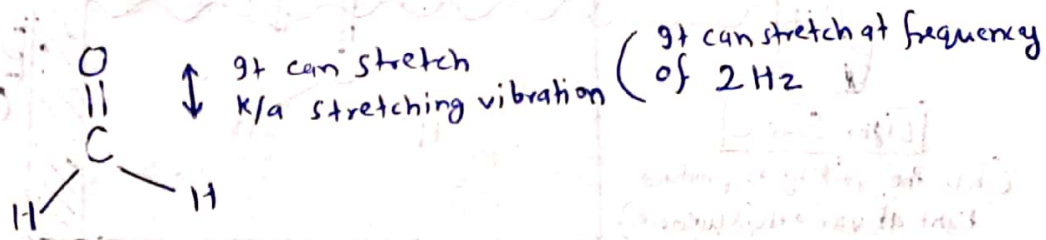


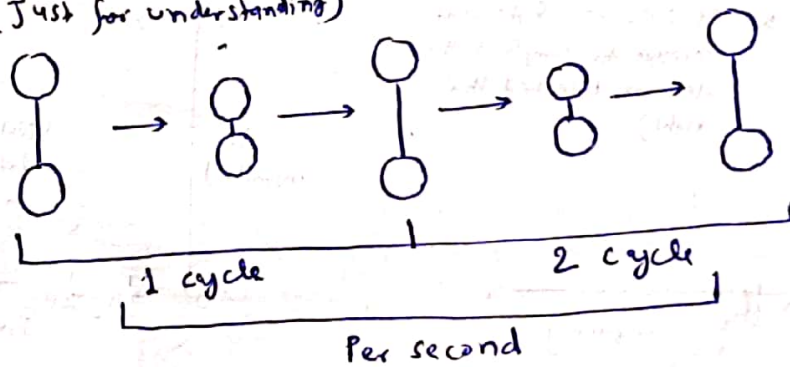
Infrared Spectroscopy

①



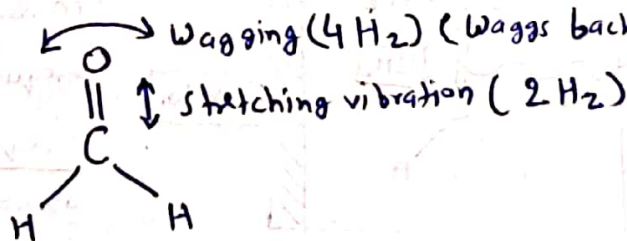
Formaldehyde (have Carbonyl functional group i.e. C doubly bonded to O)

→ Hz (Hertz) is a measure of cycle per second → So, when it is stretching at 2 Hz means (Just for understanding)



→ But actually it vibrates at a much much higher frequency.

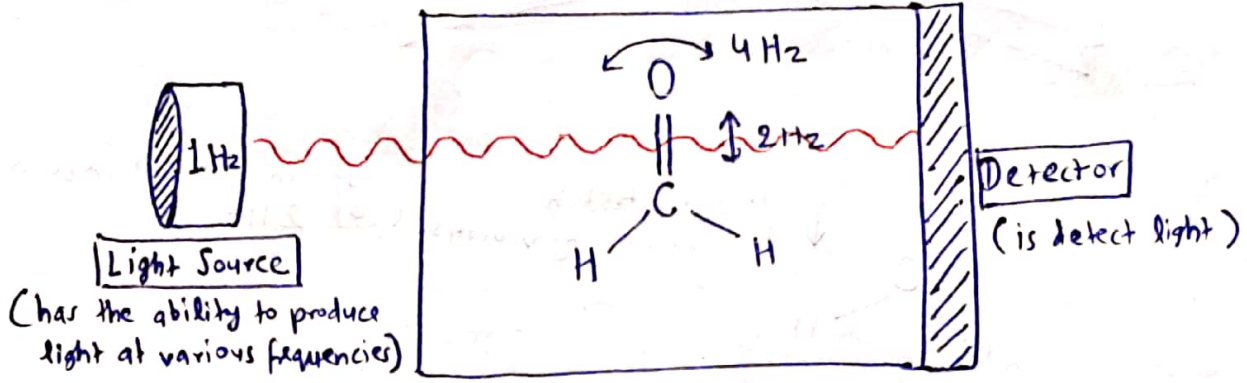
→ Vibration is temperature dependent. Just Assume room temperature for our example now: We could also measure the wagging, lets assume it wags at 4 Hz



2

At 1 Hz Frequency Light:

IR Spectrometer

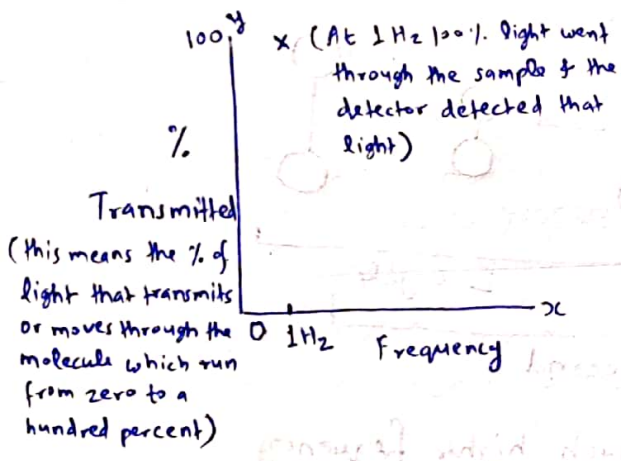


(has the ability to produce light at various frequencies)

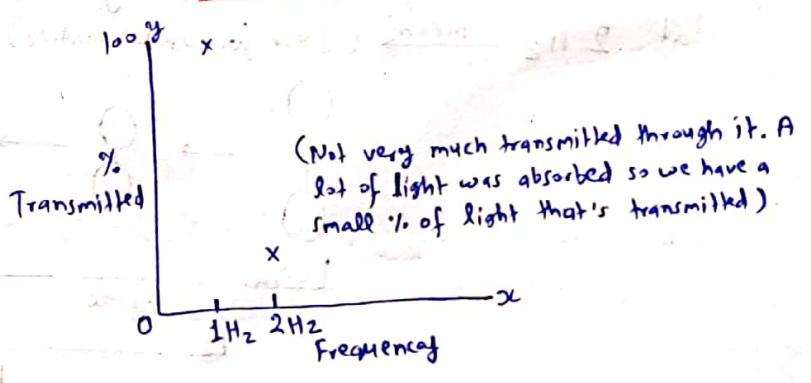
→ If we set the light source to deliver a light at

1 Hz frequency → It passes through the molecule → Hit the detector

Graph At 1 Hertz Frequency

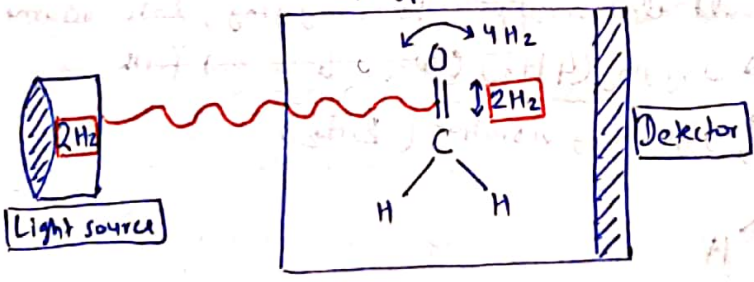


Graph At 2 Hertz Frequency



At 2 Hz Frequency Light:

IR Spectrometer



Molecule will absorb light at 2 Hz frequency

Frequency of light that's being absorbed in this case matches the frequency of the stretching when

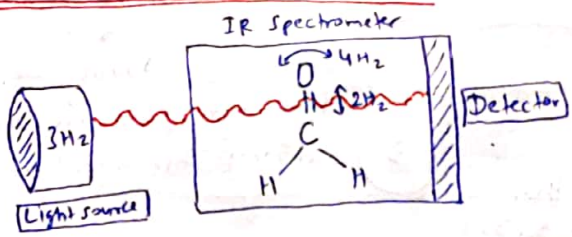
Detector doesn't detect the light

The molecule will absorb the light

← These things match up

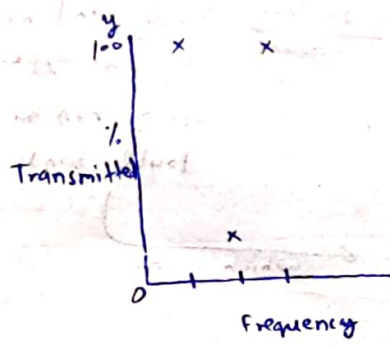
↓ b/c
Light was absorbed by the molecule

At 3Hz Frequency Light :-

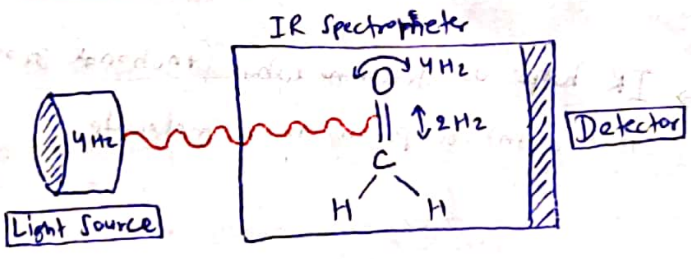


Detector would detect 100% of light transmitted through the molecule.

Graph At 3 Hertz Frequency

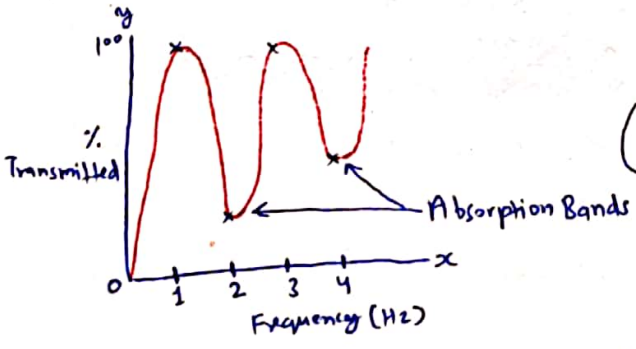


At 4Hz Frequency Light :-



At this frequency light will be absorbed but in some cases not all of light is absorbed

Graph At 4 Hertz Frequency



(These are the points that light is being absorbed by the sample molecule in the machine)

All carbon & oxygen are the same \rightarrow All carbon doubly bonded to Oxygen are the same as well

\downarrow This means

The molecule have a Carbonyl group

& if of any sample we put in the IR machine as long as we run it at room temperature

its going to \rightarrow Stretch & Wags at 2 & 4 Hz \rightarrow No matter what molecule to be in

4

Which means → If we run a sample molecule through the IR → We see absorption bands at 2 & 4 → then

Without any doubt, we can say that our molecule has a Carbonyl functional group

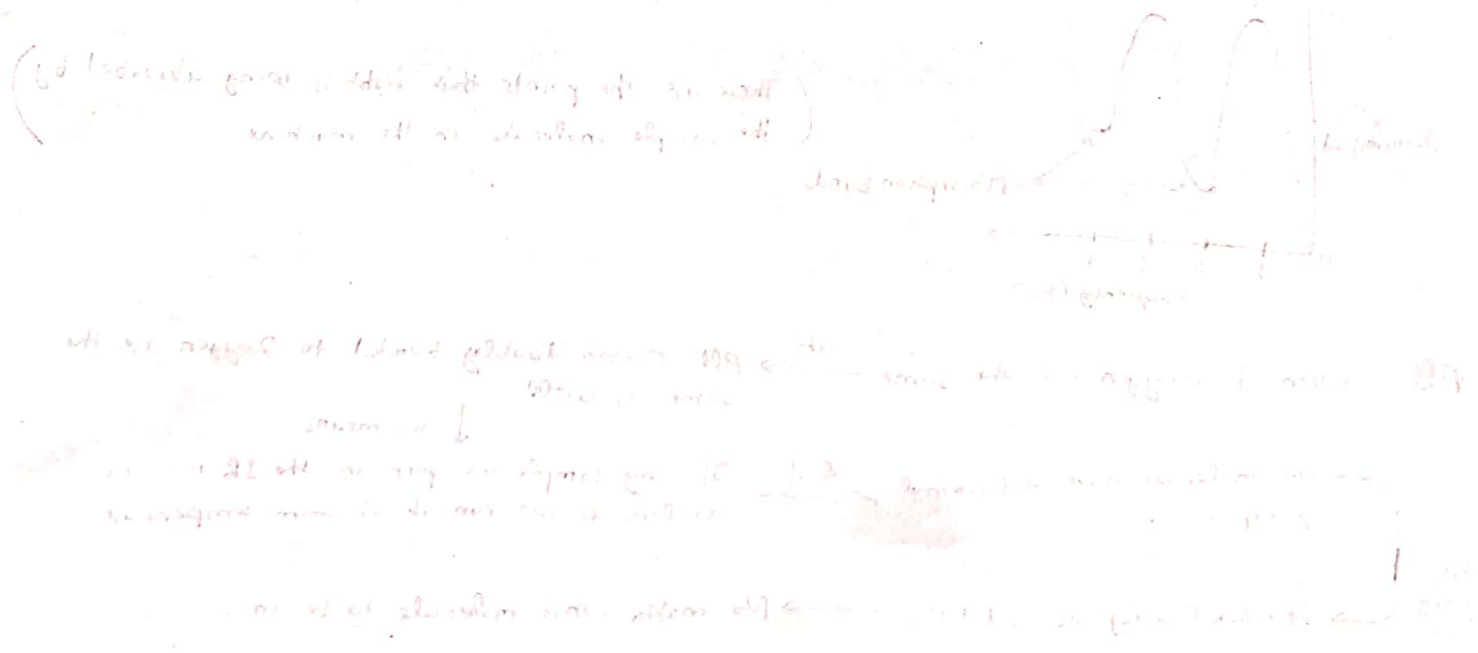
Lets assume that → Only carbonyls that stretch & waggs at those particular frequencies b/c

If Carbon were singly bonded to Oxygen → remember → single bonds are longer than double bond → so that means → single bond has different types of spring than the double bond

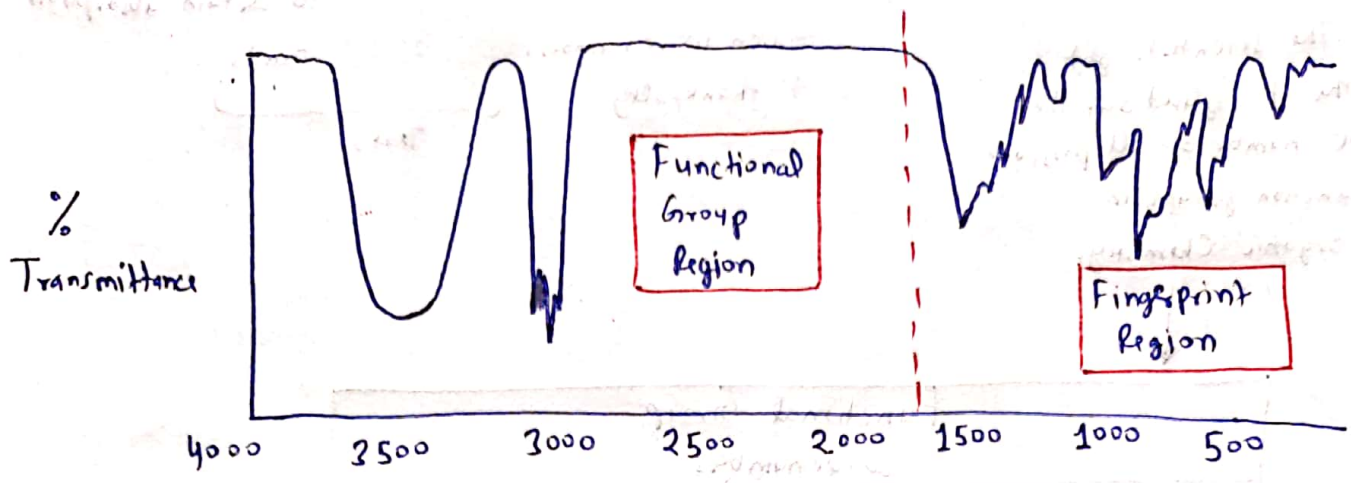
That bond would stretch & waggs at different frequencies than the C=O ← If molecule had a C singly bonded to an O (C-O) ← which means

& therefore → If have own unique absorption band → so → IR helps us determine what functional groups that might be present in a molecule.

functional groups in infrared



A Look on IR Spectra:



- ⇒ Some time spectra can be
 - Broad
 - Narrow
 - In between

→ In actual IR spectrum they don't put frequency on the X axis → They put wave number instead frequency.

→ There is a connection b/w frequency of light & wave number of light.
 ↓
 Absorption band happen at certain frequencies.
 ↓ & we can say
 Absorption bands happen at certain wave numbers

→ In above IR spectra, Wavenumber run from 4000-0.

→ In IR spectra, from 1800 - 4000 → is called Functional Group Region.
 (In this region certain types of functional group in the molecule were present.)

→ And in the other side (i.e. below 1800) is called Fingerprint Region.
 (Certain molecule have certain absorption bands in this region & those bands can act almost as fingerprint
 ↓ meaning that
 Every type of molecule in Organic Chemistry has a specific fingerprint region with its corresponding absorption bands
 ← That are unique to that molecule.

6

Remember here the whole basis of the IR machine is that → Certain functional groups corresponds to certain absorption bands

The scientists got together & figured out the wave number of all possible function groups in organic chemistry.

Given wave numbers & thankfully

That's

Functional Group Wavenumbers		
Bond	Wave	Intensity
O-H	3650 - 3200	Strong, broad
C-H	3300 - 2700	medium
N-H	3500 - 3300	medium, broad
C≡N	2260 - 2220	medium
C≡C	2260 - 2100	Weak-medium
C=C	1680 - 1600	medium
C=N	1650 - 1550	medium
C=O	1780 - 1650	Strong
C-O	1250 - 1050	Strong