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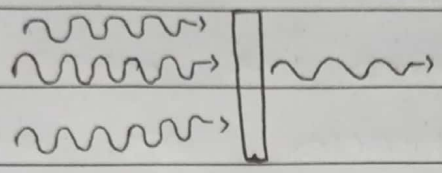
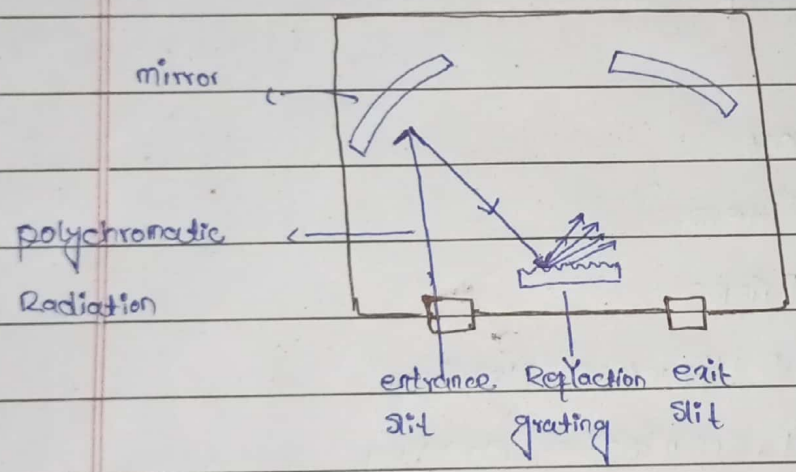
Monochromator:

Monochromator is a component of uv- visible Spectrometer which is used to produce a beam of single wavelength.



Components:



→ An entrance slit which admit polychromatic radiation from soure. It allow only a narrow beam of light.

→ Mirror are refleating the light.

→ Reflaction grating which resolve the radiation component into different wavelength.

→ An exit slit.

DAY: _____ DATE: _____

5.0 2022 (xv)

Purpose of Grating

→ Grating is used to separate polychromatic light into its constituent wavelength.

→ Diffraction grating of a spectrometer determines wavelength range and partially determines the optical resolution that the spectrometer will achieve.

→ Grating give exceptionally high resolutions of spectral lines.

Monochromators

i- Filters

ii- Prisms

iii- Diffraction grating

iv- Transmission grating

v- [redacted]

i- Filters:

Filter are prepared from special material and allow transmission of only limited wavelength region. While absorb most of radiation.

Types:

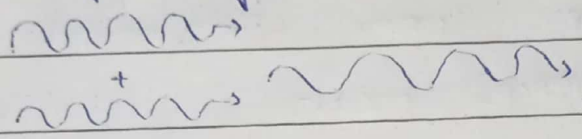
There are two types of filters.

DAY: _____ DATE: _____

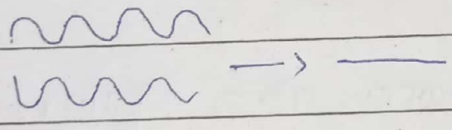
a) Interference filters:

There are two types of interference filters.

i Constructive interference: The interference in which two coherent waves are combined by adding their intensities



ii- Disconstructive interference: when two waes traveling in same direction are at the crest of the one wave and the trough of other wave.



Construction:

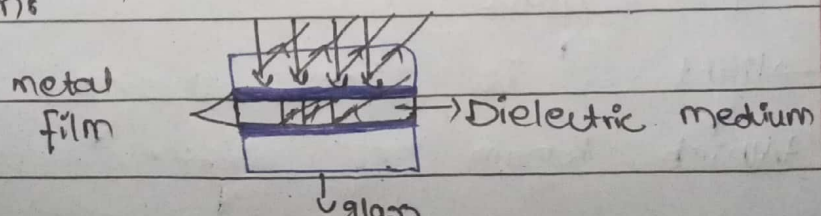
→ Dielectric medium

we use CoF_2 and MgF_2 mostly commonly used.

→ Two metal film one above and other below the dilectric medium.

→ whole assembly is enclosed in glass.

Diagram:



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Working:

When white light (400nm to 800nm) is fall on the interference filter half light is pass through first film of metal and half transmit. Half light pass in again transmitted by the lower film of metal and interference occurs.

B) Absorption filters / Coloured glass filter:

A colour filter is a sheet of transparent material that modifies a light beam by selective absorption of some colours in relation to other.

S.Q 2019 (vi)

Advantages:

→ Coloured glass filter has greater thermal stability

→ less expensive

→ Easy to clean

→ chemically resistance.

ii)

S.Q 2022 (xiii)

Prisms Monochromator:

→ Prism is made up of glass.

→ light is pass through colkmeter which beam of light.

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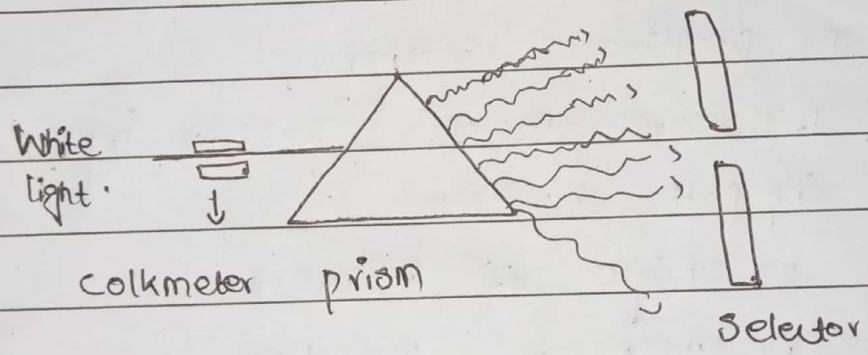
-> The beam of light is passed through the prism. The prism resolve the beam of light into different wavelength.

-> The longer wavelength more bent of wavelength occur.

-> Now we wavelength Selector and select a specific wavelength and used in experiment.



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iii- Diffraction grating monochromator:

-> A diffraction grating consist of parallel series of groves on a reflecting surface.

-> The groves can be consider as a seperator mirror form which the reflect light intracts and interference occur.

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Two types of interference Constructive and destructive

Constructive → Path length $= (n + \frac{1}{2})\lambda$

path length $= n\lambda$

The noumber of groves 300 to 2000 per/mm.

The most common noumber of groves is 1200 to 1400 per/mm.

$$n\lambda = d(\sin i + \sin r)$$

n = positive integer

λ = wavelength of incident light.

d = path difference

i = Angle of incident

r = angle of refletion.

iv- Transmission grating:

→ It is made up of transperant glass.

→ On transperant glass equal distance b/w groves are form.

→ The no of grove is 100 to 3000 per/mm.

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Working:

When white light is fall on the transmission grating each light is transmited from each groves

constructive interference

$n\lambda = d[\sin i + \sin r]$

n = positive integer

d = path length

λ = wavelength of light

i = angle of incidence

r = angle of diffraction.

5.0 2022 (xii)

✓ Allowed transition:

There are transitions having molar co-efficient 10^4 or more. These are generally designated as $\pi \rightarrow \pi^*$ transition

Example: In 1,3-butadiene which absorption at 217nm has ε_{max} value 21000 represent allowed transition These transitions are mainly favoured due to symmetry relationship.

✓ Forbidden transition:

These are the

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transition for which molar co-efficient Emax is generally less than 10^4.

Example:

transition of saturated aldehyde showing weak absorption near 290nm and having Emax 100 has been a forbidden transition.

S.Q (2021) (2022) ✓ Chromophore:

→ An atom or group of atoms whose presence is responsible for the color of a compound.

→ Absorb uv-visible light.

→ Give color to a molecules.

→ A part of molecules.

Example

	transition	λ_{max}	ε_{max}	Solvent
$>C=C<$	$\pi \rightarrow \pi^*$	175	15000	vapour
	$\pi \rightarrow \pi^*$	175	1000	Hexane

✓ Auxochrome: A group of atom attached to chromophore shifts the absorption maximum towards longer wavelengths along with an increase in the intensity of absorption.

Example

$-NH_2$ attached benzene ring absorption change 255nm (203) to 280nm (ε_{max} = 1430).

DAY: _____ DATE: _____

S.Q 2017(v) **Role of Solvent in uv spectroscopy:**

Solvent are available for use in the many uv-region. Three common Solvent are Cyclo-hexane, 95% ethan and 1,4 dioxane. Solvents play an important role in uv-spectra. Compound peak so a ~~could~~ be obsered by the Solvent peak. So a most Suitable is one that does not itself get absorbed in the region under investigation. A Solvent should be transparent in a particular region.

S.Q 2017(x) **Grating over prism in UV/vis spectroscopy**

Grating is generally better than prisms. They are more efficient. They provides a linear dispersion of wavelength and do not suffer from the absorption effect that prism have which limits their useful wavelength range. It can produce for greater deflection b/w different wavelength and so provide a greater spectral resolution. All of these reasons grating is prefferd over prism.

DAY: _____ DATE: _____

Lambert's Law:

When a beam of monochromatic radiation is passes through a homogeneous absorbing medium the rate of decrease of intensity of radiation with the thickness of absorbing medium is to proportional to the intensity of incident radiation.

mathematically form

$$-\frac{dI}{dx} = KI$$

Separate variable

$$\frac{dI}{I} = K dx$$

Absorbance is directly proportional to the path length of the sample

$$A \propto x \quad -(i)$$

$$dI/I = -K dx$$

Taking integration with in limit

$$\int_{I_0}^{I} \frac{dI}{I} = -K \int_{0}^{x} dx$$

$$[\ln I]_{I_0}^{I} = -K[x]_{0}^{x}$$

$$\ln I - \ln I_0 = -K[x - 0]$$

$$\ln \frac{I}{I_0} = -Kx$$

Taking anti-ln

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$$I/I_0 = e^{-Kx}$$

$$\boxed{I = I_0 e^{-Kx}} \quad -(i$$

So the intensity of light transmitted depends upon thickness (x) of medium and constant (K)

When change natural log by common log

$$2.303 \log I/I_0 = -Kx$$

$$I/I_0 = 10^{-\frac{Kx}{2.303}}$$

$$\alpha = \frac{K}{2.303}$$

$$\boxed{I = I_0 10^{-\alpha x}} \quad -ii)$$

II Beer's Law:

When a beam of monochromatic radiation is passes through a solution of absorbing substance the rate of decrease intensity of radiation with the thickness of the absorbing solution is proportional to the intensity of incident radiation as well as the concentration of solution.

$$-\frac{dI}{dx} = K'Ic$$

Separate variable

Absorbance is directly proportional to the concentration of solution of sample

$$A \propto c \quad -ii$$

$$-dI/I = K'C\,dx$$

DAY: Integration within Limits DATE:

$$\int_{I_0}^{I} \frac{dI}{I} = -\int_{x=0}^{x=x} K'C\,dx$$

$$[\ln I]_{I_0}^{I} = -K'C[x]_0^x$$

$$\ln I - \ln I_0 = K'Cx$$

$$\ln \frac{I}{I_0} = K'Cx$$

$$\boxed{I = I_0 e^{-K'Cx}}$$

$$\boxed{I = I_0 10^{-\alpha Cx}}$$

important for past papers 2021 Q NO # 4(a)

Beer-Lambert Law

$A \propto xC$ —(iv

A = absorbance

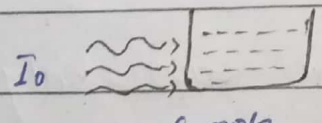
x = path length

c = concentration of sample solution.

$A = \varepsilon xC$

ε = absorptivity constant.

Absorbance:



The phenomenon in which a part of radiation is held by a medium a called absorbance.

DAY: _____ DATE: _____

$$A = \log \frac{I_0}{I} = \varepsilon \cdot C \cdot L$$

A = absorbance ε = absorbance constant

L = path length C = concentration

Transmittance:-

The phenomenon in which a part of radiation after being absorbed by a medium is called transmittance.

$$T = \frac{I}{I_0}$$

I = intensity of radiation after passing through medium.

I_0 = intensity of radiation before passing through medium.

important Question past papers 2022 GNOTES

Limitations:-

Thi

i- Dilute Solution:

Beer-Lambert law only applicable on dilute solution. If the concentration of solution is change then the linear relation is not obtained.

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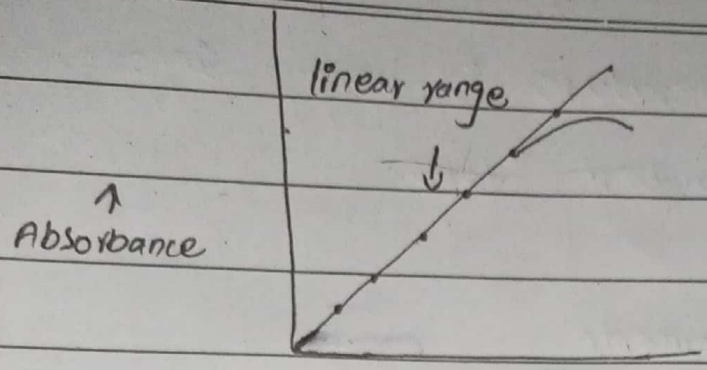

ii- Absorbing Species Reaction:

This law is also fails if the absorbing species react with the solvent such as association and dissociation takes place.

iii- High concentration:

$A = \varepsilon C l$

The molar concentration of depend upon the reflective index of absorbing medium. If concentration is increased it means that reflective index also change. So ε change.

iv- Monochromatic light:

This law is only applicable to monochromatic radiation.

v- Temperature:

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Constant temperature is very important for beer - Lambert law

vi- Width of Instrument:

Width of instrument is very important.
If the width of instrument is not proper than graph is not linear.

vii- Equilibrium

When different form of absorbing molecules are in equilibrium so this law is not obeyed.

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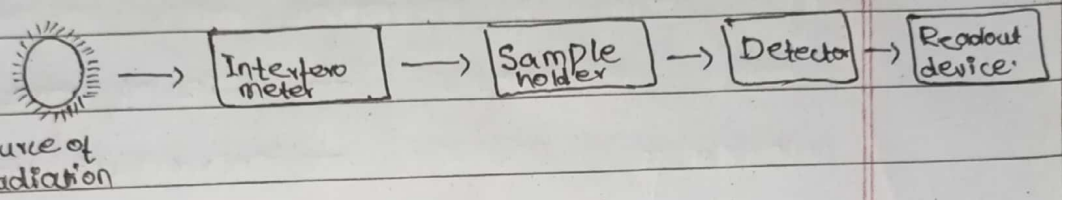
FTIR

Fourier transform infra-red spectroscopy.

In this technique interferometer is used in the place of monochromator.

Instrumentation:



The instrumentation consist of :

i- Radiation source

ii- Interferometer

iii- Sample holder

iv- Detector

v- Readout device.

=> **Radiation Source:**

In FTIR and IR are different source of radiation are used.

1) Nernest Glower

It is mostly used IR spectroscopy.

It is made up of mixture of oxides of rare earth metal.

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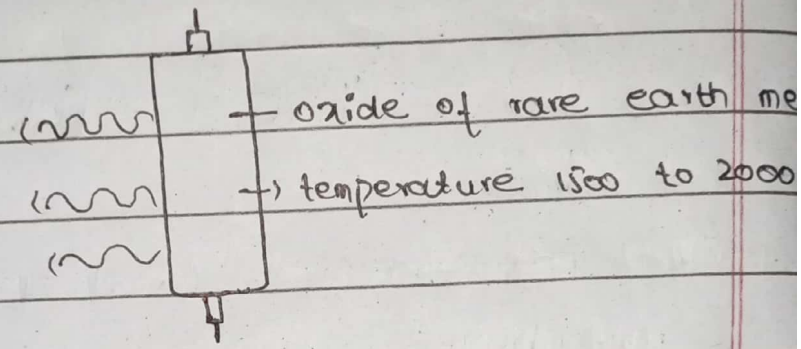
Like ZrO_2, V_2O_3 and Y_2O_3 etc.

The diameter is 2mm.

The length is about 2 to 5cm.

When we provide current and heated at 1500° to 2000°C then it emit IR radiation.



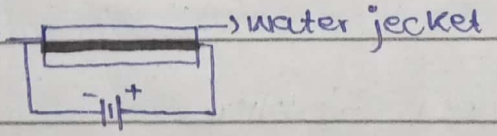
2) Globar:

Globar made up of SiC.

The length of globar is 5cm and diameter is 7mm.

It consume about 200 - 400W

It emit radiation about 1200 to 1400°C temperature.



3) Incandicent wire:

i- Nichrome Wire

Nikle and chromium alloy. Heat at 800 to 900°C emit IR radiation.

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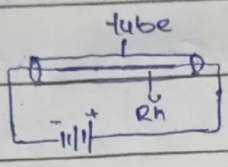
less expensive

ii) Rohindium Wire:

Rh is sealed inside the tube of Aluminum oxide. It heated at 12000°C then emit IR radiation.



ii=) Interferometer:

In FTIR Michealson interferometer is used.

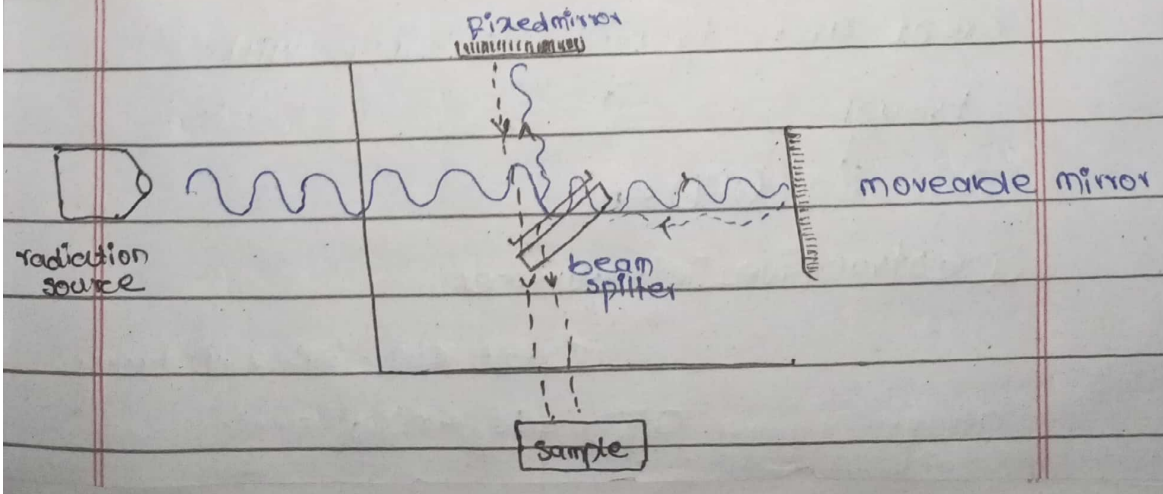
Construction:

Michealson interferometer is consist of three parts.

i- Beam Splitter

ii- Fixed mirror

iii- Moveable mirror



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Beam Splitter:

Beam Splitters are optical components used to split incident light into two parts. Beam spliter are placed at 45°C. It is made up of special material that transmits the half of radiation and other half reflect.

Working:

First of all the light is fall on beam spliter which reflect half light and half radiation is transmited. When the radiation comes toward the sample the radiation show interference. There are two types of interference.

Constructive Interference:

Crest combine with crest and trough combine with trough

$$OPD = n\lambda$$

Destructive interference:

Crest combine with trough

$$OPD = \left(\frac{1}{2} + n\right)\lambda$$

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⇒ Sample Holder:

Sample holder is made up of these substance which do not absorb IR radiation.

Glass and quartz are not used as a sample holder because glass and quartz are absorb IR radiation.

Sample holder is made up of NaBr KBr, NaCl, AgCl, they are trasperant in IR region.

types:

three types of sample are used.

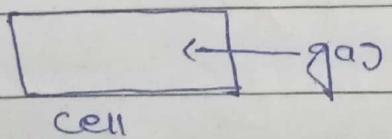
i- Solid

ii- Liquid

iii- Gas

Gas:

Sample is gas cell 10cm long is used. Gas is filled at reduced pressure. Cell made up of NaCl. The pressure of cell $\frac{1}{2}$ atm.



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Liquid Sample.:

Liquid Sample used in two ways.

i- Dired used: Liquid sample are direct used

ii- Solution form used: from Solution add solvent. These solvent are not interfer in IR radiation. The mostly slovent used like CCl_4, $CHCl_3$, CS_2

The cell is made up of rock salt because rock salt not absorb IR.

Solid Sample

Solid Sample two ways used.

i- Mull techniques

The Solid sample is mixe with mineral oil.

Now add the suspension of oil and Solid sample place b/w plated of NaCl.

It is used for analysis of functional group.

ii- KBr pellets:

KBr salt powder and Solid Sample powder mix in

DAY: _____ DATE: _____

ratio 200:1

High pressure applied.

Detectors:

Detector are the device used to analysis the radiation. There are different types of detector are used.

i- Thermocouple

ii- Bolometer

iii- Themister

iv- pyroelectric detector

Thermocouple Detector:

It consist of two wires one wire is made up of Bi or antimony and second wire is made up of Silver or pt.

These two wires are connected at one end and that ~~other~~ end is blacken. Second end of wire connected to Galvonometer.

Working:

When radiation is fall on the blacken sides of wire temperature increase on that side.

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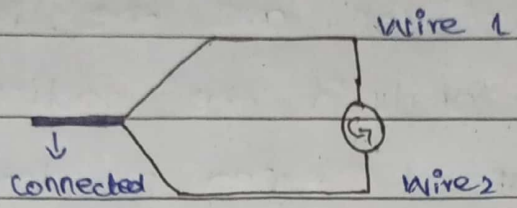
Due to the difference in temperature electrical current is produced in small quanty.



Bolometers

Constructions

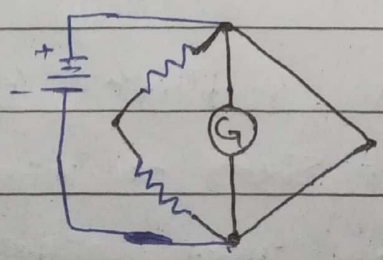
Construction is baae on wheatstone bridge.

Two register of known resistance are used.

Two pt plates are also used.

The temperature of one plates are increase are decrease and 2nd plate is constant then apply IR radiation.

Galvanometer is used for the detection of currents.



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Working:

When IR radiation are fall on the pt wires the resistance increase due to increase in temperature and current produce in the system in change the is represent the IR radiation.

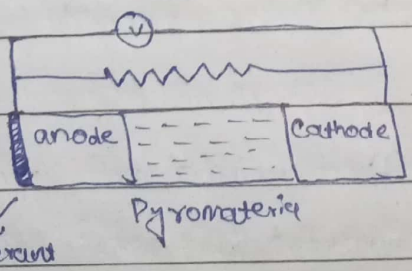
Pyroelectric Detector:

Pyroelectric material:

Pyroelectric material are these material when temperature is rise the dipoles of a material is formed and arranged in regular way.

Construction:

It is consist an anode and cathode Pyroelectric material is placed b/w anode and cathode. A voltmeter and high resistance is used in Pyroelectric detector.



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IR transperant window is attached to anode.

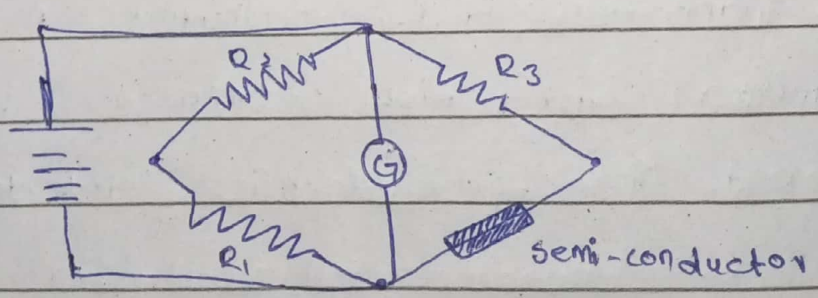
Working:

When IR radiation is fall on anode the temperature of material increase and dipole are formed. When dipoles are formed then current is flow from circut which is measure by using voltmeter.

Thermistor:

Construction:

It is a formed of bolometer we use a material which has negative co-efficient of resistivity. A Galvonometer is also used for the detection of current.



Working:

When IR radiation fall on the Semi-conductor material.

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Temperature of Semiconductor is increase
Due to increase in temperature
resistance is increase.
Due to increase resistance in
temperature stance decrease
Due to decrease in resistance
the current in Galvonometer is
influenced.

Readout Device:

The readout device is the computing system Now a days a Sophisticated Software is involved for the readout. It provides the IR Spectrum in a convenient way.

Application:

i- Polymer analysis
ii- Forensic analysis
iii- Food research
iv- Quality control
v- Environmental analysis
vi- water quality
vii- Bio-chemical research
viii- identification of unknown material.

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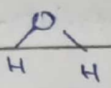
IR Active:

If a vibration results in the change in the molecular dipole moment or not zero dipole moment it is known as IR active

Example:

Carbon dioxide (CO_2) O=C=O

Water H_2O 

IR Inactive:

If a vibration result in the no change in the molecular dipole moment or zero dipole moment is known as IR inactive

Example:

O=O

N≡N

Selection Rule of IR:

The Selection rule for IR Spectroscopy states that a molecule will absorb infrared radiation if there is a change in its dipole moment during the vibration. This mean that for a vibration to be IR active. It must result

DAY: _____ DATE: _____

in a change in the distribution of electron within the molecule leading to a change in its overall dipole moment.

Kind of molecules show IR Spectra

unsymmetrical diatomic molecules CO_2 absorb in the IR spectrum. More complex molecule have many bonds, and their vibrational spectra are correspondingly more complex. like big molecules have many peaks in their IR spectra.

Water, Carbondioxide and ethanol show IR spectra.