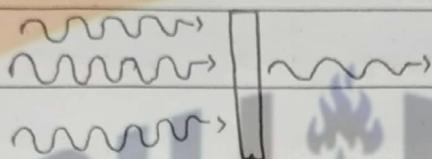


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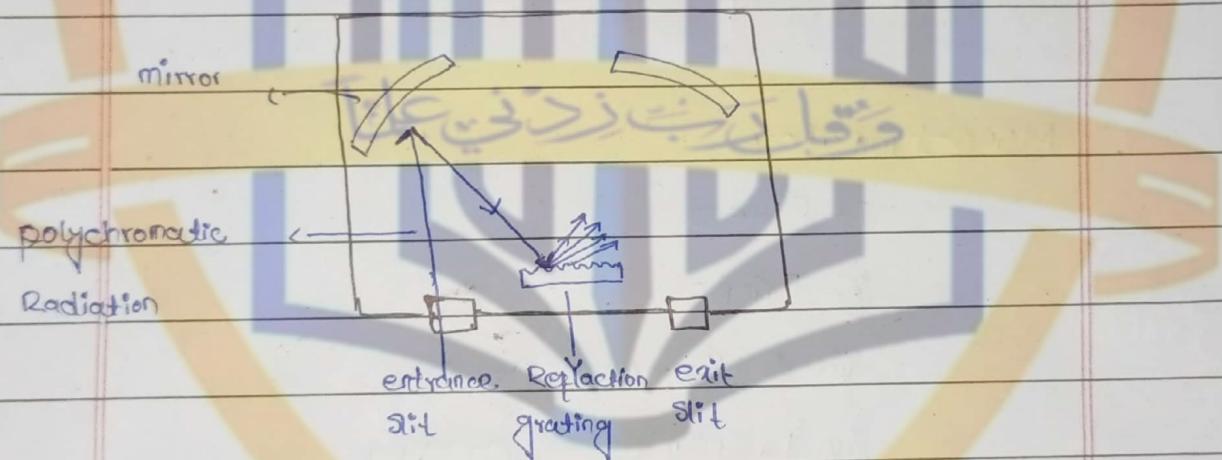
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Monochromator:

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 source. It allow only a narrow beam of light.
- Mirror are reflecting the light.
- Reflection grating which resolve the radiation component into different wavelength.
- An exit slit.

DAY: _____

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S.O
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 - Prism

iii - Diffraction grating

iv - Transmission grating

v - ~~Diffraction grating~~

i - Filters

Filters 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.

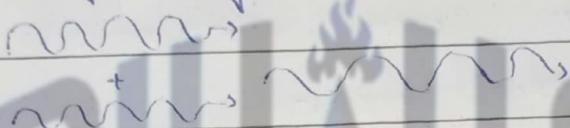
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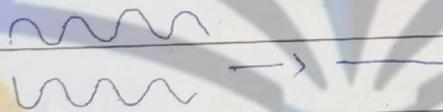
a) Interference filters:

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 waves
traveling in same direction are at the
crest of the one wave and the
trough of other wave.



Constructions:

→ Dielectric medium

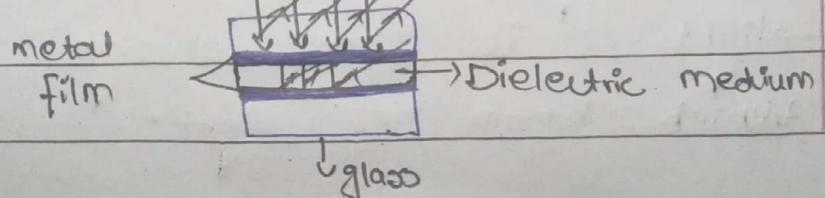
we use CO_2 and MgF_2 mostly commonly used.

→ Two metal film

one above and other below the
dielectric medium.

→ Whole assembly is enclosed in glass.

Diagrams:



D.A.Y: _____

D.I.T.E: _____

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 filters:

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.O
2012 (XIII)

Prisms Monochromators:

- Prism is made up of glass.
- light is pass through colkmeter which beam of light.

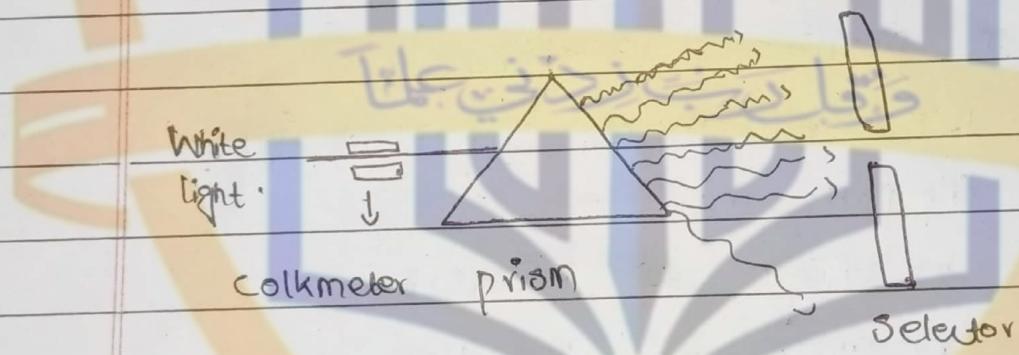
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→ The beam of light is passed through the prism. The prism resolve the beam of light into different wavelength.

→ The longer wavelength bent more than shorter wavelength occur.

→ Now we use Selector and select a specific wavelength and used in experiment.



longe

iii- Diffraction grating monochromators:

→ A

diffraction grating consist of parallel series of grooves on a reflecting surface.

→ The grooves can be consider as a separator mirror form which the reflect light interacted and interference occurs.

DAY: _____

DATE: _____

Two types of interference constructive
and destructive

Constructive

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

$$\text{path length} = n\lambda$$

The number of grooves 300 to
2000 per/mm.

The most common number of
grooves 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 reflection.

PUACP



iv- Transmission grating:

→ It is made up

of transparent glass.

→ On transparent glass equal
distance b/w grooves are form.

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

DAY: _____

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Workings:

When white light is fall on the transmission grating each light is transmitted from each grooves

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.

S.O
2022(XII)

Allowed transitions:

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 217 nm has E_{max} value

260 represent allowed transition

These transitions are mainly

favoured due to symmetry relationship.

✓ Forbidden transitions:

These are the

transition for which molar co-efficient E_{max} is generally less than 10^4 .

Example:

transition of saturated aldehyde

Showing weak absorption near 290nm

and having E_{max} less than 100 has been a forbidden transition.

S.Q. ✓
(2021) (Q)

Chromophore:

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

→ Absorb ~~U.V.~~ UV-visible light.

→ Give color to a molecule.

→ A part of molecules.

Example	transition	λ_{max}	E_{max}	Solvent
$\text{C}=\text{C}$	$\pi \rightarrow \pi^*$	175	15000	Vapour
	$\pi \rightarrow \pi^*$	175	1000	Hexane

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

Example:

$-\text{NH}_2$ attached benzene ring absorption change.

285nm (203) to 280nm ($E_{max} = 1430$).

DAY: _____

DATE: _____

S.Q.
2017(j) Role of Solvent in uv spectrophoty's
many

Solvent are available for use in the
uv-region. Three common Solvent

are Cyclo-hexane, 95% ethan and

1, 4 diazane. Solvents play an
important role in uv-spectra.

Compound peak so a shoulder be

observed 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(k) Grating over prism in UV/VIS
spectroscopy

Grating is generally better than

prisms. They are more efficient. They

provided 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 preferred over prism.

DAY: _____

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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 proportional to the intensity of incident radiation.

mathematically form

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

Absorbance is directly proportional to the path length of the sample

Separate variable

$$-\frac{dI}{I} = kdx$$

$$A \propto x - i^*$$

$$\frac{dI}{I} = -kdx$$

Taking integration with in limit

$$\int_{I_0}^I \frac{dI}{I} = -k \int_0^x dx$$

$$\left[\ln I \right]_0^I = -k \left[x \right]_0^x$$

$$\ln I - \ln I_0 = -k(x - 0)$$

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

Taking anti- ln

DATE: _____

DAY: _____

$$\frac{I}{I_0} = e^{-Kx}$$

$$[I = I_0 e^{-Kx}] - i$$

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

when change natural log by common log

$$2.303 \log \frac{I}{I_0} = -Kx$$

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

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

$$[I = I_0 10^{-\alpha x}] - ii)$$

II Beer's Law:

When a beam of monochromatic radiation is passed 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.

Solution:

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

Separate variable

Absorbance is directly proportional to the concentration of sample

$$A \propto C - 1$$

$$-\frac{dI}{I} = k' c dz$$

DAY: Integration within LimitATE:

$$\int_{I_0}^I \frac{dI}{I} = - \int_{x=0}^{x=z} k' c dz$$

$$\ln \left(\frac{I}{I_0} \right) = - k' c z$$

$$\ln I - \ln I_0 = k' c z$$

$$\frac{\ln I}{I_0} = k' c z$$

$$I = I_0 e^{-k' c z}$$

$$I = I_0 10^{-\alpha c z}$$

imploring
past paper
2021
Q&A(a)

Beer-Lambert Law

$$A \propto \text{exc}$$

A = absorbance

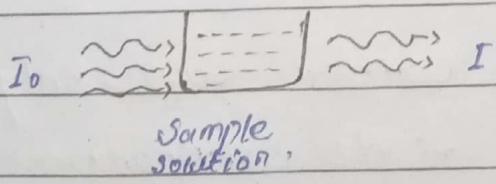
z = path length

c = concentration of sample solution.

$$A \propto E \times c$$

E = absorptivity constant.

Absorbance:



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

DAY: _____

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

 A = absorbance E = 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.

imprq Question
past paper
2012 GNO#10

Limitations:-

This

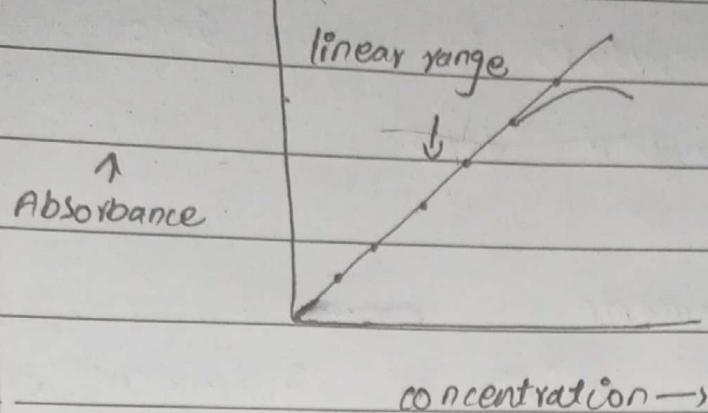
i - Dilute Solutions:

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 concentrations

$$A = E \cdot l$$

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

iv- Monochromatic light:

This law is only applicable to monochromatic radiation.

v- Temperature:

DAY: _____

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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.

PUACP

DAY: _____

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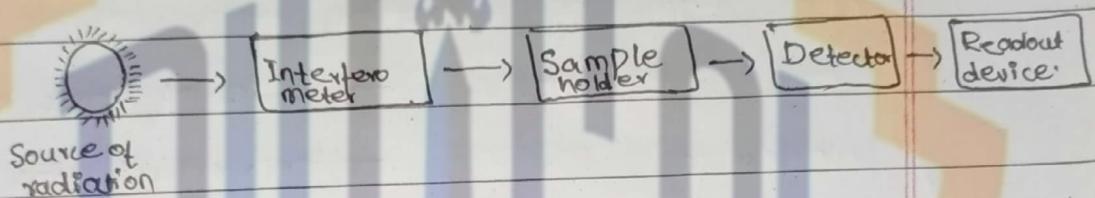
FTIR

=

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 Sources** **PUACP**

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

1) Nearest Glower

It is mostly used IR spectroscopy.

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

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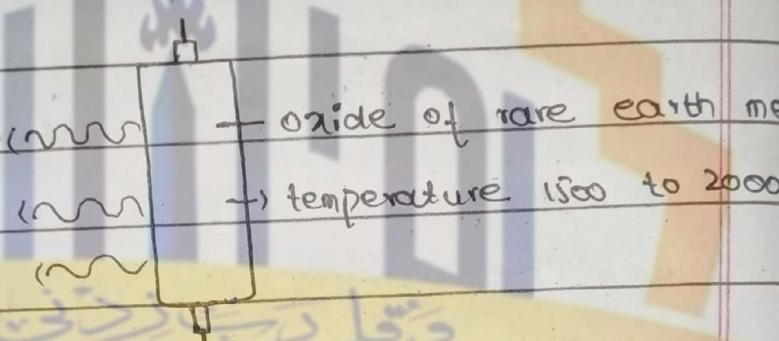
Like ZrO_2 , V_2O_3 and Y_2O_3 etc.

The diameter is 2mm

The length is about 2 to 5cm.

When we provide current and heated at $1500^\circ C$ to $2000^\circ C$ then

it emit IR radiation.



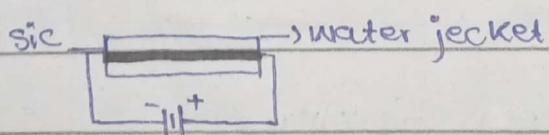
2) Globar:

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 $1400^\circ C$ temperature.



3) Incandescent wire:

i- Nichrome wire

Nikle and chromium

alloy. Heat at 800 to $900^\circ C$ emit IR radiation.

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less expensive

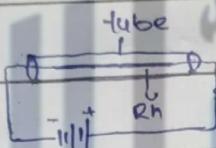
ii) Rhenium wires:

Rh is sealed inside

the tube of aluminum oxide.

It heated at 1200°C then emit

IR radiation.



iii) Interferometer:

In FTIR Michelson interferometer

is used.

Construction:

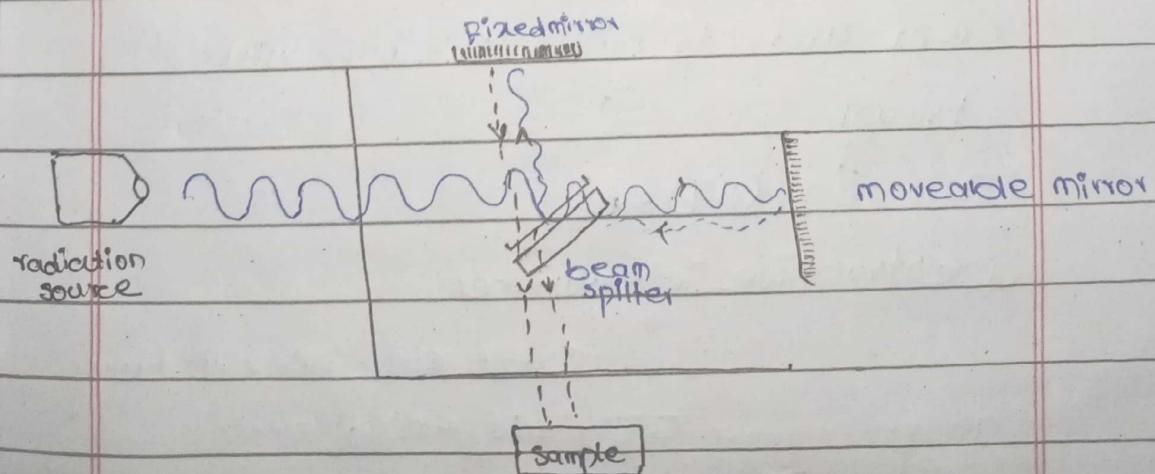
Michelson interferometer

is consist of three parts.

i - Beam Splitter

ii - Fixed mirror

iii - Moveable mirror



DAY: _____

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Beam Splitter:

Beam splitters are optical components used to split incident light into two parts. Beam splitters are placed at 45° . It is made up of special material that transmits one half of radiation and other half reflects.

Working:

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

Constructive Interference:

Create combine with crest and trough combine with trough

$$OPD = nL$$

Destructive Interference:

Create combine with trough

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

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⇒ Sample Holders:

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 transparent in IR region.

types:

three types of sample are used.

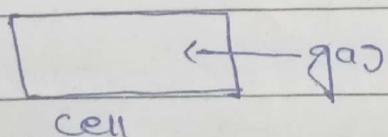
i - Solid

ii - Liquid

iii - Gas

Gas:

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



DAY: _____

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Liquid Sample:

Liquid sample used in two ways.

- i- Direct used: liquid sample are direct used
- ii- Solution form used: from solution ^{add} solvent.

These solvent are not interfer in IR

radiation. The mostly solvent used like CCl_4 , CHCl_3 , CS .

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 mix with **PIACP**.

Now add the suspension of

oil and solid sample place 10/10

plate of NaCl .

It is used for analysis of functional group.

- ii- KBr pellets:

KBr salt powder and

Solid sample powder mix in

DAY: _____

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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 - Thermister

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

blocken. Second end of wire connected

to Galvanometer.

Working:

When radiation fall on

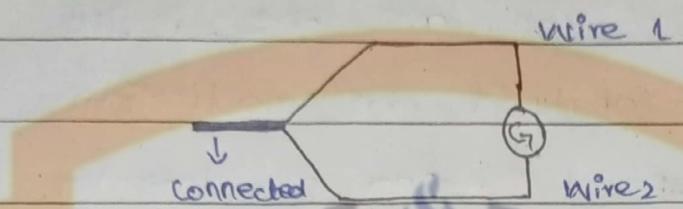
the blocken sides of wire temperature

increase on that side.

DAY: _____

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



Bolometers

Constructions

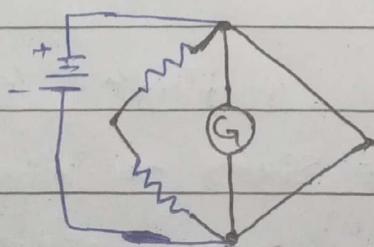
Construction is based on Wheatstone bridge.

Two resistors of known resistance are used.

Two Pt plates are also used.

If the temperature of one plate is increased or decreased and the 2nd plate is constant then apply IR radiation.

Galvanometer is used for the detection of currents.



DAY: _____

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Working:

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

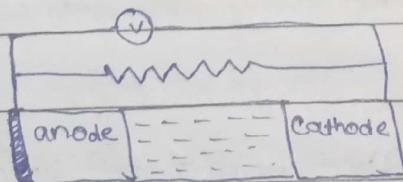
Pyroelectric Detector:

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.



IR transparent
window.

Pyromaterial

IR transparent window is attached to anode.

Working:

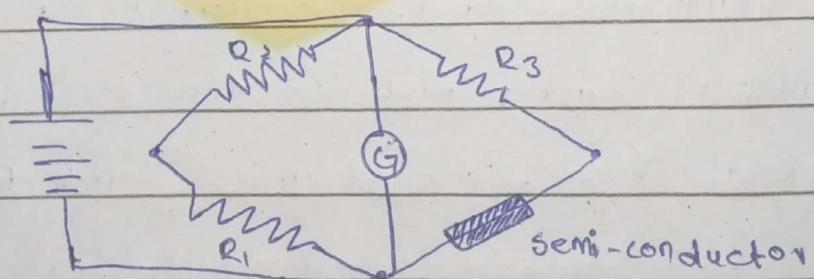
When IR radiation fall on anode the temperature of material increase and dipole are formed. When dipoles are formed then current is flow from circuit which is measure by using voltmeter.

Thermistor:

Construction:

It is a form of bolometer we use a material which has negative co-efficient of resistivity.

A Galvanometer is also used for the detection of current.



Working:

When IR radiation fall on the semi-conductor material.

DATE:

DAY:

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 Galvanometer is
increased.

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:

PUACP

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

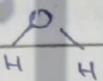
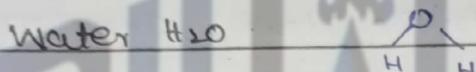
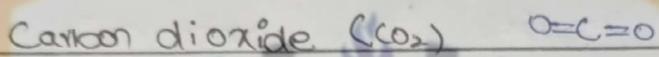
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IR Active:

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

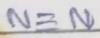
Example:



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:



Selection Rule of IR:

The Selection

rule for IR Spectroscopy stated that a molecule will absorb

infrared radiation if there is a change in its dipole moment

during the vibration. This

means 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, Carbon dioxide and
ethanol show IR spectra.