RELATIVISTIC AND NON RELATIVISTIC

Before moving to the practical lets see the basic terms and definition for proper understanding:

Relativistic Bosons:

Relativistic bosons are particles that obey Bose-Einstein statistics and have energies comparable to their rest mass energy. The distribution function for bosons is given by the Bose-Einstein distribution:

$$n(E) = \frac{1}{\exp\left(\frac{E-\mu}{k_B T}\right) - 1}$$

where:
- E is the energy of the particles.
- μ is the chemical potential.
- k_B is the Boltzmann constant.
- T is the temperature.

The density of states $g(E)$ in three dimensions for relativistic particles (considering spin s and volume V) is:

$$g(E) = \frac{2s \cdot 4\pi V}{h^3 c^3} E^2$$

The particle distribution with respect to energy is given by:

$$\frac{dN}{dE} = g(E) \cdot n(E)$$

Non-relativistic Bosons:

Non-relativistic bosons are particles whose kinetic energy is much less than their rest mass energy. The distribution function for bosons is still the Bose-Einstein distribution, but the density of states $g(E)$ for non-relativistic particles is different:

$$g(E) = \frac{(2s+1) \cdot 2\pi V (2m)^{3/2}}{h^3} E^{1/2}$$

Here, m is the mass of the particles. The particle distribution with respect to energy remains:

$$\frac{dN}{dE} = g(E) \cdot n(E)$$

Relativistic Fermions:

Relativistic fermions are particles that obey Fermi-Dirac statistics and have energies comparable to their rest mass energy. The distribution function for fermions is given by the Fermi-Dirac distribution:

$$n(E) = \frac{1}{\exp\left(\frac{E-\mu}{k_B T}\right) + 1}$$

The density of states $g(E)$ in three dimensions for relativistic particles is:

$$g(E) = \frac{2s \cdot 4\pi V}{h^3 c^3} E^2$$

The particle distribution with respect to energy is:

$$\frac{dN}{dE} = g(E) \cdot n(E)$$

Non-Relativistic Fermions:

Non-relativistic fermions are particles whose kinetic energy is much less than their rest mass energy. The Fermi-Dirac distribution still applies. The density of states $g(E)$ for non-relativistic particles is:

$$g(E) = \frac{(2s+1) \cdot 2\pi V (2m)^{3/2}}{h^3} E^{1/2}$$

The particle distribution with respect to energy is:

$$\frac{dN}{dE} = g(E) \cdot n(E)$$

EXPERIMENT 8

AIM: Plot the distribution of particles w.r.t. energy (dN/dE versus E) in 3 Dimensions for relativistic bosons both at high and low temperature.

CODE:

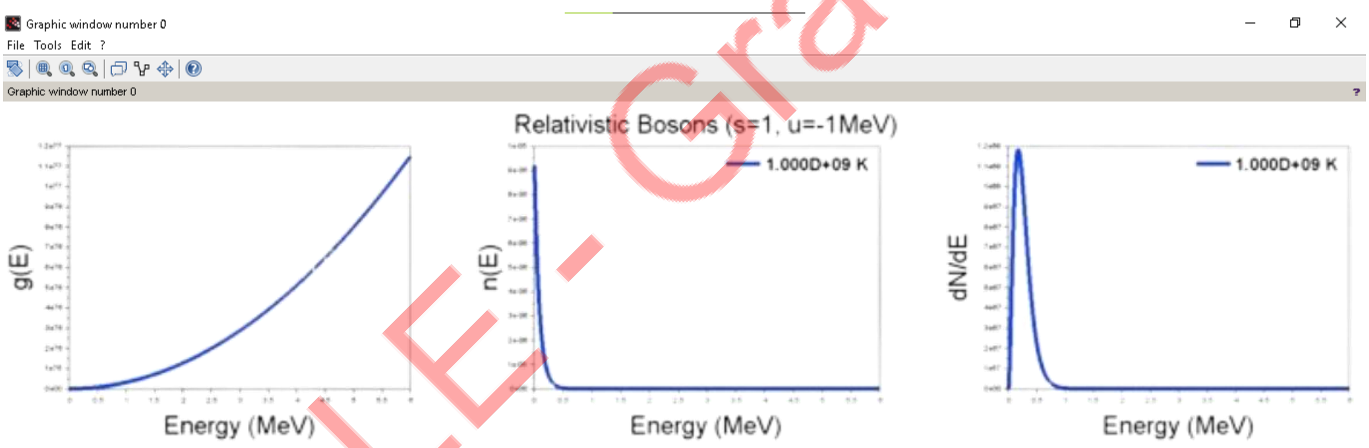
```
clc;clf;clear;
e=1.6e-19;,Kb=1.38e-23;h=6.626e-34;s=1;u=-1;V=1;c=3e8; //initialising the constant
E=0:0.001:0.5  //in MeV
T=[10^8 10^9];
Cr=(2*s*4*3.14*V)/((h^3)*(c^3));  //defining g(E)
for j=1:length(T)
     b=1/(Kb*T(j));
     for i=1:length(E)
        g(i)=Cr*(E(i))^2;
        n(j,i)=1/(exp((E(i)-u)*10^6*e*b)-1);
```

```
        f(j,i)=g(i)*n(j,i);  //defining dN/dE
     end
     subplot(2,3,j*j)   //plotting the graphs
     plot(E',g,'linewidth',4);
     ylabel('g(E)','fontsize',4);
     xlabel('Energy(MeV)','fontsize',4);

     subplot(2,3,j*j+1)
     plot(E',n(j,:)','linewidth',4); legend(string(T)+'K');
     ylabel('n(E)','fontsize',4);
     xlabel('Energy(MeV)','fontsize',4);
     title('Relativistic Bosons(s='+string(s)+',u='+string(u)+'MeV)');

     subplot(2,3,j*j+2)
     plot(E',f(j,:)','linewidth',4); legend(string(T)+'K');
     ylabel('dN/dE','fontsize',4);
     xlabel('Energy(MeV)','fontsize',4)
end
```

OUTPUT:



EXPERIMENT 9

AIM: Plot the distribution of particles w.r.t. energy (dN/dE versus E) in 3 Dimensions for non-relativistic bosons both at high and low temperature.

CODE:

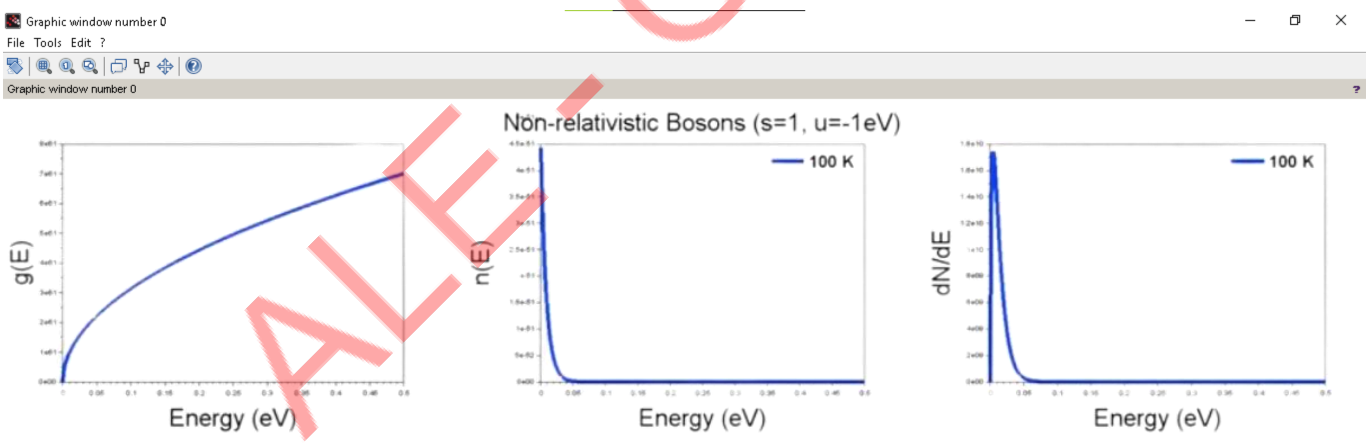
```
clc;clf;clear;
e=1.6e-19;,Kb=1.38e-23;h=6.626e-34;s=1;u=-1;V=1;
m = 4*1.66e-27;      //initialising the constant
E=0:0.001:0.5 //in eV
T=[100 1000];
Cn=((2*s+1)*(2*3.14*V)*(2*m)^1.5)/(h^3);     //defining g(E)
for j=1:length(T)
```

```
      b=1/(Kb*T(j));
      for i=1:length(E)
      g(i)=Cn*(E(i))^2;
      n(j,i)=1/(exp((E(i)-u)*e*b)-1);
      f(j,i)=g(i)*n(j,i);    //defining dN/dE
      end
subplot(2,3,j*j)     //plotting the graphs
plot(E',g,'linewidth',4);
ylabel('g(E)','fontsize',4);
xlabel('Energy(MeV)','fontsize',4);

subplot(2,3,j*j+1)
plot(E',n(j,:)','linewidth',4); legend(string(T(j))+'K');
ylabel('n(E)','fontsize',4);
xlabel('Energy(eV)','fontsize',4);
title('Non Relativistic Bosons(s='+string(s)+',u='+string(u)+'eV)');

subplot(2,3,j*j+2)
plot(E',f(j,:)','linewidth',4); legend(string(T(j))+'K');
ylabel('dN/dE','fontsize',4);
xlabel('Energy(eV)','fontsize',4)
end
```

OUTPUT:



EXPERIMENT 10

AIM: Plot the distribution of particles w.r.t. energy (dN/dE versus E) in 3 Dimensions for relativistic fermions both at high and low temperature.

CODE:

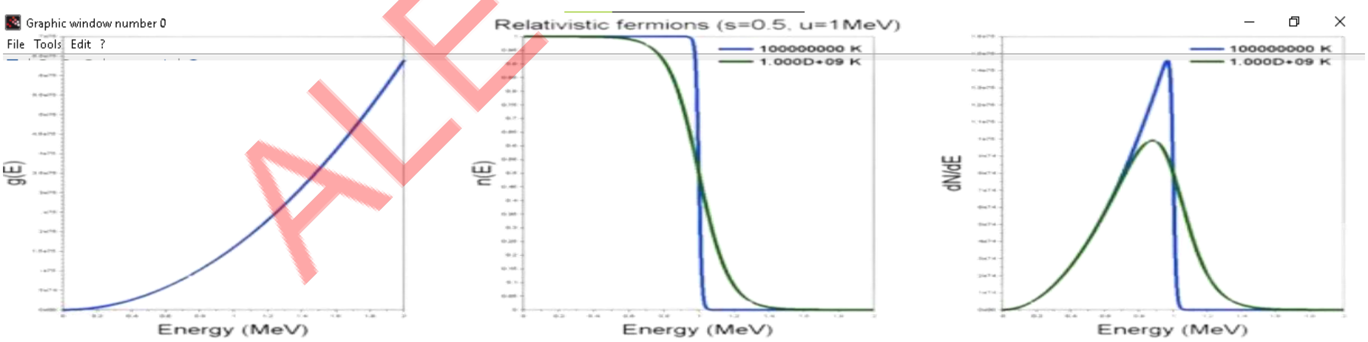
```
clc;clf;clear;
e=1.6e-19;,Kb=1.38e-23;h=6.626e-34;s=0.5;u=1;   //initialising the constants
V=1;c=3e8;
```

```
E=0:0.001:2  //in MeV
T=[10^8 10^9];
Cr=(2*s*4*3.14*V)/((h^3)*(c^3));     //defining g(E)
for j=1:length(T)
     b=1/(Kb*T(j));
     for i=1:length(E)
     g(i)=Cr*(E(i))^2;
     n(j,i)=1/(exp((E(i)-u)*10^6*e*b)+1);
     f(j,i)=g(i)*n(j,i);    //defining dN/dE
     end
end
subplot(1,3,1)     //plotting the graphs
plot(E',g,'linewidth',4);
ylabel('g(E)','fontsize',4);
xlabel('Energy(MeV)','fontsize',4);

subplot(1,3,2)
plot(E',n','linewidth',4); legend(string(T)+'K');
ylabel('n(E)','fontsize',4);
xlabel('Energy(MeV)','fontsize',4);
title('Relativistic Fermions(s='+string(s)+',u='+string(u)+'MeV)');

subplot(1,3,3)
plot(E',f','linewidth',4); legend(string(T)+'K');
ylabel('dN/dE','fontsize',4);
xlabel('Energy(MeV)','fontsize',4)
```


OUTPUT:



EXPERIMENT 11

AIM: Plot the distribution of particles w.r.t. energy (dN/dE versus E) in 3 Dimensions for non-relativistic fermions both at high and low temperature.

CODE:

```
clc;clf;clear;
```

```
e=1.6e-19;,Kb=1.38e-23;h=6.626e-34;s=0.5;    //initialising the constant
u=1;V=1;m=9.1e-31;
E=0:0.001:2   //in eV
T=[100 1000];
Cn=(2*s+1)*(2*3.14*V*(2*m)^1.5)/(h^3);     //defining g(E)
for j=1:length(T)
     b=1/(Kb*T(j));
     for i=1:length(E)
     g(i)=Cn*(E(i))^0.5;
     n(j,i)=1/(exp((E(i)-u)*e*b)+1);
     f(j,i)=g(i)*n(j,i);
     end
end
subplot(1,3,1)    //plotting the graphs
plot(E',g,'linewidth',4);
ylabel('g(E)','fontsize',4);
xlabel('Energy(eV)','fontsize',4);

subplot(1,3,2)
plot(E',n,'linewidth',4); legend(string(T)+'K');
ylabel('n(E)','fontsize',4);
xlabel('Energy(eV)','fontsize',4);
title('Non-Relativistic Fermions(s='+string(s)+',u='+string(u)+'eV)');

subplot(1,3,3)
plot(E',f','linewidth',4); legend(string(T)+'K');
ylabel('dN/dE','fontsize',4);
xlabel('Energy(eV)','fontsize',4)
```

OUTPUT: