M. Sc. (Chemistry) Examination, 2023

(4th Semester)

Paper: XVI–A

[Analytical Chemistry Special]

Time : Two Hours   Full Marks : 40

(20 marks for each unit)

Use a separate answer script for each unit.

Unit: A-4161 (a & b)

1. Answer *any five* questions :   5×2

    a) Write down the Scherrer's equation for the determination of grain size and correlate with dislocation density of defects level for a nanocomposite during PXRD analysis.

    b) What are false positive and false negative sensors? Give one example of each.

    c) Define Janus particle. How do core-shell nanoparticles differ from an ordinary system?

    d) Write the full form of common analytical tools used for characterization of materials:
        i)   STEM and (ii) DLS.
        Mention the utility of these tools in the field of material characterization.

   e) Explain the sensing properties of functionalized Au-nanoparticles towards alkali metal ions.

f) Give one example of Gas sensing thin-film, Metcars, van der waals clusters, Magnetofluorescent materials.

2. Answer *any five* questions : 5×2

a) What are the most important components in an electron microscope? What is the advantage of using electron microscope over light microscope?

b) What is the resolving power of a typical TEM instrument? How can you improve it? Explain.

c) What kind of samples are typically measured in SEM? Discuss briefly. How do you prepare biological samples for SEM analysis?

d) Explain the working principle of EDAX and EELS with their full form.

e) Can you measure oxidation state of an element from EDAX? Explain. What are alternative options for measuring oxidation state (only electron spectroscopy or microscopy options)?

f) How can you assign lattice planes from electron diffraction? Explain with an example.

g) What is the basic difference between contact and non-contact mode in AFM? What are the advantages of non-contact mode over contact mode?

Unit: A-4162

3. In kinetic methods of analyses, an analyst prefers initial rate methods to determine analyte concentration rather than monitoring the entire reaction course. Explain. 5

4. Cite one example each of complementary redox reaction and non-complementary redox reaction. Which one is expected to be faster? Explain. 5

5. With a suitable enzymatic reaction scheme, discuss an acceptable method for the determination of Michaelis-Menten constant (K_M). 5

6. Consider the following reaction scheme:

$$A + R \xrightarrow{k_A} Products$$

$$B + R \xrightarrow{k_B} Products$$
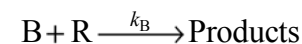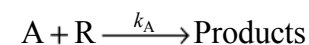
Here A and B are components of a mixture of A and B, reacting with a common reagent R with the initial condition that $[A]_0$ and $[B]_0$ both are much higher than $[R]_0$. k_A and k_B are the second-order rate constants. Show that the error in the measurements of either $[A]_0$ or $[B]_0$ will be minimum at a particular time when $[R]_0/[R]_t$ will be the base of the natural logarithm (e). 5