الجامعة الوطنية
National University
Science & Technology للعلوم والتكنولوجيا
كلية عمان البحرية الدولية
International Maritime College Oman

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 hours 30 min
Instructor's Name:	Dr. G. Chandrasekar
Exam Date:	21/12/2025
Program:	PE

	40
	10

Student Information

Name: _____ ID: _____

Signature: _____

Invigilator

Initials: _____ ☐ Student ID checked

Time received: _____

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 more than one answer in MCQ will not carry any marks

PART -A

Answer <u>All</u> Questions [10 x 1 = 10] Marks

1. Segregate the spectrum of light comes from the sun have the Visible region:

   a) 10–100 nm, b) 400–800 nm, c) 40–40 nm, d) 200–400 nm

2. The experiments on light exposure to the analyte investigated by Beer–Lambert infer that absorbance is proportional to:

   a) Wavelength, b) Concentration, c) Temperature, d) Frequency

3. In visible spectroscopical study the molar absorptivity(ε) is characteristics for the analytes and its unit is expressed as:

   a) L mol^{-1} cm^{-1}, b) mol L^{-1} cm^{-1}, c) cm^{-1}, d) g mol^{-1}

4 Infra-red spectroscopic used in the structural elucidation of organic molecules to investigate mainly to:

   a) Molecular weight, b) Functional groups, c) Enantiomers only, d) Enantiomers and Isomers.

5. Predict a suitable source which can emit IR radiation from the following.

   a) Tungsten lamp, b) Xenon lamp, c) Sodium lamp, d) Nernst glower

6. Acetophenone is an important member of the aromatic carbonyl compound having C=O group exhibiting stretching vibrations around:

   a) 2200 cm^{-1}, b) 1100 cm^{-1}, c) 1700 cm^{-1}, d) 2900 cm^{-1}

7. The IR bands observed in the spectroscopic analysis are due to:

   a) Electron transitions, b) Nuclear transitions, c) Molecular vibrations, d) Ionization

8. Material coated on the TLC plate for the molecular separation and identifications is.
   a) Silica, b) Paper, c) Cotton, d) Plastic

9. The graphical representation of the UV spectrum expressed as:

   a) Absorbance vs wavelength, b) Peak area vs time, c) Transmittance vs wavenumber, d) Weight vs temperature

10. Select the instrument having FID.

    a) HPLC, b) GC, c) IR, d) UV

PART -B

Answer <u>All</u> Questions **[5x 2 = 10] Marks**

11. Inert gases are used to separate volatile molecules by gas chromatography.
    (i) Define the retention factor (1 Mark)
    (ii) Determine the retention factor, if the compound has retention time = 10.0 min and column dead time = 2.0 min. (1 Mark)

12. Filter paper can act as a stationary phase in chromatography. Explain briefly the process of separation and identification of molecules using filter paper. (2 Marks)

13. Classify any four types of HPLC technique based on types of interaction involved between analyte and stationary phase. (2 Marks)

14. List out the stationary and mobile phases adopted for normal phase and reverse-phase HPLC? (2 Marks)

15. How will you prepare the samples for the IR spectral analysis, if one is in solid form and another in liquid form. (2 Marks)

PART -C

Answer Any Four Questions below [4x 5 = 20] Marks

16. High Pressure Liquid Chromatography (HPLC) used for organic liquids for identification, separation and quantification. Sketch the HPLC with neat diagram and explain the working principle and instrumentation. (5 Marks)

17. Separation factor is an important parameter for peak separation in gas chromatography.

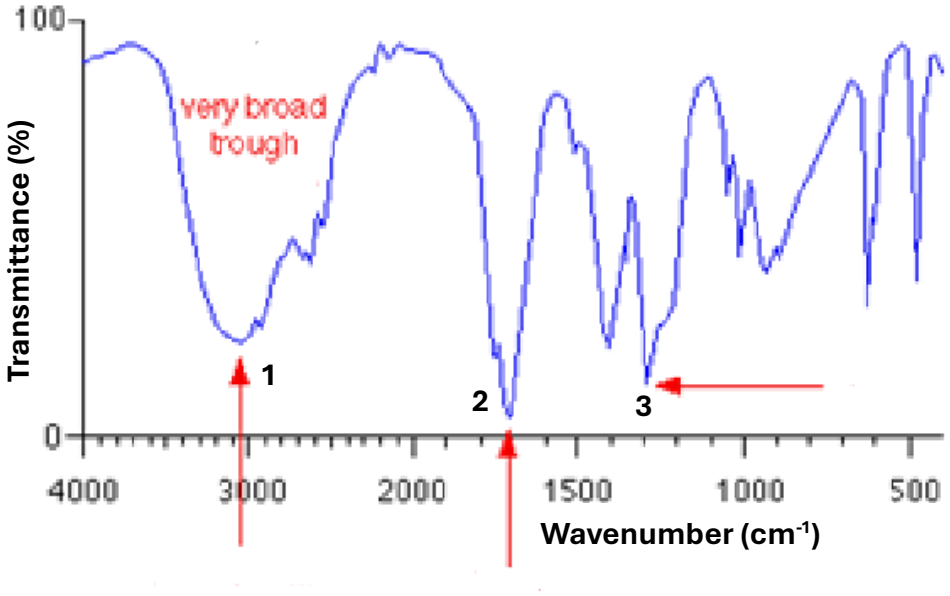
    (i) Write a short note on separation factor (α) (2 Marks)

    (ii) Calculate the separation factor (α), if the Retention time of Compound A (t_{R1}) $= 5.0$ min, Compound B (t_{R2}) $= 8.0$ min and Dead time (t_M) $= 1.0$ min. (3 Mark)

18. The infrared spectrum of acetic acid is shown below. The three main vibrational bands are indicated by the arrows. Write the functional groups that are responsible for the vibrational bands as shown by the arrows.

Arrow No.	IR vibrational band due to the functional group	
1		(1 Mark)
2		(2 Marks)
3		(2 Marks)

Infrared spectrum of acetic acid



19. If you are asked to find out the unknown concentration of the methylene blue dye sample by using UV visible spectroscopy. Explain briefly the steps which are taken to measure the unknown concentration. (5 Marks)

20. Explain the chromatography technique specifically used in bio-medical industries to separate the biomolecules. Also state the principle involved, nature of stationary phase, nature of mobile phase and elusion processes involved in the separation processes. (5 Marks)

IUPAC Periodic Table of the Elements
Key:
atomic number
Symbol
name
abridged standard atomic weight
1 H hydrogen 1.0080 ±0.0002
2 He helium 4.0026 ±0.0001
3 Li lithium 6.94 ±0.06
4 Be beryllium 9.0122 ±0.0001
5 B boron 10.81 ±0.02
6 C carbon 12.011 ±0.002
7 N nitrogen 14.007 ±0.001
8 O oxygen 15.999 ±0.001
9 F fluorine 18.998 ±0.001
10 Ne neon 20.180 ±0.001
11 Na sodium 22.990 ±0.001
12 Mg magnesium 24.305 ±0.002
13 Al aluminium 26.982 ±0.001
14 Si silicon 28.085 ±0.001
15 P phosphorus 30.974 ±0.001
16 S sulfur 32.06 ±0.02
17 Cl chlorine 35.45 ±0.01
18 Ar argon 39.95 ±0.16
19 K potassium 39.098 ±0.001
20 Ca calcium 40.078 ±0.004
21 Sc scandium 44.956 ±0.001
22 Ti titanium 47.867 ±0.001
23 V vanadium 50.942 ±0.001
24 Cr chromium 51.996 ±0.001
25 Mn manganese 54.938 ±0.001
26 Fe iron 55.845 ±0.002
27 Co cobalt 58.933 ±0.001
28 Ni nickel 58.693 ±0.001
29 Cu copper 63.546 ±0.003
30 Zn zinc 65.38 ±0.02
31 Ga gallium 69.723 ±0.001
32 Ge germanium 72.630 ±0.008
33 As arsenic 74.922 ±0.001
34 Se selenium 78.971 ±0.008
35 Br bromine 79.904 ±0.003
36 Kr krypton 83.798 ±0.002
37 Rb rubidium 85.468 ±0.001
38 Sr strontium 87.62 ±0.01
39 Y yttrium 88.906 ±0.001
40 Zr zirconium 91.224 ±0.002
41 Nb niobium 92.906 ±0.001
42 Mo molybdenum 95.95 ±0.01
43 Tc technetium [97]
44 Ru ruthenium 101.07 ±0.02
45 Rh rhodium 102.91 ±0.01
46 Pd palladium 106.42 ±0.01
47 Ag silver 107.87 ±0.01
48 Cd cadmium 112.41 ±0.01
49 In indium 114.82 ±0.01
50 Sn tin 118.71 ±0.01
51 Sb antimony 121.76 ±0.01
52 Te tellurium 127.60 ±0.03
53 I iodine 126.90 ±0.01
54 Xe xenon 131.29 ±0.01
55 Cs caesium 132.91 ±0.01
56 Ba barium 137.33 ±0.01
57-71 lanthanoids
72 Hf hafnium 178.49 ±0.01
73 Ta tantalum 180.95 ±0.01
74 W tungsten 183.84 ±0.01
75 Re rhenium 186.21 ±0.01
76 Os osmium 190.23 ±0.03
77 Ir iridium 192.22 ±0.01
78 Pt platinum 195.08 ±0.02
79 Au gold 196.97 ±0.01
80 Hg mercury 200.59 ±0.01
81 Tl thallium 204.38 ±0.01
82 Pb lead 207.2 ±1.1
83 Bi bismuth 208.98 ±0.01
84 Po polonium [209]
85 At astatine [210]
86 Rn radon [222]
87 Fr francium [223]
88 Ra radium [226]
89-103 actinoids
104 Rf rutherfordium [267]
105 Db dubnium [268]
106 Sg seaborgium [269]
107 Bh bohrium [270]
108 Hs hassium [269]
109 Mt meitnerium [277]
110 Ds darmstadtium [281]
111 Rg roentgenium [282]
112 Cn copernicium [285]
113 Nh nihonium [286]
114 Fl flerovium [290]
115 Mc moscovium [290]
116 Lv livermorium [293]
117 Ts tennessine [294]
118 Og oganesson [294]
57 La lanthanum 138.91 ±0.01
58 Ce cerium 140.12 ±0.01
59 Pr praseodymium 140.91 ±0.01
60 Nd neodymium 144.24 ±0.01
61 Pm promethium [145]
62 Sm samarium 150.36 ±0.02
63 Eu europium 151.96 ±0.01
64 Gd gadolinium 157.25 ±0.03
65 Tb terbium 158.93 ±0.01
66 Dy dysprosium 162.50 ±0.01
67 Ho holmium 164.93 ±0.01
68 Er erbium 167.26 ±0.01
69 Tm thulium 168.93 ±0.01
70 Yb ytterbium 173.05 ±0.02
71 Lu lutetium 174.97 ±0.01
89 Ac actinium [227]
90 Th thorium 232.04 ±0.01
91 Pa protactinium 231.04 ±0.01
92 U uranium 238.03 ±0.01
93 Np neptunium [237]
94 Pu plutonium [244]
95 Am americium [243]
96 Cm curium [247]
97 Bk berkelium [247]
98 Cf californium [251]
99 Es einsteinium [252]
100 Fm fermium [257]
101 Md mendelevium [258]
102 No nobelium [259]
103 Lr lawrencium [262]

MLO and Bloom's Level of Complexity

Q #	MLO Addressed	Complexity Level	Mark
1	**4**	Evaluate	**1**
2	**5**	Creative	**1**
3	**1, 2**	Understand/Apply	**1**
4	**1**	Demonstrate knowledge	**1**
5	**1, 3**	Understand/Analyze	**1**
6	**6**	Demonstrate	**1**
7	**3**	Analyze	**1**
8	**1**	Knowledge	**1**
9	**6**	Demonstrate	**1**
10	**1**	Understand	**1**
11	**4**	Evaluate	**2**
12	**1**	Understand/Knowledge	**2**
13	**2**	Apply	**2**
14	**1**	Understand	**2**
15	**4,6**	Evaluate/Demonstrate	**2**
16	**5**	Create/Design	**4**
17	**4,6**	Evaluate/Demonstrate	**4**
18	**2,6**	Apply/Demonstrate	**4**
19	**2,6**	Apply/Demonstrate	**4**
20	**4,6**	Evaluate/Demonstrate	**4**