U. G. 6th Semester Examination 2022

CHEMISTRY (Honours)

Paper Code : CEMH DSE-3

[CBCS]

Full Marks : 25 Time : Two Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Instrumental Methods of Chemical Analysis

1. Answer any ***five*** questions from the following : 1×5=5

(a) Which of the following statements is true concerning infrared spectroscopy?

(i) IR spectroscopy is useful in determining the size and shape of a compound's carbon skeleton

(ii) An IR spectrometer shines infrared light on a compound and records the positions where the light is blocked by the compound. This results in the spectrum's peaks

(iii) When the infrared light frequency matches the frequency of bond vibration in a molecule, a peak is recorded on the spectrum

(iv) None of the above

(b) What is the absorbance of an IR peak with a 25% transmittance?

(i) 2.50

(ii) 0.81

(iii) 0.60

(iv) 0.33

(c) ^{1}H and ^{13}C are two of the most common nuclides studied by high-field NMR spectroscopy due to their abundance in human tissues. Other isotopes that have been studied include ^{14}N, ^{17}O, ^{31}P, ^{79}Br, ^{127}I. Based on this information, which of the following nuclides will NOT be considered suitable for use with NMR spectroscopy?

(i) ^{2}H

(ii) ^{19}F

(iii) ^{20}Ne

(iv) ^{35}Cl

(d) Helium, rather than nitrogen, is used as carrier gas in GC with TCD detector because

(i) Being lighter than nitrogen, helium elutes the sample components more rapidly

(ii) Helium is less expensive than nitrogen

(iii) Nitrogen has stable isotopes which separate and cause anomalous column behaviour

(iv) Helium has much higher thermal conductivity than nitrogen.

(e) A copper(II) sulfate solution of unknown concentration is placed in a colorimeter and an absorbance reading of 0.46 is recorded. Using the same solution cell, a 0.055 M solution of copper(II) sulfate gives an absorbance reading of 0.34. What is the concentration of the first solution?

(i) 0 8.60×10^{-3} mol dm^{-3}

(ii) 0.35 mol dm^{-3}

(iii) 0.074 mol dm^{-3}

(iv) 0.047 mol dm^{-3}

(f) The value of diffusion current at its limiting value using a dropping mercury electrode can be calculated from

(i) Beer-Lambert law

(ii) Ilkovic equation

(iii) Least square method

(iv) Paneth-Fajans-Hahn law

(g) Which of the following gases is used as carrier gas in gas chromatography?

(i) CO

(ii) CH_4

(iii) He

(iv) SO_2

(h) The $\sin 2\theta$ values obtained from X-ray powder diffraction pattern of a solid are 2x, 4x, 6x, 8x where x is equal to 0.06. The wavelength of X-ray used to obtain this pattern is 1.54 Å. The unit cell and the unit cell length, respectively are

(i) BCC, 3.146 Å

(ii) FCC, 3.146 Å

(iii) SCC, 6.281 Å

(iv) BCC, 1.544 Å

2. Answer any ***four*** questions: 2×4=8

(a) What are the differences between XPES and AES?

(b) How many fundamental vibration frequencies would be observed on the IR absorption spectrum of H_2O? Justify your answer.

(c) Explain why electrothermal atomizers result in greatly enhanced sensitivity compared to flame atomizers in atomic absorption spectrometry.

(d) Why does a deuterium lamp produce a continuum rather than a line spectrum in the UV?

(e) What are the common solvents used in NMR spectroscopy? Why is TMS is used as internal reference in NMR spectroscopy?

(f) What do you mean by hyphenated or coupled chromatographic technique? Give two example.

(g) An analyst notes that a 1-ppm solution of sodium gives a flame emission signal of 110, while the same solution containing also 20-ppm potassium gives a reading of 125. It was determined that a 20-ppm solution of potassium exhibited no blank reading at the sodium emission wavelength. Explain the results.

(h) What is the short-wavelength limit of the continuum produced by an X-ray tube having a tungsten target and operated at 50 kV?

3. Answer any ***two*** questions : 2×6=12

(a) (i) What are the sources of noise in a spectrophotometer and how would you distinguish between signal and noise?

(ii) Calculate the relative number of protons in the higher and lower magnetic states when a sample is placed in a 4.69 T field at 20ºC. (Gyromagnetic ratio=2.6752×10^8 radian T^{-1} s^{-1})

(iii) How will you distinguish alkanes, alkenes, alkynes using IR spectroscopy? 2+2+2

(b) (i) For each of the following compounds, calculate the number of multiplets for each band and their relative areas:$Cl(CH_2)_3Cl$; (b) $CH_3CHBrCH_3$; (c) $CH_3CH_2OCH_3$.

(ii) What are the criteria of selection of exact adsorbent in column chromatography?

(iii) Why is a calibration curve likely to be linear over a wider range of concentrations at the wavelength of maximum absorption compared to a wavelength on a shoulder of the absorption curve? 3+2+1

(c) (i) Consider the following three compounds: benzene, acetone, and benzoic acid. What is the order of elution of these compounds using water as the eluting solvent for C-18 reverse phase column chromatography? Justify your answer.

(ii) What do you mean by fundamental vibration and overtones in IR-spectroscopy?

(iii) Write down the principle of atomic absorption spectroscopy (AAS) with schematic diagram. 2+2+2

(d) (i) Describe the principles of the following gas chromatography detectors:

(a) thermal conductivity, (b) flame ionization, (c) electron capture.

(ii) Methanol and ethanol are separated in a capillary GC column with retention times of 370 and 385 s, respectively, and half widths ($w_{1/2}$) of 9.42 and 10.0 s. An unretained butane peak occurs at 10.0 s. Calculate the separation factor and the resolution.

(iii) What do you mean by the term overpotential? 3+2+1

Inorganic Materials of Industrial Importance

1. Answer any ***five*** questions from the following: 1×5=5

(a) In the manufacture of glass, the addition of chromium oxide gives:

(i) Pink colour

(ii) Orange colour

(iii) Green colour

(iv) Red colour

(b) Mortor could be preparing with mixing of:

(i) Portland cement + Water

(ii) Portland cement + Sand + Water

(iii) Sand+ Water

(iv) None of these above

(c) Which is used as red pigment?

(i) Chromium oxide

(ii) Zinc oxide

(iii) Titanium dioxide

(iv) Lead tetroxide

(d) Another name of RDX is _____?

(i) Cyanohydrin

(ii) Dextran

(iii) Cyclohexane

(iv) Cyclonite

(e) Buckminster fullerene is:

(i) C90

(ii) Graphite

(iii) C60

(iv) C30

(f) Which among the following is not a nitrogenous fertilizer?

(i) Superphosphate of lime

(ii) Urea

(iii) Ammonium sulphate

(iv) Calcium cyanamide

(g) Which of the following can be used as a floating agent during preparation of enamel?

(i) Copper oxide

(ii) Soda ash

iii) Borax

(iv) Clay gum

(h) Bronze is an alloy of

(i) Cu & Zn

(ii) Cu & Sn

(iii) Cu & Au

(iv) Cu & Ag

2. Answer any *four* questions from the following: 2×4=8

(a) Outline the compositions of borosilicate glass and state how it is different from a sodalime glass.

(b) Illustrate with chemical equations (non-stoichiometric) how you can prepare superphosphate and triple-superphosphate fertilizers from phosphate rock.

(c) Name the different type of dryers used in drying clay wares.

(d) What is photosensitive glass? Mention at least one usage of photosensitive glass.

(e) What is vitrification of glass?

(f) Write the composition of Portland cement.

(g) What is primary battery?

(h) Explain the role of thinners and fillers in paint. Name some commonly used thinners and fillers.

3. Answer any *two* questions from the following : 2×6=12

(a) (i) How does 'Hydrogen-Oxygen Fuel Cells' work? Write down the advantages of fuel cells.

(ii) Discuss the spraying method of metal coating.

(iii) Classify different types of waxes based upon their sources. 3+2+1

(b) (i) How PETN (Penta erythritol tetranitrate) is prepared? Write down the important properties of PETN.

(ii) What are non-ferrous alloys? Explain the properties and applications of the common nonferrous alloys.

(iii) Give one examples of heterogeneous catalysis in industrial process. 2½+2½+1

(c) (i) Describes the manufacturing process and action of ammonium nitrate as a fertilizer.

(ii) What are Zeolites? Give two examples. 4+2

(d) (i) What is paint? What properties of paint make it ideal paint?

(ii) hat are the differences between water and oil based paints?

(iii) How can you prepare Lead azide explosive? 2+2+2

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