

## Task#85363

**What is zero point energy? Calculate the number of normal modes of vibration for the following compounds:**

**(i) PF<sub>3</sub> (ii) ClNO (iii) XeF<sub>2</sub>**

**Soution:** The vibration energy of a molecule is given by  $E=(v+1/2)h\nu$

where,  $v$ = vibrational quantum number,  $\nu$ =frequency of vibration of the bond,

At 0 K  $E_0=(1/2)h\nu$ , where,  $E_0$ =zero point energy.

That means even at 0 K temperature bond is vibrating

In order to describe a point in 3d space we need three co-ordinates. So total degree of freedom =3. So molecules containing N number of atoms =3N,

Among 3N degrees of freedom there are 3 translational degrees of freedom along co-ordinate axis and 3 rotational degrees of freedom for non-linear molecules, 2 for linear molecules. Since for linear molecules rotation along its bond axis does not change its co-ordinates.

Therefore, Total number of vibrational degrees of freedom for linear molecules=(3N-5)

And for non-linear molecules=(3N-6)

**(i) PF<sub>3</sub>:** Shape- Trigonal pyramidal (Non-linear)

Therefore, Total number of vibrational degrees of freedom=(3×4)-6=6

The number of normal modes of vibration=6

**(ii) ClNO:** Shape: V shaped (Non-linear)

Therefore, Total number of vibrational degrees of freedom=(3×3)-6=3

The number of normal modes of vibration=3

**(iii) XeF<sub>2</sub>:** Shape: Linear

Therefore, Total number of vibrational degrees of freedom=(3×3)-5=4

The number of normal modes of vibration=4