

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF CALICUT
M Phil (CHEMISTRY) ENTRANCE EXAMINATION
MODEL QUESTION PAPER

Time: 2 Hours

Max: 100 Marks

Register No	
Date	

Answer **all** Questions

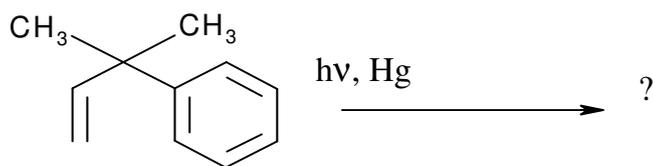
SECTION A

(Each Question carries **1** mark; **no negative mark** for **wrong** answers)

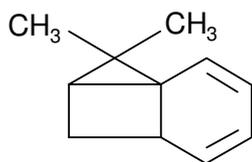
- The first noble gas compound obtained was
(A) XeF₂ (B) XePtF₆ (C) XeF₄ (D) XeOF₄
- Which of the following nuclide is the terminal member of the naturally occurring radioactive series which begins with ²³²₉₀Th ?
(A) ²⁰⁹₈₃Bi (B) ²⁰⁸₈₂Pb (C) ²⁰⁶₈₂Pb (D) ²¹⁰₈₃Bi
- A black solid (X), when heated with conc. HCl, gives a greenish yellow gas. When (X) is heated with sodium bismuthate in the presence of H₂SO₄, a purple solution is formed. (X) is likely to be
(A) PbO₂ (B) BaO₂ (C) MnO₂ (D) Pb₃O₄
- An alloy of Ca, Fe, Ni, Al and Co, used as permanent magnet is
(A) Stellite (B) Alnico (C) Nichrome (D) Pewter
- The correct order of stability of the following complexes, (I) [Ni(NH₃)₆]²⁺, (II) [Co(NH₃)₆]²⁺ and (III) [Fe(NH₃)₆]²⁺ is
(A) I < II < III (B) III < II < I (C) I < III < II (D) II < III < I
- The crystal field splitting diagram for a complex in square planar field is
(A) dxz ≈ dyz > dz² > dxy > dx²-y² (B) dxz ≈ dyz > dz² > dx²-y² > dxy
(C) dx²-y² > dz² > dxy > dxz ≈ dyz (D) dx²-y² > dxy > dz² > dxz ≈ dyz
- The spin-only formula of magnetic moment (μ) of a paramagnetic species in terms of Bohr Magneton (B.M.) and number of unpaired electrons (n) is
(A) μ = √n(n+1) B.M. (B) μ = n√(n+2) B.M.
(C) μ = √n(n+2) B.M. (D) μ = n.B.M.

8. The ground state term symbol of Mn^{2+} is
 (A) ^3F (B) ^2D (C) ^2S (D) ^6S
9. The compound $[\text{Ti}(\text{C}_5\text{H}_5)_2(\text{C}_5\text{H}_5)_2]$ obeys the 18-electron rule. Then the hapticities of C_5H_5 ligands are
 (A) 1 and 5 (B) 5 (C) 2 and 3 (D) 3
10. The correct trend in the M–C stretching frequencies of (i) $[\text{V}(\text{CO})_6]^-$ (ii) $[\text{Cr}(\text{CO})_6]$ and (iii) $[\text{Mn}(\text{CO})_6]^+$ is
 (A) (ii) > (iii) > (i) (B) (i) > (ii) > (iii)
 (C) (iii) > (ii) > (i) (D) (ii) > (ii) > (iii)
11. The most important role of manganese in biological system is
 (A) Water oxidation and dioxygen evolution (B) Dioxygen storage
 (C) Dioxygen binding and transport (D) Nitrogen fixation
12. Predict the influence of an increase in CO partial pressure above a certain threshold on the rate of cobalt-catalysed hydroformylation of 1-pentene
 (A) Rate is decreased (B) Rate is increased
 (C) No effect on rate (D) The catalyst is poisoned
13. If a plane makes an intercept 'a' on OX any goes parallel to OY and OZ. Its Miller indices are
 (A) 1 0 0 (B) 0 1 1 (C) 1 1 1 (D) 0 0 1
14. Which one of the following is an example for a covalent crystal?
 (A) NaCl (B) SiC (C) Ice (D) Iodine
15. Based on the principles of Green Chemistry, which of the following is a good solvent for the production of high value chemicals?
 (A) Ethanol (B) Methanol
 (C) Cyclohexane (D) Supercritical CO_2
16. The total number of orbitals possible in an atomic shell with Principal quantum number, $n = 4$ is
 (A) 4 (B) 9 (C) 24 (D) 16
17. How many significant figures are there in 0.067?
 (A) 4 (B) 3 (C) 2 (D) 1

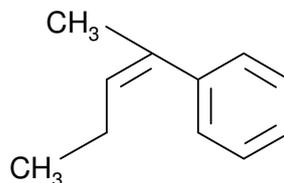
23. Predict the product in the following reaction



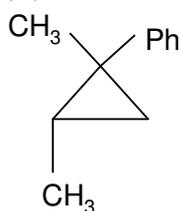
(A)



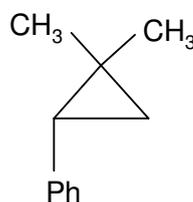
(B)



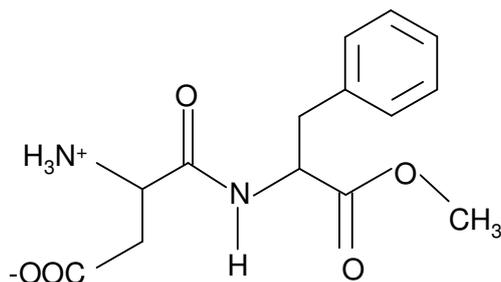
(C)



(D)



24. How many total stereoisomers exist for the following compound?



(A) 8

(B) 6

(C) 4

(D) 2

25. Arrange the following compounds in the decreasing order of their S_N1 reactivity

a. $\text{CH}_3\text{-CH}_2\text{-CH(Cl)-CH}_3$

b. $\text{CH}_2=\text{CH-CH(Cl)-CH}_3$

c. $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{Cl}$

(A) $a > b > c$

(B) $b > a > c$

(C) $c > b > a$

(D) $a > c > b$

26. Among the following amino acid carboxylates, only one molecule gives -NH stretching frequency at $\approx 3400 \text{ cm}^{-1}$. Identify it.

(A) (S)-Alanine

(B) (S)-Proline

(C) (S)-Phenylalanine

(D) (R)-Phenylalanine

27. A vitamin having pyridine nucleus in its structure is

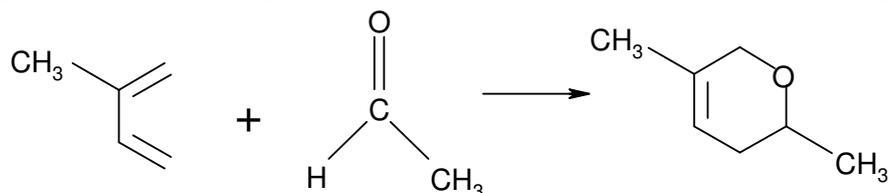
(A) Vitamin B_{12}

(B) Vitamin B_5

(C) Vitamin B_6

(D) Vitamin B_2

28. The progress of the following Diels-Alder reaction can be monitored by IR spectroscopy.



Which of the following spectroscopic features can be best utilized in determining the completion of the reaction?

- (A) The disappearance of the dienophile C=O stretch
- (B) The disappearance of the diene C=C stretch
- (C) The appearance of the product C=C stretch
- (D) The appearance of the product alkene C-H stretch.

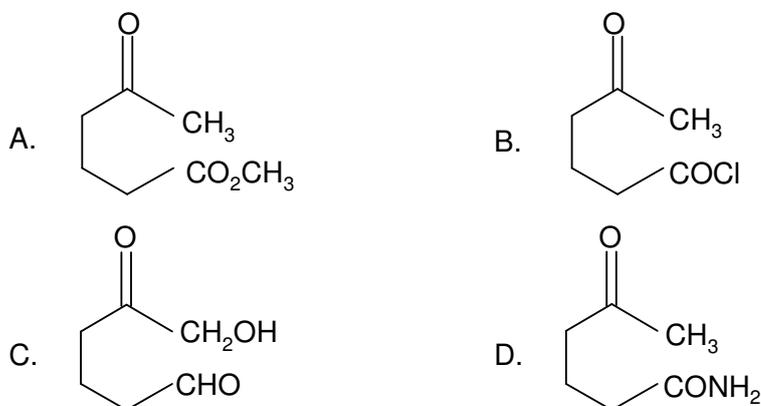
29. The triplet codon AUG used in protein synthesis stands for

- (A) Methionine
- (B) Alanine
- (C) Glycine
- (D) Proline

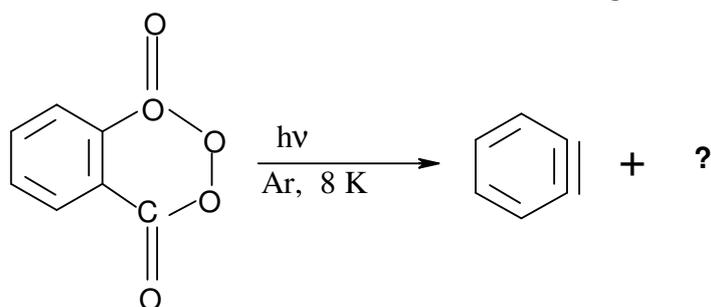
30. Wegner-Meerwein rearrangement follows through the intermediate formation of

- (A) Carbon radical
- (B) Carbanion
- (C) Carbocation
- (D) Carbene

31. 1,3-Cyclohexanedione can be prepared very easily by an intramolecular mixed Claisen condensation. What may be the structure of the substrate molecule?



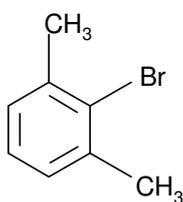
32. Predict the product, other than benzene, formed in the following reaction



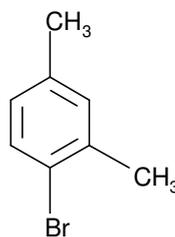
- (A) 4O₂
- (B) 2CO
- (C) 2CO₂
- (D) H₂CO₃

33. When *m*-dimethylbenzene is treated with Br₂ in the presence of FeBr₃, the major product obtained is

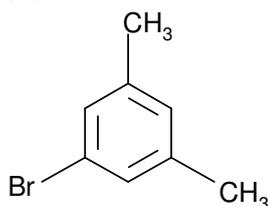
(A)



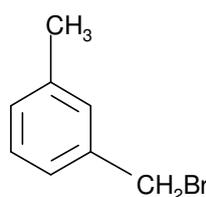
(B)



(C)



(D)



34. Which one of the following diatomic molecules would be stabilized by the removal of an electron?

(A) CN

(B) O₂

(C) N₂

(D) C₂

35. The lowest energy term symbol for silicon atom is

(A) ³P

(B) ³S

(C) ¹P

(D) ³D

36. NH₃ molecule has the symmetry point group of

(A) C_{3v}

(B) T_d

(C) C_{3h}

(D) D_{4v}

37. Number of microstates possible for the term 3F is

(A) 21

(B) 45

(C) 3

(D) 7

38. Predict the number of translational, rotational and vibrational degrees of freedom in Neon atom.

(A) 3, 0, 0

(B) 3, 1, 0

(C) 3, 0, 1

(D) 3, 1, 1

39. The motion of an electric charge, 'I' around a closed loop of area, 'A' produces a magnetic dipole, 'μ' whose magnitude is given by

(A) $\mu = IA$

(B) $\mu = I/A$

(C) $\mu = AI$

(D) $\mu = 2\pi AI$

40. The mass spectrum of a compound shows *m/e* values at 156, 127 and 29. Find out which among the following is the corresponding compound.

(A) C₂H₅Br

(B) CH₃I

(C) CH₃Br

(D) C₂H₅I

41. The structure of cesium metal at 25°C and 1 atmospheric pressure is body centered cubic. At the same temperature but at high pressure, cesium undergoes a phase transition to yield a structure much more dense than body centered cubic. Which of the following is the likely structure at high pressure?
- (A) Cubic close packed (B) Primitive cubic
(C) Primitive tetragonal (D) Amorphous
42. A 2 meter long tube is provided with inlets at both the ends so that gases 'A' and 'B' can be admitted simultaneously. Find out the distance from the gas 'A' inlet end of the tube at which 'AB' will first appear if 'A' and B are admitted at the same time, one from each end. [Given, $A + B = AB$, Molecular mass of 'B' = 4 times the Molecular mass of 'A']
- (A) 1 m (B) 1.25 m (C) 1.33 m (D) 1.67 m
43. According to the second law of thermodynamics, which of the following quantities represent the change in a state function?
- (A) q_{rev} (B) $T q_{\text{rev}}$ (C) q_{rev}/T (D) w_{rev}
44. One mole of an ideal gas expands isothermally until its volume is doubled. What is the change in Entropy, ΔS , for the process?
- (A) $RT \ln \frac{1}{2}$ (B) $RT \ln 2$ (C) $R \ln \frac{1}{2}$ (D) $R \ln 2$
45. What is the change in enthalpy (ΔH) for the reaction, $\text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2\text{O}_{(s)}$
- (A) Negative (B) Positive (C) Near Zero (D) Zero
46. The thermodynamic property that may be utilized for specifying the direction of time is
- (A) E (B) H (C) S (D) G
47. Which one among the following is correct in Joule-Thomson Expansion?
- (A) $\Delta E = 0$ (B) $\Delta H = 0$ (C) $\Delta S = 0$ (D) $\Delta G = 0$
48. For a reaction the rate constant is doubled when the temperature is increased from 17°C to 37°C . What is the activation energy for the reaction?
- (A) 3.1 k Cal (B) 6.2 k Cal (C) 12.4 k Cal (D) 24.8 k Cal
49. The potential of a half cell consisting of Zn electrode in 0.01 M ZnSO_4 solution at 25°C ($E^{\circ} = 0.763\text{ V}$) is
- (A) 0.604 V (B) 0.822 V (C) -0.822 V (D) -0.604 V
50. The solubility (S) of a sparingly soluble salt is related to specific conductance (K) and equivalent conductance (Λ_0) as
- (A) $S = 1000 \Lambda_0/K$ (B) $S = K \Lambda_0$ (C) $S = K/1000 \Lambda_0$ (D) $S = 1000 K/ \Lambda_0$

SECTION B

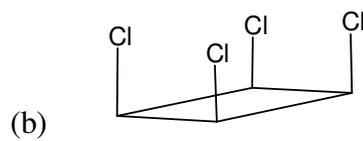
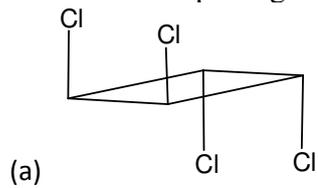
(Each Question carries 5 Marks; Answer in the space provided)

1. A) What is Fourier Transformation? How is it useful in spectroscopy?
B) Describe Z-matrix of molecules with an example (2+3 = 5 marks)

2. Discuss the theory of microwave spectroscopy.

5 marks

3. A) Write down the point groups corresponding to the following molecules:



B) Use first order perturbation theory to calculate the energy of a particle in a one-dimensional box with a slanted bottom from $x=0$ to $x=a$, such that $V(x) = V_0x/a$.
(2+3 = 5 marks)

4. B) Discuss the principle of polarography.

5 marks

5. A) Describe the uses of NaBH_4 and LiAlH_4 in organic synthesis.

B) Write a note on different polymerization techniques.

(3+2 = 5 marks)

6. Write a short note on the structure and function of DNA.

5 marks

7. Discuss the IR, NMR and mass spectra of propyl benzoate and phenyl butyrate. 5 marks

8. Briefly discuss the mechanism of outer sphere electron transfer mechanism (Marcus theory)
5 marks

9. What is EAN rule? Calculate the total electron in the following complexes and predict its stability using EAN rule. 5 marks

- a) $[\text{Cr}(\text{CO})_6]$ b) $[(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2\text{Cl}]$ c) $[\text{Mn}(\text{CO})_6]^+$ d) $\text{Fe}(\text{CO})_6$

10. Draw the M.O. picture of KMnO_4 and explain the probable charge transfer transitions.

5 marks

ROUGH WORK