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[TP] Express 2000 cm^{-1} in m^{-1}.

20% 1. 2000 m^{-1}
20% 2. 200000 m^{-1}
20% 3. 0.05 m^{-1}
20% 4. 0.0005 m^{-1}
20% 5. Something else

Lecture 8 CH101 A2 (MWF 11:15 am)

Friday, September 22, 2017

For today ...

- Review: Jiggling of bonded atoms
- Wavelength, frequency, and wavenumber

Next lecture: Infrared (IR) spectra; Ch4: (secs 1, 3, and 4 only): Atmospheric warming
Think about It e4.4: Collisional heating http://goo.gl/vQ0Nz
Think about It e4.5: IR windows http://goo.gl/I8IGz

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Jiggling of bonded atoms

Lighter faster; stronger faster; dissimilar approaches lighter

Interactive exploration

http://quantum.bu.edu/CDF/101/IRFrequency.cdf

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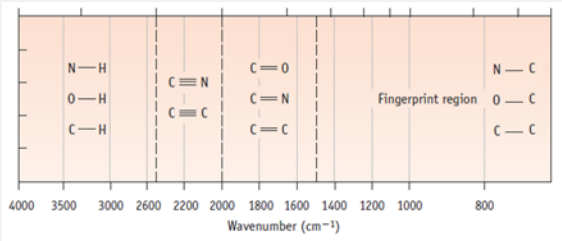
IR spectra detect function groups

Lighter faster; stronger faster; dissimilar approaches lighter



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Wavelength, frequency, and wavenumber

BOSTON UNIVERSITY 6

What's "nu"?

Frequency $\nu = c/\lambda$

Speed of light $c = 299792458$ m/s ($\approx 3 \times 10^8$ m/s)

Energy exchanged with matter $\propto \nu$

Since $1/\lambda \propto \nu$, ...

energy exchanged with matter also $\propto$ wavenumber $1/\lambda$

BOSTON UNIVERSITY 8

What's "nu"? ν = *c* / λ, *c* = 299792458 m/s

Get practice by working through tutorials e3.15 (p 75)

What is the frequency of orange light, $\lambda = 600$ nm?

Answer: $c/\lambda = 5 \times 10^{14}$/s

BOSTON UNIVERSITY 9

What's "nu"? ν = *c* / λ, *c* = 299792458 m/s

Get practice by working through tutorials e3.15 (p 75)

Wavelength (in nm) and visibility of 2×10^{15}/s light?

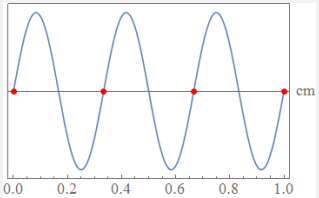
Answer: $\lambda = c/ (2.0 \times 10^{15}\text{/s}) = 150$ nm ; in UV so not visible

BOSTON UNIVERSITY 10

wavelength λ, frequency ν, wavenumber $\tilde{\nu}$ = 1 / λ

Wavenumber is the number of waves (wavelengths) that fit in one cm.

Here is figure spanning 1 cm, showing a wave with speed $u = \nu\lambda = 1$ cm/s.

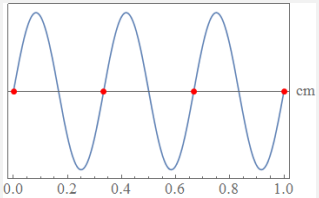


So, $\nu = 3/s$ and $\lambda = 1/3$ cm.

wavelength λ, frequency ν, wavenumber $\tilde{\nu}$ = 1 / λ

Wavenumber is the number of waves (wavelengths) that fit in one cm.

The figures shows that there are 3 wavelengths in 1 cm.

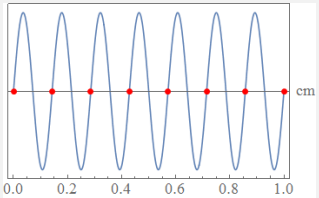


So, in this case the wavenumber is $\tilde{\nu} = 3/\text{cm}$.

wavelength λ, frequency ν, wavenumber $\tilde{\nu}$ = 1 / λ

Wavenumber is the number of waves (wavelengths) that fit in one cm.

This figure shows that there are 7 wavelengths in 1 cm.

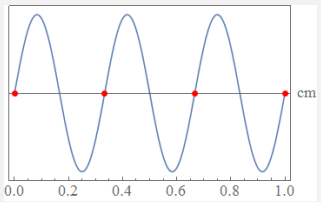


So, in this case the wavenumber is $\tilde{\nu} = 7/\text{cm}$.

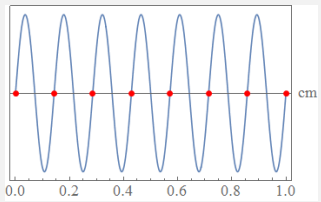
wavelength λ, frequency ν, wavenumber $\tilde{\nu}$ = 1 / λ

Wavenumber is the number of waves (wavelengths) that fit in one cm.

Larger wavenumber means smaller wavelength.



$\tilde{\nu} = 3/\text{cm}$, $\lambda = 1/3$ cm



$\tilde{\nu} = 7/\text{cm}$, $\lambda = 1/7$ cm

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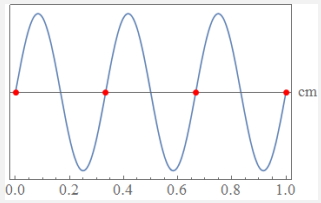
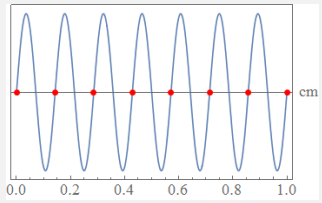
wavelength λ, frequency ν, wavenumber $\tilde{\nu}$ = 1 / λ

Wavenumber is the number of waves (wavelengths) that fit in one cm.

Larger wavenumber means larger frequency.



$\tilde{\nu} = 3/\text{cm}$, $\nu = 3/\text{s}$



$\tilde{\nu} = 7/\text{cm}$, $\nu = 7/\text{s}$

[TP] Express 2000 $\text{cm}^{-1} = 2000/\text{cm}$ in m^{-1}.

20% 1. 2000 $\text{m}^{-1} = 2000/\text{m}$
20% 2. 200000 $\text{m}^{-1} = 200000/\text{m}$
20% 3. 0.05 $\text{m}^{-1} = 0.05/\text{m}$
20% 4. 0.0005 $\text{m}^{-1} = 0.0005/\text{m}$
20% 5. Something else

wavelength λ, frequency ν, wavenumber $\tilde{\nu}$ = 1 / λ

The frequency of a light wave (speed = c) with
$\tilde{\nu} = 2000\ \text{cm}^{-1} = 2000/\text{cm}$ is ...

wavelength λ, frequency ν, wavenumber $\tilde{\nu}$ = 1 / λ

The wavelength of a light wave (speed = c) with
$\tilde{\nu} = 2000\ \text{cm}^{-1} = 2000/\text{cm}$ is ...

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What's "nu"? $\nu = c / \lambda$, c = 299792458 m/s

Get practice by working through tutorials e3.15 (p 75)

What is frequency of motion at $\tilde{\nu} = 3000\ \text{cm}^{-1}$?

Answer: $c \times 1/\lambda = 9 \times 10^{13}$/s ; in IR so not visible

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wavelength λ versus wavenumber $\tilde{\nu} = 1 / \lambda$

Given wavelength λ, get frequency ν by dividing it into c.

$\lambda = 3000$ nm $\rightarrow \nu = c / \lambda =$

$\nu = (3 \times 10^{8}\ \text{m/s}) / (3000 \times 10^{-9}\ \text{m}) = 1 \times 10^{+14}$/s

Given wavenumber $\tilde{\nu} = 1 / \lambda$, get ν by multiplying it by c.

$\tilde{\nu} = 3000\ \text{cm}^{-1} \rightarrow \nu = c \times \tilde{\nu} =$

$\nu = (3 \times 10^{10}\ \text{cm/s}) \times (3000\ \text{cm}^{-1}) = 9 \times 10^{+13}$/s

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[Quiz] Which has the lowest frequency (of jiggling)?

0% 1. An antisymmetric H stretch at 9×10^{13}/s
0% 2. A sulfide, C–S, stretch at 600 cm^{-1}
0% 3. Red light at 700 nm
0% 4. Visible light at 6×10^{14}/s

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