Q- How many translational, rotational and vibrational degree of freedoms are shown by He, H_2, HCl, CO_2, H_2O and C_6H_6.

Sol^ns-

① He - No. of atoms, $n = 1$ ∵ No. of degree of freedom $= 3n$

$\therefore N_{tr} = 3$, $N_{rot} = 0$, $N_{vib} = 0$. $= 3$

② H_2 - No. of atoms, $n = 2$

No. of degree of freedom $= 3n = 3 \times 2 = 6$

$\therefore N_{tr} = 3$, $N_{rot} = 2$, $N_{vib} = 3 \times 2 - 5 = 1$

HCl - No. of atoms, $n = 2$

No. of degree of freedom $= 3n = 3 \times 2 = 6$

$\therefore N_{tr} = 3$, $N_{rot} = 2$, $N_{vib} = 3 \times 2 - 5 = 1$

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(4) CO_2 ; No. of atoms, $n = 3$, A Linear molecule
No. of degree of freedom $= 3n = 3 \times 3 = 9$
$\therefore N_{tr} = 3$, $N_{rot} = 2$; $N_{vib} = 3 \times 3 - 5 = 4$

(5) H_2O , No. of atoms, $n = 3$, A nonlinear molecule
No. of degree of freedom $= 3n = 3 \times 3 = 9$
$\therefore N_{tr} = 3$, $N_{rot} = 3$, $N_{vib} = 3 \times 3 - 6 = 3$

(6) C_6H_6 , No. of atoms, $n = 12$, A nonlinear molecule
No. of degree of freedom $= 3n = 3 \times 12 = 36$
$\therefore N_{tr} = 3$, $N_{rot} = 3$, $N_{vib} = 3 \times 12 - 6 = 30$

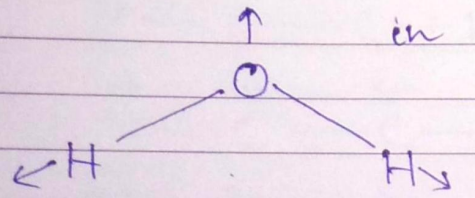
Q- Diagrammatically represents the different normal modes of vibrations of CO_2, H_2O and C_2H_2.

Soln

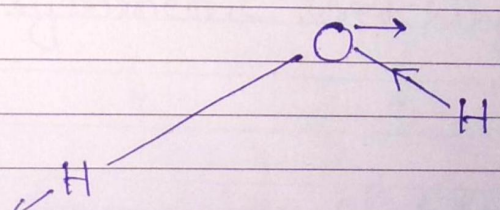
(1) H_2O - $n = 3$, A non-linear molecule

$\therefore N_{vib} = 3n - 6 = 3 \times 3 - 6 = 3$

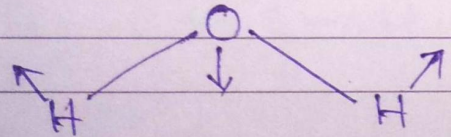
There are three normal modes of vibration in H_2O.



Symmetric stretching



Asymmetric stretching.



symmetric bending.

Remarks

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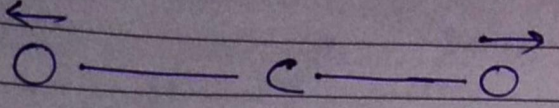
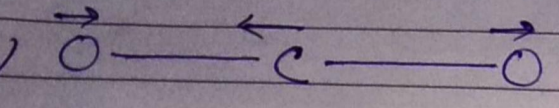
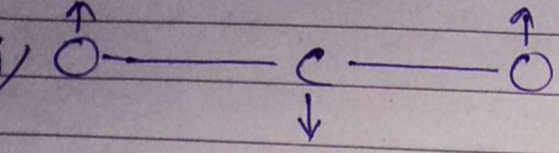
(2) CO_2 - $n=3$, A linear molecule

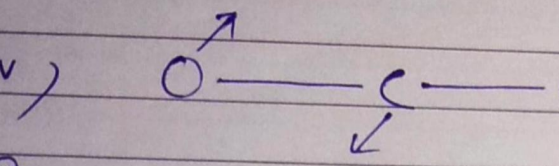
$N_{vib} = 3n-5 = 3\times3-5 = 4$

Four normal modes of vibrations are possible.

i)  Symmetric stretching.

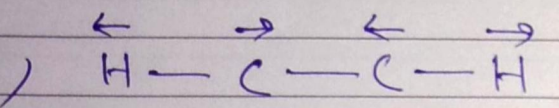
ii)  Asymmetric stretching.

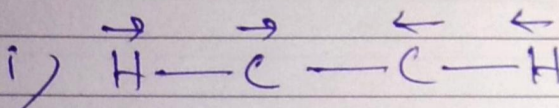
iii)  Bending in plane.

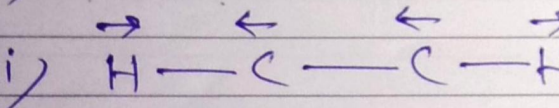
iv)  Bending out of plane.

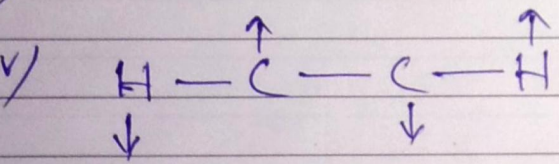
(3) C_2H_2 - $n=4$, A linear molecule.

$N_{vib} = 3n-5 = 3\times4-5 = 7$

i)  Symmetric stretching.

ii)  〃 〃

iii)  Asymmetric stretching.

iv)  Bending in plane

Remarks

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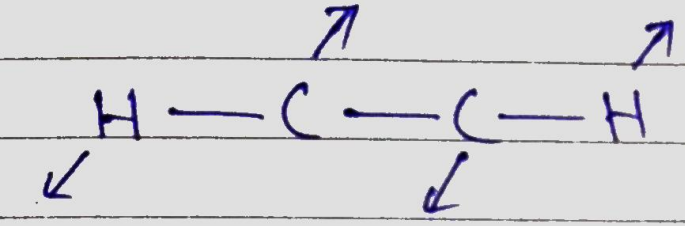
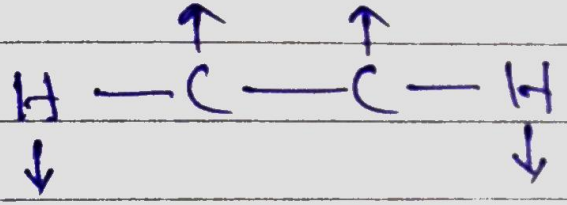
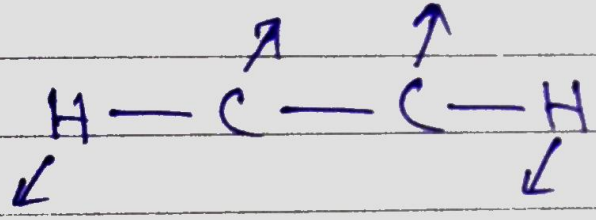
v)  Bending out of plane.

vi)  Bending in plane.

vii)  Bending out of plane.