AIM:

1. Plot Maxwell Speed Distributions at different temperatures in a 3-d System.

2. Calculate :

(a) Most Probable Speed

(b) Average Speed

(c) RMS Speed

Step-1 : Import necessary libraries

In [19]:

```
import numpy as np
import matplotlib.pyplot as plt
```

Step-2 : Define required constants

In [20]:

```
k = 1.38e-23 #Boltzmann Constant
N = 6.022e23 #Avagadro Number
```

Step-3 : Take necessary inputs from the user & find molecular mass (in kg) from given data

In [42]:

```
name = input("Enter the name of the gas : ")
M = float(input("Enter the molar mass of given gas in g/mol : "))
m = M/(N*1000) #Molecular Mass in kg (for 1 molecule)
```

```
Enter the name of the gas : Oxygen
Enter the molar mass of given gas in g/mol : 16
```

Step-4 : Define the range for velocity

In [9]:

```
v = np.arange(0,2000)
```

The distribution function for speed of particles in an ideal gas at temperature *T* is given by

$$f(v) = 4\pi\left(\frac{m}{2\pi kT}\right)^{3/2} v^2 e^{-mv^2/2kT}$$

m is the mass of gas molecules
k is the Boltzmann constant
T is the absolute temperature
v represents the speed of gas molecules

$$\text{Let } a = \frac{m}{2kT}$$

$$\boxed{f(v) = 4\pi\left(\frac{a}{\pi}\right)^{3/2} v^2 e^{-av^2}}$$

Step-5 : Using above formula, formulate a function for MSD function

In [22]:

```
def f(v,T):
    a = m/(2*k*T)
    return 4*(np.pi)*((a/np.pi)**(3/2))*(v**2)*(np.exp(-a*(v**2)))
```

Step-6 : Using above created function, evaulate MBD function at 3 different temperatures

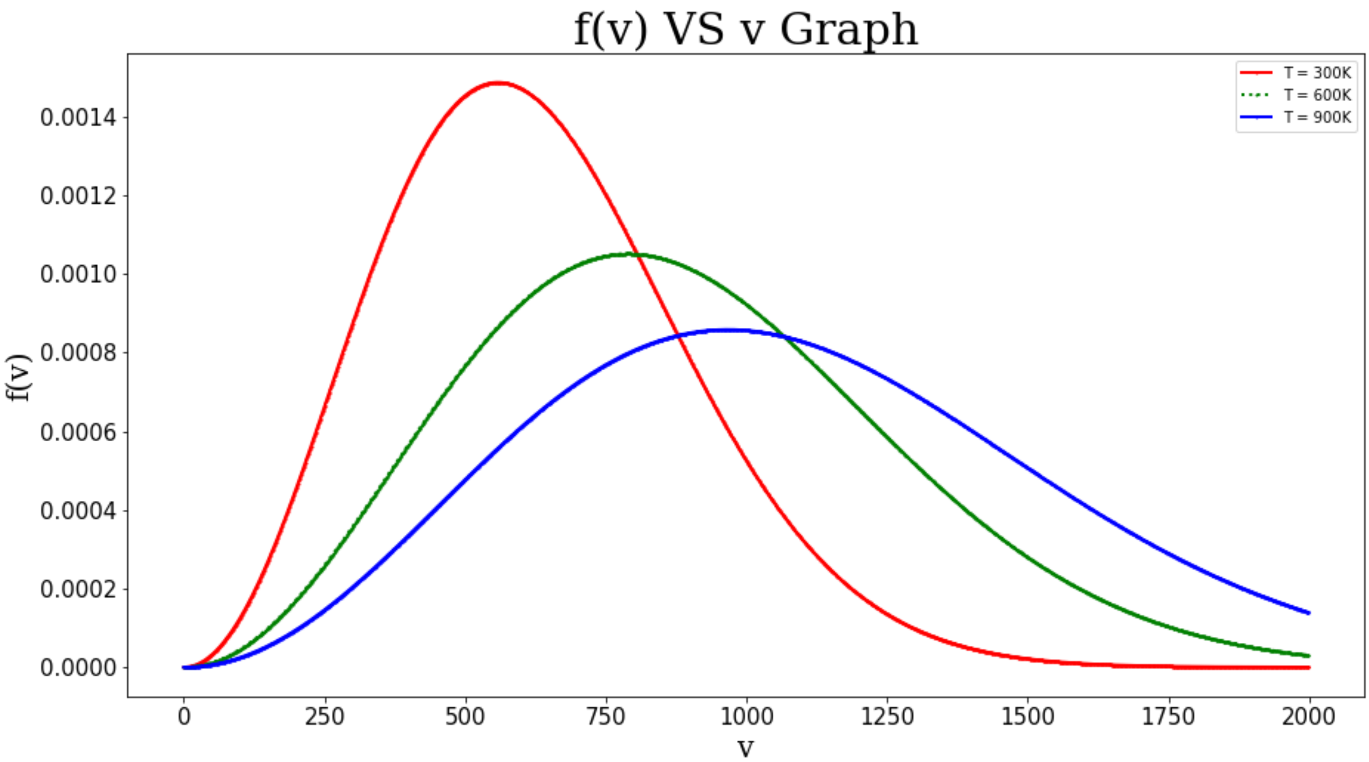
In [43]:

```
#Let us evaulate function at 3 different temperatures : Ta=300K ; Tb=600K ; Tc=900K

Ta = 300 #in Kelvin
fa = f(v,Ta)

Tb = 600 #in Kelvin
fb = f(v,Tb)

Tc = 900 #in Kelvin
fc = f(v,Tc)
```

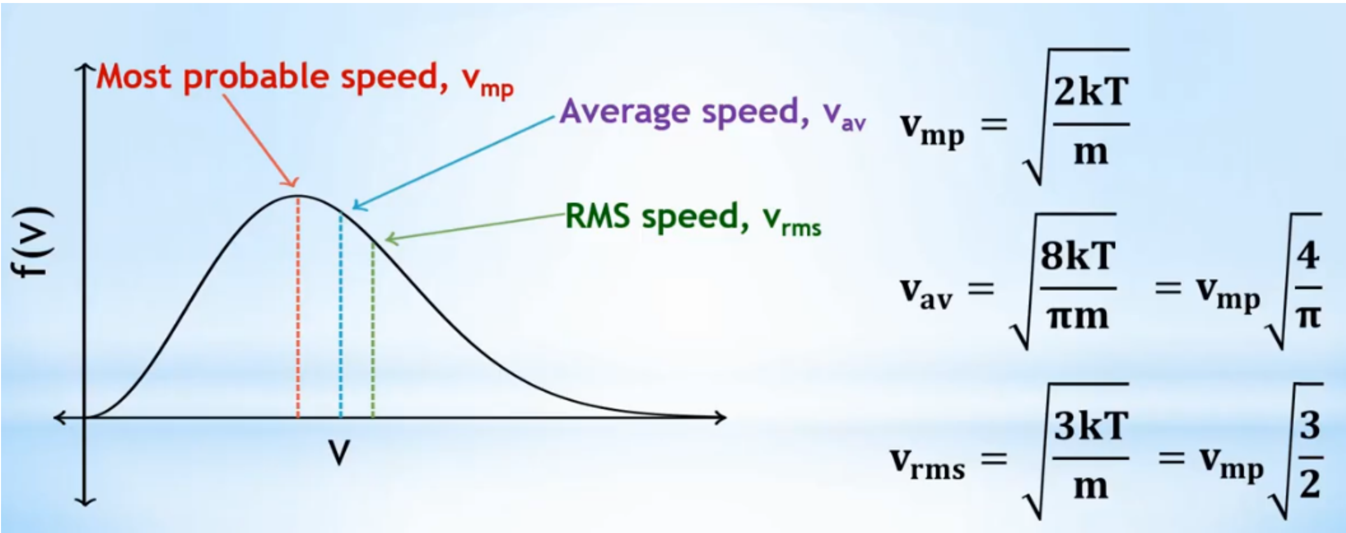
Step-7 : Plot the MBD function at given temperatures

In [44]:

```
plt.figure(figsize=(15,8)) #Setting size of the figure
fontji = {'family':'serif','size':20}
fontji2 = {'family':'serif','size':30}

plt.plot(v,fa,"o-r",lw="2",ms="1",label="T = 300K")
plt.plot(v,fb,"o:g",lw="2",ms="1",label="T = 600K")
plt.plot(v,fc,"o-b",lw="2",ms="1",label="T = 900K")
plt.legend(loc="best")
plt.xlabel("v",fontdict=fontji)
plt.ylabel("f(v)",fontdict=fontji)
plt.title("f(v) VS v Graph",fontdict=fontji2)
plt.xticks(fontsize=15)
plt.yticks(fontsize=15)
plt.show()
```



Step-8 : Evaluate Most Probable, Average & RMS Speed



In [45]:

```python
#All velocities are in m/s
a = np.where(fa == fa.max())
Vmp1 = v[a]
Vav1 = Vmp1 * np.sqrt(4/np.pi)
Vrms1 = Vmp1 * np.sqrt(3/2)
print("At T = 300K")
print("Most Probable Speed = ",Vmp1)
print("Average Speed = ",Vav1)
print("RMS Speed = ",Vrms1)

b = np.where(fb == fb.max())
Vmp2 = v[b]
Vav2 = Vmp2 * np.sqrt(4/np.pi)
Vrms2 = Vmp2 * np.sqrt(3/2)
print("\nAt T = 600K")
print("Most Probable Speed = ",Vmp2)
print("Average Speed = ",Vav2)
print("RMS Speed = ",Vrms2)

c = np.where(fc == fc.max())
Vmp3 = v[c]
Vav3 = Vmp3 * np.sqrt(4/np.pi)
Vrms3 = Vmp3 * np.sqrt(3/2)
print("\nAt T = 900K")
print("Most Probable Speed = ",Vmp3)
print("Average Speed = ",Vav3)
print("RMS Speed = ",Vrms3)
```

```
At T = 300K
Most Probable Speed =  [558]
Average Speed =  [629.63557524]
RMS Speed =  [683.40763824]

At T = 600K
Most Probable Speed =  [789]
Average Speed =  [890.29116284]
RMS Speed =  [966.32370353]

At T = 900K
Most Probable Speed =  [967]
Average Speed =  [1091.14265458]
RMS Speed =  [1184.32829064]
```