EXERCISE

Q1: Select the right answer from the choices given with each question.

1) Which of the following techniques does not involve electromagnetic radiations?
   a) Infrared spectroscopy
   b) NMR spectroscopy
   c) Mass spectroscopy
   d) All of these involve electromagnetic radiations

2) Which region of the electromagnetic spectrum is involved in the electronic excitations?
   a) Ultraviolet
   b) Visible
   c) Both of these
   d) None of these

3) Which of the following techniques is different from the others as regards the basic principle?
   a) Ultraviolet spectroscopy
   b) Visible spectroscopy
   c) Electronic spectroscopy
   d) None of these

4) Which of the following is used as a source of visible radiations?
   a) Tungsten filament lamp
   b) Hydrogen discharge lamp
   c) Deuterium discharge lamp
   d) All of these

5) What is the wavelength range of the ordinary infrared region?
   a) 0.8-2.5 μm
   b) 2.5-16 μm
   c) 800-1000nm
   d) 400-800 nm

6) The position of an infrared absorption band is commonly expressed by:
   a) Wavelength
   b) Wave number
   c) Both of these
   d) None of these

7) Which of the following is not used as a source of infrared radiations?
   a) Nernst filament
   b) Tungsten filament
   c) Globar
   d) None of these

8) Which region of the electromagnetic spectrum is involved in mass spectrometry?
   a) Visible
   b) Microwave
   c) Radiowave
   d) None of these

9) Mass spectroscopy is an analytical technique which involves:
   a) Production of gaseous ions form the sample
   b) Separation of the gaseous ions
   c) Measurement of the relative abundance of the gaseous ions
   d) All of these

10) Mass spectrometry can be used to determine:
   a) Molecular weight
   b) Molecular formula

c) Molecular structure
d) All of these

11) Which of the following species is detected in the mass spectrometer?
a) Positively charged species
b) Radicals
c) Neutral molecules
d) All of these

12) Which of the following species is produced in the ionization chamber of a mass spectrometer?
a) Positively charges species
b) Radicals
c) Neutral molecules
d) All of these

13) Which kind of information about a positively charged species obtained from a mass spectrum?
a) Molecular weight
b) Relative abundance
c) Both of these
d) None of these

14) What kind of sample can be studied in a mass spectrometer?
a) A gas
b) A liquid
c) A solid
d) All of these

15) Near ultraviolet region of these electromagnetic spectrum generally lies between:
a) 10-200 nm
b) 200-400 nm
c) 400-750 nm
d) 300-500 nm

16) Far ultraviolet or vacuum ultraviolet region generally lies between.
a) 10-200 nm
b) 200-400 nm
c) 400-750 nm
d) 300-500 nm

17) Far infrared region of the electromagnetic radiation generally lies between:
a) 50-200 nm
b) 100-400 nm
c) 50-1000 nm
d) 1-20 nm

Answers

1	c	2	c	3	c	4	a	5	c
6	b	7	c	8	a	9	c	10	a
11	a	12	a	13	b	14	a	15	a
16	b	17	c						

Q2: Give brief answers for the following questions.

Q1. What is spectroscopy? Underline its principle.

Answer

Spectroscopy

Spectroscopy involves using instruments to examine the radiation emitted or absorbed by chemicals giving information about their molecular structure.

Principle

When electromagnetic radiation, such as light or infrared, shines on a chemical the chemical may interact with the radiation in some way. The commonest example is

color. Color is produced when chemicals emit or absorb visible light of a particular frequency.

Q2. What is meant by wavelength and frequency?

Answer

Wavelength

The distance between two consecutive nodes and internodes is called wavelength.

Frequency

Number of waves pass through an area in one second is called frequency.

Q3. What is spectrometer? Briefly discuss its working?

Answer

Spectrometer

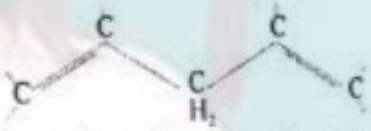
Spectrometer is used to measure the amount of electromagnetic radiations absorbed by an organic molecule.

Working

Spectrometer produces a spectrum on chart recorder from where we can see which bonds have stronger peaks which have weaker peaks.

Q4. How will you distinguish between (i) 1,3-Pentadiene and 1,4-Pentadiene (ii) Benzene and anthracene by UV-spectroscopy?

Answer

	1,3 - Pentadiene	1,4 - Pentadiene
i)		
ii)	$SP^2 - Sp^2 - SP^2 - SP^2 - SP^3$.	$SP^2 - Sp^2 - SP^3 - SP^2 - SP^2$
iii)	Double bonds are conjugated	Double bonds are not conjugated

ii)

Benzene	Anthraene
i) Absorption peak in UV-spectroscopy is 255nm.	i) Absorption peak in UV-spectroscopy is 375nm.

Q5. Two isomeric dienes (X) and (Y), having the molecular formula C_5H_8, absorb at λ_{max} 223nm and λ_{max} 178nm respectively. Write the structures of the two isomers.

Answer

$CH_2 = CH - CH_2 - CH_2 - CH_3$ (1-pentene)

$CH_3 - CH = CH - CH_2 - CH_3$ (2-pentene)

Q6. Give significant application of Atomic Absorption Spectroscopy (AAS).

Answer

Significant of Atomic Absorption Spectroscopy

i) AAS method is highly specific, hence analysis of a metal from a complex mixture is possible and a high energy source needs not be employed.

ii) Well-suited for the analysis of substance at low concentrations.

iii) Highly specific firmly established in analytical chemistry, ceramics, mineralogy, biochemistry, metallurgy etc..

Q7. How will you distinguish between 2-Pantanone and 3-Pantanoe by using mass spectra?

Answer

2 – Pantanone	3 – Pantanone
i) The major peak is at 85.	i) The major peak is at 71.
ii) The small peak one at 15.	ii) The small peak one at 29.

Q3: Give detailed answers for the following questions.

Q1. What is combustion analysis? Describe its different steps.

Answer

Empirical and molecular formulas for compounds that contain only carbon and hydrogen or carbon, hydrogen and oxygen can be determine with a process called with a process called combustion analysis. The sole products will be CO_2 and H_2O and these two products of combustion are separately collected.

Steps

i) Weight a sample of the compound to be analyzed and place it in the apparatus.

ii) Burn the compound completely. The only products of the combustion of a compound contain only carbon and hydrogen i-e CO_2.

iii) The H_2O and CO_2 are drawn through two tubes. One tube contains a substance that absorbs carbon dioxide.
Weigh each of these tubes before and after the combustion. The increase in mass in the first tube is the mass of H_2O that formed in the combustion, and the increase in the mass for the second tube is the mass of CO_2 formed.

iv) Assume that all the carbon in the compound has been converted to CO_2 and trapped in the second tube. Calculate the mass of carbon in the compound from the mass of carbon in the measured mass of CO_2.

v) Assume that all of the hydrogen in the compound has been converted to H_2O and trapped in the first tube. Calculate the mass of hydrogen in the compound from the measured mass of water.

vi) If the compound container oxygen as well as carbon and hydrogen from the total mass of the original sample of compound.

Q2. An organic compound consists of carbon; hydrogen and oxygen was subjected to combustion analysis 0.5439g of the compound gave 1.039g of CO_2, 0.6369g of H_2O. Determine the empirical formula of the compounds.

Answer

Mass of compound = 0.5439g

Mass of CO_2 = 1.039g

Mass of H_2O = 0.6369g

$$\% \text{ of C} = \frac{\text{Mass of } CO_2}{\text{Mass of Compound}} \times \frac{12}{44} \times 100$$

$$= \frac{1.039}{0.5439} \times \frac{12}{44} \times 100$$

$$= 52\%$$

$$\% \text{ of H} = \frac{\text{Mass of } H_2O}{\text{Mass of Compound}} \times \frac{2}{18} \times 100$$

$$= \frac{0.6369}{0.5439} \times \frac{2}{18} \times 100$$

$$= 13\%$$

$$\% \text{ of O} = 100 - (52 + 13)$$

$$= 35\%$$

Now we determine Empirical Formula of compound

1) Percentage composition C : H : O

= 52 : 13 : 35

2) Percentage No. of moles

(Dividing by atomic mass) $= \frac{52}{12} : \frac{13}{1.008} : \frac{35}{32}$

$= 4.33 : 12.89 : 1.09$

3) Percentage No. of moles

(Dividing by least value) $= \frac{4.33}{1.09} : \frac{12.89}{1.09} : \frac{1.09}{1.09}$

$= 3.9 : 11.8 : 1$

4) Rounding off date = 4 : 12 : 1

∴ Empirical Formula of Compound = $C_4H_{12}O_1$

Q3. The combustion analysis shows that organic compounds contain 65.44% carbon, 5.50% hydrogen and 29.06% of oxygen. What is empirical formula? If the molecular mass of this compound is

110.15gmole^{-1} then calculate molecular formula of given organic compound. **(Ans: C_3H_3O, $C_6H_6O_2$)**

Answer

	C	H	O
1) Percentage composition	= 65.44	5.50	29.06
2) No of moles	$= \frac{65.44}{12}$	$\frac{5.50}{1.008}$	$\frac{29.06}{16}$
	= 5.45	6.21	1.81
3) Mole ratios (Dividing by Least value)	$= \frac{5.45}{1.81}$	$\frac{6.21}{1.81}$	$\frac{1.81}{1.81}$

$= 3.0 : 3.43 : 1$

$= 3 : 3 : 1$

Empirical Formula (on rounding off date) $= C_3H_3O_1$

Empirical Formula Mass of $C_3H_3O_1 = 36 + 3.024 + 16$

$= 55.24$

Molecular Mass of compound $= 110.15$

$$\text{As } n = \frac{\text{Molecular Mass}}{\text{Empirical Formula Mass}}$$

$$= \frac{110.15}{55.24}$$

$= 1.99$ or 2

So Molecular Formula $= C_3H_3O_1 \times 2$

$= C_6H_6O_2$

Q4. What is meant by the term chemical shift of a particular proton in NMR spectroscopy? Also draw the splitting pattern of protons in NMR spectrum of ethyl alcohol.

Answer

Chemical Shift of Proton in NMR

The technique of NMR is useful in identifying the number and types of hydrogen atoms in a molecule. The largest peak (A) corresponds to 5H atoms in C_6H_6, second largest corresponds to 3 – H atoms in CH_3 – group and third is 2H atoms in CH_2 group. The H– atoms in particular p type of environment have sim8ilar positions in the NMR spectrum normally this position is measured as a chemical shift, from a fixed reference point. The reference point normally used is the absorption of a substance known as TMS. The chemicals shift of chemicals shift of TMS is set at zero.

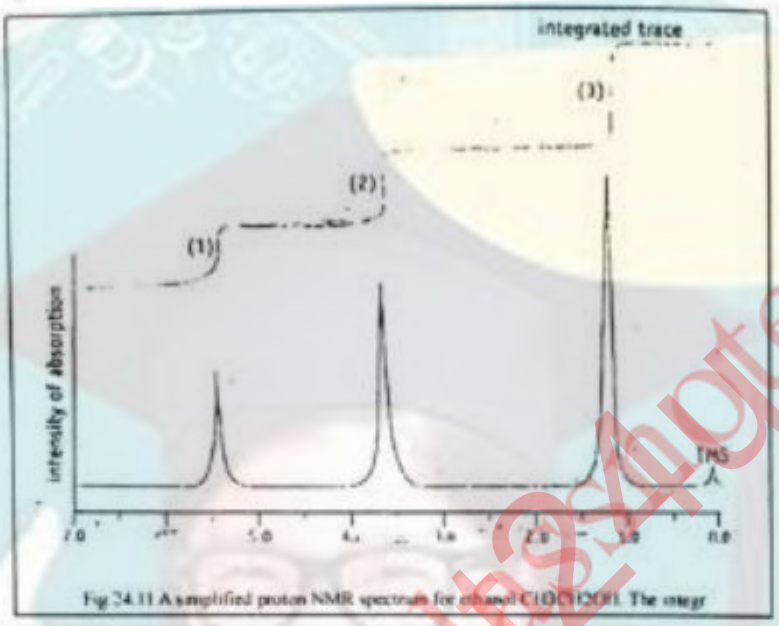


Fig 24.11 A simplified proton NMR spectrum for ethanol CH_3CH_2OH. The integr

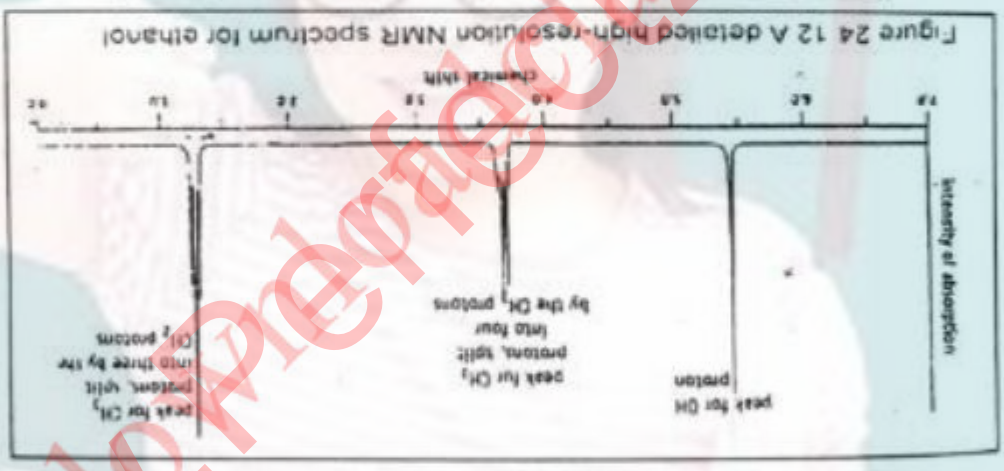


Figure 24.12 A detailed high-resolution NMR spectrum for ethanol

Q5. Discuss the general principle and instrumentation of Atomic Emission Spectroscopy.

Answer

Principle

The source vaporizes the sample and causes electronic excitation of elementary particles on the gas. Exited molecules in the gas phase emit band spectra. Thus, a molecule in an excited state of energy, E2 undrogoes a transition to a state of lower energy E1 and a proton of energy hr is emitted where

$$E2 - E1 = hr$$

Instrumentation

The process is performed in the solid or liquid state with almost equal convenience. It required minimum sample preparation as a sample can be directly introduced into the spark. Recording is done on a photographic plate which take some time to develop, prints and interpret the results.

Q6. What is the basic principle of Atomic Absorption Spectroscopy? Describe the instrumentation used.

Answer

Principle

Atomic absorption spectroscopy involves the study of the absorption of radiant energy, usually visible by natural atoms in the gaseous states of light of the resonance wavelength passes through a flame containing the atoms, then part of the light will be absorbed, and the extent of absorption will be proportional to the number of ground state atoms present in the flame. This is the underlying principle of AAS.

Instrumentation

Atomizer devices are either continuous or discrete continuous are in the form of plasmas and flame.

Discrete are in the form of electro thermal. Nebulizers are the method to introduces samples into the atomizer. Direct nebulizers creates fine droplets by aerosol.

Q7. What is the basic principle of Mass Spectrometer? How does it work?

Answer

Principle of mass spectrometer

Mass spectrometer is an instrument which turns atoms and molecules into ions and measure their mass. The basic idea can be demonstrated as wooden balls of different sizes but identical iron cores, roll down a sloping plain. At the bottom of the slope a powerful magnet attracts the iron cores and moving balls are defleated. As the balls have identical iron cores, they all attracted equally by the magnet.

Working

The working can be explained as wooden balls of different sizes but with identical iron cores, roll down a sloping plain. At the bottom of the slope a powerful magnet attracts the iron cores and the moving balls are defleated. As the balls have identical iron cores they are all attracted equally by the magnet. But the smaller balls are lighter and therefore they are defleated the most. The balls collect in different compartments depending on their mass. All balls of the same mass collect in the same compartments. Swing this simple apparatus, it is possible to separate the different sized balls according to their mass and to find the relative numbers of each present. A real mass spectrometer according works in a similar fashion to this simple model. It seperates atoms a according to their mass and shows the relative numbers of the different atoms present. Before the atoms can be defleated and separated, they must be converted to positively charged ions.