

Birla Institute of Technology & Science, Pilani, Rajasthan 333 031

First Semester, 2022-2023

Course Number: CHEM F313

Course Title: Instrumental Methods of Analysis

Marks: 40

Time: 60 min

Comprehensive Test (Closed Book)

Date: Dec. 30, 2022

Paper I

1. Answer all the questions
2. Answers written within the box will be considered only
3. Each question carries one marks and for every two wrong answers 1 marks will be deducted
4. Maximum time is 75min

Name:

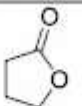
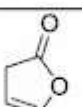
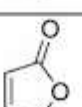
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Right answer

Wrong answer

Obtained marks

Q1. Match the structure of the compound with the carbonyl stretching frequency.

Column A	Column B
P. 	X. 1750 cm <sup>-1</sup>
Q. 	Y. 1770 cm <sup>-1</sup>
R. 	Z. 1800 cm <sup>-1</sup>

Choose the correct option.

- (A) P-Y, Q-Z, R-X; (B) P-Y, Q-X, R-Z; (C) P-Z, Q-Y, R-X; (D) P-X, Q-Z, R-Y

Q2. The number of signals that appear in the broadband decoupled <sup>13</sup>C NMR spectrum of phenanthrene and anthracene, respectively are

- (A) 10 and 4; (B) 10 and 10; (C) 7 and 4; (D) 7 and 7

Q3. The magnetic moment for a spinning nucleus ( $\mu_N$ ) and spinning electron ( $\mu_e$ ), respectively are as follows:

- (A)  $-g_N \beta_N I_Z$  and  $g_e \beta_e I_Z$ ; (B)  $g_N \beta_N I_Z$  and  $-g_e \beta_e I_Z$ ; (C)  $-g_N B_0 I_Z$  and  $g_e B_0 I_Z$ ; (D)  $g_N \beta_N I_Z$  and  $-g_e B_0 I_Z$  ( $\beta_N$  &  $\beta_e$  are the nuclear magneton and Bohr magneton, for the nucleus and electron, respectively;  $B_0$  = applied magnetic field; other symbols are usual notations)

Q4. Choose the correct option (used symbols denotes the usual notations):

- (A) Larmor frequency =  $(g_N B_Z) / 2\pi I = \mu_N \beta_N B_Z / h$ ; (B) Larmor frequency =  $(\mu_N B_Z) / 2\pi I = g_N \beta_N B_Z / h$ ;  
 (C) Larmor frequency =  $(g_N B_Z) / I = \mu_N \beta_N B_Z / h$ ; (D) Larmor frequency =  $(\mu_N B_Z) / I = g_N \beta_N B_Z / h$ ;

Q5. Choose the correct option:

- (A) In case of magnetic anisotropy, the regions where the induced magnetic field is opposed by the applied magnetic field is called the diamagnetic zone and the protons get deshielded in this zone
- (B) In case of magnetic anisotropy, the regions where the induced magnetic field is opposed by the applied magnetic field is called the paramagnetic zone and the protons get shielded in this zone
- (C) In case of magnetic anisotropy, the regions where the induced magnetic field is opposed by the applied magnetic field is called the paramagnetic zone and the protons get deshielded in this zone
- (D) In case of magnetic anisotropy, the regions where the induced magnetic field is opposed by the applied magnetic field is called the diamagnetic zone and the protons get shielded in this zone

Q6. Choose the correct option:

- (A) While recording the  $^{13}\text{C}$  NMR spectrum, the both coupling of  $^{13}\text{C}$ - $^{13}\text{C}$  and  $^{13}\text{C}$ - $^1\text{H}$  are removed by broadband coupling technique
- (B) While recording the  $^{13}\text{C}$  NMR spectrum, the both coupling of  $^{13}\text{C}$ - $^{13}\text{C}$  and  $^{13}\text{C}$ - $^1\text{H}$  are removed by broadband decoupling technique
- (C) While recording the  $^{13}\text{C}$  NMR spectrum, the only coupling of  $^{13}\text{C}$ - $^{13}\text{C}$  is removed removed by broadband coupling technique
- (D) While recording the  $^{13}\text{C}$  NMR spectrum, the only the coupling of  $^{13}\text{C}$ - $^1\text{H}$  is removed by broadband decoupling technique

Q7. Which of the following quantities is not changed at a different magnetic field strength:

- (A) Chemical shift (in hertz)
- (B) Nuclear spin population in an energy state
- (C) J coupling constant
- (D) Energy difference between two energy states of nuclei with non-zero spin quantum number

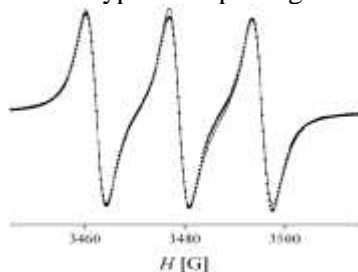
Q8. In a magnetic field, nuclear dipoles (nuclear spins with a spin quantum number of 1/2)

- (A) Precess around the magnetic field direction with random frequency
- (B) are motionless along the direction of the magnetic field
- (C) do not exist
- (D) precess around the magnetic field direction at the Larmor frequency

Q9. Which of the following electromagnetic radiation used in ESR?

- (A) IR radiation; (B) Radio waves; (C) Microwaves; (D) X-ray radiation

Q10. The hyperfine splitting in an ESR spectra observed (given below) may be due to single nuclei of



- (A)  $^1\text{H}$ ; (B)  $^{19}\text{F}$ ; (C)  $^{14}\text{N}$ ; (D)  $^{13}\text{C}$

Q11. The hyperfine splitting pattern that can be observed with three equivalent protons:

- (A) 1 : 1; (B) 1:2:1; (C) 1:3:3:1; (D) 1:1:1:1

Q12. ESR sensitivity increases with \_\_\_\_\_ temperature and with \_\_\_\_\_ magnetic field strength.

- (A) Increasing, increasing; (B) Increasing, decreasing; (C) Decreasing, decreasing; (D) Decreasing, increasing

Q13. ESR involves detecting of a physical phenomenon of \_\_\_\_\_ electromagnetic radiation.

- (A) Adsorption; (B) Absorption; (C) Radiation; (D) Reflection

Q14. Unit for measurement of hyperfine splitting constant in ESR is

- (A) Gauss / mm; (B) Tesla/sec; (C) Gauss; (D) No units
- Q15.** Glass transition temperature is related to a transition of
- (A) One form of amorphous to another form of amorphous; (B) Amorphous to Crystalline;  
 (C) Crystalline to Amorphous; (D) One form of crystalline to another form of crystalline
- Q16.** DTA records the
- (A) Absolute temperature variation of the sample with the temperature of reference  
 (B) Temperature difference of sample and reference with the temperature of reference  
 (C) Enthalpy change of the sample with the temperature of reference  
 (D) Enthalpy change of the sample and reference with the temperature of reference
- Q17.** In a TGA plot, it was seen two observations (i) initially it shows parallel to X-axis; (ii) then the line comes down with a slope. What these represents?
- (A) (i) compound is stable; (ii) compound is losing some part of it  
 (B) (i) compound is unstable; (ii) compound is losing some part of it  
 (C) (i) compound is stable; (ii) compound is gaining some part of it  
 (D) (i) compound is unstable; (ii) compound gaining some part of it
- Q18.** The temperature difference between sample and reference in DTA is measured using
- (A) Thermister; (B) Thermocouple; (C) Voltmeter; (D) Ammeter
- Q19.** Melting and oxidation peaks in DTA are
- (A) Exo and exo; (B) Endo and exo; (C) Endo and endo; (D) Endo and exo
- Q20.** DSC curves are used to check the purity of drugs and polymers. How it is determined?
- (A) By studying dimensional changes; (B) By analyzing gases formed in the thermal analysis  
 (C) By studying melting point; (D) By studying oxidative stability
- Q21.**
- |   |                     |   |  |
|---|---------------------|---|--|
| M | Working Electrode   | X | potential is varied linearly with time |
| N | Reference electrode | Y | Serves as source or sink for electrons |
| Q | Counter electrode   | Z | potential remains constant with time   |
- Choose right combinations for all cases:
- (A) MY; NX; QZ; (B) MZ, NY, QX; (C) MX, NZ, QY; (D) MX, NY, QZ
- Q22.** Primary use of cyclic voltammetric is
- (A) Quantitative analysis; (B) Qualitative analysis;  
 (C) Study the mechanism of redox process; (D) Structural analysis
- Q23.** For the reduction of silver ions with copper metal, the standard cell potential was found to be +0.46V at 25°C. The value of the standard Gibbs energy,  $\Delta^\circ G$  will be ( $F = 96500 \text{ coulomb mol}^{-1}$ ).
- (A) -98kJ; (B) -98J; (C) 89kJ; (D) -89kJ
- Q24.** The electrode potentials for  $\text{Cu}^{2+}(\text{aq}) + e \rightarrow \text{Cu}^+(\text{aq})$  and  $\text{Cu}^+(\text{aq}) + e \rightarrow \text{Cu}(\text{s})$  are +0.15V and +0.5V, respectively. The value of  $E^\circ_{\text{Cu}^{2+}/\text{Cu}}$  will be
- (A) 0.65V; (B) 0.15V (C) 0.50V (D) 0.325V
- Q25.** In atomic absorption spectroscopy with what material is the cathode in hollow cathode lamp constructed?
- (A) Tungstein; (B) Quartz; (C) Elements to be investigated; (D) Aluminium
- Q26.** Choose the correct sequence in flame photometry
- (A) Desolvation, Excitation, Atomization, Emission; (B) Atomization, Desolvation, Excitation, Emission  
 (C) Atomization, Excitation, Desolvation, Emission; (D) Desolvation, Atomization, Excitation, Emission
- Q27.** Which of the following is the principle of atomic absorption spectroscopy?
- (A) Radiation is absorbed by non-excited atoms in vapour states and are excited to higher state  
 (B) Medium absorb radiation and transmitted radiation is measured  
 (C) Colour is measured; (D) Colour is simply observed
- Q28.** The correct order for the basic features of a mass spectrometer is

- (A) Acceleration, Deflection, Detection, Ionization; (B) Acceleration, Ionization, Deflection, Detection  
(C) Ionization, Acceleration, Deflection, Detection; (D) Ionization, Acceleration, Detection, Deflection
- Q29.** The base peak in a mass spectrum is   
(A) The peak corresponding to the parent ion; (B) The lowest mass peak   
(C) The peak set to 100% relative intensity; (D) The peak showing molecular weight of a compound
- Q30.** Which of the following statements is wrong?  
(A) The energy required for removing an electron from a molecule varies in the given order: lone pair < conjugated electron < non conjugated electron  
(B) Isotopic ratio is particularly useful for the detection and estimation of number of S, Cl and Br atoms in the compound  
(C) Neutral fragments and molecules do not get detected in the detector in mass spectroscopy   
(D) The most intense peak in the mass spectroscopy is called the molecular ion peak
- Q31.** The Raman spectrum is said to consist of anti-stokes line when   
(A)  $\Delta\nu = 0$ ; (B)  $\Delta\nu > 0$ ; (C)  $\Delta\nu < 0$ ; (D) either  $\Delta\nu > 0$  or  $\Delta\nu < 0$  ( $\nu =$  wavenumber)
- Q32.** Raman Scattering is observed because of   
(A) Atmospheric scattering; (B) Rayleigh scattering; (C) Elastic collision; (D) Inelastic collision
- Q33.** In IR spectrum, the absorption band corresponding to the transition from  $\nu=0$  to  $\nu=2$  is called as   
(A) Fermi resonance; (B) Overtone; (C) Fundamental absorption band; (D) Combination band
- Q34.** Which of the following shows bathochromic shift in polar solvents?   
(A) Water; (B) Ethanol; (C) Ethylene; (D) Chloroform
- Q35.** Two samples each containing same analytes at equal concentration are irradiated with I and 2I intensities of radiation. Choose the correct option regarding the absorbances of A1 (irradiated at I) and A2 (irradiated at 2I).   
(A)  $A_2 = 4A_1$ ; (B)  $A_2 = 2A_1$ ; (C)  $A_2 = A_1$ ; (D)  $A_2 = 1/2A_1$
- Q36.** Which one is the incorrect option.   
(A) Absorptivity varies with changing the wavelength  
(B) Absorptivity varies with changing the intensity of light  
(C) Absorptivity varies with changing the temperature  
(D) Absorptivity varies with nature of the compounds
- Q37.** Anti-Kasha's rule describes the following transition.   
(A)  $S_1$  to  $S_0$ ; (B)  $S_2$  to  $S_0$ ; (C)  $S_1$  to  $T_1$ ; (D)  $T_1$  to  $S_0$
- Q38.** Which one is the correct expression of quantum yield (Q) and excited state life time (t) of a fluorophore   
(A)  $Q = kr / (kr + knr)$  and  $t = 1 / (kr + knr)$ ; (B)  $Q = kr / (kr + knr)$  and  $t = 1 / kr$ ;  
(C)  $Q = 1 / (kr + knr)$  and  $t = kr / (kr + knr)$ ; (D)  $Q = 1 / (kr + knr)$  and  $t = 1 / kr$
- Q39.** In the Stern-Volmer equation,   
$$\frac{F_0}{F} = 1 + k_q\tau_0[Q]$$
  
(A)  $k_q =$  Stern-Volmer constant and  $\tau_0 =$  quenched life time;  
(B)  $k_q =$  Bimolecular quenching constant and  $\tau_0 =$  quenched life time  
(C)  $k_q =$  Stern-Volmer constant and  $\tau_0 =$  unquenched life time   
(D)  $k_q =$  Bimolecular quenching constant and  $\tau_0 =$  unquenched life time
- Q40.** Lippert-Mataga equation cannot measures   
(A) the difference between the maxima of the absorbance and emission spectra of a fluorophore  
(B) the difference of dipole moment of excited and ground electronic states of a fluorophore  
(C) the excited state life-time of a fluorophore  
(D) the sensitivity of a fluorophore towards solvent polarity

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