

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 All 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) $\text{L mol}^{-1} \text{cm}^{-1}$, b) $\text{mol L}^{-1} \text{cm}^{-1}$, 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

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.

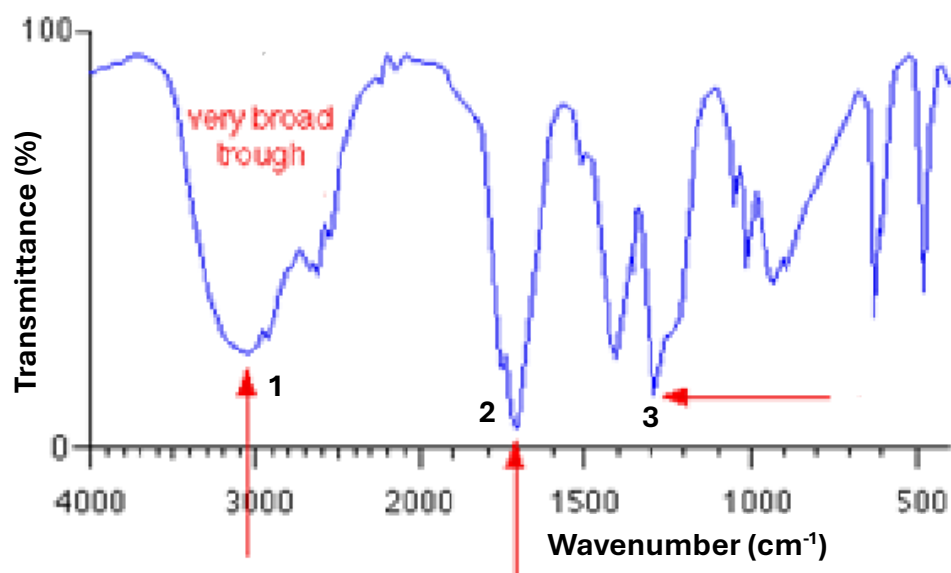
| Arrow No. | IR vibrational band due to the functional group |
|-----------|---|
| 1 | |
| 2 | |
| 3 | |

(1 Mark)

(2 Marks)

(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 elution processes involved in the separation processes. (5 Marks)

IUPAC Periodic Table of the Elements

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | | 11 | | 12 | | 13 | | 14 | | 15 | | 16 | | 17 | | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | atomic number | Symbol | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | name | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | standard atomic weight | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | H | hydrogen | 2 | He | helium | 3 | Li | lithium | 4 | Be | beryllium | 5 | B | boron | 6 | C | carbon | 7 | N | nitrogen | 8 | O | oxygen | 9 | F | fluorine | 10 | Ne | neon | 11 | Na | sodium | 12 | Mg | magnesium | 13 | Al | aluminum | 14 | Si | silicon | 15 | P | phosphorus | 16 | S | sulfur | 17 | Cl | chlorine | 18 | Ar | argon | 19 | K | potassium | 20 | Ca | calcium | 21 | Sc | scandium | 22 | Ti | titanium | 23 | V | vanadium | 24 | Cr | chromium | 25 | Mn | manganese | 26 | Fe | iron | 27 | Co | cobalt | 28 | Ni | nickel | 29 | Cu | copper | 30 | Zn | zinc | 31 | Ga | gallium | 32 | Ge | germanium | 33 | As | arsenic | 34 | Se | selenium | 35 | Br | bromine | 36 | Kr | krypton | 37 | Rb | rubidium | 38 | Sr | strontium | 39 | Y | yttrium | 40 | Zr | zirconium | 41 | Nb | niobium | 42 | Mo | molybdenum | 43 | Tc | technetium | 44 | Ru | ruthenium | 45 | Rh | rhodium | 46 | Pd | palladium | 47 | Ag | silver | 48 | Cd | cadmium | 49 | In | indium | 50 | Sn | tin | 51 | Sb | antimony | 52 | Te | tellurium | 53 | I | iodine | 54 | Xe | xenon | 55 | Cs | caesium | 56 | Ba | barium | 57-71 | lanthanoids | 72 | Hf | hafnium | 73 | Ta | tantalum | 74 | W | tungsten | 75 | Re | rhenium | 76 | Os | osmium | 77 | Ir | iridium | 78 | Pt | platinum | 79 | Au | gold | 80 | Hg | mercury | 81 | Tl | thallium | 82 | Pb | lead | 83 | Bi | bismuth | 84 | Po | polonium | 85 | At | astatine | 86 | Rn | radon | 87 | Fr | francium | 88 | Ra | radium | 89-103 | actinoids | 104 | Rf | rutherfordium | 105 | Db | dubnium | 106 | Sg | seaborgium | 107 | Bh | bohrium | 108 | Hs | hassium | 109 | Mt | meitnerium | 110 | Ds | darmstadtium | 111 | Rg | roentgenium | 112 | Cn | copernicium | 113 | Nh | nihonium | 114 | Fl | flerovium | 115 | Mc | moscovium | 116 | Lv | livermorium | 117 | Ts | tennessine | 118 | Og | oganesson | 119 | Uu | ununennium | 120 | Uub | ununbium | 121 | Uut | ununtrium | 122 | Uuq | ununquadium | 123 | Uup | ununpentium | 124 | Uuq | ununhexium | 125 | Uuh | ununheptium | 126 | Uuq | ununoctium | 127 | Uuh | ununnonium | 128 | Uuq | unundecium | 129 | Uuh | unundundium | 130 | Uuq | ununtridecium | 131 | Uuh | ununquadecium | 132 | Uuq | ununpentadecium | 133 | Uuh | ununhexadecium | 134 | Uuq | ununseptadecium | 135 | Uuh | ununoctadecium | 136 | Uuq | ununnonadecium | 137 | Uuh | ununtriacontium | 138 | Uuq | ununtrigintium | 139 | Uuh | ununquadragintium | 140 | Uuq | ununquingintium | 141 | Uuh | ununsexagintium | 142 | Uuq | ununseptuagintium | 143 | Uuh | ununoctogintium | 144 | Uuq | ununnonagintium | 145 | Uuh | ununcentium | 146 | Uuq | ununcentium | 147 | Uuh | ununcentium | 148 | Uuq | ununcentium | 149 | Uuh | ununcentium | 150 | Uuq | ununcentium | 151 | Uuh | ununcentium | 152 | Uuq | ununcentium | 153 | Uuh | ununcentium | 154 | Uuq | ununcentium | 155 | Uuh | ununcentium | 156 | Uuq | ununcentium | 157 | Uuh | ununcentium | 158 | Uuq | ununcentium | 159 | Uuh | ununcentium | 160 | Uuq | ununcentium | 161 | Uuh | ununcentium | 162 | Uuq | ununcentium | 163 | Uuh | ununcentium | 164 | Uuq | ununcentium | 165 | Uuh | ununcentium | 166 | Uuq | ununcentium | 167 | Uuh | ununcentium | 168 | Uuq | ununcentium | 169 | Uuh | ununcentium | 170 | Uuq | ununcentium | 171 | Uuh | ununcentium | 172 | Uuq | ununcentium | 173 | Uuh | ununcentium | 174 | Uuq | ununcentium | 175 | Uuh | ununcentium | 176 | Uuq | ununcentium | 177 | Uuh | ununcentium | 178 | Uuq | ununcentium | 179 | Uuh | ununcentium | 180 | Uuq | ununcentium | 181 | Uuh | ununcentium | 182 | Uuq | ununcentium | 183 | Uuh | ununcentium | 184 | Uuq | ununcentium | 185 | Uuh | ununcentium | 186 | Uuq | ununcentium | 187 | Uuh | ununcentium | 188 | Uuq | ununcentium | 189 | Uuh | ununcentium | 190 | Uuq | ununcentium | 191 | Uuh | ununcentium | 192 | Uuq | ununcentium | 193 | Uuh | ununcentium | 194 | Uuq | ununcentium | 195 | Uuh | ununcentium | 196 | Uuq | ununcentium | 197 | Uuh | ununcentium | 198 | Uuq | ununcentium | 199 | Uuh | ununcentium | 200 | Uuq | ununcentium | 201 | Uuh | ununcentium | 202 | Uuq | ununcentium | 203 | Uuh | ununcentium | 204 | Uuq | ununcentium | 205 | Uuh | ununcentium | 206 | Uuq | ununcentium | 207 | Uuh | ununcentium | 208 | Uuq | ununcentium | 209 | Uuh | ununcentium | 210 | Uuq | ununcentium | 211 | Uuh | ununcentium | 212 | Uuq | ununcentium | 213 | Uuh | ununcentium | 214 | Uuq | ununcentium | 215 | Uuh | ununcentium | 216 | Uuq | ununcentium | 217 | Uuh | ununcentium | 218 | Uuq | ununcentium | 219 | Uuh | ununcentium | 220 | Uuq | ununcentium | 221 | Uuh | ununcentium | 222 | Uuq | ununcentium | 223 | Uuh | ununcentium | 224 | Uuq | ununcentium | 225 | Uuh | ununcentium | 226 | Uuq | ununcentium | 227 | Uuh | ununcentium | 228 | Uuq | ununcentium | 229 | Uuh | ununcentium | 230 | Uuq | ununcentium | 231 | Uuh | ununcentium | 232 | Uuq | ununcentium | 233 | Uuh | ununcentium | 234 | Uuq | ununcentium | 235 | Uuh | ununcentium | 236 | Uuq | ununcentium | 237 | Uuh | ununcentium | 238 | Uuq | ununcentium | 239 | Uuh | ununcentium | 240 | Uuq | ununcentium | 241 | Uuh | ununcentium | 242 | Uuq | ununcentium | 243 | Uuh | ununcentium | 244 | Uuq | ununcentium | 245 | Uuh | ununcentium | 246 | Uuq | ununcentium | 247 | Uuh | ununcentium | 248 | Uuq | ununcentium | 249 | Uuh | ununcentium | 250 | Uuq | ununcentium | 251 | Uuh | ununcentium | 252 | Uuq | ununcentium | 253 | Uuh | ununcentium | 254 | Uuq | ununcentium | 255 | Uuh | ununcentium | 256 | Uuq | ununcentium | 257 | Uuh | ununcentium | 258 | Uuq | ununcentium | 259 | Uuh | ununcentium | 260 | Uuq | ununcentium | 261 | Uuh | ununcentium | 262 | Uuq | ununcentium | 263 | Uuh | ununcentium | 264 | Uuq | ununcentium | 265 | Uuh | ununcentium | 266 | Uuq | ununcentium | 267 | Uuh | ununcentium | 268 | Uuq | ununcentium | 269 | Uuh | ununcentium | 270 | Uuq | ununcentium | 271 | Uuh | ununcentium | 272 | Uuq | ununcentium | 273 | Uuh | ununcentium | 274 | Uuq | ununcentium | 275 | Uuh | ununcentium | 276 | Uuq | ununcentium | 277 | Uuh | ununcentium | 278 | Uuq | ununcentium | 279 | Uuh | ununcentium | 280 | Uuq | ununcentium | 281 | Uuh | ununcentium | 282 | Uuq | ununcentium | 283 | Uuh | ununcentium | 284 | Uuq | ununcentium | 285 | Uuh | ununcentium | 286 | Uuq | ununcentium | 287 | Uuh | ununcentium | 288 | Uuq | ununcentium | 289 | Uuh | ununcentium | 290 | Uuq | ununcentium | 291 | Uuh | ununcentium | 292 | Uuq | ununcentium | 293 | Uuh | ununcentium | 294 | Uuq | ununcentium | 295 | Uuh | ununcentium | 296 | Uuq | ununcentium | 297 | Uuh | ununcentium | 298 | Uuq | ununcentium | 299 | Uuh | ununcentium | 300 | Uuq | ununcentium | 301 | Uuh | ununcentium | 302 | Uuq | ununcentium | 303 | Uuh | ununcentium | 304 | Uuq | ununcentium | 305 | Uuh | ununcentium | 306 | Uuq | ununcentium | 307 | Uuh | ununcentium | 308 | Uuq | ununcentium | 309 | Uuh | ununcentium | 310 | Uuq | ununcentium | 311 | Uuh | ununcentium | 312 | Uuq | ununcentium | 313 | Uuh | ununcentium | 314 | Uuq | ununcentium | 315 | Uuh | ununcentium | 316 | Uuq | ununcentium | 317 | Uuh | ununcentium | 318 | Uuq | ununcentium | 319 | Uuh | ununcentium | 320 | Uuq | ununcentium | 321 | Uuh | ununcentium | 322 | Uuq | ununcentium | 323 | Uuh | ununcentium | 324 | Uuq | ununcentium | 325 | Uuh | ununcentium | 326 | Uuq | ununcentium | 327 | Uuh | ununcentium | 328 | Uuq | ununcentium | 329 | Uuh | ununcentium | 330 | Uuq | ununcentium | 331 | Uuh | ununcentium | 332 | Uuq | ununcentium | 333 | Uuh | ununcentium | 334 | Uuq | ununcentium | 335 | Uuh | ununcentium | 336 | Uuq | ununcentium | 337 | Uuh | ununcentium | 338 | Uuq | ununcentium | 339 | Uuh | ununcentium | 340 | Uuq | ununcentium | 341 | Uuh | ununcentium | 342 | Uuq | ununcentium | 343 | Uuh | ununcentium | 344 | Uuq | ununcentium | 345 | Uuh | ununcentium | 346 | Uuq | ununcentium | 347 | Uuh | ununcentium | 348 | Uuq | ununcentium | 349 | Uuh | ununcentium | 350 | Uuq | ununcentium | 351 | Uuh | ununcentium | 352 | Uuq | ununcentium | 353 | Uuh | ununcentium | 354 | Uuq | ununcentium | 355 | Uuh | ununcentium | 356 | Uuq | ununcentium | 357 | Uuh | ununcentium | 358 | Uuq | ununcentium | 359 | Uuh | ununcentium | 360 | Uuq | ununcentium | 361 | Uuh | ununcentium | 362 | Uuq | ununcentium | 363 | Uuh | ununcentium | 364 | Uuq | ununcentium | 365 | Uuh | ununcentium | 366 | Uuq | ununcentium | 367 | Uuh | ununcentium | 368 | Uuq | ununcentium | 369 | Uuh | ununcentium | 370 | Uuq | ununcentium | 371 | Uuh | ununcentium | 372 | Uuq | ununcentium | 373 | Uuh | ununcentium | 374 | Uuq | ununcentium | 375 | Uuh | ununcentium | 376 | Uuq | ununcentium | 377 | Uuh | ununcentium | 378 | Uuq | ununcentium | 379 | Uuh | ununcentium | 380 | Uuq | ununcentium | 381 | Uuh | ununcentium | 382 | Uuq | ununcentium | 383 | Uuh | ununcentium | 384 | Uuq | ununcentium | 385 | Uuh | ununcentium | 386 | Uuq | ununcentium | 387 | Uuh | ununcentium | 388 | Uuq | ununcentium | 389 | Uuh | ununcentium | 390 | Uuq | ununcentium | 391 | Uuh | ununcentium | 392 | Uuq | ununcentium | 393 | Uuh | ununcentium | 394 | Uuq | ununcentium | 395 | Uuh | ununcentium | 396 | Uuq | ununcentium | 397 | Uuh | ununcentium | 398 | Uuq | ununcentium | 399 | Uuh | ununcentium | 400 | Uuq | ununcentium | 401 | Uuh | ununcentium | 402 | Uuq | ununcentium | 403 | Uuh | ununcentium | 404 | Uuq | ununcentium | 405 | Uuh | ununcentium | 406 | Uuq | ununcentium | 407 | Uuh | ununcentium | 408 | Uuq | ununcentium | 409 | Uuh | ununcentium | 410 | Uuq | ununcentium | 411 | Uuh | ununcentium | 412 | Uuq | ununcentium | 413 | Uuh | ununcentium | 414 | Uuq | ununcentium | 415 | Uuh | ununcentium | 416 | Uuq | ununcentium | 417 | Uuh | ununcentium | 418 | Uuq | ununcentium | 419 | Uuh | ununcentium | 420 | Uuq | ununcentium | 421 | Uuh | ununcentium | 422 | Uuq | ununcentium | 423 | Uuh | ununcentium | 424 | Uuq | ununcentium | 425 | Uuh | ununcentium | 426 | Uuq | ununcentium | 427 | Uuh | ununcentium | 428 | Uuq | ununcentium | 429 | Uuh | ununcentium | 430 | Uuq | ununcentium | 431 | Uuh | ununcentium | 432 | Uuq | ununcentium | 433 | Uuh | ununcentium | 434 | Uuq | ununcentium | 435 | Uuh | ununcentium | 436 | Uuq | ununcentium | 437 | Uuh | ununcentium | 438 | Uuq | ununcentium | 439 | Uuh | ununcentium | 440 | Uuq | ununcentium | 441 | Uuh | ununcentium | 442 | Uuq | ununcentium | 443 | Uuh | ununcentium | 444 | Uuq | ununcentium | 445 | Uuh | ununcentium | 446 | Uuq | ununcentium | 447 | Uuh | ununcentium | 448 | Uuq | ununcentium | 449 | Uuh | ununcentium | 450 | Uuq | ununcentium | 451 | Uuh | ununcentium | 452 | Uuq | ununcentium | 453 | Uuh | ununcentium | 454 | Uuq | ununcentium | 455 | Uuh | ununcentium | 456 | Uuq | ununcentium | 457 | Uuh | ununcentium | 458 | Uuq | ununcentium | 459 | Uuh | ununcentium | 460 | Uuq | ununcentium | 461 | Uuh | ununcentium | 462 | Uuq | ununcentium | 463 | Uuh | ununcentium | 464 | Uuq | ununcentium | 465 | Uuh | ununcentium | 466 | Uuq | ununcentium | 467 | Uuh | ununcentium | 468 | Uuq | ununcentium | 469 | Uuh | ununcentium | 470 | Uuq | ununcentium | 471 | Uuh | ununcentium | 472 | Uuq | ununcentium | 473 | Uuh | ununcentium | 474 | Uuq | ununcentium | 475 | Uuh | ununcentium | 476 | Uuq | ununcentium | 477 | Uuh | ununcentium | 478 | Uuq | ununcentium | 479 | Uuh | ununcentium | 480 | Uuq | ununcentium | 481 | Uuh | ununcentium | 482 | Uuq | ununcentium | 483 | Uuh | ununcentium | 484 | Uuq | ununcentium | 485 | Uuh | ununcentium | 486 | Uuq | ununcentium | 487 | Uuh | ununcentium | 488 | Uuq | ununcentium | 489 | Uuh | ununcentium | 490 | Uuq | ununcentium | 491 | Uuh | ununcentium | 492 | Uuq | ununcentium | 493 | Uuh | ununcentium | 494 | Uuq | ununcentium | 495 | Uuh | ununcentium | 496 | Uuq | ununcentium | 497 | Uuh | ununcentium | 498 | Uuq | ununcentium | 499 | Uuh | ununcentium | 500 | Uuq | ununcentium | 501 | Uuh | ununcentium | 502 | Uuq | ununcentium | 503 | Uuh | ununcentium | 504 | Uuq | ununcentium | 505 | Uuh | ununcentium | 506 | Uuq | ununcentium | 507 | Uuh | ununcentium | 508 | Uuq | ununcentium | 509 | Uuh | ununcentium | 510 | Uuq | ununcentium | 511 | Uuh | ununcentium | 512 | Uuq | ununcentium | 513 | Uuh | ununcentium | 514 | Uuq | ununcentium | 515 | Uuh | ununcentium |

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 |