Scilab Textbook Companion for Thermal Physics by S. Garg, R. Bansal And Ghosh[1]

Created by
Vaibhav Tyagi
CBCS Bsc Honours Physics
Physics
University of Delhi
Cross-Checked by
Scilab Tbc Team

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Book Description

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

Contents

List of Scilab Codes 4

1 Ideal Gases Elementary Kinetic Theory and Maxwellian Distribution 5

2 Mean free path and Transport phenomenon 23

3 Real Gases Van der Waals Equation of state 49

4 Basic Concept of Thermodynamics 64

5 The first law of Thermodynamics 79

6 The Second law of Thermodynamics 112

7 Entropy 144

8 Thermodynamics Relations 171

9 Free Energies and Thermodynamics Equillibrium 186

10 Production of Low Temperatures and their Applications 195

11 Radiation Classical and Quantum Radiation 198

12 Basic Concept of Statistical Mechanics **217**

13 Maxwell Boltazmann Statistics **231**

14 Fermi Dirac Statistics **239**

15 Bose Einstein Statistics **250**

List of Scilab Codes

Exa 1.1 Pressure Exerted by the gas in a container . 5
Exa 1.2 Calculation of Number density 7
Exa 1.3 Probablity of Oxygen molecules having speed in certain Range 7
Exa 1.6 Different speed for Oxygen molecule 8
Exa 1.8 Temperature for equal RMS value of Hydrogen and Oxygen molecule 9
Exa 1.10 Temperature of Nitrogen gas for equal Maxwellian function 10
Exa 1.12 Doppler broadening in Sodium line 11
Exa 1.13 RMS value of Hydrogen and Oxygen molecule 12
Exa 1.14 RMS value of Methane 13
Exa 1.15 Calculation of number density and number of molecules 14
Exa 1.16 Rms value of a perfect gas 15
Exa 1.18 Claculation of Temperature of the mixing . 16
Exa 1.19 Heat required to increase the rms speed by three times 18
Exa 1.20 calculation of Avogadros Number 19
Exa 1.22 Temperature for which oxygen Distribution function has peak at given speed 19
Exa 1.23 Mean speed of Nitrogen molecules 21
Exa 1.24 Temperature required for nuclear fusion . . 22
Exa 2.1 Calculation of collision frequency and mean free path 23
Exa 2.2 Molecular diameter and number of collision per unit distance 24

Exa 2.3	Mean Free path and collision frequency of helium gas	25
Exa 2.4	Mean free path if Temperature and Pressure is Doubled	27
Exa 2.5	Mean free path for Argon Atoms	28
Exa 2.7	Diameter of Helium molecule	29
Exa 2.8	Mean free path and Molecular Diameter of the gas	30
Exa 2.9	Coefficient of viscosity of Hygrogen gas	31
Exa 2.10	Thermal Conductivity of gas	32
Exa 2.11	Density and mean free path of the Oxygen molecules	33
Exa 2.12	Mass of nitrigen diffusing per unit time	34
Exa 2.13	Coefficient of viscosity and Thermal Conductivity of Air	35
Exa 2.14	calculation of Avogadros Number	37
Exa 2.15	calculation of Boltzmann Constant	38
Exa 2.16	Mean time between collision of nitrogen molecules	39
Exa 2.17	Mean Free path a gas	40
Exa 2.18	frequency of sound wave	41
Exa 2.19	Mean free path for the Molecular of a gas	42
Exa 2.20	Mean free path Collision frequency and molecular diameter	43
Exa 2.21	Mean free path of hydrogen molecule	44
Exa 2.22	Molecular diameter of oxygen molecule	45
Exa 2.23	Coefficient of viscosity of hydrogen gas	46
Exa 2.24	Pressure in Vaccum flask	47
Exa 3.1	Pressure of an Ideal and van der waals Gas	49
Exa 3.2	Temperatue of Van der Waals Gas	50
Exa 3.3	Critical Temperature of Helium	51
Exa 3.4	Van der Waals Constants and Molecular dismeter of the Helium	52
Exa 3.5	Drop in Temperature when oxygen undergoes adiabatic throttling	53
Exa 3.6	Drop in Temperature when helium undergoes Joules Thomson Expansion	54

Exa 3.7 Inversion Temperature and Drop in Temperature when hydrogen undergoes joules Thomson expansion 55
Exa 3.9 Van der Waals Constants for Helium Gas . . 56
Exa 3.10 Drop in Temperature when oxygen undergoes adiabatic throttling 57
Exa 3.11 Drop in Temperature when helium undergoes Joules Thomson Expansion 58
Exa 3.12 Boyles Temperature Inversion Temperature and Drop in Temperature of a diatomic gas . . . 59
Exa 3.13 Radius of Nitrogen Molecule 60
Exa 3.14 Van der Waals Constants of a gas Contained in Closed Vessel 61
Exa 3.16 Internal pressure and Temperature of a monoatomic Van der Waals Gas 62
Exa 4.2 Final pressure of copper Block 64
Exa 4.3 Rise in temperature of Mercury 65
Exa 4.4 Final pressure of Mercury 66
Exa 4.5 Pressure applied on the metal block 67
Exa 4.6 Final Tension and Frequency of the Vibrating string 68
Exa 4.7 Temperature on Resistance Scale of Platinium 69
Exa 4.8 Length and Temperature of the Mercury Column 70
Exa 4.10 Ration of the pressure of a gas at steam and triple point of water 71
Exa 4.11 Temperature of Bath of Platinium Thermometer 72
Exa 4.12 Temperature of Bath on Platinium and gas Scale 73
Exa 4.14 Change in tension of the rails 74
Exa 4.16 Temperature of Heat Bath 75
Exa 4.17 Temperature of the Hot Junction 76
Exa 5.1 Work done on the steel wire 79
Exa 5.4 Change in Internal energy of Air 80
Exa 5.5 Work done and increase energy of Boiling Water 81
Exa 5.6 Amount of heat Absorbed 82

Exa 5.7	Final Temperature of the Air in the pump	83
Exa 5.8	Atomaticity of the gas	84
Exa 5.12	Work done heat flow change in internal energy and final temperature of air Compressed isothermally and adiabatically	84
Exa 5.13	New Temperature and Work done by Oxygen gas	86
Exa 5.14	Rise in temperature	87
Exa 5.15	Work done during the cycle	88
Exa 5.16	change in Internal energy and work done	90
Exa 5.17	Change in Temperature and Pressure	93
Exa 5.18	Final Temperature of the sedan Car	94
Exa 5.19	Temperature after compression of the monoatomic and diatomic gas	95
Exa 5.21	Work done by a gas in adiabatic compression	97
Exa 5.22	Rise in temperature	97
Exa 5.23	Change in Temperature of Air	98
Exa 5.24	Final Temperature and Pressure of the ideal Gas	99
Exa 5.25	Change in internal Energy	100
Exa 5.26	Final Temperature and Pressure of Air	101
Exa 5.28	Change in Temperature	102
Exa 5.29	Change in temperature	103
Exa 5.30	Change in internal Energy	104
Exa 5.31	Increase in volume	106
Exa 5.32	change in temperature	107
Exa 5.33	Specefic heat at constant pressure	108
Exa 5.34	Heat Absorbed and work done by Oxygen gas when its Temperature changes	109
Exa 6.1	Efficiency of Carnot Engine	112
Exa 6.2	Rise in temperature of the source	113
Exa 6.3	Heat Reject and Work done in each cycle	114
Exa 6.4	Temperature of source and sink	115
Exa 6.5	Temperature of the reserviour	116
Exa 6.6	Feasibility of a carnot engine	117
Exa 6.7	Temperature of the Hot reserviour	118
Exa 6.8	Work done and Temperature outside the room	119
Exa 6.9	Time require to freeze water at 0 degree C	121

Exa 6.10	Heat Require and Work done by the regrigerator	122
Exa 6.13	Net work done per Kg of air	123
Exa 6.14	Efficiency of the engine	125
Exa 6.16	Efficiency of Engine Predicted by inventor	126
Exa 6.17	Fraction of the time Compressor runs in delhi	127
Exa 6.18	Efficiency and Heat rejected by the engine	129
Exa 6.19	Change in temperature of the source	130
Exa 6.20	Amount of heat Absorbed rejected and Efficiency of the engine	132
Exa 6.21	Temperature of the Sourse and Sink	133
Exa 6.22	Efficiency of Carnot Engine	134
Exa 6.23	Temperature of sink	135
Exa 6.24	Efficiency for a canot cycle	136
Exa 6.25	Ratio of Temperature of Operation of Engine	139
Exa 6.26	Coefficient of Performance and Heat rejected by the Freezer	140
Exa 6.27	Coefficient of Performance and Work done	141
Exa 6.28	Power Developed by heat Engine made by a Inventor	142
Exa 7.1	Change in Entropy of steam	144
Exa 7.3	Total Increase in Entropy of TS Diagram	145
Exa 7.4	Total Increase in Entropy	146
Exa 7.5	Total Increase in Entropy	147
Exa 7.6	Total Increase in Entropy	149
Exa 7.8	Nature of the Process	151
Exa 7.11	Change of entropy of Ideal Gas	153
Exa 7.12	Change of entropy of Hydrogen	153
Exa 7.13	Change of entropy of Hydrogen and Oxygen gas	154
Exa 7.14	Entropy of steel	155
Exa 7.15	Total change in Entropy	157
Exa 7.16	Total Increase in Entropy of the Reserviour and the Universe	158
Exa 7.17	Change in Entropy of the System	159
Exa 7.18	Change in Entropy	161
Exa 7.19	Total Increase in Entropy of Oxygen	162
Exa 7.21	Change in Entropy of the System	163

Exa 7.22 Total Increase in Entropy 164
Exa 7.23 Total Increase in Entropy 166
Exa 7.24 Change in Entropy of the System 167
Exa 7.25 Change in entropy of Aliminium 169
Exa 8.1 Change in Melting Point 171
Exa 8.2 Mean Temperature and Latent heat of fusion 172
Exa 8.6 Difference in Heat Capacities of He 174
Exa 8.7 Molar specefic heat at constant volume and Adiabatic Compressibility 175
Exa 8.13 Latent heat of vaporisation of He 176
Exa 8.14 Change in melting point of ice 177
Exa 8.15 Pressure Required to boil Water 178
Exa 8.16 Change in boiling point 179
Exa 8.17 Latent heat of steam 180
Exa 8.18 Heat Transferred to the droplet 181
Exa 8.19 Heat Transferred and Change in Internal Energy 182
Exa 8.20 Heat treansferred 184
Exa 9.6 Triple point temperature and Pressure . . . 186
Exa 9.8 Temperature at which water boils in the cooker 187
Exa 9.11 Latent heat of Vaporisation Enthalpy and Gibbs free energy 188
Exa 9.12 Triple point Temperature and latent heat of Vaporisation and Melting 189
Exa 9.13 Coordinates of the Triple point 191
Exa 9.14 Specefic heat Capacity of steam 192
Exa 10.2 Drop in Temperature 195
Exa 10.3 Fall in Temperature 196
Exa 11.3 Rate of Loss and Gain of heat 198
Exa 11.4 Heat Loss Time in which Temperature falls 199
Exa 11.5 Heat Transferred Work done and Final Temperature 200
Exa 11.6 Energy and Pressure Density of solar radiation 202
Exa 11.7 Wavelength for Maximum Emission 203
Exa 11.8 Number of modes in the frequency Range . 204
Exa 11.9 Rate of Cooling 205
Exa 11.10 Temperature of the planet 206

Exa 11.11	Time taken for metal to cool	207
Exa 11.12	Average energy of Classical and planck oscillator	208
Exa 11.13	Number of modes in the wavelength and frequency range	209
Exa 11.15	Rate of loss of Heat and time taken by it to cool	210
Exa 11.16	Temperature of the Filament	211
Exa 11.17	Work done pressure and Final Temperature	212
Exa 11.18	specefic heat Capacity of the metal	214
Exa 11.19	Temperature and Wavelength of the body	215
Exa 12.3	Number of Quantum States	217
Exa 12.4	Quantum number of Helium Atom	218
Exa 12.7	Number of ways according to Maxwell Boltzmann Fermi Dirac and Bose Einstein Statisitcs	219
Exa 12.8	Thermodymanic Probablity and Number of Microistates	220
Exa 12.9	Number of ways according to Maxwell Boltzmann Fermi Dirac and Bose Einstein Statisitcs	224
Exa 12.10	Number of ways according to Fermi Dirac and Bose Einstein Statisitcs	225
Exa 12.14	Probrablity of Vibrational mode	226
Exa 12.16	Temperature of the Sysytem	228
Exa 12.17	Ratio of Number of Particle in Second excited to ground state	229
Exa 13.3	Root mean Square Speed of rotation	231
Exa 13.4	Energy in eV for 1st excitation in Sodium	232
Exa 13.5	Ratio of Number of Particle in Second excited to ground state of Sodium	233
Exa 13.6	Ratio of Spontaneous Emission to Spontaneous Emission	233
Exa 13.8	Entropy of Thallium	234
Exa 13.9	Specefic heat Capacity of solid and Maximum Lattice Frequency	235
Exa 13.10	Bond Length of HCL Molecule	237
Exa 14.1	Fermi Energy and Fermi Temperature	239

Exa 14.2	Fermi Energy and Pressure in Aluminium .	240
Exa 14.3	Fermi Energy and Electronic Heat Capacity	241
Exa 14.4	Fermi Momentum Temperature and and Heat Capacity	242
Exa 14.6	Number of Conduction electrons in Lithium	243
Exa 14.7	Fermi Energy for Copper	244
Exa 14.8	Density of Neutron in the beam	245
Exa 14.9	Fermi Wavelength Fermi Energy of electron ann Neutron	246
Exa 14.10	Density of ejected electron	247
Exa 14.11	Current Density for Silver	248
Exa 14.12	Range of Fermi energy	249
Exa 15.1	Average number of photons	250
Exa 15.2	Final Pressure of black Body radiation . . .	251

Chapter 1

Ideal Gases Elementary Kinetic Theory and Maxwellian Distribution

Scilab code Exa 1.1 Pressure Exerted by the gas in a container

```
//Scilab code Exa 1.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_1.txt")
m = 5*10^(-26);    // mass of each molecule in Kg
vx = 483 ;         // translational speed in m/sec
L = 0.2 ;          // side of cube in m
Na = 6*10^23 ;     // Avogadro constant
deltaP = 2*m*vx ;  // Change in momentum between two
    successive collision in Nsec
disp("Change in momentum between two successive
   collision in Nsec is ;",deltaP)
deltaT = 2*L/vx ;  // time interval between two
   successive collision in sec
disp("Time interval between two successive collision
    in sec is ;",deltaT)
```

```
disp("Rate of Change of momentum of one molecule in N is ;",deltaP/deltaT)
Fx = (deltaP/deltaT)*Na ; // Force exerted by all molecules in N
p = Fx/(3*L^2);          // average pressure exerted by all molecules in N/m^2
disp("average pressure exerted by all molecules in N/m^2 is ; ",p)


// Result


//    4.830D-23

// Change in momentum between two successive collision in Nsec is ;

//    0.0008282

// Time interval between two successive collision in sec is ;

//    5.832D-20

// Rate of Change of momentum of one molecule in N is ;

//    291611.25

// average pressure exerted by all molecules in N/m^2 is ;

// Answer varies due to round off error
```

Scilab code Exa 1.2 Calculation of Number density

```
//Scilab code for Exa 1.2
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_2.txt")
n1 = 2.7*10^25;     // number density of air  per m^3
     at 1atm
p1 = 1.013*10^5 ; // pressure in N/m^2 corresponds
    to n1
p2 = 1.33*10^(-4); //  pressure in N/m^2 corresponds
     to n2
// we know p = (m*n*vrms)/3
n2 = p2*n1/p1;  // number density per m^3 at
    pressure p2
disp("number density per m^3 at pressure p2 is;",n2)

//Result
//3.545D+16

// number density per m^3 at pressure p2 is;
// Answer varies due to round off error.
```

Scilab code Exa 1.3 Probablity of Oxygen molecules having speed in certain Range

```
// Scilab Code Exa 1.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
```

```
clc;
clear;
diary("Ex1_3.txt")
v = 100; // speed of oxygen molecule in m/sec
dv = 1; // interval of speed in m/sec
Na = 6.02*10^26  // Avogadro constant in kmol^(-1)
kb=1.38*10^(-23); // Boltzmann Constant in J/K
m = 32/Na; // mass of oxygen molecule in Kg
T = 200; // temperature in K
fv = 4*%pi*((m/(2*%pi*kb*T))^(3/2))*(v^2)*exp(-(m*(v^2))/(2*kb*T))*dv ; // probablity of a molecule having speed in range v to v+dv
disp("probablity of a oxygen molecule having speed in range 100m/sec to 101m/sec is ;",fv)

//Result
//0.0006125

// probablity of a oxygen molecule having speed in range 100m/sec to 101m/sec is ;
// "Answer given in textbook is wrong"
```

Scilab code Exa 1.6 `Different speed for Oxygen molecule`

```
// scilab code  for Exa 1.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_6.txt")
kb = 1.38*10^(-23); // Boltzmann Constant in J/K
m = 5.31*10^(-26);  // mass of oxygen molecule in Kg
T = 300;  // Temperature in K
x = sqrt(kb*T/m);   // in m/sec
```

```
disp("(kb*T/m)^1/2 in m/sec is ;",x)
V_bar = sqrt(2.55)*x;  //  average speed in m/sec
V_rms = sqrt(3)*x;  //  RMS speed in m/sec
V_p = sqrt(2)*x;  // Most Probable speed in m/sec
disp("average speed in m/sec is ; ",round(V_bar))
disp("RMS speed in m/sec is ; ",round(V_rms))
disp("Most Probable speed in m/sec is ; ",round(V_p
  ))

//Result
//279.22411

// (kb*T/m)^1/2 in m/sec is ;

//   446.

// average speed in m/sec is ;

//   484.

// RMS speed in m/sec is ;

//   395.

// Most Probable speed in m/sec is ;
```

Scilab code Exa 1.8 Temperature for equal RMS value of Hydrogen and Oxygen molecul

```
// Scilab Code for Exa 1.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_8.txt")
```

```
Na = 6*10^26;  //  Avagadro Constant  Kmol^(-1)
g = 9.8;  // acceleration due to gravity in m/s^2
kb = 1.38*10^(-23); // boltzmann constant in J/K
R0 = 6.4*10^6 ; // Radius of earth in m
mH2 = 2/Na ; //mass of hydrogen in Kg
mO2 = 32/Na ; // mass of oxygen in Kg
TH2 = (2*mH2*g*R0)/(3*kb) // Temperature for Hydrogen molecule at which Vrms = Vesc  in K
TO2 = (2*mO2*g*R0)/(3*kb) // Temperature for Oxygen molecule at which Vrms = Vesc  in K
disp("Temperature for Hydrogen molecule  at which Vrms = Vesc  in K ;",TH2)
disp("Temperature for Oxygen molecule at which Vrms = Vesc  in K ;",TO2)


// Result
//10099.839

// Temperature for Hydrogen molecule  at which Vrms = Vesc  in K;

//   161597.42

// Temperature for Oxygen molecule at which Vrms = Vesc  in K ;

// Answer given in textbook are rounded off.
```

Scilab code Exa 1.10 Temperature of Nitrogen gas for equal Maxwellian function

```
// Scilab Code for Exa 1.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
```

```
clc;
clear;
diary("Ex1_10.txt")
v1 = 300; // speed of nitrogen gas in m/sec
v2 = 600; // speed of nitrogen gas in m/sec
M = 0.028; // mass of nitrogen in Kg/mol
R = 8.31 ; // Gas Constant in J K^(-1) mol^(-1)

T = M *(v2^2 - v1^2)/(4 * R * log(v2/v1))  //
    Temperature at which two distribution at velocity
     v1 & v2 are equal in K
disp("Temperature at which two distribution at
    velocity v1 & v2 are equal in K is ;",round(T))


// Result
//  328.

// Temperature at which two distribution at velocity
     v1 & v2 are equal in  K is ;
```

Scilab code Exa 1.12 Doppler broadening in Sodium line

```
// Scilab code for Exa 1.12
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_12.txt")
lambda_0 = 589*10^(-9); //  wavelength of sodium in
   m
c = 3*10^8 ; // Speed of light in m/sec
R = 8.31*10^3 ; // Gas Constant in J Kmol^(-1) K
    ^(-1)
```

```
T = 400 ; // Temperature in K
M = 23 ; // mass of nitrogen in Kg Kmol^(-1)

b = (lambda_0/c)*sqrt(2*R*T*log(2)/M); // Doppler Broadening in sodium line in m
disp("Doppler Broadening in sodium line in m is;",b)

// result


//    8.788D-13

// Doppler Broadening in sodium line in m is;
```

Scilab code Exa 1.13 RMS value of Hydrogen and Oxygen molecule

```
// Scilab code for Exa 1.13
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_13.txt")
TO2 = 336 ; // Temperature of Oxygen in K
// vrmsO2 = 2 vrmsH2 , rms value of oxygen is twice the rms value of Hydrogen
// MO2 = 16 MH2 , Mass of oxygen is 16 times the mass of Hydrogen

TH2 =  4*TO2/16 ; //  Temperature of Hydrogen in K
disp("Temperature of Hygrogen  in K is ; ",TH2)
disp("Temperature of Hygrogen  in degree C is ;",TH2-273)


```

```
// Result
//    84.

// Temperature of Hygrogen  in K is ;

//   -189.

// Temperature of Hygrogen  in degree C is ;
```

Scilab code Exa 1.14 `RMS value of Methane`

```
// Scilab Code for Exa 1.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_14.txt")
p1 = 1; // pressure in atm
p = 5; // Pressure in atm
v1 = 22.4; // volume at STP ie "O degree C"  in Ltr/mol
T1 = 273 ; // Temperatures in K
T2 = 20 + 273 ; // Temperatures in K

// Applying Ideal Gas Equation

v = (T2 * v1 * p1)/(T1 * p); // Volume at tempoerature T2 in Ltr/mol


m = 16*10^(-3) ; // Molar wt. of CH4 in Kg/mol
rho = m/v*10^3 ; // density in Kg/m^3
disp("density in Kg/m^3 is ;",rho)
vrms = sqrt(3*p*10^5/rho);  // rms speed in m/sec
```

```
disp("rms speed in m/sec is ;",vrms)

// Result

// 3.3276451

// density in Kg/m^3 is ;

//   671.3935

// rms speed in m/sec is ;
```

Scilab code Exa 1.15 Calculation of number density and number of molecules

```
// Scilab Code for 1.15
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_15.txt")
epsilon = 4*10^(-11); // Mean KE of molecule in J (
    or N-m)
p = 1.5*10^5 ;  // Pressure in N/m^2
Na = 6.023*10^(23) // Avagadro Constant

//(a) number density per litre

n = (3*p)/(2*epsilon); // number density per m^3
disp("number density per m^3 is ;",n)
disp("number density per liter is ;",n/10^6)

//(b) Number of molecules in a room of 5mX4mX3m
v = 5*4*3 ; // volume in m^3
N = v*Na/(22.4*10^(-3))
```

```
disp("Number of molecules is;",N)


//Result

//    5.625D+15

// number density per m^3 is ;

//    5.625D+09

// number density per liter is ;

//    1.613D+27

// Number of molecules is;
// Note "Answer Provided in the Testbook is wrong"
```

Scilab code Exa 1.16 Rms value of a perfect gas

```
// Scilab Code for 1.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_16.txt")
T = 18 + 273 ;    // Temperature of the gas in Kelvin
m = 2.7*10^(-3);   // weight of the gas in Kg
p = 10^5 ;        // Pressure of the gas in Nm(-2)
V = 1.29 ;    // Volume in Litre
R = 8.31 ;    // J mol(-1) K(-1)
M = (m*R*T)/(p*V*10^(3)*10^(-6)) ;     // Mass of the gas in Kg/mol
disp("Mass of the gas in Kg/mol is ;",M)
```

```
Vrms = sqrt(3*R*T/M) ;          // RMS value of the gas
    in m/sec
disp("RMS of the gas in m/sec is ;",Vrms)



//Result
//0.0506137

// Mass of the gas in Kg/mol is ;

//    378.59389

// RMS of the gas in m/sec is ;
```

Scilab code Exa 1.18 Claculation of Temperature of the mixing

```
// Scilab Code for 1.18
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_18.txt")


//  (a) For both momoatomic gas

T1 = 40 +273 ;     //   temperature in Kelvin
T2 = 56 +273 ;     //   temperature in Kelvin
n1 = 1 ;           //   Number of Moles
n2 = 1 ;           //   Number of Moles
T = (n1*T1 + n2*T2)/(n1 + n2) ;  //  Temperature of
    mixing in Kelvin
```

```
disp(" Temperature of mixing of the gas in Kelvin is ;",T)
disp(" Temperature of mixing of the gas in degree C is ;",T-273)

//   (b)  For Oxygen and Helium

T1 = 27  +273 ;     //   temperature in Kelvin
T2 = 127 +273 ;     //   temperature in Kelvin
n1 = 1 ;          //   Number of Moles
n2 = 2 ;          //   Number of Moles
f1 = 5 ;          //    Degree of freedom  of Oxygen
f2 = 3 ;         //    Degree of freedom  of Hydrogen
T = (f1*n1*T1 + f2*n2*T2)/(f1*n1 + f2*n2) ;  //  Temperature of mixing in Kelvin
disp(" Temperature of mixing of the gas in Kelvin is ;",T)
disp(" Temperature of mixing of the gas in degree C is ;",T-273)


// Result

/*    321.

  Temperature of mixing of the gas in Kelvin is ;

   48.

  Temperature of mixing of the gas in degree C is ;

   354.54545

  Temperature of mixing of the gas in Kelvin is ;

   81.545455

  Temperature of mixing of the gas in degree C is ;
```

```
*/
```

Scilab code Exa 1.19 Heat required to increase the rms speed by three times

```
// Scilab Code for 1.19
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_19.txt")

T1 = 47 +273 ;     //    Temperature in Kelvin
// Vrms proportional to sqrt(T)
T2 = 9*T1 ;        //    Temperature in Kelvin
disp(" Temperature in Kelvin ;",T2)
R = 8.31 ;     //   Gas constant in J mol^(-1) K^(-1)
m = 10 ;    // Mass in gram
M = 2  ;    // Molar Mass of  Hydrogen in g / mol
Q = (8*m/M)*(5*R/2)*T1;   // Heat required to
   increase the rms speed by three fold  in J
disp(" Heat required in J is ;",Q)
disp(" Heat required in Calories is ;",round(Q/4.2))


// Result

/*
   2880.

  Temperature in Kelvin ;

   265920.

  Heat required in J is ;
```

```

  63314.

 Heat required in Calories is ;
*/
```

Scilab code Exa 1.20 calculation of Avogadros Number

```
// Scilab Code for 1.20
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_20.txt")
Vrms = 1.45*10^(-2) ;   //  Rms Value Particle
m = 5.9*10^(-17) ;    //  mass of the Particle
T = 27 + 273 ;     //  Temperature in Kelvin
R = 8.31 ;     //  Gas constant in J mol^(-1) K^(-1)
Na = (3*R*T)/(m*(Vrms)^2) ;     //  Avogadro's Number  per mol
disp(" Avogadro Number  per mol ;",Na)


/* Result
  6.029D+23

 Avogadro Number  per mol ;   */
```

Scilab code Exa 1.22 Temperature for which oxygen Distribution function has peak a

```
// Scilab Code for 1.22
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_22.txt")
/* Vrms = Vp + 150 m/sec
we know Vrms = (3KbT/m)^(1/2)
        Vp = (2KbT/m)^(1/2)
on squaring and simplifying we get
T = m*22500/(kb*(5-2*6^(1/2)))  */
// (a) Vrms - Vp = 150 m/sec
m = 32/(6.023*10^26);    //   mass of Oxygen in Kg / mol
kb = 1.38*10^(-23);      //   Boltzmann Constant in J/K
T = m*(22500)/(kb*(5-2*sqrt(6))) ;    // Temperature in Kelvin
disp(" Temperature in Kelvin ;",T)
// (b) Peak of Distribution function for oxygen
Vp = 400     //  Most Probable speed for oxygen in m/sec
T = (m*Vp^2)/(2*kb)   ;  // // Temperature in Kelvin
disp(" Temperature in Kelvin ; ",T)

/* Result


   857.49377

  Temperature in Kelvin ;

   307.99808

  Temperature in Kelvin ;

  Answers given in text book are rounded off.

   */
```

Scilab code Exa 1.23 Mean speed of Nitrogen molecules

```
// Scilab Code for 1.23
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_23.txt")
Na = 6.023*10^(26) ;   // Avogadro Number
E = 15.6*10^(-21);    // Mean Energy in  J , (E = 5
   KbT/2)
kbT = 2*E/5 ;  //  Value of kbT using mean energy in
    J
disp(" Value of kbT in J is ; ", kbT)
m= 28/Na ;   // mass of nitrogen molecule in Kg/mol
Vmean = sqrt(8*kbT/(m*%pi)) ;   // mean speed in m\
   sec
disp(" mean speed in  m/sec is ; ",Vmean)

/*   Result

  6.240D-21

  Value of kbT in J is ;

   584.64167

  mean speed in  m/sec is ;
   */
```

Scilab code Exa 1.24 Temperature required for nuclear fusion

```
// Scilab Code for 1.24
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex1_24.txt")
epsilon = 0.72 ;  //  average energy in Mev
one_eV = 1.6*10^(-19) ; // value of 1 ev in J
kb = 1.38*10^(-23);       //   Boltzmann Constant in J/K
T = (2*epsilon*10^(6)*one_eV)/(3*kb) ;   // Temperature for nuclear fusion in Kelvin
disp(" Temperature in Kelvein ;",T)


/*   Result

  5.565D+09

  Temperature in Kelvein ;

   Answer vary due to round off error
   */
```

Chapter 2

Mean free path and Transport phenomenon

Scilab code Exa 2.1 Calculation of collision frequency and mean free path

```
// Scilab Code for 2.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_1.txt")
d = 2*1.37*10^(-10) ;     //    Diameter of hydrogen
    molecule in m
v = 1840 ;          //    Speed of hydrogen molecule in
     m/sec
n = 3*10^25 ;     //   Number density in per m^3
// (i) Microscopic collision Cross section
sigma = %pi*d^2 ;  //  Microscopic collision Cross
    section in m^2
disp(" Microscopic collision Cross section in m^2 is
     ; ",sigma)
// (ii)  Collision frequency
Pc = n*v*sigma  ;   // Collision frequency in per
```

```
    sec
disp(" Collision frequency in per sec is ; ",Pc)
//  (iii) Mean free path
lambda = 1/(n*sigma) ; // mean free path in m
disp(" mean free path in nm is ; ",lambda/10^(-9))


/* Result


   2.359D-19

  Microscopic collision Cross section in m^2 is ;

   1.302D+10

  Collision frequency in per sec is ;

   141.32785

  mean free path in nm is ;

   Answer varies due to round off error
   */
```

Scilab code Exa 2.2 Molecular diameter and number of collision per unit distance

```
// Scilab Code for 2.2
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_2.txt")
lambda = 2.85*10^(-7)  ;   //  mean free path in m
```

```
n = 3*10^25 ;     //  Number density in per m^3
// (a) Molecular diameter
d = sqrt(1/(sqrt(2)*%pi*lambda*n))  ;   // Molecular diameter in m
disp(" Molecular diameter in m is ; ",d)
disp(" Molecular diameter in Angstrom is ; ",d/10^(-10))
// (b)  collision per unit distance
Ns = 1/lambda ;  //  No of Collision per unit distance , m^(-1)
disp(" No of Collision per unit distance , m^(-1) is ; ",Ns)

/* Result

   1.622D-10

  Molecular diameter in m is ;

   1.6224993

  Molecular diameter in Angstrom is ;

   3508771.9

  No of Collision per unit distance , m^(-1) is ;

  Answer Vary due to roundoff error

   */
```

Scilab code Exa 2.3 Mean Free path and collision frequency of helium gas

```
// Scilab Code for 2.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_3.txt")
d = 10^(-10) ; // Molecular diameter in m
Na = 6*10^(23) ; // Avagadro Number per mol
R = 8.4 ; // Gas constant in J mol^(-1) K^(-1)
V = 20 ; // Volume in litre
T = 20 ; // temperature in Kelvin
M = 4*10^(-3) ; // Molar mass of helium in Kg/mol
n= Na/(V*10^(-3)) ; // Number density in per m^3
lambda = 1/(sqrt(2)*%pi*d^2*n) ; // mean free path in m
disp(" mean free path in 10^(-7) m is ; ",lambda/10^(-7) )
Vmean = sqrt(2.55*R*T/M) ; // mean speed in m/sec
disp(" mean speed in m/sec is; ",Vmean)
Pc = Vmean/lambda ; // Collision frequency in per sec
disp( " Collision frequency in per sec is ;",Pc)
Tau = 1/Pc ; // Mean free time in sec
disp( " Mean free time in sec ;",Tau)


/* Result

  7.502636

 mean free path in 10^(-7) m is ;

  327.26136 , "Answer vary due to round off error"

 mean speed in m/sec is;

  4.362D+08 , "Answer vary due to round off error"
```

```

Collision frequency in per sec is ;

 2.293D-09    , "Answer(mean free time) given in
    textbook is wrong "

Mean free time in sec ;

  */
```

Scilab code Exa 2.4 Mean free path if Temperature and Pressure is Doubled

```
// Scilab Code for 2.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_4.txt")
lambda = 3*10^(-7) ;  //  mean free path in m
/* lambda = (kb*T)/(2^(1/2)*3.14*d^2*p)
lambda proportional to T , inversely proportional to
    p

(a) T is doubled  */
lambda_p_2T = 2*lambda ;  // mean free path in m
   when T is doubled
disp(" mean free path in 10^(-7) m when T is doubled
    is; ",lambda_p_2T/10^(-7))
// (b)  p is doubled
lambda_2P_T = lambda/2 ;   // mean free path in m
   when p is doubled
disp(" mean free path in 10^(-7) m when p is doubled
    is; ",lambda_2P_T/10^(-7))

```

```
/* Result


   6.

  mean free path in 10^(-7) m when T is doubled is;

   1.5    ,  "Answer given in textbook is wrong"

  mean free path in 10^(-7) m when p is doubled is;


    "lamda given in question is wrong , 10^(-7)
       instead of 10^(7)"


*/
```

Scilab code Exa 2.5 Mean free path for Argon Atoms

```
// Scilab Code for 2.5
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_5.txt")
d = 2*0.128*10^(-9) ;  // diameter of argon atom in
   m
T = 25 + 273 ;         //  Temperature in kelvin
p = 1.013*10^(5);      //  pressure in Nm^(-2)
kb = 1.38*10^(-23) ;   //  Boltzmann constant in J/K
lambda = (kb*T)/(sqrt(2)*%pi*d^2*p)  ;  // mean free
    path in m
disp(" mean free path in  10^(-7) m is ; ",lambda
```

```
/10^(-7))

/*  Result

  1.3942514

  mean free path in  10^(-7) m is ;

   */
```

Scilab code Exa 2.7 Diameter of Helium molecule

```
// Scilab Code for 2.7
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_7.txt")
eta = 2*10^(-4) ;  // Coefficient of viscosity of Helium in poise  , 1poise = 0.1 Kg m^(-1) sec^(-1)
T = 27 + 273 ;  // Temperature in Kelvin
kb = 1.38*10^(-23) ;   // Boltzmann constant in J/K
Na = 6*10^23  ;    // Avagadro Number in per mol
m = 4/(Na*10^3) ;   // mass in Kg
disp("Mass of He molecule in Kg ; ",m)
Vmean = sqrt(2.55*kb*T/m) ;   //  mean Speed in m/sec
disp(" mean Speed in m/sec is ;",Vmean )
d = sqrt((m*Vmean)/(3*2^(1/2)*%pi*eta*0.1)) ;  // Diameter of Helium molecule in m
disp(" Diameter of Helium molecule in m is; ",d)


```

```
/* Result

  6.667D-27

 Mass of He molecule in Kg ;

   1258.3918

  mean Speed in m/sec is ;

   1.774D-10        "Answer varies due to round of
      error"

  Diameter of Helium molecule in m is;

   */
```

Scilab code Exa 2.8 Mean free path and Molecular Diameter of the gas

```
// Scilab Code for 2.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_8.txt")
eta = 16.6*10^(-6) ;  // Coefficient of viscosity of
    gas in Nsm^(-2)
n = 2.7*(10^25)  ;   //   number density per m^3
Vmean = 450 ;     //   Average speed in m/sec
rho = 1.25  ;     //   density of gas in Kgm^(-3)
lambda = (3*eta)/(rho*Vmean) ;   //    mean free
   path in m
disp(" mean free path in m is ; ",lambda)
d = sqrt(1/(sqrt(2)*%pi*n*lambda))  ;    //
```

```
    Molecular diameter of the gas in m
disp(" Molecular diameter of the gas in m is; ",d)

/*  Result


   8.853D-08

  mean free path in m is ;

   3.069D-10

  Molecular diameter of the gas in m is;

   ""Answer (Molecular diameter) given in textbook
      is wrong""
```

Scilab code Exa 2.9 Coefficient of viscosity of Hygrogen gas

```
// Scilab Code for 2.9
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_9.txt")
d = 2.92*10^(-10) ;   //Molecular diameter of the
    hydrogen molecule in m
m = 2.016*1.66*10^(-27) ;  //   mass in Kg
T = 27 + 273 ;  //   Temperature in Kelvin
kb = 1.38*10^(-23) ;   //  Boltzmann constant in J/K
Vmean = sqrt((8*kb*T)/(%pi*m)) ; //  average speed
    in m/sec
disp(" average speed in m/sec is ;",Vmean)
eta = (m*Vmean)/(3*2^(1/2)*%pi*d^2) ;  //
```

```
    Coefficient of viscosity of Hygrogen gas  in
    10^(-6) Nsm^(-2)
disp(" Coefficient of viscosity of Hygrogen gas  in
    10^(-6) Nsm^(-2) is; ",eta/10^(-6))

/*  Result

  8.853D-08

  mean free path in m is ;

   3.069D-10

  Molecular diameter of the gas in m is;

  "Answer vary due to round off error"

   */
```

Scilab code Exa 2.10 Thermal Conductivity of gas

```
// Scilab Code for 2.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_10.txt")
rho = 1.6  ;      //   density of gas in Kgm^(-3)
Vmean = 480 ;      //   Average speed in m/sec
lambda = 8*10^(-8) ; //  Mean free path in m
Y = 1.4 ;    //       Adiabatic constant
R = 8.31*10^3  ;  //  J Kmol^(-1) K^(-1)
M = 32 ;    // molar mass of the gas in Kg Kmol^(-1)
Cv = (5/2)*R ;    //  specefic Heat in J Kmol^(-1) K
```

```
^(-1)
disp(" specefic Heat in J Kmol^(-1) K^(-1) is ;",Cv)
K = (Cv*rho*lambda*Vmean)/(3*M) ;  // Thermal Conductivity of gas in J m^(-1) s^(-1) K^(-1)
disp(" Thermal Conductivity of gas in J m^(-1) s^(-1) K^(-1) is ;",K)

/* Result

  20775.

  specefic Heat in J Kmol^(-1) K^(-1) is ;

   0.013296

  Thermal Conductivity of gas in J m^(-1) s^(-1) K^(-1) is ;

  "Answer vary due to roundoff error"

   */
```

Scilab code Exa 2.11 Density and mean free path of the Oxygen molecules

```
// Scilab Code for 2.11
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_11.txt")
eta = 1.95*10^(-5) ;  // Coefficient of viscosity of gas in Nsm^(-2)
Vmean = 440 ;    //  Average molecular speed in m/sec
```

```
D = 1.22*10^(-5) ;    //  Coefficient of diffusion for oxygen in m^2 / sec
rho = eta/D ;      //  Density of the gas in Kg m^(-3)
disp("  Density of the gas in Kg m^(-3) is ;",rho)
lambda = (3*D)/Vmean ;  //  Mean free p-ath in m
disp(" Mean free p-ath in m is ;",lambda)

/*  Result

  1.5983607

   Density of the gas in Kg m^(-3) is ;

   8.318D-08

  Mean free p-ath in m is ;

  "Answer vary due to round off error"

   */
```

Scilab code Exa 2.12 Mass of nitrigen diffusing per unit time

```
// Scilab Code for 2.12
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_12.txt")
lambda = 10^(-7) ; //  Mean free path in m
Vmean = 480 ;    //  Average molecular speed in m/sec
R = 1.26 ;   //  Concentration gradient ( d_rho/d_y
```

```
    = R )in Kg m^(-4)
M = (1/3)*Vmean*lambda*(R) ;    //  Mass of nitrogen
    diffusing per unit time in  Kg m^(-2) sec^(-1)
disp(," Mass of nitrogen diffusing per unit time in
    10^(-5) Kg m^(-2) sec^(-1) is ;",M/10^(-5))
/*  Result

   2.016

  Mass of nitrogen diffusing per unit time in
     10^(-5) Kg m^(-2) sec^(-1) is ;\


  "Answer vary due to roundoff error"
   */
```

Scilab code Exa 2.13 Coefficient of viscosity and Thermal Conductivity of Air

```
// Scilab Code for 2.13
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_13.txt")
rho = 1.29  ;     //   density of gas in Kgm^(-3)
Vmean = 460 ;     //   Average speed in m/sec
lambda = 6.4*10^(-8) ; //  Mean free path in m
R = 8.31*10^3  ;  //  J Kmol^(-1) K^(-1)
M = 29   ;    //  Molar mass in Kg Kmol^(-1)
eta = (1/3)*rho*Vmean*lambda ;  // Coefficient of
    viscosity of Air  in Nsm^(-2)
disp(" Coefficient of viscosity of Air 10^(-5) Nsm
    ^(-2) ;",eta/10^(-5))
Cv = (5/2)*R ;  //  specefic Heat in J Kmol^(-1) K
```

```
^(-1)
disp(" specefic Heat in 10^(3) J Kmol^(-1) K^(-1) is ;",Cv/10^(3))
K = eta*Cv/M ;  // Thermal Conductivity of Air in J m^(-1) s^(-1) K^(-1)
disp(" Thermal Conductivity of Air in 10^(-3) J m^(-1) s^(-1) K^(-1) is ;",K/10^(-3))
D = (1/3)*Vmean*lambda ;  // Coefficient of diffusion in m^2 / sec
disp(" Coefficient of diffusion in 10^(-6) m^2 / sec is ;",D/10^(-6))

/*  Result


   1.26592

  Coefficient of viscosity of Air 10^(-5) Nsm^(-2) ;

   20.775

  specefic Heat in 10^(3) J Kmol^(-1) K^(-1) is ;

   9.068789

  Thermal Conductivity of Air in 10^(-3) J m^(-1) s^(-1) K^(-1) is ;

   9.8133333

  Coefficient of diffusion in 10^(-6) m^2 / sec  is ;

  "Answer vary due to roundoff error"

   */
```

Scilab code Exa 2.14 `calculation of Avogadros Number`

```
// Scilab Code for 2.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_14.txt")
R = 8.31  ;  // Gas Constant J mol^(-1) K^(-1)
T = 20 + 273 ;     //  Temperature in Kelvin
rho = 1.194*10^(3) ;   //  density of gamboge in Kg m^(-3)
rho_dash = 1*10^(3) ;   //  density of water in Kg m^(-3)
r = 0.212*10^(-6) ;    //  radius of each particle in m
g = 9.8  ;   //  acceleration due to gravity in m sec^(-2)
z = 60*10^(-6) ;  // tnickness of layer in m
n0 = 49 ;   // number of particle per cm^(2)  in one layer
n = 14 ;   // number of particle per cm^(2) in higher layer
Na = (3*R*T*log(n0/n))/(4*%pi*r^3*(rho - rho_dash)*g*z)  //  Avogadros Number per mol is
disp(" Avogadros Number per mol is ; ",Na)


/* Result


    6.700D+23

```

```
  Avogadros Number per mol is ;

   */
```

Scilab code Exa 2.15 calculation of Boltzmann Constant

```
// Scilab Code for 2.15
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_15.txt")
C = 9.428*10^(-16) ;   // Torsion Constant in N m rad^(-1)
T = 287.1 ;   //  Temperature in Kelvin
Theta_square = 4.178*10^(-6) ;   // Angular deflection in rad^2
Kb = C*Theta_square/T  ;   //  Boltzmann Constant in J/K
disp(" Boltzmann Constant in J/K is ;",Kb)

/* Result

1.372D-23

  Boltzmann Constant in J/K is ;

  "Answer vary due to round off error "

   */
```

Scilab code Exa 2.16 Mean time between collision of nitrogen molecules

```
// Scilab Code for 2.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_16.txt")
Kb = 1.38*10^(-23)  ;   //  Boltzmann Constant in J/K
d = 10^(-10) ;  // diameter of N2 molecule in m
T = 27 + 273 ;  // Temperature in Kelvin
p = 1.013*10^(5) ;  // Pressure in N m^(-2)
m = 28/(6.023*10^26) ;  // mass in Kg
lambda = (Kb*T)/(2^(1/2)*%pi*d^2*p) ;   // Mean free path in m
disp(" Mean free path in 10^(-6) m is ;",lambda/10^(-6))
Vmean = sqrt(2.55*Kb*T/m) ;   // mean speed in m/sec
disp(" mean speed in m/sec is ;",Vmean)
t = lambda/Vmean ;   // Mean time between collision in sec
disp(" Mean time between collision in sec is ;",t)

/* Result


   0.9198691

  Mean free path in 10^(-6) m is ;

   476.53815

```

```
mean speed in m/sec is ;

 1.930D-09

Mean time between collision in sec is ;

"Answer vary due to round off error"
 */
```

Scilab code Exa 2.17 Mean Free path a gas

```
// Scilab Code for 2.17
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_17.txt")
d = 0.2*10^(-9) ;  // diameter of molecules in m
n = (6.023*10^(23)*10^(-9)/(22.4*10^(-3)*0.76)) ; // Number of molecules per m^(-3)
disp(" No. of molecules per m^(3) is ;",n)
lambda = 1/(2^(1/2)*%pi*d^2*n) ;  // Mean free path in m
disp(" Mean free path in m is ;",lambda)

/* Result


 3.538D+16

No. of molecules per m^(3) is ;

 159.04642

```

```
    Mean free path in m is ;

    "Answer vary due to round off error"

     */
```

Scilab code Exa 2.18 frequency of sound wave

```
// Scilab Code for 2.18
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_18.txt")
V = 22.4*10^(-3) ;   // Volume in m^3
v = 330 ;   //  speed in m/sec
Na = 6.023*10^23 ;   // Avagadro Number
d = 3*10^(-10) ;   // diameter in m
n = Na/V ;   // Number density in per m^3
disp(" Number density in per m^3 is ;",n)
lambda = 1/(2^(1/2)*%pi*d^2*n) ;  // Mean free path
   in m
disp(" Mean free path in m is ;",lambda)
f = v/lambda ;  //  frequency of sound wave per sec
disp(" frequency of sound wave per sec is ;",f)

/*  Result


     2.689D+25

    Number density in per m^3 is ;

     9.301D-08
```

```

Mean free path in m is ;

 3.548D+09

frequency of sound wave per sec is ;

 */
```

Scilab code Exa 2.19 Mean free path for the Molecular of a gas

```
// Scilab Code for 2.19
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_19.txt")
V = 22.4  ;  // // Volume in m^3
Na = 6.023*10^26 ;   // Avagadro Number
d = 2*3*10^(-10) ;   // diameter in m
n = Na/V ;   // Number density in per m^3
lambda = 1/(2^(1/2)*%pi*d^2*n) ;  // Mean free path
   in m
disp(" Mean free path in m is ;",lambda)

/*  Result


 2.325D-08

Mean free path in m is ;

"Answer vary due to round off error"

```

```
*/
```

Scilab code Exa 2.20 `Mean free path Collision frequency and molecular diameter`

```
// Scilab Code for 2.20
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_20.txt")
eta = 1.66*10^(-5) ;  // Coefficient of viscosity of gas in Nsm^(-2)
Vmean = 450 ;    //  Average molecular speed in m/sec
rho = 1.25 ;   // Density of ther gas in Kg m^(-3)
// (a) Meab free path of the gas
lambda = (3*eta)/(rho*Vmean) ;  //  Mean free p-ath in m
disp(" Mean free p-ath in m is ;",lambda)
// (b) Collision frequency
f = Vmean/lambda ;  // Collision frequency per sec
disp( " Collision frequency per sec is ;",f)
// (c) Molecular diameter of in m
V = 22.4*10^(-3) ;   // Volume in m^3
Na = 6.023*10^23 ;   // Avagadro Number
n = Na/V ;   // Number density in per m^3
disp(" Number density in per m^3 is ;",n)
d = sqrt(1/(sqrt(2)*%pi*lambda*n)) ;   // Molecular diameter in m
disp( " Molecular diameter in m is ;",d)

/*  Result


```

```
 8.853D-08

Mean free p-ath in m is ;

 5.083D+09

Collision frequency per sec is ;

 2.689D+25

Number density in per m^3 is ;

 3.075D-10

Molecular diameter in m is ;

 */
```

Scilab code Exa 2.21 Mean free path of hydrogen molecule

```
// Scilab Code for 2.21
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_21.txt")
Kb = 1.38*10^(-23)  ;   //  Boltzmann Constant in J/
   K
T = 273 ;  // Temperature in Kelvin
p = 1.013*10^(5) ;   //  Pressure in N m^(-2)
sigma = 80*10^(-28) ; //  Molecular diameter in m^2
lambda = (Kb*T)/(2^(1/2)*p*sigma) ;  // Mean free
   path in m
disp(" Mean free path in m is ;",lambda)
```

```

/* Result


   3.2872089

  Mean free path in m is ;

   " Answer given textbook is wrong"
   " Temperature used in Calculation is different
      that given in question"
   */
```

Scilab code Exa 2.22 Molecular diameter of oxygen molecule

```
// Scilab Code for 2.22
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_22.txt")
Na = 6.023*10^26 ;   // Avagadro Number per mol
Kb = 1.38*10^(-23)  ;   //  Boltzmann Constant in J/
    K
eita = 169*10^(-6) ;  // Coefficient of viscosity of
     oxygen gas in poise
T = 16 + 273 ;  // Temperature in Kelvin
m = 32/Na ;   //  mass of the gas in Kg
Vmean = sqrt(2.55*Kb*T/m) ;  // Average molecular
    speed in m/sec
disp(" Average molecular speed in m/sec is ",Vmean)
d = sqrt((m*Vmean)/(3*2^(1/2)*%pi*eita*0.1)) ;  //
    Molecular diameter in m
disp(" Molecular diameter in m is ",d)
```

```
/* Result


   437.51203

  Average molecular speed in m/sec is

   3.212D-10

  Molecular diameter in m is

   */
```

Scilab code Exa 2.23 Coefficient of viscosity of hydrogen gas

```
// Scilab Code for 2.23
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_23.txt")
rho = 8.9*10^(-2) ;    //  density in Kg m^(-3)
lambda = 2*10^(-7) ;   // Mean free path in m
Kb = 1.38*10^(-23)  ;    //  Boltzmann Constant in J/
    K
Na = 6.023*10^26 ;    // Avagadro Number per mol
m = 2/Na ;    //  mass of hydrogen in Kg
T = 273 ;    //  Temperature in Kelvin
Vmean = sqrt(2.55*Kb*T/m) ;   // Average molecular
    speed in m/sec
disp( " Average molecular speed in m/sec is ;",Vmean
    )
eta = (1/3)*rho*Vmean*lambda ;  // Coefficient of
```

```
    viscosity of gas in Kg m^(-1) sec^(-1)
disp(," Coefficient of viscosity of gas in 10^(-5)
    Kg m^(-1) sec^(-1) is  ;",eta/10^(-5))

/* Result


   1700.9141

  Average molecular speed in m/sec is ;

   1.0092091

  Coefficient of viscosity of gas in 10^(-5) Kg m
    ^(-1) sec^(-1) is  ;

   */
```

Scilab code Exa 2.24 Pressure in Vaccum flask

```
// Scilab Code for 2.24
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex2_24.txt")
lambda = 100*10^(-9) ; //  mean free path in m
p = 1*10^5 ; // pressure in Pa
lambda_1 = 4*10^(-3) ; //  gap between two glass
    cylinder in m
// we Know lambda  = (1/2)^1/2*(Kb T)/(p sigma)
// lambda.p  = constant
p_1 = lambda*p/lambda_1 ; // pressure in Pa
disp(" pressure reduced below in Pa is ",p_1)
```

```
// given pressure reduced to 10^(-3) of its value at
    1atm
disp(" Pressure in Pa is ",p_1*10^(-3))

/* Result

2.5

pressure reduced below in Pa is

0.0025

Pressure in Pa is
```

Chapter 3

Real Gases Van der Waals Equation of state

Scilab code Exa 3.1 Pressure of an Ideal and van der waals Gas

```
// Scilab Code for 3.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_1.txt")
V = 550*10^(-6) ;  //  Volume of the gas in m^3
T = 0 + 273 ;  // Temperature in Kelvin
R = 8.31 ;  //  Gas Constant in J mol^(-1) K^(-1)
a = 0.37 ;  //  Van der Walls gas Constant "a" in N m^4 mol^(-2)
b = 43*10^(-6) ;  //  Van der Walls gas Constant "b" in  m^3 mol^(-1)
// (a) For ideal gas
p = R*T/V ;  // Pressure of ideal gas in N m^(-2)
disp(" Pressure of ideal gas in N m^(-2) is ;",p)
//  (b) For Van der Walls gas
p = R*T/(V-b) - a/V^2 ;  // Pressure of Van der Walls gas in N m^(-2)
disp(" Pressure of Van der Walls gas in N m^(-2) is
```

```
    ;",p)

/* Result

    4124781.8

  Pressure of ideal gas in N m^(-2) is ;

    3251474.9

  Pressure of Van der Walls gas in N m^(-2) is ;

    */
```

Scilab code Exa 3.2 Temperatue of Van der Waals Gas

```
// Scilab Code for 3.2
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_2.txt")
a = 1.34*10^(12) ;  //  Van der Walls gas Constant "
    a" in dyne cm^4 mol^(-1)
b = 31.2 ;  //  Van der Walls gas Constant "b" in
    cm^3 mol^(-1)
p = 5*1.013*10^(6) ;    //  Pressure in dyne cm^(-2)
V = 20*10^(3) ;         //  Volume in cm^3
n  = 5 ;    //  number of moles
R = 8.31*10^(7) ;  //  Gas Constant in erg mol^(-1)
    K^(-1)
T = (p + (n^2*a/V^2))*(V - n*b)/(n*R) ;    //
    Temperature in Kelvin
disp(" Temperature in Kelvin is ;",T)
```

```
/* Result

 245.90083

  Temperature in Kelvin is ;

   */
```

Scilab code Exa 3.3 Critical Temperature of Helium

```
// Scilab Code for 3.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_3.txt")
Pc = 2.26*1.013*10^(5) ;  //  critical Pressure in N
    m^(-2)
rho_c = 69 ;   //  Critical density in Kg m^3
Vc = 4/rho_c ;  // Critical Volume  in m^3 kmol^(-1)
R = 8.31*10^3 ;  //  Gas Constant in J Kmol^(-1) K
   ^(-1)
Tc = (8*Pc*Vc)/(3*R) ;  // Critical Temperature in
   Kelvin
disp(" Critical Temperature in Kelvin is ;",Tc)

/* Result


   4.2588907

  Critical Temperature in Kelvin is ;

```

```
"Answer vary due to round off error"

*/
```

Scilab code Exa 3.4 Van der Waals Constants and Molecular dismeter of the Helium

```
// Scilab Code for 3.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_4.txt")
Tc = 5.3  ;   // critical Temperature in Kelvin
Pc = 2.25*1.013*10^(5) ;  //  critical Pressure in N
    m^(-2)
R = 8.31 ;  //  Gas Constant in J mol^(-1) K^(-1)
Na = 6.023*10^23 ;   // Avagadro Number per mol
a = (27*R^2*Tc^2)/(64*Pc) ;   //  Van der Walls gas
    Constant "a" in N m^4 mol^(-2)
disp(" Van der Walls gas Constant a in  10^(-3)  N m
    ^4 mol^(-2) is ;",a/10^(-3))
b = (R*Tc)/(8*Pc) ;   // Van der Walls gas Constant
    "b" in  m^3 mol^(-1)
disp(" Van der Walls gas Constant b in  10^(-5)  m^3
    mol^(-1) is ;",b/10^(-5))
d = ((3*b)/(2*%pi*Na))^(1/3) ;  // Molecular
    diameter in m
disp(" Molecular diameter in m  is ;",d)
/* Result


   3.590423

  Van der Walls gas Constant a in  10^(-3)  N m^4
```

```
    mol^(-2) is ;

  2.4154327

 Van der Walls gas Constant b in  10^(-5)  m^3 mol
    ^(-1) is ;

  2.675D-10

 Molecular diameter in m  is ;

 "Answer vary due to round off error"

  */
```

Scilab code Exa 3.5 Drop in Temperature when oxygen undergoes adiabatic throttling

```
// Scilab Code for 3.5
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_5.txt")
a = 13.2*10^(-2) ;  //  Van der Walls gas Constant "
   a" in N m^4 mol^(-2)
b = 31.2*10^(-6) ;  //  Van der Walls gas Constant "
   b" in  m^3 mol^(-1)
R = 8.31 ;  //  Gas Constant in J mol^(-1) K^(-1)
Cp = 3.4*R ;  //  Specefic heat at constant pressure
T = 27 + 273 ;  // Temperature in Kelvin
delta_p = 50*1.013*10^(5) ;   //  Pressure
   difference in N m^(-2)
// p1-p2 = delta_p
delta_T = (delta_p/Cp)*(((2*a)/(R*T))-b) ;   // Drop
```

```
    in Temperature in Kelvin
disp(" Drop in Temperature in Kelvin ;",delta_T)

/* Result


   13.390593

  Drop in Temperature in Kelvin ;

  "Answer vary due to round off error"
   */
```

Scilab code Exa 3.6 Drop in Temperature when helium undergoes Joules Thomson Expan

```
// Scilab Code for 3.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_6.txt")
a = 3.41*10^(-3) ;  //  Van der Walls gas Constant "
   a" in N m^4 mol^(-2)
b = 23.7*10^(-6) ;  //  Van der Walls gas Constant "
   b" in  m^3 mol^(-1)
R = 8.3 ;  //  Gas Constant in J mol^(-1) K^(-1)
Cp = 2.5*R ;  //  Specefic heat at constant pressure
T = -173 + 273 ;  // Temperature in Kelvin
delta_p = 20*1.013*10^(5) ;   //  Pressure
   difference in N m^(-2)
delta_T = (delta_p/Cp)*(((2*a)/(R*T))-b) ;   // Drop
    in Temperature in Kelvin
disp(" Drop in Temperature in Kelvin ;",delta_T)

```

```
/* Result

  -1.5117507

  Drop in Temperature in Kelvin ;



  */
```

Scilab code Exa 3.7 Inversion Temperature and Drop in Temperature when hydrogen un

```
// Scilab Code for 3.7
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_7.txt")
a = 2.47*10^(-2) ;  //  Van der Walls gas Constant "
    a" in N m^4 mol^(-2)
b = 26.5*10^(-6) ;  //  Van der Walls gas Constant "
    b" in  m^3 mol^(-1)
R = 8.3 ;  //  Gas Constant in J mol^(-1) K^(-1)
// (a) Inversion Temperature
Ti = (2*a)/(R*b) ;  // Inversion Temperature in
    Kelvin
disp( " (a) Inversion Temperature in Kelvin is ;",Ti
    )
// (b) Joule-Thomson Colling
Cp = (7/2)*R ;  //  Specefic heat at constant
    pressure
T = 100 ;  // Temperature in Kelvin
delta_p = 2*1.013*10^(5) ;   //  Pressure difference
     in N m^(-2)
```

```
delta_T = (delta_p/Cp)*(((2*a)/(R*T))-b) ;    // Drop in Temperature in Kelvin
disp("(b) Drop in Temperature in Kelvin ;",delta_T)

/* Result

   224.5965

  (a) Inversion Temperature in Kelvin is ;

   0.2302741

 (b) Drop in Temperature in Kelvin ;

 "Answers vary due to round off error"

   */
```

Scilab code Exa 3.9 Van der Waals Constants for Helium Gas

```
// Scilab Code for 3.9
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_9.txt")
Tc = 5  ;   // critical Temperature in Kelvin
Pc = 2.3*1.013*10^(5) ;  //  critical Pressure in N m^(-2)
R = 8.314 ;  //  Gas Constant in J mol^(-1) K^(-1)
b = (Tc/Pc)*(R/8) ;   // Van der Walls gas Constant "b" in  m^3 mol^(-1)
disp(" Van der Walls gas Constant b in  10^(-5) m^3 mol^(-1) is ;",b/10^(-5))
```

```
a = (27/Pc)*(Tc*R/8)^2 ;    // Van der Walls gas Constant "a" in N m^4 mol^(-2)
disp( " Van der Walls gas Constant a in 10^(-3) N m^4 mol^(-2) is ;",a/10^(-3))

/*  Result



  2.2302459

 Van der Walls gas Constant b in  10^(-5) m^3 mol^(-1) is ;

  3.1290072

 Van der Walls gas Constant a in 10^(-3) N m^4 mol^(-2) is ;

 */
```

Scilab code Exa 3.10 Drop in Temperature when oxygen undergoes adiabatic throttlin

```
// Scilab Code for 3.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_10.txt")
a = 1.32*10^(-6)*1.013*10^(5) ;  //  Van der Walls gas Constant "a" in N m^4 mol^(-2)
b = 3.12*10^(-5) ;  //  Van der Walls gas Constant "b" in  m^3 mol^(-1)
R = 8.314 ;  //  Gas Constant in J mol^(-1) K^(-1)
```

```
Cp = 7.03*4.186 ;  //  Specefic heat at constant pressure
T = 300 ;  // Temperature in Kelvin
delta_p = 50*1.013*10^(5) ;   //  Pressure difference in N m^(-2)
delta_T = (delta_p/Cp)*(((2*a)/(R*T))-b) ;   // Drop in Temperature in Kelvin
disp(" Drop in Temperature in Kelvin ;",delta_T)

/* Result


   13.084636

  Drop in Temperature in Kelvin ;

   */
```

Scilab code Exa 3.11 Drop in Temperature when helium undergoes Joules Thomson Expa

```
// Scilab Code for 3.11
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_11.txt")
a = 0.0341*10^(-6)*1.013*10^(5) ;  //  Van der Walls gas Constant "a" in N m^4 mol^(-2)
b = 0.0237*10^(-3) ;  //  Van der Walls gas Constant "b" in  m^3 mol^(-1)
R = 8.3 ;  //  Gas Constant in J mol^(-1) K^(-1)
Cp = (5/2)*R ;  //  Specefic heat at constant pressure
T = 100 ;  // Temperature in Kelvin
```

```
delta_p = 20*1.013*10^(5) ;   //  Pressure difference in N m^(−2)
delta_T = (delta_p/Cp)*(((2*a)/(R*T))-b) ;   // Drop in Temperature in Kelvin
disp(" Drop in Temperature in Kelvin ;",delta_T)

/* Result

-1.501321

  Drop in Temperature in Kelvin ;


  "Answer vary due to round off error"
  */
```

Scilab code Exa 3.12 Boyles Temperature Inversion Temperature and Drop in Temperat

```
// Scilab Code for 3.12
// OS : "Windows 10" , Scilab : 6.0.2 64−bit
clc;
clear;
diary("Ex3_12.txt")
a = 24.8*10^(-3) ;  //  Van der Walls gas Constant "a" in N m^4 mol^(−2)
b = 0.0266*10^(-3) ;  //  Van der Walls gas Constant "b" in  m^3 mol^(−1)
R = 8.314 ;  //  Gas Constant in J mol^(−1) K^(−1)
Cp = 3.5*R ;  //  Specefic heat at constant pressure
T = 100 ;  // Temperature in Kelvin
delta_p = 2*1.013*10^(5) ;   //  Pressure difference in N m^(−2)
// (a) Boyle and Inversion Temperature in Kelvin
```

```
Tb = a/(b*R) //  Boyle  Temperature in Kelvin
disp(" (a) Boyle  Temperature in Kelvin is ;",Tb)
Ti = (2*a)/(R*b) ;  // Inversion Temperature in
   Kelvin
disp(" Inversion Temperature in Kelvin is ;",Ti)
// (b) Drop in Temperature in Kelvin
delta_T = (delta_p/Cp)*(((2*a)/(R*T))-b) ;   // Drop
    in Temperature in Kelvin
disp(" (b) Drop in Temperature in Kelvin ;",delta_T)

/* Result

   112.13986

  (a) Boyle  Temperature in Kelvin is ;

   224.27973

  Inversion Temperature in Kelvin is ;

   0.2301671

  (b) Drop in Temperature in Kelvin ;

  "Answer vary due to round of error"

   */
```

Scilab code Exa 3.13 Radius of Nitrogen Molecule

```
// Scilab Code for 3.13
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
```

```
clear;
diary("Ex3_13.txt")
Vc = 81 ; //  Critical volume in cm^3
b = Vc/3 ;  // Van der Walls gas Constant "b" in  cm
    ^3
Na = 6.023*10^(23) ;  // Avagadro Number
V1 = b/3 ;  //  Actual volume of a mole of N2 gas in
     cm^3
V2 = V1/Na ;    //  Actual volume of one molecule of
     N2 gas in cm^3
r = ((3*V2)/(4*%pi))^(1/3) ;  //  Radius of Nitrogen
     molecule in Cm
disp(" Radius of Nitrogen molecule in Cm is ;",r)

/* Result

1.528D-08

  Radius of Nitrogen molecule in Cm is ;

   */
```

Scilab code Exa 3.14 Van der Waals Constants of a gas Contained in Closed Vessel

```
// Scilab Code for 3.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_14.txt")
T1 = 300 ;    //  Temperature in state 1 in Kelvin
T2 = 325 ;    //  Temperature in state 1 in Kelvin
V = 0.25 ;    // Volume in lit mol^(-1)
R = 8.314 ;  //  Gas Constant in J mol^(-1) K^(-1)
```

```
p1 = 90 ;    //  Pressure difference in N m^(-2)
p2 = 100 ;    //  Pressure difference in N m^(-2)
a = (V^2)*((T1*p2-T2*p1)/(T2-T1))  ;  // Van der Walls gas Constant "a" in atm lit^2 mol^(-2)
disp(" Van der Walls gas Constant a in atm lit^2 mol^(-2) is ;",a)
b = V*10^(-3) - (R*(T2-T1)/((p2-p1)*1.013*10^(5))) ;   // Van der Walls gas Constant "b" in  lit mol^(-1)
disp(" Van der Walls gas Constant b in  lit mol^(-1) is ;",b/10^(-3))

/* Result


   1.875

  Van der Walls gas Constant a in atm lit^2 mol^(-2) is ;

   0.0448174

  Van der Walls gas Constant b in  lit mol^(-1) is ;

   */
```

Scilab code Exa 3.16 Internal pressure and Temperature of a monoatomic Van der Waa

```
// Scilab Code for 3.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex3_16.txt")
```

```
a = 4.05  ;  // Van der Walls gas Constant "a" in
    atm lit^2 mol^(-2)
b = 0.037  ;   // Van der Walls gas Constant "b" in
     lit mol^(-1)
R = 0.082 ;  //  Gas Constant in atm lit mol^(-1) K
    ^(-1)
p = 36 ;  //   pressure in atm
V = 0.8 ;  //  Volume of Gas in lit mol^(-1)
Pi = a/V^2 ;  //  Internal pressure in atm
disp(" Internal pressure in atm  is ;",Pi)
T = (p+a/V^2)*(V-b)/R  ;  // Temperature of the gas
    in Kelvin
disp(" Temperature of the gas in Kelvin is ;",T)

/* result


   6.328125

  Internal pressure in atm  is ;

   393.85804

  Temperature of the gas in Kelvin is ;

"Answer vary due to round off error"
   */
```

Chapter 4

Basic Concept of Thermodynamics

Scilab code Exa 4.2 Final pressure of copper Block

```
// Scilab Code for 4.2
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex4_2.txt")
alpha = 48*10^(-6)  ;  // Expansivity of copper in per K
Et = 1.3*10^(11) ;   //  Isothermal elasticity of copper in N m^(-2)
T1 = 0 + 273 ;    //  Temperature  in Kelvin
T2 = 10 + 273 ;    //  Temperature  in Kelvin
// T2 - T1 = delta_T
p1 = 1 ;     //  Atmospheric Pressure in atm
V1 = 1000 ;  //  Volume in cc at T1
V2 = 1000.1 ;    // Volume in cc  at T2
dV = (V2-V1)*10^(-6)  ;   //  Change in Volume in m^3
// (a) Final Pressure in atm when V is fixed
dp =  alpha*Et*(T2-T1) ;  //  Final Pressure in N m
```

```
^(-2)
p2 = dp/10^(5) + p1 ;    // Final Pressure in atm
disp("(a) Final Pressure in atm is ;",p2)
// (b) Final Pressure in atm when V increases
dp =  - (Et*dV/(V1*10^(-6))) + (alpha*Et*(T2-T1)) ;
    //  Final Pressure in atm when V increases in N
   m^(-2)
p2 = dp/10^(5) + p1 ;  // Final Pressure in atm
disp("(b) Final Pressure in atm when V increases is
   ;",p2)


/*
Result

 625.

 (a) Final Pressure in atm is ;

   495.

 (b) Final Pressure in atm when V increases  is ;

 */
```

Scilab code Exa 4.3 Rise in temperature of Mercury

```
// Scilab Code for 4.3
diary("Ex4_3.txt")
clc
Beta_t = 35*10^(-12) ;    //  Isothermal
   Compressibility of Mercury in N^(-1) m^(2)
Et = 1/Beta_t ;   //  Isothermal elasticity of
```

```
Mercury in N m^(-2)
disp(" Isothermal elasticity of Mercury in N m^(-2) is ;",Et)
disp(" Isothermal elasticity of Mercury in atm is ;",Et/10^(5))
delta_p = 4000 ;   //  change in Pressure P2-P1 in atm
alpha = 17.5*10^(-5)  ;  // Expansivity of Mercury in per K
delta_T = (delta_p)/(alpha*Et*10^(-5))  ;  // rise in temperature in Kelvin
disp(" Rise in temperature in Kelvin  is ;",delta_T)

/* Result

   2.857D+10

  Isothermal elasticity of Mercury in N m^(-2) is  ;

   285714.29

  Isothermal elasticity of Mercury in atm is  ;

   80.

  Rise in temperature in Kelvin  is ;

  "Answer varies due to round off error"
   */
```

Scilab code Exa 4.4 Final pressure of Mercury

```
// Scilab Code for 4.4
```

```
diary("Ex4_4.txt")
clc
Beta_t = 35*10^(-12) ;   //  Isothermal
    Compressibility of Mercury in N^(-1) m^(2)
Et = 1/Beta_t ;   //  Isothermal elasticity of
    Mercury in N m^(-2)
alpha = 17.5*10^(-5)  ;  //  Volume Expansivity of
    Mercury in per K
delta_T = 24 ;  // Temperature difference in Kelvin
p1 = 1 ;     //  Atmospheric Pressure in atm
p2 = p1 + alpha*Et*10^(-5)*(delta_T) ;  //  Final
    Pressure in atm
disp(" Final Pressure in atm is ; ",p2)

/* Result

1201.

  Final Pressure in atm is ;

   " Answer given in the Textbook is wrong"
   */
```

Scilab code Exa 4.5 Pressure applied on the metal block

```
// Scilab Code for 4.5
diary("Ex4_5.txt")
clc
Beta_t = 1.2*10^(-6) ;   //  Isothermal
    Compressibility of Metal in atm^(-1)
Et = 1/Beta_t ;   //  Isothermal elasticity of
    Mercury in N m^(-2)
alpha = 5*10^(-5)  ;  //  Volume Expansivity of
```

```
    Metal in per K
delta_T = 12 ;   // Temperature difference in Kelvin
V = 5*10^3  ;  // Volume in cm^3
delta_V = 0.5 ;  // Change in Volume in cm^3
// dp = p2 - p1
p1 = 1 ;     //  Atmospheric Pressure in atm
p2 = (alpha*delta_T/Beta_t) - delta_V/(Beta_t*V) +
    p1 ;  //  Final Pressure in atm
disp(" Final Pressure in atm is;",p2)

/* Result


   417.66667

  Final Pressure in atm is;

  "Answer varies due to the round off error"

   */
```

Scilab code Exa 4.6 Final Tension and Frequency of the Vibrating string

```
// Scilab Code for 4.6
diary("Ex4_6.txt")
clc
A = 0.85*10^(-6)  ;   //  Cross section Area in m^2
alpha = 1.5*10^(-5)  ;  //  linear Expansivity in
    per K
Y = 2*10^(11) ;   //  Isothermal Youngs Modulus in N
     m^(-2)
T1 = 20 + 273 ;  // Temperature in Kelvin
T2 = 8 + 273 ;   // Temperature in Kelvin
```

```
F1 = 20 ;        // Tension in N
L = 1.2 ;     //  Length in m
rho = 9*10^3 ;     //  Density of the material in Kg m^(-3)
m = A*rho ;     //    mass of the material in Kg
// (a) Final tension in  N
F2 = F1 + A*alpha*Y*(T1-T2) ;  // Final tension in N
disp("(a) Final tension in  N is ;",F2)
// (b) Frequency of vibration of the wire
v = 1/(2*L)*sqrt(F1/m) ;     //  Frequency of vibration of the wire in Hz
disp( " (b) Frequency of vibration of the wire in Hz is ;",v)

/* Result


   50.6

 (a) Final tension in  N is ;

   21.304583

  (b) Frequency of vibration of the wire in Hz is ;

  "Answer varies due to round off error"

   */
```

Scilab code Exa 4.7 Temperature on Resistance Scale of Platinium

```
// Scilab Code for 4.7
```

```
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex4_7.txt")
alpha = 3.5*10^(-3)  ;   //  Temperature - Resistant Consatant
beta = -3*10^(-6) ;   // Temperature - Resistant Consatant
Theta_R =((50*alpha + 2500*beta)/(100*alpha + 10000*beta))*100 ;  // Temperature on Resistance Scale degree C
disp(" Temperature on Resistance Scale degree C is ; ",Theta_R)

/* Result

52.34375

  Temperature on Resistance Scale degree C is ;

   */
```

Scilab code Exa 4.8 Length and Temperature of the Mercury Column

```
// Scilab Code for 4.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex4_8.txt")
Ltp = 6 ;  //  Length of the mercury in liquid thermometer at its Triple point
T = 273.16 ;  //  Triple point of the water in kelvin
```

```
Theta_steam = 373.15 ;  // Temperature in Steam
    Point in Kelvin
// Theta_steam = Theta_L
// (a) length of the column at the Steam Point
L = Theta_steam*Ltp/T ;  //  length of the column at
     the Steam Point in cm
disp(" (a) length of the column at the Steam Point
    in cm is ;",L)
// (b) Temperature for which Length of the Column is
     7.2 cm
Theta = 273.16*(7.2/Ltp) ;  // Temperature in Kelvin
disp(" (b) Temperature in Kelvin is ;",Theta)

/* Result

 8.1962952

  (a) length of the column at the Steam Point in cm
     is ;

   327.792

  (b) Temperature in Kelvin is ;

  "Answer varies due to round off error"
   */
```

Scilab code Exa 4.10 Ration of the pressure of a gas at steam and triple point of

```
// Scilab Code for 4.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
```

```
diary("Ex4_10.txt")
theta_sp = 373.15 ; // Temperature at the steam
   point in Kelvin
theta_p = 273.16 ;  // Triple point of the water
P_Ptr = theta_sp/theta_p ;  //  Ratio of the
   pressure of the gas atr steam point and at the
   triple point of the water
disp(" Ratio of the pressure of the gas atr steam
   point and at the triple point of the water is ;",
   P_Ptr)

/* Result

  1.3660492   "Answer varies due to roundoff error"

  Ratio of the pressure of the gas at steam point
     and at the triple point of
 the water is ;

   */
```

Scilab code Exa 4.11 Temperature of Bath of Platinium Thermometer

```
// Scilab Code for 4.11
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex4_11.txt")
T = 273.16 ;  // Temperature in Kelvin
Rtr = 60 ;   // Resistance of  a platinium
   Thremometer at triple point ohm
R = 75 ;  // Resistance of the bulb in ohm
Theta_R = T*(R/Rtr) ;  //  Temperature of a Bath in
```

```
Kelvin
disp(" Temperature of a Btah in ohm  is ;",Theta_R)

/* Result

  341.45

  Temperature of a Btah in ohm  is ;

   */
```

Scilab code Exa 4.12 Temperature of Bath on Platinium and gas Scale

```
// Scilab Code for 4.12
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex4_12.txt")
R_0 = 5 ;  // Resistance of  a platinium Thremometer at ice point ohm
R_100 = 5.9 ; // Resistance of  a platinium Thremometer at steam point ohm
R_theta = 5.8 ;  // Resistance of  a platinium Thremometer ohm
p_0 = 1.0 ;  // Pressure of  a platinium Thremometer at ice point in mHg
p_100 = 1.366 ; // Pressure of  a platinium Thremometer at steam point mHg
p_theta = 1.325 ;  // Pressure of  a platinium Thremometer mHg
// (a) Temperature of the bath on platinium scale
Theta_R = 100*(R_theta - R_0)/(R_100 - R_0) ; // Temperature of the bath on platinium scale in
```

```
degree celcius
disp(" (a) Temperature of the bath on platinium scale in degree celcius is ;",Theta_R)
// Temperature of the bath on gas scale in degree celcius
Theta = 100*(p_theta - p_0)/(p_100 - p_0) ; // Temperature of the bath on gas scale in degree celcius
disp(" (b) Temperature of the bath on gas scale in degree celcius is ;",Theta)

/* Result

   88.888889

  (a) Temperature of the bath on platinium scale in degree celcius is ;

   88.797814

  (b) Temperature of the bath on gas scale in degree celcius is ;

  "Answer varies due to round off error"
   */
```

Scilab code Exa 4.14 Change in tension of the rails

```
// Scilab Code for 4.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex4_14.txt")
```

```
A = 3.6*10^(-3)  ;   //  Cross section Area in m^2
alpha = 8*10^(-6)  ;  //  linear Expansivity in per K
Y = 2*10^(11) ;   //  Isothermal Youngs Modulus in N m^(-2)
delta_T = -20 ;   // Change in Temperature in degree C
delta_F = -Y*A*alpha*delta_T ; //  Change in Tension in N
disp(delta_F/10^(5) , "Change in Tension in 10^(5) N is ")

/* Result

 Change in Tension in 10^(5) N  is

   1.152

   */
```

Scilab code Exa 4.16 Temperature of Heat Bath

```
// Scilab Code for 4.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex4_16.txt")
alpha = 3.9*10^(-3)  ;   //  Temperature - Resistant Consatant
beta = -0.00000057 ;   //     Temperature - Resistant Consatant
R_0 = 20 ;  //  Resistance in ohm
R_t = 26.24 ;  //  Resistance in ohm
```

```
// defining the polynomial
t_x = poly([1-(R_t/R_0) alpha beta],'t','c');

// using root function to find the roots of the
   polynomial in terms
t = roots(t_x)     //   Temperature of the bath in
   degree C

disp(" Temperature of the bath in degree C ",t(1))
disp(" Temperature of the bath in degree C (It is
   not possible)",t(2))

/* Result

   6761.1473

  Temperature of the bath in degree C

   80.957919

  Temperature of the bath in degree C (It is not
     possible)

  " Answer varies due to round off error because in
     textbook rounding off takes place is each steps
       thats why final answer varies "


   */
```

Scilab code Exa 4.17 Temperature of the Hot Junction

```
// Scilab Code for 4.17
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex4_17.txt")
C1 = 40*10^(-6)  ;   //   Thermo-electric Constant
    in V per degree C
C2 = -0.01*10^(-6) ;   // Thermo-electric Constant
    in V per degree C^2
E = 2.3*10^(-2) ;  // Thermo-emf in V

// defining the polynomial
t_x = poly([-E C1 C2],'t','c');


// using root function to find the roots of the
    polynomial in terms
t = roots(t_x)    //   Temperature of the bath in
    degree C


disp(" Temperature of the bath in 10^2 degree C ;",
    round(t(2)/10^2))
disp(" Temperature of the bath in 10^2 degree C (It
    is not possible) ;", t(1)/10^2)

/* Result

   7.

  Temperature of the bath in 10^2 degree C ;

   33.038405

  Temperature of the bath in 10^2 degree C (It is
     not possible) ;

  "Answer varies due to round off error"
```

```
    */
```

Chapter 5

The first law of Thermodynamics

Scilab code Exa 5.1 Work done on the steel wire

```
// Scilab Code for 5.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_1.txt")
A = 2.5*10^(-6)  ;   //  Cross section Area in m^2
Y = 2*10^(11) ;   //  Isothermal Youngs Modulus in N
    m^(-2)
L = 2.5 ;  // Length of the steel wire in m
M = 5 ;   // Mass in kg
g = 9.8 ;   // Acceleration due to gravity in m/sec
    ^2
delta_L = (L*M*g)/(Y*A) ;  //  Change in Length in m
disp(" Change in Length in m is ;",delta_L)
W = M*g*delta_L ;  //  Work done on the wire in J
disp(" Work done on the wire in J is ;",W)

/* Result

```

```
 0.000245

Change in Length in m is ;

 0.012005

Work done on the wire in J is ;


 */
```

Scilab code Exa 5.4 Change in Internal energy of Air

```
// Scilab Code for 5.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_4.txt")
dV = 0 ;    // change is Volume
dT = 1 ; // change is Temperature
Cv = 0.172 ;  // Specefic heat at constant volume in
    cal g^(-1) C^(-1)
m = 5 ; // Mass of air in g
dU = m*Cv*dT ;  //  Change in internal Energy in cal
disp(" Change in internal Energy in cal  is ;",dU)
disp(" Change in internal Energy in J  is ;",dU
   *4.184)

/* Result


 0.86

```

```
 Change in internal Energy in cal  is ;

  3.59824

 Change in internal Energy in J  is ;

  */
```

Scilab code Exa 5.5 `Work done and increase energy of Boiling Water`

```
// Scilab Code for 5.5
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_5.txt")
dV = 0.825 ;    // change is Volume in m^3
p = 2*1.013*10^(5)    //  Pressure in N m^(-2)
dW = p*dV ;  //  Work done against pressure in J
disp(" (a) Work done against pressure in 10^6 J is;"
   ,dW/10^6)
m_L = 2.2*10^(6) ;  //  Heat exchanged in J/Kg
dU = m_L - dW ;  //  Change in internal Energy in J
disp(" (b) Change in internal Energy in 10^6 J  is ;
   ",dU/10^6)


/* Result


  0.167145

 (a) Work done against pressure in 10^6 J is;

```

```
   2.032855

  (b) Change in internal Energy in 10^6 J  is ;

   */
```

Scilab code Exa 5.6 Amount of heat Absorbed

```
// Scilab Code for 5.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_6.txt")
Cv = 20.9 ;  // Specefic heat at constant volume in J mol^(-1) K^(-1)
R = 8.3  ;  //  Gas Constant in J mol^(-1) K^(-1)
n = 1 ; // No.  of moles
V2_V1 = 2 ; //  Ration of the Volume
T1 = 0 + 273 ;  //  Temperature in K
T2 = T1*(V2_V1) ;  //  Temperature in K
disp(" Final Temperature in K is ;",T2)
delta_T = T2-T1 ;     // change in temperature
dQ = n*(Cv+R)*delta_T ; // Heat requires to raise temperature in J
disp("Heat requires to raise temperature in J is ;",dQ)

/* Result


   546.

  Final Temperature in K is ;
```

```

   7971.6

 Heat requires to raise temperature in J is ;

   */
```

Scilab code Exa 5.7 Final Temperature of the Air in the pump

```
// Scilab Code for 5.7
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_7.txt")
Y = 1.4 ;   //  Adiabatic constant
Pf_Pi = 2^Y ;  //  Ratio of final and initial
   pressure
Ti = 300 ;  //  Initial temperature in K
Tf = (Pf_Pi)*Ti/2 ;  // final temperature in K
disp("final temperature in K is ;",round(Tf))

/* Result


   396.

 final temperature in K is ;

   */
```

Scilab code Exa 5.8 Atomaticity of the gas

```
// Scilab Code for 5.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_8.txt")
Y = 1.4 ;   // Adiabatic constant
Pf = 1*10^(5) ;  //  final  pressure in Pa
Pi = 1.4*10^(5) ;  //  Initial  pressure in Pa
Ti = 320 ;  //  Initial temperature in K
Tf = 286 ;  // final temperature in K
Y = ((log(Tf/Ti)/log(Pi/Pf)) + 1 )^(-1) ;  //
   Adiabatic constant
disp(" Adiabatic constant is ;",Y)
disp("Thus the gas is diatomic ")
/* Result

   1.5011495

  Adiabatic constant is ;

 Thus the gas is diatomic

 */
```

Scilab code Exa 5.12 Work done heat flow change in internal energy and final tempe

```
// Scilab Code for 5.12
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_12.txt")
R = 8.31  ;  //  Gas Constant in J mol^(-1) K^(-1)
V2_V1 = 1/2 ; //  Ration of final and initial Volume
T1 = 273 ;   //  temperature in K in state 1
T2 = 273 ;   //  temperature in K in state 2
p3_p2 = 1/2 ; // Ratio of pressure in state 3  to state 2
Y = 1.4 ;   //  Adiabatic constant
T3 = ((p3_p2)^(1-1/Y))*T2 ;
// (a)  Net work done by the gas
W_isothermal = R*T1*log(V2_V1) ;  // Net work done by the gas in J
disp(" (a) Net work done by the gas in J is ;",W_isothermal)
disp(" Temperature in State 3 , T3 = ;",T3)
W_adiabatic = R*(T1-T3)/(Y-1);  // Net work done by the gas in J in adiabatic process is
disp("work done by the gas in J in adiabatic process is ;",W_adiabatic)
disp(" Net work done by the gas in J is ;",W_adiabatic + W_isothermal)
// (b) Net heat flowing into the gas
disp(" (b) Net Heat flowing into the gas in J during isothermal process is ;",W_isothermal)
// (c) Change in internal energy
disp( "(c) Change in internal energy is  ;",W_adiabatic)
// (d) Final Temperature
disp("(d) Final Temperature in Kelvin ;",T3)

/* Result

   223.95155
```

```
 Temperature in State 3 , T3 = ;

  1018.9815

work done by the gas in J in adiabatic process is ;

 -553.51298

 Net work done by the gas in J is ;

 -1572.4945

 (b) Net Heat flowing into the gas in J during
    isothermal process is ;

  1018.9815

(c) Change in internal energy is  ;

  223.95155

(d) Final Temperature in Kelvin ;

"Answer vaies due to round off error"

  */
```

Scilab code Exa 5.13 New Temperature and Work done by Oxygen gas

```
// Scilab Code for 5.13
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
```

```
clear;
diary("Ex5_13.txt")
R = 8.31  ;  //  Gas Constant in J mol^(-1) K^(-1)
Y = 1.4 ;   //  Adiabatic constant
P2 = 5 ;  //   final  pressure in Pa
P1 = 1 ;  //   Initial  pressure in Pa
T1 = 0 + 273 ;  // Temperature in K
T2 = ((P2/P1)^(1-1/Y))*T1 ; //  Final Temperature in
   K
disp(" Final Temperature in K is ;",T2)
disp(" Final Temperature in degree C  is ;",T2-273)
W = (R*(T1-T2))/(Y-1) ; //  Adiabatic work done by
   the gas in J
disp("  Adiabatic work done by the gas in J is ;",W)

/* Result

    432.38275

  Final Temperature in K is ;

   159.38275

  Final Temperature in degree C  is ;

  -3311.1767

   Adiabatic work done by the gas in J is ;

   "Answer varies due to round off error"

  */
```

Scilab code Exa 5.14 Rise in temperature

```
// Scilab Code for 5.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_14.txt")
m = 50 ;  // mass in Kg
h = 6;  //  height in m
g = 9.8 ;  //  Acceleration due to gravity
Cv = 332;   // Specefic heat at constant volume in J
    mol^(-1) K^(-1)
E = m*g*h ;  // Potential energy in J
disp(" Potential energy in J is ;",E)
delta_T = E/(h*Cv) ;  // Rise in Temperature in  K
disp(" Rise in Temperature in  K is ;",delta_T)

/* Result

  2940.

  Potential energy in J is ;

   1.4759036

  Rise in Temperature in  K is ;

   " Answer(E,Potential Energy) given in Textbook is
       wrong "

*/
```

Scilab code Exa 5.15 Work done during the cycle

```
// Scilab Code for 5.15
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_15.txt")
pi = 5*10^(6) ; // Pressure of a perfect gas in N/m^2
Vi = 0.2 ; // Volume in m^3
Vf = 0.5 ; // Volume in m^3
R = 8.314 ; // Gas Constant in J mol^(-1) K^(-1)
T = 300 ; // Temperature in Kelvin
n = (pi*Vi)/(R*T) ; // Number of moles
disp(" Number of moles is ;",n)
// (a) Final pressure at the end of the isothermal expansion
pf = (pi*Vi)/Vf ; // Final pressure at the end of the isothermal expansion in N/m^2
disp("(a) Final pressure at the end of the isothermal expansion in 10^6 N/m^2 is ;",pf/10^6)
W_AB = n*R*T*log(Vf/Vi) ; // Work done by the Gas from A to B in J
disp(" Work done by the Gas from A to B in 10^5 J is ;",W_AB/10^5)
// (b) Work done on the gas in going from B to C
W_BC = pf*(Vf-Vi) ; // Work done on the gas in going from B to C in J
disp("(b) Work done on the gas in going from B to C in 10^5 J is ;",W_BC/10^5)
disp("(c) Work done from C to a is 0")
W = W_AB - W_BC ; // Total work done in the cycle by the gas
disp(" Total work done in the cycle by the gas in 10^5 J is ;",W/10^5)

/* Result

   400.93016
```

```
 Number of moles is ;
  2.
(a) Final pressure at the end of the isothermal expansion in 10^6 N/m^2 is  ;
  9.1629073
 Work done by the Gas from A to B in 10^5 J is ;
  6.
(b) Work done on the gas in going from B to C  in 10^5 J is ;
(c) Work done from C to a is 0
  3.1629073
 Total work done in the cycle by the gas in 10^5 J is ;
 "Answers Varies due to round off error "
  */
```

Scilab code Exa 5.16 change in Internal energy and work done

```
// Scilab Code for 5.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
```

```
clear;
diary("Ex5_16.txt")
pi = 1 ;  // Initial Pressure of a perfect gas in N/m^2
pf = 3 ;  // Final Pressure of a perfect gas in N/m^2
Ta = 300 ; // Temperature at state a in Kelvin
Tc = 900 ; // Temperature at state c in Kelvin
R = 8314 ;  //  Gas Constant in J Kmol^(-1) K^(-1)
Tb  = Ta*(pf/pi) ;  //  Temperature at state b in Kelvin
disp(" Temperature at state b in Kelvin , Tb = ;",Tb)
delta_T = Tb - Ta ;  // Temperature difference in Kelvin
disp(" Temperature difference in Kelvin , delta_T = ;",delta_T)
Cv = (5/2)*R ;   // Specefic heat at constant volume in J Kmol^(-1) K^(-1)
mu = 1 ;  // Number of Kmoles
dU_ab = mu*Cv*delta_T ;  //  Change in  internal energy in J
disp(" Change in  internal energy from a to b in 10^7 J is ;",dU_ab/10^7)
Vf_Vi = pf/pi ;  // Ratio of final and initial volume
W = 2.3*mu*R*Tb*log10(Vf_Vi) ; // Work done by an ideal gas during isothermal expansion in J
disp(" Work done by an ideal gas during isothermal expansion in 10^7 J is ;",W/10^7)
dU_ca = (5/2)*mu*R*(Ta-Tc) ;  //  Change in internal energy from c to a in J
disp(" Change in  internal energy from c to a in 10^7 J is ;",dU_ca/10^7)
delta_Q = (7/2)*mu*R*(Ta-Tc) ;  // Heat given out at constant pressure in J
disp(" Heat given out at constant pressure in 10^7 J is ;",delta_Q/10^7)
```

```
delta_W = delta_Q - dU_ca ;  //  Work done on the gas in J
disp(" Work done on the gas in 10^7 J  is  ;", delta_W/10^7)
del_W = W + delta_W ; // Net Work done by the gas in J
disp(" Net Work done by the gas in 10^7 J is ;", del_W/10^7)

/* Result

   900.

  Temperature at state b in Kelvin , Tb = ;

   600.

  Temperature difference in Kelvin , delta_T =  ;

    1.2471

  Change in  internal energy from a to b in 10^7 J is ;

   0.8211247

  Work done by an ideal gas during isothermal expansion in 10^7 J is ;

  -1.2471

  Change in  internal energy from c to a in 10^7 J is ;

  -1.74594

  Heat given out at constant pressure in 10^7 J is ;

```

```
 -0.49884         , " Answer given in Textbook is wrong "

 Work done on the gas in 10^7 J  is  ;

  0.3222847      , " Answer given in Textbook is wrong "

 Net Work done by the gas in 10^7 J is ;


*/
```

Scilab code Exa 5.17 `Change in Temperature and Pressure`

```
// Scilab Code for 5.17
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_17.txt")
R = 8.31  ;  //  Gas Constant in J mol^(-1) K^(-1)
V1_V2 = 1/3 ; //  Ration of final and initial Volume
T1 = 273 ;   //  temperature in K in state 1
Y = 1.4 ;   //  Adiabatic constant
p1 = 1 ; // initial pressure in atm
T2 = T1*(V1_V2)^(Y-1) ;   //  temperature in K in state 2
disp(" Temperature in K in state 2 is ;",T2)
disp(" Change in Temperature in Kelvin is ;",T2-T1)
p2 = p1*(V1_V2)^Y ;  // Final pressure in atm
disp(" Final pressure in atm is ;",p2)
disp(" Change in pressure  in atm is ;",p2-p1)
```

```

/* Result


  175.91957

 Temperature in K in state 2 is ;

 -97.080434

 Change in Temperature in Kelvin is ;

  0.214798

 Final pressure in atm is ;

 -0.785202

 Change in pressure  in atm is ;

 "Answers vries due to round off error"

 */
```

Scilab code Exa 5.18 Final Temperature of the sedan Car

```
// Scilab Code for 5.18
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_18.txt")
Y = 1.4 ;   //  Adiabatic constant
P2 = 1 ;  //   final  pressure in Pa
```

```
P1 = 2 ;  //   Initial  pressure in Pa
T1 = 300 ; // Initial Temperature in K
T2 = ((P2/P1)^(1-1/Y))*T1 ; //  Final Temperature in
    K
disp(" Final Temperature in K is ;",T2)
disp(" Final Temperature in degree C  is ;",T2-273)

/* Result


   246.10061

  Final Temperature in K is ;

  -26.899393

  Final Temperature in degree C  is ;

  "Answer varies due to round off error"


  */
```

Scilab code Exa 5.19 Temperature after compression of the monoatomic and diatomic

```
// Scilab Code for 5.19
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_19.txt")
V1_V2 = 10 ; //  Ration of initial and final  Volume
T1 = 27 + 273 ;   //  temperature in K in state 1
Y1 = 1.67 ;   //  Adiabatic constant for monoatomic
```

```
gas
Y2 = 1.4 ;    //  Adiabatic constant for diatomic gas
T2_m = T1*(V1_V2)^(Y1-1) ;    // Final temperature in K for monoatomic gas
disp(" Final temperature in K for monoatomic gas is ;",T2_m)
disp(" Final temperature in degree C for monoatomic gas is ;",T2_m-273)
T2_d = T1*(V1_V2)^(Y2-1) ;    // Final temperature in K for monoatomic gas
disp(" Final temperature in K for diatomic gas is ;",T2_d)
disp(" Final temperature in degree C for diatomic gas is ;",T2_d-273)

/* Result


   1403.2054

  Final temperature in K for monoatomic gas is ;

   1130.2054

  Final temperature in degree C for monoatomic gas is ;

   753.56593

  Final temperature in K for diatomic gas is ;

   480.56593

  Final temperature in degree C for diatomic gas is ;

      "Answer varies due to round off error"

```

```
*/
```

Scilab code Exa 5.21 Work done by a gas in adiabatic compression

```
// Scilab Code for 5.21
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_21.txt")
Y = 1.67 ;   // Adiabatic constant for monoatomic gas
V1 = 10^(-3) ;  // Initial Volume in m^3
V2 = V1/2 ;  // Final Volume in m^3
W = (1/(1-Y))*(V2^(1-Y)-V1^(1-Y)) ;  // Work done by a gas in adiabatic compression in J
disp(" Work done by a gas in adiabatic compression in J  is ;",W)

/* Result


  -90.27475

  Work done by a gas in adiabatic compression in J is ;

  */
```

Scilab code Exa 5.22 Rise in temperature

```
// Scilab Code for 5.22
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_22.txt")
T1 = 27 + 273 ;   //  temperature in K in state 1
p2_p1 = 8 ; // Ratio of pressure in state 2  to
    state 1
Y = 1.5 ;   //  Adiabatic constant
T2 = ((p2_p1)^(1-1/Y))*T1 ; // temperature in K in
    state 2
disp("temperature in K in state 2 , T2 =  ;",T2)
delta_T = T2-T1 ;  // Rise in temperature in Kelvin
disp(" Rise in temperature in Kelvin is ;",delta_T)

/* Result

   600.

 temperature in K in state 2 , T2 =  ;

   300.

  Rise in temperature in Kelvin is ;


  "Answer varies due to round off error"

   */
```

Scilab code Exa 5.23 `Change in Temperature of Air`

```
// Scilab Code for 5.23
```

```
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_23.txt")
V1_V2 = 2 ; //  Ration of initial and final  Volume
T1 = 273 ;   //  temperature in K in state 1
Y = 1.4 ;   //  Adiabatic constant
T2 = T1*(V1_V2)^(Y-1) ;   // Final temperature in K
    for monoaomic gas
disp(" Final temperature in K  is ;",T2)
disp(" Change in Temperature in Kelvin is ;",T2-T1)

/* Result

360.22566

  Final temperature in K  is ;

   87.22566

  Change in Temperature in Kelvin is ;

   */
```

Scilab code Exa 5.24 Final Temperature and Pressure of the ideal Gas

```
// Scilab Code for 5.24
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_24.txt")
Y = 1.5 ;   //  Adiabatic constant
V1_V2 = 1/4 ; //  Ration of initial and final
```

```
Volume
p1 = 8 ;  // Pressure in State 1 in Atm
p2 = p1*(V1_V2)^Y ;  // Pressure in State 2 in Atm
disp(" Pressure in State 2 in Atm is ;",p2)
T1 = 27 + 273 ;   //  temperature in K in state 1
T2 = T1*(V1_V2)^(Y-1) ;   // Final temperature in K for monoaomic gas
disp(" Final temperature in K  is ;",T2)

/* Result

   1.

  Pressure in State 2 in Atm is ;

   150.

  Final temperature in K  is ;

   */
```

Scilab code Exa 5.25 Change in internal Energy

```
// Scilab Code for 5.25
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_25.txt")
dT = 1 ; // change is Temperature
Cp = 999 ;  // Specefic heat at constant volume in J Kg^(-1) K^(-1)
Y = 5/3 ;   //  Adiabatic constant
m = 5 ; // Mass of air in g
```

```
dU = m*Cp*dT/Y ;   //  Change in internal Energy in
    cal
disp(" Change in internal Energy in J  is ;",dU)

/* Result


   2997.

  Change in internal Energy in J  is ;

   */
```

Scilab code Exa 5.26 Final Temperature and Pressure of Air

```
// Scilab Code for 5.26
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_26.txt")
Y = 1.4 ;   //  Adiabatic constant
V1_V2 = 10/0.5 ; //  Ration of initial and final
    Volume
p1 = 76 ;  // Pressure in State 1 in Cm of Hg
p2 = p1*(V1_V2)^Y ;  // Pressure in State 2 in Atm
disp(" Pressure in State 2 in Cm of Hg is ;",p2)
disp(" Pressure in State 2 in Atm is ;",p2/76)
T1 = 17 + 273 ;   //  temperature in K in state 1
T2 = T1*(V1_V2)^(Y-1) ;   // Final temperature in K
    for monoaomic gas
disp(" Final temperature in K  is ;",T2)
disp(" Final temperature in degree C is ;",T2-273)

```

```
/* Result


 5037.9701

Pressure in State 2 in Cm of Hg is ;

 66.28908

Pressure in State 2 in Atm is ;

 961.19167

Final temperature in K  is ;

 688.19167

Final temperature in degree C is ;

 */
```

Scilab code Exa 5.28 Change in Temperature

```
// Scilab Code for 5.28
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_28.txt")
a = 0.0245  ;   //  Van der waals constant a in  in N m^4 mol^(-2)
Cv = 21 ;  // Specefic heat at constant volume in J Kg^(-1) K^(-1)
V = 2*10^(-3) ; // Volume in m^3
```

```
dV = 4*10^(-3) ;  // change in Volume in m^3
dT = -a*dV/(Cv*V^2) ;  //  Change in Temperature in
   K
disp(" Change in Temperature in K is ;",dT)


/* Result


  -1.1666667

  Change in Temperature in K is ;

  "Answer varies due to round off error"

  */
```

Scilab code Exa 5.29 Change in temperature

```
// Scilab Code for 5.29
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_29.txt")
Y = 5/3 ;   //  Adiabatic constant
p2_p1 = 50 ;  // Ration of final and initial
    Pressure in Atm
T1 = 27 + 273 ;   //  temperature in K in state 1
T2 = T1*(p2_p1)^(1-1/Y) ;   // Final temperature in
   K for monoaomic gas
disp(" Final temperature in K  is ;",T2)
disp(" Final temperature in degree C is ;",T2-273)
disp(" Change in Temperature in degree C ;",T2-T1)
```

```
/* Result

   1434.5287

  Final temperature in K  is ;

   1161.5287

  Final temperature in degree C is ;

   1134.5287

  Change in Temperature in degree C ;

   */
```

Scilab code Exa 5.30 Change in internal Energy

```
// Scilab Code for 5.30
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_30.txt")

// (a) internal energy
del_Q = 600 ;  // Heat absorbs in cal
del_W = 420/4.2 ;  // Work done in cal
dU = del_Q - del_W ;  // Internal Energy in Cal
disp(" (a) Internal Energy in Cal is ;",dU)
disp("As dU > 0  so Temperature will Rise")
```

```
// (b) internal energy
del_Q = 0 ;  // Heat absorbs in cal
del_W = -210/4.2 ;  // Work done in cal
dU = del_Q - del_W ;  // Internal Energy in Cal
disp(" (b) Internal Energy in Cal is ;",dU)
disp("As dU > 0  so Temperature will Rise")

// (c) internal energy
del_Q = -250 ;  // Heat absorbs in cal
del_W = -350/4.2 ;  // Work done in cal
dU = del_Q - del_W ;  // Internal Energy in Cal
disp(" (c) Internal Energy in Cal is ;",dU)
disp("As dU < 0  so Temperature will Fall")



/* Result


   500.

  (a) Internal Energy in Cal is ;

 As dU > 0  so Temperature will Rise

   50.

  (b) Internal Energy in Cal is ;

 As dU > 0  so Temperature will Rise

  -166.66667

  (c) Internal Energy in Cal is ;

 As dU < 0  so Temperature will Fall

```

```
*/
```

Scilab code Exa 5.31 Increase in volume

```
// Scilab Code for 5.31
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_31.txt")
p = 1.013*10^5 ;    // Pressure of the gas in N m^(-2)
del_Q = 500 ;   // Heat absorbs in cal
del_W = 420/4.2 ;   // Work done in cal
dU = 420/4.2 ;   // Internal Energy in Cal
del_W = del_Q - dU ;   // Work done in cal
disp(" Work done in cal is ;",del_W)
disp(" Work done in Joule is ;",del_W*4.2)
dV = (del_W*4.2)/p ;   // change in Volume in m^3
disp(" change in Volume in 10^-2 m^3 is   ;",dV/10^-2)
disp(" change in Volume in 10^4 cm^3 is   ;",dV*10^2)
/* Result


   400.

  Work done in cal is ;

   1680.

  Work done in Joule is ;

   1.6584403
```

```

change in Volume in 10^-2 m^3 is  ;

 1.6584403

change in Volume in 10^4 cm^3 is  ;

 */
```

Scilab code Exa 5.32 change in temperature

```
// Scilab Code for 5.32
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_32.txt")
a = 1.38 ;  //  Van der waals constant a in  in
   litre atm mol^(-2)
R = 0.082  ;  //  Gas Constant in Litre atm mol^(-1)
    K^(-1)
V1 = 22.4 ;  // Volume in litre
V2 = 2*V1 ;  // Volume in litre
delta_T = ((2*a)/(3*R))*(1/V2 - 1/V1) ;  // change
   in temperature in K
disp(" change in temperature in K is ;",delta_T)
disp(" Thus N2 will Cool slightly due to joule
   Heating ")


/* Result

  -0.2504355

```

```
change in temperature in K is ;

Thus N2 will Cool slightly due to joule Heating

*/
```

Scilab code Exa 5.33 Specefic heat at constant pressure

```
// Scilab Code for 5.33
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_33.txt")
Cp = 3.456 ;  // Specefic heat at constant pressure
    in Cal g^(-1) K^(-1)
p = 10^6 ;  // atmospheric pressure in dynes cm^(-2)
T = 273 ;  // Temperatue in K
M = 0.0896 ;  // Mass in g
V = 1000 ;  // Volume in cm^3
Cv = Cp - ((p*V*10^(-7))/(T*M*4.2)) ; // Specefic
    heat at constant pressure in Cal g^(-1) K^(-1)
disp(" Specefic heat at constant pressure in Cal g
    ^(-1) K^(-1) is ;",Cv)


/* Result

  2.4826253

  Specefic heat at constant pressure in Cal g^(-1) K
    ^(-1) is ;

   */
```

Scilab code Exa 5.34 Heat Absorbed and work done by Oxygen gas when its Temperatur

```
// Scilab Code for 5.34
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex5_34.txt")
Cv = 0.156 ;  // Specefic heat at constant Volume in Cal g^(-1) K^(-1)
M = 32 ;  // Molar mass in g
R = 2 ;  // Gas Constant in cal mol^(-1) K^(-1)
Cp  =  Cv + R/M ;  // Specefic heat at constant Pressure in Cal g^(-1) K^(-1)
disp(" Specefic heat at constant Volume in Cal g^(-1) K^(-1) is ;",Cp)
m = 30 ; // mass of gas in g
dT = 100 - 30 ;  // increase in temperature in K

// (a) For Constant Volume
dU = m*Cv*dT ; // internal energy in cal
disp(" (a) internal energy For Constant Volume in cal is ;",dU)
del_Q = dU ;  // heat absorbed For Constant Volume in cal
disp(" heat absorbed For Constant Volume in cal is ;",del_Q)
disp("Work done is zero")  // dv = 0

// (b) For Constant pressure
del_Q = m*Cp*dT ; // heat Ansorbes in cal
disp("(b) heat absorbed For Constant Pressure in cal is ;",del_Q,)
```

```
dU = m*Cv*dT ; // internal energy in cal
disp(" internal energy For Constant Pressure in cal is ;",dU)
del_W = del_Q - dU ;  // heat absorbed in cal
disp(" Work done  For Constant Pressure in cal is ;",del_W)
disp(" Work done  For Constant Pressure in J is ;",del_W*4.2)



/* Result

0.2185

  Specefic heat at constant Volume in Cal g^(-1) K^(-1) is ;

   327.6

   (a) internal energy For Constant Volume in cal is ;

   327.6

  heat absorbed For Constant Volume in cal is ;

 Work done is zero



   458.85

 (b) heat absorbed For Constant Pressure in cal is ;

   327.6

  internal energy For Constant Pressure in cal is ;
```

```

  131.25

 Work done  For Constant Pressure in cal is ;

  551.25

 Work done  For Constant Pressure in J is ;


"Answer varies due to round off error"


*/
```

Chapter 6

The Second law of Thermodynamics

Scilab code Exa 6.1 `Efficiency of Carnot Engine`

```
// Scilab Code for 6.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_1.txt")
T1 = 0 + 273 ;   //  Temperature in Kelvin
T2 = -200 + 273 ;   //  Temperature in Kelvin
eta = (T1-T2)/T1 ;   //  Efficiency of Carnot Engine
disp("Efficiency of Carnot Engine is ;",eta)

/* Result


   0.7326007

 Efficiency of Carnot Engine is ;

   */
```

Scilab code Exa 6.2 Rise in temperature of the source

```
// Scilab Code for 6.2
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_2.txt")
T2 = 27 + 273 ;   //  Temperature sink in Kelvin
eta_1 = 0.30 ;   //  Efficiency of Carnot Engine
T1 = T2/(1 - eta_1) ;   //  Temperature of source in Kelvin
disp("Temperature of source when efficiency is 30% ;",T1)
eta_1 = 0.50 ;   //  Efficiency of Carnot Engine
T1_dash = T2/(1 - eta_1) ;   //  Temperature of source  in Kelvin
disp("Temperature of source when efficiency is 50% ;",T1_dash)
disp(" rise in temperature of the source is ;", T1_dash - T1 )



/* result


   428.57143

 Temperature of source when efficiency is 30%  ;

   600.

```

```
 Temperature of source when efficiency is 50%  ;

   171.42857

  rise in temperature of the source is ;

   */
```

Scilab code Exa 6.3 Heat Reject and Work done in each cycle

```
// Scilab Code for 6.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_3.txt")
T1 = 100 + 273 ;   //  Temperature of steam point in
    Kelvin
T2 = 0 + 273 ;   // Temperature of ice point  in
   Kelvin
// (a)  Heat reject to the Cold reservoir
Q1 = 746 ;   // Heat receives from the hot
   Reserviour in cal
Q2 = (T2/T1)*Q1 ;   // Heat reject to the Cold
   reservoir in cal
disp("(a) Heat reject to the Cold reservoir in cal
   is ;",Q2)
// (b)  Work done in each cycle
disp("(b) Work done in each cycle in Cal is  ;",Q1-
   Q2)


/* Result

```

```
  546.

(a) Heat reject to the Cold reservoir in cal is ;

  200.

(b) Work done in each cycle in Cal is  ;

  */
```

Scilab code Exa 6.4 Temperature of source and sink

```
// Scilab Code for 6.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_4.txt")
eta_1 = 1/6 ;   //  Efficiency of heat  Engine
eta_2 = 2*eta_1 ;  //  Efficiency of heat  Engine
T1 = 62/(eta_2 - eta_1) ; // Temperature of source
   in Kelvin
T2 = (1 - eta_1)*T1 ;  // Temperature of sink  in
   Kelvin
disp(" Temperature of sorce  in Kelvin , T1 is ;",T1
   )
disp(" Temperature of sink  in Kelvin , T2 is ;",T2)


/* Result

  372.

 Temperature of sorce  in Kelvin , T1 is ;
```

```

   310.

  Temperature of sink  in Kelvin , T2 is ;

   */
```

Scilab code Exa 6.5 Temperature of the reserviour

```
// Scilab Code for 6.5
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_5.txt")
T1 = 900 ;  // Temperature in K
T2 = 400 ; // Temperature in K
// (a) Work outputs are equal
T = (T1 + T2) /2 ;  // Temperature of the reserviour in K
disp("(a) Temperature of the reserviour in K is ;",T)
// (b) Efficiency are equal
T = sqrt(T1*T2) ;  // Temperature of the reserviour in K
disp("(b) Temperature of the reserviour in K is ;",T)

/* Result


   650.

 (a) Temperature of the reserviour in K is ;
```

```

600.

(b) Temperature of the reserviour in K is ;

*/
```

Scilab code Exa 6.6 Feasibility of a carnot engine

```
// Scilab Code for 6.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_6.txt")
T1 = 1400 + 273 ;    //  Temperature  in Kelvin
T2 = 30 + 273 ;   // Temperature   in Kelvin
// (a)  Feasibility
Q1 = 4.2 ;    // Heat receives from the hot
    Reserviour in kJ/s
Q2 = (T2/T1)*Q1 ;    // Heat reject to the Cold
    reservoir kJ/s
disp(" Heat reject to the Cold reservoir in kJ/s is
    ;",Q2)
disp("Work done in each cycle in KW is  ;",Q1-Q2)
disp("Power developed is more than the actual power
    , so it is not VALID")
disp("(b) T1 should raised and T2 lowered ")


/* Result

    0.7606695

```

```
 Heat reject to the Cold reservoir in kJ/s is ;

  3.4393305

Work done in each cycle in KW is  ;

Power developed is more than the actual power , so
   it is not VALID

(b) T1 should raised and T2 lowered

*/
```

Scilab code Exa 6.7 Temperature of the Hot reserviour

```
// Scilab Code for 6.7
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_7.txt")
eta_1 = 0.5 ;   //  Efficiency of heat  Engine
eta_2 = 0.7 ;  //  Efficiency of heat  Engine
T2 = 280 ;  // Temperature of Low temperature
   reserviour  in Kelvin
T1 = T2/(1 - eta_1) ; // Temperature of Hot
   reserviour in Kelvin
disp(" Temperature of Hot reserviour  in Kelvin , T1
    is ;",T1)
T1_dash = T2/(1 - eta_2) ; // Temperature of Hot
   reserviour in Kelvin
disp(" Temperature of Hot reserviour  in Kelvin ,
   T1_dash is ;",T1_dash)
disp(" temperature of the sourse can be increased in
```

```
    Kelvin is ;",T1_dash - T1)


/* Result


  560.

 Temperature of Hot reserviour  in Kelvin , T1 is ;

  933.33333

 Temperature of Hot reserviour  in Kelvin , T1_dash
    is ;

  373.33333

 temperature of the sourse can be increased in
   Kelvin is ;

  */
```

Scilab code Exa 6.8 Work done and Temperature outside the room

```
// Scilab Code for 6.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_8.txt")
Q2 = 1.5 ;  // Amount of heat removed by A C in K
   cal
T1 = 40 + 273 ;  // Temperature outside the room in
   K
```

```
P = 2000 ;  // Power require to run A C  in W
t = 1 ;   //  Time in sec
C = 4184 ;   // 1kcal in joule
W = P*t ;  //  Work done in J
disp(" Work done in J is ;",W)
disp(" Work done in Kcal is ;",W/C)
T2 = (10*Q2*T1)/(W/C + 10*Q2) ;  // Temperature inside the room in K
disp(" Temperature inside the room in K is ;",T2)
disp(" Temperature inside the room in degree C is ;",T2-273)


/* Result

 2000.

  Work done in J is ;

   0.4780115

  Work done in Kcal is ;

   303.33354

  Temperature inside the room in K is ;

   30.333539

  Temperature inside the room in degree C is ;

  "Answer varies due to round off error"

   */
```

Scilab code Exa 6.9 `Time require to freeze water at 0 degree C`

```
// Scilab Code for 6.9
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_9.txt")
T1 = 20 + 273 ;   //  Temperature in Kelvin
T2 = 0 + 273 ;   //  Temperature in Kelvin
m = 100 ;   //  Mass of water in Kg
L = 332*1000; // Latent heat of fusion of ice in J Kg^(-1)
eta = 0.6 ;   //  Efficiency of Refrigerator
W = 1000*eta ; //  Input Energy in J/sec
disp(" Input Energy in J/sec is ;",W)
Q2 = W*T2/(T1-T2) ; //  Heat in J/sec
disp(" Heat in J/sec is ;",Q2)
disp(" Heat required to freeze 100 Kg of Water ;",m*L)
t =  m*L/Q2 ; // Time require to freeze water at 0 degree C  in s
disp(" Time require to freeze water at 0 degree C in s is ;",t)
disp(" Time require to freeze water at 0 degree C in min is ;",t/60)



/* Result


   600.
```

```
Input Energy in J/sec is ;

 8190.

Heat in J/sec is ;

 33200000.

Heat required to freeze 100 Kg of Water ;

 4053.7241

Time require to freeze water at 0 degree C in s is
    ;

 67.562068

Time require to freeze water at 0 degree C in min
   is ;

"Answer varies due to round off error"

 */
```

Scilab code Exa 6.10 Heat Require and Work done by the regrigerator

```
// Scilab Code for 6.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_10.txt")
T1 = 20 + 273 ;    //  Temperature in Kelvin
```

```
T2 = 0 + 273 ;   //  Temperature in Kelvin
m = 2 ;   //  Mass of water in Kg
L = 332*1000; // Latent heat of fusion of ice in J
    Kg^(-1)
Q2 = m*L/3600 ;  // Amount of heat required to be
    removed in J/s
disp(" Amount of heat required to be removed in J/s
    is ;",Q2)
W = Q2*(T1/T2 -1) ;  //  Work done by the
    regrigerator in W
disp(" Work done by the refrigerator in W is ;",W)



/* Result


   184.44444

  Amount of heat required to be removed in J/s is ;

   13.512414

  Work done by the refrigerator in W is ;

   */
```

Scilab code Exa 6.13 Net work done per Kg of air

```
// Scilab Code for 6.13
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
```

```
diary("Ex6_13.txt")
R = 8.314 ;  // Gas Constant in kJ kmol^(-1) K^(-1)
M = 28.97 ;  // Molecular wt. of air in Kg mol^(-1)
Cv = (5/2)*R/M ;  // Molar Specefic heat at constant volume in kJ K^(-1)
disp(" Molar Specefic heat at constant volume in kJ K^(-1) is ;",Cv)
p2 = 1.5  ;   // Pressure in MPa
p3 = 4.5  ;   // Pressure in MPa
T2 = 550  ;   // Temperature in Kelvin
T3 = p3*T2/p2  ;  // Temperature in Kelvin
disp(" Temperature in Kelvin is ;",T3)
eta = 0.5647 ;  //  Efficiency
W =eta*Cv*(T3-T2) ; // Net work done per Kg of air in KJ
disp(" Net work done per Kg of air in KJ is ;",W)


/* Result

  0.7174663

  Molar Specefic heat at constant volume in kJ K
     ^(-1) is ;

   1650.

  Temperature in Kelvin is ;

   445.66857

  Net work done per Kg of air in KJ is ;

   */
```

Scilab code Exa 6.14 Efficiency of the engine

```
// Scilab Code for 6.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_14.txt")
Y = 1.4 ;  // Adiabatic Conatant
M = 28.97 ;  // Molecular wt. of air in Kg
Cp = 29.2 ;  // Specefic heat at constant Pressure
    in J mol^(-1) K^(-1)
Q1 = 600 ; // Heat Intake in KJ Kg^(-1)
T3 = 1200  ;  // Temperature in Kelvin
T1 = 300  ;  // Temperature in Kelvin
T2 = T3 - (Q1*M)/Cp ;  // Temperature in Kelvin
disp(" Temperature in Kelvin is ;",T2)
// For the Adiabatic process a -> b
p1 = 120 ;   // Pressure in KPa
p2 = p1*(T2/T1)^(Y/(Y-1))  ;   // Pressure in KPa
disp(" Pressure in KPa , p2 ; ",p2)
rho_c = (p2/p1)^(1/Y) ;  //  Compression Ratio
disp("The Compression Ratio is ;",rho_c)
r_c = T3/T2 ;      //  The cut-off Ratio
disp("The Cut off Ratio is ;",r_c)
// For the process b -> c
eta = 1 - (r_c^Y-1)/((r_c-1)*Y*rho_c^(Y-1)) ;    //
    Efficiency of the engine
disp("Efficiency of the engine ;",eta)



/*
```

```

Result


  604.72603

 Temperature in Kelvin is ;

  1395.4432

 Pressure in KPa , p2 ;

  5.7689067

The Compression Ratio is ;

  1.9843697

The Cut off Ratio is ;

  0.4203676

Efficiency of the engine ;

"Answer varies due to round off error"
*/
```

Scilab code Exa 6.16 Efficiency of Engine Predicted by inventor

```
// Scilab Code for 6.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
```

```
diary("Ex6_16.txt")
W = 10^3 ;  // Rate of work done by heat engine i n
    J/s
Q1 = (65/60)*10^3  ;  // Amount of energy Absorbed
    in KJ/s
T1 = 1127 + 273  ;   //  Temperature in Kelvin
T2 = 27 + 273 ;   //  Temperature in Kelvin
eta = (T1-T2)/T1 ;   //  Efficiency of Carnot Engine
disp(" Efficiency of  Engine Predicted by inventor
    is ;",eta)
disp("  Efficiency of  Engine Predicted by inventor
    is  ;",W/Q1)
disp(" Not Possible ")


/* Result

   0.7857143

  Efficiency of  Engine Predicted by inventor is ;

   0.9230769

   Efficiency of  Engine Predicted by inventor is  ;

  Not Possible

   */
```

Scilab code Exa 6.17 Fraction of the time Compressor runs in delhi

```
// Scilab Code for 6.17
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
```

```
clc;
clear;
diary("Ex6_17.txt")
TL = 273 - 23; //  Temperature in Kelvin
TH = 27 +273 ;  // Temperature in Kelvin
omega = TL/(TH-TL) ;  // Coefficient of performance
disp("(a) Coefficient of performance  is ;",omega)
P = 200 ; // Power of compressor
QL = 5*10^4 ; // Rate of Cooling in KJ/day
W = QL/omega ;  // Work done by the Compressor in KJ
   /day
disp(" Work done by the Compressor in KJ/day is ;",W
   )
d = 3600*24 ; // no of second in 1 day
t = W*1000/(P*d) ; // Fraction of the time
   Compressor runs in delhi
disp("  Fraction of the time Compressor runs in
   delhi  is ;",t)
TL = -23+273 ; //  Temperature in Kelvin
TH = 47 +273 ;  // Temperature in Kelvin
omega = TL/(TH-TL) ;  // Coefficient of performance
disp("(b) Coefficient of performance  is ;",omega)
P = 200 ; // Power of compressor
QL = 5*10^4 ; // Rate of Cooling in KJ/day
W = QL/omega ;  // Work done by the Compressor in KJ
   /day
disp(" Work done by the Compressor in KJ/day is ;",W
   )
t = W*1000/(P*3600*24) ; // Fraction of the time
   Compressor runs in delhi
disp("  Fraction of the time Compressor runs in
   delhi  is ;",t)

/* Result


   5.

```

```
(a) Coefficient of performance  is ;

  10000.

 Work done by the Compressor in KJ/day is ;

  0.5787037

  Fraction of the time Compressor runs in delhi  is
     ;

  3.5714286

(b) Coefficient of performance  is ;

  14000.

 Work done by the Compressor in KJ/day is ;

  0.8101852

  Fraction of the time Compressor runs in delhi  is
     ;

  */
```

Scilab code Exa 6.18 Efficiency and Heat rejected by the engine

```
// Scilab Code for 6.18
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_18.txt")
```

```
T1 = 127 + 273 ;    // Temperature in Kelvin
T2 = 27 + 273 ;    // Temperature in Kelvin
eta = (T1-T2)/T1 ;    // Efficiency of Carnot Engine
disp(" Efficiency of Carnot Engine is ;",eta)
disp("Efficiency of Carnot Engine in % is ;",eta
    *100)
Q1 = 80 ;  // Heat taken in cal
W = eta*Q1 ; // Work done in cal
disp("  Work done in cal is ;",W)
disp(" heat rejected by the engine in cal ;",Q1-W)

/* Result

   0.25

  Efficiency of Carnot Engine is ;

   25.

 Efficiency of Carnot Engine in % is ;

   20.

   Work done in cal is ;

   60.

  heat rejected by the engine in cal ;

   */
```

Scilab code Exa 6.19 Change in temperature of the source

```
// Scilab Code for 6.19
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_19.txt")
T2 = 27 + 273 ;   //  Temperature sink in Kelvin
eta = 0.30 ;   //  Efficiency of Carnot Engine
T1 = T2/(1 - eta) ;   //  Temperature of source  in
    Kelvin
disp("Temperature of source when efficiency is 30%
    ;",T1)
eta = 0.50 ;   //  Efficiency of Carnot Engine
T1_dash = T2/(1 - eta) ;   //  Temperature of source
      in Kelvin
disp("Temperature of source when efficiency is 50%
    ;",T1_dash)
disp(" rise in temperature of the source is ;",
    T1_dash - T1)



/* result

   428.57143

 Temperature of source when efficiency is 30%  ;

   600.

 Temperature of source when efficiency is 50%  ;

   171.42857

  rise in temperature of the source is ;

   */
```

Scilab code Exa 6.20 Amount of heat Absorbed rejected and Efficiency of the engine

```
// Scilab Code for 6.20
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_20.txt")
T2 = 27 + 273 ;   //  Temperature sink in Kelvin
T1 = 127 + 273 ;   //  Temperature of source  in
    Kelvin
W = 100000;   // Work done in W
Q2 = 3*W ;  // Amount of heat Absorbed in J/s
disp(" Amount of heat Absorbed in J/s is ;",Q2)
Q1 = W + Q2 ;  // Amount of heat Rejected in J/s
disp(" Amount of heat Rejected in J/s is ;",Q1)
eta = 1 - (T2/T1) ;  // Efficiency of Carnot Engine
disp(" Efficiency of Carnot Engine ;",eta)


/* Result


   300000.

  Amount of heat Absorbed in J/s is ;

   400000.

  Amount of heat Rejected in J/s is ;

   0.25

```

```
  Efficiency of Carnot Engine ;

   */
```

Scilab code Exa 6.21 Temperature of the Sourse and Sink

```
// Scilab Code for 6.21
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_21.txt")
eta_1 = 1/8 ;   // Efficiency of heat  Engine
eta_2 = 2*eta_1 ;  // Efficiency of heat  Engine
T1 = 95/(eta_2 - eta_1) ; // Temperature of source in Kelvin
T2 = (1 - eta_1)*T1 ;  // Temperature of sink  in Kelvin
disp(" Temperature of sorce  in Kelvin , T1 is ;",T1)
disp(" Temperature of sink  in Kelvin , T2 is ;",T2)



/* Result


   760.

  Temperature of sorce  in Kelvin , T1 is ;

   665.

  Temperature of sink  in Kelvin , T2 is ;
```

```
*/
```

Scilab code Exa 6.22 `Efficiency of Carnot Engine`

```
// Scilab Code for 6.22
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_22.txt")
eta = 0.5 ;   // Efficiency of Carnot  Engine
T1 = 400 ; // Temperature of source  in Kelvin
T2 = (1-eta)*T1 ;  // Temperature of sink  in Kelvin
disp(" Temperature of sink  in Kelvin is ;",T2)
// In second stage
T1 = 500 ; // Temperature of source  in Kelvin
T2 = 300 ;  // Temperature of sink  in Kelvin
eta_dash = 1-(T2/T1) ;  //  Efficiency of carnot
   Engine
disp("Efficiency of carnot  Engine if temperature of
    both sink and source is increased bt 100 ;",
   eta_dash)
// in third stage
T1 = 300 ; // Temperature of source  in Kelvin
T2 = 100 ;  // Temperature of sink  in Kelvin
eta_double_dash = 1-(T2/T1) ;  //  Efficiency of
   carnot  Engine
disp("Efficiency of carnot  Engine if temperature of
    both sink and source is reduced bt 100 ;",
   eta_double_dash)

/* result

```

```
200.

 Temperature of sink  in Kelvin is ;

  0.4

 Efficiency of carnot  Engine if temperature of both
    sink and source is increased bt 100 ;

  0.6666667

 Efficiency of carnot  Engine if temperature of both
    sink and source is reduced bt 100 ;


  */
```

Scilab code Exa 6.23 Temperature of sink

```
// Scilab Code for 6.23
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_23.txt")
/*
eta_A = 1 - Q2/Q1
eta_B = 1 - (Q3*2)/Q2
W_A = W_B =>

T = (1 + T3/(2*T1))*(2*T1/3)
*/
T1 = 500 ;    //  Temperature in Kelvin
T3 = 200 ;    //  Temperature in Kelvin
```

```
T = (1 + T3/(2*T1))*(2*T1/3) ;    //  Temperature of
    sink in Kelvin
disp(" Temperature of sink in Kelvin is ;",T)


/* Result


   400.

  Temperature of sink in Kelvin is ;

   */
```

Scilab code Exa 6.24 Efficiency for a canot cycle

```
// Scilab Code for 6.24
diary("Ex6_24.txt")
clc
// a to b  Isochoric compression
// b to c  Adiabatic Expansion
// c to a  Isothermal compression
// del_Wab = 0    As the process is isochoric
R = 8.314 ;    // Gas Constant
Tb = 300 ;     //  Temperature in Kelvin
Ta = 30 ;      //  Temperature in Kelvin
p = 5*10^2 ;    // Pressure in N/m^2
V = 2*10^(-3) ;    // Volume in m^3
n = p*V/(R*Ta)  ;     // number of moles of gas in J/
   K
Cv = (3/2)*R   ;      // Specefic heat
Gamma = 1.67 // ratio of Cp/Cv

```

```
// a to b
Qab = n*Cv*(Tb-Ta);        // Heat absorbed in J from a to b
disp(" Heat absorbed in J from a to b is; ",Qab)
// Ua = Uc = 0     Internal energy at a and c
Ub = Qab ;    // Internal energy in J at b
disp(" Internal energy in J at b  is; ",Ub)
// b to c
// Qbc = 0  Heat absorbed from b to c
Wbc = Ub ;    //  Work done in J from b to c
disp("Work done in J from b to c is ",Wbc)
// c to a
Vc_Vb = (Tb/Ta)^(1/(Gamma-1)) ;    // Ratio of volume at c and b
disp("Vc/Vb is ",Vc_Vb)
Wca = -n*R*Ta*log(Vc_Vb) ;    // work done in J from c to a
disp("Work done in J from c to a is ",Wca)
Qca = Wca ;    //  heat absorbed in J from c to a
disp(" Heat absorbed in J from c to a is; ",Qca)
disp("Net work done in J is",Wbc+Wca)
disp(" Heat absoebed in J is ", Qab)
Eta = ((Wbc+Wca)/(Qab))*100 ;      //  Efficiency in %
disp("Efficiency in % is" ,Eta)





/* Result


   13.5

  Heat absorbed in J from a to b is;

   13.5
```

```
 Internal energy in J at b  is;

  13.5

Work done in J from b to c is

  31.08403

Vc/Vb is

 -3.4366942

Work done in J from c to a is

 -3.4366942

 Heat absorbed in J from c to a is;

  10.063306

Net work done in J is

  13.5

 Heat absoebed in J is

  74.543006

Efficiency in % is

"Answer varies due to round off error"


  */
```

Scilab code Exa 6.25 `Ratio of Temperature of Operation of Engine`

```
// Scilab Code for 6.25
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_25.txt")
COP = 2.5 ; // Coefficient of Performance
W = 12 ;    // Work input in KW
Q2 = W*COP ;  // Heat extracted at lower temperature
     in KW
disp("Heat extracted at lower temperature in KW is ;
    ",Q2)
Q1 = Q2 + 10 ;  // Heat in KW
disp(" Heat  in KW is ;",Q1)
disp(" Ration of Temperature = ;",Q1/Q2)


/* Result


   30.

 Heat extracted at lower temperature in KW is ;

   40.

  Heat  in KW is ;

   1.3333333

  Ration of Temperature = ;
```

```
*/
```

Scilab code Exa 6.26 Coefficient of Performance and Heat rejected by the Freezer

```
// Scilab Code for 6.26
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_26.txt")
T2 = -10 + 273 ;   //  Temperature in Kelvin
T1 = 30 +273 ;   //  Temperature in Kelvin
COP = T2/(T1-T2) ; // Coefficient of Performance
disp(" Coefficient of Performance is ;",COP)
Q2 = 1200 ;  // rate of Heat removed in J/s
W = Q2/COP ;  // Rate of work done in J/s
disp(" Rate of work done in J/s is  ;",W)
Q1 = W + Q2 ;  // Amount of heat released in J/s
disp(" Amount of heat released in J/s is ;",Q1)


/* result


   6.575

  Coefficient of Performance is ;

   182.50951

  Rate of work done in J/s is  ;

   1382.5095
```

```

  Amount of heat released in J/s is ;

   */
```

Scilab code Exa 6.27 Coefficient of Performance and Work done

```
// Scilab Code for 6.27
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_27.txt")
T2 = 200 ;    //  Temperature in Kelvin
T1 = 300 ;    //  Temperature in Kelvin
Q2 = 150 ;    //  Heat in W
COP_max = T2/(T1-T2) ; // Coefficient of Performance
disp(" Coefficient of Performance is ;",COP_max)
// (a) For 100% COP
W = Q2/COP_max ;    // Work in  W
disp(" (a) Work in W is ;",W)
// (b) For 60% COP
COP = 0.60*COP_max  ;  // Coefficient of Performance
W = Q2/COP ;    // Work in W
disp(" (b) Work in W ;",W)


/* Result


   2.

  Coefficient of Performance is ;

```

```
  75.

 (a) Work in W is ;

  125.

 (b) Work in W ;

  */
```

Scilab code Exa 6.28 Power Developed by heat Engine made by a Inventor

```
// Scilab Code for 6.28
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex6_28.txt")
T2 = -43 + 273 ;   //  Temperature in Kelvin
T1 = 137 + 273 ;   //  Temperature in Kelvin
Q1 = 250 ;   //  Heat receives by heat engine in
   kcal per min
Q2 = Q1*(T2/T1) ; // Heat in kcal per min
disp(" Heat in kcal per min is ;",Q2)
W = Q1 - Q2;  // Work obtained from the engine per
   minutes
disp(" Work obtained from the engine per minutes in
   Kcal is ;",W)
disp(" Power developed in J/s is ;",W*4180/60)
disp(" Power developed in HP is ;",W*4180/(60*746))



/* Result
```

```
 140.2439

Heat in kcal per min is ;

 109.7561           "Answer varies due to round off
     error"

Work obtained from the engine per minutes in Kcal
   is ;

 7646.3415          "Answer varies due to round
    off error"

Power developed in J/s is ;

 10.249787          "Answer varies due to round
    off error"

Power developed in HP is ;


 */
```

Chapter 7

Entropy

Scilab code Exa 7.1 `Change in Entropy of steam`

```
// Scilab Code for 7.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_1.txt")
m = 10^(-2) ;  // Mass in Kg
L = 2.26*10^6 ;  // Latent heat of steam in J/Kg
T = 100 + 273 ;   // Temperature in K
dS = -(m*L)/T ;  // Change in Entropy in J/K
disp(" Change in Entropy in J/K is ;",dS)



/* Result

  -60.589812

  Change in Entropy in J/K is ;

  */
```

Scilab code Exa 7.3 Total Increase in Entropy of TS Diagram

```
// Scilab Code for 7.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_3.txt")
m = 1 ;  // Mass in Kg
L = 2.26*10^6 ;  // Latent heat of steam in J/Kg
T1 = 0 + 273 ;   // Temperature in K
T2 = 100 + 273 ;   // Temperature in K
c = 4.18*10^3 ;  // Specefic heta capacity in J Kg^(-1) K^(-1)
del_S1 = m*c*log(T2/T1) ;  // Change in Entropy in J/K
disp(" Change in Entropy in  J/K from A to B is ;",del_S1)
del_S2 = m*L/T2 ; // Change in Entropy in J/K
disp(" Change in Entropy in J/K from B to C is ;",del_S2/10^3)
disp(" Total Increase in Entropy in J/K  is ;",del_S1+del_S2)
/* Result

   1304.6057

  Change in Entropy in  J/K from A to B is ;

   6.0589812

  Change in Entropy in J/K from B to C is ;

```

```
   7363.5869

  Total Increase in Entropy in J/K  is ;

  "Answer varies due yo round off error"

   */
```

Scilab code Exa 7.4 Total Increase in Entropy

```
// Scilab Code for 7.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_4.txt")
m1 = 10 ;  // Mass of water in g
m2 = 30 ;  // Mass of water in g
L = 2.26*10^6 ;  // Latent heat of steam in J/Kg
c = 1 ; // specefic heta in cal g^(-1) K^(-1)
T1 = 60 + 273 ;   // Temperature in K
T3 = 20 + 273 ;   // Temperature in K
t = (m1*c*T1 + m2*c*T3)/(m1*c + m2*c) ;  //
    Temperature of mixing in K
disp(" Temperature of mixing in K is ;",t)
disp(" Temperature of mixing in degree C is ;",t
    -273)
del_S1 = m1*c*log(t/T1) ;  // Change in Entropy when
     temperature changes from 60 to 30 in cal/K
disp(" Change in Entropy when temperature changes
    from 60 to 30 in cal/K is ;",del_S1)
del_S2 = m2*c*log(t/T3) ; // Change in Entropy when
    temperature changes from 20 to 30 in cal/K
disp(" Change in Entropy when temperature changes
```

```
    from 20 to 30 in cal/K is ;",del_S2)
disp(" Total Increase in Entropy in cal/K  is ;",
    del_S1+del_S2)


/* Result


 303.

  Temperature of mixing in K is ;

 30.

  Temperature of mixing in degree C is ;

  -0.9440968

  Change in Entropy when temperature changes from 60
      to 30 in cal/K is ;

 1.0068059

  Change in Entropy when temperature changes from 20
      to 30 in cal/K is ;

 0.0627091

  Total Increase in Entropy in cal/K  is ;


 */
```

Scilab code Exa 7.5 Total Increase in Entropy

```
// Scilab Code for 7.5
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_5.txt")
m1 = 2000 ;  // Mass of water in g
m2 = 1000 ;  // Mass of water in g
L = 2.26*10^6 ;  // Latent heat of steam in J/Kg
c = 1 ; // specefic heta in cal g^(-1) K^(-1)
T1 = 300  ;   // Temperature in K
T3 = 291 ;   // Temperature in K
t = (m1*c*T1 + m2*c*T3)/(m1*c + m2*c) ;  // Temperature of mixing in K
disp(" Temperature of mixing in K is ;",t)
del_S1 = m1*c*log(t/T1) ;  // Change in Entropy when temperature changes from 300 to 297 in cal/K
disp(" Change in Entropy when temperature changes from 300 to 297 in cal/K is ;",del_S1)
del_S2 = m2*c*log(t/T3) ; // Change in Entropy when temperature changes from 291 to 297 in cal/K
disp(" Change in Entropy when temperature changes from 291 to 297 in cal/K is ;",del_S2)
disp(" Total Increase in Entropy in cal/K  is ;", del_S1+del_S2)


/* Result


    297.

   Temperature of mixing in K is ;

   -20.100672

   Change in Entropy when temperature changes from
```

```
    300 to 297 in cal/K is ;

     20.408872     ,       " Answer Given in the
        Textbook is Wrong"  the value of ln(t/T3) is
         wrong used in book used for calculation

  Change in Entropy when temperature changes from
    291 to 297 in cal/K is ;

   0.3081999     ,      " Answer Given in the
      Textbook is Wrong"  the value of del_S2 is
      wrong

  Total Increase in Entropy in cal/K  is ;

   */
```

Scilab code Exa 7.6 Total Increase in Entropy

```
// Scilab Code for 7.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_6.txt")
m = 50 ;  // Mass of water in g
L1 = 2.26*10^6 ;  // Latent heat of steam in J/Kg
L2  = 3.35*10^5 ;  // Latent heat of ice in J/Kg
c = 2090 ; // specefic heat of ice in J Kg^(-1) K
    ^(-1)
c1 = 4180 ; // specefic heat of water in J Kg^(-1) K
    ^(-1)
T1 = -10+273  ;   // Temperature in K
T2 = 0+273 ;   // Temperature in K
```

```
T3 = 100+273 ;    // Temperature in K

// (a) ice at −10 heates at 0 degree C
del_S1 = m*(10^(-3))*c*log(T2/T1) ;   // Change in
    Entropy when ice at −10 heated at 0 degree C
disp("(a) Change in Entropy when ice at −10 heated
    at 0 degree C  in J/K is ;",del_S1)

// (b) ice at 0 is converted to water at0 )
del_S2 = m*(10^(-3))*L2/T2 ;   // Change in Entropy
    when ice at 0 is converted to water at 0
disp("(b) Change in Entropy when ice at 0 is
    converted to water at 0 degree C  in J/K is ;",
    del_S2)

// (c) Water from 0 to 100 degree C
del_S3 = m*(10^(-3))*c1*log(T3/T2) ;   // Change in
    Entropy when Water from 0 to 100 degree C
disp("(a) Change in Entropy when Water from 0 to 100
     degree C  in J/K is ;",del_S3)

// (d) Water at 100 Converted  into steam
del_S4 = m*(10^(-3))*L1/T3 ;  // Change in Entropy
    when Water at 100 Converted  into steam
disp("(b) Change in Entropy when Water at 100
    Converted  into steam  in J/K is ;",del_S4)
disp(" Total Increase in Entropy in cal/K  is ;",
    del_S1+del_S2+del_S3+del_S4)


/* Result

3.8997062

 (a) Change in Entropy when ice at -10 heated at 0
     degree C  in J/K is ;

   61.355311
```

```

 (b) Change in Entropy when ice at 0 is converted to
     water at 0 degree C  in J/K is ;

   65.230285

 (a) Change in Entropy when Water from 0 to 100
    degree C  in J/K is ;

   302.94906

 (b) Change in Entropy when Water at 100 Converted
    into steam  in J/K is ;

   433.43436

  Total Increase in Entropy in cal/K  is ;


   */
```

Scilab code Exa 7.8 Nature of the Process

```
// Scilab Code for 7.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_8.txt")
Q1 = 100 ; // Amount of heat receives in Kcal
Q2 = 50 ; // Amount of heat receives in Kcal
Q3 = 75 ; // Amount of heat receives in Kcal
Q4 = 25 ; // Amount of heat receives in Kcal
T1 = 1000; // Temperature in K
```

```
T2 = 500; // Temperature in K
S1 = (Q1/T1) - (Q2/T2) ; //  Change in entropy
disp(" Chage in entropy is ;",S1)
disp("Reversible")
S2 = Q1/T1 - Q3/T2 ; //  Change in entropy
disp(" Chage in entropy is ;",S2)
disp("Irreversible")
S3 = Q1/T1 - Q4/T2 ; //  Change in entropy
disp(" Chage in entropy is ;",S3)
disp("Reversible")


/* Result


   0.

  Chage in entropy is ;

 Reversible

  -0.05

  Chage in entropy is ;

 Irreversible

   0.05

  Chage in entropy is ;

 Reversible

 */
```

Scilab code Exa 7.11 Change of entropy of Ideal Gas

```
// Scilab Code for 7.11
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_11.txt")
V2_V1 = 4 ; //  Ratio of Final and initial Volume
del_S = log(V2_V1) ; // Change of entropy in terms
   of R
disp(" Change of entropy in terms of R ;",del_S)

/* Result

   1.3862944

  Change of entropy in terms of R ;

   */
```

Scilab code Exa 7.12 Change of entropy of Hydrogen

```
// Scilab Code for 7.12
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_12.txt")
m = 1 ; // mass of hydrogen in g
```

```
M = 2 ; // Molar Mass of H2 molecule in g/mol
n = m/M ;  // Number of moles
disp(" Number of moles is ;",n)
V2_V1 = 4 ; //  Ratio of Final and initial Volume
T1 = -173+273 ; // Temperature in K
T2 = 27+273 ; // Temperature in K
Cv = 4.86 ;  // Specefic heat in cal mol(-1) K^(-1)
R = 2 ;  // Gas constant in cal mol(-1) K^(-1)
del_S = n*((Cv*log(T2/T1))+(R*log(V2_V1))) ; //
    Change in Entropy in Cal /K
disp(" Change in Entropy in Cal /K is ;",del_S)


/*Result


   0.5

  Number of moles is ;

   4.0559222

  Change in Entropy in Cal /K is ;

   */
```

Scilab code Exa 7.13 Change of entropy of Hydrogen and Oxygen gas

```
// Scilab Code for 7.13
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_13.txt")
```

```
x1 = 0.5 ; // Mole fraction
x2 = 0.5 ; //  Mole fraction
del_S = -(x1*log(x1)+x2*log(x2)) ; // Change of
    entropy in terms of R
disp(" Change of entropy in terms of R ;",del_S)


/* Result


   0.6931472

  Change of entropy in terms of R ;

   */
```

Scilab code Exa 7.14 Entropy of steel

```
// Scilab Code for 7.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_14.txt")
m1 = 30 ;  // Mass of Steel in Kg
m2 = 150 ;  // Mass of Oil in Kg
L = 2.26*10^6 ;  // Latent heat of steam in J/Kg
c1 = 500 ; // specefic heat of steel in J Kg^(-1) K
    ^(-1)
c2 = 2500 ; // specefic heat of oil in J Kg^(-1) K
    ^(-1)
T1 = 627+273  ;   // Temperature in K
T2 = 27+273 ;   // Temperature in K
T = (m1*c1*T1 + m2*c2*T2)/(m1*c1 + m2*c2) ;  //
```

```
    Temperature of mixing in K
disp(" Temperature of mixing in K is ;",T)
del_S1 = (m1/1000)*c1*log(T/T1) ;  // Change in
    Entropy of steel when put  in oil
disp(" Change in Entropy of steel when put  in oil
    in KJ/K is ;",del_S1)
del_S2 = (m2/1000)*c2*log(T/T2) ; // Change in
    Entropy of oil when steel lump put in it
disp(" Change in Entropy of oil when steel lump put
    in it in KJ/K is ;",del_S2)
disp(" Total Increase in Entropy in KJ/K  is ;",
    del_S1+ del_S2)


/* Result

  323.07692

  Temperature of mixing in K is ;

  -15.367565

  Change in Entropy of steel when put  in oil in KJ/
     K is ;

   27.79049

  Change in Entropy of oil when steel lump put in it
      in KJ/K is ;

   12.422925

  Total Increase in Entropy in KJ/K  is ;

   */
```

Scilab code Exa 7.15 Total change in Entropy

```
// Scilab Code for 7.15
diary("Ex7_15.txt")
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
// All Calculations are in terms of m
T1 = 0+273  ;   // Temperature in K
T2 = 80+273 ;   // Temperature in K
t = (T1 + T2)/(2) ;  // Temperature of mixing in K
disp(" Temperature of mixing in K is ;",t)
del_S1 = 1*log(t/T1) ;  // Change in Entropy when
   temperature of water changes from 273 to 313 K
disp(" Change in Entropy when temperature of water
   changes from 273 to 313 K in m cal g ^(-1) K^(-1)
    is ;",del_S1)
del_S2 = 1*log(t/T2) ; // Change in Entropy when
   temperature of water changes from 353 to 313 K
disp(" Change in Entropy when temperature of water
   changes from 273 to 313 K in m cal g ^(-1) K^(-1)
    is ;",del_S2)
disp(" Total Increase in Entropy in  m cal g ^(-1) K
   ^(-1)  is ;",del_S1+del_S2)


/* Result


   313.

  Temperature of mixing in K is ;
```

```
 0.1367314

Change in Entropy when temperature of water
   changes from 273 to 313 K in m cal g ^(-1) K
   ^(-1) is ;

-0.1202649

Change in Entropy when temperature of water
   changes from 273 to 313 K in m cal g ^(-1) K
   ^(-1) is ;

 0.0164665

Total Increase in Entropy in  m cal g ^(-1) K^(-1)
     is ;

 */
```

Scilab code Exa 7.16 Total Increase in Entropy of the Reserviour and the Universe

```
// Scilab Code for 7.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_16.txt")
m = 10 ;  // Mass in Kg
T1 = 0 + 273 ;   // Temperature in K
T2 = 100 + 273 ;   // Temperature in K
s = 4.18*10^3 ;  // Specefic heta capacity in J Kg
   ^(-1) K^(-1)
del_S1 = m*s*log(T2/T1) ;  // Change in Entropy in J
```

```
    /K
disp(" Change in Entropy in 10^3 J/K when
    temperature increases from 273 to 373 K  is ;",
    del_S1/10^3)
del_S2 = -m*s*(T2-T1)/T2 ; // Change in Entropy in J
    /K
disp(" Change in Entropy of Reserviour in 10^3 J/K
    is ;",del_S2/10^3)
disp(" Total Increase in Entropy in 10^3 J/K  is ;"
    ,(del_S1+del_S2)/10^3)



/* Result

     13.046057

   Change in Entropy in 10^3 J/K when temperature
      increases from 273 to 373 K  is ;

   -11.206434

   Change in Entropy of Reserviour in 10^3 J/K  is ;

    1.8396226

   Total Increase in Entropy in 10^3 J/K  is ;

   "Answer varies due to round off error"
    */
```

Scilab code Exa 7.17 Change in Entropy of the System

```
// Scilab Code for 7.17
```

```
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_17.txt")
m = 2.5 ; // Mass of water in Kg
s = 4184 ;  // Specefic heat of water in J/K
T1 = 273  ;   // Temperature in K
T2 = 373 ;   // Temperature in K
T = (T1 + T2)/(2) ;  // Equillibirium Temperature in K
disp(" Equillibirium Temperature  in K is ;",T)
del_S1 = m*s*log(T/T1) ;  // Change in Entropy of Can with Cold water
disp(" Change in Entropy of Can with Cold water in J/K is ;",del_S1)
del_S2 = m*s*log(T/T2) ; // Change in Entropy of Can with Hot water
disp(" Change in Entropy of Can with Cold water inJ/K is ;",del_S2)
disp(" Total Increase in Entropy in  J/K  is ;",del_S1+del_S2)


/* Result

   323.

  Equillibirium Temperature  in K is ;

   1759.1683

  Change in Entropy of Can with Cold water in J/K is ;

  -1505.467

  Change in Entropy of Can with Cold water inJ/K is ;
```

```

   253.70135

  Total Increase in Entropy in  J/K  is ;

   */
```

Scilab code Exa 7.18 Change in Entropy

```
// Scilab Code for 7.18
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_18.txt")
function I=f(T)
    I=(0.07*2)-(0.0003*2*T) -(2*0.15)/T ;   //
       integral  2*Cp/T
endfunction
T1 = 80;    // Lower limit
T2 = 100;    //  upper limit
del_S = intg(T1,T2,f);   //   change in entropy
disp(" Change in entropy in Cal/K ;",del_S)


/* Result

   1.6530569

  Change in entropy in Cal/K ;

   */
```

Scilab code Exa 7.19 Total Increase in Entropy of Oxygen

```
// Scilab Code for 7.19
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_19.txt")
m = 0.032 ; // mass of oxygen in Kg
M = 32 ; // Molar Mass of H2 molecule in Kg/mol
V2_V1 = 2 ; //  Ratio of Final and initial Volume
T1 = 27+273 ; // Temperature in K
T2 = 100+273 ; // Temperature in K
Cv = 20.8*10^3 ;  // Specefic heat in KJ mol(-1) K
    ^(-1)
R = 8.314 ;  // Gas constant in J  mol(-1) K^(-1)
del_S = (m/M)*((Cv*log(T2/T1))+(R*log(V2_V1))) ; //
    Change in Entropy in J /K
disp(" Change in Entropy in J /K is ;",del_S)


/*Result


   4.5359185

  Change in Entropy in J /K is ;

   */
```

Scilab code Exa 7.21 Change in Entropy of the System

```
// Scilab Code for 7.21
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_21.txt")
m1 = 10 ;  // Mass of Steam in g
m2 = 90 ;  // Mass of water in g
L = 540 ;  // Latent heat  in cal/g
s = 1 ; // specefic heat of cal g^(-1) K^(-1)
T1 = 100+273  ;   // Temperature in K
T2 = 0+273 ;   // Temperature in K
del_S1 = - m1*L/T1  ;   // Change in Entropy during
    Condensation
disp(" Change in Entropy during Condensation in cal/
    K ;",del_S1)
T = (m1*L + m1*s*T1 + m2*s*T2)/(m1*s + m2*s) ;  //
    Temperature of mixing in K
disp(" Temperature of mixing in K is ;",T)
del_S2 = m1*s*log(T/T1) ;  // Change in Entropy from
     373 to 335
disp(" Change in Entropy from 373 tom 335 in cal/K
    is ;",del_S2)
del_S3 = m2*s*log(T/T2) ; // Change in Entropy from
    273 to 335
disp(" Change in Entropy from 273 to 335 cal/K is ;"
    ,del_S3)
disp(" Total Increase in Entropy in cal/K  is ;",
    del_S1+del_S2+del_S3)


```

```
/* Result

  Change in Entropy during Condensation in cal/K

  -14.477212        ,     "Answer given in textbook is
     wrong"

  Temperature of mixing in K is

   337              ,     "Answer given in textbook is
      wrong"

  Change in Entropy from 373 tom 335 in cal/K is

  -1.0149549         , " Answer given in the textbook
     are wrong "

  Change in Entropy from 273 to 335 cal/K is

   18.955002       ,    " Answer given in the textbook
      are wrong "

  Total Increase in Entropy in cal/K  is

   3.4628355       ,    " Answer given in the textbook
      are wrong "
```

Scilab code Exa 7.22 Total Increase in Entropy

```
// Scilab Code for 7.22
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
```

```
diary("Ex7_22.txt")
m = 1000;  // Mass of Solid in g
L = 14 ;  // Latent heat  in cal/g
c1 = 0.055 ; // specefic heat of Solid Phase cal g^(-1) K^(-1)
c2 = 0.064 ; // specefic heat of Liquid Phase cal g^(-1) K^(-1)
T2 = 237+273  ;   // Temperature in K
T1 = 157+273 ;   // Temperature in K
T3 = 330+273 ;   // Temperature in K
del_S1 = m*c1*log(T2/T1)  ;   // Change in Entropy when solid is heated
disp(" Change in Entropy when solid is heated in cal/K ;",del_S1)
del_S2 = m*L/T2 ;  // Change in Entropy When solid melts
disp(" Change in Entropy When solid melts in cal/K is ;",del_S2)
del_S3 = m*c2*log(T3/T2) ; // Change in Entropy when molten solid heated
disp(" Change in Entropy when molten solid heated cal/K is ;",del_S3)
disp(" Total Increase in Entropy in cal/K  is ;",del_S1+del_S2+del_S3)



/* Result


    9.3844034

  Change in Entropy when solid is heated in cal/K ;

    27.45098

  Change in Entropy When solid melts in cal/K is ;

```

```
 10.720414      ,      "Answer given in textbook is
    wrong"

Change in Entropy when molten solid heated  cal/K
   is ;

 47.555798      ,       "Answer given in textbook is
    wrong"

Total Increase in Entropy in cal/K  is ;
```

Scilab code Exa 7.23 Total Increase in Entropy

```
// Scilab Code for 7.23
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_23.txt")
m = 1;  // Mass of Solid in Kg
L1 = 3.36*10^(5) ;  // Latent heat of ice in J/Kg
L2 = 2.26*10^(6) ;  // Latent heat of steam in J/Kg
s = 500*4.2 ; // specefic heat of ice  J Kg^(-1) K
   ^(-1)
sw = 1000*4.2 ; // specefic heat of ice  J Kg^(-1) K
   ^(-1)
T2 = 0+273  ;   // Temperature in K
T1 = -20+273 ;   // Temperature in K
T3 = 100+273 ;   // Temperature in K
del_S1 = m*s*log(T2/T1)  ;   // Change in Entropy
disp(" Change in Entropy  in J/K ;",del_S1)
del_S2 = m*L1/T2 ;  // Change in Entropy
disp(" Change in Entropy  in J/K is ;",del_S2)
del_S3 = m*sw*log(T3/T2) ; // Change in Entropy
```

```
disp(" Change in Entropy in J/K is ;",del_S3)
del_S4 = m*L2/T3 ;  // Change in Entropy
disp(" Change in Entropy  in J/K is ;",del_S4)
disp(" Total Increase in Entropy in J/K  is ;",
   del_S1+del_S2+del_S3+del_S4)


/* Result

   159.77284

  Change in Entropy  in J/K ;

   1230.7692   ,    " Answer given in textbook is
      wrong"

  Change in Entropy  in J/K is ;

   1310.8478

  Change in Entropy in J/K is ;

   6058.9812

  Change in Entropy  in J/K is ;

   8760.3711

  Total Increase in Entropy in J/K  is ;

   */
```

Scilab code Exa 7.24 Change in Entropy of the System

```
// Scilab Code for 7.24
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_24.txt")
m = 20;  // Mass of Solid in g
L_ice = 80 ;  // Latent heat of ice in cal/g
s = 0.5 ; // specefic heat of ice  cal g^(-1) K^(-1)
sw = 1 ; // specefic heat of Water  Cal g^(-1) K
    ^(-1)
T2 = 0+273  ;   // Temperature in K
T1 = 50+273 ;   // Temperature in K
T3 = -10+273 ;   // Temperature in K
del_S1 = m*sw*log(T2/T1)  ;   // Change in Entropy
disp(" Change in Entropy  in cal/K  ;",del_S1)
del_S2 = -m*L_ice/T2 ;  // Change in Entropy
disp(" Change in Entropy  in cal/K is ;",del_S2)
del_S3 = m*s*log(T3/T2) ; // Change in Entropy
disp(" Change in Entropy in cal/K is ;",del_S3)
disp(" Total Increase in Entropy in cal/K  is ;",
   del_S1+del_S2+del_S3)


/* Result


  -3.3636106     ,     " Answer given in textbook is
      wrong"

  Change in Entropy  in cal/K  ;

  -5.8608059

  Change in Entropy  in cal/K is ;

  -0.3731776

  Change in Entropy in cal/K is ;
```

```
  -9.5975941      ,      " Answer given in textbook
     is wrong"

  Total Increase in Entropy in cal/K  is ;

   */
```

Scilab code Exa 7.25 Change in entropy of Aliminium

```
// Scilab Code for 7.25
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex7_25.txt")
funcprot(0)
function I=f(T)
    I=(3*10^(3))*(0.77/T + 0.46*10^(-3)) ;   //
       integral  m*Cv/T
endfunction
T1 = 300;    // Lower limit
T2 = 500;    //  upper limit
del_S = intg(T1,T2,f);   //   change in entropy
disp(" Change in entropy of Aluminium in J/K ;",
   del_S)


/* Result



   1456.0072

```

```
Change in entropy of Aluminium in J/K ;

"Answer varies due to rpund pff error"

 */
```

Chapter 8

Thermodynamics Relations

Scilab code Exa 8.1 Change in Melting Point

```
// Scilab Code for 8.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_1.txt")
L = 79.6*4.186*10^(7) ;  // Latent heat of fusion in
    erg/g
T = 273.16  // Temperature in Kelvin
v_water = 1.0001 ; // Specefic volume of water in cm
   ^3 /g
v_ice = 1.0908 ; // Specefic volume of ice in cm^3 /
   g
dp_dT = L/(T*(v_water-v_ice)) ;  //   dP/dT in dyne
   cm^(-2) K^(-1)
disp("dP/dT in dyne cm^(-2) K^(-1) is;",dp_dT)
dp = 2.026*10^(6)  // Change in pressure in dyne/cm
   ^2
dT = dp*T*(v_water-v_ice)/L ; // Change in melting
   point in K
disp("Change in melting point in K is ;",dT)
disp("Change in melting point in degree C is ;",dT)
```

```
// The melting point decreases with pressure
p = 1/0.0075  ;   //  Pressure in atm to lower the melting point by 1 degree C
disp(" Pressure in atm to lower the melting point by 1 degree C  is ;",p)



/* Result

  -1.345D+08

 dP/dT in dyne cm^(-2) K^(-1) is;

  -0.0150644

 Change in melting point in K is ;

  -0.0150644

 Change in melting point in degree C is ;

   133.33333

  Pressure in atm to lower the melting point by 1 degree C  is ;

  */
```

Scilab code Exa 8.2 Mean Temperature and Latent heat of fusion

```
// Scilab Code for 8.2
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
```

```
clc;
clear;
diary("Ex8_2.txt")
T1 = 99+273 ;       // Temperature in K
T2 = 101+273 ;      // Temperature in K
T = (T1 + T2)/2 ;    // Mean Temperature in K
disp(" Mean Temperature in K is ;",T)
v1 = 104/100 ;     //  Specepic Volume in cm^(3)/g
v2 = 167404/100 ;     //  Specepic Volume in cm^(3)/g
dp = (78.80-73.37)*13.6*980 ;    // Change in
    pressure in dyne/cm^2
dT = 101-99  ; // Change in Temperature in K
L = T*(v2-v1)*dp/dT  ;  // Latent heat of fusion in
    erg/g
disp(" Latent heat of fusion in erg/g is ;",L)
disp(" Latent heat of fusion in cal/g is ;",L
    /(4.18*10^(7)))



/* Result


   373.

  Mean Temperature in K is ;

   2.258D+10

  Latent heat of fusion in erg/g is ;

   540.21086

  Latent heat of fusion in cal/g is ;

   */
```

Scilab code Exa 8.6 Difference in Heat Capacities of He

```
// Scilab Code for 8.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_6.txt")
T = 6 ;    // Temperature in Kelvin
V = 2.64*10^(-2) ;     //  Specepic Volume in m^(3)/
    kmol
alpha = 5.35*10^(-2) ;  // Volume expansivity in
    per K
Beta =  9.42*10^(-8) ;   // Isothermal
    Compressibility in m^2 / N
cp_cv = (T*V*(alpha^2))/Beta ;  // Difference in
    Heat Capacities of He in J Kmol^(-1) K^(-1)
disp(" Difference in Heat Capacities of He in J Kmol
    ^(-1) K^(-1) is ;",cp_cv )




/* Result


   4812.9554

  Difference in Heat Capacities of He in J Kmol^(-1)
      K^(-1) is ;

  "Answer varies due to round off error"

```

```
*/
```

Scilab code Exa 8.7 Molar specefic heat at constant volume and Adiabatic Compressi

```
// Scilab Code for 8.7
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_7.txt")
cp = 27.96 ;       // specefic heat at constant
    pressure in J mol^(-1) k^(-1)
T = 273 ;   // Temperature in Kelvin
V = 14.72*10^(-6) ;    //  Specepic Volume in m^(3)/
    mol
alpha = 1.81*10^(-4) ;  // Volume expansivity in
    per K
Beta_T =  3.88*10^(-11) ;       // Isothermal
    Compressibility in m^2 / N
cp_cv = T*V*(alpha^2)/Beta_T ;  // Difference in
    Heat Capacities  in J mol^(-1) K^(-1)
disp(" Difference in Heat Capacities  in J mol^(-1)
    K^(-1) is ;",cp_cv)
cv = cp - cp_cv ;  // specefic heat at constant
    volume in J mol^(-1) k^(-1)
disp("specefic heat at constant volume in J mol^(-1)
     k^(-1) is ;",cv)
disp("Ratio of Cp/Cv is  ;",cp/cv)
Beta_S = (Beta_T)/(cp/cv) ;  // Adiabatic
    Compressibility in m^2 / N
disp(" Adiabatic Compressibility in m^2 / N is ;",
    Beta_S)
```

```
/* Result


  3.3930939

 Difference in Heat Capacities  in J mol^(-1) K
   ^(-1) is ;

  24.566906

specefic heat at constant volume in J mol^(-1) k
   ^(-1) is ;

  1.1381165

Ratio of Cp/Cv is  ;

  3.409D-11

 Adiabatic Compressibility in m^2 / N is ;

 "Answers varies due to round off error"

 */
```

Scilab code Exa 8.13 Latent heat of vaporisation of He

```
// Scilab Code for 8.13
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_13.txt")
R = 8.314   ;  // gas constant in J mol^(-1) K^(-1)
```

```
T = 4.2  ;   // Temperature in Kelvin
T0 = 1.2  ;   // Temperature in Kelvin
p_p0 = (10^5)/(10^(-3)*13.6*10^(3)*9.8) ;    //
    ration of pressure
L = R*T*T0*log(p_p0)/(T-T0) ;  // Latent heat of
    vaporisation in J/mol
disp(" Latent heat of vaporisation in J/mol is ;",L)



/* Result


   92.471593

  Latent heat of vaporisation in J/mol is ;

   */
```

Scilab code Exa 8.14 Change in melting point of ice

```
// Scilab Code for 8.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_14.txt")
L = 80*4.2*10^(7) ;  // Latent heat of fusion in erg
    /g
T = 273  // Temperature in Kelvin
v2 = 1 ; // Specefic volume of water in cm^3 /g
v1 = 1.09 ; // Specefic volume of ice in cm^3 /g
dp = (100-1)*1.013*10^(6)  // Change in pressure in
    dyne/cm^2
```

```
dT = dp*T*(v2-v1)/L ; // Change in melting point in K
disp("Change in melting point in K is ;",dT)
disp("Change in melting point in degree C is ;",dT)


/* Result

-0.7333487

 Change in melting point in K is ;

  -0.7333487

 Change in melting point in degree C is ;
  */
```

Scilab code Exa 8.15 Pressure Required to boil Water

```
// Scilab Code for 8.15
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_15.txt")
L = 540*4.2*10^(7) ;  // Latent heat of fusion in erg/g
T = 373  // Temperature in Kelvin
v2_v1 = 1676 ; // Change in Specefic volume  in cm^3
dT = 250-100 ; // Change in melting point in K
p0 = 1 ;  // Pressure in atm
dp = (dT*L)/(T*v2_v1)  // Change in pressure in dyne/cm^2
disp("Change in pressure  in dyne/cm^2 is ;",dp)
```

```
disp(" Change in pressure  in atm is ;",dp/10^6)
disp(" Required Pressure in atm is ;",dp/10^6 +1)


/* Result


   5441911.4

 Change in pressure  in dyne/cm^2 is ;

   5.4419114

 Change in pressure  in atm is ;

   6.4419114

  Required Pressure in atm is ;

   */
```

Scilab code Exa 8.16 Change in boiling point

```
// Scilab Code for 8.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_16.txt")
L = 540*4.2*10^(7) ;  // Latent heat of fusion in
   erg/g
T = 373  // Temperature in Kelvin
v2 = 1677 ; // Specefic volume of steam in cm^3 /g
v1 = 1 ; // Specefic volume of water in cm^3 /g
```

```
dp = (76-74)*13.6*980   // Change in pressure in dyne
    /cm^2
dT = dp*T*(v2-v1)/L ; // Change in melting point in
    K
disp("Change in melting point in K is ;",dT)
disp("Change in melting point in degree C is ;",dT)


/* Result


   0.7347418

 Change in melting point in K is ;

   0.7347418

 Change in melting point in degree C is ;
   */
```

Scilab code Exa 8.17 Latent heat of steam

```
// Scilab Code for 8.17
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_17.txt")
T = 373  ;    // Temperature in Kelvin
v2 = 1601 ; // Specefic volume of water in cm^3 /g
v1 = 1 ; // Specefic volume in cm^3 / g
dp = (787-760)*0.1*13.6*980 ;     // Change in
    pressure in dyne/cm^2
dT = (101-100)   ;   // change in temperature in K
```

```
d = 4.2*10^7 ;     //  dyne to erg conversion
L = T*(v2-v1)*dp/(dT*d) ;  // Latent heat of steam in cal/g
disp(" Latent heat of steam in cal/g is ;",L)


/* Result


   511.33824

  Latent heat of steam in cal/g is ;

   */
```

Scilab code Exa 8.18 Heat Transferred to the droplet

```
// Scilab Code for 8.18
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_18.txt")
T = 25+273  ;   // Temperature in Kelvin
v = 1.00187*10^(-3) ; // Specefic volume of water in m^3 /Kg
r = 10^(-6) ;   // Average radius of the droplets in m
N =  3*v/(4*3.1417*r^3)  ;   // Number of droplets per Kg
disp(" Number of droplets per Kg is  ;",N)
A = 4*%pi*(r^2)*N  ; // Total Surface area of droplets in m^2 per Kg
disp(" Total Surface area of droplets in 10^3 m^2
```

```
per Kg is ;",A/10^(3))
dsigma_dT = -0.152*10^(-3)  ;  // Rate of change of Surface tensionwith Tempearure in N m^(−1) K^(−1)
Q_T = -T*(dsigma_dT)*A ; // Heat Transferred to the droplet in J/Kg
disp(" Heat Transferred to the droplet in J/Kg is ;",Q_T)


/* Result

   2.392D+14

  Number of droplets per Kg is  ;

   3.0055073

  Total Surface area of droplets in 10^3 m^2 per Kg is ;

   136.13746

  Heat Transferred to the droplet in J/Kg is ;

   */
```

Scilab code Exa 8.19 Heat Transferred and Change in Internal Energy

```
// Scilab Code for 8.19
// OS : "Windows 10" , Scilab : 6.0.2 64−bit
clc;
clear;
diary("Ex8_19.txt")
```

```
cp = 27.96 ;        // specefic heat at constant pressure in J mol^(-1) k^(-1)
T = 273 ;    // Temperature in Kelvin
V = 14.7*10^(-6) ;     //  Specepic Volume in m^(3)/mol
alpha = 180*10^(-6) ;  // Volume expansivity in  per K
E_T =  2.6*10^(10) ;        // Isothermal elasticity in  N/m^2
pf = 101*1.013*10^5 ; // final pressure in N m^(-2)
pi = 1*1.013*10^5 ; // final pressure in N m^(-2)
pf_pi = 100*1.013*10^5 ;  // Change in Pressure in N m^(-2)
Q = -T*V*alpha*(pf-pi) ;  // Total heat transfer in J/mol
disp(Q," Total heat transfer in J/mol is ")
disp(Q/4.18," Total heat transfer in cal/mol is ")
W = (V*(pi^2 - pf^2))/(2*E_T) ;  // Work done in J/mol
disp(W," Work done in J/mol is  ")
disp(W/4.18," Work done in caL/mol is  ")
U = (Q - W)/4.18 ; // Change in Internal Energy in cal/mol
disp(U," Change in Internal Energy in cal/mol is ")


/* Result

  Total heat transfer in J/mol is

  -7.3174865

  Total heat transfer in cal/mol is

  -1.7505949

  Work done in J/mol is

```

```
-0.0295892

Work done in caL/mol is

-0.0070788

Change in Internal Energy in cal/mol is

-1.7435161

*/
```

Scilab code Exa 8.20 Heat treansferred

```
// Scilab Code for 8.20
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex8_20.txt")
cp = 27.96 ;       // specefic heat at constant pressure in J mol^(-1) k^(-1)
T = 0+273 ;    // Temperature in Kelvin
V = 10/1 ;     //  Specepic Volume in cm^(3)
alpha = -6.7*10^(-5) ;  // Volume expansivity in per K
del_p = 1000 ;    // change in Pressure in atm
del_Q = -T*V*alpha*del_p*10^5 ;  // Heat treansferred in dyne/cm^(2)
disp(" Heat treansferred in dyne/cm^(2) or erg is  ;",del_Q)
disp(" Heat treansferred in J is  ;",del_Q/10^(7))
disp(" Heat treansferred in cal is  ;",del_Q/(4.2*10^(7)))
```

```
/* Result


   18291000.

  Heat treansferred in dyne/cm^(2) or erg is  ;

   1.8291

  Heat treansferred in J is  ;

   0.4355

  Heat treansferred in cal is  ;

  "Answer varies due to round off error"

   */
```

Chapter 9

Free Energies and Thermodynamics Equillibrium

Scilab code Exa 9.6 Triple point temperature and Pressure

```
// Scilab Code for 9.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex9_6.txt")
T_tr = (3754-3063)/(27.92-24.38) ;        // Triple
   point temperature in Kelvin
disp(" Triple point temperature in Kelvin ;",T_tr)
p_tr = exp(27.92 - (3754/T_tr)) ;  // Triple point
   Pressure in Pa
disp(" Triple point Pressure in Pa is ;",p_tr)


/* Result

   195.19774

  Triple point temperature in Kelvin ;

```

```
   5932.6126

  Triple point Pressure in Pa is ;

   "Answer given in the textbook is wrong"
   */
```

Scilab code Exa 9.8 Temperature at which water boils in the cooker

```
// Scilab Code for 9.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex9_8.txt")
p2 = 202*10^3 ;    // Pressure in Pa
p1 = 101*10^3 ;    // Pressure in Pa
R = 0.4619*10^3 ; // gas Constant in J Kg^(-1) K
   ^(-1)
L_vap = 2257*10^3  ;    //  Latent heat of
   vaporisation in J/Kg
T1 = 373 ; // Temperature in Kelvin
T2 = (1/T1 - R*log(p2/p1)/L_vap)^(-1) ;   //
   temperature in Kelvin
disp(" Temperature at which water boils in the
   cooker in Kelvin is ;",T2)
disp(" Temperature at which water boils in the
   cooker in Celcius is ;",T2-273)


/* Result

   393.83862

```

```
Temperature at which water boils in the cooker in
  Kelvin is ;

 120.83862

Temperature at which water boils in the cooker in
  Celcius is ;

 */
```

Scilab code Exa 9.11 Latent heat of Vaporisation Enthalpy and Gibbs free energy

```
// Scilab Code for 9.11
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex9_11.txt")
T = 373 ; // Temperature in Kelvin
S_steam = 1.76  ; // entropy of steam in cal/(g K)
S_water = 0.31  ; // entropy of water in cal/(g K)
del_S = S_steam-S_water  // Change in entropy in cal
   /(g K)
L = T*del_S ;  // Latent heat of Vaporisation in cal
   /g
disp("(a) Latent heat of Vaporisation in cal/g is ;"
   ,L)
H_steam = 640 ;  // Enthalpy of steam in cal/g
H_water = 99 ;  // Enthalpy of Water in Cal/g
disp("(b) Enthalpy of Water in Cal/g is ;",H_water)
G_water = H_water - T*S_water ; // Gibbs free energy
    in Cal/g
disp("(c) Gibbs free energy of water in Cal/g is ;",
   G_water)
```

```
G_steam = H_steam - T*S_steam ; // Gibbs free energy
    in Cal/g
disp(" Gibbs free energy of steam in Cal/g is ;",
   G_steam)


/* Result


  540.85

 (a) Latent heat of Vaporisation in cal/g is ;

  99.

 (b) Enthalpy of Water in Cal/g is ;

 -16.63

 (c) Gibbs free energy of water in Cal/g is ;

 -16.48

 Gibbs free energy of steam in Cal/g is ;

 "Answers veries due to round off error"

 */
```

Scilab code Exa 9.12 Triple point Temperature and latent heat of Vaporisation and

```
// Scilab Code for 9.12
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
```

```
clc;
clear;
diary("Ex9_12.txt")
/*
ln p = 23.03-3754/T
ln p = 19.49-3063/T

equating both pressure we can solve for T
*/
R = 8.314 ; // Gas Constant in J/(mol K)
T_tr = (3754-3063)/(23.03-19.49) ;       // Triple point temperature in Kelvin
disp("(a) Triple point temperature in Kelvin ;",T_tr)

// Using , ln p = 23.03-3754/T
p = exp(23.03 - (3754/T_tr)) ;  // Triple point Pressure in Pa
disp(" Triple point Pressure in mm of Hg is ;",p)

/*
we know dp/dT = L/(TV)
and using ,  ln p = 19.49-3063/T
takind differentiaiton we get
       dp/dT = 3063p/T^2

       so L = TVdp/dT


*/
L_vap = 3063*R ; // Latent heat in J/mol
disp("(b) Latent heat of Vapourisation in J/mol is ;",L_vap)
L_sub = 7508*4.2 ;  // Latent heat of sublimation in J/mol
L_mel = L_sub - L_vap ;  // Latent heat of melting in J/mol
disp("(c) Latent heat of melting in J/mol is ;",
```

```
    L_mel)
disp(" Latent heat of melting in cal/mol is ;",L_mel
    /4.2)


/* Result


   195.19774

 (a) Triple point temperature in Kelvin ;

   44.621686

  Triple point Pressure in mm of Hg is ;

   25465.782

 (b) Latent heat of Vapourisation in J/mol is ;

   6067.818

 (c) Latent heat of melting in J/mol is ;

   1444.7186

  Latent heat of melting in cal/mol is ;
 "Answer varies due to round off error"
   */
```

Scilab code Exa 9.13 Coordinates of the Triple point

```
// Scilab Code for 9.13
```

```
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex9_13.txt")
p = 760 ;  // Pressure in mm of Hg
p1 = 4.60 ;   // Pressure at 0 degree C in mm of Hg
p2 = 4.94 ;   // Pressure at 1 degree C in mm of Hg
T = 0.0075 ;  // Increase in temperature for per atm decrease in pressure
//  p  = p1 + (p2-p1)*t
// del_p = 760 - (p1 +(p2-p1)*t )

// p*t = T*(del_p)/p
t = T*755.4/(p+0.34)
disp("The value of t is ;",t)
p  = p1 + (p2-p1)*t   ;   // Pressure at t in mm of Hg
 disp("Pressure at t in mm of Hg ;" , p)


/*
Result

   0.0074513

 The value of t is ;

   4.6025334

 Pressure at t in mm of Hg ;

*/
```

Scilab code Exa 9.14 Specefic heat Capacity of steam

```
// Scilab Code for 9.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex9_14.txt")
L_110 = 533.17 ;   // Latent heat in cal
L_100 = 539.3 ;   // Latent heat in cal
L_90 = 545.25 ;   // Latent heat in cal
T1 = 110+273 ;  // Temperature in Kelvin
T2 = 100+273 ;  // Temperature in Kelvin
T3 = 90+273 ;  // Temperature in Kelvin
dL_dT = (L_110 - L_90)/(T1 - T3) ;  //  dL/dT  in
   cal/(g K)
disp(" dL/dT  in cal/(g K) is ;",dL_dT)
C_water = 1.013 ;    // Specefic heat Capacity of
   Water in Cal/(g K)
C_steam = C_water + dL_dT - (L_100/T2)  ;  //
   Specefic heat Capacity of steam in Cal/(g K)
disp("Specefic heat Capacity of steam in Cal/(g K)
   is ;",C_steam)


/* Result


  -0.604

  dL/dT  in cal/(g K) is ;

  -1.0368445

 Specefic heat Capacity of steam in Cal/(g K) is ;


  */
```

Chapter 10

Production of Low Temperatures and their Applications

Scilab code Exa 10.2 Drop in Temperature

```
// Scilab Code for 10.2
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex10_2.txt")
a = 1.34*10^(-6)  ;    // Wander walls constant a in
    atm m^6 mol^(-2)
b = 36.5*10^(-6)  ;    // Wander walls constant b in
    m^3 mol^(-1)
Cp = 28.7*10^(-5) ;    // Specefic heat at constant
    pressure in atm m^(3) K^(-1) mol^(-1)
R = 8.2*10^(-5) ;    // Gas Constant in atm m^3 K
    ^(-1) mol^(-1)
T = 273  ;  // Temperature in Kelvin
mu = (2*a/(R*T)-b)/Cp ;  // Joule-Kelvin Coefficient
    in K/atm
disp(" Joule-Kelvin Coefficient in K/atm is ;",mu)
```

```
pi = 41.2 ;    // Initial pressure in atm
pf = 1.2 ;    // Initial pressure in atm
del_p = pi-pf ;   // Change in pressure in atm
del_T = mu*del_p ; // Drop in Temperature in K
disp(" Drop in Temperature in Kelvin is  ;",del_T)


/* Result


   0.2899571

  Joule-Kelvin Coefficient in K/atm is ;

   11.598283

  Drop in Temperature in Kelvin is  ;

  "Answer varies due to round off error"
   */
```

Scilab code Exa 10.3 `Fall in Temperature`

```
// Scilab Code for 10.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex10_3.txt")
Bo = 10000  ;   // Magnetic field in Oe
Cb = 0.42*10^7  ;    //  Constant in erg g^(-1) K ^(-1)
kV = 0.042  ;     // Curie consatnt in k g^(-1) oe ^(-1)
```

```
T = 2 ; // Initial temperature in Kelvin
del_T = -(kV*Bo^2)/(2*Cb*T)  ;   // Fall in
    Temperature in Kelvin
disp(" Fall in Temperature in Kelvin is ;",del_T)



/* Result

  -0.25

  Fall in Temperature in Kelvin is ;
  */
```

Chapter 11

Radiation Classical and Quantum Radiation

Scilab code Exa 11.3 Rate of Loss and Gain of heat

```
// Scilab Code for 11.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_3.txt")
T1 = 500 ;     // Temperature in Kelvin
T2 = 200 ;     // Temperature in Kelvin
T0 = 300  ;    // Temperature of the walls in Kelvin
E1 = (T1^4 - T0^4) ;  // Rate of loss of heat (in
    terms of sigma )
disp("(a) Rate of loss of heat by Black body ;",E1)
E2 = (T0^4 - T2^4) ;  // Rate of gain of heat (in
    terms of sigma )
disp("(b) Rate of gain of Heat by Black Body  ;",E2)
disp(" Ratio of E1/E2 is ;",E1/E2)



/* Result
```

```



  5.440D+10

 (a) Rate of loss of heat by Black body ;

  6.500D+09

 (b) Rate of gain of Heat by Black Body  ;

  8.3692308   ,     "Answer given in textbook is Wrong"

  Ratio of E1/E2 is ;


  */
```

Scilab code Exa 11.4 Heat Loss Time in which Temperature falls

```
// Scilab Code for 11.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_4.txt")
T0 = 300  ;  //  Temperature in Kelvin
T = 310 ;  // Temperature in Kelvin
T_av = (T0+T)/2  ; // Average Temperature in Kelvin
A = 6*(25*10^(-4)) ;  // Area of Cube in m^2
sigma = 5.67*10^(-8) ; // Stephen's Constant
m = 125 ; // Mass in gram
s = 1 ;  // Specefic Heat of the water in g/cm^3
Q = m*s*(T-T0) ; // Heat lost by the water in cal
```

```
disp(" Heat lost by the water in cal is ;",Q)
t = (Q*4.2)/(A*sigma*(T_av^4 - T0^4)) ;  // Time in
    sec
disp("Time in which Temperature falls in hrs is ;",(
    t/3600))
disp("Time in which Temperature falls is 3 hr and
    5.822346 ")


/* Result

   1250.

  Heat lost by the water in cal is ;

   3.0970391

 Time in which Temperature falls in hrs is ;

 Time in which Temperature falls is 3 hr and
    5.822346

 Time 3.0970391 hrs is equivalent to 3 hrs and
    5.8822346 minutes

 "Answer varies due to round off error"

   */
```

Scilab code Exa 11.5 Heat Transferred Work done and Final Temperature

```
// Scilab Code for 11.5
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
```

```
clc;
clear;
diary("Ex11_5.txt")
Vf_Vi = 10^(-3)  ;  //  Change in Volume in m^3
Vi = 100 ;   // Initial Volume in m^3
Vf = 1100 ;   // Final Volume in m^3
sigma = 5.672*10^(-8) ;   // Stephen's Constant in J
    m^(-2) K^(-4) s^(-1)
T = 2000 ;    // Temperature in Kelvin
c = 3*10^8 ;  // Speed of light in m/sec
Q = (16*sigma*T^4*Vf_Vi)/(3*c) ;   // Heat
   Transferred in Joule
disp("(a) Heat Transferred in  10^(-5) Joule is  ;",
   Q/10^(-5))
W = (4*sigma*(T^4)*Vf_Vi)/(3*c)  ;    // Work done
   in Joule
disp("(b) Work done in 10^(-5)  Joule is  ;",W
   /10^(-5))
Tf = T*(Vi/Vf)^(1/3) ;  // Final Temperature in
   Kelvin
disp(" Final Temperature in Kelvin is ;",Tf)


/* Result
(a) Heat Transferred in Joule is

   0.0000161

 (b) Work done in 10^(-5)  Joule is

   0.4033422    ,    "Answer  given in the textbook
      is wrong"

  Final Temperature in Kelvin is

   899.28863   ,     "Amswer varies due to round off
       error"

```

```
*/
```

Scilab code Exa 11.6 Energy and Pressure Density of solar radiation

```
// Scilab Code for 11.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_6.txt")
b = 2.892*10^(-3)  ;   // Weins Constant in mK
lamda1 = 470*10^(-9) ;  // Wavelength in m
lamda2 = 14*10^(-6) ;  // Wavelength in m
T1 = b/lamda1 ;    //  Temperature for 1st Maxima in Kelvin
disp("(a) Temperature for 1st Maxima in 10^3 Kelvin is ;",T1/10^3)
sigma = 0.5672*10^(-7) ;   // Stephen's Constant in J m^(-2) K^(-4) s^(-1)
c = 3*10^8 ;  // Speed of light in m/sec
u1 =(4*sigma*T1^4)/c ;  // Energy Density of solar radiation in J/m^3
disp(" Energy Density of solar radiation in J/m^3 is ;",u1)
disp("Pressure Density of solar radiation in N/m^2 is ;",u1/3)
T2 = b/lamda2 ;    //  Temperature for 1st Maxima in Kelvin
disp("(b) Temperature for 1st Maxima in 10^3 Kelvin is ;",T2/10^3)
u2 =(4*sigma*T2^4)/c ;  // Energy Density of solar radiation in J/m^3
disp(" Energy Density of solar radiation in 10^(-6) J/m^3 is ;",u2/10^(-6))
```

```
disp("Pressure Density of solar radiation 10^(-6) in
    N/m^2 is ;",u2*10^(6)/3)



/* Result


   1.0841183

  Energy Density of solar radiation in J/m^3 is ;

   0.3613728

 Pressure Density of solar radiation in N/m^2 is ;

   0.2065714

 (b) Temperature for 1st Maxima in 10^3 Kelvin is ;

   1.3770699

  Energy Density of solar radiation in 10^(-6)_J/m^3
      is ;

   0.4590233

 Pressure Density of solar radiation 10^(-6) in N/m
    ^2 is ;
   */
```

Scilab code Exa 11.7 Wavelength for Maximum Emission

```
// Scilab Code for 11.7
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_7.txt")
T = 500 ; // Temperature in Kelvin
A = 4*%pi*(16*10^(-4)) ;  // Area of Cube in m^2
sigma = 5.67*10^(-8) ; // Stephen's Constant
R = sigma*A*(T^4) ; // Rate of Emission of Energy in W
disp("Rate of Emission of Energy in W is ;",R)
b = 2898*10^(-6)  ;   // Weins Constant in mK
lamda_max = b/T ;  // Wavelength for Maximum Emission in m
disp(" Wavelength for Maximum Emission in 10^(-6) m is ;",lamda_max/10^(-6))


/* Result

   71.251321

 Rate of Emission of Energy in W is ;

   5.796

  Wavelength for Maximum Emission in 10^(-6) m is ;
   */
```

Scilab code Exa 11.8 Number of modes in the frequency Range

```
// Scilab Code for 11.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
```

```
clc;
clear;
diary("Ex11_8.txt")
V = 10^(-4) ;    // Volume of the chamber in m^3
v = 4*10^14 ;    // Frequency in Hz
dv = 0.01*10^14 ;   // Change in Frequency in Hz
c = 3*10^8 ;  // Speed of light in m/sec
Nv_dv = (8*%pi*V*v^2*dv)/c^3 ;   // Number of modes in the frequency Range
disp(" Number of modes in the frequency Range is ;",Nv_dv)


/* Result

  1.489D+13

  Number of modes in the frequency Range is ;

   */
```

Scilab code Exa 11.9 Rate of Cooling

```
// Scilab Code for 11.9
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_9.txt")
A = 0.1 ;  // Area of Cube in m^2
sigma = 5.672*10^(-8) ;     // Stephen's Constant in J m^(-2) K^(-4) s^(-1)
m = 1 ; // Mass in Kg
s = 100*4.2 ;  // Specefic Heat  in J Kg^(-1) K^(-1)
```

```
T0 = 300  ;  //  Temperature in Kelvin
T = 500 ;  // Temperature in Kelvin
dT_dt = (A*sigma*(T^4 - T0^4))/(m*s) ; // Rate of
    Cooling  in  K/s
disp(" Rate of Cooling  in  K/s is ;",dT_dt)


/* Result

   0.734659

  Rate of Cooling  in  K/s is ;

   "Answer given in textbook is Wrong"
*/
```

Scilab code Exa 11.10 Temperature of the planet

```
// Scilab Code for 11.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_10.txt")
d = 15*10^10  ;  // Distance of the planet from
    centre of the sum in m
R = 7.5*10^8  ;  // Radius of the sun in m
T1 = 6000 ; // Surface temperature of the sun in
    Kelvin
T = T1*sqrt(R/(2*d)) ; // Temperature of the planet
    in Kelvin
disp("Temperature of the planet in Kelvin is ;",T)


```

```
/* Result

   300.

 Temperature of the planet in Kelvin is ;

   */
```

Scilab code Exa 11.11 Time taken for metal to cool

```
// Scilab Code for 11.11
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_11.txt")
A = 4*%pi*(0.1)^2 ;  // Area of Cube in m^2
sigma = 5.672*10^(-8) ;      // Stephen's Constant in
    J m^(-2) K^(-4) s^(-1)
rho = 7.8*10^3 ;  // Density of iron in Kg/m^3
m = (4*%pi*rho*0.1^3)/3 ; // Mass in Kg
s = 0.11 ;  // Specefic Heat  in J Kg^(-1) K^(-1)
c = (m*s)/(sigma*A) ;   // constants
funcprot(0)
function I=f(T)
    I=-c*T^(-4) ;   // integral
endfunction
T1 = 200;    // Lower limit
T2 = 100;    //  upper limit
t = intg(T1,T2,f);   //   Time in   sec
disp(" Time in sec ;",t)


/* Result
```

```


 147.06747

Time in sec ;

 */
```

Scilab code Exa 11.12 Average energy of Classical and planck oscillator

```
// Scilab Code for 11.12
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_12.txt")
v = 1.5*10^14 ;  // Frequency of oscillator in Hz
Kb = 1.38*10^(-23) ;  // Boltzmann Constant in J/K
h = 6.62*10^(-34)  ;  // Plancks Constant in J/s
T = 1800 ;  // Temperature in Kelvin
// (a) Average energy of Classical oscillator
epsilon_bar = Kb*T ;  // Average energy of Classical
    oscillator in J
disp("(a) Average energy of Classical oscillator in
   J is ;",epsilon_bar)
// (a) Average energy of Plancks oscillator
epsilon_bar = (h*v)/(exp((h*v)/(Kb*T))-1)  ;   //
   Average energy of Plancks oscillator in J
disp("(b) Average energy of Plancks oscillator in J
   is ;",epsilon_bar)


/* Result

```

```
  2.484D-20

(a) Average energy of Classical oscillator in J is
  ;

  1.857D-21     ,    "Answer given in textbook is
    Wrong"

(b) Average energy of Plancks oscillator in J is ;

  */
```

Scilab code Exa 11.13 Number of modes in the wavelength and frequency range

```
// Scilab Code for 11.13
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_13.txt")
lamda_1 = 500*10^(-7) ;   // Wavelength in cm
lamda_2 = 500.2*10^(-7) ;  // Wavelength in cm
v1 = 1.5*10^(14) ;  // frequency in Hz
v2 = 1.51*10^(14) ;  // frequency in Hz
c = 3*10^10  ;  // Speed of light in cm/s
V = 100 ;   // Volume in cm^3
N1 = (V*8*%pi*(lamda_2-lamda_1))/(lamda_1^4) ; //
   Number of modes in the wavelength range
disp("(a) Number of modes in the wavelength range is
    ;",N1)
N2 = (V*(v1^2)*8*%pi*(v2-v1))/(c^3) ; // Number of
   modes in the wavelength range
disp("(b) Number of modes in the Frequency range is
   ;",N2)
```

```
/* Result


   8.042D+12

 (a) Number of modes in the wavelength range is  ;

   2.094D+12

 (b) Number of modes in the Frequency range is  ;

   */
```

Scilab code Exa 11.15 Rate of loss of Heat and time taken by it to cool

```
// Scilab Code for 11.15
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_15.txt")
e = 0.4 ;  // Surface Emissivity of the metal
sigma = 5.672*10^(-8) ;   // Stephen's Constant in J
    m^(-2) K^(-4) s^(-1)
s_al = 920 ;   // Specefic heat of aluminium in J Kg
   ^(-1) K^(-1)
rho_al = 2700 ;   // Density of the aluminium in Kg/
   m^3
T_al = 77+273 ;   // Temperature of the aluminium
   sphere in Kelvin
T_jar = 27+273 ;   // Temperature of the Jar in
```

```
    Kelvin
A = 4*%pi*(0.05)^2   ;    // Area in m^2
Q = e*sigma*A*(T_al^4 - T_jar^4) ;    //  Rate of
    loss of Heat in J/s
disp(" Rate of loss of Heat in J/s is ;",Q)
m = (rho_al*4*%pi*(0.05)^3)/3    ;  // mass in Kg
disp(" mass in Kg is ;",m)
del_T = 10 ;   // Temperature difference in Kelvin
del_t = m*s_al*del_T/Q   ;   // Time taken by it to
    cool in s
disp("Time taken by it to cool in s is  ;",del_t)


/* Result


   4.9225301

  Rate of loss of Heat in J/s is ;

   1.4137167

  mass in Kg is ;

   2642.1765      ,     "Answer given in textbook is
       wrong"

 Time taken by it to cool in s is  ;
   */
```

Scilab code Exa 11.16 Temperature of the Filament

```
// Scilab Code for 11.16
```

```
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_16.txt")
e = 0.38 ;  // Surface Emissivity of the metal
sigma = 5.672*10^(-8) ;   // Stephen's Constant in J
    m^(-2) K^(-4) s^(-1)
T_al = 77+273 ;   // Temperature of the aluminium
   sphere in Kelvin
T_jar = 27+273 ;   // Temperature of the Jar in
   Kelvin
r = 25*10^(-6) ;  // Radius of the Filament in m
l = 0.02  ;   // length of the filament in m
A = 2*%pi*r*l   ;   // Area in m^2
P = 1  ;   // Power in J/s
T0 = 300 ;  // Temperature in Kelvin
T =  (T0^4 + P/(e*sigma*A))^(1/4)  ;   //
   Temperature of the Filament in Kelvin
disp("Temperature of the Filament in Kelvin is ;",T)



/* Result

   1960.614

 Temperature of the Filament in Kelvin is ;

 "Answer varies due to round off error"
   */
```

Scilab code Exa 11.17 Work done pressure and Final Temperature

```
// Scilab Code for 11.17
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_17.txt")
sigma = 5.672*10^(-8) ;    // Stephen's Constant in J
    m^(-2) K^(-4) s^(-1)
c = 3*10^8 ;   // Speed of light in m/sec
Ti = 2500 ;    // Initial Temperature in Kelvin
p = (4*sigma*(Ti^4))/(3*c)  ;   // Pressure in N/m^2
disp("(a) Pressure in N/m^2 10^(-2) is ;",p/10^(-2))
del_V = 1.01*10^(-3)  -  10^(-5)  ;  // Change in
   Volume in m^3
W = p*del_V ;   // Work done in J
disp("(b) Work done in 10^(-5) J is ;",W/10^(-5))
Tf = Ti*((100)^(1/3))  ;  // Final Temperature in
   Kelvin
disp("(c) Final Temperature in Kelvin is ;",Tf)




/*
Result

  0.9847222      , "Answer given in textbook is
     wrong"  "T used is different"

 (a) Pressure in N/m^2 10^(-2) is ;

   0.9847222    , ,  "Answer given in textbook is
      wrong"  "T used is different"

 (b) Work done in 10^(-5) J is ;

   11603.972

 (c) Final Temperature in Kelvin is ;
```

```
*/
```

Scilab code Exa 11.18 specefic heat Capacity of the metal

```
// Scilab Code for 11.18
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_18.txt")
sigma = 5.7*10^(-5) ;   // Stephen's Constant in erg
    cm^(-2) K^(-4) s^(-1)
A = 4*%pi*(10)^2   ;   // Area in cm^2
T = 127+273 ;   // Temperature in Kelvin
T0 = 27+273 ;   // Temperature in Kelvin
m = 5*10^3  ;  // mass in g
dtheta_dt = 3*10^(-2)  ;  //  Rate of Fall of
   temperature
c = 4.2*10^7 //  conversion   J / Kg to cal / g
s = sigma*A*(T^4 - T0^4)/(m*dtheta_dt*c)  ;   //
   specefic heat Capacity of the metal in cal g^(-1)
    C^(-1)
disp("specefic heat Capacity of the metal in cal g
   ^(-1) C^(-1)  is  ;",s)



/* Result


   0.1989675

 specefic heat Capacity of the metal in cal g^(-1) C
   ^(-1)  is  ;
```

```


"Answer varies due to round off error"
  */
```

Scilab code Exa 11.19 Temperature and Wavelength of the body

```
// Scilab Code for 11.19
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex11_19.txt")
eA = 0.01 ;  // Emissivities of Body A
eB = 0.81 ;  // Emissivities of Body B
TB = 1661+273 ;  // Temperature of Body B in Kelvin
TA = TB*(eB/eA)^(1/4) ;    // Temperature of Body A
   in Klevin
disp("Temperature of Body A in Kelvin is ;",TA)
disp("Temperature of Body A in Kelvin is ;",TA-273)
lambda_B = TA*10^4/(TA-TB) ;  // Wavelength of Body
   B in m
disp("Wavelength of Body B in Angstrom is  ;",
   lambda_B)


/* Result

  5802.

 Temperature of Body A in Kelvin is ;

  5529.

```

```
Temperature of Body A in Kelvin is ;

  15000.

Wavelength of Body B in Angstrom is  ;

  */
```

Chapter 12

Basic Concept of Statistical Mechanics

Scilab code Exa 12.3 `Number of Quantum States`

```
// Scilab Code for 12.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_3.txt")
x0 = 10^(-5) ;   // in m
p0 = 2*10^(-25)  ;   // momentum in Kg m / s
h = 6.626*10^(-34)  ;  // Plancks constant in Js
n = x0*p0/h  ;   // Number of Quantum States in 1-D
disp("(a) Number of Quantum States in 1-D ;",n)
r0 = 10^(-14) ;  // Radius of the proton in m
p = 10^(-19) ; //  momentum of proton in Kg m / s
Vr = (4*%pi*r0^3)/3  ;   // Volume in Coordiante Space in m^3
Vp = (4*%pi*p^3)/3  ;   // Volume in Momentum Space in m^3
n2 = (Vr*Vp)/h^3  ;   // Number of Quantum States for proton
disp("(b) Number of Quantum States for proton is  ;"
```

```
,n2)



/* Result

(a) Number of Quantum States in 1-D

   3018.4123   ,   "Answer given in textbook is wrong"

 (b) Number of Quantum States for proton is

   60.314666     ,   "Answer given in textbook is wrong"

   */
```

Scilab code Exa 12.4 Quantum number of Helium Atom

```
// Scilab Code for 12.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_4.txt")
V = 0.0224 ;  // Volume of the cube in m^3
m = 6.65*10^(-27) ;   // Mass of a He atom
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
T = 273  ;   // Temperature in Klevin
h = 6.626*10^(-34)  ;  // Plancks constant in Js
C = (h^2)/(8*m*V^(2/3)) ;  // Constant
E = (3/2)*Kb*T  ;  // Energy in J
n_x = (E/(3*C))^(1/2) ;  // Quantum number
```

```
disp("Quantum number ;",n_x)

/* Result

   4.259D+09

 Quantum number ;

 "Answer varies due due to round off error"

   */
```

Scilab code Exa 12.7 Number of ways according to Maxwell Boltzmann Fermi Dirac and

```
// Scilab Code for 12.7
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_7.txt")
ni = 2 ;    // Number of Particles
gi = 3 ;    // Number of states
function n  = fac(n)
    if  (n<=0) then n=1
    else
        n = n*fac(n-1)
    end
endfunction
omega_MB = (gi^ni) ;
disp("Number of ways according to MB stats is ;",
   omega_MB)
omega_FD = fac(gi)/(fac(ni)*fac(gi-ni)) ;
disp("Number of ways according to FD stats is ;",
   omega_FD)
```

```
omega_BE = fac(ni+gi-1)/(fac(ni)*fac(gi-1)) ;
disp("Number of ways according to BE stats is ;",
   omega_BE)

/* Result

   9.

 Number of ways according to MB stats is ;

   3.

 Number of ways according to FD stats is ;

   6.

 Number of ways according to BE stats is ;

   */
```

Scilab code Exa 12.8 Thermodymanic Probablity and Number of Microistates

```
// Scilab Code for 12.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_8.txt")
ni = 6 ;    // Number of Particles
gi = 3 ;    // Number of states
N = gi^ni  ;  // Total no. of miocrostates
disp("(a) Total no. of miocrostates is ;",N)
function n  = fac(n)
    if  (n<=0) then n=1
```

```
    else
        n = n*fac(n-1)
    end
endfunction
P_1 = fac(6)/(fac(6)*fac(0)*fac(0)) ;  //
   Thermodynamic Probablity for macrostate 1
disp("(b) Thermodynamic Probablity for macrostate 1
   ;",P_1)
P_2 = fac(6)/(fac(5)*fac(1)*fac(0)) ;  //
   Thermodynamic Probablity for macrostate 2
disp("Thermodynamic Probablity for macrostate 2 ;",
   P_2 )
P_3 = fac(6)/(fac(4)*fac(2)*fac(0)) ;  //
   Thermodynamic Probablity for macrostate 3
disp("Thermodynamic Probablity for macrostate 3 ;",
   P_3 )
P_4 = fac(6)/(fac(4)*fac(1)*fac(1)) ;  //
   Thermodynamic Probablity for macrostate 4
disp("Thermodynamic Probablity for macrostate 4 ;",
   P_4 )
P_5 = fac(6)/(fac(3)*fac(2)*fac(1)) ;  //
   Thermodynamic Probablity for macrostate 5
disp("Thermodynamic Probablity for macrostate 5 ;",
   P_5 )
P_6 = fac(6)/(fac(3)*fac(3)*fac(0)) ;  //
   Thermodynamic Probablity for macrostate 6
disp("Thermodynamic Probablity for macrostate 6 ;",
   P_6 )
P_7 = fac(6)/(fac(2)*fac(2)*fac(2)) ;  //
   Thermodynamic Probablity for macrostate 7
disp("Thermodynamic Probablity for macrostate 7 ;",
   P_7 )
omega_1 = P_1*fac(3)/fac(2) ;  // Number of
   Microstates for macrostate 1
disp("(c) Number of Microstates for macrostate 1 ;",
   omega_1 )
omega_2 = P_2*fac(3) ;  // Number of Microstates for
    macrostate 2
```

```
disp("Number of Microstates for macrostate 2 ;", omega_2 )
omega_3 = P_3*fac(3) ;  // Number of Microstates for macrostate 3
disp("Number of Microstates for macrostate 3 ;", omega_3 )
omega_4 = P_4*fac(3)/fac(2) ;  // Number of Microstates for macrostate 4
disp("Number of Microstates for macrostate 4 ;", omega_4 )
omega_5 = P_5*fac(3) ;  // Number of Microstates for macrostate 5
disp("Number of Microstates for macrostate 5 ;", omega_5 )
omega_6 = P_6*fac(3)/fac(2) ;  // Number of Microstates for macrostate 6
disp("Number of Microstates for macrostate 6 ;", omega_6 )
omega_7 = P_7*fac(3)/fac(3) ;  // Number of Microstates for macrostate 7
disp("Number of Microstates for macrostate 7 ;", omega_7 )
/* Result
   729.
 (a) Total no. of miocrostates is ;
   1.
  (b) Thermodynamic Probablity for macrostate 1 ;
   6.
```

```
Thermodynamic Probablity for macrostate 2 ;
  15.
Thermodynamic Probablity for macrostate 3 ;
  30.
Thermodynamic Probablity for macrostate 4 ;
  60.
Thermodynamic Probablity for macrostate 5 ;
  20.
Thermodynamic Probablity for macrostate 6 ;
  90.
Thermodynamic Probablity for macrostate 7 ;
  3.
(c) Number of Microstates for macrostate 1 ;
  36.
Number of Microstates for macrostate 2 ;
  90.
Number of Microstates for macrostate 3 ;
  90.
Number of Microstates for macrostate 4 ;
```

```
  360.

Number of Microstates for macrostate 5 ;

  60.

Number of Microstates for macrostate 6 ;

  90.

Number of Microstates for macrostate 7 ;

  */
```

Scilab code Exa 12.9 Number of ways according to Maxwell Boltzmann Fermi Dirac and

```
// Scilab Code for 12.9
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_9.txt")
ni = 2 ;    // Number of Particles
gi = 3 ;    // Number of states
function n  = fac(n)
    if  (n<=0) then n=1
    else
        n = n*fac(n-1)
    end
endfunction
omega_MB = (gi^ni)-3 ;
disp("Number of ways according to MB stats is ;",
   omega_MB)
omega_FD = fac(gi)/(fac(ni)*fac(gi-ni)) ;
```

```
disp("Number of ways according to FD stats is ;",omega_FD)
omega_BE = fac(ni+gi-1)/(fac(ni)*fac(gi-1)) ;
disp("Number of ways according to BE stats is ;",omega_BE)



/* Result

   6.

 Number of ways according to MB stats is ;

   3.

 Number of ways according to FD stats is ;

   6.

 Number of ways according to BE stats is ;

   */
```

Scilab code Exa 12.10 `Number of ways according to Fermi Dirac and Bose Einstein St`

```
// Scilab Code for 12.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_10.txt")
ni = 3 ;    // Number of Particles
gi = 3 ;    // Number of states
```

```
function n  = fac(n)
    if  (n<=0) then n=1
    else
        n = n*fac(n-1)
    end
endfunction
omega_BE = fac(ni+gi-1)/(fac(ni)*fac(gi-1)) ;
disp("(a) Number of ways according to BE stats is ;",omega_BE)
omega_FD = fac(gi)/(fac(ni)*fac(gi-ni)) ;
disp("(b) Number of ways according to FD stats is ;",omega_FD)

/* Result

   10.

 (a) Number of ways according to BE stats is ;

   1.

 (b) Number of ways according to FD stats is ;

   */
```

Scilab code Exa 12.14 `Probrablity of Vibrational mode`

```
// Scilab Code for 12.14
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_14.txt")
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
```

```
h = 6.626*10^(-34)  ;  // Plancks constant in Js
c = 3*10^8  ;   // Speed of light in m/s
T = 1000 ; // Temperature in Kelvin
k = 54000 ;  // wave number per m
C = h*c*k/(Kb*T*2*%pi) ;  // Value of hv/KbT
disp("Value of hv/KbT is ;",C)
P1 = exp(0) ;  // Probrablity of first Vibrational
   mode
disp("Probrablity of first Vibrational mode is ;",P1
   )
P2 = exp(-C) ;  // Probrablity of first Vibrational
   mode
disp("Probrablity of first Vibrational mode is ;",P2
   )
P3 = exp(-2*C) ;  // Probrablity of first
   Vibrational mode
disp("Probrablity of first Vibrational mode is ;",P3
   )



/* Result


   0.1237963

 Value of hv/KbT is ;

   1.

 Probrablity of first Vibrational mode is ;

   0.8835598

 Probrablity of first Vibrational mode is ;

   0.780678

```

```
 Probrablity of first Vibrational mode is ;

   */
```

Scilab code Exa 12.16 Temperature of the Sysytem

```
// Scilab Code for 12.16
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_16.txt")
Epsilon1 = 30.1*10^(-3) ; // Energy in level 1 in eV
Epsilon2 = 21.5*10^(-3) ; // Energy in level 2 in eV
Epsilon3 = 12.9*10^(-3) ; // Energy in level 3 in eV
Epsilon4 = 4.3*10^(-3) ; // Energy in level 4 in eV
n1 = 3.1  ;       // Population in level 1
n2 = 8.5  ;       // Population in level 2
n3 = 23  ;       // Population in level 3
n4 = 63  ;       // Population in level 4
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
T1 = (Epsilon1-Epsilon2)*1.6*10^(-19)/(log(n2/n1)*Kb
   ) ; // Temperature T1 in Kelvin
disp("Temperature T1 in Kelvin is  ;",T1)
T2 = (Epsilon2-Epsilon3)*1.6*10^(-19)/(log(n3/n2)*Kb
   ) ; // Temperature T2 in Kelvin
disp("Temperature T2 in Kelvin is  ;",T2)



/* Result


   98.853672
```

```

Temperature T1 in Kelvin is  ;

  100.16811     ,   "Answer varies due to round off error"

Temperature T2 in Kelvin is  ;

  */
```

Scilab code Exa 12.17 Ratio of Number of Particle in Second excited to ground stat

```
// Scilab Code for 12.17
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex12_17.txt")
E1 = -13.6 ; // Energy in level 1 in eV
E3 = -13.6/9 ; // Energy in level 3 in eV\
KbT = 0.8 ;
N3_N1 = exp((E1-E3)/KbT) ;  // Ratio of Number of Particle in Second excited to ground state
disp("Ratio of Number of Particle in Second excited to ground state  in the order of 10^(-7) is ;", N3_N1/10^(-7))

/* Result

 2.7373342

 Ratio of Number of Particle in Second excited to ground state  in the o
 rder of 10^(-7) is ;
```

```

"Answer varies due to round off error"


 */
```

Chapter 13

Maxwell Boltazmann Statistics

Scilab code Exa 13.3 Root mean Square Speed of rotation

```
// Scilab Code for 13.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex13_3.txt")
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
T = 300 ;  // Temperature in Kelvin
m = 1.66*10^(-27)  ;  // Mass in Kg
r = 10^(-10)  ;  // Radius of hydrogen atom in m
w_bar = sqrt(4*Kb*T/(m*r^2))  ;   // Root mean
   Square Speed of rotation in per sec
disp("Root mean Square Speed of rotation in per sec
    ;",w_bar)



/* Result

  3.158D+13

 Root mean Square Speed of rotation in per sec  ;
```

```
 "Answer varies due to round off error"

   */
```

Scilab code Exa 13.4 `Energy in eV for 1st excitation in Sodium`

```
// Scilab Code for 13.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex13_4.txt")
h = 6.626*10^(-34)  ;  // Plancks constant in Js
c = 3*10^8  ;   // Speed of light in m/s
lamda = 590*10^(-9)  // Wavelength of sodium lamp in m
E2_E1 = h*c/lamda ;  // Energy in eV for 1st excitation in Sodium
disp("Energy in eV for 1st excitation in Sodium is ; ",E2_E1/(1.6*10^(-19)))


/* result


   2.1057203

 Energy in eV for 1st excitation in Sodium is ;

   */
```

Scilab code Exa 13.5 Ratio of Number of Particle in Second excited to ground state

```
// Scilab Code for 13.5
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex13_5.txt")
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
h = 6.6*10^(-34)  ;  // Plancks constant in Js
c = 3*10^8  ;   // Speed of light in m/s
T = 600 ; // Temperature in Kelvin
lamda = 590*10^(-9) ;  // wave length in  m
N2_N1 = exp(-h*c/(Kb*T*lamda)) ;  // Ratio of Number
    of Particle in Second excited to ground state
disp("Ratio of Number of Particle in Second excited
   to ground state  is; ",N2_N1)


/* Result

   2.499D-18

 Ratio of Number of Particle in Second excited to
    ground state  is;
   */
```

Scilab code Exa 13.6 Ratio of Spontaneous Emission to Spontaneous Emission

```
// Scilab Code for 13.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex13_6.txt")
c = 3*10^8  ;   // Speed of light in m/s
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
T = 1200 ;  // Temperature in Kelvin
lamda = 550*10^(-9) ;  // wave length in  m
v = c/lamda ; // Frequency in Hz
h = 6.62*10^(-34)  ;  // Plancks constant in Js
A_21_B_21_U_v = exp(h*v/(Kb*T)) - 1  ;  // Ratio of
   Spontaneous Emission to Spontaneous Emission
disp("Ratio of Spontaneous Emission to Spontaneous
   Emission is ;",A_21_B_21_U_v)



/* Result


   2.950D+09

 Ratio of Spontaneous Emission to Spontaneous
    Emission is ;

 "Answer varies due to round off error"

   */
```

Scilab code Exa 13.8 Entropy of Thallium

```
// Scilab Code for 13.8
```

```
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex13_8.txt")
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
E = 1.55*10^(-19)  ;  // Emergy in J
T = E/Kb  ;  // Temperature in Kelvin
disp("Temperature in Kelvin is ;",T)
S_measured = 203 ;  // Measued Entropy in  J mol
    ^(-1) K^(-1)
N = 6.023*10^(23) ; // Avagadro Number
S1 = 197.5  ;  // Entropy in J mol^(-1) K^(-1)
S2 = N*Kb*log(2) ;  // Entropy in J mol^(-1) K^(-1)
S = S1+S2 ;  // Entropy in J mol^(-1) K^(-1)
disp("Entropy in J mol^(-1) K^(-1) is ;",S)


/* Result


   11231.884

 Temperature in Kelvin is ;

   203.26126

 Entropy in J mol^(-1) K^(-1) is ;


   */
```

Scilab code Exa 13.9 Specefic heat Capacity of solid and Maximum Lattice Frequency

```
// Scilab Code for 13.9
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex13_9.txt")
T1 = 30 ;  // Temperature in Kelvin
T2 = 50 ;  // Temperature in Kelvin
theta_D = 2230 ;  // Debye Temperature un Kelvin
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
R = 8.314  ;   // gas Constsnt
h = 6.62*10^(-34)  ;  // Plancks constant in J s
Cv = (12*(%pi^4)*R/5)*(T1/theta_D)^3 ;  // Specefic heta Capacity ofsolid in J K^(-1) mol^(-1)
disp("Specefic heta Capacity ofsolid in 10^(-3) J K^(-1) mol^(-1) is ;",Cv/10^(-3))
funcprot(0)
function I=f(T)
    I = (12*(%pi^4)*R*T^2)/(5*(theta_D)^3) ;   // integral Cv/T
endfunction
T1 = 30;    // Lower limit
T2 = 50;    //  upper limit
del_S = intg(T1,T2,f);   //   change in entropy
disp(" Change in entropy in 10^(-3) J K^(-1) mol^(-1) ;",del_S/10^(-3))
v_m = Kb*theta_D/h  ;  // Maximum Lattice Frequency in Hz
disp("Maximum Lattice Frequency in Hz is ;",v_m)



/* Result

   4.7322745

 Specefic heta Capacity ofsolid in 10^(-3) J K^(-1) mol^(-1) is ;

```

```
  5.7254679

 Change in entropy in 10^(-3) J K^(-1) mol^(-1) ;

  4.649D+13

Maximum Lattice Frequency in Hz is ;
  */
```

Scilab code Exa 13.10 Bond Length of HCL Molecule

```
// Scilab Code for 13.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex13_10.txt")
B = 10.4 ;  // Wavenumber in per cm
m = 1.67*10^(-24)  ;  // Mass of proton in g
mu = 35.5*1*m/36.5 ;  // Reduced mass in g
h = 6.62*10^(-27)  ;  // Plancks constant in erg s
C = 3*10^10  ;  //
r = sqrt(h/(8*(%pi^2)*mu*B*C)) ;  // Bond Length in
   cm
disp("Bond Length in cm is  ;",r)
disp("Bond Length in Angstrom is  ;",r/10^(-8))


/* Result


  1.286D-08

Bond Length in cm is  ;
```

```
   1.2862662

Bond Length in Angstrom is  ;

   */
```

Chapter 14

Fermi Dirac Statistics

Scilab code Exa 14.1 Fermi Energy and Fermi Temperature

```
// Scilab Code for 14.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_1.txt")
h = 6.62*10^(-34)  ;  // Plancks constant in J s
m = 9.11*10^(-31)  ;  // Mass of electron in Kg
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
n = 5.86*10^28  ;  // Number density N/V
Epsilon_f = ((h^2/(8*m))*(3*n/%pi)^(2/3))   ; // Fermi Energy in J
disp("Fermi Energy in eV is ;",Epsilon_f/(1.6*10^(-19)) )
Tf = Epsilon_f/Kb  ;  // Fermi tempertaure in Kelvin
disp("Fermi tempertaure in 10^4 Kelvin is  ;",Tf/10^4)


/* Result

 5.4983658
```

```

 Fermi Energy in eV is ;

   6.3749169

 Fermi tempertaure in 10^4 Kelvin is  ;

"Anwer varies due to round off error"

   */
```

Scilab code Exa 14.2 Fermi Energy and Pressure in Aluminium

```
// Scilab Code for 14.2
diary("Ex14_2.txt")
clc
h = 6.62*10^(-34)  ;  // Plancks constant in J s
m = 9.11*10^(-31)  ;  // Mass of electron in Kg
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
d = 2.7*10^3  ;  // Density of Al in Kg /mol
N = 6.02*10^26   ;   // Avagadro Number per Kmol
M = 26.98   ;  // Atomic Weight of Al
n = 3*d*N/M  ;  // Number density N/V
Epsilon_f = ((h^2/(8*m))*(3*n/%pi)^(2/3))   ; //
   Fermi Energy in J
disp(Epsilon_f/(1.6*10^(-19)),"Fermi Energy in eV is
    " )
pf = 2*n*Epsilon_f/5  ;  // Fermi Pressure in N/m^2
disp(pf,"Fermi Pressure in N/m^2 is  ")
disp(pf/(10^5),"Fermi Pressure in Atm is  ")
/* Result
 Fermi Energy in eV is

```

```
  11.650063

Fermi Pressure in N/m^2 is

  1.348D+11

Fermi Pressure in Atm is

  1347559
  */
```

Scilab code Exa 14.3 Fermi Energy and Electronic Heat Capacity

```
// Scilab Code for 14.3
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_3.txt")
h = 6.62*10^(-34)  ;  // Plancks constant in J s
m = 9.11*10^(-31)  ;  // Mass of electron in Kg
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
n = 8.5*10^28  ;  // Number density N/V
T = 300 ;  // Temperature un Kelvin
R = 8.314  ;  // gas Constsnt
Epsilon_f = ((h^2/(8*m))*(3*n/%pi)^(2/3))  ; //
   Fermi Energy in J
disp(Epsilon_f/(1.6*10^(-19)),"Fermi Energy in eV is
   " )
Cv = (%pi^2)*Kb*T*R/(2*Epsilon_f);  // Electronic
   Heat Capacity in J K^(-1) mol^(-1)
disp(Cv,"Electronic Heat Capacity in J K^(-1) mol
   ^(-1) is  ")
/* Result
```

```
 Fermi Energy in eV is

   7.0455436

 Electronic Heat Capacity in J K^(-1) mol^(-1) is

   0.1506765
   */
```

Scilab code Exa 14.4 Fermi Momentum Temperature and and Heat Capacity

```
// Scilab Code for 14.4
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_4.txt")
h = 6.62*10^(-34)  ;  // Plancks constant in J s
me = 9.11*10^(-31)  ;  // Mass of electron in Kg
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
T = 100 ;  // Temperature un Kelvin
NA = 6.02*10^26   ;   // Avagadro Number per mol
R = 8.314  ;   // gas Constsnt
Epsilon_f = 18.66*10^(-19)   ; // Fermi Energy in J
Mf = sqrt(2*me*Epsilon_f)  ;  // Fermi Momentum in
   Kg m /s
disp("Fermi Momentum in Kg m /s  is ;",Mf)
disp("Fermi momentum in m/s  is ;",Mf/me)
Tf = Epsilon_f/Kb  ;  // Fermi tempertaure in Kelvin
disp("Fermi tempertaure in Kelvin is  ;",Tf)
disp("Average energy per electron in ev ;",3*
   Epsilon_f/(5*1.6*10^(-19)))
Cv = (%pi^2)*Kb*T*NA/(2*Tf);  // Electronic Heat
```

```
    Capacity in J K^(-1) mol^(-1)
disp("Electronic Heat Capacity in J K^(-1) mol^(-1)
    is  ;",Cv)



/* result

   1.844D-24

 Fermi Momentum in Kg m /s  is ;

   2024005.2

 Fermi momentum in m/s  is ;

   135217.39

 Fermi tempertaure in Kelvin is  ;

   6.9975

 Average energy per electron in ev ;

   30.318853

 Electronic Heat Capacity in J K^(-1) mol^(-1) is  ;

 "Answer varies due to round off error "

   */
```

Scilab code Exa 14.6 Number of Conduction electrons in Lithium

```
// Scilab Code for 14.6
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_6.txt")
h = 6.62*10^(-34)  ;   // Plancks constant in J s
m = 9.31*10^(-31)  ;   // Mass of electron in Kg
Epsilon_f = 4.72*1.6*10^(-19)   ; // Fermi Energy in J
n = (%pi/3)*((8*m*Epsilon_f)/h^2)^(3/2)  ;  // Number of Conduction electrons in Lithium Per m^3
disp(" Number of Conduction electrons in Lithium Per m^3  is ;",n)


/* Result


   4.815D+28

  Number of Conduction electrons in Lithium Per m^3 is ;


  "Answer given in textook is wrong . Used wrong value of mass of electron"
   */
```

Scilab code Exa 14.7 Fermi Energy for Copper

```
// Scilab Code for 14.7
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
```

```
clear;
diary("Ex14_7.txt")
h = 6.62*10^(-34)  ;  // Plancks constant in J s
m = 9.11*10^(-31)  ;  // Mass of electron in Kg
d = 8.94*10^3  ;  // Density of Al in Kg /m^3
N_A = 6.023*10^23   ;   // Avagadro Number per mol
M = 63.57   ;  // Atomic Weight of Al
Epsilon_f = ((h^2/(8*m))*(3*2*N_A*d/(%pi*M))^(2/3))
     ; // Fermi Energy in J
disp("Fermi Energy in eV is ;",Epsilon_f
   /(1.6*10^(-19)))


/* Result

 Fermi Energy in eV is

   0.1115432
   */
```

Scilab code Exa 14.8 Density of Neutron in the beam

```
// Scilab Code for 14.8
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_8.txt")
m = 1.67*10^(27)  ;  // Mass of neutron in Kg
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
T = 300 ;  // Temperature un Kelvin
Flux = 10^12  ;   // Flux in m^2 / s
n = (sqrt(m/(3*Kb*T)))*Flux*exp(-Kb*T) ;  // Density
    of Neutron in per m^3 in the beam
```

```
disp(n,"Density of Neutron in the beam")
/* Result
Density of Neutron in per m^3 in the beam

   3.667D+35
   "Answer given in Textbook is wrong"
   */
```

Scilab code Exa 14.9 Fermi Wavelength Fermi Energy of electron ann Neutron

```
// Scilab Code for 14.9
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_9.txt")
m_e = 9.1*10^(-31)  ;  // Mass of electron in Kg
m_n = 1.67*10^(-27)  ;  // Mass of neutron in Kg
N = 4.2*10^21  ;  // Number of particles
V = 1    ;     // Volume in Cm^3
h = 6.62*10^(-34)  ;  // Plancks constant in J s
eV = 1.6*10^(-19)  ;    //  1 joule is 1.6*10^(-19)
   eV
lamda_F = (10^7)*(8*%pi*V/(3*N))^(1/3)  ;  // Fermi
   Wavelength in nm ( 10^7 is used to convert
   wavelength from cm to nm )
disp(lamda_F,"Fermi Wavelength in nm is  ")
Epsilon_f_electron = (1/(2*m_e))*(h*10^9/lamda_F)^2
    ; // Fermi Energy of electron in J
disp(Epsilon_f_electron,"Fermi Energy of electron in
   J is " )
Epsilon_f_neutron =  (m_e/m_n)*Epsilon_f_electron  ;
   // Fermi Energy of neutron in J
disp(Epsilon_f_neutron,"Fermi Energy of neutron in J
```

```
    is " )
disp(Epsilon_f_neutron/eV,"Fermi Energy of neutron
    in eV is " )
/* Result
Fermi Wavelength in nm is

   1.2587991

 Fermi Energy of electron in J is

   1.520D-19

 Fermi Energy of neutron in J is

   8.281D-23

 Fermi Energy of neutron in eV is

   0.0005175

   "Answer Varies due to round off error"


   */
```

Scilab code Exa 14.10 Density of ejected electron

```
// Scilab Code for 14.10
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_10.txt")
A = 120  ;
```

```
T = 1500 ;    // Temperature in Kelvin
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
phi = 2.5*1.6*10^(-19) ;  //  work function in J
j_th = A*T^2*exp(-phi/(Kb*T))  ;   // Density of
   ejected electron in A/m^2
disp(j_th,"Density of ejected electron in A/m^2 is "
   )
/* Result

 Density of ejected electron in A/m^2 is

   1.0944599      "Answer varies due to roundoff
      error"
   */
```

Scilab code Exa 14.11 `Current Density for Silver`

```
// Scilab Code for 14.11
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_11.txt")
m = 9.1*10^(-31)  ;  // Mass of electron in Kg
e = 1.6*10^(-19)  ;  // Charge of electron in C
T = 300 ;   // Temperature in Kelvin
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
h = 6.62*10^(-34)  ;  // Plancks constant in J sJ
j_0 = (2*%pi^3*m*e*Kb^2*T^2)/(3*h^3)  ;   // Current
    Density in A/m^2
disp(j_0,"Current Density in A/m^2 is ")
/* Result
Current Density in A/m^2 is

```

```
   1.778D+11
   */
```

Scilab code Exa 14.12 Range of Fermi energy

```
// Scilab Code for 14.12
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex14_12.txt")
n1 = 1/(exp(1) + 1) ;    // n1 occupancy number
disp(n1,"n1 is ")
n2 = 1/(exp(-1) + 1) ;    // n2  occupancy number
disp(n2,"n2 is ")
disp(n2-n1,"Range of Fermi energy is ")
/* Result
n1 is

   0.2689414

 n2 is

   0.7310586

 Range of Fermi energy is

   0.4621172
   */
```

Chapter 15

Bose Einstein Statistics

Scilab code Exa 15.1 Average number of photons

```
// Scilab Code for 15.1
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex15_1.txt")
V = 22.4*10^(-3)  ;  // Volume in m^3
T = 273 ;   // Temperature in Kelvin
Kb = 1.38*10^(-23) ;  // Boltzmann Constnt in J/K
h = 6.62*10^(-34)  ;  // Plancks constant in J s
c = 3*10^8  ;   // speed of light in m/s
zeta_3 = 1.162;   // value of standard zeta(3)
N = 16*%pi*V*zeta_3*(Kb*T/(h*c))^3  ;   // Average number of photons
disp(N,"Average number of photons  is ")
/* Result
 Average number of photons  is 

   8.931D+12
   */
```

Scilab code Exa 15.2 Final Pressure of black Body radiation

```
// Scilab Code for 15.2
// OS : "Windows 10" , Scilab : 6.0.2 64-bit
clc;
clear;
diary("Ex15_2.txt")
Vi = 1  ;  // Initial Volume in m^3
Vf = 2  ;   // Final Volume in m^3
pi = 1.49*10^(-2) ;  // Initial Pressure in N/m^2
pf_1 = pi*(Vi/Vf)^(4/3)  ;  // Final Pressure in N/m
    ^2
disp(pf_1,"(a) Final Pressure in N/m^2")
pf_2 = pi*2^(4/3)  ;  // Final Pressure in N/m^2
disp(pf_2,"(b) Final Pressure in N/m^2")
/* Result
 (a) Final Pressure in N/m^2

   0.0059131

 (b) Final Pressure in N/m^2

   0.0375456
   */
```