```
(*  problem 1      electrons in Cu metal      *)
ClearAll["Global`*"]

ne = 9 * 10^(28) / m^3;
ge = 2.;
kF = ( 6 * Pi^2 * ne / ge)^(1 / 3)
hbar = 6.626176 / (2 * Pi) * 10^(-34) * kg * m^2 / s;
me = 9.1 * 10^(-31) * kg
EF = Assuming[m > 0, Simplify[(hbar^2 / 2 / me) * kF^2]]
eV = 1.6 * 10^(-19) * kg * m^2 / s^2;
EF / eV
```

$$1.3864 \times 10^{10} \left(\frac{1}{m^3}\right)^{1/3}$$

$$9.1 \times 10^{-31}\ \text{kg}$$

$$\frac{1.17455 \times 10^{-18}\ \text{kg}\ m^2}{s^2}$$

```
7.34092
```

```
(*  problem 2      electrons in Cu metal, thermal correction
 using  (30.39) at fixed mu *)

kB = 1.38064852 × 10^(-23) * m^2 * kg / s^2 / K;
T = 300 * K
delNoverN = Pi^2 / 8 * (kB * T / EF)^2
```

$$300\ \text{K}$$

```
0.0000153418
```

```
(*  problem 3a, nuclear matter as a Fermi gas *)
gN = 4;
nN = 0.16 * 10^(45) / m^3;
kFN = ( 6 * Pi^2 * nN / gN)^(1 / 3)
mN = 1.67 * 10^(-27) * kg;
EFN = Assuming[m > 0, Simplify[(hbar^2 / 2 / mN) * kFN^2]]
MeV = 10^6 * 1.6 * 10^(-19) * kg * m^2 / s^2;
EFN / MeV
```

$$1.33302 \times 10^{15} \left(\frac{1}{m^3}\right)^{1/3}$$

$$\frac{5.91689 \times 10^{-12}\ \text{kg}\ \text{m}^2}{\text{s}^2}$$

```
36.9806
```

```
(* problem 3b, neutron matter as a Fermi gas
  only gN=2 is changed *)
gN = 2;
kFN = ( 6 * Pi^2 * nN / gN)^(1 / 3)
EFN = Assuming[m > 0, Simplify[(hbar^2 / 2 / mN) * kFN^2]] / MeV
```

$$1.6795 \times 10^{15} \left(\frac{1}{m^3}\right)^{1/3}$$

```
58.703
```

```
(* the mean negative potential V should be such that V+36.9 MeV <0,
but  V+ 58.7 MeV > 0 *)


(* problem 4 : thermal gas as a model for excited nucleus
  here I express all in MeV *)
ClearAll["Global`*"]
```

In[72]:=
```
(* ignoring one extra nucleon,
one conclude from (30.39) that μ[T]=μ[0]*(1+Pi^2/8*(kB*T/[0])^2)
   including it as done in (30.41) one finds that
   delE=(5*Pi^2/12*(T/EFN)^2)*(3/5*A*EFN) *)
```

In[73]:=
```
A = 200;
DelEinMeV = 10;
EFNinMeV = 36.980581803094246`;
t = Solve[
    5 * Pi ^ 2 / 12 * (TA / EFNinMeV) ^ 2 * (3 / 5 * A * EFNinMeV) == DelEinMeV, TA][[2, 1, 2]];
t
```

$$\frac{t\,10^{6}}{8.6173303\times 10^{-5}}$$

Out[77]= 0.865669

Out[78]= 1.00457×10^{10}

```
(* T is 0.865 MeV *)
```

In[88]:=
```
A = 200;
kb = 1.38 × 10^-23;
n = 0.16 × 10^45;
m = 1.67 * 10 ^ (-27);
h = 6.626176 / (2 * Pi) * 10 ^ (-34);
DelE = 10 × 1.6021773 × 10^-13;
EFN = 36.980581803094246` × 1.6021773 × 10^-13;
EFNT[t_] := EFN (1 - π^2 kb^2 t^2 / (12 EFN^2));
Solve[5 * Pi ^ 2 / 12 * (kb t / EFN) ^ 2 * (3 / 5 * A * EFN) == DelE, t]
Solve[2 A / n / (5 π^2) (2 m / h^2)^(3/2) (EFNT[t]^(5/2) + 5 π^2 / 8 (kb t)^2 EFNT[t]^(1/2) - EFN^(5/2)) == DelE, t]
```

Out[96]= $\{\{t \to -1.00504\times 10^{10}\}, \{t \to 1.00504\times 10^{10}\}\}$

Out[97]= $\{\{t \to -4.69011\times 10^{11}\}, \{t \to -1.0041\times 10^{10}\},$
$\{t \to 0. - 2.84749\times 10^{11}\,i\}, \{t \to 0. + 2.84749\times 10^{11}\,i\},$
$\{t \to 0. - 1.08289\times 10^{12}\,i\}, \{t \to 0. + 1.08289\times 10^{12}\,i\}, \{t \to 0. - 1.0989\times 10^{12}\,i\},$
$\{t \to 0. + 1.0989\times 10^{12}\,i\}, \{t \to 1.0041\times 10^{10}\}, \{t \to 4.69011\times 10^{11}\}\}$