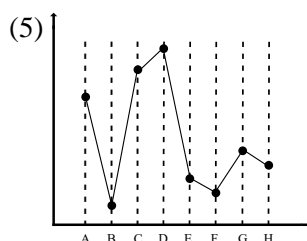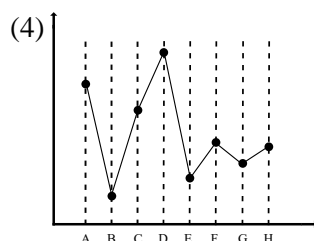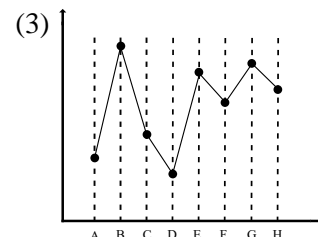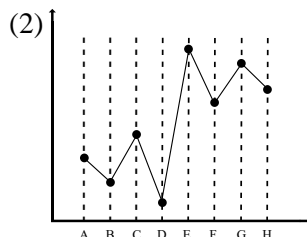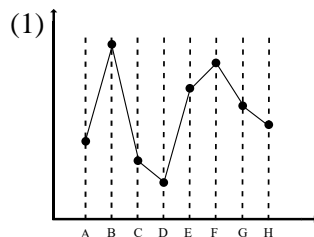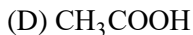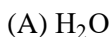   (1) 16×10^{-3} (2) 6.4×10^{-2}
    (3) 1.6×10^{-3} (4) 64×10^{-2}
    (5) 4×10^{-3}

29. $3A_{(g)} + 2B_{(g)} \rightleftharpoons C_{(g)} \qquad \Delta H < 0$

    The above reaction is initiated with a higher number of moles of A than B, and after reaching a dynamic equilibrium, a certain amount of A is added to that system. Select the correct graph depicting the variation of concentrations of A, B and C and the variation of reaction rate, until the system reaches a dynamic equilibrium again.
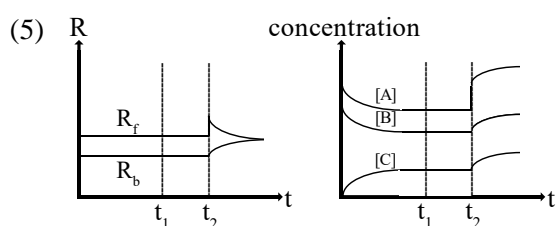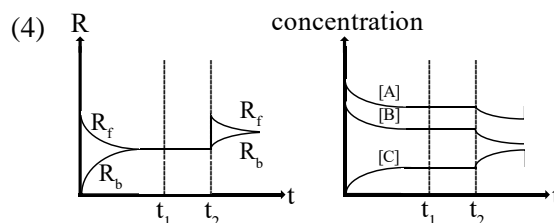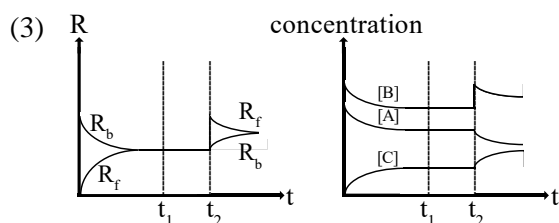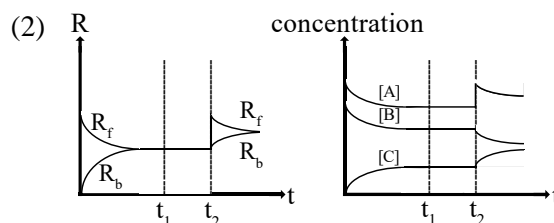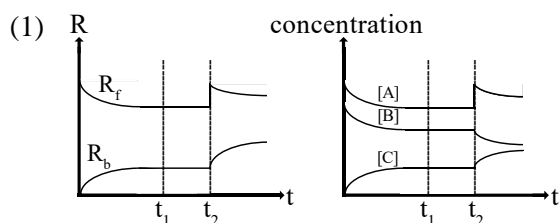
30. Select the graph depicting the **correct** variation of relative basicity of the following compounds.

(A) H_2O (B) CH_3CH_2MgBr (C) CH_3OH

(D) CH_3COOH (E) $CH_3CH_2CH_2NH_2$ (F) $CH_3NHCH_2CH_3$

(G) CH_3-NH_2 (H) NH_3

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

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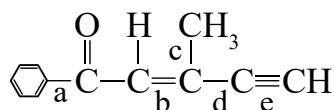   (5)   if **any other** number or combination of responses is correct.

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. Correct statement regarding 3d block elements and ions formed by them.

(a) The colours of MnO_4^- and CrO_4^{2-} are resulted due to transfer of electrons between orbitals.

(b) All 3d elements show +2 oxidation state.

(c) 3d elements are sometimes used as sources of radiation.

(d) Due to the presence of half-filled or empty d orbitals that can give or receive electrons, most transition metals show catalytic properties.

32. True statement regarding

$$\underset{a}{\overset{O}{\overset{\|}{C}}}-\underset{b}{\overset{H}{\overset{|}{C}}}=\underset{d}{\overset{CH_3}{\overset{c|}{C}}}-\underset{e}{\overset{}{C}}\equiv CH$$

(a) All carbon atoms are on the same plane.
(b) The C-C bond length increases as e < d < b < a < c.
(c) The C-C bond length increases as e < d < a < b < c.
(d) There are three C atoms with sp^2 hybridization.

33. True statement regarding the equilibrium constant (K)
(a) The value of K remains constant in any condition.
(b) Under standard conditions, K is a quantity with no dimensions.
(c) The K of a reaction that can be presented as an addition of two reactions, can be obtained by the product of the K of the two reactions.
(d) When all the coefficients of a balanced chemical equation of an equilibrium is multiplied by n, the new K value is K^n.

34. True statement/s regarding the process of formation of an ester using an alcohol and a carboxylic acid in the presence of a catalyst.
(a) A nucleophilic addition occurs in the first step of the process.
(b) A tetrahedral intermediate compound is formed.
(c) The C-OH bond undergoes homolysis.
(d) Here, first a nucleophilic addition occurs and then a nucleophilic substitution occurs.

35. MX is a water insoluble ionic compound. HX is a weak acid. **Correct** statement/s out of the following is/are,
(a) MX dissolves well in strong acids.
(b) In the addition of $HNO_{3(aq)}$ to a saturated solution of MX, the H^+ concentration may reduce sometimes.
(c) If M^+ solution is added to an aqueous solution of HX, the pH of the solution is increased.
(d) When HX is added to a saturated solution of MX, MX is always precipitated.

36. Select the **correct** statement/s regarding bio diesel out of the following.
(a) The 100% renewable or non- renewable nature of the bio diesel produced is determined by the method by which the raw material ethanol is obtained.
(b) It is essential for free fatty acids to be present in plant oils for the transesterification to occur properly.
(c) Both homogenous and heterogenous catalysts can be used in this process, and the mixture must be stirred well in the steps where the catalysts are added.
(d) Glycerol is the major by-product of bio diesel production.

37. The **incorrect** statement/s regarding the chemistry of Al is/are,
(a) In Friedel-Craft alkylation and acylation , Al in $AlCl_3$ acts as a Lewis acid.
(b) The hydroxide of Al is white and gelatinous.
(c) The hydroxide of Al dissolves in conc. ammonia and gives a clear colourless solution.
(d) $AlCl_3$ dimerizes in aqueous medium to complete its octet.

38. The **correct** statement/s regarding calomel electrodes is/are,
   (a) An oxidation occurs here.
   (b) Hg liquid is deposited at the bottom.
   (c) The Pt wire is used to establish an electrical connection with the external circuit.
   (d) The KCl solution used for electrical conduction should be saturated.

39. Incorrect statement/s regarding gas molecules is/are,
   (a) Repulsion forces between gas molecules become stronger in high pressures.
   (b) The compressibility factor of real gases is less than 1 in high pressures.
   (c) The diffusion rate of gas molecules increase with the increase in molar mass.
   (d) Ideal gas collisions are always perfectly elastic.

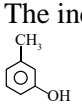**40.** The **correct** statement/s regarding polymers is/are,
   (a) There are polymers for which a definite repeating unit cannot be presented.
   (b) The transparency of plastics with crystalline areas is comparatively high.
   (c) The number of ester bonds formed in condensation polymers like polyester can be calculated, if the volume of water released can be measured accurately.
   (d) Phenol formaldehyde is a thermoplastic polymer.

- 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.	Although phenolphthalein can be used as an indicator for a titration of HCl and NaOH in 0.1 mol dm^{-3} concentrations, only bromothymol blue is suitable for concentrations of 0.001 mol dm^{-3}.	As the pH values of strong acids reduce by 1 when diluted by ten times, the range of rapid pH change at the end point reduces.
42.	The solubility of $PbCl_{2(s)}$ in conc. HCl is lower than that in water.	The solubility of a certain salt in a solution is reduced by the presence of a common ion.
43.	HFC is a gas that does not produce any ill effects globally.	The GWP value of HCF gas is very high.
44.	The most stable Lewis structure of carbon monoxide is $C^{(-)} \equiv O^{(+)}$.	As there is a (+) charge on the more electronegative O, it is unstable. Therefore, it does not exist in nature.
45.	$CH_3COO^{(-)}$ is more basic than the ion $CH_3O^{(-)}$.	$CH_3COO^{(-)}$ ion stabilizes through resonance.

46.	In peroxide medium, addition of HBr to propene occurs against the Markovnikov's rule.	That reaction occurring in the presence of H_2O_2 occurs through a free radical mechanism.
47.	Hardness of water is its capacity to precipitate soap.	The total concentrations of monovalent and multivalent metal cations affect the hardness of water.
48.	The inclination shown by [structure] and [structure] to be attacked by an electrophile is the same.	Both $-CH_3$ and -OH activate the benzene ring.
49.	The intermediate compound of a multistep reaction can never be observed.	An intermediate is a compound formed in one step, and spent in the next.
50.	The major causative agent of the Minamata disease is the heavy metal Cd.	Since there is no definite definition for heavy metals, various definitions are given in different instances.

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