

Final Exam  
**TACHEM: ANALYTICAL CHEMISTRY**  
Fall 2025

**Points of attention:**

- For each question, the maximum earned points are specified in the question.
- Write clearly! Answers that are not readable are not marked and don't earn marks!
- All answers should be written in English using **blue or black pens** only.
- Use the pencil only for diagrams and graphs.
- Show all the calculation steps in the given space.
- When finished, submit the question paper, together with the answer scripts and the signed cover page to the invigilator.
- Any cheating/copying may result in an instant failing of the examination.

**Exam Duration:** 2.5 hours  
**Instructor's Name:** Dr. G. CHANDRASEKAR  
**Exam Date:** 21/12/2025  
**Program:** PE

	<b>40</b>
	<b>10</b>

Student Information			
Name:	<input type="text"/>	ID:	<input type="text"/>
Signature:	<input type="text"/>		

Invigilator		
Initials:	<input type="text"/>	<input type="checkbox"/> Student ID checked
Time received:	<input type="text"/>	

**Instructions:**

- (i) SI units must be used.
- (ii) Diagram or Scheme must be provided wherever is required.
- (iii) Half mark will be reduced, if unit is not mentioned.
- (iv) Selection of two answers for one question in MCQ will not carry an any marks

**PART -A****Answer All Questions below****[10x 1 = 10] Marks**

1. Solid samples are prepared using KBr in.  
a) UV,      b) IR,      c) Thermogravimetry,      d) GC
  
2. Select a suitable range of wavenumbers producing molecular vibrations for spectral analysis.  
a) 40–200  $\text{cm}^{-1}$ ,      b) 400–4000  $\text{cm}^{-1}$ ,      c) 200–400  $\text{cm}^{-1}$ ,      d) 10–100  $\text{cm}^{-1}$
  
3. Suggest a source that can discharge infrared rays.  
a) D2 lamp, b) Sodium lamp, c) Nernst glow, d) Xenon lamp
  
4. Photodetectors are used in \_\_\_\_\_ instrument.  
a) Visible spectroscopy, b) Thermogravimetry, c) Mass spectroscopy, d) UV spectroscopy
  
5. Beer–Lambert Law relates absorbance is directly proportional to:  
a) Wavelength, b) Intensity, c) Pathlength, d) Frequency
  
6. Electronic transitions phenomena involved in \_\_\_\_\_ spectroscopy.  
a) Rotational, b) IR, c) Visible, d) Mass

7. The electromagnetic radiation in Visible region generally lies between:  
a) 10–100 nm, b) 400–800 nm, c) 800–1200 nm, d) 200–400 nm
8. Choose the suitable material to coat on the TLC plate for stationary phase.  
a)  $\text{Fe}_2\text{O}_3$ , b) Alumina, c) Cotton, d) Silicon carbide
9. In the UV-Vis spectroscopy, the spectrum is plotted as:  
(a) Absorbance vs wavelength, b) Peak area vs time, c) Transmittance vs wavenumber,  
d) Weight vs temperature.
10. Deuterium and Tungsten lamps are used for \_\_\_\_\_ and \_\_\_\_\_ radiation.  
a) X-ray and Gamma ray, (b) IR and Radio wave, (c) UV and Visible, (d) Microwave and x-ray

**PART -B****Answer All Questions below****[5x 2 = 10] marks**

11. Describe fabrication of capillary columns used in GC. (2 Marks)

12. Determine the analyte concentration, if the GC data are as given below

Peak area of analyte : 520

Peak area of standard : 260

Concentration of standard : 5 ppm

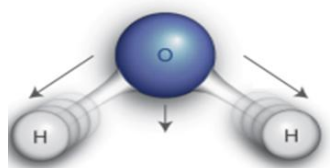
Response factor : 1.25

(2 Marks)

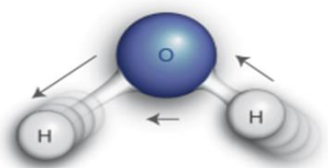
13. Draw the relationship of absorbance Vs concentrations and transmission Vs concentrations in visible spectroscopy and brief your understanding from the graph.  
(2 Marks)

14. List any four differences in the molecular separation process by normal-phase and reverse-phase HPLC? (2 Marks)

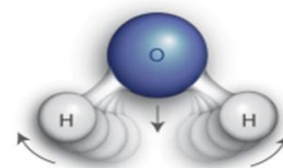
15. Indicate the mode of vibrations observed in the water molecules as shown below:



(A)



(B)



(C)

Molecule	Mode of vibrations
(A)	
(B)	
(C)	

(2 Marks)

**PART -C****Answer Any Four Questions below [4x 5 = 20] marks**

16. Elaborate the working principle and instrumentation of FTIR with neat diagram. (5 Marks)

17. Discuss the working functions of (i) FID and (ii) TCD used in gas chromatography with neat diagram. (5 Marks)



18. Thin Layer Chromatography (TLC) is used to identify Active Pharmaceutical Ingredients (API) in pharma industries. Demonstrate the principals involved in the technique and justify the significance of  $R_f$  in separating the compounds. (5 Marks)

19. Calibration curve is used to find out the unknown concentration of analyte.

- (i) Discuss the preparation method of 1 ppm, 2 ppm, 3 ppm and 5 ppm of standard solutions from the 100 ppm of the stock solution. (3 marks)
- (ii) Construct the calibration curve with the data as shown below. (2 marks)

<b>Concentration of Standard Solution</b>	<b>Absorbance</b>
1 ppm	0.1
2 ppm	0.25
3 ppm	0.35
5 ppm	0.48
Unknown	0.31



20. Sketch the double beam UV-Visible spectroscopy and enumerate the working principle and functions of each component involved in the analysis. (5 Marks)

IUPAC Periodic Table of the Elements

		13		14		15		16		17		18	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 <b>H</b> hydrogen 1.0080 ±0.0002	2 <b>He</b> helium 4.0026 ±0.0001	3 <b>Li</b> lithium 6.94 ±0.001	4 <b>Be</b> beryllium 9.0122 ±0.0001	5 <b>B</b> boron 10.81 ±0.02	6 <b>C</b> carbon 12.011 ±0.002	7 <b>N</b> nitrogen 14.007 ±0.001	8 <b>O</b> oxygen 15.999 ±0.001	9 <b>F</b> fluorine 18.998 ±0.001	10 <b>Ne</b> neon 20.180 ±0.001	11 <b>Na</b> sodium 22.990 ±0.001	12 <b>Mg</b> magnesium 24.305 ±0.002	13 <b>Al</b> aluminum 26.982 ±0.001	14 <b>Si</b> silicon 28.085 ±0.001
19 <b>K</b> potassium 39.098 ±0.001	20 <b>Ca</b> calcium 40.078 ±0.004	21 <b>Sc</b> scandium 44.956 ±0.001	22 <b>Ti</b> titanium 47.867 ±0.001	23 <b>V</b> vanadium 50.942 ±0.001	24 <b>Cr</b> chromium 51.996 ±0.001	25 <b>Mn</b> manganese 54.938 ±0.001	26 <b>Fe</b> iron 55.845 ±0.002	27 <b>Co</b> cobalt 58.933 ±0.001	28 <b>Ni</b> nickel 58.693 ±0.001	29 <b>Cu</b> copper 63.546 ±0.003	30 <b>Zn</b> zinc 65.38 ±0.02	31 <b>Ga</b> gallium 69.723 ±0.001	32 <b>Ge</b> germanium 72.630 ±0.006
37 <b>Rb</b> rubidium 85.468 ±0.001	38 <b>Sr</b> strontium 87.62 ±0.01	39 <b>Y</b> yttrium 88.906 ±0.001	40 <b>Zr</b> zirconium 91.224 ±0.002	41 <b>Nb</b> niobium 92.906 ±0.001	42 <b>Mo</b> molybdenum 95.95 ±0.01	43 <b>Tc</b> technetium [97]	44 <b>Ru</b> ruthenium 101.07 ±0.02	45 <b>Rh</b> rhodium 102.91 ±0.01	46 <b>Pd</b> palladium 106.42 ±0.01	47 <b>Ag</b> silver 107.87 ±0.01	48 <b>Cd</b> cadmium 112.41 ±0.01	49 <b>In</b> indium 114.82 ±0.01	50 <b>Sn</b> tin 118.71 ±0.01
55 <b>Cs</b> caesium 132.91 ±0.01	56 <b>Ba</b> barium 137.33 ±0.01	57-71 lanthanoids	72 <b>Hf</b> hafnium 178.49 ±0.01	73 <b>Ta</b> tantalum 180.95 ±0.01	74 <b>W</b> tungsten 183.84 ±0.01	75 <b>Re</b> rhenium 186.21 ±0.01	76 <b>Os</b> osmium 190.23 ±0.03	77 <b>Ir</b> iridium 192.22 ±0.02	78 <b>Pt</b> platinum 195.08 ±0.02	79 <b>Au</b> gold 196.97 ±0.01	80 <b>Hg</b> mercury 200.59 ±0.01	81 <b>Tl</b> thallium 204.38 ±0.01	82 <b>Pb</b> lead 207.2 ±1.1
87 <b>Fr</b> francium [223]	88 <b>Ra</b> radium [226]	89-103 actinoids	104 <b>Rf</b> rutherfordium [261]	105 <b>Db</b> dubnium [268]	106 <b>Sg</b> seaborgium [269]	107 <b>Bh</b> bohrium [270]	108 <b>Hs</b> hassium [269]	109 <b>Mt</b> meitnerium [277]	110 <b>Ds</b> darmstadtium [281]	111 <b>Rg</b> roentgenium [282]	112 <b>Cn</b> copernicium [285]	113 <b>Nh</b> nihonium [286]	114 <b>Fl</b> flerovium [290]
85 <b>At</b> astatine [210]	86 <b>Rn</b> radon [222]	87 <b>Fr</b> francium [223]	88 <b>Ra</b> radium [226]	89 <b>Ac</b> actinium [227]	90 <b>Th</b> thorium 232.04 ±0.01	91 <b>Pa</b> protactinium 231.04 ±0.01	92 <b>U</b> uranium 238.03 ±0.01	93 <b>Np</b> neptunium [237]	94 <b>Pu</b> plutonium [244]	95 <b>Am</b> americium [243]	96 <b>Cm</b> curium [247]	97 <b>Bk</b> berkelium [247]	98 <b>Cf</b> californium [251]
117 <b>Ts</b> tennessine [294]	118 <b>Og</b> oganesson [294]	119 <b>Uu</b> unununium [295]	120 <b>Uub</b> ununbium [295]	121 <b>Uut</b> ununtrium [295]	122 <b>Uuq</b> ununquadium [295]	123 <b>Uuq</b> ununquadium [295]	124 <b>Uuq</b> ununquadium [295]	125 <b>Uuq</b> ununquadium [295]	126 <b>Uuq</b> ununquadium [295]	127 <b>Uuq</b> ununquadium [295]	128 <b>Uuq</b> ununquadium [295]	129 <b>Uuq</b> ununquadium [295]	130 <b>Uuq</b> ununquadium [295]

Key:  
 atomic number  
**Symbol**  
 name  
 abbreviated standard  
 atomic weight

57 <b>La</b> lanthanum 138.91 ±0.01	58 <b>Ce</b> cerium 140.12 ±0.01	59 <b>Pr</b> praseodymium 140.91 ±0.01	60 <b>Nd</b> neodymium 144.24 ±0.01	61 <b>Pm</b> promethium [145]	62 <b>Sm</b> samarium 150.36 ±0.02	63 <b>Eu</b> europium 151.96 ±0.01	64 <b>Gd</b> gadolinium 157.25 ±0.03	65 <b>Tb</b> terbium 158.93 ±0.01	66 <b>Dy</b> dysprosium 162.50 ±0.01	67 <b>Ho</b> holmium 164.93 ±0.01	68 <b>Er</b> erbium 167.26 ±0.01	69 <b>Tm</b> thulium 168.93 ±0.01	70 <b>Yb</b> ytterbium 173.05 ±0.02	71 <b>Lu</b> lutetium 174.97 ±0.01
89 <b>Ac</b> actinium [227]	90 <b>Th</b> thorium 232.04 ±0.01	91 <b>Pa</b> protactinium 231.04 ±0.01	92 <b>U</b> uranium 238.03 ±0.01	93 <b>Np</b> neptunium [237]	94 <b>Pu</b> plutonium [244]	95 <b>Am</b> americium [243]	96 <b>Cm</b> curium [247]	97 <b>Bk</b> berkelium [247]	98 <b>Cf</b> californium [251]	99 <b>Es</b> einsteinium [252]	100 <b>Fm</b> fermium [257]	101 <b>Md</b> mendelevium [258]	102 <b>No</b> nobelium [259]	103 <b>Lr</b> lawrencium [262]

**MLO and Bloom's Level of Complexity**

<b>Q #</b>	<b>MLO Addressed</b>	<b>Complexity Level</b>	<b>Mark</b>
1	1	Knowledge	1
2	1	Understand	1
3	1	Knowledge	1
4	1	Knowledge	1
5	2	Apply	1
6	2	Apply	1
7	1	Knowledge	1
8	4	Evaluate	1
9	5	Creative	1
10	2	Apply	1
11	4	Evaluate	2
12	4	Evaluate	2
13	5	Creative	2
14	3	Analyze	2
15	5	Creative	2
16	3, 5	Analyze and Creative	5
17	3	Analyze	5
18	3, 4	Analyse/Evaluate	5
19	5,6	Creative/Demonstration	5
20	5	Design	5