047/2025

PART – II

Total Number of Questions : 40	Maximum Marks : 200	Time : 3 Hours

INSTRUCTIONS (നിർദ്ദേശങ്ങൾ)

1. Question cum Answer Booklets are processed by electronic means. The following instructions are to be strictly followed to avoid invalidation of answer scripts.
(ചോദ്യവും ഉത്തരവും അടങ്ങുന്ന ഈ ബുക്ക് ലെറ്റുകൾ ഇലക്ട്രോണിക് സാങ്കേതിക വിദ്യയുടെ സഹായത്തോടുകൂടെ മൂല്യനിർണ്ണയം നടത്തുന്നതിനാൽ ഇവ അസാധുവാകാതിരിക്കുവാൻ താഴെപ്പറയുന്ന നിർദ്ദേശങ്ങൾ പൂർണ്ണമായും പാലിക്കുക.)

2. The first page of this question cum Answer Booklet is an OMR data Sheet (Part I). All entries in the OMR sheet are to be made with blue or black ball point pen only.
(ഈ പുസ്തകത്തിന്റെ ഒന്നാമത്തെ പേജ് ഒരു ഒ.എം.ആർ. ഡാറ്റാ ഷീറ്റാണ് (പാർട്ട് I). ഇത് നീലയോ, കറുപ്പോ നിറത്തിലെ ബോൾ പോയിന്റ് പേന ഉപയോഗിച്ച് മാത്രമേ പൂരിപ്പിക്കാവൂ.)

3. Make sure that register number is bubbled correctly and completely; no correction is permitted.
(രജിസ്റ്റർ നമ്പർ രേഖപ്പെടുത്തുന്നതിനുള്ള കുമിളകൾ കൃത്യമായും പൂർണ്ണമായും കറുപ്പിച്ചിട്ടുണ്ടെന്ന് ഉറപ്പു വരുത്തുക. തിരുത്തലുകൾ അനുവദനീയമല്ല.)

4. Do not tamper the bar code printed on the OMR sheet and subsequent pages. Tampering of bar code will result in the invalidation of this booklet.
(ഈ പുസ്തകത്തിൽ എവിടെയും പ്രിന്റ് ചെയ്തിരിക്കുന്ന ബാർ കോഡിൽ ഒരു കാരണവശാലും തിരുത്തലുകളോ, മാർക്കുകളോ പാടില്ല. ഇതിനു വിരുദ്ധമായി ചെയ്യുന്ന പക്ഷം ഈ പുസ്തകം അസാധുവാകുന്നതാണ്.)

5. Answers should be written with blue or black ball point pen only.
(ഉത്തരങ്ങൾ നീലയോ, കറുപ്പോ നിറത്തിലെ ബോൾ പോയിന്റ് പേന ഉപയോഗിച്ച് മാത്രമേ എഴുതാവൂ.)

6. Do not write anything outside the margin of space provided for writing the answer and write only one line of answer between two lines.
(പുസ്തകത്തിൽ ഉത്തരം എഴുതുവാൻ നൽകിയിരിക്കുന്ന സ്ഥലത്തിനു വെളിയിൽ യാതൊന്നും തന്നെ എഴുതുവാൻ പാടില്ല. രണ്ടു വരകൾക്കിടയിൽ ഒരു വരി ഉത്തരം മാത്രമേ എഴുതുവാൻ പാടുള്ളൂ.)

7. Rough work should be done only in the specific page provided with.
(റഫ് വർക്കുകൾ ഇതിനായി നൽകിയിരിക്കുന്ന പേജിൽ മാത്രമേ ചെയ്യുവാൻ പാടുള്ളൂ.)

1. Calculate the wavelength of the spectral line with the highest energy in the Lyman series of hydrogen spectrum. $\left(R \approx 1\times10^{7}\, m^{-1}\right)$ (5 Marks)

2. Describe the quantum numbers of electron in the lowest energy orbital of the N-shell of an atom. (5 Marks)

3. 8.4 g of nitrogen and 2 g of hydrogen are mixed together to form ammonia. Calculate the number of moles of excess reactant. (5 Marks)

4. "He_2 molecule does not exist but He_2^+ ion exist predominantly". Justify using molecular orbital theory. (5 Marks)

5. Calculate the enthalpy of formation of benzene from the following thermochemical equations (5 Marks)

   (a) $C_6H_{6(l)} + 15O_{2(g)} \rightarrow 6CO_{2(g)} + 3H_2O_{(l)}\ \Delta H = -3200\ kJ$

   (b) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}\ \Delta H = -390\,kJ$

   (c) $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}\ \Delta H = -280\,kJ$

6. The value of K_p for the equilibrium (5 Marks)

   $2H_2O_{(g)} + 2Cl_{2(g)} \qquad 4HCl_{(g)} + O_{2(g)}$

   is 30 atm at 27°C when the partial pressure are expressed in atmosphere. Calculate the value of K_C for the same reaction. K_P and K_C are the equilibrium constant in terms of partial pressure and concentration. R = 0.0820 dm^3 atm k^{-1} mol^{-1}.

7. Haber process is used to produce ammonia from nitrogen and hydrogen. (5 Marks)

   $N_{2(g)} + 3H_{2(g)} \qquad 2NH_{3(g)}\ \Delta H = -92.4$ kJ/Mol

   What will be the effect of

   (a) Increase in pressure at constant temperature

   (b) Increase in temperature at constant pressure

   (c) Increase in concentration of nitrogen

8. For the redox reaction (5 Marks)

$Zn_{(s)} + Cu^{2+}{}_{(0.1\,M)} \rightarrow Zn^{2+}{}_{(1M)} + Cu_{(s)}$

E^0_{cell} is 1.10 V

(a) Calculate E_{cell} of the reaction

(b) Write the half cell reactions

9. Express Langmuir adsorption isotherm mathematically and graphically. What will happen this isotherm at very low pressure and very high pressure? (5 Marks)

10. Consider the reaction between reactants A and B to give products C and D

$2A + 2B \rightarrow C + D$ (5 Marks)

	[A] (mol dm^{-3})	[B] (mol dm^{-3})	Rate (r) mol $dm^{-3}s^{-1}$
(i)	0.006	0.001	0.012
(ii)	0.006	0.002	0.024
(iii)	0.002	0.0015	0.002
(iv)	0.004	0.0015	0.008

Rate $\propto [A]^a\ [B]^b$

(a) Write the order of the reaction with respect to A and B

(b) Write the overall order of the reaction

(c) Calculate rate constant of the reaction

11. Calculate the mole fraction of water in a mixture containing 9 g water, 60 g acetic acid and 92 g ethanol. (Molecular mass of water = 18, acetic acid = 60 and ethanol = 46) (5 Marks)

12. Write any five differences between physisorption and chemisorption. (5 Marks)

13. Among the two octahedral complexes of Cobalt (III), the one with NH_3 ligand is diamagnetic, while the one with fluoride ligand is paramagnetic. Justify this observation using Valence Bond Theory (VBT) (5 Marks)

14. Using Crystal Field Theory (CFT), explain why $[Fe(CN)_6]^{4-}$ is a low-spin and diamagnetic complex, whereas $[Fe(H_2O)_6]^{2+}$ is a high-spin and paramagnetic complex. (5 Marks)

15. Compare the packing efficiency of Face-Centered Cubic (FCC) and Body-Centered Cubic (BCC) unit cells and explain why FCC structures are more densely packed. (5 Marks)

16. An element X crystallizes in a face-centered cubic (FCC) structure. The atomic radius of X is 141.4 pm. The mass of 10^{20} atoms of X is given as 0.01 g. Calculate the density of X. (Avogadro's number, $N_A = 6 \times 10^{23}$) (5 Marks)

17. *Uranium-235 undergoes nuclear fission to produce krypton-92, Barium-141 and three neutrons.* (5 Marks)

    (a) Write the balanced nuclear reaction. (1)

    (b) Calculate the total energy released if the energy per fission reaction is 200 MeV and 2 grams of $_{92}^{235}U$ undergo complete fission. (2)

    (c) The mass of Uranium-235 nucleus is 235.04 u and the sum of the masses of the fission products and neutrons is 234.92 u. Calculate the packing fraction of Uranium-235. (2)

18. *Radioisotopes have significant applications in medicine, industry and archaeology.* (5 Marks)

    (a) How is Technetium-99m used in medical imaging? Why is it preferred over other radioisotopes? (2)

    (b) Explain how Carbon-14 dating helps in determining the age of ancient fossils. What is the limitation of this method? (2)

    (c) In industrial applications, how is Cobalt-60 used for material testing? Explain the principle behind its working. (1)

19. *Qualitative analysis of cations and anions is based on principles like solubility product and the common ion effect.* (5 Marks)

(a) Explain how the common ion effect influences the precipitation of a sparingly soluble salt. (2)

(b) In the qualitative analysis of cations, Group II cations (Pb^{2+}, Hg^{2+}, Cu^{2+}, etc.) are precipitated as sulfides. How does the solubility product (Ksp) principle help in their selecting precipitation? (2)

(c) A solution contains Ni^{2+} and Pb^{2+} ions. How can you distinguish between them using a spot test with dimethylglyoxime and sodium rhodizonate? (1)

20. *Understanding molecular bonding and shape is essential for predicting chemical properties and reactivity.* (5 Marks)

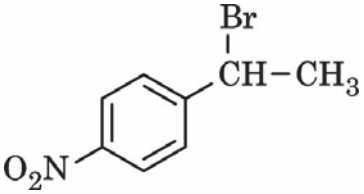
(a) The bonding in ionic compounds is not 100% ionic and bonding in covalent compounds is not 100% covalent. Explain this statement using Fajan's rule and provide examples where covalent character is observed in ionic compounds. (2)

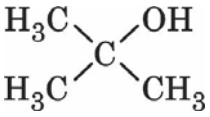
(b) Using VSEPR theory, predict and explain the shape of SF_4 and ClF_3. (2)

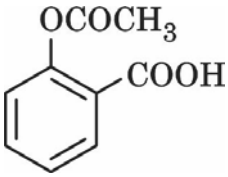
(c) Both BF_3 and NH_3 and AX_3-type molecules. However, their geometries are different. Explain the reason. (1)

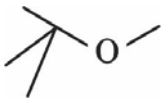
21. How will you prepare mesityloxide from acetone? Write the mechanism for the reaction. (5 Marks)

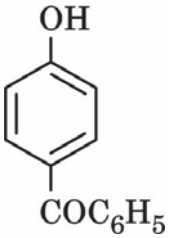
22. Write the IUPAC name of the following compounds. (5 Marks)

(a) 

(b) 

(c) 

(d) 

(e) 

23. Write the reaction and mechanism for the preparation of benzoic acid from benzene. (5 Marks)

24. Suggest a method for the conversion of phthalimide for ethylamine. Write the steps involved in the reaction. (5 Marks)

25. Which of the following compounds are chiral? Justify your answer.

(5 Marks)

(a) 2-chloropentane

(b) 3-methyl-1-Hexane

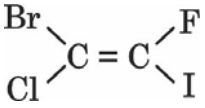
(c) 3-methyl hexane

(d) 5-ethyl 3,3-dimethylpentane

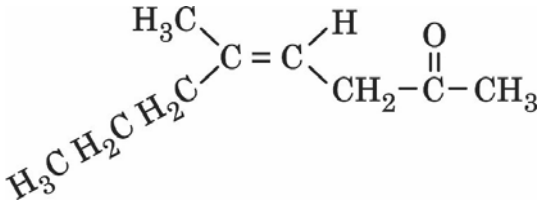
(e) 3-methylpentane

26. Compound (A) C_6H_7N, on diazotisation yield (B) which then reaction with cuprous chloride to form (C). Identify A, B and C and show the reactions involved. (5 Marks)

27. (a) Assign E/Z notation applicable to the following systems with proper explanation. (5 Marks)

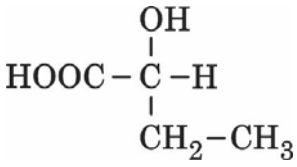


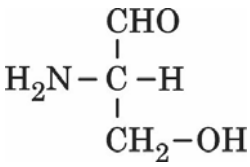
(I)



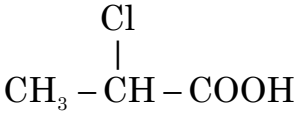
(II)

(b) Assign R or S configuration to each of the following compounds.

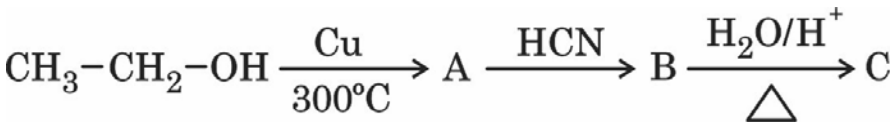
(i) 

(ii) 

28. Arrange the following compounds in the increasing order of acidity and explain your answer. (5 Marks)

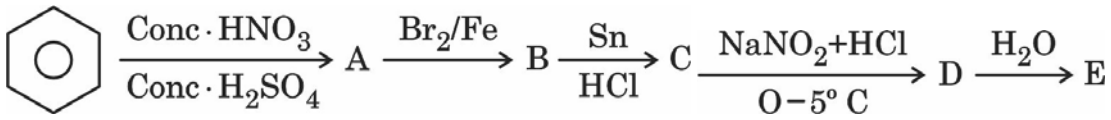
Cl_3COOH, H_3C COOH, $ClCH_2COOH$, HCOOH, 

29. Identify A, B and C in the following reaction sequence and write the reaction mechanism. (5 Marks)



30. Write the structures from A to E in the following reaction sequence.

(5 Marks)



31. Explain the phenomena of muterotation exhibited by glucose with the help of its open chain and cyclic structures? Does fructose and glucose form the same osazone? Justify your answer with relevant equation. (5 Marks)

32. Explain and comment on the significance of each structure of protein? Also briefly outline the mechanism of enzyme catalysis proposed by Michaelis and Menten. (5 Marks)

33. Explain the relevance of the following terms with respect to DNA and RNA: Replication, Transcription, Translation, Genetic code and Mutation. (5 Marks)

34. Discuss the principle, applications and advantages of thin layer chromatography. (5 Marks)

35. What is the difference between fluorescence and phosphorescence in terms of persistence of light emission? Account for the difference. (5 Marks)

36. Compare the Grotthus-Draper Law and the Stark-Einstein Law taking photosynthesis as an example. (5 Marks)

37. Briefly describe the role of catalyst in Contact Process. Explain any three characteristics of a catalyst taking Contact Process as an example.

(5 Marks)

38. Write the Van der Waals equation for one mole of a real gas and explain the significance of the constants 'a' and 'b'. How does the Van der Waals equation provide a better description of real gases compared to the ideal gas law? (5 Marks)

39. What are properties of nanomaterials and how are they synthesized?

(5 Marks)

40. Discuss the causes and effects of Greenhouse effect. (5 Marks)