أسئلة و اجوبة

في

التحليل الطيفي

بسم الله الرحمن الرحيم

فيما يلي أسئلة و أجوبة في طرق التحليل الطيفي في المجالين المرئي و الفوق بنفسجي . على الطالب أن يحاول الاجابة على الاسئلة قبل الذهاب الى الأجوبة حتى يختبر معلوماته حيث يوجد في نهاية أسئلة كل موضوع إجابة لتلك الأسئلة . و للراغبين في زيادة معلومات حول هذا الموضوع مراجعة العنوان :

طرق التحليل الطيفي

اعداد الاستاذ الدكتور / ابراهيم زامل الزامل

قسم الكيمياء – كلية العلوم – جامعة الملك سعود

QUESTIONS ABOUT ELECTROMAGNETIC RADIATION :

Question1.

Which of the following wavelengths of light would have the highest radiant energy?

A. 200 nm
B. 300 nm
C. 400 nm
D. 500 nm

Question2.

In regard to electromagnetic waves of radiant energy, the distance that a periodic wave propagates in one period of the distance between wave crests is referred to as:

A. Wavelength
B. Modulation
C. Amplitude
D. Frequency

Question3.

Arrange the following types of EM radiation in order of increasing frequency:

Infrared , X-rays , ultraviolet , visible , gamma.

Question 4.

Calculate the frequency of an EM wave with a wavelength of 400 nm ?

Question 5.

Give an example of the use of each type of EM radiation, i.e. gamma rays, X-rays, ultraviolet light, visible light, infrared, microwave and radio waves.

Question 6.

Calculate the frequency of violet light with a wavelength of 4,4 $\times 10^{-7}$ m. Type your answer in scientific notation rounding to one digit after the decimal comma .

Question 7.

Yellow light has a wavelength of 597 nm in a vacuum. Determine the frequency of yellow light. The speed of light is 3×10^{8} m·s^{-1}.

Question 8.

What type of electromagnetic radiation is used to sterilise medical equipment?

Question 9.

What is the energy of a photon of a ultraviolet light wave with a frequency of $2{,}15 \times 10^{16}$ Hz?

Question 10.

Choose the word or term which best describes following definition:
The type of EM radiation that has the lowest energy.

Question 11.

The frequency increases as the wavelength of light gets longer. True or false ?

Question 12.

What form of light is closely related to heat?
Ultraviolet
Radio Waves
Infrared
Gamma

Question 13.
Visible light makes up most of the electromagnetic spectrum.
True or False ?

Question 14.
The Earth's atmosphere filters out what types of EMR?
Ultraviolet
Infrared
X-Rays
All of the Above

Question 15.
All electromagnetic radiation is dangerous.
True or False ?

Question 16.

What type of waves are used to transmit telephone messages?

A.Gamma rays
B.Radio waves
C.Microwaves
D.Visible light

Question 17.

Which electromagnetic waves have the shortest wavelengths and highest frequencies?
A.Gamma rays
B.Radio waves
C.X-rays
D.Ultraviolet rays

Question 18.
Electromagnetic waves that you can see are called

A.Infrared rays

B.Microwaves
C.X-rays
D.Visible light

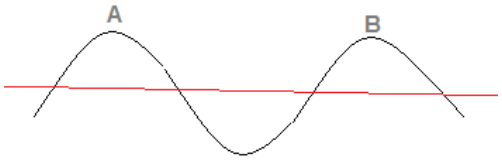
Question 19.

The waves that have shorter wavelengths than visible light are: (check all that apply)

A.microwaves
B.Radio waves
C.Ultraviolet rays
D.Gamma rays

Question20. How much of the electromagnetic spectrum is visible?

A.All of it
B.None of it
C.Most of it
D.Only a small part



Qustion 21.
The distance between A and B is the _____.
A.Frequency
B.Period
C.Amplitude
D. Wavelength

Question 22.

If the velocity of the wave is 400 m/s and the wavelength is 2m, what is its frequency?

A.200 Hz
B.800 Hz
C.20 Hz
D.400 Hz

Question 23.

What type of electromagnetic radiation is used to image the human body?

Question 24.

What is frequency?

Question 25.

How are frequency and wavelength related?

Question 26.

What is wavelength?

Question 27.

An FM radio station broadcasts at a frequency of 87.5 MHz. What is the wavelength of the station in meters?

Question 28.

Which of the following ranges of the electromagnetic spectrum exhibits the highest frequency?

- Visible Light
- X-rays

- Microwaves
- Ultra-Violet
- All have the same frequency.

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Which of the following ranges of the electromagnetic spectrum exhibits the longest wavelength?

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Which of the following ranges of the electromagnetic spectrum travels at the fastest speed?

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Question 31.

A white T-shirt that is absorbing radiation in which visible region?

- Purple.
- Red.
- It is absorbing no visible radiation.
- Yellow.
- It is absorbing all visible radiation.

Question 32.

What is the energy of a photon of EM radiation with a frequency of 3×10^8 Hz?

Question 33.

What is the energy of a photon of light with a wavelength of 532 nm and one with a frequency of 13 GHz and which has the longer wavelength?

Question 34.

List the main uses of:

1. radio waves
2. infrared
3. gamma rays
4. X-rays

Question 35.

Explain why we need to protect ourselves from ultraviolet radiation from the Sun.

Question 36.

List some advantages and disadvantages of using X-rays?

Question 37.

Explain why some types of electromagnetic radiation are more penetrating than others?

Question 38.

Which of the following shows the correct order of various electromagnetic waves if arranged in increasing order of their frequencies?

A- Gamma rays, infrared waves, visible light, ultraviolet rays, x-rays and radio waves .

B- Radio waves, infrared waves, visible light, ultraviolet rays, x-rays and gamma rays .

C- Radio waves, visible light, infrared waves, x-rays, ultraviolet rays and gamma rays .

D- Gamma rays, visible light, infrared waves, x-rays, ultraviolet rays and radio waves .

Question 39.

On the electromagnetic spectrum, the waves with the highest frequencies have the smallest

-speeds
- periods
- amplitudes
- wavelengths
- energies

Question 40.

Leaves are green because:

1) they only emit frequencies corresponding to green
2) they only reflect frequencies corresponding to green
3) they only absorb frequencies corresponding to green .

Question 41.

You emit radiation: True or False ?

Question 42.
What is the Difference Between Black and White?

Question 43.
The visible region of the electromagnetic spectrum lies between wavelengths of

A. 200-300
B. 340-850
C. 380-750
D. 500-900

Question 44.

What is the relationship between wavelength (ʎ) and frequency (v)? ("c" is the speed of light) ?

A) ʎ v = c
B) ʎ /v = c
C) v/ʎ = c
D) ʎc = v

Question 45.
The human eye is most sensitive to light with a wavelength near 550 nm. To what photon energy is the human eye most sensitive? $E_{(J)} = E_{(eV)} \times 1.602176565 \cdot 10^{-19}$,
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A) 2.49 eV
B) 3.61 X10^{-19} eV
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Which of the following forms of electromagnetic radiation are dangerous to humans, but also enables your body to make a particular vitamin?

Infrared rays
X rays
Ultraviolet waves
Gamma rays .

Question 47.

Which statement about electromagnetic radiation is correct?

All types have the same frequency in a vacuum.
All types have the same wavelength in a vacuum.
All types have the same speed in a vacuum.

Question 48.

What are the units of frequency?

- m/s
- s
- Hz
- J

Qustion 49.

What color coat might you buy if you wanted to stay warm on a cold, sunny winter day?

a. Black. c. It does not matter what color the coat is
b. White. d. silver.

ANSWERS OF QUESTIONS ABOUT ELECTROMAGNETIC RADIATION :

Question 1.

Which of the following wavelengths of light would have the highest radiant energy?

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A. Wavelength
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Arrange the following types of EM radiation in order of increasing frequency:

Infrared , X-rays , ultraviolet , visible , gamma.

Answer

Infrared, visible, ultra-violet, X-rays, gamma

Question 4.

Calculate the frequency of an EM wave with a wavelength of 400 nm ?

Answer

$v=c/\lambda = 3\times10^{8}$ m/s / 400×10^{-9} m $= 7{,}5\times10^{14}$ Hz

Question 5.

Give an example of the use of each type of EM radiation, i.e. gamma rays, X-rays, ultraviolet light, visible light, infrared, microwave and radio waves.

Answer :

Gamma rays: Gamma Rays cause and treat cancers . Doctors use gamma-ray imaging to see inside your body

X-rays: Searching baggage at the airport

ultra-violet Used for sterilization . produces vitamin D

Visible light: by which humans can see .

infrared: Used for night-vision goggles, objects emit infrared radiation because they are warm and can therefore be detected at night using infrared goggles.

Microwaves: Microwave ovens emit microwave radiation that excites motion in water molecules in foodstuffs, thereby warming it up

radio waves: Use for telecommunication

Question 6.

Calculate the frequency of violet light with a wavelength of 4,4 $\times 10^{-7}$ m. .

Answer :

The speed of light is $c = 3 \times 10^{8}$ m·s −1 .

We use the formula $\nu = c/\lambda$ to calculate the frequency.

$$\nu = c/\lambda = 3 \times 10^{8} / 4{,}4 \times 10^{-7} = 6{,}8 \times 10^{14} \text{ Hz}$$

Question 7.

Yellow light has a wavelength of 597 nm in a vacuum. Determine the frequency of yellow light. The speed of light is 3×10^{8} $m \cdot s^{-1}$.

Answer :

We are given the wavelength of yellow light and are asked to find the frequency of the light. We can use:

$$v = c/\lambda$$

to calculate the frequency.

We need to convert the given wavelength to m. We note that $1\ nm = 1 \times 10^{-9}$ m Therefore the wavelength in metres is 597×10^{-9} m.

$$v = c/\lambda = 3 \times 10^{8}\ m \cdot s\ -1\ 597 \times 10^{-9}\ m = 5{,}03 \times 10^{14}\ Hz$$

Question 8.

What type of electromagnetic radiation is used to sterilise medical equipment?

Answer : Gamma rays are used to sterilize medical equipment.

Question 9.

What is the energy of a photon of a ultraviolet light wave with a frequency of $2{,}15 \times 10^{16}$ Hz?

Answer : The energy of a photon can be calculated using the formula:

$$E = h \times v = (6{,}63 \times 10^{-34}\ J \cdot s)(2{,}15 \times 10^{16}\ Hz) = 1{,}425 \times 10^{-17}\ J$$

Question 10.
Choose the word or term which best describes the following definition:
The type of EM radiation that has the lowest energy.

Answer : radio waves

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The frequency increases as the wavelength of light gets longer.
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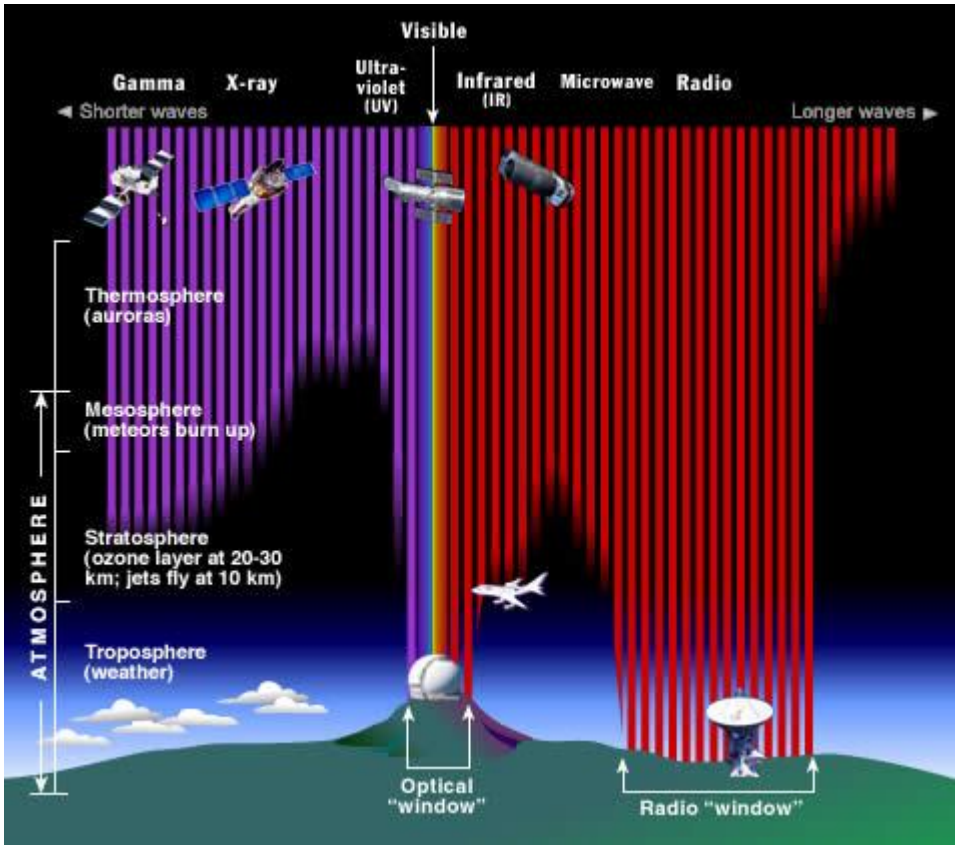

The Earth's atmosphere stops most types of electromagnetic radiation from space from reaching Earth's surface. This illustration shows how far into the atmosphere different parts of the EM spectrum can go before being absorbed. Only portions of radio and visible light reach the surface.

Question 15.

All electromagnetic radiation is dangerous.

True or False ?

it is not all dangerous. Something like green light or radio waves do not affect you. As you move towards shorter wavelengths such as X-rays and Gamma rays, more damage can be done to your cells. Remember that too much of anything is bad for you. Even simple visible light can blind you when it's bright enough. Never look directly at any bright light source.

Question 16.
What type of waves are used to transmit telephone messages?

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B.Radio waves
C.Microwaves
D.Visible light

Qurstion17.

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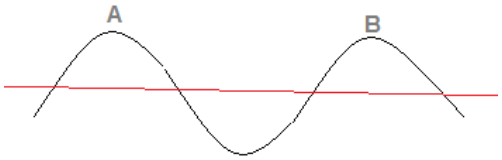

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Question 23.

What type of electromagnetic radiation is used to image the human body?

Answer :

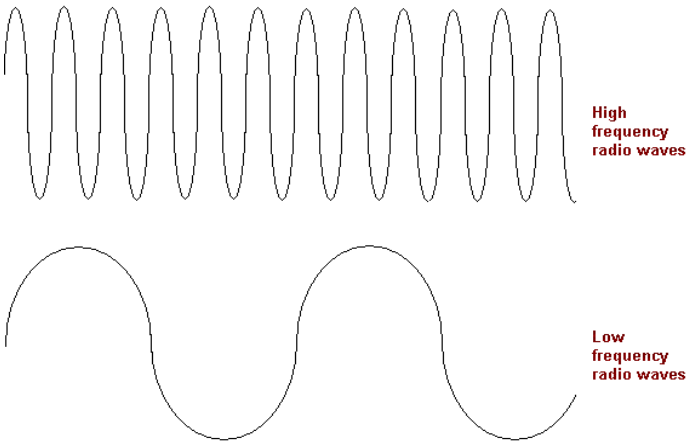
X-RAYS

Question 24.

What is frequency?

Answer :

Frequency describes the number of waves that pass a fixed place in a given amount of time.



Question 25.

How are frequency and wavelength related?

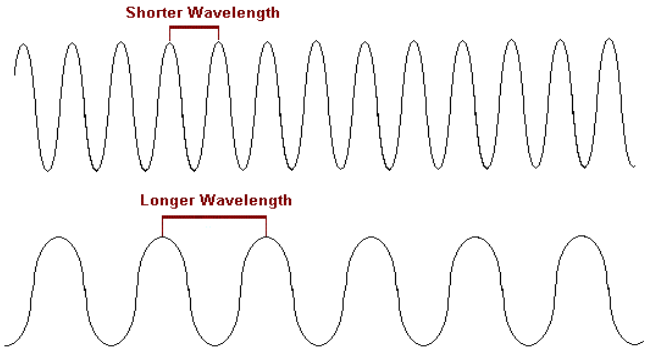
F α 1/ʎ

Question26.

What is wavelength?

Answer :

The distance between two identical points



The difference in wavelength is the way we separate different kinds of electromagnetic energy apart.

Question 27.

An FM radio station broadcasts at a frequency of 87.5 MHz. What is the wavelength of the station in meters?

Answer :

$$\lambda = \frac{3.00 X 10^{8}\ m/s}{87.5\ X\ 10^{6}\ Hz} = 3.43\ m$$

Question 28.

Which of the following ranges of the electromagnetic spectrum exhibits the highest frequency?

- Visible Light.
- X-rays .
- Microwaves .
- Ultra-Violet .
- All have the same frequency.

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Which of the following ranges of the electromagnetic spectrum exhibits the longest wavelength?

- Visible Light .
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Which of the following ranges of the electromagnetic spectrum travels at the fastest speed?

- Visible Light .
- X-rays
- Microwaves .
- Ultra-Violet .
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Question 31.

A white T-shirt that is absorbing radiation in which visible region?

- Purple.
- Red.
- Yellow.
- It is absorbing no visible radiation.
- It is absorbing all visible radiation.

Question 32.

What is the energy of a photon of EM radiation with a frequency of 3×10^8 Hz?

Answer:

$E=h\nu$

$E=6.626\times10^{-34}\cdot3\times10^{8}$

$E=2\times10^{-25}$ Joule

Question 33.

What is the energy of a photon of light with a wavelength of 532 nm and one with a frequency of 13 KHz and which has the longer wavelength?

Answer:

For the photon with $\lambda=532nm$:

$E=h\nu=h\,c/\lambda$

$E=(6{,}6\times10^{-34})(3\times10^{8}\ m.s^{-1})\ /\ 532\times10^{-9}\ m\ =3{,}7\times10^{-19}$ J

For the photon with $\nu=13KHz$:

$E=h\nu=(6{,}6\times10^{-34})(13\times10^{3}\ Hz)=8{,}6\times10^{-30}$ J

$\lambda=c/\nu=3\times10^{8}\ /\ 13\times10^{9}\ =2.3\times10^{-2}$ m

So the photon with a frequency of 13KHz has a longer wavelength.

Question 34. List the main uses of:

1. radio waves
2 . infrared
3 . gamma rays
4 . X-rays

Answer:

1) radio waves: radio, television broadcasts
2) infrared: night vision.
3) Gamma rays: used to kill the bacteria and to sterilise medical equipment
4) X-rays: used to image bone structures

Question 35.

Explain why we need to protect ourselves from ultraviolet radiation from the Sun.

Answer:
It causes sunburn and skin cancer.

Question 36.

List some advantages and disadvantages of using X-rays?

Answer:
Advantages: It can be used to look inside humans, to look at broken bones,
Disadvantages: Prolonged exposure to x-rays can lead to cell damage and cancer.

Question 37.

Explain why some types of electromagnetic radiation are more penetrating than others?

Answer:
Usually, radiation with higher energy levels (higher frequency - shorter wavelengths) have greater penetrating ability than radiation with lower energy. This makes the higher frequency radiation (ultraviolet, x-ray and gamma ray) radiation more penetrating than the lower frequency radiation (microwaves, radio waves, infrared)

Qustion 38.

Which of the following shows the correct order of various electromagnetic waves if arranged in increasing order of their frequencies?

- Gamma rays, infrared waves, visible light, ultraviolet rays, x-rays and radio waves
- Radio waves, infrared waves, visible light, ultraviolet rays, x-rays and gamma rays
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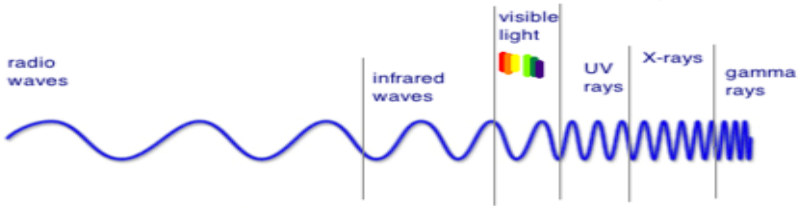

Question 39.

On the electromagnetic spectrum, the waves with the highest frequencies have the shortest :

speeds

periods

amplitudes

wavelengths

energies

Question 40.

Leaves are green because:

1) they only emit frequencies corresponding to green

2) they only reflect frequencies corresponding to green

3) they only absorb frequencies corresponding to green .

Question 41.
You emit radiation: True or False
Your skin feels warm, you emit infrared radiation

Question 42.
What are the difference between black and White ?

Answer :
A- White light contains all the frequencies of the visible part of the spectrum.
B- White paint – reflects all frequencies of the visible part of the spectrum equally.
C- Black paint – absorbs all frequencies of the visible part of the spectrum .

Question 43.
The visible region of the electromagnetic spectrum lies between wavelengths of

A. 200-300
B. 340-850
C. 380-750
D. 500-900

Q44. What is the relationship between wavelength (ʎ) and frequency (v)? ("c" is the speed of light)

A) ʎ v = c
B) ʎ /v = c
C) v/ʎ = c
D) ʎc = v

Question 45.
The human eye is most sensitive to light with a wavelength near 550 nm. To what photon energy is the human eye most sensitive? $E_{(J)} = E_{(eV)} \times 1.602176565 \cdot 10^{-19}$,

h = 6.63 × 10^{-34} J·s , c = 3 x 10^{10}cm/s

A) 2.49 eV
B) 3.61 X10^{-19} eV
C) 2.25 eV
D) 1.83 eV

Answer :

E = H X c/ʎ = 6.63 × 10^{-34} J·s X 3 x 10^{10} / (550 X 10^{-7}) cm = 3.61 X10^{-19} J

E = 3.61 X10^{-19} J /1.602176565·10^{-19} = 2.25 ev

Question 46.

Which of the following forms of electromagnetic radiation are dangerous to humans, but also enables your body to make a particular vitamin?

Infrared rays
X rays
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What are the units of frequency?

- m/s
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- Hz
- J

Question 49.

What color coat might you buy if you wanted to stay warm on a cold, sunny winter day?

a. black b. white
c. silver d. It does not matter what color the coat is .

QUESTIONS ABOUT THE INTERACTION OF ELECTROMAGNETIC RADIATIONS WITH MATTER

Question 1. What is spectrophotometry ?

Question 2. The spectroscopic methods can be classified according to : (choose many)
- type of matter .
- type of instrument .
- type of radiation .
- concentration of matter.
- nature of interaction of radiation with matter .

Question 3. Match the following :

1- absorption	**……. nephelometry**
2- emission.	**……. measuring the transmitted radiation.**
3- scattering.	**……. can be induced by flame , electricity or radiation**

Question 4. Match the following :

Type of Radiation	Type of Transition
1- **Microwaves**	**….. nuclear**
2- **radio waves**	**….. inner electron**
3- **UV / vis**	**….. outer electron**
4- **X-rays**	**….. molecular vibrations**
5- **γ-rays**	**….. molecular rotations,**
6- IR	….. nuclear spin flips

Question 5. Match the followings :

1- Absorption of EMR .	**Contains only electronic transitions .....**
2- Atomic spectrum .	**Contains electronic , vibrational and rotational transitions.....**
3- Molecular spectrum .	**Electrons go from lower energy state to higher energy state.....**
4- emission of EMR .	**Electrons return from higher energy state to lower energy state.....**

Question 6. What is the main difference between molecular spectrum (ms) and atomic spectrum (as) ? select the correct answer :

A- (ms) involves electronic , vibrational and rotational transitions and consists of bands while(as) involves only electronic transitions and consists of lines .

B- (as) involves electronic , vibrational and rotational transitions and consists of bands while (ms) involves only electronic transitions and consists of lines .

C- (as) involves electronic , vibrational and rotational transitions and consists of lines while (ms) involves only electronic transitions and consists of bands .

Question 7. Bonding (outer) electrons interact with what type of electromagnetic radiation ?

Question 8. What is the difference between a continuum , a

band and a line spectrum?

Question 9. An atom drops from 7.64 eV to 5.98 eV. What is the frequency of the photon emitted by the atom ?

$E_{(J)} = E_{(eV)} \times 1.60 \cdot 10^{-19}$,

h = 6.63×10^{-34} J·s , c = 3 x 10^{10}cm/s

a. 5.86×10^{-14} Hz
b. 2.50×10^{14} Hz
c. 2.66×10^{19} Hz
d. 4.00×10^{14} Hz

Question 10. An atom drops from 8.62 eV to 7.05 eV. What is the wavelength of the photon emitted by the atom?

$E_{(J)} = E_{(eV)} \times 1.60 \cdot 10^{-19}$,

h = 6.63×10^{-34} J·s , c = 3 x 10^{10}cm/s

a. 1270 nm
b. 796 nm
c. 250 nm
d. 496 nm

Question.11. An atom drops from 8.45 eV to 6.02 eV. What is the energy of the photon emitted by the atom?

a. 14.47 eV
b. 2.15 eV
c. 1.40 eV
d. 2.43 eV

Question 12. When a beam of UV/Visible radiation is directed into a matter what will happen to the matter?

Question 13. When a beam of UV/Visible radiation is absorbed by a matter what will happen to the matter ?

Question 14. What are the following Abbreviations stand for : AAS , AES and ICP ?

Question 15. What is the difference between absorption and emission ?

ANSWERS OF QUESTIONS ABOUT THE INTERACTION OF ELECTROMAGNETIC RADIATIONS WITH MATTER

Question 1. What is spectrophotometry ?

Answer :

It is the technique that measures the intensity of light absorbed , emitted or scattered by matter at a selected wavelength and relates this measurement to the matter's concentration .

Question 2. The spectroscopic methods can be classified according to : (choose many)

- type of matter .
- type of instrument .
- type of radiation .
- concentration of matter.
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3- UV / vis	…3.. outer electron
4- X-rays	…6.. molecular vibrations
5- γ-rays	…1.. molecular rotations,
6- IR	…2.. nuclear spin flips

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Answer :

Ultraviolet and visible .

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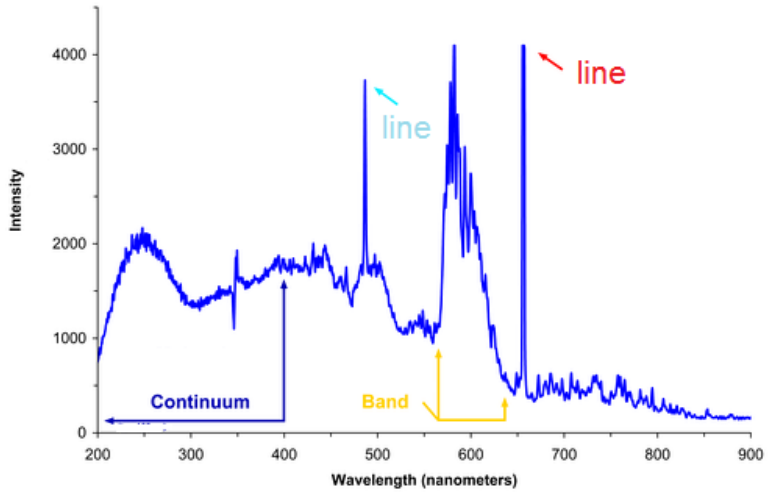
Answer :



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$E_{(J)} = E_{(eV)} \times 1.60 \cdot 10^{-19}$,

$h = 6.63 \times 10^{-34}$ J·s

a. 5.86×10^{-14} Hz
b. 2.50×10^{14} Hz
c. 2.66×10^{19} Hz
d. 4.00×10^{14} Hz

$\Delta E = .64 - 5.98 = 1.66$ eV $= 1.66 \times 1.60 \times 10^{-19}$ J $= 2.656\times10^{-19}$ J

$E = hv$

$2.656 \text{ X } 10^{-19} = 6.63 \times 10^{-34}$ J·s X v

V = 400603318250377 Hz

Question 10. An atom drops from 8.62 eV to 7.05 eV. What is the wavelength of the photon emitted by the atom?
$E_{(J)} = E_{(eV)} \times 1.60\cdot10^{-19}$,
$h = 6.63 \times 10^{-34}$ J·s , c = 3 x 10^{10}cm/s

a. 1270 nm
b. 796 nm
c. 250 nm
d. 496 nm
$\Delta E = 8.62 - 7.05 = 1.57$ eV $= 1.57 \text{ X } 1.60\cdot10^{-19}$ J $= 2.5 \text{ X } 10^{-19}$
$E = h \text{ X } c / \lambda$
$2.5 \text{ X } 10^{-19}$ J $= 6.63 \times 10^{-34}$ J·s X 3 x 10^{10}cm/s / λ
$\lambda = 0.00007956$ cm $= 0.00007956$ cm $/10^{-7} = 796$nm

Question.11. An atom drops from 8.45 eV to 6.02 eV. What is the energy of the photon emitted by the atom?
a. 14.47 eV
b. 2.15 eV
c. 1.40 eV
d. 2.43 Ev

Question 12. When a beam of uv/visible radiation is directed into a matter what will happen to the incident radiation ?

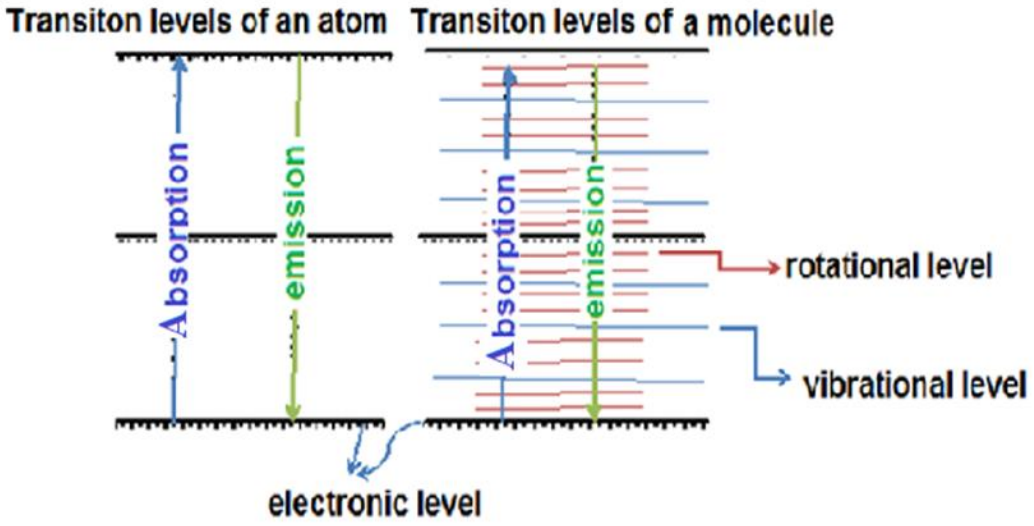
Answer :

the incident radiation will be either absorbed , reflected , scattered , transmitted or the absorbed radiation may be emitted .

Question 13. When a beam of uv/visible radiation is absorbed by a matter what will happen to the matter ?

Answer :

If the matter contains atoms , the absorbed radiation will cause only electronic transitions but if it contains molecules the absorbed radiation will cause electronic transitions as well as vibrational and rotational transitions .



Question 14. What are the following Abbreviations stand for : AAS , AES and ICP-AES ?

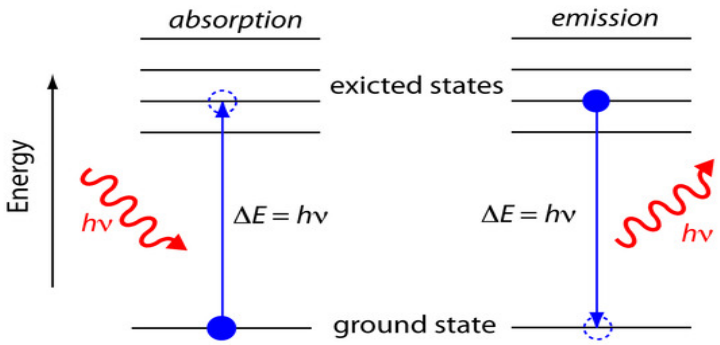
AAS : Atomic Absorption Spectrometry.

AES :Atomic Emission Spectrometry .

ICP-AES : Inductively Coupled Plasma Atomic Emission Spectroscopy

Question 15. What is the difference between absorption and emission?

Answer :



QUESTIONS ABOUT SPECTROMETRIC INSTRUMENTATIONS

Question 1. Give 3 examples of light sources used in spectroscopic instruments and label each source as continuum or line?

Question 2. Define bandwidth ?

Question 3. What cuvette material would be appropriate to use for a spectrophotometric measurement of 250 nm light? Why?

Question 4. List some ideal qualities of a radiation detector ?

Question 5. The most sensitive device used in spectrophotometers for the conversion of polychromatic radiation to monochromatic is :
- Diffraction grating .
- prism .
- filter .

Question 6. Which of the following components of a monochromator is the dispersing element?
a) The collimating lens
b) The entrance slit
c) The diffraction grating .

Question 7. Why must the voltage supplied to a tungsten lamp be *very* stable?

a) Because if it wasn't the lamp would burn out
b) Because amount of energy the lamp emits is proportional to the operating voltage
c) Because the lamp will only function at a specific voltage

Question 8. How to choose the ʎ at which absorption or emission of the analyte is measured .

Question 9. what are the objective of each component of a spectrophotometer? Match the followings :

1- Component	**objective**
2- Cuvette	…..To allow only desired ʎ to pass.
3- detector	…..To contain the sample solution.
4- Radiation source	…..To Convert radiation intensity to current.
5-monochromator	…..To emit radiation that can interact …..with the analyte.
6- mirror	…..To collimate radiation .
7- slit	…..To separate radiation according to ʎ .
8- Lens	…..To direct radiation .

Question 10. List some advantages of double beam over single beam spectrophotometer ?

Question.11. A component of a spectrophotometer that isolates radiant energy of a specific wavelength and excludes that of other wavelengths is called :

a. Fluorometer
b. Incandescent lamp
c. Monochromator
d. Photo-tube

Question 12. What term is used for an optical device that has many rows of equally spaced grooves that also produce interference patterns?

a. diffraction slit .
b. diffraction grating .
c. interference filament .
d. thin film plate .

Question13. What are the requirements of a radiation source ?

Question 14. Calculate the resolution of a reflection grating that can separate 350 nm light from 354 nm light.

Question 15. Sketch and label the basic and vital components in a Spectrophotometer showing the path of light through the instrument ?

Question 16. a ddiffraction grating contains 500 grooves / cm , calculate it's length which is required to separate 589.5 nm from 589.0 ? n = 1

Question 17. if $\Theta_r = 100^0$, $\Theta_i = 50^0$, d = 1µm and n = 1 , calculate the reflected wavelength ?

Question 18. Draw a picture, labeling all parts, of a grating monochrometer ?

Question 19. If 340 nm light hits a grating with 2400 grooves/mm, at an angle of incidence of 50 ^{o}, what is the diffraction angle of the second order radiation on the opposite side of the grating ?

(a) 2.9 ^{o} (b) 30 ^{o} (c) 60 ^{o} (d) none of these

ANSWERS OF QUESTIONS ABOUT SPECTROMETRIC INSTRUMENTATIONS

Question 1. Give 3 examples of light sources used in spectroscopic instruments and label each source as continuum or line?

- Tungsten - Visible - continuum
- D_2 (Deuterium) – UV/Visible- continuum
- Hollow Cathode Lamb UV/Visible- line

Question 2. Define bandwidth ?

The size of the monochromator exit slit determines the bandwidth . A wider slit width gives higher sensitivity because higher radiation intensity passes to the sample but on the other hand, narrow slit width gives better resolution i.e. less spectral interferences.

Question 3. What cuvette material would be appropriate to use for a spectrophotometric measurement of 250 nm light? Why?

- Quartz would be the appropriate cuvette material to use for a spectrophotometric measurement of 250 nm light because quartz does not absorb in the range 200 - 2000 nm.

Question 4. List some ideal qualities of a radiation detector ?

- High signal to noise ratio
- High sensitivity (detect small amounts of light)
- Fast response time
- constant wavelength response.

Question 5. The most sensitive device used in spectrophotometers for the conversion of polychromatic radiation to monochromatic is :

- Diffraction grating .
- prism .
- filter .

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a) Because if it wasn't the lamp would burn out
b) Because amount of energy the lamp emits is proportional to the operating voltage

c) Because the lamp will only function at a specific voltage
Question 8. How to choose the ʎ at which absorption or emission of the analyte is measured .

Choose a wavelength at an absorption or emission maximum . Pick peak in spectrum where analyte is only compound absorbing or emitting light or choose a wavelength where the analyte has the largest difference in its absorbance or emission relative to other sample components . Choose a wavelength on broad horizontal band on the spectrum not on steep portion of the spectrum .

Question 9. what are the objective of each component of a spectrophotometer? Match the followings :

Component	**objective**
1- Cuvette	…6..To allow only desired ʎ to pass.
2- detector	…1..To contain the sample solution.
3- Radiation source	…2..To Convert radiation intensity to current.
4-monochromator	…3..To emit radiation that can interact with the analyte.
5- mirror	…7..To collimate radiation .
6- slit	…4..To separate radiation according to ʎ .
7- Lens	…5..To direct radiation .

Question 10. List some advantages of double beam over single beam spectrophotometer ?

Single beam spectrophotometer is inconvenient because the sample and blank must be placed alternately in the light path ,while in double beam they can be measured automatically at the same time . Therefore , small changes . in P or in detector response have no effect in double beam but may have great effect with single beam.

In double beam we can make automatic scanning and continuous recording of spectrum which we cannot with single beam .

Question.11. A component of a spectrophotometer that isolates radiant energy of a specific wavelength and excludes that of other wavelengths is called :

a. Fluorometer
b. Incandescent lamp
c. Monochromator
d. Photo-tube

Question 12. What term is used for an optical device that has many rows of equally spaced grooves that also produce interference patterns?

a. diffraction slit .
b. diffraction grating .
c. interference filament .
d. thin film plate .

Question 13. What are the requirements of a radiation source ?

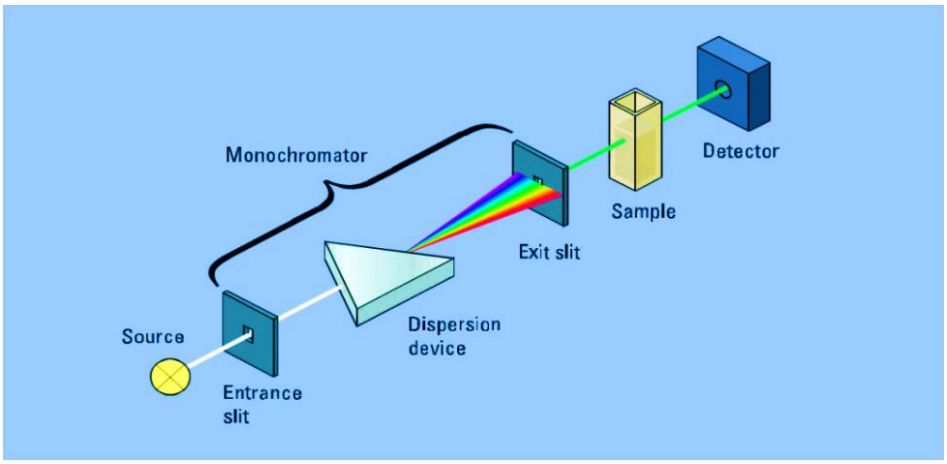
Sources of radiation should be stable and of high intensity .

Question 14. Calculate the resolution of a reflection grating that can separate 350 nm light from 354 nm light.

Solution : $\lambda^- = (350 + 354) / 2 = 352$

R = wavelength/delta wavelength = $\lambda^- / \Delta\lambda = 352$ nm/ 4 nm = 88

Question 15. Sketch and label the basic and vital components in a Spectrophotometer showing the path of light through the instrument ?



Question 16. a ddiffraction grating contains 500 grooves / cm , calculate it's length which is required to separate 589.5 nm from 589.0 ? n = 1

Answer :

$\lambda^- = (598.5 + 589.0) / 2 = 589.25$ nm

$\Delta\lambda = 589.5 – 589.0 = 0.5$

R = 589.25 / 0.5 = 1178.5

R = Nn , 1178.5 = N

The required length = 1178.5 / 500 = 2.357 cm

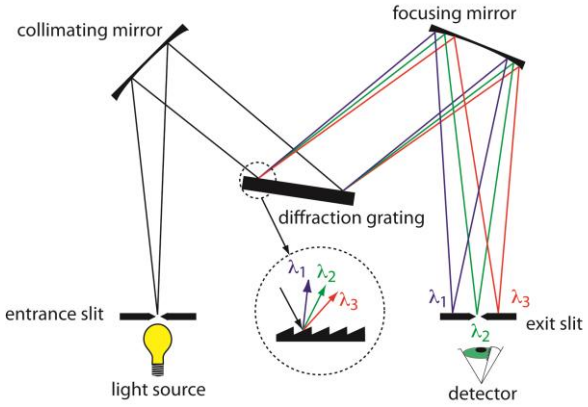
Question 17. if $\Theta_r = 100^0$, $\Theta_i = 50^0$, d = 1µm and n = 1 , calculate the reflected wavelength ?

Answer :

$\mathbf{n}\,\lambda = d\,(\sin\theta_i + \sin\theta_r)$

$\lambda = 1\,(\sin 100 + \sin 50) = 0.8\ \mu m = 800\ nm$

Question 18. Draw a picture, labeling all parts, of a grating monochrometer ?



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(a) 2.9 ^{o} (b) 30 ^{o} (c) 60 ^{o} (d) none of these

QUESTIONS ABOUT UV/VISIBLE MOLECULAR ABSORPTION SPECTROMETRY

Question 1.

Beer's Law states that;

b) Absorbance is proportional to the log of the concentration of the absorbing species

c) Absorbance is equal to P_0 / P

Question 2.

UV-Vis. Spectroscopy of organic compounds is usually concerned with which electronic transition(s)?

a) $\sigma \rightarrow \sigma^*$

b) $n \rightarrow \sigma^*$

c) $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$

Question 3.

Peaks resulting from $n \rightarrow \pi^*$ transitions are shifted to shorter wavelengths (*blue shift*) with increasing solvent polarity.

True or false?

Question 4.

Why in molecular absorption spectrophotometry we use absorbance instead of transmittance ?

- because the relationship between transmittance and concentration is not linear while the absorbance vs concentration is linear .

- because the absorbance is easier to measure compared to transmittance .

- because the calculation using transmittance is complicated .

Question 5.

A 5.2×10^{-5} M solution of compound A exhibited an absorbance of 0.87 at 530 nm in a 1.000 cm cuvette. A blank had an absorbance of 0.03. The absorbance of an unknown solution of compound A was 0.67.

Find the concentration of A in the unknown ?

Question 6.

A 0.001 M solution of substance D had an absorbance of 0.80 at 630 nm in a 1.00 cm cuvette, and an absorbance of 0.05 at 420 nm. A 0.004 M solution of substance E had absorbances of 0.01 and 0.60 at 630 and 420 nm, respectively. A mixture of X and Y had absorbances of 0.60 and 0.40 at 630 and 420 nm, respectively. Calculate the concentration of X and Y in the mixture ?

Question 7.

Bonding electrons interact with what types of electromagnetic radiation?

Question 8.

Explain how a photomultiplier tube works ?

Question 9 .

Match the following :

chromophore	transition
1- C-C	……. $\pi \rightarrow \pi^*$
2- C = C or C ≡ C	……. $\pi \rightarrow \pi^* + n \rightarrow \pi^*$
3- C = O	……. $\sigma \rightarrow \sigma^*$
4- C – X	……. $n \rightarrow \sigma^*$

Question 10.

You have the following data for the analysis of an analyte concentration by AAS . Show how to apply the standard addition method for finding the analyte concentration ?When you prefer standard addition method over standard calibration ?

No.	Sample added ml	Standard added ml	Concentration of standard µg/ml	Last concentration µg/ml	Response
1	10	0	150	?	3.06
2		5		?	4.56
3		10		?	6.06
4		15		?	7.56
5		20		?	9.06

V_L = 50 ml

Question 11.

What is the effect of aromaticity on the absorption of a compound ?

Question 12.

What are the advantages of spectrophotometric titration over conventional titration ?

Question 13.

How to determine non-absorbing analyte using UV/Visible region ?

Question 14.

Absorbance (A) of a solution may be converted to percent transmittance (%T) using the formula?

A. 1 + Log %T
B. 2 + Log %T
C. 1 - Log %T
D. 2 - Log %T

Question 15.

The nanometer is used as a measure of?

- **A.** Absorbance
- **B.** % transmittance
- **C.** Intensity of radiant energy
- **D.** Wavelength of radiant energy

Question 16.

Light is passed through a solution with a light path of 2 cm and the absorbance is recorded as 0.40. If light is passed through the same solution at the same wavelength and the light path is reduced to 1 cm, the absorbance should be:

- **A.** 0.80
- **B.** 0.40
- **C.** 0.20
- **D.** 0.10

Question 17.

A component of a spectrophotometer that isolates radiant energy of a specific wavelength and excludes that of other wavelengths is called a or an .....

- **A.** Fluorometer
- **B.** Incandescent lamp
- **C.** Monochromator
- **D.** Photomultiplier tube

Question 18.

An absorbance spectrum may be used to:

- **A.** Find the wavelength of maximum absorbance
- **B.** Select a wavelength best suited for measuring a compound
- **C.** Identify an unknown compound by comparing its absorption spectra to that of a known compound
- **D.** All of the above

Question 19.

A blank absorbance reading is used to:

A. Compensate for variations in reagent interferences and its absorbance is subtracted from the absorbance of the net reaction with sample

B. Compensate for variations in reagent and sample interferences and its absorbance is subtracted from the absorbance of the net reaction with sample

C. Compensate for variations in sample interferences and its absorbance is subtracted from the absorbance of the net reaction with sample

D. Compensate for variations in reagent interferences and light source variation and its absorbance is subtracted from the absorbance of the net reaction with sample

Question 20.

Monochromatic light is defined as

A. The measurement of the intensity of light at selected wavelengths

B. Emission of light by molecules in an excited state produced by a chemical reaction or the absorption ionizing radiation

C. Electromagnetic radiation of one wavelength or extremely narrow wavelengths

D. Measurement of scattered light by suspended particles

Question 21.

What units of measurement are traditionally applied to wavelength in the visible portion of the electromagnetic spectrum?

A. Milimeters (mm)

B. Centimeters (cm)

C. Micrometers (um)

D. Nanometers (nm)

Question 22.

Method requiring the measurement of absorbance in the UV region of the electromagnetic spectrum require that the sample cuvette be made of:

A. Glass
B. Plastic
C. Quartz

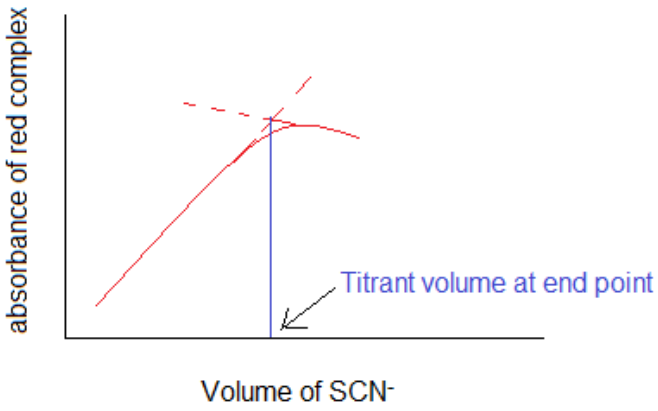
Question 23.

Analytical sensitivity is related to:

A. Lowest concentration of analyte that can be detected and accurately quantitated
B. The minimum cross reactivity with other analytes with similar structures
C. Highest concentration of analyte that can be detected and accurately quantitated
D. The highest cross reactivity with other analytes with similar structure .

Question 24.

spectrophotometric titration of Fe^{+3} with SCN^- solution to make the red FeSCN complex would give what titration curve?



Question 25.

Why such a photometric titration be more accurate than relying on Beer's law to make the concentration estimate? Select all that apply:

a. Matrix effects are unimportant in photometric titration.
b. Photometric titration uses an internal standard.
c. Beer's law is always obeyed in photometric titrations.
d. Beer's law need not be obeyed in photometric titrations.
e. Photometric titration relies on titrant volume and titrant concentration which can be measured accurately.
f. Photometric titration relies on absolute absorbance which can be measured exactly.
g. Photometric titration does not require sample preparation.

Question 26.

Name some factors causing deviation from Beer's law ?

- High concentration .
- Using polychromatic radiation .
- Stray radiation .
- Dissociation and reaction of the analyte .
-

Question 27.

An analyte at concentration of $5.0X10^{-3}$ M gives an absorbance 0f 0.50 at a specific wavelength and a cell path length of 1.00 cm . What is the molar absorptivity ?

a. 100 M.cm
b. 100 M^{-1} cm^{-1}
c. 100 $M.cm^{-1}$
d. 200 $L.mol^{-1}$ cm^{-1}

Question 28 .

The percent transmitance (%T) is the prcentage of light :

a. absorbed by the sample .

b. not absorbed by the sample .
c. reflected by the sample .
d. emitted by the sample .

Question 29 .

You are analyzing compound X using molecular absorption spectrometry . A standard containing 50 µg/ml of X gives a %T of 15.9 . The %T of the blank is 97.2 . What is the concentration (µg/ml) of a sample of X that gives a %T of 47.8 ?

a. 128 µg/ml , b. 20.4 µg/ml , c. 150 µg/ml , d. 19.6 µg/ml

Question 30 .

State a reason for measuring at λ_{max} ?
To increase the sensitivity .

Question 31 .

List 3 specific examples of chromophoric groups:
a) .....
b) .....
c) .....

Question 32 .

Using molecular orbital terminology name the type of molecular transitions occurring during excitation in:
a) double and triple bonds .....
b) single bond ....
c) non bonded electrons .....

Question 33 .

A mixture containing cobalt and nickel was dissolved, complexed with 2,3-quinoxalinedi-thiol, and measured spectrophotometrically. At 510 nm, the reading from the Spectronic 21 was 36.1%T, while at 656 nm the reading was 34.4%T. All measurements were in a 1.00 cm cell.
Molar absorptivities for the complexes are as follows:

	ε_{Co}	ε_{Ni}
510 nm	36,400	5,520
656 nm	1,240	17,500

Calculate the concentration of cobalt and nickel in the solution.

Question 34.

Given the following spectrophotometric data:
Calculate the concentration in ppm of solutions with %T = 68.7 ?

ppm	**%T**
3.00	73.62
6.00	53.21
9.00	38.90
12.0	28.77
15.0	21.33
?	Analyte 68.7

Question 35.

What is the molar absorptivity of a compound if a 4.4 X 10^{-5} molar solution has an absorbance of 0.105 when the path length is 1.0 cm?

(a) 4.2 X 10^{-5} (b) 1.0 X 10^{8} (c) 2.4 X 10^{3} (d) 4.62 X 10^{-6}

Question 36.

The % transmittance of a sample is measured to be 34%. What will the absorbance be if the concentration is doubled?

(a) 0.94 (b) 0.68 (c) 0.23 (d) 0.17

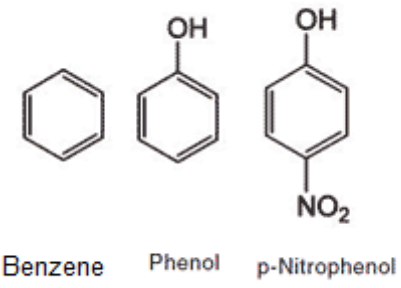
Question 37.

Which transition has the smallest and which has the largest molar absorptivity?

(a) $\pi \rightarrow \pi^*$ highest (b) $\sigma \rightarrow \sigma^*$ lowest (c) $n \rightarrow \pi^*$ (d) $\sigma \rightarrow \pi^*$

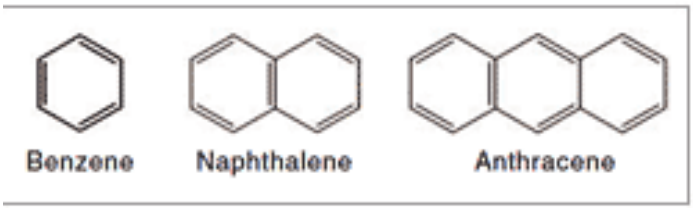
Question 38.

Compare the following compounds regarding λ_{max} ?



Question 39.

Compare the following compounds regarding λ_{max} and molar absorptivity ε ?



Question 40.

Compare (I) with (II) and (III) regarding λ_{max} and gmolar absorptivity ε ?

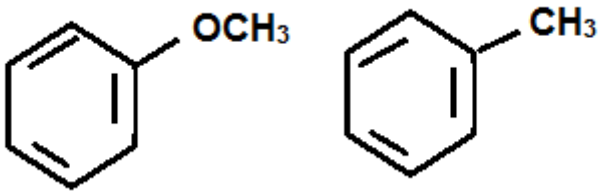
(I) CH_3 - CH = CH - CH_3

(II) CH_3 - CH = CH - CH = CH_2

(III) CH_3 - CH = CH - CH_2 - CH = CH_2

Question 41.

Compare the following compounds regarding λ_{max} and molar absorptivity ε ?



(I) (II)

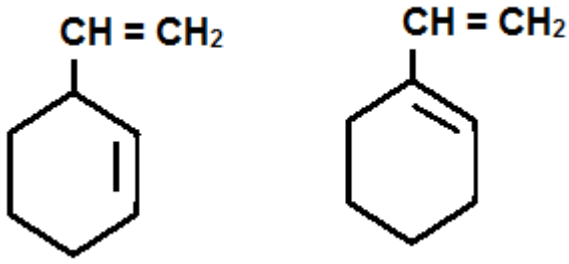
Question 42.

Compare the following compounds regarding λ_{max} and molar absorptivity ε ?

a) $CH_2 = CHCO_2H$, b) $CH_3 - CH_2CO_2H$

Question 43.

Compare the following compounds regarding λ_{max} ?



(I) (II)

ANSWERS OF QUESTIONS ABOUT UV/VISIBLE MOLECULAR ABSORPTION SPECTROMETRY

Question 1.

Beer's Law states that;

a) Absorbance is proportional to both the path length and concentration of the absorbing species

b) Absorbance is proportional to the log of the concentration of the absorbing species

c) Absorbance is equal to P_0 / P

Question 2.

UV-Vis. Spectroscopy of organic compounds is usually concerned with which electronic transition(s)?

a) $\sigma \rightarrow \sigma^*$

b) $n \rightarrow \sigma^*$

c) $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$

Question 3.

Peaks resulting from $n \rightarrow \pi^*$ transitions are shifted to shorter wavelengths (*blue shift*) with increasing solvent polarity.

True or false?

Question 4.

Why in molecular absorption spectrophotometry we use absorbance instead of transmittance ?

Answer :

- because the relationship between transmittance and concentration is not linear while the absorbance vs concentration is linear .

- because the absorbance is easier to measure compared to transmittance .

- because the calculation using transmittance is complicated .

Question 5.

A 5.2×10^{-5} M solution of compound A exhibited an absorbance of 0.87 at 530 nm in a 1.000 cm cuvette. A blank had an absorbance of 0.03. The absorbance of an unknown solution of compound A was 0.67.
Find the concentration of A in the unknown ?

Answer :

$A = \varepsilon bc$, $0.87 - 0.03 = \varepsilon \times 1 \times 5.2 \times 10^{-5}$, $\varepsilon = 16153.8$

$c = A / \varepsilon . b$, $c = (0.67 - 0.03) / 16153.8 = 4 \times 10^{-5}$ M

Question 6.

A 0.001 M solution of substance D had an absorbance of 0.80 at 630 nm in a 1.00 cm cuvette, and an absorbance of 0.05 at 420 nm. A 0.004 M solution of substance E had absorbances of 0.01 and 0.60 at 630 and 420 nm, respectively. A mixture of X and Y had absorbances of 0.60 and 0.40 at 630 and 420 nm, respectively. Calculate the concentration of X and Y in the mixture ?

Answer :

Standards :

At 420 nm : $\varepsilon_D = 0.05 / 0.001 = 50$, $\varepsilon_E = 0.60 / 0.004 = 150$

At 630 nm : $\varepsilon_D = 0.80 / 0.001 = 800$, $\varepsilon_E = 0.01 / 0.004 = 2.5$

Mixture :

At 420 nm : $0.40 = 50 \times C_D + 150 \times C_E$

At 630 nm : $0.60 = 800\ C_D + 2.5 \times C_E$

Solving these two equations gives :

$C_D = 7.52 \times 10^{-3}$ M = 0.00752 M

$C_E = 1.6 \times 10^{-4}$ M = 0.00016 M

Question 7.

Bonding electrons interact with what types of electromagnetic radiation?

Ultraviolet and Visible

Question 8.

Explain how a photomultiplier tube works ?

Answer :

- The cathode releases an e^- when illuminated.
- The e^- then goes to the dynode and is multiplied. Every time the e^- (or electrons) hit another dynode, they are multiplied again. There are ten dynodes in total.
- All of the electrons will go to the anode. There will be about 10^6 to 10^7 e^- when they reach the anode.
- Fast response time
- Sensitivity is limited by dark current.

Question 9 .

Match the following :

chromophore	transition
1- C-C	….2…. $\pi \rightarrow \pi^*$
2- C = C or C ≡ C	…3….. $\pi \rightarrow \pi^* + n \rightarrow \pi^*$
3- C = O	…1….. $\sigma \rightarrow \sigma^*$
4- C – X	…4….. $n \rightarrow \sigma^*$

Question 10.

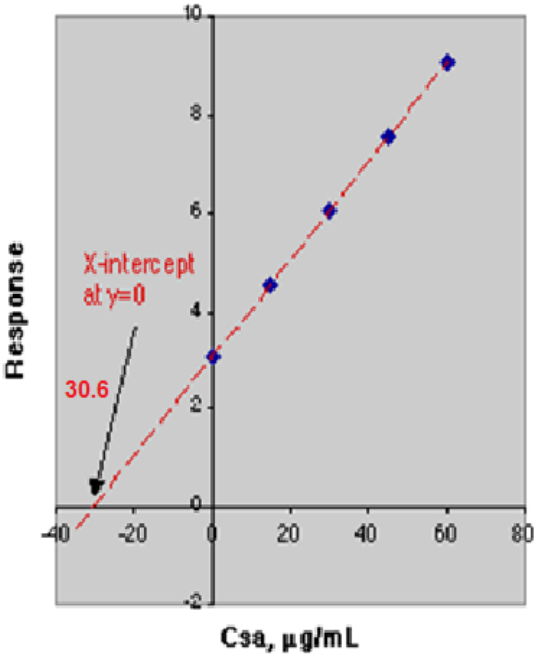
You have the following data for the analysis of an analyte concentration by AAS . Show how to apply the standard addition method for finding the analyte concentration ?When you prefer standard addition method over standard calibration ?

No.	Sample added ml	Standard added ml	Concentration of standard µg/ml	Last concentration µg/ml	Response
1	10	0	150	?	3.06
2		5		?	4.56
3		10		?	6.06
4		15		?	7.56
5		20		?	9.06

V_L = 50 ml

Answer :

No	Sample added ml	Standard added ml	Con.^{n} of standard µg/ml	Last concentration µg/ml	Response
1	10	0	150	0	3.06
2		5		(5X150)/50 = 15	4.56
3		10		(10X150)/50 = 30	6.06
4		15		(15X150)/50 = 45	7.56
5		20		(20X150)/50 = 60	9.06



In many cases the intensity of the signal of the analyte is affected by the composition of the matrix, by the temperature and other factors. One of the methods to overcome these problems is the method of standard additions. Two conditions have to be fulfilled for successful application of the method:

(a)the calibration graph must be linear,

(b)the calibration curve of the analyte passes through the origin.

Question 11.

What is the effect of aromaticity on the absorption of a compound ?

Answer :

If we assume a molar absorptivity of about 10,000 L mol^{-1} cm^{-1} for each double bond, we expect the sum of the three double bonds in benzene to be just above 30,000 L mol^{-1} cm^{-1} (at 185 nm) but actually the value is about 60,000 L mol^{-1} cm^{-1} due to increased delocalization as a result of aromaticity.

Question 12.

What are the advantages of spectrophotometric titration over conventional titration ?

Answer :

Advantages of Photometric Titrations

1. Usually, photometric titrations are more accurate than visual titrations.

2. Photometric titrations are faster than visual titrations as only few points at the beginning and end of the titration is necessary. Extrapolation of the straight lines will intersect at the end point.

3. Titration reactions that are slow at the end point can not be performed by visual titrations but are well suited for spectrophotometric titrations.

Question 13.

How to determine non-absorbing analyte using UV/Visible region ?

Answer :

Non absorbing species can be determined by reaction with a suitable reagent to produce an absorbing compound as the case of metal ions when complexed to ligands

Question 14.

Absorbance (A) of a solution may be converted to percent transmittance (%T) using the formula?

A. 1 + Log %T
B. 2 + Log %T
C. 1 - Log %T
D. 2 - Log %T

Question 15.

The nanometer is used as a measure of?

A. Absorbance
B. % transmittance
C. Intensity of radiant energy
D. Wavelength of radiant energy

Question 16.

Light is passed through a solution with a light path of 2 cm and the absorbance is recorded as 0.40. If light is passed through the

same solution at the same wavelength and the light path is reduced to 1 cm, the absorbance should be:

A. 0.80
B. 0.40
C. 0.20
D. 0.10

Answer :

$0.40 = \varepsilon \times 2 \times C$ (1)

$A = \varepsilon \times 1 \times C$ (2)

Dividing (1) by (2) and cancelation give : A = 0.20

Question 17.

A component of a spectrophotometer that isolates radiant energy of a specific wavelength and excludes that of other wavelengths is called a or an .....

A. Fluorometer
B. Incandescent lamp
C. Monochromator
D. Photomultiplier tube

Question 18.

An absorbance spectrum may be used to:

A. Find the wavelength of maximum absorbance
B. Select a wavelength best suited for measuring a compound
C. Identify an unknown compound by comparing its absorption spectra to that of a known compound
D. All of the above

Question 19.

A blank absorbance reading is used to:

A. Compensate for variations in reagent interferences and its absorbance is subtracted from the absorbance of the net

reaction with sample

B. Compensate for variations in reagent and sample interferences and its absorbance is subtracted from the absorbance of the net reaction with sample

C. Compensate for variations in sample interferences and its absorbance is subtracted from the absorbance of the net reaction with sample

D. Compensate for variations in reagent interferences and light source variation and its absorbance is subtracted from the absorbance of the net reaction with sample

Question 20.

Monochromatic light is defined as

A. The measurement of the intensity of light at selected wavelengths

B. Emission of light by molecules in an excited state produced by a chemical reaction or the absorption ionizing radiation

C. Electromagnetic radiation of one wavelength or extremely narrow wavelengths

D. Measurement of scattered light by suspended particles

Question 21.

What units of measurement are traditionally applied to wavelength in the visible portion of the electromagnetic spectrum?

A. Milimeters (mm)

B. Centimeters (cm)

C. Micrometers (um)

D. Nanometers (nm)

Question 22.

Method requiring the measurement of absorbance in the UV region of the electromagnetic spectrum require that the sample cuvette be made of:

A. Glass
B. Plastic
C. Quartz

Question 23.

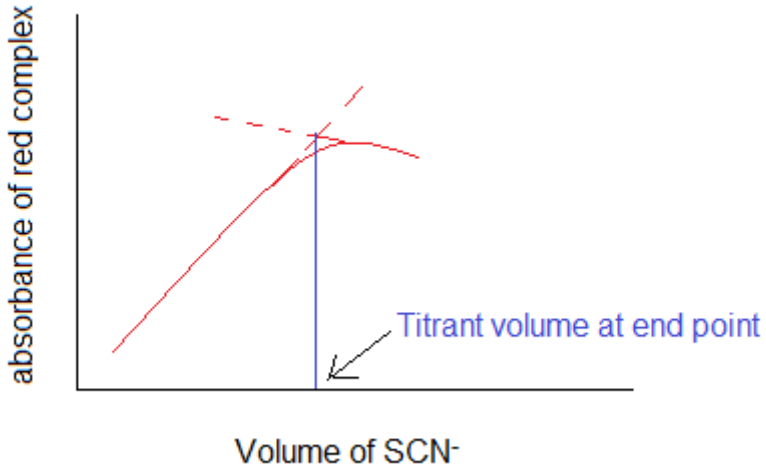
Analytical sensitivity is related to:

A. Lowest concentration of analyte that can be detected and accurately quantitated
B. The minimum cross reactivity with other analytes with similar structures
C. Highest concentration of analyte that can be detected and accurately quantitated
D. The highest cross reactivity with other analytes with similar structure .

Question 24.

spectrophotometric titration of Fe^{+3} with SCN^- solution to make the red FeSCN complex would give what titration curve?

Answer :



Question 25.

Why such a photometric titration be more accurate than relying on Beer's law to make the concentration estimate? Select all that apply:

a. Matrix effects are unimportant in photometric titration.

b. Photometric titration uses an internal standard.

c. Beer's law is always obeyed in photometric titrations.

d. Beer's law need not be obeyed in photometric titrations.

e. Photometric titration relies on titrant volume and titrant concentration which can be measured accurately.

f. Photometric titration relies on absolute absorbance which can be measured exactly.

g. Photometric titration does not require sample preparation.

Question 26.

Name some factors causing deviation from Beer's law ?

Answer :

- High concentration .
- Using polychromatic radiation .
- Stray radiation .
- Dissociation and reaction of the analyte .

Question 27.

An analyte at concentration of $5.0X10^{-3}$ M gives an absorbance 0f 0.50 at a specific wavelength and a cell path length of 1.00 cm . What is the molar absorptivity ?

a. 100 M.cm

b. 100 M^{-1} cm^{-1}

c. 100 $M.cm^{-1}$

d. 200 $L.mol^{-1}$ cm^{-1}

Question 28 .

The percent transmitance (%T) is the prcentage of light :

a. absorbed by the sample .

b. not absorbed by the sample .

c. reflected by the sample .

d. emitted by the sample .

Question 29 .

You are analyzing compound X using molecular absorption spectrometry . A standard containing 50 µg/ml of X gives a %T of 15.9 . The %T of the blank is 97.2 . What is the concentration (µg/ml) of a sample of X that gives a %T of 47.8 ?

a. 128 µg/ml , b. 20.4 µg/ml , c. 150 µg/ml , d. 19.6 µg/ml

Question 30 .

State a reason for measuring at λ_{max} ?

To increase the sensitivity .

Question 31 .

List 3 specific examples of chromophoric groups in the UV/Vis region :

a) .....C = C.....

b) .....C ≡ C.....

c) .....C = O.....

Question 32 .

Using molecular orbital terminology name the type of molecular transitions occurring during excitation in:

a) double and triple bonds .....π __> π* .....

b) single bond ..... σ __> σ*.....

c) non bonded electrons n —> σ*.....and..... n —> π*

Question 33 .

A mixture containing cobalt and nickel was dissolved, complexed with 2,3-quinoxalinedi-thiol, and measured spectrophotometrically. At 510 nm, the reading from the Spectronic 21 was 36.1%T, while at 656 nm the reading was 34.4%T. All measurements were in a 1.00 cm cell.
Molar absorptivities for the complexes are as follows:

	ε_{Co}	ε_{Ni}
510 nm	36,400	5,520
656 nm	1,240	17,500

Calculate the concentration of cobalt and nickel in the solution.

See answer of question 6

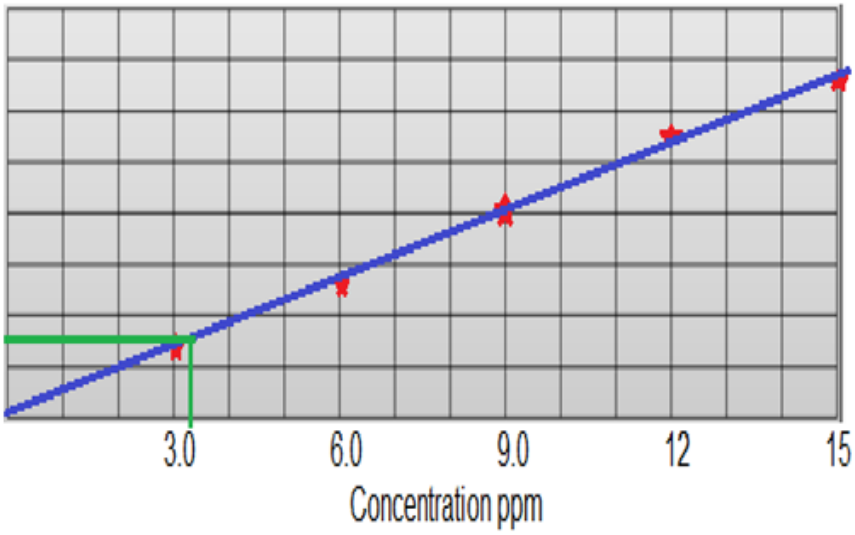
Question 34.

Given the following spectrophotometric data:
Calculate the concentration in ppm of solutions with %T = 68.7 ?

ppm	%T
3.00	73.62
6.00	53.21
9.00	38.90
12.0	28.77
15.0	21.33
?	Analyte 68.7

Answer :

ppm	%T	A
3.00	73.62	0.133
6.00	53.21	0.274
9.00	38.90	0.410
12.0	28.77	0.541
15.0	21.33	0.671
3.33	Analyte 68.7	0.163



Question 35.

What is the molar absorptivity of a compound if a 4.4 X 10^{-5} molar solution has an absorbance of 0.105 when the path length is 1.0 cm?

(a) 4.2 X 10^{-5} (b) 1.0 X 10^{8} (c) 2.4 X 10^{3} (d) 4.62 X 10^{-6}

$\varepsilon = 0.105 / 4.4 \text{ X } 10^{-5} = 2.4 \text{ X } 10^{3} \text{ M}^{-1} \text{ cm}^{-1}$

Question 36.

The % transmittance of a sample is measured to be 34%. What will the absorbance be if the concentration is doubled?

(a) 0.94 (b) 0.68 (c) 0.23 (d) 0.17

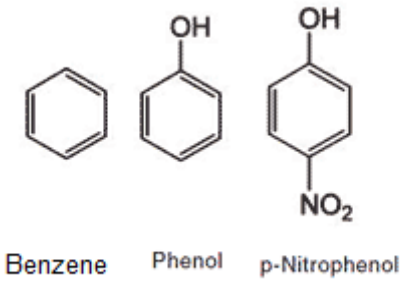
Question 37.

Which transition has the smallest and which has the largest molar absorptivity?

(a) $\pi \rightarrow \pi^*$ highest (b) $\sigma \rightarrow \sigma^*$ lowest (c) $n \rightarrow \pi^*$ (d) $\sigma \rightarrow \pi^*$

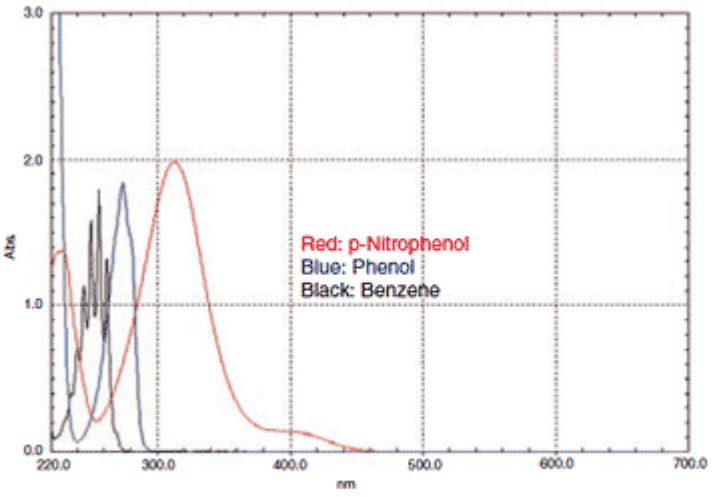
Question 38.

Compare the following compounds regarding λ_{max} ?



Benzene Phenol p-Nitrophenol

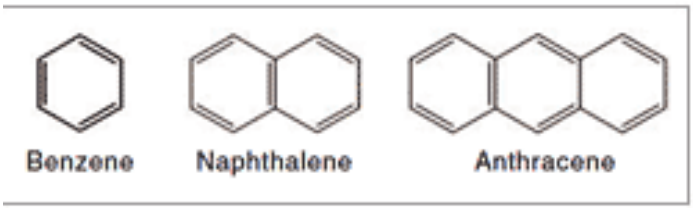
Answer :



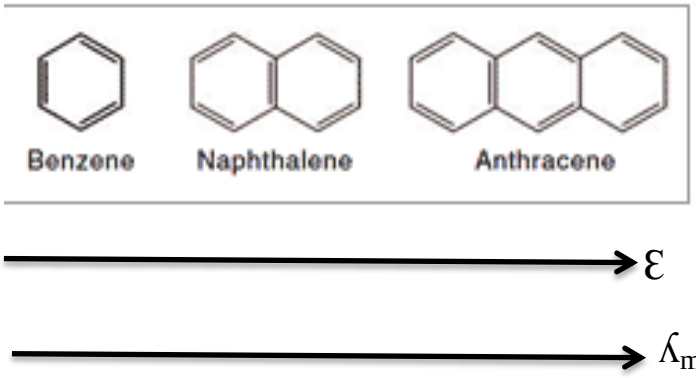
Absorption Spectra of Benzene, Phenol, and p-Nitrophenol

Question 39.

Compare the following compounds regarding λ_{max} and molar absorptivity ε ?



Answer :



Because of increasing double bonds , conjugation and benzene rings .

Question 40.

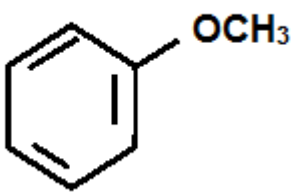
Compare (I) with (II) and (III) regarding $ʎ_{max}$ and gmolar absorptivity Ɛ ?

(I) CH_3 - CH = CH - CH_3
(II) CH_3 - CH = CH - CH = CH_2
(III) CH_3 - CH = CH - CH_2 - CH = CH_2

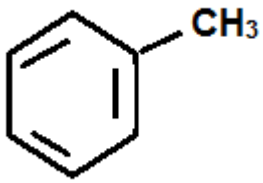
Answer :
$ʎ_{max}$ of (II) is longer than (I) due to increase in double bonds and also Ɛ increases in (II) due to conjugation while (III) has larger Ɛ than (I) but both have similar $ʎ_{max}$ because there is no conjugation .

Question 41.

Compare the following compounds regarding $ʎ_{max}$ and molar absorptivity Ɛ ?



(I)



(II)

Answer :

(I) has a longer wavelength because it contains free non-bonding electrons .

Question 42.

Compare the following compounds regarding λ_{max} and molar absorptivity Ɛ ?

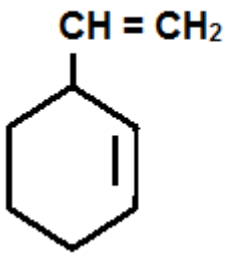
a) $CH_2 = CHCO_2H$, b) $CH_3 – CH_2CO_2H$

Answer :

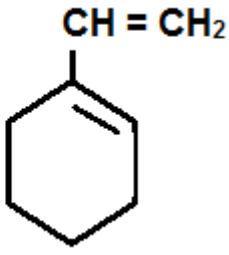
a) has longer wavelength and larger Ɛ because it contains one more double bond .

Question 43.

Compare the following compounds regarding λ_{max} ?



(I)



(II)

Answer :

(II) has longer wavelength than (I) due to conjugation .

QUESTIONS IN MOLECULAR LUMINSCENCE SPECTROSCOPY

Question 1 .

What are the advantages and disadvantages of fluorescence spectroscopy over molecular absorption spectroscopy?

Question 2.

Which of the following statements about fluorometry are true?

A. A compound is said to fluoresce when it absorbs light at one wavelength and emits light at a second wave length

B. Detectors in fluorometers are placed 180 degrees from the excitation source

C. It is less sensitive than spectrophotometry

Question 3.

Distinguish different types of molecular luminescence ?

Question 4.

Compare fluorescence spectroscopy to UV / Vis molecular absorption spectroscopy?

Question 5.

What are the effects of substitution on fluorescence ?

Question 6.

In fluorometry, the emission radiation could be:

A. Equal to excitation radiation

B. Longer wavelength than the excitation radiation

C. Shorter wavelength than the excitation radiation

D. More energetic than the excitation radiation

Question 7.

Which of the following statements best defines Luminescence?

A. The emission of light by a substance after absorption of radiation .

B. Emission of light due to a chemical reaction or the absorption of radiation

C. This light is absorbed by the ground state atoms

D. Emission of light requiring a light source

Question 8.

Which of the following analytical systems does not require a light source?

A. Atomic absorption

B. Spectrophotometry

C. Spectrofluorometry

D. Chemiluminescence

Question 9.

Which one of the following is true ?

A. Fluoroescence intensity is directly proportional to molar absorptivity and inversely related to fluorescence efficiency

B. Fluorescence intensity is directly related to the amount of emitted light

C. Fluorescence intensity is inversely proportional to concentration

D. Flourescence intensity decreases as molar absorptivity increases

Question 10.

Two monochromators positioned at right angles is a chracteristic of which instrument?

A. Flame photometer

B. Atomic Absorption Spectrophotometer

C. Fluorimeter

D. Colorimeter

Question 11.

Standard addition techniques are used to -

(a) compensate for the sample matrix (b) obtain calibration curves (c) measure the spectrum of mixtures(d) calculate the average of a measurement.

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A fluorescence spectrum is obtained by -

(a) holding the emission wavelength constant while scanning the excitation wavelength.

(b) holding the excitation wavelength constant while scanning the emission wavelength.

(c) essentially the same as the absorbance spectrum.

(d) collecting the fluorescence at 90 ^{o} to the sample.

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Phosphorescence lifetimes are -

(a) shorter than fluorescence lifetimes

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Intersystem crossing refers to -

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Triplet states have

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What is the difference between fluorescence and phosphorescence ?

Question 17.

Which ones describe general properties of the emitted light ?

- The emitted light usually has a longer wavelength, and therefore lower energy, than the absorbed radiation.
- Fluorescence occurs when an orbital electron of a molecule or atom relaxes to its ground state by emitting a photon of light after being excited to a higher quantum state by some type of energy.
- In a phosphorescence, excitation of electrons to a higher state is accompanied with the change of a spin state. Relaxation is a slow process since it involves energy state transitions "forbidden" in quantum mechanics.
- All of the above statements .

Question 18.

Draw a block diagram of a spectrofluorometer ?

Question 19.

What is the difference between a singlet and a triplet state?

Question 20.

In fluorescence spectroscopy :

- The emitted photon has (longer , shorter , equal) wavelength than the absorbed photon .
- The emitted photon has (lower , higher , equal) energy than the absorbed photon.
- the absorbed photon is in the (X-ray, UV-Vis, IR, microwave,) region .

Question 21.

Which lamp is commonly used in fluorescence?

(a) hollow cathode (b) D_2 (c) H_2 (d) xenon lamp .

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Which molecule is most likely to have the largest fluorescence quantum yield?

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What is the difference between photoluminescence and chemiluminescence ?

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2- the quantum efficiency ϕ .

3- the intensity of the radiation used for excitation P^0 (source radiation) .

4 - Fluorescence depend on all the mentioned factors 1-3

Question 30.

Give examples to prove that fluorescence is favored in molecules that possess rigid structure ?

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List factors affecting fluorescence intensity ?

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If the analyte does not exhibit fluorescence how it can be determined by fluorometry ?

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Quenching:

A. Causes nonlinearity of a reaction response that occurs when the absorbance of a solution increases to greater than 2% of the exciting light
B. Involves fluorophores with small stokes shifts that have overlapping excitation and emission spectra and are susceptible to loss of detection because of background light

scatter

C. Is related to the interaction of a fluorophore with a solvent or with a solute dissolved in the solvent that might result in a loss of fluorescence owing to energy transfer

ANSWERS OF QUESTIONS IN MOLECULAR LUMINSCENCE SPECTROSCOPY

Question 1 .

What are the advantages and disadvantages of fluorescence spectroscopy over molecular absorption spectroscopy?

Advantages :

a) Fluorescence spectroscopy is more sensitive than absorption spectroscopy because

1. If you increase the power of the lamp (or light source), then fluorescence will increase, while absorption will stay the same.
2. Fluorescence has a dark background and will show up better if there is a slight change than absorption will.

Fluorescence is more selective because the compounds that fluoresce less than those absorb.

b) larger linear concentration range .

Disadvantages :

1- analytes have to be very pure due to high sensitivity .

2- only comparatively few molecules exhibit fluorescence .

Question 2.

Which of the following statements about fluorometry are true?

A. A compound is said to fluoresce when it absorbs light at one wavelength and emits light at a second wave length

B. Detectors in fluorometers are placed 180 degrees from the excitation source

C. It is less sensitive than spectrophotometry

Question 3.

Distinguish different types of molecular luminescence ?

Answer :

Fluorescence: excitation by absorption of photon, short-lived excited state (singlet), emission of photon.

Phosphorescence: excitation by absorption of photon, long-lived excited state (triplet), emission of photon.
These two types are called photoluminescence where molecules are excited by absorption of electromagnetic radiation
Chemiluminescence: no excitation source – chemical reaction energy to excite molecule which emit radiation .

Question 4.

Compare fluorescence spectroscopy to UV / Vis molecular absorption spectroscopy?

Answer :

The advantages of fluorescence spectroscopy over UV / Vis molecular absorption spectroscopy are :

- More sensitive .
- More selective .
- Has a wider linear range .

Question 5.

What are the effects of substitution on fluorescence ?

Answer :

- heavy atom effect (decreases)
- electron donating substituent - increase
- electron withdrawing – kills fluorescence
- n-π* generally no good

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In fluorometry, the emission radiation could be:

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B. Longer wavelength than the excitation radiation
C. Shorter wavelength than the excitation radiation
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Answer :

Fluorescence arises from the transition of an electron from an excited singlet to the ground singlet state S_0 while phosphorescence results from electron transition from an excited triplet state to the ground singlet state S_0 .

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Which ones describe general properties of the emitted light ?

- The emitted light usually has a longer wavelength, and therefore lower energy, than the absorbed radiation.
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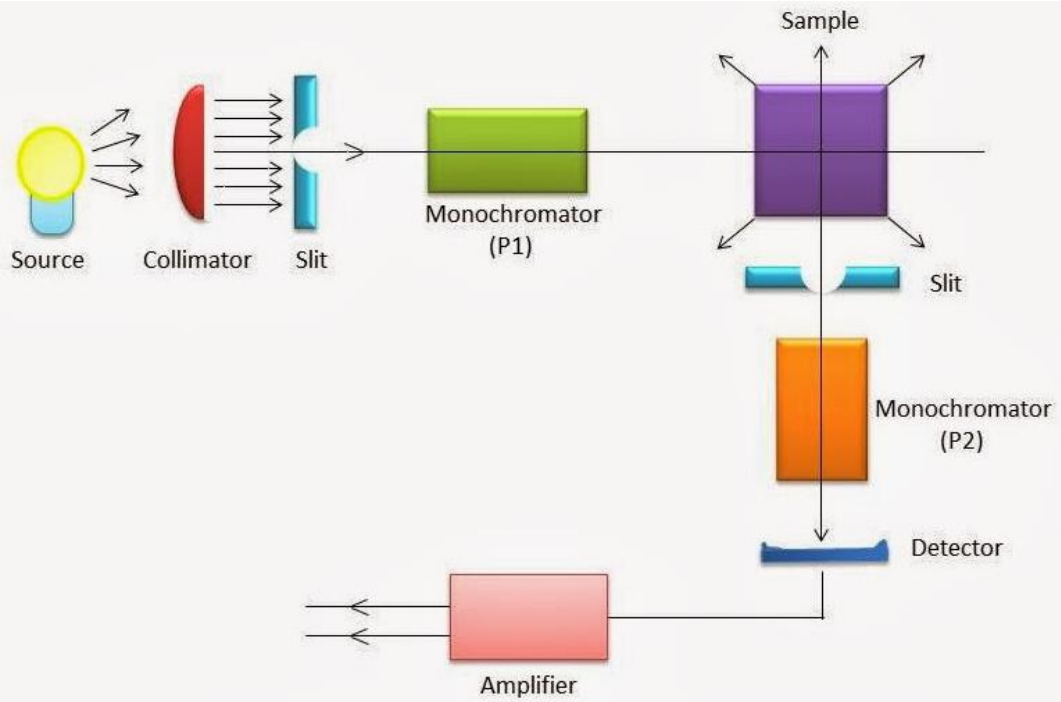

Question 19.

What is the difference between a singlet and a triplet state?

Answer :

- The life time of an electron in the excited state is shorter than that in triplet state .

- The energy of triplet state is lower than the corresponding singlet state .

- The non-radiative transitions in triplet is more than in singlet .

- The electron to transfer from singlet to triplet or vice versa must change it's spin .

Question 20.

In fluorescence spectroscopy :

- The emitted photon has (longer , shorter , equal) wavelength than the absorbed photon .
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Which lamp is commonly used in fluorescence?

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(d) xenon lamp .

Question 22.

Which molecule is most likely to have the largest fluorescence quantum yield?

Answer :

The more rigid the structure of the molecule the more the intensity the fluorescence .

Question 23

What is the difference between photoluminescence and chemiluminescence ?

Answer :

In photoluminescence (i.e. fluorescence and phosphorescence) the excitation of the electrons is the result of absorption of EM radiation while in chemiluminescence it is the result of a chemical reaction .

Question 24.

What is the difference between excitation spectrum and fluorescence spectrum ? Which one of the two resembles the absorption spectrum ?

Answer :

For scanning an excitation spectrum λ_{em} of emission (fluorescence) is kept constant and the fluorescence is measured while varying λ_{ex} , for the emission (fluorescence) spectrum it is the other way round λ_{ex} is kept constant while varying λ_{em} . The excitation spectrum resembles the absorption spectrum .

Question 25.

When quantum efficiency ϕ is high , the sensitivity of fluorescence is high . True or false ?

Question 26.

Why λ_{ex} is longer than λ_{em} ?

Due to non-radiation transitions .

Question 27.

Make a sketch showing fluorescence , absorption and phosphorescence on a single spectrum ?

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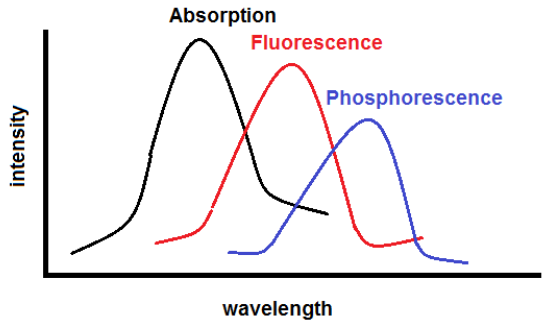

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Which is emitted at longer wavelength , fluorescence or phosphorescence ? Why ?

Answer :

Phosphorescence ʎ(T_1 → S_0) is longer than fluorescence ʎ (S_1 → S_0) because triplet state is of less energy than the respective singlet state and because non-radiation transitions in triplet state is more likely than singlet state .

Question 29.

Does fluorescence intensity of a compound depend on :

1- the molar absorptivity Ɛ at $ʎ_{ex}$.

2- the quantum efficiency ϕ .

3- the intensity of the radiation used for excitation P^0 (source radiation) .

4- Fluorescence depend on all the mentioned factors 1-3

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Give examples to prove that fluorescence is favored in molecules that possess rigid structure ?

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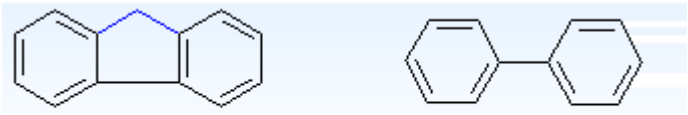

fluoren biphenyl

ϕ = 1.0 **ϕ = 0.2**

This is a result of the increased rigidity by bridging methylene group in fluorene .

Question 31 .

List factors affecting fluorescence intensity ?

Answer :

Quenching , Temperature , pH , Conjugation , rigidity of structure and solvent .

Question 32 .

If the analyte does not exhibit fluorescence how it can be determined by fluorometry ?

Answer :

In order to determine a non-fluorescent analyte by fluorimetry we need a fluorophore for being linked to the analyte or another non-fluorescent molecule yielding a fluorescent compound upon reacting with the analyte .

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Quenching:

A. Causes nonlinearity of a reaction response that occurs when the absorbance of a solution increases to greater than 2% of the exciting light
B. Involves fluorophores with small stokes shifts that have overlapping excitation and emission spectra and are susceptible to loss of detection because of background light scatter
C. Is related to the interaction of a fluorophore with a solvent or with a solute dissolved in the solvent that might result in a loss of fluorescence owing to energy transfer

QUESTIONS ABOUT MOLECULAR SCATTERING METHODS

Question 1.

Which one of the following statements concerning turbidimetry is true?

A. It is the measure of the concentration of particles by measuring the amount of incident light absorbed by the particles
B. In a turbidimetric procedure, the measurement of light is made at right angles to the incident light
C. The intensity of the scattered light is inversely proportional to the number of particles in solution
D. In a turbidimetric measurement, light scattered by particles in the solution is measured at 180 degrees from the incident light

Question 2.

Raman spectra can be plagued with a large background because of :

(a) the interference of water
(b) dissolved gases like O_2 and N_2
(c) fluorescence of the analyte
(d) inelastic photon scattering

Question 3.

The amount of Rayleigh scattering that occurs to a beam of light is dependent upon?

A. The size of the particles and wavelength of the light
B. The size of particles, wavelength, and concentration
C. Size of particle and temperature

Question 4.
What is the difference between elastic and inelastic scattering ?

Question 5.
What is Rayleigh scattering ?

Question 6.
How you differentiate between stokes and anti-stokes Raman scattering ?

Question 7.
Make a comparison between nephelometry and turbidimetry ?

Question 8

Make a sketch to the instrument for each of nephelometry and turbidimetry ?

ANSWERS OF QUESTIONS ABOUT MOLECULAR SCATTERING METHODS

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A. The size of the particles and wavelength of the light
B. The size of particles, wavelength, and concentration
C. Size of particle and temperature

Question 4.
What is the difference between elastic and inelastic scattering ?

Answer :

elastic scattering, is the scattered radiation of the same energy (wavelength) as the incident radiation, and inelastic scattering, is the scattered radiation which has higher or lower energy than the incident radiation.

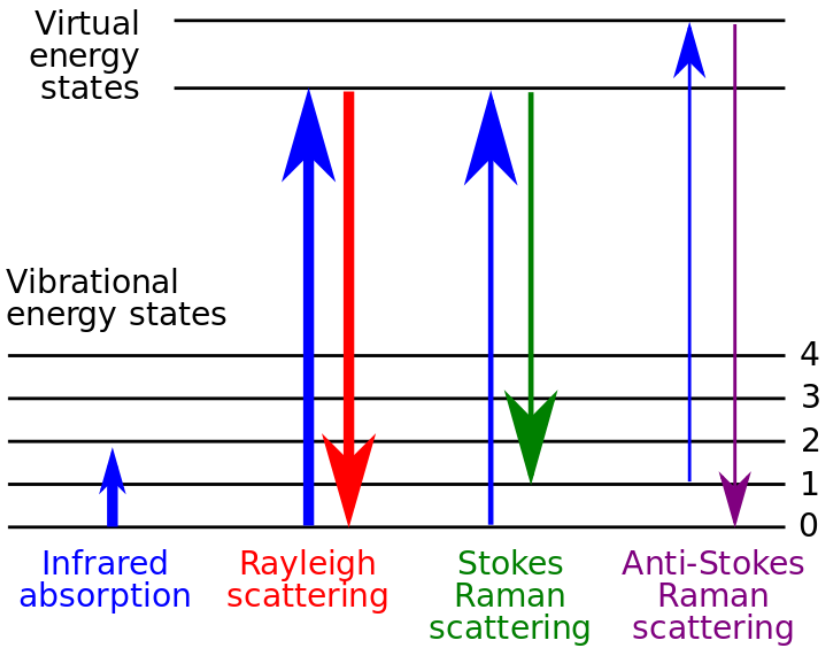
Question 5.
What is Rayleigh scattering ?

Answer :

It is the scattered radiation of the same energy (wavelength) as the incident radiation .

Question 6.
How you differentiate between stokes and anti-stokes Raman scattering ?

Answer :



Question 7.

Make a comparison between nephelometry and turbidimetry ?

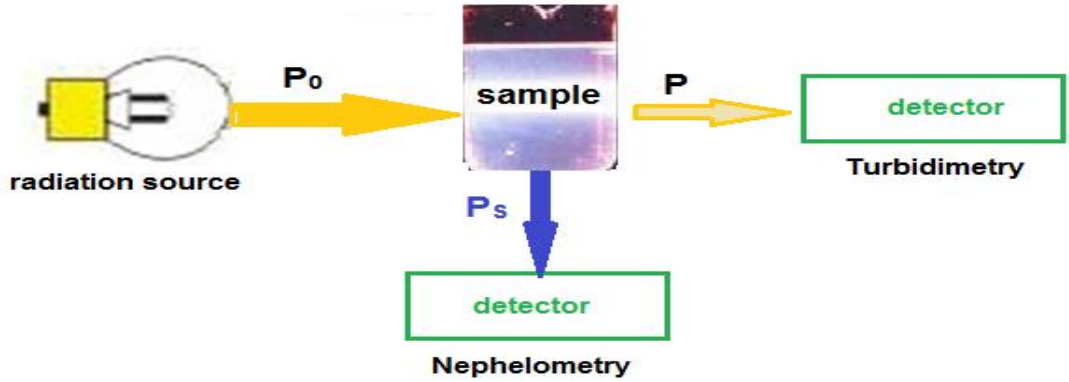
Answer :

	Nephlometer	Turbidimeter
Definition Instrument used	the measurement of the intensity of scattered light at right angles to the direction of the incident light as a function of the concentration of the dispersed phase ,It is most sensitive for very dilute suspensions (100 mg/L). Nephlometery machine	Light passing through a medium with dispersed particles, so the intensity of light transmitted is measured. spectrophotometer
Type of light measured	Scattered light	Transmitted light
Arrangement of photometer	measure the light scattered at right angle to the direction of the propagation of light from the source. It could be movable detectors which allow operator to vary the angle of detection	made in the same direction as the propagation of the light from the source.
Applications	Clinical uses inorganic cations and anions clarity of water and food products	Clinical uses Inorganic cations and anions clarity of water and food products

Question 8

Make a sketch to the instrument for each of nephelometry and turbidimetry ?

Answer :


P0
sample
P
detector
Turbidimetry
radiation source
Ps
detector
Nephelometry

QUESTIONS ABOUT FLAME ATOMIC EMISSION SPECTROMETRY (FAES)

Question 1.

In flame atomization, what is an important factor when deciding on a fuel and oxidant for the flame?

Question 2.

Interference resulting when two or more elements have emission spectra in adjacent or overlapping wavelengths is referred to as:

A. Self-absorption
B. Cationic Interference
C. Ionization Interference
D. Spectral Interference

Question 3.

In flame emission photometry, a photon of light with a wavelength specific for a given element is emitted when:

A. An orbital electron is raised to a higher energy state by incident light
B. The bonds of the molecule vibrate and release light
C. Thermal energy is absorbed by orbital electrons to a higher energy state and release energy when the orbital electrons return to the ground state
D. The element absorbs ultraviolet radiation and release energy at longer wavelengths

Question 4.

Interferences in FAES . Match the following

Name of interferences	Description of interference	Elimination of interference
1- spectral	…..… Formation of thermally stable compounds	….. viscosity and surface tension should be the same for sample and standards solutions .
2- chemical	…..… two elements having lines very near to each other .	…..… add K or Cs into sample and standards solution .
3- ionization	…..…The properties of sample solution different from standards solutions.	…..… add La or EDTA into sample and standards solution .
4- physical	…….Occur in hot flames with metals having low excitation potential .	…..… use another wavelength even if it is less sensitive .

Question 5.

FAES is used mainly for the analysis of …

1- most elements .

2- only heavy metals .

3- nonmetals .

4- easily excited elements .

Question 6.

The temperature of flame depends on …

1- The types of nebulizer and burner used .

2- The types of fuel and oxidant and their ration .

3- The type of analyte .

4- All of these factors .

Question 7.

FAE Spectrophotometer components are in the following order …

1- Nebulizer next burner next monochromator next detector finally computer .

2- Burner next nebulizer next monochromator next detector finally computer.

3- Burner next nebulizer next monochromator next computer finally detector.

4- Nebulizer next burner next monochromator next computer finally detector.

Question 8.

What are the differences between total consumption burner (1) and pre-mixed burner (2)

But (1) or (2) in the appropriate space :

…….use less sample solution .

…….gases mixture that their combustion velocity more than their flow rate cannot be used.

……. large droplets reach the flame.

……. only small droplets reach the flame .

……. gases mixed before reaching the flame .

……. gases mixed in the flame .

Question 9.

An atom emits a photon when one of its orbital electrons

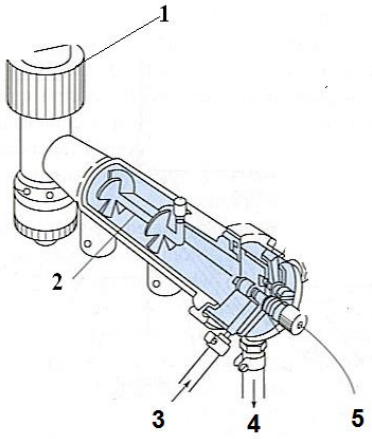
1- jumps from a higher to a lower energy level.

2- drops from a higher to a lower energy level.

3- struck by x-rays .

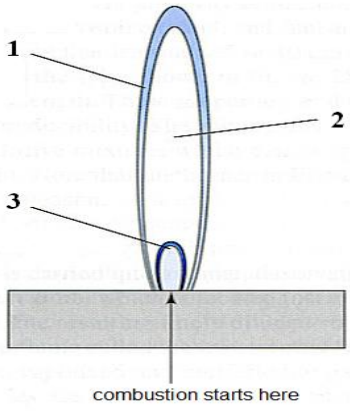
Question 10.

Label the following numbered components of a pre-mixed burner?



Question 11.

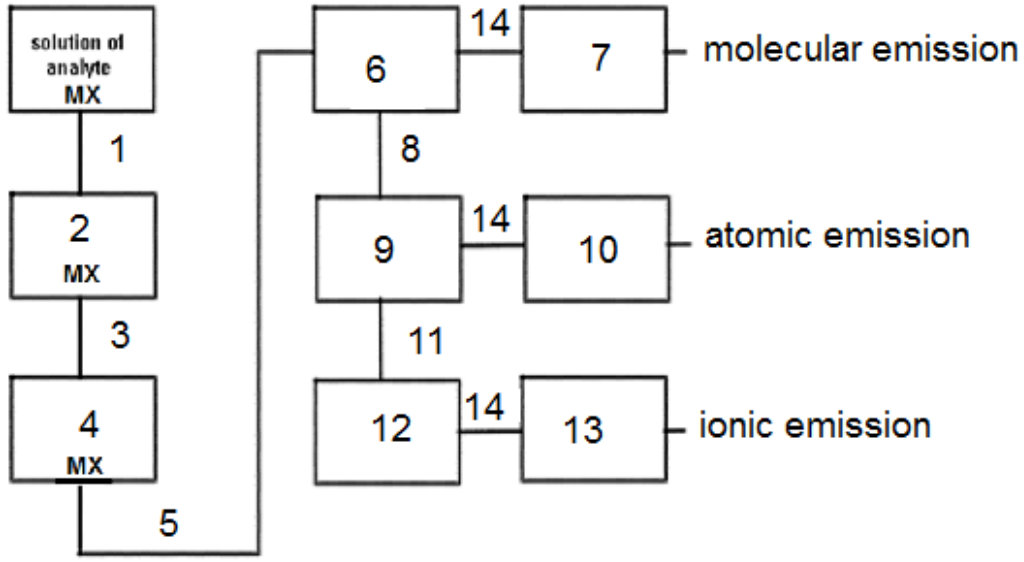
Name the three important parts of a flame labeled below and describe each part?



Question 12.

what hapens to the analyte solution MX in the flame ?

replace the numbers with what you thik they mean



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Which is the correct order of events in the process of atomization?

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(c) desolvation – atomization - volatilization - nebulization

(d) nebulization - volatilization – desolvation - atomization

Question 14.

Define Atomic Emission and flame atomization ?

Question 15.

Define the following terms : Nebulization , Pneumatic Nebulizer , Desolvation , Volatilization , Atomization ?

Question 16.

What is the percentage of the ground state atoms in the flame that can be excited by the flame ?

a) 50 % , b) 20 % , c) more than 10% , d) less than 5%

Question 17.

What are the main differences between FAES , ICP , arc spark emission , AFS and AFS ?

Question 18.

Draw a sketch for the FAES instrument ?

Question 19.

Which ones are true about the Mechanism of the atomic excitation in the flame :

a. by collision with flame constituents .
b. through internal conversion with other excited species
c. by chemiluminescence .
d. all the above statements .

Question 20 :

What are the differences between molecular emission (ME) and atomic emission (AE) ?

ANSWERS OF QUESTIONS ABOUT FLAME ATOMIC EMISSION SPECTROMETRY (FAES)

Question 1.

In flame atomization, what is an important factor when deciding on a fuel and oxidant for the flame?

Answer :

What type of fuel and oxidant you decide to use is important because the type of fuel and oxidant used decides the range of temperature that the flame will be.

Question 2.

Interference resulting when two or more elements have emission spectra in adjacent or overlapping wavelengths is referred to as:

A. Self-absorption
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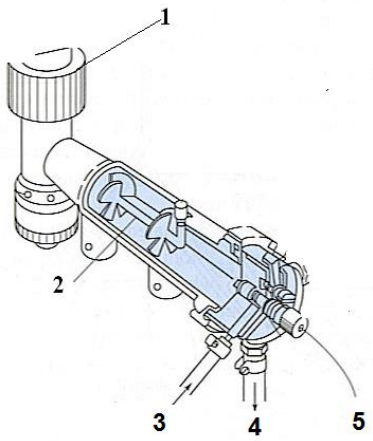


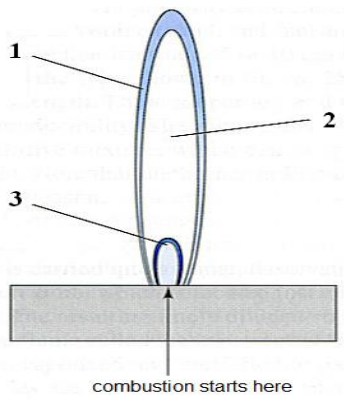
Answer :

1- burner. 2- nebulizer. 3- fuel. 4- oxidant. 5- sample solution .

Question 11.

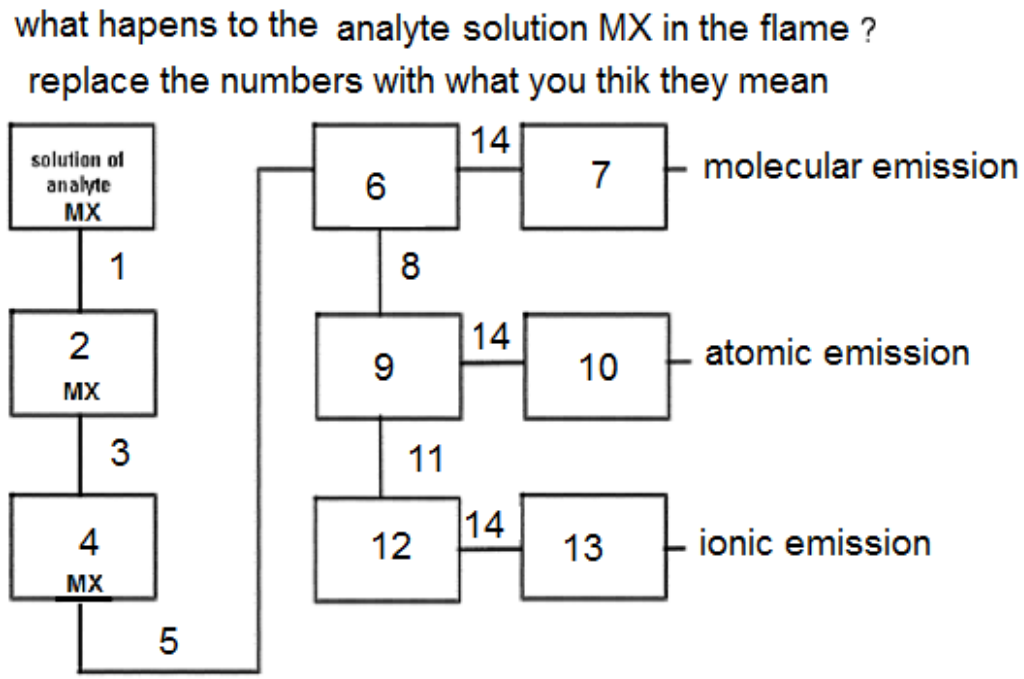
Name the three important parts of a flame labeled below and describe each part?

Answer :



1- Primary combustion zone : high background emission .
2- Interzonal region : low background emission and hotest part of flame , suitable for measuring emission .
3- Secondary combustion zone : high background emission not suitable for measuring emission .

Question 12.



1 – nebulization 2- mist 3- desolvation 4- solid 5- volatilization 6- gaseous molecules MX(g) 7- excited molecules MX^* 8- dissociation 9- atoms M^0
10- excited atoms M^* 11- ionization 12- ions M^+ 13- . excited ions M^{+*} 14- excitation

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Which is the correct order of events in the process of atomization?

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(c) desolvation – atomization - volatilization - nebulization

(d) nebulization - volatilization – desolvation - atomization

Question 14.

Define Atomic Emission and flame atomization ?

Answer :

Atomic emission : Energy from some external process raises atoms into a spectroscopically excited state. The excited state atoms themselves then act as a source, re-emitting radiation as they decay back to the ground state.

Flame Atomization: The process that breaks down the gaseous molecules into its constituent atoms.by burning in a flame.

Question 15.

Define the following terms : Nebulization , Pneumatic Nebulizer , Desolvation , Volatilization , Atomization ?

Nebulization : The process of converting a liquid sample into a fine spray mist of tiny droplets.

Pneumatic Nebulizer : A device that uses the flow of gas past the orifice of an capillary tube of small diameter; gas flow pulls the liquid from the capillary into the gas phase due to the reduced pressure (Venturi effect); surface tension of

the liquid causes the column of liquid exiting the capillary to break apart into droplets.

Desolvation : The process that evaporates the solvent leaving a solid/gas aerosol.

Volatilization : The process that vaporizes the aerosol gas leaving behind gaseous molecules.

Question 16.

What is the percentage of the ground state atoms in the flame that can be excited by the flame ?

a) 50 % , b) 20 % , c) more than 10% , d) less than 5%

Question 17.

What are the main differences between FAES , ICP , arc spark emission , AFS and AFS ?

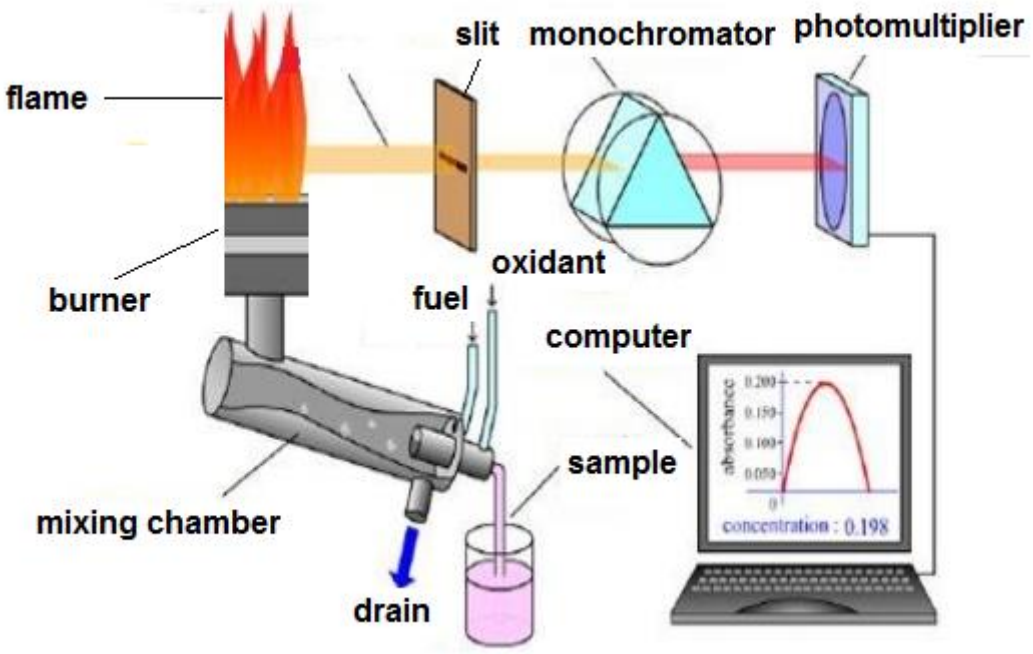
Answer :

	FAES	**ICP**	**arc spark**	**AFS**	**AAS**
Atomization	flame	Electrical mean	Electrical mean	Flame or Electrical mean	Flame or Electrical mean
Excitation	flame	Electrical mean	Electrical mean	radiation	radiation
Measured signal	emission	emission	emission	emission	absorption
Application	Easily excited elements	Multi-element	Multi-element	Multi-element	Most elemnts

Question 18.

Draw a sketch for the FAES instrument ?

Answer :



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Question 20 :

What are the differences between molecular emission (ME) and atomic emission (AE) ?

Answer :

	ME	AE
Measured Species	Excited molecules in solution or in the gaseous phase	Excited atoms in the gaseous phase
spectrum	Band	Line
Transitions	Electronic , vibrational and rotational	Only electronic

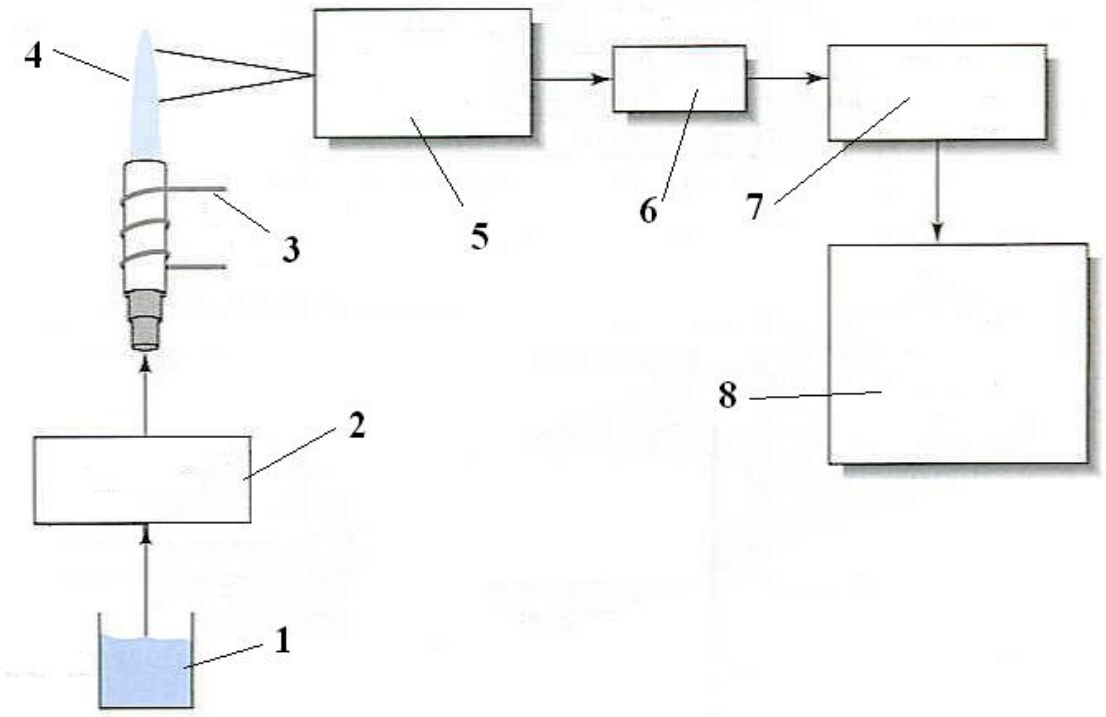
QUESTIONS ABOUT ATOMIC EMISSION SPECTROMETRY(ICP – AES)

Question 1 .

What is the difference between emission and absorption in an atom?
(a) In emission, the nucleus goes from a lower to a higher orbit.
(b) In emission, the nucleus goes from a lower to a higher orbit.
(c) In absorption, the electron goes from a lower to a higher orbit.
(d) Both (b) and (c) .

Question 2 .

Identify the numbered components associated with a typical ICP-AES spectrometer pictured below:



Question 3 .
What is a Plasma ?

Question 4 .
which techniques use electrothermal means to atomize and excite the analyte ?
1- ICP-AES and FAES .
2- AAS and ICP-AES.
3- ICP-AES and arc –spark spectrometry.

Question 5 .
Formation of oxides or molecular species in flame/plasma can be suppressed by:
a. EDTA or other complexing agents
b. Addition of KCl to the matrix
c. Addition of oxyanions such as sulfate or phosphate.
d. Standard

Question 6 .
Ionization of analyte atoms in flame/plasma can be suppressed by:
a. EDTA or other complexing agents
b. Addition of KCl to the matrix
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d. Internal standards methods.

Question 7 .
Compare inductively coupled plasma atomic emission spectrometry (ICP-AES) to flame atomic absorption spectroscopy (FAAS) in the following categories:

Quality	Technique	circle correct choice	Technique
Cost to buy / operate	ICP-AES is	higher, lower, equal cost than	FAAS
Simultaneous Multielement detection	ICP-AES is	more, less, equally competent than	FAAS
Dynamic Range	ICP-AES is	larger, smaller, equal dynamic range than	FAAS
Detection Limit	ICP-AES is	higher, lower, equal detection limits than	FAAS

Question 8 .

Compare Ar-plasma and air-C_2H_2 flames in the following categories:

Quality		circle correct	
Temperature	Ar-plasma has	higher lower equal temperature than	air-C_2H_2 flame.
Chemical reactivity	Ar-plasma has	higher lower equal reactivity than	air-C_2H_2 flame.
Formation of oxides	Ar-plasma has	higher lower equal likelihood than	air-C_2H_2 flame.
Atomization efficiency	Ar-plasma has	superior inferior equal to	air-C_2H_2 flame.

Question 9 .

Which technique generally has the most complete atomization?
(a) flame (b) graphite furnace (c) inductively coupled plasma

Question 10.

For each of the following, describe the adverse effect that's caused on ICP spectroscopy and how this effect is typically overcome.

a) physical interferences

b) chemical interferences

Question 11 .

Define Inductively Coupled Plasma (ICP)

Question 12 .

8) Atomic Emission Spectroscopy can analyze:

a) one element or ion at a time .

b) molecules, ions and elements.

c) 40 – 50 elements simultaneously .

d) only solid samples .

Question 13 .

Name 4 basic components of an ICP-AES Instrument ?

Question 14 .

List the main advantages of ICP-AES ?

Question 15 .

What are the differences between ICP-AES and AAS ?

Question 16 .

List some applications of ICP-AES ?

Question 17 .

What are the advantages of ICP compared to AAS ?

QUESTIONS ABOUT ATOMIC EMISSION SPECTROMETRY(ICP – AES)

Question 1 .

What is the difference between emission and absorption in an atom?
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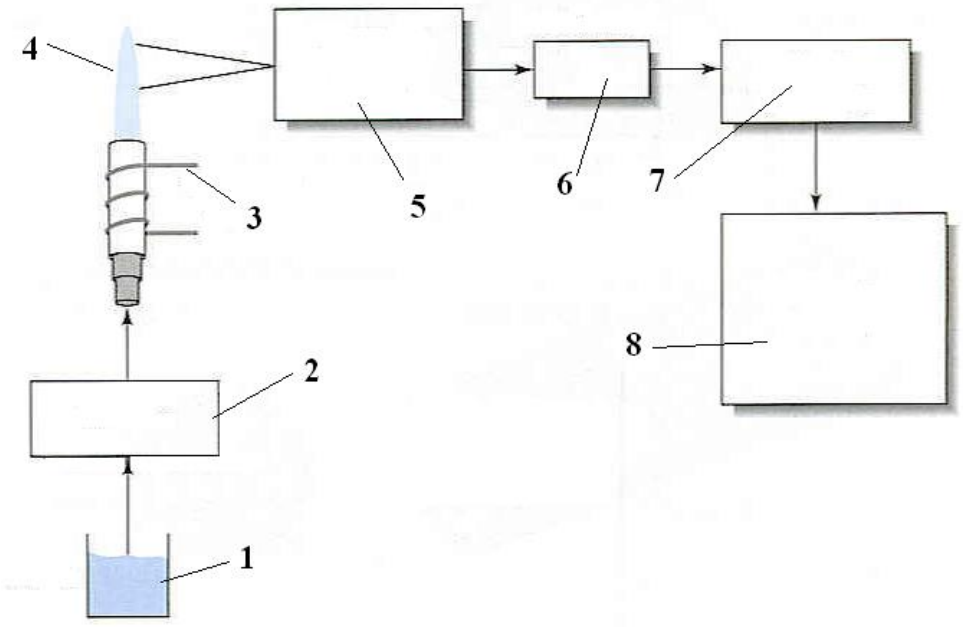

1- sample solution , 2- nebulizer , 3- torch coil , 4- plasma

5- monochromator , 6- detector , 7- microwprocessor , 8- data output .

Question 3 .
What is a Plasma ?

Answer :
It is an electrically conducting gaseous mixture containing a large concentration of cations and electrons with a net charge = 0; Ar is the usual gas used but O2 is also possible.

Question 4 .
which techniques use electrothermal means to atomize and excite the analyte ?
1- ICP-AES and FAES .
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Which technique generally has the most complete atomization?

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Question 10.

For each of the following, describe the adverse effect that's caused on ICP spectroscopy and how this effect is typically overcome.

b) physical interferences

b) chemical interferences

Question 11 .

Define Inductively Coupled Plasma (ICP) ?

Answer :

Name given when the power supply used to energize the plasma is a radiofrequency induction coil.

Question 12 .

8) Atomic Emission Spectroscopy can analyze:

a) one element or ion at a time .

b) molecules, ions and elements.

c) 40 – 50 elements simultaneously .

d) only solid samples .

Question 13 .

Name 4 basic components of an ICP-AES Instrument ?

Answer :

Sample delivery system - IC plasma - optical spectrometer - computer

Question 14 .

List the main advantages of ICP-AES ?

Answer :

1- simultaneous excitation of many elements.
2- Several atomic and ionic lines can be used .
3- Less chemical interferences due to very high temperature .
4- low background and high S/N ratio .
5- wide linear range .
6- elements that are difficult to be determined by AAS e.g. Zr , P and B, can be easily determined by ICP-AES .

Question 15 .

What are the differences between ICP-AES and AAS ?

Answer :

The basic difference between the two techniques is that AAS relies upon an atomic absorption process while ICP=AES is an atomic/ionic emission spectroscopic technique. The next essential difference is the means by which the atomic or ionic species are generated. A combustion flame or graphite furnace is typically used for AAS while ICP-AES uses a plasma.

Non metals such as sulfur, nitrogen, carbon, and the halogens (e.g. I, Cl, Br) can only be determined by ICP-AES not by AAS.

Question 16 .

List some applications of ICP-AES ?

Answer :

Trace elements in a wide variety of aqueous matrices: drinking water, river, lake and ground water, waste water and effluent, and seawater.

Trace elements in solids after digestion: sediment, soil, sludge, road dust, air particulate matter, plant tissue and grain, rocks and minerals, etc.

Trace elements in samples of body fluids, including blood, plasma, and urine.

Question 17 .

What are the advantages of ICP compared to AAS ?

Answer :

AAS vs ICP

- Inductively Coupled plasma (ICP) is newer method of atomic analysis which has less interferences problems.
- Have better capability for multi element analysis.
- Good for elements that tend to form refractories.
- ICP can also be used for non metal analysis such as Bromine, chlorine, iodine and sulfur.
- AAS is simpler and less expensive than ICP.
- ICP requires extensive sample pretreatment protocol.
- ICP high temperature allow complete atomization.
- Plasma measurement have greater linearity compared to AAS, this is due to the constant temperature which is not affected by the introduction of the sample. In AAS introduction of the sample leads to variation in temp. and creation of noises.
- Plasma technique offer less noise and low background interferences.

QUESTIONS ABOUT ATOMIC ABSORPTION SPECTROMETRY (AAS)

Question 1.

Define each of the following terms : **(** a) A releasing agent (b) A protective agent (c) An ionization suppressor (d) Atomization **(**e) A hollow cathode lamp **(**f) Sputtering , (g) Self-absorption **?**

Question 2.

What is spectral interferences and how it can be reduced ?

Question 3.

What is chemical interferences and how it can be reduced ?

Question 4.

What is a radiation buffer ?

Question 5.

Define Doppler broadening ?

Question 6.

What are the advantages of using electrothermal atomization over a flame in AAS ?

Question 7.

Describe a background correction technique employed for AAS?

Question 8.

What is the purpose of source modulation in AAS ?

Question 9.

What is the reason for the increased signal in presence of organic solvents such as ethanol ?

Question 10.

Explain the self-absorption that happens in HCL ?

Question 11.

Why AES is more affected by flame temperature than AAS ?

Question 12.

In the analysis of $MgCl_2$ solution by AAS , explain the processes that will happen during this analysis ?

Question 13.

Which of the following statements about atomic absorption is not true:

A. It requires that element to be measurement be brought to a non-ionized ground state
B. It uses a tungsten lamp as a light source
C. It uses a cathode made of the same element being measured
D. It measures the absorption of light

Question 14.

In atomic absorption spectroscopy, Which of the following statements is false:

A. Flame is used to excite the element to a higher energy state
B. A Hallow-Cathode Lamp with a cathode made of the element to be analyzed is used to produce a wavelength of light specific for the material
C. This light is absorbed by the ground state atoms in the flame

D. There is a net decrease in the intensity of the beam

Question 15.

Provide information on possible interference during measurements for the following methods AAS and ICP-AES ?

Question 16.

When an atom absorbs a photon of light, which of the following can happen?

(a) an electron shifts to a state of smaller quantum number.

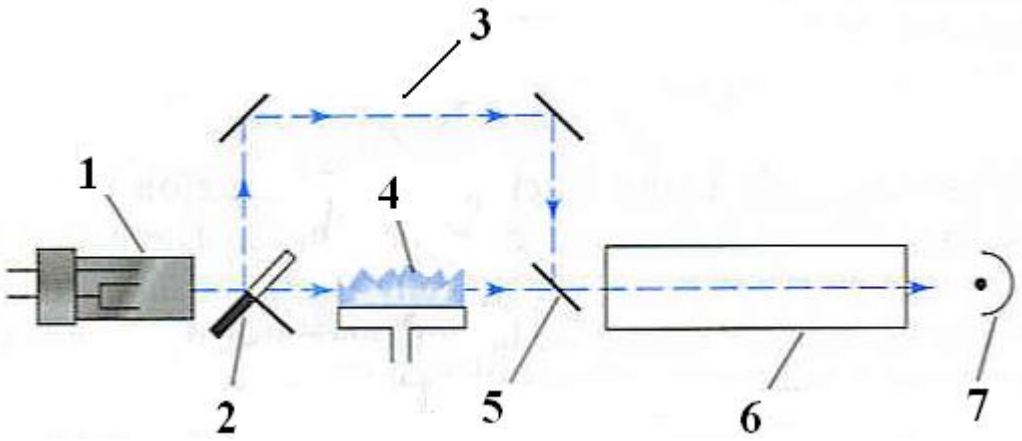
(b) an electron shifts to a state of higher quantum number.

(c) an electron is absorbed by the atom.

(d) an x-ray photon is emitted .

Question 17.

Identify the numbered components in the following figure of a double-beam atomic absorption spectrometer:



Question 18.

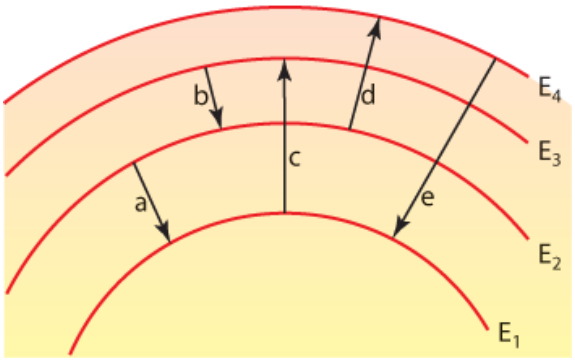
What do ETAAS , FAAS and FAES stand for?

Question 19.

In flame atomization, what is an important factor when deciding on a fuel and oxidant for the flame?

Question 20.

The diagram below shows possible transitions of electrons between energy levels in an atom of a particular element. Which transition would produce the line of shortest wavelength on the absorption spectrum of the element?



- Transition a
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Question 21.

It is important for the source lamp used in atomic absorption spectroscopy to -

(a) be independent of wavelength
(b) last a long time
(c) have a narrower linewidth than the sample absorption linewidth
(d) have a wider linewidth than the sample absorption linewidth.

Question 22.

In which part of the flame is atomic spectroscopy performed?

(a) primary combustion zone (b) interzonal region

(c) secondary combustion zone .

Question 23.

Which is the correct order of events in the process of atomization?

(a) nebulization - desolvation – volatilization

(b) volatilization - desolvation - nebulization

(c) desolvation - volatilization - nebulization

(d) nebulization - volatilization - desolvation

Question 24.

Compare Atomic Absorption Spectroscopy and Flame Atomic Emission Spectroscopy. What are differences in instrument design and how are the observed signals generated? Describe at least one disadvantage for each technique ?

Question 25.

Protecting agents in atomic spectroscopy are effective because they

a) lower the flame temperature

b) bind to analyte , to form volatile compound easily atomized.

c) form preferential compounds with interfering ions

d) produce an excess of electrons

Question 26.

Which of the following statements are true?

1. An excited atom can return to its ground state by absorbing radiation.
2. The energy of an atom is increased when electromagnetic radiation is emitted from it.
3. The energy of electromagnetic radiation increases as its frequency increases.
5. The frequency and wavelength of electromagnetic radiation are inversely proportional to each other.

Question 27.

Monochromatic light is defined as

A. The measurement of the intensity of light at selected wavelengths
B. Emission of light by molecules in an excited state produced by a chemical reaction or the absorption ionizing radiation
C. Electromagnetic radiation of one wavelength or extremely narrow wavelengths
D. Measurement of scattered light by suspended particles

Question 28.

Interference resulting when two or more elements have emission spectra in adjacent or overlapping wavelengths is referred to as:

A. Self-absorption
B. Cationic Interference
C. Ionization Interference
D. Spectral Interference

Question 29.

What is interference ?

a. the overlapping of two waves to create a new resultant wave.
b. the bending of light around a barrier .
c. the bending of light as it travels from one medium to another medium .
d. the change in direction of a wave as it strikes a surface .

Question 30.

Name and describe one factor that contributes to the widening of atomic spectral lines ?

Question 31.

Deuterium lamp cannot be used as a source in Atomic Absorption Spectroscopy because they:

a) provide a broad bandwidth of UV/Vis radiation .
b) provide rapid sample atomization
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Question 32.

A primary difference between UV/vis spectroscopy and Atomic Absorption spectroscopy is:

a) analytes must be aqueous soluble for UV/vis spectroscopy
b) AAS uses a hollow cathode lamp that emits IR radiation
c) a deuterium lamp is never used in UV/vis spectroscopy.
d) the sample is atomized in AAS prior to measuring an absorbance .

Question 33.

Describe the Hollow cathode lamp ?

Question 34.

Describe Electrothermal / Graphite
Furnace?

Question 35.

What is Ionization Interference and how it can be reduced ?

Question 36.

What do we mean with Matrix Effects ?

Question 37 .

Compare atomic absorption spectra with molecular absorption spectra ?

ANSWERS OF QUESTIONS ABOUT ATOMIC ABSORPTION SPECTROMETRY (AAS)

Question 1.

Define each of the following terms : **(** a) A releasing agent (b) A protective agent (c) An ionization suppressor (d) Atomization **(**e) A hollow cathode lamp **(**f) Sputtering , (g) Self-absorption **?**

Answer :

(a) **A releasing agent** is a cation that reacts preferentially with an anion to release the analyte. The releasing agent should form a compound of higher stability than that formed by the analyte.

(b) **A protective agent** is usually a ligand that reacts with the analyte forming a relatively volatile complex.

(c) **An ionization suppressor** is a salt of an alkali metal added to suppress ionization of an analyte. The alkali metal is easily ionized resulting in a flux of electrons which shift the ionization equilibrium of analyte towards formation of atoms.

(d) **Atomization** is the process whereby gaseous molecules will breakdown to form atoms.

(e) **A hollow cathode lamp** is the most common line source used in AAS. A HCL lamp is composed of a glass envelope (with a quartz window) encompassing a hollow cathode, covered with a layer of the metal of interest, and a wire anode. The lamp contains an inert gas like argon at low pressure.

(f) **Sputtering** is a process whereby energetic argon ions rapidly strike the hollow cathode surface thus releasing too many atoms from the cathode surface.

(g) **Self-absorption** is a process observed when a HCL lamp is operated at high currents where sputtering of a large number of atoms takes place. Most atoms do not get enough excitation energy in this process and thus absorb emitted radiation from

other excited atoms within the lamp. The result is a splitting of the atomic line where the center of the line would have a minimum exactly at the wavelength of the original line.

Question 2.

What is spectral interferences and how it can be reduced ?

Answer :

Type of interference in atomic spectroscopy due to unwanted absorption or emission from molecular species, or from closely overlapping spectral lines of two analytes; solutions include changing fuel gas, increasing T, using appropriate background correction, and decreasing the slit width.

Question 3.

What is chemical interferences and how it can be reduced ?

Answer :

Most common type of chemical interference in atomic spectroscopy where anions form compounds of low volatility and reduce the rate at which the analyte is atomized; typical for refractory oxide formation M + O ! MO; these interferences can be reduced by using a fuel rich flame to increase reducing species and restore free M atoms or by using a releasing agent e.g. La^{3+} or protecting agent e.g. EDTA .

Question 4.

What is a radiation buffer ?

Answer :

A radiation buffer is a substance added to both sample and standards in such a concentration that largely exceeds the concentration initially present in the sample. The reason for

addition of a radiation buffer is to make the interference from the initial substance in the sample insignificant since now a large excess is added to both sample and standards.

Question 5.

Define Doppler broadening ?

Answer :

Doppler broadening is a manifestation of the Doppler effect where a detector will see a higher frequency for a fast moving atoms towards it and will see a lower frequency for atoms moving away from it. Doppler broadening is a major reason for line broadening in atomic spectroscopy and is largely increased at higher temperatures.

Question 6.

What are the advantages of using electrothermal atomization over a flame in AAS ?

Answer :

a. Higher sensitivity and less chemical interferences due to the higher temperatures of electrothermal methods.

b. The residence time of atoms inside the graphite furnace is much longer than that in flames resulting in higher sensitivities due to longer exposure times.

c. less background emission and less physical interferences.

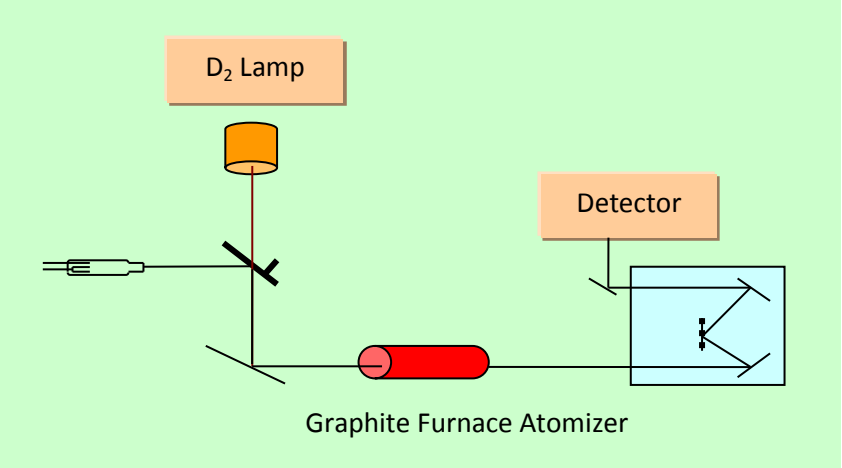
One of the disadvantages is lack of reproducibility .

Question 7.

Describe a background correction technique employed for AAS?

Answer :

In this technique, radiation from a deuterium lamp and a HCL lamp alternately pass through the graphite tube analyzer. It is essential to keep the slit width of the monochromator sufficiently wide in order to pass a wide bandwidth of the deuterium lamp radiation. In this case, the absorbance by analyte atoms is negligible and absorbance can be attributed to molecular species in matrix. The absorbance of the beam from the deuterium lamp is then subtracted from the analyte beam (HCL) and thus a background correction is obtained.



Question 8.

What is the purpose of source modulation in AAS ?

Answer :

Source modulation is used in atomic absorption spectroscopy in order to overcome the problems due to emission in flames resulting from impurities in fuel as well as burner head .

Question 9.

What is the reason for the increased signal in presence of organic solvents such as ethanol ?

Answer :

Increased nebulization rate due to lower surface tension in presence of ethanol which produces smaller droplets.

Question 10.

Explain the self-absorption that happens in HCL ?

Answer :

Self-absorption is a process observed when a HCL lamp is operated at high currents where sputtering of a large number of atoms takes place. Most atoms do not get enough excitation energy in this process and thus absorb emitted radiation from other excited atoms within the lamp. The result is a splitting of the atomic line where the center of the line would have a minimum exactly at the wavelength of the original line.

Question 11.

Why AES is more affected by flame temperature than AAS ?

Answer :

Atomic emission is the technique that will be severely affected by fluctuations in temperature since signal is dependent on the number of atoms in the excited state. This number is significantly affected by fluctuations in temperature as derived from the Boltzmann equation. However, in the case of atomic absorption, the signal depends on the number of atoms in ground state that will absorb energy. Always the number of atoms in ground state is very high as related to the number of excited atoms:

$N_j/N_o = 1.72x10^{-4}$
or
172 excited atoms for each 10^6 atoms in ground state

Question 12.

In the analysis of $MgCl_2$ solution by AAS , explain the processes that will happen during this analysis ?

Answer :

Initially, nebulization of the $MgCl_2$ will take place resulting in the formation of a spray of small sized droplets containing $MgCl_2$. Desolvation of the droplets in flame will render the spray into a solid aerosol of $MgCl_2$ particles. These particles will be converted to gaseous molecules of $MgCl_2$. The gaseous molecules will then be atomized giving Mg and Cl atoms. Mg atoms will then absorb energy from a HCL where absorbance can be measured.

Question 13.

Which of the following statements about atomic absorption is not true:

A. It requires that element to be measurement be brought to a non-ionized ground state
B. It uses a tungsten lamp as a light source
C. It uses a cathode made of the same element being measured
D. It measures the absorption of light

Question 14.

In atomic absorption spectroscopy, Which of the following statements is false:

A. Flame is used to excite the element to a higher energy state
B. A Hallow-Cathode Lamp with a cathode made of the element to be analyzed is used to produce a wavelength of light specific for the material
C. This light is absorbed by the ground state atoms in the flame

D. There is a net decrease in the intensity of the beam

Question 15.

Provide information on possible interference during measurements for the following methods AAS and ICP-AES ?

Answer :

AAS

Atomic absorption interferences can be divided into chemical and spectral interferences. Spectral interferences can arise from sample spectra overlap and scattering. Spectra overlap for different elements in a sample are not very common and can be correct by selection of a different transition. Scattering is due to formation of oxides in the flame during measurement. Chemical interference is more common and stems from the formation of compounds with low volatility, dissociation equilibria, or ionization equilibria. Additives such as EDTA can be used to decrease volatility by removal of the compounds.

ICP-AES

The main interference from AES comes from emission lines. In particular, Ar lines from the torch can cause interference.

Question 16.

When an atom absorbs a photon of light, which of the following can happen?

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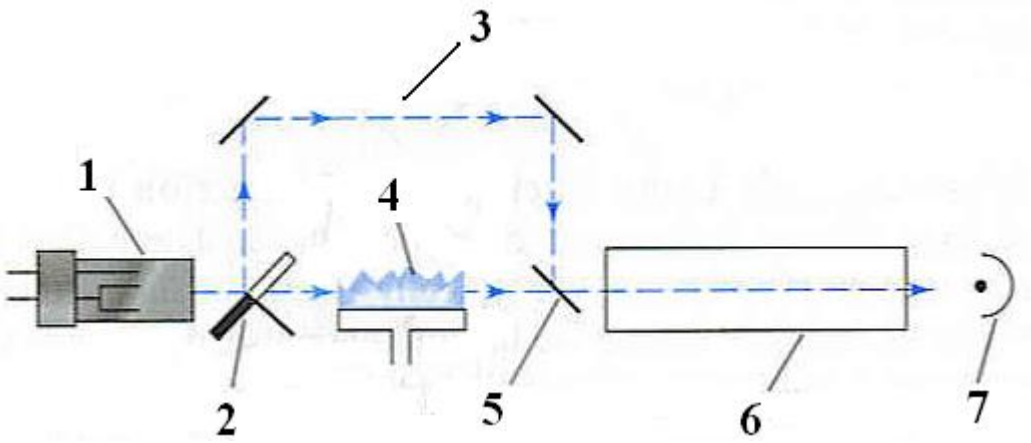

Answer :

1- HCL , 2- beam splitter , 3- P^0 , 4- flam , 5- beam collector , 6- detector , 7- readout .

Question 18.

What do ETAAS , FAAS and FAES stand for?

Answer :

ETAAS : ElectroThermal Atomic Absorption Spectrometry
FAAS : Flame Atomic Absorption Spectrometry .

FAES : Flame Atomic Emission Spectrometry .

Question 19.

In flame atomization, what is an important factor when deciding on a fuel and oxidant for the flame?

Answer :

What type of fuel and oxidant you decide to use is important because the type of fuel and oxidant used decides the range of temperature that the flame will be and also the ratio of fuel to oxidant .
-Flame background emission considerations .

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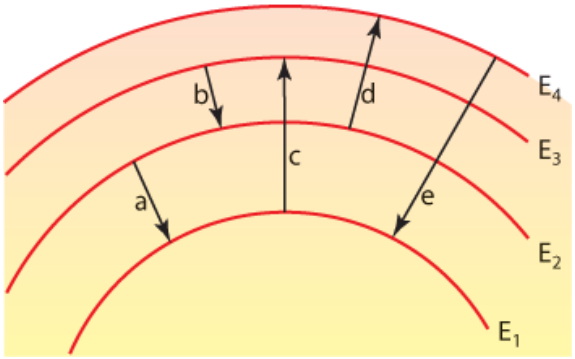
The diagram below shows possible transitions of electrons between energy levels in an atom of a particular element. Which transition would produce the line of shortest wavelength on the absorption spectrum of the element?



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Which is the correct order of events in the process of atomization?

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(b) volatilization - desolvation - nebulization
(c) desolvation - volatilization - nebulization
(d) nebulization - volatilization - desolvation

Question 24.

Compare Atomic Absorption Spectroscopy and Flame Atomic Emission Spectroscopy. What are differences in instrument design and how are the observed signals generated? Describe at least one disadvantage for each technique ?

Answer :

Atomic Absorption Spectroscopy

1) sample needs to be atomized before placing in light beam, use flame or electro thermal source
2) need light source with a narrow bandwidth for light output since use separate Hollow cathode lamp for each element
3) because of background (flame, molecules) need to modulate source using chopper, multiple lamps or magnetic field (Zeeman effect)

Flame Atomic Emission Spectroscopy

1) no external light source
2) need good temperature control to get reproducible signal
3) very similar to AA spectroscopy

For FAES, the observed signal is generated by the relaxation of excited atoms/ions in the flame. AAS is comparable to UV/vis spectroscopy. The signal is a result of the relative absorbance of light by the atom/ions in the flame over a range of frequencies

Disadvantage:

AAS – can only observe one element at a time.

FAES – lower sensitivity compared to AAS, only a small percentage of the atoms/ions are excited by the flame.

Question 25.

Protecting agents in atomic spectroscopy are effective because they

a) lower the flame temperature

b) bind to analyte , to form volatile compound easily atomized.

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d) produce an excess of electrons

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c. the bending of light as it travels from one medium to another medium .
d. the change in direction of a wave as it strikes a surface .

Question 30.

Name and describe one factor that contributes to the widening of atomic spectral lines ?

Answer :

Pressure (collision) broadening is a mechanism whereby atomic lines are broadened due to collisions, especially at high pressures. Broadening takes place since atoms of analyte in the ground states assume different energies due to collisions.

Question 31.

Deuterium lamp cannot be used as a source in Atomic Absorption Spectroscopy because they:

a) provide a broad bandwidth of UV/Vis radiation .
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c) a deuterium lamp is never used in UV/vis spectroscopy.
d) the sample is atomized in AAS prior to measuring an absorbance .

Question 33.

Describe the Hollow cathode lamp ?

Answer :

A typical narrow line source used in atomic absorption spectroscopy. An HCL consists of a anode and cathode sealed in a glass tube at low pressure (<30 torr); the cathode is constructed of the atomic element of interest; a potential voltage difference between the anode and cathode causes the atoms in the cathode to become excited; return of the excited state atoms back to the ground state leads to emission of radiation and produces atomic line spectra specific for the cathode element.

Question 34.

Describe Electrothermal / Graphite Furnace?

Answer :

Electrothermal / Graphite Furnace
Alternative to flame atomization methods. Electrothermal / graphite furnace consists of a cylindrical graphite tube equipped with optical windows at the ends; sample is added to the tube and dryed/ashed/atomized by electrical heating of the graphite tube to a final T ~3000 K.

Question 35.

What is Ionization Interference and how it can be reduced ?

Answer :

Type of chemical interference common in atomic spectroscopy at high T's especially with O_2 or N_2O as oxidant; the ion M^+ possesses a different electronic configuration than the neutral metal atom M and will interfere with the desired atomic absorption and emission processes; these interferences can be reduced by adding an ionization buffer (i.e. a more easily ionized species) to the sample to shift the ionization equilibrium away from M^+.

Question 36.

What do we mean with Matrix Effects ?

Answer :

Type of interference in atomic spectroscopy where the observed spectrum is negatively affected by sample constituents; usually worse for solid samples and can be severe in methods such as graphite furnace AA, DC arc, or AC spark sources; cause is usually variation of sample volatilization, atomization and

excitation. solutions include using closely matched standards and sample .

Question 37 .

Compare atomic absorption spectra with molecular absorption spectra ?

Answer :

Atomic absorption spectra	Molecular absorption spectra
1- The outer most electrons occupy one of the atomic orbitals .	The outer most electrons occupy σ, π or n electronic energy in the ground state.
2- Upon excitation electrons are promoted to any permissible higher atomic energy levels	Upon excitation electrons raised to π* or σ* energy levels
3-Since there are no bonds there are no vibrational or rotational energy levels in either the ground or excited state.	Since there are bonds, there are vibrational and rotational energy levels in both the ground and excited states
4- The analytical wavelength is the resonance wavelength of the analyte	The analytical wavelength is the λ_{max}.
5- The spectra are line form.	The spectra are in the form of bands due to the presence of very close, superimposed and unresolved vibrational and rotational energy levels in the the excited state.

QUESTIONS ABOUT ATOMIC FLUORESCENCE SPECTROMETRY (AFS)

Question 1 .

Draw a sketch for a spctrophotometr that can be used for both AAS and AFS ?

Question 2 .

what we mean with matrix effects ?

Question 3 .

what is AFS ?

1 -Re-emission of radiation by atoms that are excited by radiation .

2- Re-emission of radiation by atoms that are excited by graphite furnace.

3- Re-emission of radiation by atoms that are excited by flame .

Question 4.

Electrothermal / graphite furnace consists of a cylindrical graphite tube equipped with optical windows at the ends; sample is added to the tube and dried / ashed / atomized by electrical heating of the graphite tube to a final T ~3000 K.

True or false

Question 5.

continuous source background correction is Atomic spectroscopy background correction method using a continuum source (e.g. D2 lamp) in conjunction with a hollow cathode lamp line source; radiation from the HCL and D2 lamp is passes through a beam splitter or rotating chopper and the detector is

synchronized such that it detects each signal separately, A corrected = A sample – A background = A HCL – A D2.

True or false

Question 6.

Match the followings :

technique	description
AAS	..... atomization by flame or electrothermal mean , excitation by radiation and measuring emission .
AFS	..... atomization by flame or electrothermal mean , excitation by radiation and measuring absorption .
AES	..... atomization and excitation by electrothermal mean and measuring emission .
ICP	..... atomization and excitation by flame, and measuring emission .
Arc - Spark	..... atomization and excitation by plasma and measuring emission .

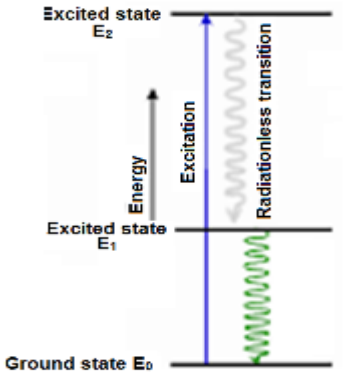
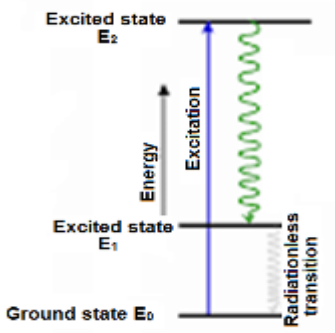
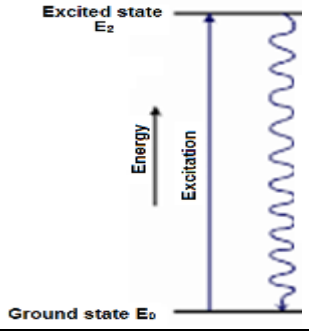
Question 7.

Why AFS is more sensitive than AAS ?

1- because in AFS we measure fluorescence at 90 C^0 while in AAS absorption at 180 C^0 from the incident beam .
2- because in AFS we use laser beam while in AAS we use HCL as a radiation source .
3- because in AFS we measure F for analyte and zero for blank while in AAS we measure P for analyte and P^0 for the blank .

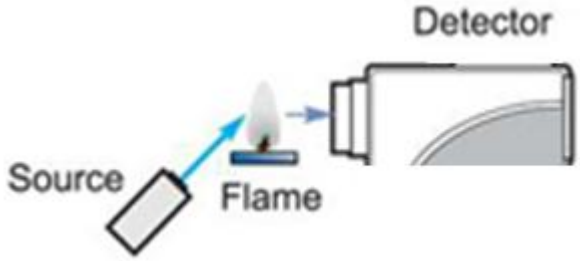
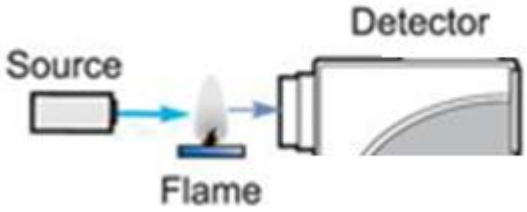
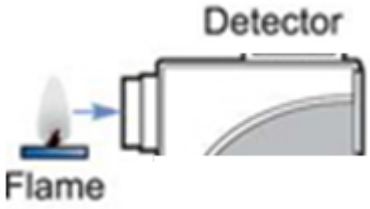
Question 8.

Match the followings :

Name of the fluorescence	description
1- Resonance fluorescence	
2- Stepwise fluorescence	
3- Direct line fluorescence	

Question 9.

Match the figure with the name of the technique :

Name of technique	Figure
AAS	
FAES	
AFS	

Question 10.

Match the followings

Atomic spectroscopic techniques	principles
1- AAS	…… The flame plays the role of atomization and excitation.
2- FAES	……. Use radiation source and flame or graphite furnace for the atomization .it measures absorption .
3- AFS	…… use electrical means as atomization and excitation
4- ICP	……. Use radiation source and flame or graphite furnace for the atomization .it measures emission .

Question 11.

What are the differences between atomic absorption and atomic fluorescence ?.

Question 12.

Standards addition is a commonly used method in many practical analyses.
Discuss when an analyst would choose a standards addition instead of a standard calibration curve method ?

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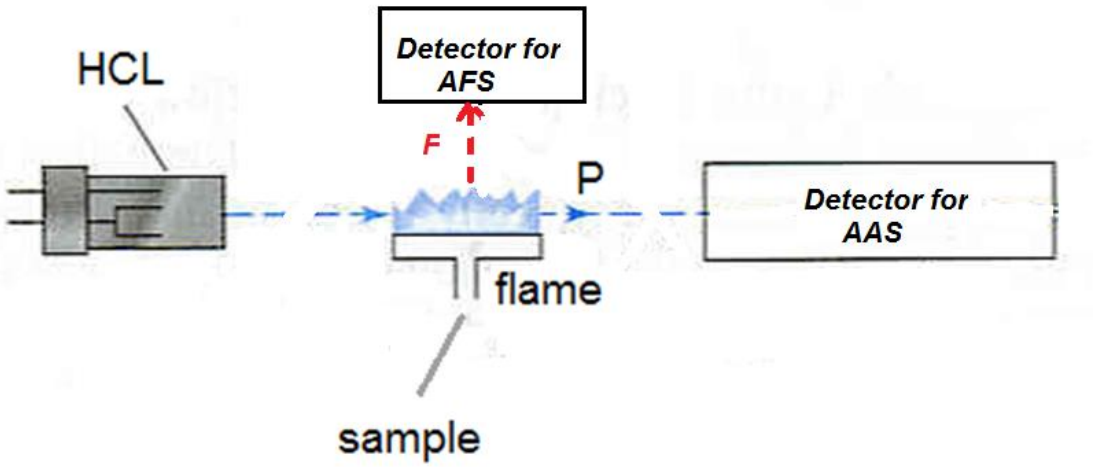

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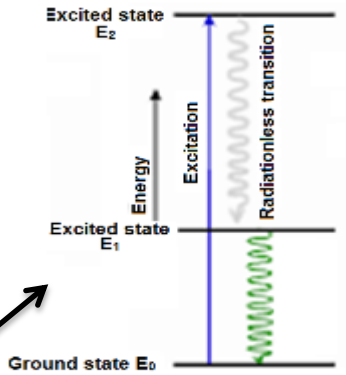
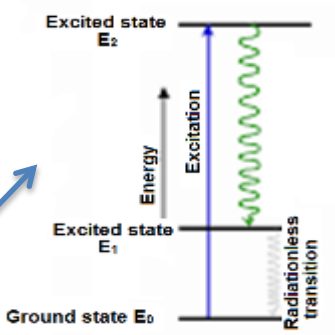
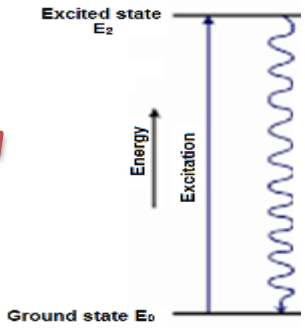
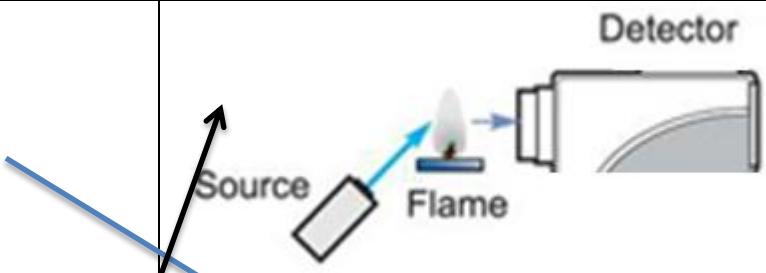
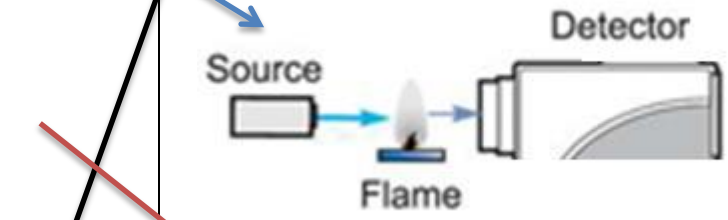
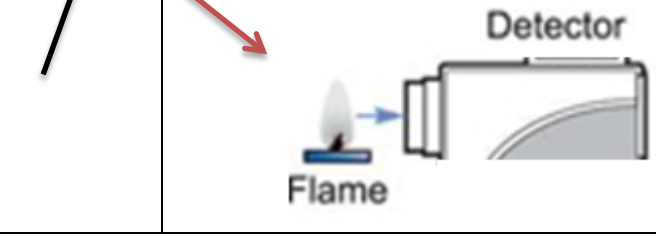
Name of the fluorescence	description
1- Resonance fluorescence	
2- Stepwise fluorescence	
3- Direct line fluorescence	

Question 9.

Match the figure with the name of the technique :

Name of technique	Figure
AAS	
FAES	
AFS	

Question 10.

Match the followings

Atomic spectroscopic techniques	principles
1- AAS	…2… The flame plays the role of atomization and excitation.
2- FAES	…1…. Uses radiation source and flame or graphite furnace for the atomization .it measures absorption .
3- AFS	…4… uses electrical means as atomization and excitation
4- ICP	…3…. Use radiation source and flame or graphite furnace for the atomization .it measures emission .

Question 11.

What are the differences between atomic absorption and atomic fluorescence ?

Answer :

atomic Absorption
Absorption of radiation by atoms. The radiation is supplied by an external source. Atomic absorption is the atomic analog of molecular absorption spectroscopy.The atomization process is made by a flam or electrothermal means .

Atomic Fluorescence
Re-emission of radiation by atoms from an excited state; emitted radiation is of longer wavelength than that of the initial absorption. The atomization process is made by a flam or electrothermal means .

Question 12.

Standards addition is a commonly used method in many practical analyses.
Discuss when an analyst would choose a standards addition instead of a standard calibration curve method ?

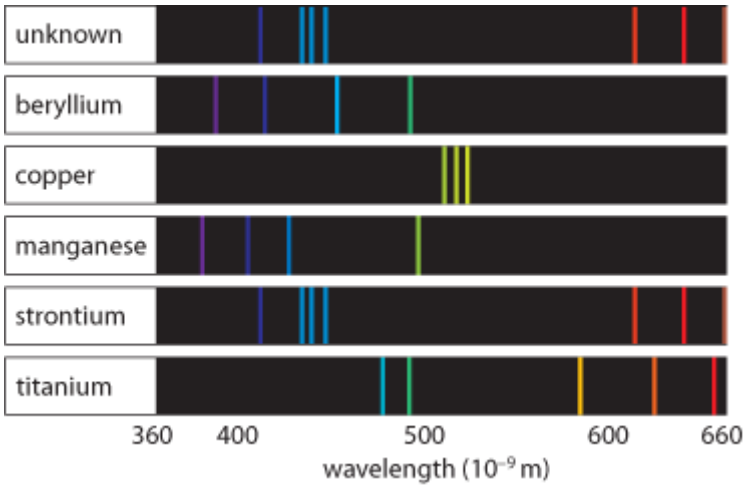
Answer :

When the matrix is unknown so that it is difficult to match the sample solution with the standards .

QUESTIONS ABOUT ARC- SPARK ATOMIC EMISSION SPECTROMTRY

Question 1 .

A composition of a crushed rock sample was investigated using atomic emission spectroscopy. After dissolving in acid the rock sample solution was heated to produce an emission spectrum. Shown below is this emission spectrum, along with those of five metals. Based on this spectral analysis it can be concluded that the rock sample contains



- all five of the metals.
- strontium and beryllium, but none of the other three metals.
- strontium, but none of the other four metals.
- none of the five metals.

Question 2 .

Standards addition is a commonly used method in many practical analyses.
Discuss when an analyst would choose a standards addition over a method based on use of a calibration curve.

1- in case of unknown matrix .

2- in case of very dilute analyte concentration .

3- in case of presence of interferences .

Question 3 .

When it is preferable to apply internal standard method ?

1- in case of presence of interferences .

2- in case of unknown matrix .

3- in case of uncontrolled factors (low precision).

Question 4 .

What are the differences between Direct Current (DC) Arc and Alternating Current (AC) Spark ?

Question 5 .

Sketch an arc – spark spectrophotometer ?

Question 6 .

Why Graphite is a good choice for an electrode material ?

Question 7 .

What is the main interference in arc spark emission spectrometry ?

Question 8 .

Why arc source is only suitable for qualitative not for quantitative analysis ?

Question 9 .

Why the internal standard method is most suitable for arc spark spectrometry than calibration method ?

Question 10 .

Arc spark spectrometry is more suitable for the analysis of solid samples . True or false .

Question 11 .

How to improve the precision of Arc spark spectrometry ?

Question 12 .

In the analysis of sodium by flame atomic emission spectroscopy, lithium may be used as an internal standard. Using the data below, calculate the concentration of sodium in the sample. Compare the precision of the result from the internal standard method with that achieved with the calibration curve method (ie, if the lithium emission signals were ignored).

solution	Na emission	Li emission
0.2 ppm Na, 500 ppm Li	0.22	48
0.5 ppm Na, 500 ppm Li	0.53	47
2.0 ppm Na, 500 ppm Li	2.30	51
5.0 ppm Na, 500 ppm Li	5.00	46
Unknown , 500 ppm Li	0.88	48

ANSWERS OF QUESTIONS ABOUT ARC- SPARK ATOMIC EMISSION SPECTROMTRY

Question 1 .

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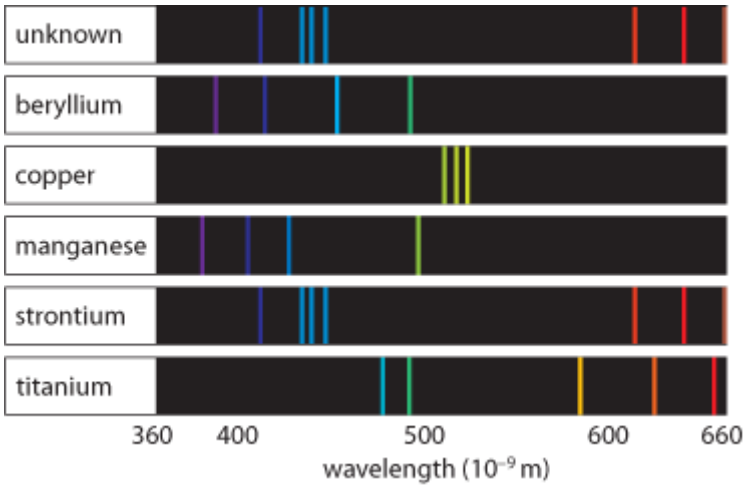

- all five of the metals.
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1- in case of presence of interferences .

2- in case of unknown matrix .

3- in case of uncontrolled factors (low precision).

Question 4 .

What are the differences between Direct Current (DC) Arc and Alternating Current (AC) Spark ?

Answer :

Direct Current (DC) Arc

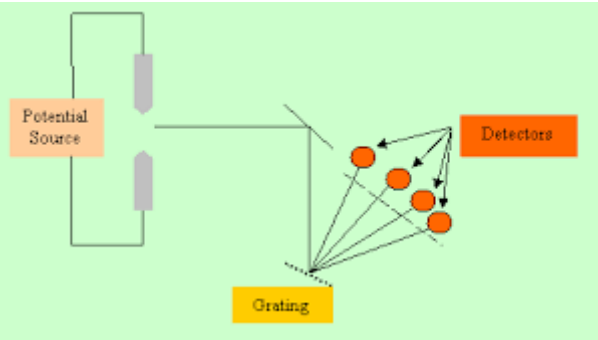
Source for atomic emission spectrochemical analysis formed from graphite or metal electrodes a few mm apart; current (30 A, 200 V) is passed between these electrodes, causing high temperature (4000 - 5000 K) arcing and sample atomization.

Alternating Current (AC) Spark

Source for atomic emission spectrochemical analysis formed from graphite or metal electrodes a few mm apart; typical operating conditions (10-50 kV, 1000 A instantaneous current) result in spark gap temperatures of 10,000 K.

Question 5 .

Sketch an arc – spark spectrophotometer ?



Question 6 .
Why Graphite is a good choice for an electrode material ?

Answer :

because it is conductive , does not spectrally interfere with the assay of most metals and metalloids ,thermally stable , cheap , available and easily shaped .

Question 7 .
What is the main interference in arc spark emission spectrometry ?

Answer :
Usually, cyanogens compounds are formed due to reaction of graphite electrodes with atmospheric nitrogen. Emission bands from cyanogens compounds occur in the region from 350-420 nm. Unfortunately, several elements have their most sensitive lines in this same region which limits the technique. However, use of controlled atmosphere around the arc (CO_2 , helium, or argon) very much decreases the effect of cyanogens emission.

Question 8 .
Why arc source is only suitable for qualitative not for quantitative analysis ?

Answer :
Because of it's bad reproducibility and good sensitivity , Arc source is very good for qualitative analysis of elements but not suitable for quantitative analysis .

Question 9 .
Why the internal standard method is most suitable for arc spark spectrometry than calibration method ?

Answer :
To eliminate the effects of some factors that are difficult to control i.e. to improve the precision .

Question 10 .

Arc spark spectrometry is more suitable for the analysis of solid samples . True or false .

Question 11 .

How to improve the precision of Arc spark spectrometry ?

Answer :

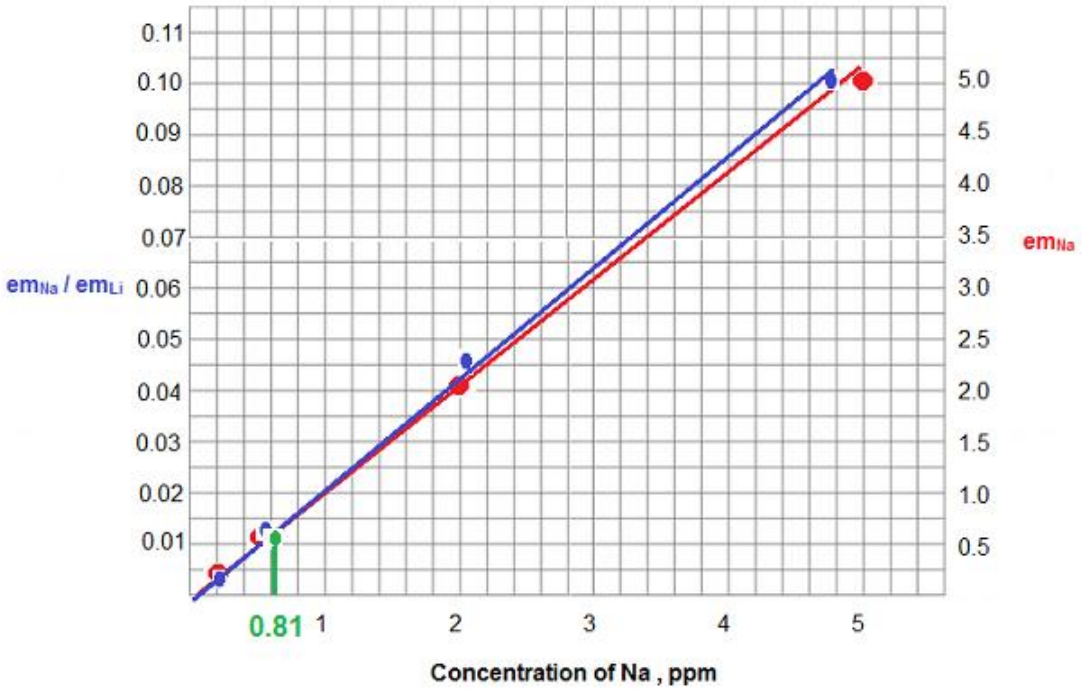
The precision of Arc spark spectrometry can be improved by matrix-matching the standards with the sample. Use of the internal-standard method also improves precision.

Question 12 .

In the analysis of sodium by flame atomic emission spectroscopy, lithium may be used as an internal standard. Using the data below, calculate the concentration of sodium in the sample. Compare the precision of the result from the internal standard method with that achieved with the calibration curve method (ie, if the lithium emission signals were ignored).

solution	Na emission	Li emission	em_{Na} / em_{Li}
0.2 ppm Na, 500 ppm Li	0.22	48	0.005
0.5 ppm Na, 500 ppm Li	0.53	47	0.011
2.0 ppm Na, 500 ppm Li	2.30	51	0.045
5.0 ppm Na, 500 ppm Li	5.00	46	0.109
Unknown , 500 ppm Li	0.88	48	0.018

Answer : 0.81



In the above example, fluctuations in the flame temperature will affect the analyte signal by changing the degree of thermal excitation and ionization of the analyte. Presumably, temperature fluctuations will affect the lithium atoms - which are also easiliy excited and ionized in the atomizer - in a similar manner. The analytical technique must be capable of yielding multichannel data in order for the method to work, and the concentration of internal standard must be the same in all solutions.

QUESTIONS ABOUT MASS SPECTROMETRY

Question 1 .

The largest peak in a mass spectrum is called the -

(a) parent or molecular ion peak (b) standard peak
(c) base peak (d) calibration peak

Question 2 .

Draw a block diagram of a mass spectrometer ?

Question 3 .

What function does the ICP torch have in ICP-MS?

Question 4 .

What are the ordinate and the abscissa of an ordinary atomic mass spectrum?

Question 5 .

Why has ICP-MS become an important and widely used analytical method?

Question 6 .

What is the main purpose of an interface between the ICP torch and the mass spectrometer ?

Question 7 .

What types of interferences are encountered in mass spectrometry?

Question 8 .

In mass spectrometry, the analyte molecules are bombarded with ...
1- electrons .
2- photons .
3- protons .

Question 9 .

In mass spectrometry, the analyte molecules are mainly converted to ...
1- positive ions .
2- negative ions .
3- neutral fragments .

Question 10 .

In mass spectrometry, the analyte fragments are separated according to...
1-their masses .
2- their charges .
3- their mass to charge ratio .

Question 11 .

What is the main significance of parent ion peak *?*
1- it gives the molecular weight of the analyte .
2- it shows the identity of the analyte .
3- it gives the quantity of the analyte .

Question 12 .

What is the main difference between MS and IR , NMR and UV/VIS ?

Question 13 .

What information can be obtained from the mass spectrum ?

Question 14 .

What are the possible ionic fragments of the compound ABC ?

Question 15 .

What are the advantages of mass spectrometry ?

Question 15 .

Draw a sketch of (1) ICP – MS Spectrometer (2) GC – MS Spectrometer
(3) HPLC – MS Spectrometer ?

(1)

(2)

(3)

Question 15 .

Compare atomic spectrometric methods of analysis ?

Question 16 .

Compare ICP-MS , ICP-OES and GFAAS ?

Question 17 .

Atomic spectroscopic methods differ in the atomization mean and the signal measured . Explain this statements ?

Question 18 .

What is the purpose of using high vacuum in mass spectrometry ?

ANSWERS OF QUESTIONS ABOUT MASS SPECTROMETRY

Question 1 .

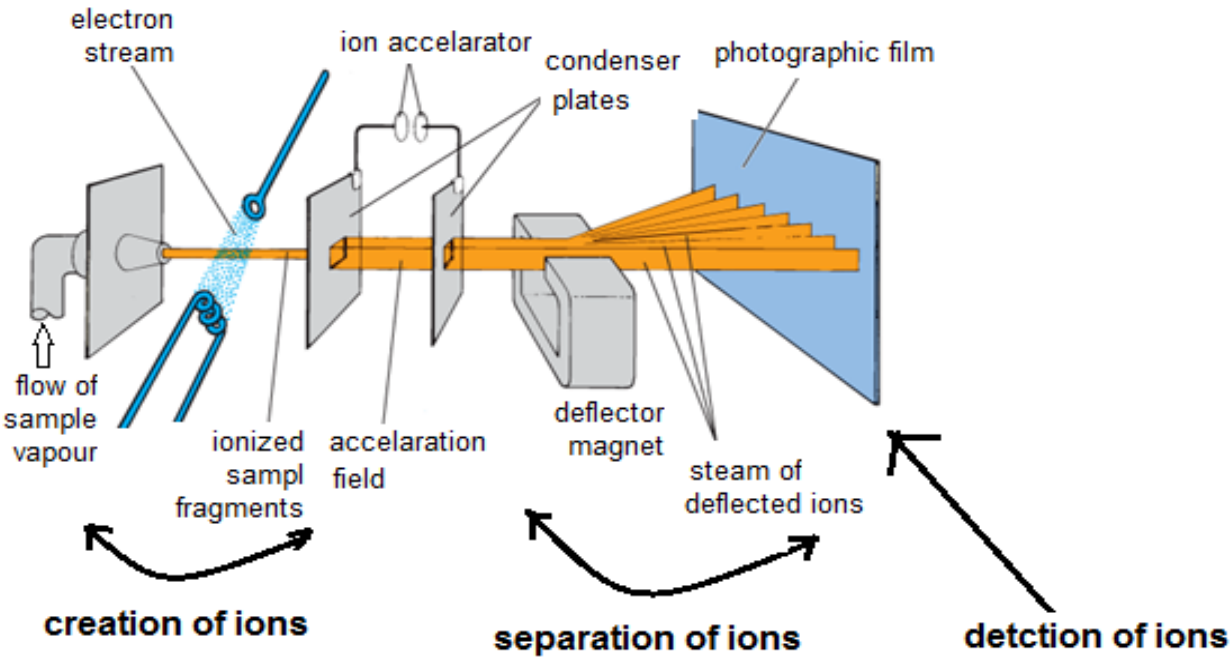
The largest peak in a mass spectrum is called the -

(a) parent or molecular ion peak (b) standard peak

(c) base peak (d) calibration peak

Question 2 .

Draw a block diagram of a mass spectrometer ?



Question 3 .

What function does the ICP torch have in ICP-MS?

Answer :

Causes atomization and ionization of the species which can then be separated by the mass spectrometer.

Question 4 .

What are the ordinate and the abscissa of an ordinary atomic mass spectrum?

Answer :

Ordinate (Y axis) is the relative abundances or intensities of the ions; the abscissa (x axis) is the mass to charge ratio.

Question 5 .

Why has ICP-MS become an important and widely used analytical method?

Answer :

High sensitivity, high degree of selectivity, good precision for determining many different elements

Question 6 .

What is the main purpose of an interface between the ICP torch and the mass spectrometer ?

Answer :

Generally speaking, the interface can be described as the point at which sample from the
ICP portion of the instrument is introduced to the mass spectrometry (MS) portion of the
instrument. The interface portion of the instrument serves to allow the ICP and MS portions to be
coupled.

Question 7 .

What types of interferences are encountered in mass spectrometry?

Answer :

main interferences are encountered when species that have the same mass as that of an analyte ion are present. A second type of interference is from matrix species that combine with the analyte and reduce the analyte signal as a result.

Question 8 .

In mass spectrometry, the analyte molecules are bombarded with ...

1- electrons .

2- photons .

3- protons .

Question 9 .

In mass spectrometry, the analyte molecules are mainly converted to ...

1- positive ions .

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2- it shows the identity of the analyte .
3- it gives the quantity of the analyte .

Question 12 .

What is the main difference between MS and IR , NMR and UV/VIS ?

Answer :

All used for structural analysis of organic compounds but In mass spectrometry no absorption of radiation is involved as in the case of the others .

Question 13 .

What information can be obtained from the mass spectrum ?

Answer :

1- It can give the exact molecular mass .
2- It help in finding of elemental composition of parent ion and fragment ions .
3- It can give a molecular formula or it can reveal the presence of certain structure units (e.g. functional group) in a molecule.
Thus, the mass spectrum of each compound is unique and can be used as a chemical fingerprint to characterize the sample .

Question 14 .

What are the possible ionic fragments of the compound ABC ?

Answer :

ABC^+ (parent ion) , AB^+ , BC^+ , AC^+ , A^+, B^+ and C^+ .

Question 15 .

What are the advantages of mass spectrometry ?

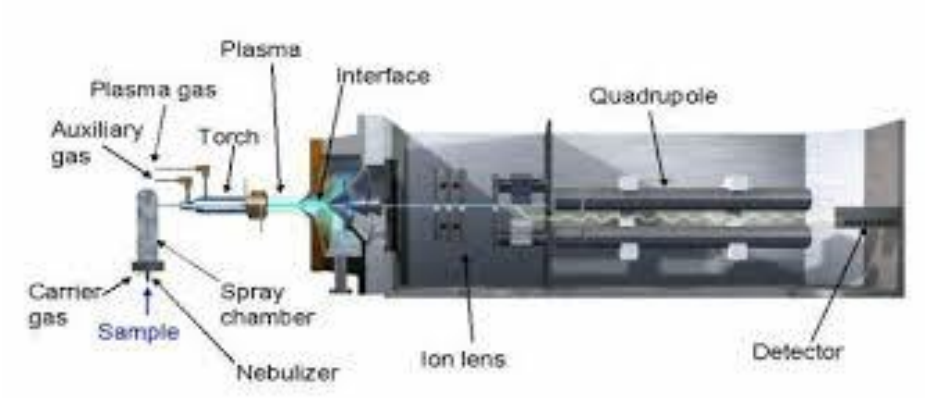
Answer :

Solid , liquid or gas samples can be analyzed . Mass spectrometry has special advantages such as high sensitivity and accuracy and the widely used coupling of mass spectrometry with ICP or chromatographic techniques such as Gas chromatography GC or high performance liquid chromatographic HPLC .Mass spectrometry has wide applications in the analysis of various samples in food (pesticides) , clinical samples (drugs in blood and urine) … etc. .

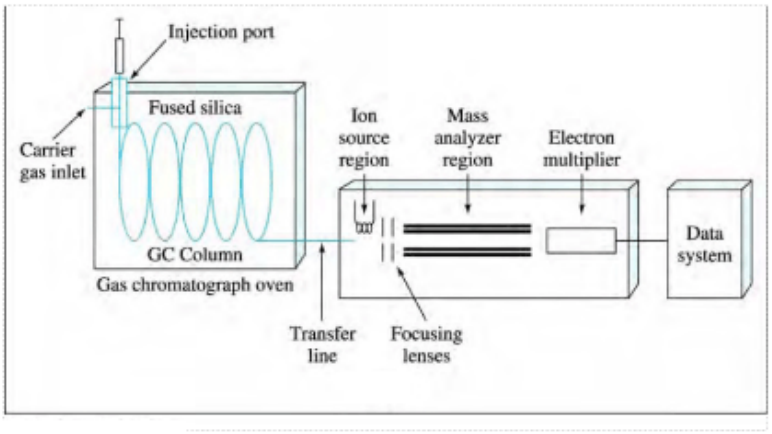
Question 15 .

Draw a sketch of (1) ICP – MS Spectrometer (2) GC – MS Spectrometer
(3) HPLC – MS Spectrometer ?

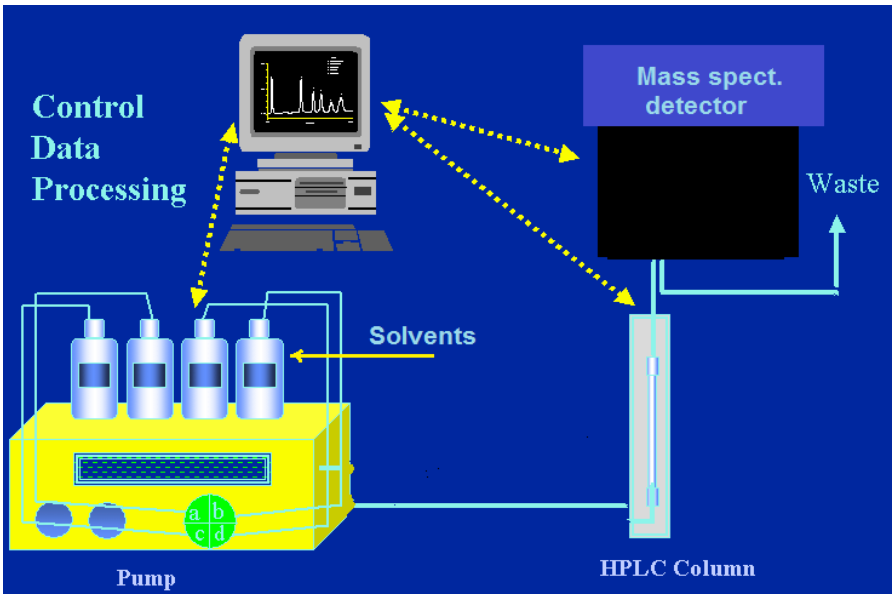
(1)



(2)



(3)



Question 15 .

Compare atomic spectrometric methods of analysis ?

Comparison of atomic analysis methods

	Flame absorption	Furnace absorption	Plasma emission	Plasma–mass spectrometry
Detection limits (ng/g)	10–1 000	0.01–1	0.1–10	0.000 01–0.000 1
Linear range	10^2	10^2	10^5	10^8
Precision	0.1–1%	0.5–5%	0.1–2%	0.5–2%
Interferences				
spectral	very few	very few	many	few
chemical	many	very many	very few	some
mass	—	—	—	many
Sample volume	large	very small	medium	medium
Purchase cost	1	2	4–9	10–15

Question 16 .

Compare ICP-MS , ICP-OES and GFAAS ?

ANSWER :

	ICP-MS	ICP-OES	GFAAS
# of Elements	60 of 75	60 of 70	28 of 50
LOD (ppb)	< 0.1	1-50	0.1
LDR (orders of magnitude)	8	5	2
Rapid multielement analysis	Yes	Yes	No
Data acquisition Elements/min	75	10-60	1
Spectra	Simple	Complex	Simple
Interferences	Isobaric Polyatomic	Spectral	Chemical Molecular
Sample Prep	Some care	Some care	Complex
Method Development	Easy	Complex	Complex

Question 17 .

Atomic spectroscopic methods differ in the atomization mean and the signal measured . Explain this statements ?

Answer :

Classification of Atomic Spectroscopic Methods			
Atomization Method	Typical Atomization Temperature, °C,	*measured signal*	*Analysis Method*
Inductively coupled plasma	6000–8000	Emission	ICPAES
		Mass	ICP-MS
Flame	1700–3150	Absorption	AAS
		Emission	AES
		Fluorescence	AFS
Electrothermal	1200–3000	Absorption	AAS
		Fluorescence	AFS
Direct-current plasma	5000–10,000	Emission	DCP
Electric arc	3000–8000	Emission	Arc-source emission spectroscopy
Electric spark	Varies with time and position	Emission	Spark-source emission spectroscopy
		Mass	Spark-source mass spectroscopy

Question 18 .

What is the purpose of using high vacuum in mass spectrometry ?

Answer :

to prevent interaction of analyte’s ions with atmosphere’s Components

QUESTIONS ABOUT FLOW INJECTION ANALYSIS (FIA)

Question 1 .

Define the term : flow injection analysis (FIA) ?

Question 2 .

State true or false

1. One of the benefits of automation is that it saves reagents.
2. One of the benefits of automation is that it reduces time of analysis .
3. The total number of tests is decreased by automation.
4. Automation improves reproducibility .

Question 3 .

List the advantages and disadvantages of FIA ?

Question 4 .

What types of detectors used in FIA ?

Question 5 .

The following are manual procedures for the determination of analyte A :

1-Add 10 ml of the sample solution containing analyte A into 50 ml beaker .

2- add 5 ml of a buffer solution of pH = 8 .

3. add 5 ml of reagent B which react with A at 70 C^0 to produce D .

$$A + B \rightarrow D$$

Put the beaker in a water bath at 70 C^0 for 5 min.

4- Add 5 ml of reagent C which will react with the formed D in the presence of catalyst X to produce the colored compound E , the absorption of which is measured by a

spectrophotometer at 500 nm . Draw a manifold for the determination of analyte A by flow injection analysis using the above method ?

ANSWERS OF QUESTIONS ABOUT FLOW INJECTION ANALYSIS (FIA)

Question 1 .

Define the term : flow injection analysis (FIA) ?

Answer :

The automatic flow of laboratory samples and reagents through the instrument one after the other is referred to as flow injection analysis .

Question 2 .

State true or false

1. One of the benefits of automation is that it saves reagents. true
2. One of the benefits of automation is that it reduces time of analysis . true
3. The total number of tests is decreased by automation. false
4. Automation improves reproducibility true

Question 3 .

List the advantages and disadvantages of FIA ?

Answer :

Advantages and Disadvantages of Automatic Analysis

- Automated instruments offer a major economic advantage because of their savings in labor costs.

- Their speed, which is frequently significantly greater than that of manual devices.

- A well-designed analyzer can usually produce more reproducible results over a long period of time than can an operator employing a manual instrument.

- It offers an additional level of protection to technicians when handling or testing toxic substances .

- Separations by liquid/liquid extraction, or ion – exchange … etc. are readily carried out automatically with flow-injection systems.

-The equipment is computer compatible as well, providing quicker analysis while limiting the data entry errors possible in manual testing .

- The main drawback is that it leads to increased unemployment because the number of employees in the laboratory will be reduced because of the lab 's reliance on automatic analysis .

Question 4 .

What types of detectors used in FIA ?

Answer :

The detectors used in FIA are mainly spectrometric such as UV/VIS spectrometer , fluorimeter , AES , AAS , AFS , chemiluminesence and many others.

Question 5 .

The following are manual procedures for the determination of analyte A :
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Answer :