Scilab Textbook Companion for Heat and Thermodynamics by Brijlal and N. Subrahmanyam[1]

Created by
Mutra Chanakya Reddy
M.tech (Integrated) -Advanced manufacturing
Mechanical Engineering
SASTRA UNIVERSITY
College Teacher
None
Cross-Checked by
K. V. P. Pradeep

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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

Chapter 1

THERMOMETRY

Scilab code Exa 1.1 Temperature

```
clc
clear
//Input data
C=6500;//Temperature of the surface of the sun in degrees centigrade

//Calculations
K=((C/100)*(100))+273;//Temperature of the surface of the sun in Kelvin
R=((C/100)*180)+492;//Temperature of the surface of the sun in degree Rankine

//Output
printf('The temperature of the surface of the sun corresponding to 6500 degrees centigrade is \n\n(1)%3.0f Kelvin and (2)%3.0f degree Rankine',K,R)
```

Scilab code Exa 1.2 Temperature

```
clc
clear
//Input data
C=-183;//The normal boiling point of liquid oxygen
    in degrees centigrade

//Calculations
K=((C/100)*100)+273;//The normal boiling point of
    liquid oxygen in Kelvin
R=((C/100)*180)+492;//The normal boiling point of
    liquid oxygen in degree Rankine

//Output data
printf('The boiling point of liquid oxygen
    corresponding to −183 degree centigrade is \n\n
    (1)%3.0f Kelvin and (2)%3.1f degree Rankine',K,R)
```

Scilab code Exa 1.3 Temperature

```
clc
clear
//Calculations
x=((273*180)-(32*100))/80;//The temperature at which
     Kelvin and Fahrenheit scale coincide in Kelvin
    and degree Fahrenheit

//Output
printf('The temperature at which Kelvin and
    Fahrenheit coincide is %3.2f degree',x)
```

Scilab code Exa 1.4 Temperature

```
clc
```

```
clear
//Calculations
x=(-(32*100))/80;//The temperature at which degree centigrade and Fahrenheit scale coincide in degree centigrade and degree Fahrenheit

//Output
printf('The temperature at which degree centigrade and Fahrenheit coincide is %3.0f degree',x)
```

Scilab code Exa 1.5 Temperature

```
clc
clear
//Input data
K=20.2;//The normal boiling point of liquid hydrogen in Kelvin

//Calculations
R=(((K-273)/100)*180)+492;//The normal boiling point of liquid hydrogen in degree Rankine

//Output data
printf('The boiling point of liquid hydrogen corresponding to 20.2 Kelvin is %3.2f degree Rankine',R)
```

Scilab code Exa 1.6 Temperature

```
clc
clear
//Input data
```

```
V=1000;//Volume of the bulb of the callendar's
    compensated constant pressure air thermometer in
    cm^3
v=100;//Volume of mercury drawn out of the reservoir
     in cm^3

//Calculations
t=((v)/(V-v))*273;//The temperature of the bath in
    degree centigrade

//Output data
printf('The temperature of the bath on the celsius
    scale is %3.2f degree centigrade',t)
```

Scilab code Exa 1.7 Temperature

```
clc
clear
//Input data
Pt=100;//Pressure of air when the bulb is placed in
    hot water in cm of Hg
P100=109.3;//Pressure of air in a constant volume
    thermometer at 100 degree centigrade in cm of Hg
P0=80;//Pressure of air in a constant volume
    thermometer at 0 degree centigrade in cm of Hg

//Calculations
t=((Pt-P0)/(P100-P0))*100;//The temperature of the
    hot water in degree centigrade

//Output data
printf('The temperature of the hot water is %3.2f
    degree centigrade',t)
```

Scilab code Exa 1.8 Temperature

```
clc
clear
//Input data
P0=76;//The pressure in the bulb at 0 degree
   centigrade in cm of Hg
Pt=152+P0;//The excess pressure in the bulb in cm of
    Hg
T0=273;//Temperature in K

//Calculations
T=(Pt/P0)*T0;//The temperature of the furnace in
   Kelvin
T1=T-273;//The temperature of the furnace in degree
   centigrade

//Output data
printf('The temperature of the furnace T = %3.0f
   Kelvin = %3.0f degree centigrade',T,T1)
```

Scilab code Exa 1.9 Temperature

```
clc
clear
//Input data
R0=5;//The resistance of the platinum wire of a
   platinum resistance thermometer at the ice point
   in ohms
R100=5.93;//The resistance of the platinum wire of a
    platinum resistance thermometer at the steam
   point in ohms
```

```
Rt=5.795;//The resistance of the platinum wire when
    both the thermometers are inserted in a hot bath
    in ohms
P0=100;//The pressure at ice point in cm of Hg
P100=136.6;//The pressure at steam point in cm of Hg
Pt=131.11;//The pressure of the gas in cm of Hg

//Calculations
Tp=((Rt-R0)/(R100-R0))*100;//The temperature of the
    bath on the platinum scale in degree centigrade
T=((Pt-P0)/(P100-P0))*100;//The temperature of the
    bath on the gas scale in degree centigrade

//Output data
printf('The temperature of the bath , \n (1)On the
    platinum scale is %3.2f degree centigrade \n (2)
    On the gas scale is %3.0f degree centigrade',Tp,T
    )
```

Scilab code Exa 1.10 Temperature

```
clc
clear
//Input data
t1=50;//Temperature on platinum scale in degree
    centigrade
t11=50.25;//Temperature on gas scale in degree
    centigrade
t2=150;//Temperature on gas scale in degree
    centigrade

//Calculations
g=(t1-t11)/((t1/100)^2-(t1/100));
x=t2-(g*((t2/100)^2-(t2/100)));//The temperature on
    the platinum scale corresponding to 150 degrees
```

```
centigrade on gas scale in degree centigrade

//Output data
printf('The temperature on the platinum scale is %3.2f degree centigrade',x)
```

Scilab code Exa 1.11 Temperature

```
clc
clear
//Input data
R0=5.5;//The resistance of a platinum wire at 0 degree centigrade in ohms
R100=7.5;//The resistance of a platinum wire at 100 degree centigrade in ohms
R444=14.5;//The resistance of a platinum wire at 444.5 degree centigrade in ohms

//Calculations
b=((900-(2*444.6))/(5.5*444.6*100*344.6));//The value of beta in per degree centigrade square
a=(2/(5.5*100))-(100*(b));//The value of alpha in per degree centigrade

//Output
printf('The values are b = %3.4g /degree centigrade square \n    and a = %3g /degree centigrade ',b,a)
```

Chapter 2

EXPANSION

Scilab code Exa 2.1 Expansion

```
clc
clear
//Input data
l=1;//The thickness of the crystal in cm
w=5890d-8;//The wavelength of light used in cm
t2=50;//The final temperature of the crystal in degree centigrade
t1=20;//The initial temperature of the crystal in degree centigrade
p=14;//The number of fringes that crossed the field of view

//Calculations
t=t2-t1;//The temperature difference in degree centigrade
a=(p*w)/(2*l*t);//The coefficient of linear expansion of the crystal in per degree centigrade

//output
printf('The coefficient of linear expansion of the crystal is %3.4g /degree centigrade',a)
```

Scilab code Exa 2.2 Stress

```
clc
clear
//Input data
L=500;//The length of a steel rod in cm
t=40;//The increase in temperature in degree
    centigrade
y=2*10^12;//The youngs modulus of elasticity of
    steel in dynes/cm^2
e=12*10^-6;//The coefficient of linear expansion of
    steel in per degree centigrade

//Calculations
S=y*e*t;//The stress in the rod in dynes/cm^2

//Output
printf('The stress in the rod is %3g dynes/cm^2',S)
```

Scilab code Exa 2.3 Tension

```
clc
clear
//Input data
L=800;//The length of the wire in cm
r=0.2;//The radius of the wire in cm
t=10;//The temperature fall in degree centigrade
a=12*10^-6;//The coefficient of linear expansion of
    steel wire in per degree centigrade
y=2*10^12;//The youngs modulus of elasticity of
    steel in dynes/cm^2
```

```
pi=(22/7);//Mathematical constant pi

//Calculations
I=y*a*t*pi*r^2;//The increase in tension in dynes

//Output
printf('The increase in tension is %3g dynes',I)
```

Scilab code Exa 2.4 Energy

```
clc
clear
//Input data
A=2*10^-6;//The cross section area of a uniform rod
    in m^2
t=20;//The change in temperature in degree
    centigrade
y=10^11;//The youngs modulus of the rod in newtons/m
    ^2
a=12*10^-6;//The coefficient of linear expansion of
    rod in per degree centigrade

//Calculations
F=y*a*t*A;//The force required to prevent it from
    expanding in newtons
E=(1/2)*y*a*t*a*t;//The energy stored per unit
    volume in j/m^3

//Output
printf('The force required to prevent the rod from
    expanding is %3.0f newtons \n The Energy stored
    per unit volume is %3.0f j/m^3',F,E)
```

Scilab code Exa 2.5 Force

```
clc
clear
//Input data
d=10^-3;//The diameter of a steel wire in m
t=20;//The difference in the temperature in degree
    centigrade
y=2*10^11;//The youngs modulus of a steel wire in
    newtons/m^2
a=12*10^-6;//The coefficient of linear expansion of
    steel wire in per degree centigrade
pi=(22/7);//Mathematical constant value

//calculations
A=(pi*d^2)/4;//The cross sectional area of the steel
     wire in m^2
F=(y*a*t*A)/(9.8);//Force required to maintain the
    original length in kg wt

//output
printf('Force required to maintain the original
    length is %3.3f kg wt ',F)
```

Chapter 3

CALORIMETRY

Scilab code Exa 3.1 Time

```
clc
clear
//Input data
T=5;//Time taken for a liquid to cool from 80 to 50
   degree centigrade in minutes
t11=80;//The initial temperature of the liquid in
   degree centigrade
t12=50;//The final temperature of the liquid in
   degree centigrade
t21=60;//If the initial temperature of the liquid in
    degree centigrade
t22=30;//If the final temperature of the liquid in
   degree centigrade
ts=20;//The temperature of the surrounding in degree
    centigrade

//Calculations
T1=((log((t22-ts)/(t21-ts)))/(log((t12-ts)/(t11-ts))
   ))*T;//The time taken for the liquid to cool from
    60 to 30 degree centigrade in minutes

```

```
//Output
printf('The time taken for a liquid to cool from 60
    to 30 degree centigrade is t = %3.0f minutes ',T1
    )
```

Scilab code Exa 3.2 Thermal capacity

```
clc
clear
//Input data
dw=1;//The density of water in g/cm^3
da=0.8;//The density of alcohol in g/cm^3
t1=100;//The time taken for the water to cool from
    50 to 40 degree centigrade in seconds
t2=74;//The time taken for the alcohol to cool from
    50 to 40 degree centigrade in seconds
V=1;//Let the volume of either liquid be in cm^3

//Calculations
m=V*dw;//The mass of water in g
M=V*da;//The mass of alcohol in g
w=V;//Water equivalent of each calorimeter in cm^3
C=((((m+w)*t2)/(M*t1))-(w/M));//The specific heat of
     alcohol in calorie/g-K

//Output
printf('The specific heat of alcohol is C = %3.1f
    calorie/g-K',C)
```

Scilab code Exa 3.3 Temperature

```
clc
clear
```

```
//Input data
t=5;//Time taken for a body to cool from 60 to 40 degree centigrade in minutes
t11=60;//The initial temperature of the body in degree centigrade
t12=40;//The final temperature of the body in degree centigrade
ts=10;//The temperature of the surrounding in degree centigrade

//Calculations
K=log((t12-ts)/(t11-ts));//The constant value for the first case at ts
x=((exp(K))*(t12-ts))+ts;//The temperature after the next 5 minutes in degree centigrade

//Output
printf('The temperature after the next 5 minutes is x = %3.0f degree centigrade ',x)
```

Scilab code Exa 3.4 Time

```
clc
clear
//Input data
T=4;//Time taken for a liquid to cool from 70 to 50 degree centigrade in minutes
t11=70;//The initial temperature of the liquid in degree centigrade
t12=50;//The final temperature of the liquid in degree centigrade
t21=50;//If the initial temperature of the liquid in degree centigrade
t22=40;//If the final temperature of the liquid in degree centigrade
```

```
ts=25;//The temperature of the surrounding in degree
     centigrade

//Calculations
T1=((log((t22-ts)/(t21-ts)))/(log((t12-ts)/(t11-ts))
   ))*T;//The time taken for the liquid to cool from
     50 to 40 degree centigrade in minutes

//Output
printf('The time taken for a liquid to cool from 50
   to 40 degree centigrade is t = %3.3f minutes ',T1
   )
```

Scilab code Exa 3.5 Temperature

```
clc
clear
//Input data
t=6;//Time taken for a liquid to cool from 80 to 60
   degree centigrade in minutes
T=10;//To find the temperature after the time in
   minutes
t11=80;//The initial temperature of the liquid in
   degree centigrade
t12=60;//The final temperature of the liquid in
   degree centigrade
ts=30;//The temperature of the surrounding in degree
     centigrade

//Calculations
K=(log((t12-ts)/(t11-ts)))/(-t);//The constant value
     for the first case at ts
x=((exp(-T*K))*(t12-ts))+ts;//The temperature after
   the next 10 minutes in degree centigrade

```

```
//Output
printf('The temperature after the next 10 minutes is x = %3.2f degree centigrade ',x)
```

Scilab code Exa 3.6 Temperature

```
clc
clear
//Input data
t=5;//The time taken for a body to cool from 80 to 64 degree centigrade in minutes
t11=80;//The initial temperature of the body in degree centigrade
t12=64;//The final temperature of the body in degree centigrade
t21=52;//The temperature of the body after 10 minutes in degree centigrade
T=10;//The time taken for a body to cool from 80 to 52 degree centigrade in minutes
T1=15;//To find the temperature after the time in minutes

//Calculations
ts=((t21*t11)-(t12^2))/(t11+t21-(2*t12));//The temperature of the surroundings in degree centigrade
K=(log((t21-ts)/(t12-ts)));//The constant value for the first case at ts
x=((exp(K))*(t21-ts))+ts;//The temperature after the next 15 minutes in degree centigrade

//Output
printf('(1)The temperature of the surroundings is %3.0f degree centigrade \n (2)The temperature after the 15 minutes is %3.0f degree centigrade ',ts,x
```

```
)
```

Scilab code Exa 3.7 Thermal constant

```
clc
clear
//Input data
t2=2;//The time taken for the liquid to cool from 50
    to 40 degree centigrade in minutes
t11=50;//The initial temperature of the liquid in
   degree centigrade
t12=40;//The final temperature of the liquid in
   degree centigrade
t1=5;//The time taken for the water to cool from 50
   to 40 degree centigrade in minutes
m=100;//The mass of water in gms
M=85;//The mass of liquid in gms
w=10;//Water equivalent of the vessel in gms

//Calculations
C=(((m+w)*(t2*60))/(M*(t1*60)))-(w/M);//The specific
    heat of a liquid in calories/g-K

//Output
printf('The specific heat of a liquid is C = %3.1f
   calories/g-K',C)
```

Scilab code Exa 3.8 Gas constant

```
clc
clear
//Input data
```

```
V=22400;//The volume of One gram molecule of a gas
    at N.T.P in cm^3
p=76;//The pressure in cm of Hg
T=273;//The temperature in K

//Calculations
P=p*13.6*981;//The pressure in dynes/cm^2
R=(P*V)/T;//The universal gas constant for one gram
    molecule of a gas in ergs/mole-K

//Output
printf('The universal gas constant for one gram
    molecule of a gas is R = %3.4g ergs/mole-K',R)
```

Scilab code Exa 3.9 Specific heat

```
clc
clear
//Input data
Cp=0.23;//Specific heat of air at constant pressure
J=4.2*10^7;//The amount of energy in ergs/cal
d=1.293;//The density of air at N.T.P in g/litre
p=76;//The pressure in cm of Hg
T=273;//The temperature in K

//Calculations
P=p*13.6*980;//The pressure in dynes/cm^2
V=(1000/d);//Volume of one gram of air at N.T.P in
    cm^3
r=(P*V)/T;//The gas constant for one gram of a gas
    in ergs/g-K
Cv=Cp-(r/J);//Specific heat of air at constant
    volume

//Output
```

```
printf('The specific heat of air at constant volume
    is Cv = %3.4f ',Cv)
```

Scilab code Exa 3.10 Specific heat

```
clc
clear
//Input data
w=4;//The Molecular weight of helium
v=22400;//The volume of one gram molecule of a gas
    at N.T.P in cm^3
p=76;//The pressure in cm of Hg
T=273;//The temperature in K
J=4.2*10^7;//The amount of energy in ergs/cal

//Calculations
V=(v/w);//The volume of one gram of helium at N.T.P
    in cm^3
P=p*13.6*980;//The pressure in dynes/cm^2
r=(P*V)/T;//The gas constant for one gram of a gas
    in ergs/g-K
C=r/J;//The difference in the two specific heats of
    one gram of helium

//Output
printf('The difference in the two specific heats of
    one gram of helium is Cp-Cv = %3.4f',C)
```

Scilab code Exa 3.11 Efficiency

```
clc
clear
//Input data
```

```
V=25;//Volume of gasoline consumed by an engine in litres/hour
cv=6*10^6;//The calorific value of gasoline in calories/litre
P=35;//The output of the engine in kilowatts

//Calculations
h=V*cv;//Total heat produced by gasoline in one hour in calories
H=h/3600;//Heat produced per second in cal/s
I=H*4.2;//Heat produced per second in joules/s or watts
E=((P*1000)/I)*100;//The efficiency in percent

//Output
printf('The efficiency of the engine is %3.0f percent ',E)
```

Chapter 4

CHANGE OF STATE

Scilab code Exa 4.1 Heat required

```
clc
clear
//Input data
m=1000;//Mass of Ice in gms
Sp=0.5;//Specific heat of Ice in cal/g-K
t1=-10;//Initial temperature of Ice in degree
    centigrade
t2=0;//The final temperature of Ice in degree
    centigrade
Li=80;//Latent heat of fusion of ice in cals per
    gram
Ls=540;//Latent heat of fusion of steam in cals per
    gram

//Calculations
h1=m*-t1*Sp;//Heat required to raise the temperature
     of Ice in cals
h2=m*Li;//Heat required to melt ice at 0 degree
    centigrade in cals
h3=m*100;//Heat required to raise the temperature of
     water from 0 to 100 degree centigrade in cals
```

```
h4=m*Ls;//Heat required to convert water into steam at 100 degree centigrade in cals
T=h1+h2+h3+h4;//Total quantity of heat required in cals

//Output
printf('Total quantity of heat required is %3.0f cals ',T)
```

Scilab code Exa 4.2 Amount of ice

```
clc
clear
//Input data
m=1;//Mass of steam in gms
Ls=537;//Latent heat of fusion of steam in cal per gram
mi=100;//mass of ice in gms
Li=80;//Latent heat of fusion of ice in cal per gram

//Calculations
h1=m*Ls;//Heat given out by one gram of steam when converted from steam into water at 100 degree centigrade in cals
h2=1*100;//Heat given out by one gram of water when cooled from 100 to 0 degree centigrade in cals
h=h1+h2;//Total quantity of heat given out by one gram of steam in cals
m=h/Li;//The amount of Ice melted in gms

//Output
printf('The amount of Ice melted is m = %3.2f gms ',m)
```

Scilab code Exa 4.3 Ice

```
clc
clear
//Input data
m=100;//Mass of water in gms
tw=40;//The temperature of water in degree
    centigrade
mi=52;//Mass of Ice in gms
Lw=100;//Latent heat of fusion of water in cals per
    gram
Li=80;//Latent heat of fusion of Ice in cals per
    gram

//Calculations
h=Lw*tw;//Heat lost by water when its temperature
    falls from 40 to 0 degree centigrade in cals
hi=mi*Li;//Heat gained by Ice in cals
hg=h;//The amount of heat gained by Ice in cals
ml=(hg/Li);//The amount of Ice melted in gms
M=mi-ml;//The amount of ice remaining in gms
W=m+(mi-M);//The amount of water in gms

//Output
printf('The remaining Ice is %3.0f g \n Hence the
    result will be %3.0f g of Ice and %3.0f g of
    water at 0 degree centigrade ',M,M,W)
```

Scilab code Exa 4.4 Latent heat

```
clc
clear
```

```
//Input data
m=100;//Let the mass of water in gms
t=15;//Time taken for an electric kettle to heat a
    certain quantity of water from 0 to 100 degree
    centigrade in minutes
T=80;//Time taken to turn all the water at 100
    degree centigrade into steam in minutes
Lw=100;//Latent heat of fusion of water in cals per
    gram

//Calculations
h1=m*Lw;//Heat required to raise its temperature
    from 0 to 100 degree centigrade in cals
h2=h1;//Heat produced by electric kettle in 15
    minutes in cals
h3=h2/15;//Heat produced by electric kettle in 1
    minute in cals
h4=h3*80;//Heat produced by electric kettle in 80
    minutes in cals
L=h4/m;//Latent heat of steam in cal/g

//Output
printf('The latent heat of steam is L = %3.2f cal/g
    ',L)
```

Scilab code Exa 4.5 Heat removed

```
clc
clear
//Input data
m=50;//Mass of water in gms
t1=15;//Initial temperature in degree centigrade
t2=-20;//Final temperature in degree centigrade
Sp=0.5;//Specific heat of Ice in cal/g-K
Li=80;//Latent heat of fusion of Ice in cals per
```

```
    gram

//Calculations
h1=m*1*t1;//Heat removed in cooling water from 15 to
     0 degree centigrade in cal
h2=m*Li;//Heat removed in converting water into Ice
    at 0 degree centigrade in cal
h3=m*Sp*-t2;//Heat removed in cooling ice from 0 to
    -20 degree centigrade in cal
H=h1+h2+h3;//Total heat removed in one hour in cal
H1=H/60;//Heat removed per minute in cal/minute

//Output
printf('The Quantity of heat removed per minute is
    %3.1f cal/minute ',H1)
```

Scilab code Exa 4.6 Specific heat

```
clc
clear
//Input data
M=20;//Mass of the substance in g
t=100;//The temperature of the substance in degree
    centigrade
a=1/100;//Area of cross section in cm^2
l=5;//The length of the coloumn through which liquid
     moves in cm
V1=1000;//The volume of water in cm^3
V2=1090;//The volume of Ice from the volume of water
     on freezing in cm^3
Li=80;//Latent heat of Ice in cals per gram

//Calculations
V=V2-V1;//The decrease in volume of Ice in cm^3
Vi=V/1000;//The decrease in volume when one gram of
```

```
   ice melts in cm^3
v=l*a;//Decrease in volume in cm^3
S=(Li*v)/(Vi*M*t);//Specific heat of the substance
   incal/g degree centigrade

//Output
printf('The specific heat of the substance is %3.3f
   cal/g.degree centigrade ',S)
```

Scilab code Exa 4.7 Specific heat

```
clc
clear
//Input data
M=27;//The mass of the substance in g
t=100;//The temperature of the substance in degree
   centigrade
a=3/100;//Area of cross section in cm^2
l=10;//The length of the coloumn through which
   liquid moves in cm
Li=80;//Latent heat of Ice in cals per gram
V1=1000;//The volume of water in cm^3
V2=1090;//The volume of Ice from the volume of water
    on freezing in cm^3

//Calculations
v=l*a;//Decrease in volume in cm^3
V=V2-V1;//The decrease in volume of Ice in cm^3
Vi=V/1000;//The decrease in volume when one gram of
   ice melts in cm^3
S=(Li*v)/(Vi*M*t);//Specific heat of the substance
   incal/g degree centigrade

//Output
printf('The specific heat of the substance is %3.3f
```

```
cal/g.degree centigrade ',S)
```

Scilab code Exa 4.8 Relative humidity

```
clc
clear
//Input data
t=16.5;//The temperature of air in degree centigrade
d=6.5;//The dew point in degree centigrade
s1=7.05;//S.V.P at 6 degree centigrade in mm
s2=7.51;//S.V.P at 7 degree centigrade in mm
s3=13.62;//S.V.P at 16 degree centigrade in mm
s4=14.42;//S.V.P at 17 degree centigrade in mm

//Calculations
s5=(s1+s2)/2;//S.V.P at 6.5 degree centigrade in mm
s6=(s3+s4)/2;//S.V.P at 16.5 degree centigrade in mm
R=(s5/s6)*100;//Relative humidity of air in percent

//Output
printf('The percentage relative humidity of air is R
    .H = %3.1f percent ',R)
```

Scilab code Exa 4.9 Dew point

```
clc
clear
//Input data
R=52;//The relative humidity of air in percent
t=20;//The temperature of air in degree centigrade
s1=17.5;//S.V.P of water at 20 degree centigrade in
   mm
```

```
s2=9.2;//S.V.P of water at 10 degree centigrade in
   mm
s3=8.6;//S.V.P of water at 9 degree centigrade in mm

//Calculations
s4=(R/100)*s1;//S.V.P at dew point in mm
s5=s2-s3;//S.V.P for 1 degree centigrade difference
    in mm
d=9+((s4-s3)/(s2-s3));//The dew point temperature in
     degree centigrade

//Output
printf('The dew point temperature is %3.2f degree
    centigrade ',d)
```

Chapter 5

NATURE OF HEAT

Scilab code Exa 5.1 Temperature

```
clc
clear
//Input data
v=480;//The velocity of a lead bullet in m/s
Sp=0.03;//Specific heat of lead cal/g-K

//Calculations
m=10;//Let us assume the mass of bullet in gms
V=v*100;//The velocity of the bullet in cm/s
W=(1/2)*m*(V^2);//The work done in ergs
J=4.2*10^7;//The mechanical equivalent of heat in ergs/calorie
H=W/J;//The amount of heat produced in cals
H1=H/2;//Half of the heat energy is used to raise the temperature of the bullet in cals
t=H1/(m*Sp);//The rise in the temperature in degree centigrade

//Output
printf('The rise in the temperature is t = %3.2f degree centigrade ',t)
```

Scilab code Exa 5.2 Energy

```
clc
clear
//Input data
t=1;//The increase in the temperature of a piece of aluminium in degree centigrade
a=6*10^23;//The number of atoms present in 27 g of aluminium in atoms
Sp=0.22;//The specific heat of aluminium in cal/g-K
m=27;//The amount of aluminium in g
J=4.2*10^7;//The mechanical equivalent of heat in ergs/calorie

//Calculations
H=m*Sp*t;//Heat required to raise the temperature of 27 gms of aluminium by 1 degree centigrade in cals
E=m*Sp*J;//Energy gained by atoms of aluminium in ergs
E1=E/a;//Increase in energy per atom of aluminium in ergs

//Output
printf('The increase in energy per atom of aluminium is %3.4g ergs ',E1)
```

Scilab code Exa 5.3 Temperature

```
clc
clear
```

```
//Input data
h=50;//The height from which water falls in metres
m=100;//Let us assume the mass of the water in gms
g=980;//Gravitational constant in gms/s^2
J=4.2*10^7;//The mechanical equivalent of heat in ergs/calorie

//Calculations
h1=h*100;//The height from which water falls in cm
W=m*g*h1;//The work done in ergs
t=W/(J*m);//The rise in temperature of water in degree centigrade

//Output
printf('The rise in temperature of water is t = %3.3f degree centigrade ',t)
```

Scilab code Exa 5.4 Molecules

```
clc
clear
//Input data
v=1;//The volume of oxygen at N.T.P in cm^3
d=13.6;//The density of mercury in g/cm^3
r=4.62*10^4;//The R.M.S velocity of oxygen molecules at 0 degree centigrade in cm/s
m=52.8*10^-24;//Mass of one molecule of oxygen in g
g=980;//Gravitational constant in gms/s^2

//Calculations
P=76*g*d;//The pressure in dynes/cm^2
n=((3*P)/(m*r^2));//Number of molecules in 1 cc of oxygen at N.T.P

//Output
```

```
printf('The number of molecules in 1 c.c of oxygen
    at N.T.P is n = %3.4g ',n)
```

Scilab code Exa 5.5 Temperature

```
clc
clear
//Input data
t=-100;//The given temperature in degree centigrade

//Calculations
T1=t+273;//The given temperature in K
m1=1;//number of hydrogen molecules
m2=16;//number of oxygen molecules
m=m2/m1;//Number of oxygen molecules to the hydrogen
    molecules
T2=(T1*m)-273;//The temperature in degree centigrade

//Output
printf('The temperature at which the oxygen
    molecules have the same root mean square velocity
    \n as that of hydrogen molecules is T2 = %3.0f
    degree centigrade ',T2)
```

Scilab code Exa 5.6 Velocity

```
clc
clear
//Input data
t=27;//The given temperature in degree centigrade
d=13.6;//The density of mercury in g/cm^3
g=980;//Gravitational constant in gms/s^2
m1=16;//number of oxygen molecules
```

```
D=0.000089;//The density of hydrogen at N.T.P in g/
   cc
T=273;//The temperature at N.T.P in K

//Calculations
P=76*g*d;//The pressure in dynes/cm^2
p=m1*D;//The density of oxygen at N.T.P in g/cc
C=((3*P)/(p))^(1/2);//The RMS velocity of oxygen
   molecule in cm/s
T1=t+T;//The given temperature in K
C1=C*(T1/T)^(1/2);//The RMS velocity of the
   molecules at 27 degree centigrade in cm/s

//Output
printf('The RMS velocity of the oxygen molecules at
   27 degree centigrade is C1 = %3.4g cm/s ',C1)
```

Scilab code Exa 5.7 Volume

```
clc
clear
//Input data
d=13.6;//The density of mercury in g/cm^3
g=980;//Gravitational constant in gms/s^2
m=3.2;//Mass of oxygen in gms
t=27;//The given temperature in degree centigrade
p=76;//The pressure in cm of Hg
R=8.31*10^7;//The Universal gas constant in ergs/g
   mol-K

//Calculations
P=p*g*d;//The given pressure in dynes/cm^2
T=t+273;//The given temperature in K
V=(T*R)/P;//Volume per g mol of oxygen in cc per g
   mol
```

```
m1=32;//Molecular weight of Oxygen
V1=V*(m/m1);//Volume of 3.2 g of oxygen in cc

//Output
printf('The Volume occupied by 3.2 gms of Oxygen is
    V = %3.0f cc ',V1)
```

Scilab code Exa 5.9 Molecules

```
clc
clear
//Input data
v=1;//The volume of an Ideal gas at N.T.P in m^3
d=13.6;//The density of mercury in g/cm^3
g=980;//Gravitational constant in gms/s^2
p=76;//The pressure in cm of Hg
R=8.31*10^7;//The Universal gas constant in ergs/g
    mol-K
N=6.023*10^23;//The Avogadro number
T=273;//The temperature at N.T.P in K

//Calculations
P=p*g*d;//The given pressure in dynes/cm^2
x=(P*N*10^6)/(R*T);//Number of molecules in one
    cubic metre volume

//Output
printf('The number of molecules in one cubic metre
    of an ideal gas at N.T.P is x = %3.4g ',x)
```

Scilab code Exa 5.10 Molecules

```
clc
```

```
clear
//Input data
v=1;//The volume of an ideal gas in litre
d=13.6;//The density of mercury in g/cm^3
g=980;//Gravitational constant in gms/s^2
p=76;//The pressure in cm of Hg
R=8.31*10^7;//The Universal gas constant in ergs/g
    mol-K
N=6.023*10^23;//The Avogadro number
T=273;//The temperature at N.T.P in K
t=136.5;//The given temperature in degree centigrade
p1=3;//The given atmospheric pressure in atm
    pressure

//Calculations
T1=T+t;//The given temperature in K
P=p*g*d;//The given pressure in dynes/cm^2
x=(p1*P*N*10^3)/(R*T1);//Number of molecules in one
    litre volume

//Output
printf('The number of molecules in one litre of an
    ideal gas volume is x = %3.4g ',x)
```

Scilab code Exa 5.11 Molecules

```
clc
clear
//Input data
v=1;//The volume of a gas in cc
d=13.6;//The density of mercury in g/cm^3
p2=10^-7;//The pressure in cm of Hg
g=980;//Gravitational constant in gms/s^2
p1=76;//The pressure in cm of Hg
R=8.31*10^7;//The Universal gas constant in ergs/g
```

```
    mol-K
N=6.023*10^23;//The Avogadro number
T=273;//The temperature at N.T.P in K
n1=2.7*10^19;//The number of molecules per cc of gas
    at N.T.P
t2=0;//The given temperature in degree centigrade
t3=39;//The given temperature in degree centigrade

//Calculations
P1=p1*g*d;//The given pressure in dynes/cm^2
P2=p2*g*d;//The given pressure in dynes/cm^2
n2=n1*(P2/P1);//The number of molecules per cc of
    the gas at 0 degree centigrade
T2=t2+273;//The given temperature in K
T3=t3+273;//The given temperature in K
n3=n2*(T2/T3);//The number of molecules per cc of
    the gas at 398 degree centigrade

//Output
printf('The number of molecules per cc of the gas ,
    \n (1)at 0 degree centigrade and 10^-6 mm
    pressure of mercury is n2 = %3.4g \n (2)at 39
    degree centigrade and 10^-6 mm pressure of
    mercury is n3 = %3.4g',n2,n3)
```

Scilab code Exa 5.12 Kinetic energy

```
clc
clear
//Input data
T=300;//The given temperature in K
R=8.3*10^7;//The Universal gas constant in ergs/g
    mol-K

//Calculations
```

```
E=((3/2)*(R*T))/10^7;//The total random kinetic
   energy per gram -molecule of oxygen in joules

//Output
printf('The total random kinetic energy of one gm-
   molecule of oxygen at 300 K is K.E = %3.0f joules
   ',E)
```

Scilab code Exa 5.13 Kinetic energy

```
clc
clear
//Input data
T=300;//The given temperature in K
k=1.38*10^-16;//Boltzmann constant in erg/molecule-
   deg

//Calculations
E=(3/2)*k*T;//The average Kinetic energy of a
   molecule in ergs

//Output
printf('The Average Kinetic energy of a molecule of
   a gas at 300 K is K.E = %3.4g ergs ',E)
```

Scilab code Exa 5.14 Kinetic energy

```
clc
clear
//Input data
R=8.32;//Universal gas constant in joules/mole-K
t=727;//The given temperature in degree centigrade
N=6.06*10^23;//The Avogadro number
```

```

//Calculations
T=273+t;//The given temperature in K
k=R/N;//Boltzmann constant in joules/mol-K
E=(3/2)*k*T;//Mean translational kinetic energy per molecule in joules

//Output
printf('The mean translational kinetic energy per molecule is K.E = %3.4g joule ',E)
```

Scilab code Exa 5.15 Kinetic energy

```
clc
clear
//Input data
T=300;//The given temperature in K
M=28;//Molecular weight of nitrogen in g
R=8.3*10^7;//The Universal gas constant in ergs/g mol-K

//Calculations
E=(3/2)*R*T;//The total random kinetic energy of nitrogen in ergs
E1=E/(M*10^7);//The total random kinetic energy of one gram of nitrogen at 300 K in joule

//Output
printf('The total random kinetic energy of one gram of nitrogen at 300 K is K.E = %3.1f joule ',E1)
```

Scilab code Exa 5.16 Kinetic energy

```
clc
clear
//Input data
T=200;//The given temperature in K
m=2;//Given mass of Helium in g
M=4;//Molecular weight of helium in g
R=8.3*10^7;//The Universal gas constant in ergs/g
   mol-K

//Calculations
E=(m*(3/2)*(R*T)/(M))/10^7;//The energy for 2 g of
   helium in joules

//Output
printf('The total random kinetic energy of 2 g of
   helium at 200 K is K.E = %3.0f joules',E)
```

Scilab code Exa 5.17 Velocity

```
clc
clear
//Input data
T=300;//The given temperature in K
R=8.3*10^7;//The Universal gas constant in ergs/g
   mol-K
M=221;//The molecular weight of mercury

//Calculations
C=((3*R*T)/(M))^(1/2);//The root mean square
   velocity of a molecule of mercury vapour at 300 K
    in cm/s

//Output
printf('The root mean square velocity of a molecule
   of mercury vapour at 300 K is C = %3.4g cm/s ',C)
```

Scilab code Exa 5.18 Speed

```
clc
clear
//Input data
T=300;//The given temperature in K
M=32;//Molecular weight of oxygen
R=8.3*10^7;//The Universal gas constant in ergs/g
    mol-K

//Calculations
E=(3/2)*R*T;//Total random kinetic energy of 1 g
    molecule of oxygen in ergs
v=((E)*(2/M))^(1/2);//The required speed of one gram
     molecule of oxygen in cm/s

//Output
printf('The required speed of one gram molecule of
    oxygen is v = %3.2g cm/s ',v)
```

Scilab code Exa 5.19 Temperature

```
clc
clear
//Input data
v=8;//The speed of the earths first satellite in km/
    s
R=8.3*10^7;//The Universal gas constant in ergs/g
    mol-K
M=2;//Molecular weight of hydrogen

```

```
//Calculations
V=v*10^5;//The speed of the earths first satellite
   in cm/s
T=(M*V^2)/(3*R);//The temperature at which it
   becomes equal in K

//Output
printf('The temperature at which the r.m.s velocity
   of a hydrogen molecule \n will be equal to the
   speed of earths first satellite is T = %3.4g K',T
   )
```

Scilab code Exa 5.20 Temperature

```
clc
clear
//Input data
t1=0;//The given temperature in degree centigrade

//Calculations
T1=t1+273;//The given temperature in K
T2=(1/2)^2*T1;//The temperature at which the r.m.s
   velocity of a gas be half its value at 0 degree
   centigrade in K
T21=T2-273;//The required temperature in degree
   centigrade

//Output
printf('The required temperature is  T2 = %3.2f K  (
   or) %3.2f degree centigrade ',T2,T21)
```

Scilab code Exa 5.21 Mean free path

```
clc
clear
//Input data
n=1.66*10^-4;//The viscosity of the gas in dynes/cm^2
C=4.5*10^4;//The R.M.S velocity of the molecules in cm/s
d=1.25*10^-3;//The density of the gas in g/cc
N=6.023*10^23;//The Avogadro number
V=22400;//The volume of a gas at N.T.P in cc
pi=3.142;//The mathematical constant of pi

//Calculations
L=(3*n)/(d*C);//The mean free path of the molecules of the gas in cm
F=(C/L);//The frequency collision in per sec
n=N/V;//Number of molecules per cc
D=1/((1.414*pi*n*L)^(1/2));//Molecular diameter of the gas molecules in cm

//Output
printf('(1)The mean free path of the molecules of the gas is %3.0g cm \n (2)The frequency of collision is N = %3.0g /sec \n (3)Molecular diameter of the gas molecules is d = %3.0g cm ',L,F,D)
```

Scilab code Exa 5.22 Mean free path

```
clc
clear
//Input data
n=2.25*10^-4;//The viscosity of the gas in dynes/cm^2
C=4.5*10^4;//The RMS velocity of the molecules in cm
```

```
    /s
d=10^-3;//The density of the gas in g/cc

//Calculations
L=(3*n)/(d*C);//The mean free path of the molecules
    in cm

//Output
printf('The mean free path of the molecules is %3g
    cm ',L)
```

Scilab code Exa 5.23 Mean free path

```
clc
clear
//Input data
d=2*10^-8;//The molecular diameter in cm
n=3*10^19;//The number of molecules per cc
pi=3.14;//Mathematical constant of pi

//Calculations
L=1/((pi*(d)^2*n));//The mean free path of a gas
    molecule in cm

//Output
printf('The mean free path of a gas molecule is %3.0
    g cm ',L)
```

Scilab code Exa 5.24 Mean free path

```
clc
clear
//Input data
```

```
p=760;//The given pressure in mm of Hg
T=273;//The temperature of the chamber in K
V=22400;//The volume of the gas at N.T.P in cc
p1=10^-6;//The pressure in the chamber in mm of mercury pressure
N=6.023*10^23;//The Avogadro number
d=2*10^-8;//Molecular diameter in cm
pi=3.14;//Mathematical constant of pi

//Calculations
n=(N*p1)/(V*p);//The number of molecules per cm^3 in the chamber in molecules/cm^3
L=1/(pi*(d)^2*n);//The mean free path of the gas molecules in the chamber in cm

//Output
printf('The mean free path of gas molecules in a chamber is %3.4g cm ',L)
```

Scilab code Exa 5.25 Van der Waals

```
clc
clear
//Input data
Tc=132;//The given temperature in K
Pc=37.2;//The given pressure in atms
R=82.07;//Universal gas constant in cm^3 atoms K^-1

//Calculations
a=(27/64)*((R)^2*(Tc)^2)/Pc;//Vander Waals constant in atoms cm^6
b=((R*Tc)/(8*Pc));//Vander Waals constant in cm^3

//Output
printf('The Van der Waals constants are , \n (1) a =
```

```
%3.4g atoms cm^6 \n (2) b = %3.2f cm^3 ',a,b)
```

Chapter 6

THERMODYNAMICS

Scilab code Exa 6.1 Heat

```
clc
clear
//Input data
H=80;//The Heat flows into the system in joules
W=30;//The Work done by the system in joules

//Calculations
U=H-W;//The internal energy of the system in joules
W1=10;//The work done along the path ADB in joules
H1=W1+U;//The heat flows into the system along the
    path ADB in joules
W2=-20;//The work done on the system from B to A in
    joules
H2=W2-U;//The heat liberated from B to A in joules
Ua=0;//Internal energy at A in joules
Ud=40;//Internal energy at D in joules
Wa=10;//Work done from A to D in joules
Wd=0;//Work done from D to B in joules
Uc=50;//Internal energy at C in joules
Had=(Ud-Ua)+Wa;//Heat absorbed in the process AD in
    joules
```

```
Hdb=Uc-Ud+Wd;//Heat absorbed in the process DB in
    joules

//Output
printf('(a)Heat flows into the system along the path
     ADB is H = %3.0f joules \n (b)The heat liberated
     by the system is H = %3.0f joules \n (c)The heat
     absorbed in the process AD is H = %3.0f joules
      and \n The heat absorbed in the process DB is
    H = %3.0f joules ',H1,H2,Had,Hdb)
```

Scilab code Exa 6.2 Temperature

```
clc
clear
//Input data
p=2;//Given Pressure of a motor car tyre in atms
t=27;//The room temperature in degree centigrade
g=1.4;//Adiabatic index

//Calculations
P1=p;//The pressure of a motor car tyre in atms
T1=t+273;//The room temperature in K
P2=1;//The surrounding pressure in atms
T2=((P2/P1)^((g-1)/g))*T1;//The resulting
    temperature in K
T21=T2-273;//The resulting temperature in degree
    centigrade

//Output
printf('The resulting temperature is T2 = %3.1f K (
    or) %3.1f degree centigrade ',T2,T21)
```

Scilab code Exa 6.3 Temperature

```
clc
clear
//Input data
t=27;//The room temperature of air in degree
   centigrade
g=1.4;//Adiabatic index

//Calculations
V1=1;//Let the Original volume in cc
V2=V1/2;//The final volume i.e half the original
   volume in cc
P1=1;//The atmospheric pressure in atms
P2=P1*(V1/V2)^g;//The final pressure in atms
T1=t+273;//The room temperature in K
T2=T1*(V1/V2)^(g-1);//The final temperature in K
T21=T2-273;//The final temperature in degree
   centigrade

//Output
printf('(1)The final pressure is P2 = %3.3f
   atmospheres \n (2)The final temperature is T2 =
   %3.1f K (or) %3.1f degree centigrade ',P2,T2,
   T21)
```

Scilab code Exa 6.4 Temperature

```
clc
clear
//Input data
g=1.4;//Adiabatic index

//Calculations
V1=1;//Let the initial volume be in cc
```

```
V2=V1/2;//The final volume is half the initial
   volume in cc
T1=1;//Let the initial temperature of air be in K
T2=T1*(V1/V2)^(g-1);//The final temperature of air
   in K
T=T2-T1;//The change in temperature of air in K

//Output
printf('The change in the temperature is %3.3fT1 K '
   ,T)
```

Scilab code Exa 6.5 Temperature

```
clc
clear
//Input data
g=(5/3);//Adiabatic index for monoatomic
t=27;//The room temperature in degree centigrade
P1=1;//The initial pressure in atmosphere
P2=50;//The final pressure in atmosphere

//Calculations
T1=t+273;//The room temperature in K
T2=((P2/P1)^((g-1)/g))*T1;//The final temperature in
    K
T21=T2-273;//The final temperature in degree
   centigrade

//Output
printf('The Final temperature is T2 = %3.0f K  (or)
    %3.0f degree centigrade ',T2,T21)
```

Scilab code Exa 6.6 Temperature

```
clc
clear
//Input data
t=27;//The temperature of dry air in degree
    centigrade
g=1.4;//Adiabatic index

//Calculations
V1=1;//Let us assume the initial volume in cc
V2=V1/3;//Then the final volume is 1/3 of the
    initial volume in cc
T1=t+273;//The initial temperature of dry air in K
T2=((V1/V2)^(g-1))*T1;//The final temperature of air
     in K
T21=T2-273;//The final temperature of air in degree
    centigrade
T=T21-t;//The change in temperature in degree
    centigrade

//Output
printf('(1)When the process is slow the temperature
    of the system remains constant so, there is no
    change in the temperature \n (2)When the
    compression is sudden then, \n The temperature of
     the air increases by T = %3.1f degree centigrade
      (or) %3.1f K',T,T)
```

Scilab code Exa 6.7 Pressure

```
clc
clear
//Input data
g=1.4;//Adiabatic index

//Calculations
```

```
V1=1;//Let the initial volume of the gas in cc
V2=3*V1;//Then the final volume of the gas is 3
    times the initial volume of the gas in cc
T1=273;//Initial temperature of the gas at NTP in K
T2=((V1/V2)^(g-1))*T1;//The resulting temperature in
     K
T21=T2-273;//The resulting temperature in degree
    centigrade
P1=1;//The atmospheric pressure in atms
P2=((V1/V2)^(g))*P1;//The resulting atmospheric
    pressure in atmosphere

//Output
printf('(1)The resulting temperature is T2 = %3.0f K
      (or)  %3.0f degree centigrade \n (2)The
    resulting pressure is P2 = %3.4f atmosphere ',T2,
    T21,P2)
```

Scilab code Exa 6.8 Efficiency

```
clc
clear
//Input data
t1=100;//The temperature at steam point in degree
    centigrade
t2=0;//The temperature at ice point in degree
    centigrade

//Calculations
T1=t1+273;//The temperature at steam point in K
T2=t2+273;//The temperature at ice point in K
n=(1-(T2/T1))*100;//The efficiency of the carnots
    engine in percent

//Output
```

```
printf('The efficiency of the Carnot engine is %3.2f
    percent ',n)
```

Scilab code Exa 6.9 Efficiency

```
clc
clear
//Input data
t1=127;//The temperature at initial point in degree
    centigrade
t2=27;//The temperature at final point in degree
    centigrade

//Calculations
T1=t1+273;//The temperature at initial point in K
T2=t2+273;//The temperature at final point in K
n=(1-(T2/T1))*100;//The efficiency of the carnots
    engine in percent

//Output
printf('The efficiency of the Carnot engine is %3.0f
    percent ',n)
```

Scilab code Exa 6.10 Temperature

```
clc
clear
//Input data
T1=400;//The temperature of the source in k
H1=200;//The amount of heat taken by the engine at
    T1 in calories
H2=150;//The amount of heat rejected by the engine
    to the sink in calories
```

```

//Calculations
T2=(H2/H1)*T1;//The temperature of the sink in K
n=(1-(T2/T1))*100;//The efficiency of the engine in
    percent

//output
printf('The temperature of the sink is T2 = %3.0f K
    \n The efficiency of the engine is %3.0f percent
    ',T2,n)
```

Scilab code Exa 6.11 Work done

```
clc
clear
//Input data
T1=450;//The temperature of the source in k
H1=1000;//The amount of heat taken by the engine at
    T1 in calories
T2=350;//The temperature of the sink in K

//Calculations
H2=(T2/T1)*H1;//The amount of heat rejected to the
    sink in each cycle in calories
n=(1-(T2/T1))*100;//The efficiency of the engine in
    percent
W=H1-H2;//The work done by the engine in each cycle
    in calories
W1=W*4.2;//The work done by the engine in each cycle
     in joules

//Output
printf('The amount of heat rejected to the sink in
    each cycle is H2 = %3.2f cals \n The efficiency
    of the engine is %3.2f percent \n The work done
```

```
by the engine in each cycle is W = %3.2f joules',H2,n,W1)
```

Scilab code Exa 6.12 Work done

```
clc
clear
//Input data
T1=300;//The higher temperature of the reservoir in K
T2=260;//The lower temperature of the reservoir in K
H2=500;//The amount of heat from the reservoir at the lower temperature in calories

//Calculations
H1=(T1/T2)*H2;//The amount of heat rejected to the reservoir at the higher temperature in calories
W=(H1-H2)*4.2;//The amount of work done in each cycle to operate the refrigerator in joules

//Output
printf('The amount of heat rejected to the reservoir at the higher temperature is H1 = %3.2f cal \n The amount of work done in each cycle to operate the refrigerator is W = %3.2f joules ',H1,W)
```

Scilab code Exa 6.13 Performance

```
clc
clear
//Input data
T2=273;//The lower temperature of the reservoir for a carnot refrigerator in K
```

```
T1=27+273;//The higher temperature of the reservoir
    for a carnot refrigerator in K
H2=1000*80;//The amount of heat from the reservoir
    to the lower temperature in cal
J=4.2;//The one calorie in joules

//Calculations
H1=(T1/T2)*H2;//The amount of heat discarded to the
    room in calories
W=J*(H1-H2);//The work done by the refrigerator in
    joules
C=H2/(H1-H2);//The coefficient of performance

//output
printf('The amount of heat discarded to the room is
    H1 = %3.0f cal \n The work done by the
    refrigerator is W = %3.4g joules \n The
    coefficient of performance of the machine is %3.2
    f ',H1,W,C)
```

Scilab code Exa 6.14 Temperature

```
clc
clear
//Input data
t2=7;//The lower temperature of the reservoir in
    degree centigrade
n=50;//The efficiency of the carnot engine in
    percent
n1=70;//It is desired to increase the efficiency in
    percent

//Calculations
T2=t2+273;//The lower temperature of the reservoir
    in K
```

```
T1=T2/(1-(n/100));//The higher temperature of the
    reservoir for 50% efficiency of the engine in K
T11=T2/(1-(n1/100));//The higher temperature of the
    reservoir for 70% efficiency of the engine in K
T=T11-T1;//Increase in temperature for the change in
     efficiencies in K

//Output
printf('The temperature of the high temperature
    reservoir should be increased by %3.0f K ',T)
```

Scilab code Exa 6.15 Efficiency

```
clc
clear
//Input data
T1=600;//The higher temperature of the reservoir in
   K
T2=300;//The lower temperature of the reservoir in K
n1=52;//The efficiency claimed by the inventor in
    percent

//Calculations
n=(1-(T2/T1))*100;//The efficiency of the carnot
    engine in percent

//Output
printf('The efficiency of the carnot engine is %3.0f
     percent \n The efficiency claimed is %3.0f
    percent \n The efficiency of the engine is more
    than the efficiency of the carnot engine \n .But
    no engine can have an efficiency more than a
    carnots engine, \n so his claim is invalid',n,n1)
```

Scilab code Exa 6.16 Power

```
clc
clear
//Input data
P=10^5;//The average pressure of the steam in a
   double acting steam engine in newtons/m^2
L=1;//The length of the stroke in m
A=0.15;//The area of the piston in m^2
N=5;//Number of strokes in strokes per second

//Calculations
P=(2*P*L*A*N)/1000;//The power of the engine in
   kilowatts

//Output
printf('The power of the engine is %3.0f kilowatts '
   ,P)
```

Scilab code Exa 6.17 Temperature

```
clc
clear
//Input data
l=80;//The latent heat of ice in calories per gram
V1=1.091;//The specific volume of 1 gram of ice at 0
    degree centigrade in cm^3
V2=1.000;//The specific volume of 1 gram of water at
    0 degree centigrade in cm^3
p=1;//The pressure in atm
T=273;//The temperature at 0 degree centigrade in K

```

```
//Calculations
L=80*4.2*10^7;//The latent heat of ice in ergs
P=76*13.6*980;//The pressure in dynes/cm^2
T=(P*T*(V2-V1))/L;//The depression in the melting
    point of ice produced by one atmosphere increase
    of pressure in K
T1=-T;//The decrease in the melting point of ice
    with an increase in pressure of one atmosphere

//Output
printf('The decrease in the melting point of ice
    with an increase , \n in pressure of one
    atmosphere is %3.4f K (or) %3.4f degree
    centigrade ',T1,T1)
```

Scilab code Exa 6.18 Temperature

```
clc
clear
//input data
p=1;//The pressure in atm
V1=1.000;//The specific volume of one gram of water
    in cm^3
V2=1677;//The specific volume of one gram of steam
    in cm^3
l=540;//Latent heat of vaporisation of steam in cal/
    gram

//Calculations
P=76*13.6*980;//The pressure in dynes/cm^2
T=100+273;//The temperature at 100 degree centigrade
     in K
L=l*4.2*10^7;//The latent heat of vapourisation in
    ergs
T=(P*T*(V2-V1))/L;//The increase in the boiling
```

```
    point of water with an increase in pressure of
    one atmosphere in degree centigrade

//Output
printf('The increase in the boiling point of water
    with an increase , \n in pressure of one
    atmosphere is %3.2f degree centigrade (or) %3.2
    f K ',T,T)
```

Scilab code Exa 6.19 Temperature

```
clc
clear
//Input data
l=537;//Latent heat of steam in cal/g
V2=1674;//The specific volume of one gram of steam
    in cm^3
V1=1.000;//The specific volume of one gram of water
    in cm^3
p=2.712;//The increase in the pressure in cm of Hg
t=100;//The boiling point of water in degree
    centigrade

//Calculations
T=t+273;//The boiling point of water in K
P=p*13.6*980;//The increase in the pressure in dynes
    /cm^2
L=l*4.2*10^7;//Latent heat of steam in ergs
T1=(P*T*(V2-V1))/L;//The change in the temperature
    of the boiling water when the pressure is
    increased in K

//Output
printf('The change in temperature of boiling water
    is %3.0f K (or) %3.0f degree centigrade ',T1,T1
```

```
)
```

Scilab code Exa 6.20 Temperature

```
clc
clear
//Input data
l=4563;//The latent heat of fusion of naphthalene in
    cal/mol
V=18.7;//The increase in volume of fusion in cm^3/
   mol
p=1;//The pressure in atm
t=80;//The melting point of naphthalene in degree
   centigrade

//Calculations
L=l*4.2*10^7;//The latent heat of fusion of
   naphthalene in ergs/mol
T=t+273;//The melting point of naphthalene in K
P=76*13.6*980;//The pressure in dynes/cm^2
T1=(P*T*(V))/L;//The increase in the melting point
   of naphthalene with an increase in pressure of
   one atmosphere in K

//Output
printf('The increase in the melting point of
   naphthalene with an increase,\n in pressure of
   one atmosphere is %3.5f K (or) %3.5f degree
   centigrade ',T1,T1)
```

Scilab code Exa 6.21 Temperature

```
clc
```

```
clear
//Input data
p1=80;//The under pressure of benzene in cm of Hg
t=80;//The normal boiling point of benzene in degree
    centigrade
l=380;//The latent heat of vapourisation in joules/g
d2=4;//Density of vapour at boiling point in g/litre
d1=0.9;//Density of liquid in g/cm^3

//Calculations
p=p1-76;//The change in pressure in cm of Hg
P=p*13.6*980;//The change in pressure in dynes/cm^2
T=t+273;//The normal boiling point of benzene in K
L=l*10^7;//Latent heat of vapourisation in ergs/g
V1=1/d1;//The specific volume of liquid in cm^3
V2=1000/d2;//The specific volume of vapour in cm^3
T1=(P*T*(V2-V1))/L;//The increase in the boiling
   point of benzene in K
T2=t+T1;//The boiling point of benzene at a pressure
    of 80 cm of Hg in degree centigrade

//Output
printf('The boiling point of benzene at a pressure
   of 80 cm of Hg is  %3.3f degree centigrade ',T2)
```

Scilab code Exa 6.22 Temperature

```
clc
clear
//Input data
t=100;//The boiling point of water in degree
   centigrade
p1=1;//Initial pressure in atm
p2=1.10;//Final pressure in atm
l=537;//Latent heat of water at 100 degree
```

```
centigrade in cal/g
V1=1;//The specific volume of one gram of water in cm^3
V2=1676;//The specific volume of one gram of steam in cm^3

//Calculations
p=p2-p1;//The change in pressure in atm
P=p*76*13.6*980;//The change in pressure in dynes/cm^2
T=t+273;//The boiling point of water in K
L=l*4.2*10^7;//The latent heat of water at 100 degree centigrade in ergs/g
T1=(P*T*(V2-V1))/L;//The change in boiling point of water in K (or) degree centigrade

//Output
printf('The increase in the boiling point of water with an increase,\n of 0.1 atmosphere pressure is %3.3f K  (or)  %3.3f degree centigrade ',T1,T1)
```

Scilab code Exa 6.23 Temperature

```
clc
clear
//Input data
p1=1;//The atmospheric pressure in atm
p2=100;//The given pressure in atm
d1=0.917;//The density of ice in g/cm^3
l=336;//The latent heat of ice in j/g

//Calculations
p=p2-p1;//The change in pressure in atms
P=p*76*13.6*980;//The change in pressure in dynes/cm^2
```

```
L=l*10^7;//The latent heat of ice in ergs/g
T=273;//The temperature of melting point of ice in K
V2=1;//The specific volume of one gram of water in
   cm^3
V1=1/d1;//The specific volume of ice in cm^3
T1=(T*P*(V2-V1))/L;//The change in the melting point
    of ice in K
T2=-T1;//The decrease in the melting point of ice in
    K (or) degree centigrade

//Output
printf('The decrease in the melting point of ice,\n
   with a pressure of 100 atmospheres is %3.4f
   degree centigrade ',T2)
```

Scilab code Exa 6.24 Pressure

```
clc
clear
//Input data
l=79.6;//latent heat of ice in cal/g
V2=1;//The specific volume of water at 0 degree
   centigrade in cm^3
V1=1.091;//The specific volume of ice at 0 degree
   centigrade in cm^3
p=1.013*10^6;//One atmospheric pressure in dynes/cm
   ^3
T=-1;//The change in temperature in K
T1=273;//The temperature of water at 0 degree
   centigrade in K
p1=1;//The atmospheric pressure in atm

//Calculations
L=l*4.18*10^7;//The latent heat of ice in ergs/g
P=((L*T)/(T1*(V2-V1)*p));//The change in pressure in
```

```
    atmospheres
P1=P+p1;//The pressure required in atmospheres

//Output
printf('The pressure required to lower melting point
    of ice,\n by 1 degree centigrade is  %3.1f
   atmospheres ',P1)
```

Scilab code Exa 6.25 Latent heat

```
clc
clear
//Input data
t=100;//The temperature at which water boils in
   degree centigrade
p2=787;//The pressure at which water boils in mm of
   Hg
J=4.2*10^7;//Joule in ergs/cal
p1=760;//The atmospheric pressure in mm of Hg
V2=1601;//The specific volume of 1 g of water at 100
    degree centigrade in cm^3
V1=1;//The specific volume of 1 g of water at 0
   degree centigrade in cm^3

//Calculations
T=t+273;//The temperature at which water boils in K
T1=1;//The difference in the temperature in K
p=p2-p1;//The difference in the pressure in mm of Hg
P=(p/10)*13.6*980;//The difference in the pressure
   in dynes/cm^2
L=(T*P*(V2-V1))/T1;//The latent heat of steam in
   ergs/g
L1=L/J;//The latent heat of steam in cal/g

//Output
```

```
printf('The Latent heat of steam is L = %3.1f cal/g ',L1)
```

Scilab code Exa 6.26 Temperature

```
clc
clear
//Input data
T=600;//The melting point of lead in K
d1=11.01;//Initial density of the lead in g/cm^3
d2=10.65;//The final density of the lead in g/cm^3
l=24.5;//The latent heat of fusion of lead in j/g
p1=1;//The atmospheric pressure in atmospheres
p2=100;//The given pressure in atmospheres

//Calculations
p=p2-p1;//The change in pressure in atmospheres
P=p*76*13.6*980;//The change in pressure in dynes/cm^2
L=l*10^7;//The latent heat of fusion of lead in ergs/g
V1=1/d1;//The initial specific volume of the lead in cm^3
V2=1/d2;//The final specific volume of the lead in cm^3
T1=(T*P*(V2-V1))/L;//The change in the temperature in K
T2=T+T1;//Melting point of lead at 100 atmospheres pressure in K

//Output
printf('The melting point of lead at a pressure of 100 atmospheres is  %3.4f K ',T2)
```

Scilab code Exa 6.28 Pressure

```
clc
clear
//Input data
t2=120;//The given temperature for the water to boil
    in degree centigrade
t1=100;//The actual boiling point of water in degree
    centigrade
V=1676;//The change in specific volume in cm^3
l=540;//Latent heat of steam in cal/g
J=4.2*10^7;//joule in ergs/cal

//Calculations
T1=t2-t1;//The change in temperature in degree
   centigrade (or) K
T=t1+273;//The boiling point of water in K
L=l*J;//The latent heat of steam in ergs/g
p=1;//The atmospheric pressure in atmospheres
P=(L*T1)/(T*V);//The change in pressure in dynes/cm
   ^2
P1=P/10^6;//The change in pressure in atmospheres
P2=P1+p;//The required pressure in atmospheres

//Output
printf('The required pressure is %3.4f atmospheres '
   ,P2)
```

Scilab code Exa 6.29 Entropy

```
clc
clear
```

```
//Input data
l=80;//Latent heat of ice in cal/g
m=10;//Mass of ice in g
T=273;//The temperature of ice in K

//Calculations
H=m*l;//Heat absorbed by 10 g of ice at 273 K when
    it is converted into water at 273 K in cal
S=H/T;//The gain in entropy in cal/K

//Output
printf('The gain in entropy is  %3.2f cal/K',S)
```

Scilab code Exa 6.30 Entropy

```
clc
clear
//Input data
m=5;//Mass of water in kg
t=100;//The temperature of water in degree
    centigrade
l=540;//Latent heat of water at 100 degree
    centigrade in cal/g

//Calculations
T=t+273;//The temperature of water in K
M=m*1000;//Mass of water in g
H=M*l;//Heat absorbed by 5 kg of water at 100 degree
     centigrade when it is converted into steam at
    100 degree centigrade in cal
S=H/T;//The gain in entropy in cal/K

//Output
printf('The gain in entropy is  %3.0f cal/K ',S)
```

Scilab code Exa 6.31 Entropy

```
clc
clear
//Input data
m=1;//mass of ice in g
t1=-10;//The given temperature of ice in degree centigrade
t2=100;//The given temperature of steam in degree centigrade
S=0.5;//Specific heat of ice
s=1;//Specific heat of water
l1=80;//Latent heat of ice in cal/g
l2=540;//Latent heat of steam in cal/g

//Calculations
T=273;//The temperature of ice at 0 degree centigrade in K
T1=t1+273;//The given temperature of ice in K
T2=t2+273;//The given temperature of steam in K
S1=m*S*2.3026*log10(T/T1);//Increase in entropy when the temperature of 1 gram of ice increases from −10 to 0 degree centigrade in cal/K
S2=l1/T;//Increase in entropy when 1 g of ice at 0 degree centigrade is converted into water at 0 degree centigrade in cal/K
S3=m*s*2.3026*log10(T2/T);//Increase in entropy when 1 g of water raised from 0 to 100 degree centigrade in cal/K
S4=l2/T2;//Increase in entropy when 1g water at 100 degree centigrade is converted into steam at 100 degree centigrade in cal/K
S5=S1+S2+S3+S4;//Total increase in entropy in cal/K

```

```
//Output
printf('The total increase in entropy is %3.5f cal/K',S5)
```

Scilab code Exa 6.32 Entropy

```
clc
clear
//Input data
V1=1;//Let us assume the initial volume be one in cc
V2=4*V1;//Then the final volume is four times the initial volume in cc

//Calculations
S=2.3026*(log10(V2/V1));//The gain in entropy in terms of the gas constant in cal/K

//Output
printf('The gain in entropy in terms of the gas constant is %3.3f (R/J)cal/K',S)
```

Scilab code Exa 6.33 Entropy

```
clc
clear
//Input data
m1=50;//Mass of water at 0 degree centigrade in g
m2=50;//Mass of water at 83 degree centigrade in g
t1=0;//The temperature of water in degree centigrade
t2=83;//The temperature of water in degree centigrade

//Calculations
```

```
T1=t1+273;//Temperature of water in K
T2=t2+273;//Tempearture of water in K
s=1;//The specific heat of water
T=((m2*s*T2)+(m1*s*T1))/((m1+m2)*s);//The final
    temperature of the mixture in K
S1=(m1*s*log(T/T1));//The change in entropy by 50 g
    of water when its temperature rises from 273 K to
     313 K in cal/K
S2=(m2*s*log(T/T2));//The change in entropy by 50 g
    of water when its temperature falls from 353 K to
     313 K in cal/K
S3=S1+S2;//The total gain in the entropy of the
    system in cal/K

//Output
printf('The total gain in entropy of the system is
   %3.3f cal/K ',S3)
```

Scilab code Exa 6.34 Entropy

```
clc
clear
//Input data
m1=50;//Mass of water at 15 degree centigrade in g
m2=80;//Mass of water at 40 degree centigrade in g
t1=15;//The temperature of water in degree
    centigrade
t2=40;//The temperature of water in degree
    centigrade

//Calculations
T1=t1+273;//Temperature of water in K
T2=t2+273;//Tempearture of water in K
s=1;//The specific heat of water
T=((m2*s*T2)+(m1*s*T1))/((m1+m2)*s);//The final
```

```
temperature of the mixture in K
S1=(m1*s*log(T/T1));//The change in entropy by 50 g of water when its temperature rises from 288 K to 303.4 K in cal/K
S2=(m2*s*log(T/T2));//The change in entropy by 80 g of water when its temperature falls from 313 K to 303.4 K in cal/K
S3=S1+S2;//The total gain in the entropy of the system in cal/K

//Output
printf('The net increase in the entropy of the system is %3.3f cal/K ',S3)
```

Scilab code Exa 6.35 Entropy

```
clc
clear
//Input data
m1=10;//Mass of steam in g
t1=100;//The temperature of the steam in degree centigrade
m=90;//mass of water in g
t2=0;//The temperature of water in degree centigrade
m2=m+m1;//The total mass of water in g
l=540;//The latent heat of steam in cal/g

//Calculations
T1=t1+273;//The temperature of the steam in K
T2=t2+273;//The temperature of the water in K
T=((m1*l)+(m1*T1)+(m2*T2))/(m1+m2);//The final temperature in K
S1=m2*log(T/T2);//The change in entropy when the temperature of water and calorimeter rises from 273 K to 331.2 K in cal/K
```

```
S2=-(m1*l)/T1;//The change in entropy when 10 grams
    of steam at 373 K condenses to water at 373K in
    cal/K
S3=m1*log(T/T1);//Change in entropy when 10 g of
    water at 373 K is cooled to water at 331.2 K in
    cal/K
S4=S1+S2+S3;//Net change in entropy in cal/K

//Output
printf('The net increase in the entropy of the
    system is  %3.3f cal/K ',S4)
```

Scilab code Exa 6.36 Entropy

```
clc
clear
//Input data
m=1;//Mass of water in g
t1=20;//The temperature of water in degree
    centigrade
t2=-10;//The temperature of ice in degree centigrade
s1=4.2;//Heat capacity for one gram of water in J/g-
   K
s2=2.1;//Heat capacity for ice in J/g-K
li=335;//Latent heat of fusion of ice at 0 degree
    centigrade in J/g

//Calculations
T=273;//The temperature of water at 0 degree
    centigrade in K
T1=t1+273;//The temperature of water in K
T2=t2+273;//The temperature of ice in K
S1=m*s1*log(T/T1);//Change in entropy when the
    temperature of 1 g of water at 293 K falls to 273
     K in J/K
```

```
S2=-(m*li)/T;//Change in entropy when 1 g of water
    at 273 K is converted into ice at 273 K in J/K
S3=m*s2*log(T2/T);//Change in entropy when the
    temperature of 1 g of ice at 273 K falls to 263 K
     in J/K
S4=S1+S2+S3;//The total change in entropy of the
    system in J/K

//Output
printf('The total change in the entropy of the
    system is  %3.5f J/K \n  (Negative sign indicates
     that there is decrease in the entropy of the
    system)',S4)
```

Scilab code Exa 6.37 Entropy

```
clc
clear
//Input data
M=1;//Mass of water in kg
m=M*1000;//Mass of water in g
T1=273;//The temperature of the water in K
T2=373;//The temperature of the heat reservoir in K
s=1;//Specific heat of water

//Calculations
S1=m*s*log(T2/T1);//Increase in entropy when the
    temperature of 1000 g of water is raised from 273
     K to 373 k in cal/K
S2=-(m*s*(T2-T1))/T2;//Change in entropy of the
    reservoir in cal/K
S=S1+S2;//Change in entropy of the universe in cal/K

//Output
printf('(1)The change in entropy of water when
```

```
temperature reaches 373 K is  %3.0f cal/K \n (2)
(i)The Change in entropy of the reservoir is  %3
.1f cal/K  \n (ii)The Change in entropy of the
universe is  %3.1f cal/K ',S1,S2,S)
```

Scilab code Exa 6.42 Pressure

```
clc
clear
//Input data
l=540;//Latent heat of vapourisation of steam in cal
    /g
L=l*4.2*10^7;//Latent heat of vapourisation of steam
     in ergs/g
V=1676;//The change in specific volume when 1 g of
    water is converted into steam in cc
t1=100;//The actual boiling temperature of water in
    degree centigrade
t2=150;//The given temperature at which water must
    boil in degree centigrade
p=1;//The atmospheric pressure in atmospheres

//Calculations
T1=t1+273;//The actual boiling temperature of water
    in K
T2=t2+273;//The given temperature at which water
    must boil in K
T=T2-T1;//The change in temperature in K
P=(L*T)/(T1*V);//The pressure in dynes/cm^2
P1=P/10^6;//The pressure in atmospheres
P2=P1+p;//The pressure at which water would boil at
    150 degree centigrade in atmospheres

//Output
printf('The pressure at which water would boil at
```

```
150 degree centigrade is %3.3f atmospheres ',P2)
```

Scilab code Exa 6.43 Pressure

```
clc
clear
//Input data
l=80;//Latent heat of fusion of ice in cal/g
L=l*4.2*10^7;//Latent heat of fusion in ergs/g
V=0.091;//The change in specific volume when 1 g of
   water freezes into ice in cc
t1=0;//The actual freezing point of ice in degree
   centigrade
t2=-1;//The given temperature at which ice must
   freeze in degree centigrade
p=1;//The atmospheric pressure in atmospheres

//Calculations
T1=t1+273;//The actual freezing point of ice in K
T2=t2+273;//The given temperature at which ice must
   freeze in K
T=T1-T2;//The change in temperature in K
P=(L*T)/(V*T1);//The pressure in dynes/cm^2
P1=P/10^6;//The pressure in atmospheres
P2=P1+p;//The pressure under which ice would freeze
   in atmospheres

//Output
printf('The pressure under which ice would freeze at
    -1 degree centigrade is %3.1f atmospheres ',P2)
```

Scilab code Exa 6.44 Specific heat

```
clc
clear
//Input data
t=100;//The given temperature of water in degree
    centigrade
C1=1.01;//The specific heat of water at 100 degree
    centigrade in cal/g
L=-0.64;//The rate at which the latent heat of
    vapourisation decreases with rise in temperature
    in cal/K
l=540;//The latent heat of vapourisation of steam in
     cal

//Calculations
T=t+273;//The given temperature of water in K
C2=L-(l/T)+C1;//The specific heat of saturated steam
     in cal/g

//Output
printf('The specific heat of satureted steam is  %3
    .3f cal/g \n (The specific heat of saturated
    steam is negative)',C2)
```

Scilab code Exa 6.45 Specific heat

```
clc
clear
//Input data
t=100;//The temperature of saturated steam in degree
     centigrade
L1=545.25;//The latent heat of saturated steam at 90
     degree centigrade in cal
L2=539.30;//The latent heat of saturated steam at
    100 degree centigrade in cal
L3=533.17;//The latent heat of saturated steam at
```

```
110 degree centigrade in cal
C1=1.013;//The specific heat of water at 100 degree centigrade in cal/g

//Calculations
T=t+273;//The temperature of saturated steam in K
L=(L3-L1)/(110-90);//The rate at which the latent heat of saturated steam decreases with rise in temperature in cal/K
C2=C1+L-(L2/T);//The specific heat of saturated steam at 100 degree centigrade in cal/g

//Output
printf('The specific heat of saturated steam at 100 degree centigrade is %3.3f cal/g',C2)
```

Chapter 8

TRANSMISSION OF HEAT

Scilab code Exa 8.1 Conductivity of iron

```
clc
clear
//Input data
l1=10;//Length of the copper rod in cm
l2=4;//Length of the iron rod in cm
K1=0.9;//The thermal conductivity of copper

//Calculations
K2=(l2^2/l1^2)*K1;//The Thermal conductivity of iron

//Output
printf('The thermal conductivity of iron is K2 = %3
    .3f ',K2)
```

Scilab code Exa 8.2 Heat

```
clc
clear
```

```
//Input data
K=0.2;//The thermal conductivity of the plate
d=0.2;//The thickness of the plate in cm
A=20;//The area of the plate in cm^2
T=100;//The temperature difference in degree
    centigrade
t=60;//The given time in seconds

//Calculations
Q=(K*A*T*t)/d;//The quantity of heat that will flow
    through the plate in one minute in cal

//Output
printf('The quantity of heat that will flow through
    the plate in one minute is Q = %3.4g cal ',Q)
```

Scilab code Exa 8.3 Heat

```
clc
clear
//Input data
l=30;//The length of the bar in cm
A=5;//The uniform area of cross section of a bar in
    cm^2
ta=200;//The temperature maintained at the end A in
    degree centigrade
tc=0;//The temperature maintained at the end C in
    degree centigrade
Kc=0.9;//The thermal conductivity of copper
Ki=0.12;//The thermal conductivity of iron

//Calculations
T=((Kc*A*ta)+(Ki*A*tc))/((Kc+Ki)*A);//The
    temperature after the steady state is reached in
    degree centigrade
```

```
Q=(Kc*A*(ta-T))/(l/2);//The rate of flow of heat along the bar when the steady state is reached in cal/sec

//Output
printf('The rate of flow of heat along the bar when the steady state is reached is Q = %3.2f cal/s ',Q)
```

Scilab code Exa 8.4 Temperature

```
clc
clear
//Input data
d1=1.75;//The thickness of the wood in cm
d2=3;//The thickness of the cork in cm
t2=0;//The temperature of the inner surface of the cork in degree centigrade
t1=12;//The temperature of the outer surface of the wood in degree centigrade
K1=0.0006;//The thermal conductivity of wood
K2=0.00012;//The thermal conductivity of cork

//Calculations
T=(((K1*t1)/d1)+((K2*t2)/d2))/((K1/d1)+(K2/d2));//The temperature of the interface in degree centigrade

//Output
printf('The temperature of the interface is T = %3.2f degree centigrade ',T)
```

Scilab code Exa 8.5 Time

```
clc
clear
//Input data
x1=3;//The thickness of the ice layer on the surface of a pond in cm
x=1;//The increase in the thickness of the ice when the temperature is maintained at -20 degree centigrade in mm
x2=x1+(x/10);//The increased thickness of the ice layer on the surface of a pond in cm
T=-20;//The temperature of the surrounding air in degree centigrade
d=0.91;//The density of ice at 0 degree centigrade in g/cm^3
L=80;//The latent heat of ice in cal/g
K=0.005;//The thermal conductivity of ice

//Calculations
t=((d*L)/(2*K*(-T)))*(x2^2-x1^2);//The time taken to increase its thickness by 1 mm in sec
t1=t/60;//The time taken to increase its thickness by 1 mm in min

//Output
printf('The time taken to increase its thickness by 1 mm is t = %3.2f s',t)
```

Scilab code Exa 8.6 Time

```
clc
clear
//Input data
x1=10;//The thickness of the ice layer on the surface of a pond in cm
x=5;//The increase in the thickness of the ice when
```

```
    the temperature is maintained at -10 degree
    centigrade in cm
x2=x1+(x);//The increased thickness of the ice layer
     on the surface of a pond in cm
T=-10;//The temperature of the surrounding air in
    degree centigrade
d=0.90;//The density of ice at 0 degree centigrade
    in g/cm^3
L=80;//The latent heat of ice in cal/g
K=0.005;//The thermal conductivity of ice

//Calculations
t=((d*L)/(2*K*(-T)))*(x2^2-x1^2);//The time taken to
     increase its thickness by 5 cm in sec
t1=t/(60*60);//The time taken to increase its
    thickness by 5 cm in hours

//Output
printf('The time taken to increase its thickness by
    5 cm is t = %3.0g s (or) %3.0f hours',t,t1)
```

Scilab code Exa 8.7 Rate of energy transfer

```
clc
clear
//input data
T1=300;//The temperature maintained on one sphere (
    black body radiator) in K
T2=200;//The temperature maintained on another
    sphere (black body radiator) in K
s=5.672*10^-8;//Stefans constant in M.K.S units

//Calculations
R=s*(T1^4-T2^4);//The net rate of energy transfer
    between the two spheres in watts/m^2
```

```

//output
printf('The net rate of energy transfer between the
    two spheres is R = %3.2f watts/m^2',R)
```

Scilab code Exa 8.8 Radiant

```
clc
clear
//Input data
T1=400;//The given temperature of a black body in K
T2=4000;//The given temperature of a black body in K
s=5.672*10^-8;//Stefans constant in M.K.S units

//Calculations
R1=s*T1^4;//The radiant emittance of a black body at
     400 k in watts/m^2
R2=(s*T2^4)/1000;//The radiant emittance of a black
    body at 4000 k in kilo-watts/m^2

//Output
printf('The Radiant emittance of a black body at a
    temperature of ,\n (i) 400 K  is  R = %3.0f watts
    /m^2 \n (ii) 4000 K  is  R = %3.0f kilo-watts/m^2
    ',R1,R2)
```

Scilab code Exa 8.9 Emittance

```
clc
clear
//Input data
e=0.35;//The relative emittance of tungsten
```

```
A=10^-3;//The surface area of a tungsten sphere in m
   ^2
T1=300;//The temperature of the walls in K
T2=3000;//The temperature to be maintained by the
   sphere in K
s=5.672*10^-8;//Stefans constant in M.K.S units

//Calculations
R=s*A*e*(T2^4-T1^4);//The power input required to
   maintain the sphere at 3000 K in watts

//Output
printf('The power input required to maintain the
   sphere at 3000 K is R = %3.0f watts',R)
```

Scilab code Exa 8.10 Rate of heat transfer

```
clc
clear
//Input data
e=0.1;//The relative emittance of an aluminium foil
T1=300;//The temperature of one sphere in K
T2=200;//The temperature of another sphere in K
s=5.672*10^-8;//Stefans constant in M.K.S units

//Calculations
x=(((T1^4+T2^4)/2)^(1/4));//The temperature of the
   foil after the steady state is reached in K
R=e*s*(T1^4-x^4);//The rate of energy transfer
   between one of the spheres and foil in watts/m^2

//Output
printf('(1)The temperature of the foil after the
   steady state reached is x = %3.1f K \n (2)The
   rate of energy transfer between the sphere and
```

```
the foil is R = %3.1f watts/m^2',x,R)
```

Scilab code Exa 8.11 Energy radiated

```
clc
clear
//Input data
A=5*10^-5;//The surface area of the filament in m^2
e=0.85;//The relative emittance of the filament
s=5.672*10^-8;//Stefans constant in M.K.S units
t=60;//The time in seconds
T=2000;//The temperature of the filament of an
   incandescent lamp in K

//Calculations
E=A*e*s*t*(T^4);//The energy radiated from the
   filament in joules

//Output
printf('The energy radiated from the filament is E =
    %3.0f joules ',E)
```

Scilab code Exa 8.12 Temperature

```
clc
clear
//Input data
E=1.53*10^5;//The energy radiated from an iron
   furnace in calories per hour
A=10^-4;//The cross section area of an iron furnace
   in m^2
e=0.8;//The relative emittance of the furnace
t=3600;//The time in seconds
```

```
s=1.36*10^-8;//Stefans constant in cal/m^2-s-K^4

//Calculations
T=((E)/(A*e*s*t))^(1/4);//The temperature of the
    furnace in K

//Output
printf('The temperature of the furnace is T = %3.0f
   K ',T)
```

Scilab code Exa 8.13 Temperature

```
clc
clear
//Input data
S=2.3;//Solar constant in cal/cm^2/minute
r=7*10^10;//The radius of the sun in cm
R=1.5*10^13;//The distance between the sun and the
    earth in cm
s=1.37*10^-12;//Stefans constant in cal/cm^2/s

//Calculations
E=(S/60)*(R/r)^(2);//The energy radiated from the
    sun in cal/s
T=(E/s)^(1/4);//The black body temperature of the
    sun in K

//Output
printf('The black body temperature of the sun is T =
     %3.0f K ',T)
```

Chapter 9

STATISTICAL THERMODYNAMICS

Scilab code Exa 9.1 Relative probabilities

```
clc
clear
//Input data
N=6000;//Number of particles in a system
e=3;//The number of energy states with equal spacing
n1=3000;//Number of particles in the lower level
n2=2500;//Number of particles in the middle level
n3=500;//Number of particles in the upper level
n11=3001;//Number of particles in the lower level in the second case
n22=2498;//Number of particles in the middle level in the second case
n33=501;//Number of particles in the upper level in the second case
g=1;//Let us assume the probability of locating a particle in a certain energy state is one

//Calculations
P1=1/(2500*2499);//The probability in the first case
```

```
P2=1/(3001*501);//The probability in the second case
P=P2/P1;//Comparing the relative probabilities

//Output
printf('By comparing the relative probabilities P = %3.1f  \n (It means the transfer of one particle from the middle to the\n upper and the lower state has changed the probability by a factor %3.1f \n Hence both the distributions are not near the equilibrium state)',P,P)
```

Chapter 10

Appendix 2

Scilab code Exa 10.1 Kinetic energy

```
clc
clear
//page number 470
//Input data
T=300;//The given temperature in K
R=8.31;//Universal gas constant in J/mole-K

//Calculations
U=(3/2)*R*T;//The total random kinetic energy of one
    gram mole of oxygen in J

//Output
printf('The total random kinetic energy of one gram
   mole of oxygen is U = %3.0f J ',U)
```

Scilab code Exa 10.2 Temperature

```
clc
```

```
clear
//Page number 470
//Input data
a=0.245;//Van der Waals constant in atoms-litre^2-
    mole^-2
b=2.67*10^-2;//Van der Waals constant in litre-mole
    ^-1
R=8.314*10^7;//Universal gas constant in ergs/mole-K

//Calculations
a1=a*76*13.6*980*10^6;//Van der Waals constant in
    dynes-cm^4-mole^-2
b1=b*10^3;//Van der Waals constant in cm^3mole^-1
Tc=(8/27)*(a1/b1)*(1/R);//The critical temperature
    in K
Tc1=Tc-273;//The critical temperature in degree
    centigrade

//Output
printf('The critical temperature is Tc = %3.2f K (
    or) %3.2f degree centigrade ',Tc,Tc1)
```

Scilab code Exa 10.3 Avogadro number

```
clc
clear
//Page number 470
//Input data
t=0;//The given temperature in degree centigrade
E=5.64*10^-21;//The mean kinetic energy of molecules
     of hydrogen in J
R=8.32;//Universal gas constant in J/mole-K

//Calculations
T=t+273;//The given temperature in K
```

```
N=(3/2)*(R/E)*(T);//Avogadros number

//Output
printf('The Avogadro number is N = %3.4g ',N)
```

Scilab code Exa 10.4 Mean free path

```
clc
clear
//Page number 471
//Input data
d=2*10^-8;//The diameter of the molecule of a gas in
   cm
k=1.38*10^-23;//Boltzmanns constant in J/K
T=273;//The temperature at NTP in K
pi=3.14;//The mathematical constant of pi

//Calculations
d1=d/100;//The diameter of the molecule of a gas in
   m
P=0.76*13.6*9.8*1000;//The pressure at NTP
n=P/(k*T);//The number of molecules per cubic meter
l=1/(pi*d1^2*n);//The mean free path in m

//Output
printf('The mean free path at NTP is %3.4g m ',l)
```

Scilab code Exa 10.6 Mean free path

```
clc
clear
//Page number 472
//Input data
```

```
n=3*10^25;//The number of molecules per cubic metre
d=3.6*10^-10;//The diameter of oxygen molecule in m
M=32;//Molecular weight of oxygen
N=6.023*10^26;//Avogadro number
k=1.38*10^-23;//Boltzmans constant in J/K
T=273;//The temperature at NTP in K
pi=3.14;//The mathematical constant of pi

//Calculations
m=M/N;//The mass of oxygen atom in kg
V=((8*k*T)/(pi*m))^(1/2);//Average speed of oxygen
    molecule at 273K in m/s
c=pi*d^2*V*n;//The collision frequency of the
    molecules
l=1/(pi*d^2*n);//The mean free path in m

//Output
printf('(a)The collision frequency of the molecules
    is  %3.2g collisions/second \n (b)The mean free
    path is  %3.4g m ',c,l)
```

Scilab code Exa 10.7 Pressure

```
clc
clear
//Page number 472
//Input data
d=9000;//The density of copper in kg/m^3
w=63.5;//The atomic weight of copper in kg
N=6.023*10^26;//Avogadros number
pi=3.14;//Mathematical constant of pi
h=6.624*10^-34;//Planks constant in Js

//Calculations
V=w/d;//The volume of copper in m^3
```

```
Ef=((h^2/(8*9*10^-31))*((3/pi)*(N/V))^(2/3))
    /(1.6*10^-19);//The fermi energy in eV
P=(2/3)*(N/V)*Ef;//The pressure at absolute zero for
     copper in N/m^2

//Output
printf('(a)The Fermi energy is E = %3.3f eV \n (b)
    The pressure at absolute zero for copper is P =
    %3.6g N/m^2 ',Ef,P)
```

Scilab code Exa 10.8 Gas

```
clc
clear
//Page number 473
//Input data
p1=80;//The initial pressure of a gas in cm of Hg
p2=60;//The final pressure of a gas in cm of Hg
v2=1190;//The final volume occupied by a gas in cc
v1=1000;//The initial volume occupied by a gas in cc

//Calculations
g=(log10(p1/p2))/(log10(v2/v1));//The adiabatic
    index

//Output
printf('The adiabatic index is  %3.3f ',g)
```

Scilab code Exa 10.9 Work done

```
clc
clear
//Page number 473
```

```
//Input data
t=27;//The given temperature in degree centigrade
R=8.3;//Universal gas constant in J/deg mole

//Calculations
T=t+273;//The given temperature in K
v1=1;//Let the original volume be in cc
v2=2*v1;//The final volume in cc
W=R*T*log(v2/v1);//The work done in J

//Output
printf('The work done is W = %3.1f J ',W)
```

Scilab code Exa 10.10 temperature

```
clc
clear
//Page number 474
//Input data
t1=27;//The initial temperature of the gas in degree
    centigrade
T1=t1+273;//The initial temperature of the gas in K
g=1.5;//The adiabatic index
p=8;//The ratio of final pressure to the initial
   pressure

//Calculations
T2=((p)^((g-1)/g))*T1;//The final temperature of the
    gas in K
T21=T2-273;//The final temperature of the gas in
   degree centigrade

//Output
printf('The final temperature of the gas is T2 = %3
   .0f K (or) %3.0f degree centigrade ',T2,T21)
```

Scilab code Exa 10.11 Temperature

```
clc
clear
//Page number 475
//Input data
n=0.3;//The efficiency of a carnot engine
t=27;//The temperature of the sink in degree
    centigrade
n1=0.5;//The increased efficiency of a carnot engine

//Calculations
T2=t+273;//The temperature of the sink in K
T1=T2/(1-n);//The temperature of the source for 0.3
    efficiency in K
T11=T2/(1-n1);//The temperature of the source for
    0.5 efficiency in K
T=T11-T1;//The increase in temperature in K

//Output
printf('The increase in temperature is T = %3.2f K '
    ,T)
```

Scilab code Exa 10.12 Efficiency

```
clc
clear
//Page number 475
//Input data
T1=2100;//One of the operating temperature in K
T2=700;//One of the another operating temperature in
    K
```

```
n1=40;//The actual efficiency of the engine in
   percent

//Calculations
n=(1-(T2/T1))*100;//The efficiency of the engine in
   percent
n2=(n1/n)*100;//The percentage of actual efficiency
   to the maximum possible efficiency in percent

//Output
printf('The percentage of actual efficiency to the
   maximum possible efficiency is %3.0f percent ',n2
   )
```

Scilab code Exa 10.13 Efficiency

```
clc
clear
//Page number 475
//Input data
T1=600;//The working temperature of the engine in K
T2=300;//The another working temperature of the
   engine in K
n=52;//Efficiency of the engine claimed by the
   inventor in percent

//Calculations
n1=(1-(T2/T1))*100;//The carnot efficiency of the
   engine in percent

//Output
printf('The efficiency of the engine claimed by
   inventor is n = %3.0f percent\nThe carnot
   efficiency of the engine is n = %3.0f percent \n
   (The efficiency claimed is more than the carnots
```

```
    engine efficiency \n No engine can have
    efficiency more than carnots efficiency \n Hence
    the claim is invalid)',n,n1)
```

Scilab code Exa 10.14 Work done

```
clc
clear
//Page number 476
//Input data
H1=10^4;//The heat absorbed by a carnots engine in
    calories
t1=627;//The temperature from a reservoir in degree
    centigrade
t2=27;//The temperature of the sink in degree
    centigrade

//Calculations
T1=t1+273;//The temperature of the reservoir in K
T2=t2+273;//The temperature of the sink in K
n=(1-(T2/T1))*100;//The efficiency of the engine in
    percent
H2=H1*(T2/T1);//The heat rejected to the sink in
    calories
W=(H1-H2)*4.2;//The work done by the engine in J

//Output
printf('The efficiency of the engine is n = %3.2f
    percent \n The work done by the engine is W = %3
    .2g J ',n,W)
```

Scilab code Exa 10.15 Efficiency

```
clc
clear
//Page number 476
//Input data
w=100;//The given power of an engine in kW
t1=117;//The operating temperature of an engine in
    degree centigrade
t2=17;//The another operating temperature of an
    engine in degree centigrade

//Calculations
T1=t1+273;//The operating temperature of an engine
    in K
T2=t2+273;//The another operating temperature of an
    engine in K
W=w*1000;//The given power of an engine in J/s
n=(1-(T2/T1))*100;//The efficiency of an engine in
    percent
H=(T1/T2);//The amount of heat absorbed to the
    amount of heat rejected
H2=W/(H-1);//The amount of heat rejected per second
    in J/s
H1=H*H2;//The amount of heat absorbed per second in
    J/s

//Output
printf('(i)The amount of heat absorbed is %3.0g J/s
    \n (ii)The amount of heat rejected is %3.0g J/s \
    n (iii)The efficiency of the engine is %3.1f
    percent ',H1,H2,n)
```

Scilab code Exa 10.16 Entropy

```
clc
clear
```

```
//Page number 477
//Input data
m1=10;//The mass of water at 60 degree centigrade in
    g
m2=30;//The mass of water at 20 degree centigrade in
    g
t1=60;//The temperature of 10 g water in degree
   centigrade
t2=20;//The temperature of 30 g water in degree
   centigrade

//Calculations
T1=t1+273;//The temperature of 10g water in K
T2=t2+273;//The temperature of 30g water in K
T=((m1*T1)+(m2*T2))/(m1+m2);//The final temperature
   of water in K
s1=m1*log(T/T1);//The change in entropy of 10g water
    from 333 to 303 K in cal/K
s2=m2*log(T/T2);//The change in entropy of 30g water
    from 293 to 303 K in cal/K
s=s1+s2;//The total gain in the entropy of the
   system in cal/K

//Output
printf('The change in entropy is %3.4f cal/K ',s)
```

Scilab code Exa 10.17 Entropy

```
clc
clear
//Page number 478
m=10;//The given amount of water in kg
t1=100;//The temperature of water in degree
   centigrade
L=540;//The latent heat of vapourisation of steam in
```

```
    cal

//Calculations
m1=m*1000;//The given amount of water in g
T1=t1+273;//The temperature of water in K
S=(m1*L)/T1;//The increase in entropy in cal/K

//Output
printf('The increase in entropy is %3.0f cal/K ',S)
```

Scilab code Exa 10.18 Entropy

```
clc
clear
//Page number 478
//Input data
m=50;//The given amount of water in g
t1=10;//The initial temperature of water in degree
    centigrade
t2=90;//The final temperature of water in degree
    centigrade

//Calculations
T1=t1+273;//The initial temperature of water in K
T2=t2+273;//The final temperature of water in K
S=m*log(T2/T1);//The increase in entropy in cal/K

//Output
printf('The increase in entropy is %3.3f cal/K ',S)
```

Scilab code Exa 10.19 Entropy

```
clc
```

```
clear
//Page number 479
//Input data
m=10;//The given amount of ice in g
T1=273;//The initial temperature of ice in K
T2=373;//The final temperature of steam in K
L1=80;//The latent heat of ice in cal/g
L2=540;//The latent heat of vapourisation of steam
    in cal

//Calculations
s1=(m*L1)/T1;//Increase in entropy from ice at 273K
    to water at 273K in cal/K
s2=(m)*log(T2/T1);//Increase in entropy from water
    at 273K to water at 373K in cal/K
s3=(m*L2)/T2;//Increase in entropy from water at 373
    K to steam at 373K in cal/K
s=s1+s2+s3;//The total increase in entropy in cal/K

//Output
printf('The total increase in entropy is %3.2f cal/K
    ',s)
```

Scilab code Exa 10.20 Entropy

```
clc
clear
//Page number 479
//Input data
m=1;//The given amount of nitrogen in g
t1=50;//The initial temperature of nitrogen in
    degree centigrade
t2=100;//The final temperature of nitrogen in degree
    centigrade
Cv=0.18;//Molar specific heat of nitrogen
```

```
w=28;//Molecular weight of nitrogen

//Calculations
T1=t1+273;//The initial temperature of nitrogen in K
T2=t2+273;//The final temperature of nitrogen in K
S=(Cv/w);//The Specific heat of nitrogen
s=m*S*log(T2/T1);//The change in entropy in cal/K

//Output
printf('The change in entropy is %3.4g cal/K ',s)
```

Scilab code Exa 10.21 Temperature

```
clc
clear
//Page number 480
//Input data
p=135.2;//The given increase in the pressure in
    atmospheres
V=-0.091;//The given increase in the specific volume
     when 1g of water freezes into ice in cm^3
L=80;//Latent heat of fusion of ice in cal/gram
T=273;//The temperature of ice in K

//Calculations
L1=L*4.18*10^7;//The latent heat of fusion of ice in
     ergs/g
P=p*1.013*10^6;//The given increase in the pressure
    in dynes/cm^2
t=(P*T*V)/L1;//The temperature at which ice will
    freeze in degree centigrade
t1=t+273;//The temperature at which ice will freeze
    in K

//Calculations
```

```
printf('The temperature at which ice will freeze is
    %3.0f degree centigrade (or) %3.0f K ',t,t1)
```

Scilab code Exa 10.22 Entropy

```
clc
clear
//Page number 480
//Input data
m=1;//The given amount of water in kg
s=1000;//The specific heat of water in cal/kg-K
T1=273;//The initial temperature of water in K
T2=373;//The temperature of the heat reservoir in K

//Calculations
S=m*s*log(T2/T1);//The increase in entropy in cal/K

//Output
printf('The increase in the entropy of water is %3.0
    f cal/K',S)
```

Scilab code Exa 10.23 Entropy

```
clc
clear
//Page number 480
//input data
m=0.0273;//The given amount of ice in kg
L=80;//The latent heat of fusion of ice in cal/gram
T=273;//The temperature of ice in K

//Calculations
```

```
L1=L*1000;//The latent heat of fusion of ice in cal/
    kg
S=(m*L1*4.2)/T;//The change in entropy in J/K

//Output
printf('The change in entropy is %3.1f J/K',S)
```

Scilab code Exa 10.24 Temperature

```
clc
clear
//Page number 481
//Input data
t1=27;//The given initial temperature in degree
    centigrade
p=50;//The reduce in the pressure in atmospheres
a=13.2*10^-2;//Van der Waals constant in Nm^4mole^-2
b=31.2*10^-6;//Van der Waals constant in mole^-1m^3
R=8.3;//Universal gas constant in JK^-1(mole)^-1
Cp=3.5;//The specific heat at constant pressure
M=32;//Molecular weight of oxygen

//Calculations
T=t1+273;//The given initial temperature in K
P=p*0.76*13.6*1000*9.8;//The reduce in the pressure
    in N/m^2
T1=((P)/(4.2*M*Cp*R))*(((2*a)/(R*T))-b);//The drop
    in the temperature in K

//Output
printf('The drop in the temperature is %3.4f K ',T1)
```

Scilab code Exa 10.25 Specific heat

```
clc
clear
//Page number 481
//Input data
T=300;//The temperature of the metallic copper disc
    in K
Cp=24.5;//The specific heat at constant pressure in
    J/mol K
a=50.4*10^-6;//The coefficient of thermal expansion
    in K^-1
K=7.78*10^-12;//Isothermal compressibility in N/m^2
V=7.06*10^-6;//The specific volume in m^3/mol

//Calculations
C=(T*V*a^2)/K;//The change in specific heats in J/
    mol K
Cv=Cp-C;//The specific heat at constant volume in J/
    mol K

//Output
printf('The specific heat at constant volume is Cv =
    %3.4f J/mol-K ',Cv)
```

Scilab code Exa 10.26 Temperature

```
clc
clear
//Page number 482
//Input data
p=50;//The reduced pressure in atmospheres
t=27;//The initial temperature of the gas in degree
    centigrade
a=1.32*10^12;//Van der Waal constant a in cm^4 dynes
    /mole^2
b=31.2;//Van der Waal constant b in cm^3/mole
```

```
Cp=7;//The specific heat at constant pressure in cal
    /mole-K

//Calculations
P=p*76*13.6*980;//The reduced pressure in dynes/cm^2
Cp1=Cp*4.2*10^7;//The specific heat at constant
    pressure in ergs/mole-K
T=t+273;//The initial temperature of the gas in K
R=8.31*10^7;//The real gas constant in ergs/mole-K
dT=(P/Cp1)*(((2*a)/(R*T))-b);//The drop in
    temperature in K or degree centigrade

//Output
printf('The drop in temperature produced by
    adiabatic throttling process is %3.3f K (or) %3
    .3f degree centigrade ',dT,dT)

//Error . There is a change in the result compared
    to the textbook because the final calculations
    did in the textbook went wrong , so the final
    result varied from the textbook
```

Scilab code Exa 10.27 Index

```
clc
clear
//Page number 482
//Input data
t=0;//The initial temperature of mercury in degree
    centigrade
p=1;//The initial pressure of mercury in atmospheres
Cp=28;//The specific heat at constant pressure in J/
    mol K
V=1.47*10^-5;//The given specific volume in m^3/mol
b=1.81*10^-6;//The given volume expansivity in K^-1
```

```
k=3.89*10^-11;//The given compressibility in pa^-1

//Calculations
T=t+273;//The initial temperature of mercury in K
Cv=Cp-((T*V*b^2)/k);//The specific heat at constant
    volume in J/mol K
g=Cp/Cv;//The adiabatic index

//Output
printf('The adiabatic index is %3.0f ',g)
```

Scilab code Exa 10.28 Radius

```
clc
clear
//Page number 483
//Input data
K=24*10^-3;//The coefficient of thermal conductivity
     of an oxygen molecule in J/m.s.K
Cv=20.9*10^3;//The specific heat at constant volume
    in J/kilo.mole.K
k=1.38*10^-23;//The boltzmanns constant in J/K
m=5.31*10^-26;//The mass of an oxygen molecule in kg
T=273;//The temperature of the molecule in K
pi=3.142;//Mathematical constant of pi

//Calculations
C=((3*k*T)/m)^(1/2);//The velocity of the molecule
    in m
r=(((3*k*T*m)^(1/2)*Cv)/(3*2^(1/2)*pi*K))^(1/2);//
    The radius of an oxygen molecule in m

//Output
printf('The radius of an oxygen molecule is  %3.4g m
     ',r)
```

```

//Error . There is a change in the result compared
    to the textbook because the final calculations
    did in the textbook went wrong , so the final
    result varied from the textbook
```

Scilab code Exa 10.29 Temperature

```
clc
clear
//Page number 483
//Input data
b=0.3;//The given wiens constant in cm-K
l=5500;//The given wavelength in A units

//Calculations
L=l*10^-8;//The given wavelength in cm
T=b/L;//The temperature of the sun in K

//Output
printf('The temperature of the sun is  %3.0f K ',T)
```

Scilab code Exa 10.30 Temperature

```
clc
clear
//Page number 483
//Input data
R=1*10^4;//The rate at which black body loses
    thermal energy in watts/m^2
s=5.672*10^-8;//Stefans constant in SI units

//Calculations
```

```
T=(R/s)^(1/4);//The temperature of the black body in
    K

//Output
printf('The temperature of the black body is  %3.0f
   K',T)
```

Scilab code Exa 10.31 Temperature

```
clc
clear
//Page number 484
//Input data
T=6174;//The temperature of the black body in K
l=4700;//The wavelength of the black body emitting
    in amstrong units
l1=1.4*10^-5;//The wavelength to be emitted by the
    black body in m

//Calculations
L=l*10^-10;//The wavelength of the black body
    emitted at 6174 K in m
L1=l1;//The wavelength to be emitted by the black
    body in m
T1=(L*T)/L1;//The temperature to be maintained by
    the black body in K

//Output
printf('The temperature to be maintained by the
    black body is %3.2f K ',T1)
```

Scilab code Exa 10.32 Energy

```
clc
clear
//Page number 484
//Input data
T=5800;//The temperature of the sun in K

//Calculations
r=7*10^8;//The radius of the sun in m
pi=3.142;//The mathematical constant of pi
A=4*pi*r^2;//The surface area of the sun in m^2
s=5.672*10^-8;//Stefans constant in SI units
U=A*s*T^4;//The total energy emitted by sun per second in J
r1=1.5*10^11;//The distance of the earths atmosphere from the sun in m
R=(U/(4*pi*r1^2))/1000;//Energy reaching the top of earths atmosphere in kW/m^2

//Output
printf('The total radiant energy emitted by sun per second is %3.4g J \n The rate at which energy is reaching earths atmosphere is %3.1f kW/m^2 ',U,R)
```

Scilab code Exa 10.33 Energy

```
clc
clear
//Page number 485
//Input data
n=5;//The molecules of ozone in grams
t=27;//The temperature of ozone in degree centigrade
R=8.3;//The universal gas constant in J/g-mol/K

//Calculations
```

```
T=t+273; //The temperature of ozone in K
U=n*((3/2)*R*T); //The energy of ozone in J

//Output
printf('The energy of 5 gms molecules of ozone at 27
    degree centigrade is %3.6g J ',U)
```

Scilab code Exa 10.34 Pressure

```
clc
clear
//Page number 485
//Input data
t=-1; //The pressure required to lower the melting
   point of ice in K
l=79.6; //The latent heat of ice in cal/g
V1=1; //The specific volumes of water at 0 degree
   centigrade in cm^2
V2=1.091; //The specific volumes of ice at 0 degree
   centigrade in cm^2
p=1.013*10^6; //One atmospheric pressure in dyne/cm^2

//Calculations
T=273; //The temperature of water in K
L=l*4.18*10^7; //The latent heat of ice in ergs/g
p1=(L*t)/(T*(V1-V2)); //The obtained pressure in
   dynes/cm^2
P=p1/p; //The obtained pressure in atmospheres
P1=P+1; //The required pressure in atmospheres

//Output
printf('The pressure required is %3.2f atmospheres
   ',P1)
```

Scilab code Exa 10.35 Energy

```
clc
clear
//Page number 485
//Input data
t1=127;//The temperature of the black body in degree
    centigrade
t2=27;//The temperature of the walls maintained in
    degree centigrade
s=5.672*10^-8;//Stefans constant in SI units

//Calculations
T1=t1+273;//The temperature of the black body in K
T2=t2+273;//The temperature of the walls maintained
    in K
R=s*(T1^4-T2^4);//The net amount of energy lost by
    body in W/m^2

//Output
printf('The net amount of energy lost by body per
    sec per unit area is  %3.1f watts/m^2',R)
```

Scilab code Exa 10.36 Temperature

```
clc
clear
//Page number 486
//Input data
t2=7;//The low temperature of reservoir in degree
    centigrade
```

```
n1=50;//The efficiency of the carnots engine in
   percentage
n2=70;//The increased efficiency of the carnots
   engine in percentage

//Calculations
T2=t2+273;//The low temperature of the reservoir in
   K
T1=T2/(1-(n1/100));//The temperature of the source
   reservoir in K
T11=T2/(1-(n2/100));//The temperature to be
   maintained by the source reservoir in K
T=T11-T1;//The increase in temperature of the source
    in K or degree centigrade

//Output
printf('The increase in temperature of the source is
    %3.1f K (or) %3.1f degree centigrade ',T,T)
```

Scilab code Exa 10.37 Temperature

```
clc
clear
//Page number 486
//Input data
T1=6174;//The temperature of the black body in K
l1=4700;//The wavelength emitted by the black body
   in amstrong units
l2=1400;//The wavelength to be emitted by the black
   body in amstrong units

//Calculations
T2=(l1*T1)/l2;//The temperature to be maintained by
   the black body in K

```

```
//Output
printf('The temperature to be maintained by the
   black body is  %3.0f K ',T2)
```

Scilab code Exa 10.38 Energy

```
clc
clear
//Page number 487
//Input data
e=8.5*10^28;//The given energy density of electrons
   in copper in electrons/m^3
k=1.38*10^-23;//The boltzmann constant in J/K
h=6.62*10^-34;//Planks constant in J.s
m=9.1*10^-31;//The given mass of electrons in kg
pi=3.14;//The mathematical constant of pi

//Calculations
E=(((3*e)/pi)^(2/3))*(h^2)*(1/8)*(1/m);//The fermi
   energy for copper in J
EF=E/(1.6*10^-19);//The fermi energy for copper in
   eV

//Output
printf('The fermi energy for copper at absolute zero
    is  %3.3f eV ',EF)
```

Scilab code Exa 10.39 mass

```
clc
clear
//Page number 487
//Input data
```

```
t1=100;//The temperature of the source in degree
    centigrade
t2=0;//The temperature of the sink in degree
    centigrade
P=100;//The power of the engine in watts (or) J/s
l=80;//The latent heat of ice in cal/g

//Calculations
T1=t1+273;//The temperature of the source in K
T2=t2+273;//The temperature of the sink in K
L=l*4.2*10^3;//The latent heat of ice in ergs/kg
W=P*60;//The amount of work done in one minute in J
H2=(W*T2)/(T1-T2);//The amount of heat at the sink
    in J
m=(H2/L);//The amount of ice melts in kg

//Output
printf('The amount of ice that will melt in one
    minute is %3.5f kg ',m)
```

Scilab code Exa 10.40 Speed

```
clc
clear
//Page number 488
//Input data
C1=1.84;//The RMS speed of molecules of hydrogen at
    NTP in km/s
p1=2;//The molecular weight of hydrogen
p2=32;//The molecular weight of oxygen

//Calculations
C2=C1*(p1/p2)^(1/2);//The RMS speed of oxygen at NTP
    in km/s
C21=C2*1000;//The RMS speed of oxygen at NTP in m/s
```

```
//Output
printf('The RMS speed of oxygen at NTP is  %3.2f km/s (or) %3.0f m/s ',C2,C21)
```

Scilab code Exa 10.41 Heat

```
clc
clear
//Page number 488
//Input data
t=101;//The temperature at which water boils in degree centigrade
p=787;//The pressure maintained at water boils in mm of Hg
t1=100;//Normal boiling point of water in degree centigrade
T=t1+273;//Normal boiling point of water in K
p1=760;//The normal maintained pressure in mm of Hg
V2=1601;//The specific volume of water evaporation in cm^3
V1=1;//The specific volume of water in cm^3

//Calculations
V=V2-V1;//The change in specific volume in cm^3
dT=t-t1;//The change in temperature in degree centigrade or K
dP=(p-p1)/10;//The change in pressure in cm of Hg
L=(T*dP*13.6*980*V)/dT;//Latent heat of steam in ergs/g
L1=L/(4.2*10^7);//The latent heat of steam in cal/g

//Output
printf('The latent heat of steam is  %3.4g ergs/g  (or) %3.2f cal/g ',L,L1)
```

Scilab code Exa 10.42 Fermi energy

```
clc
clear
//Page number 488
//Input data
d=7.7*10^3;//The density of aluminium in kg/m^3
w=27;//The atomic weight of Al in kg/k.mol
N=6.023*10^26;//The number of free electrons in Al
k=1.38*10^-23;//The boltzmann constant in J/K
h=6.62*10^-34;//Planks constant in J.s
m=9.1*10^-31;//The given mass of electrons in kg
pi=3.14;//The mathematical constant of pi

//Calculations
V=w/d;//The volume occupied by Al in m^3/k.mol
E=(((3*(N/V))/pi)^(2/3))*(h^2)*(1/8)*(1/m);//The
    fermi energy for aluminium in J
EF=E/(1.6*10^-19);//The fermi energy for aluminium
    in eV
p=(2/3)*(N/V)*(E);//The pressure of electrons in
    aluminium at absolute zero in N/m^2

//Output
printf('The fermi energy for aluminium at absolute
    zero is %3.3f eV \n The pressure of electrons in
     aluminium at absolute zero is %3.4g N/m^2',EF,p
    )
```

Scilab code Exa 10.43 Heat

```
clc
clear
//Page number 489
//Input data
t2=20;//The temperature of room in degree centigrade
t1=37;//The skin temperature of the boy in degree
    centigrade
t=10;//The given time in min
A=3;//The surface area of the student in m^2
e=0.9;//The emissivity of the student

//Calculations
T2=t2+273;//The temperature of the room in K
T1=t1+273;//The skin temperature of the boy in K
t1=t*60;//The given time in sec
s=5.67*10^-8;//Stefans constant in W/m^2-K^4
R=e*A*s*(T1^4-T2^4);//Heat loss by the skin in one
    second in J/s
Q=R*t1;//Total heat loss by the skin in 10 minutes
    in J

//Output
printf('The total heat loss by the skin in 10
    minutes is %3.4g J ',Q)
```

Scilab code Exa 10.44 Pressure

```
clc
clear
//Page number 489
//Input data
t1=20;//The temperature of the air in the cylinder
    of a combustion engine in degree centigrade
p1=1;//The initial pressure of the air in
    atmospheres
```

```
V1=8*10^-4;//The initial volume of the air in m^3
V2=6*10^-5;//The final volume of the air in m^3
g=1.4;//The adiabatic index

//Calculations
T1=t1+273;//The temperature of the air in K
p2=p1*(V1/V2)^(g);//The final pressure of the gas in
    atmospheres
T2=(p2/p1)*(V2/V1)*T1;//The final temperature of the
    gas in K
T21=T2-273;//The final temperature of the gas in
    degree centigrade

//Output
printf('The final pressure of the gas is %3.1f
    atmospheres \n The final temperature of the gas
    is %3.1f K (or) %3.1f degree centigrade ',p2,T2
    ,T21)
```

Scilab code Exa 10.47 Mean Free path

```
clc
clear
//Page number 491
//Input data
d=2*10^-10;//The molecular diameter of an ideal gas
    in m
t=20;//The temperature of the gas in degree
    centigrade
p=1;//The pressure of the gas in atmosphere
pi=3.142;//The mathematical constant of pi

//Calculations
T=t+273;//The temperature of the gas in K
P=1.01*10^5;//The pressure of the gas in N/m^2
```

```
v=511;//The velocity of the molecules at 20 degree
    centigrade in m/s
k=1.38*10^-23;//Boltzman constant in J/K
n=P/(k*T);//The number of molecules per m^3
l=1/(1.414*pi*d^2*n);//The mean free path in m
f=v/l;//The collision frequency in per second

//Output
printf('(a)The mean free path is  %3.4g m  \n (b)The
     collision frequency is  %3.4g per second ',l,f)
```

Scilab code Exa 10.48 Collision

```
clc
clear
//Page number 492
//Input data
l=1.876*10^-7;//The mean free path of the gas in m
v=511;//The average speed of the molecule in m/s

//Calculations
f=v/l;//The collision frequency in per second

//Output
printf('The collision frequency is  %3.4g per second
     ',f)
```

Scilab code Exa 10.49 Entropy

```
clc
clear
//Page number 492
//Input data
```

```
s=1;//The specific heat of water in k cal kg C
m=1;//The mass of ice in kg
H=80;//The latent heat of ice in kcal/kg
H1=540;//The latent heat of steam in kcal/kg
T=273;//The temperature of the ice in K
T1=373;//The temperature of water at 100 degree
    centigrade in K

//Calculations
S1=H/T;//The increase in entropy when 1 kg of ice at
     273 K is converted into water at 273 K in kcal/K
S2=m*s*log(T1/T);//The increase in entropy when 1 kg
     of water at 273 K is converted into water at 373
     K in kcal/K
S3=H1/T1;//The increase in entropy when 1 kg of
    water at 373 K is converted into steam at 373 K
    in kcal/K
S=S1+S2+S3;//The total increase in entropy in kcal/K

//Output
printf('The total increase in entropy is  %3.3f kcal
    /K ',S)
```

Scilab code Exa 10.50 Temperature

```
clc
clear
//Page number 493
//Input data
t1=27;//The initial temperature of the gas in degree
     centigrade
g=1.4;//The adiabatic index
p1=1;//Let the initial pressure in atmospheres
p2=2*p1;//The final pressure in atmospheres

```

```
//Calculations
T1=t1+273;//The initial temperature of the gas in K
T2=(((p2/p1)^(g-1))*(T1)^g)^(1/g);//The final temperature of the gas in K
T=T2-T1;//The rise in temperature of a gas in K or degree centigrade

//Output
printf('The rise in temperature is  %3.1f degree centigrade ',T)
```

Scilab code Exa 10.51 Work done

```
clc
clear
//Page number 493
//Input data
V1=10^-3;//One litre of monoatomic perfect gas at NTP in m^3
V2=(V1/2);//The final volume in m^3
g=1.67;//The adiabatic index

//Calculations
W=(1/(g-1))*((1/(V2)^(g-1))-(1/(V1)^(g-1)));//The work done on the gas in J

//Output
printf('The work done on the gas is  %3.1f J ',W)
```

Scilab code Exa 10.52 Temperature

```
clc
clear
```

```
//Page number 494
//Input data
T1=1200;//The temperature at which first engine
    receives heat in K
T2=300;//The temperature at which second engine
    rejects to heat reservoir in K

//Calculations
Tw=(T1+T2)/2;//The temperature when the work outputs
     of two engines are equal in K
Te=(T1*T2)^(1/2);//The temperature when the
    efficiency of two engines are equal in K

//Output
printf('(a)The temperature when the work outputs of
    two engines are equal is %3.0f K \n (b)The
    temperature when the efficiency of two engines
    are equal is %3.0f K ',Tw,Te)
```

Scilab code Exa 10.53 Work done

```
clc
clear
//Page number 495
//Input data
t1=27;//The temperature of the source in degree
    centigrade
t2=-73;//The temperature of the sink in degree
    centigrade
H2=300;//The amount of heat released by the sink in
    cal

//Calculations
T1=t1+273;//The temperature of the source in K
T2=t2+273;//The temperature of the sink in K
```

```
H1=H2*(T1/T2);//The amount of heat released by the
    source in cal
W=H1-H2;//The work performed per cycle in cal
W1=W*4.2;//The work performed per cycle in J

//Output
printf('The work performed by the engine per cycle
    is  %3.0f J ',W1)
```

Scilab code Exa 10.54 Power

```
clc
clear
//Page number 495
//Input data
m=3;//The rate at which ice melts in kg/hour
t=28;//The external temperature in degree centigrade
Li=3.3*10^5;//Specific latent heat of ice fusion in
    Jkg^-1
s=4.2*10^3;//The specific heat in Jkg^-1.C

//Calculations
Q=(m*Li)+(m*s*t);//The heat taken by the ice to melt
     into water in J
P=Q/3600;//To prevent melting of ice ,the
    refrigerator should have the power out in J/s

//Output
printf('The minimum power output of the motor is  %3
    .0f watts ',P)
```

Scilab code Exa 10.55 Temperature

```
clc
clear
//Page number 496
//Input data
Li=3.3*10^5;//Specific latent heat of ice fusion in
   Jkg^-1
V1=1.090*10^-3;//The specific volume of one kg of
   ice in m^3
V2=10^-3;//The specific volume of one kg of water in
    m^3
T=273;//The temperature maintained in K
dP=1.01*10^5;//The increase in pressure in N/m^2

//Calculations
dT=-(dP*T*(V2-V1))/Li;//The depression in the
   melting point of ice in K (or) degree centigrade

//Output
printf('The depression of melting point of ice is
   %3.2g K  (or) %3.2g degree centigrade ',dT,dT)
```

Scilab code Exa 10.56 Temperature

```
clc
clear
//Page number 497
//Input data
dp=100;//The change in mercury pressure in cm of Hg
v2=1601;//Specific volume of steam in cm^3/gram
v1=1;//Specific volume of water in cm^3/gram
l=536;//Latent heat in cal/gram
t=100;//The temperature of the steam in degree
   centigrade

//calculations
```

```
dP=1*13.6*10^3*9.8;//The change in mercury pressure
   in N/m^2
V2=v2*10^-3;//Specific volume of steam in m^3/kg
V1=v1*10^-3;//Specific volume of water in m^3/kg
L=l*4.2*10^3;//Latent heat in J/kg
T=t+273;//The temperature of the steam in K
dT=(dP*T*(V2-V1))/L;//The increase in boiling point
   of water in K or degree centigrade

//Output
printf('The increase in boiling point of water is
   %3.2f K  (or) %3.2f degree centigrade ',dT,dT)
```

Scilab code Exa 10.57 Temperature

```
clc
clear
//Page number 497
//Input data
L=80;//The latent heat of fusion of ice in cal/gm
Li=3.3*10^5;//Specific latent heat of ice fusion in
   Jkg^-1
dp=1;//The increase in pressure in atmospheres
t=0;//The given temperature in degree centigrade
v=-0.1;//The change in specific volume in cm^3/gm

//Calculations
dP=0.76*13.6*10^3*9.8;//The increase in pressure in
   N/m^2
V=v*10^-3;//The change in specific volume in m^3/kg
T=t+273;//The given temperature in K
dT=-(dP*T*(V))/Li;//The decrease in the melting
   point of ice with increase in the pressure of one
    atmosphere in K

```

```
//Output
printf('The decrease in melting point of ice is %3
    .4f K (or) %3.4f degree centigrade ',dT,dT)
```

Scilab code Exa 10.58 Entropy

```
clc
clear
//Page number 498
//Input data
R=8.4;//The universal gas constant in J.mol^-1.K^-1
Cv=21;//The spacific heat at constant volume in J.
    mol^-1.K^-1
P1=2*10^5;//The initial pressure of gas in N/m^2
V1=20;//The initial volume of the gas occupied in
    litres
P2=5*10^5;//The final pressure of the gas in N/m^2
V2=50;//The final volume of the gas occupied in
    litres

//Calculations
T=(P2*V2)/(P1*V1);//The ratio of final temperature
    to the initial temperature for perfect gas
V=V2/V1;//The ratio of final volume to the initial
    volume for perfect gas
S=(Cv*log(T))+(R*log(V));//The change of entropy in
    J/K

//Output
printf('The increase in entropy is %3.2f J/K ',S)
```

Scilab code Exa 10.59 Entropy

```
clc
clear
//Page number 499
//Input data
s=4.2*10^3;//The specific heat of water is J/kg.C
m1=0.1;//The mass of water at 15 degree centigrade
    in kg
m2=0.16;//The mass of water at 40 degree centigrade
    in kg
t1=15;//The temperature of the first water in degree
     centigrade
t2=40;//The temperature of the second water in
    degree centigrade

//Calculations
T1=t1+273;//The temperature of the first water in K
T2=t2+273;//The temperature of the second water in K
T=((m1*T1)+(m2*T2))/(m1+m2);//The final mixed
    temperature in K
s1=m1*s*2.3026*log10(T/T1);//The change in entropy
    for 0.1 kg of water in J/K
s2=m2*s*2.3026*log10(T/T2);//The change in entropy
    for 0.16 kg of water in J/K
S=s1+s2;//The net change in the entropy of the
    system in J/K

//Output
printf('The net increase in entropy is  %3.2f J/K ',
    S)
```

Scilab code Exa 10.60 Entropy

```
clc
clear
//Page number 500
```

```
//Input data
m=12.5*10^-3;//The amount of ice in kg
li=80;//Latent heat of ice in cal/gram
l=536;//Latent heat of steam in cal/gram
si=0.5;//Specific heat of ice in cal/gram-K
sw=1;//Specific heat of water in cal/gram-K
T1=-24+273;//The initial temperature of ice in K
T2=0+273;//The final temperature of ice in K
T3=100+273;//The final temperature of water in K

//Calculations
Li=li*10^3*4.2;//The latent heat of ice in J/kg
Ls=l*10^3*4.2;//The latent heat of water in J/kg
Si=si*10^3*4.2;//The specific heat of ice in J/kg-K
Sw=sw*10^3*4.2;//The specific heat of water in J/kg-K
s1=m*Si*log(T2/T1);//The increase in entropy of ice from 249 K to 273 K in J/K
s2=(m*Li)/T2;//The increase in entropy from 273 K ice to 273 K water in J/K
s3=m*Sw*log(T3/T2);//The increase in entropy of water from 273 K to 373 K in J/K
s4=(m*Ls)/T3;//The increase in entropy from water at 373 K to steam at 373 K in J/K
S=s1+s2+s3+s4;//The total increase in entropy in J/K

//Output
printf('The total increase in entropy is %3.2f J/K ',S)
```

Scilab code Exa 10.61 Time

```
clc
clear
//Page number 502
```

```
//Input data
x1=20;//The initial thickness of the layer in cm
x2=30;//The final thickness of the layer in cm
t1=-15;//The temperature of the surroundings in
   degree centigrade
L=80;//The latent heat of ice in cal/gram
d=0.9;//The given density of ice in g/cm^3
K=0.005;//The coefficient of thermal conductivity in
    C.G.S units

//Calculations
t=((d*L)/(2*K*t1))*(x1^2-x2^2);//The time taken in
   sec

//Output
printf('The time taken for a layer of ice to
   increase the thickness is %3.2g sec ',t)
```

Scilab code Exa 10.62 Temperature

```
clc
clear
//Page number 502
//Input data
t1=121;//The temperature of solid copper sphere in
   degree centigrade
dt1=2.6;//The rate of cooling of copper sphere in
   degree centigrade per minute
t2=195;//The temperature of another solid sphere in
   degree centigrade
t=30;//The surrounding temperature in degree
   centigrade

//Calculations
T1=t1+273;//The temperature of solid copper sphere
```

```
in K
T2=t2+273;//The temperature of another solid copper sphere in K
T0=t+273;//The surrounding temperature in K
R1=1;//Let the radius of the first sphere in m
R2=2*R1;//The radius of the second sphere in m
dt2=(dt1)*(R1/R2)*((T2^4-T0^4)/(T1^4-T0^4));//The rate at which solid copper sphere cools in degree centigrade per minute

//Output
printf('The rate at which solid copper sphere cools is %3.3f degree centigrade per minute ',dt2)
```

Scilab code Exa 10.63 Heat

```
clc
clear
//Page number 504
//Input data
dt=250;//The temperature gradient of an insulated copper rod in degree centigrade per metre
x=0.05;//The distance between the two points in m
K=384;//The thermal conductivity of copper in W.m^-1.K^-1
A=1;//The surface area of the copper rod in m^2
t=1;//The given time in seconds

//Calculations
T=dt*x;//The temperature difference in degree centigrade
Q=K*A*(dt)*t;//The amount of heat crossed per unit area per sec in J/s

//Output
```

```
printf('(1)The difference in temperature between two points seperated by 0.05m is %3.1f degree centigrade \n (2)The amount of heat crossing per second per unit area normal to the rod is %3.2g J/s ',T,Q)
```

Scilab code Exa 10.64 Radiant

```
clc
clear
//Page number 505
//Input data
T1=200;//The first temperature of the black body in K
T2=2000;//The second temperature of the black body in K
s=5.672*10^-8;//Stefans constant in M.K.S units

//Calculations
R=(s*T1^4)/(s*T2^4);//The comparision of radiant emittance of a black body for given temperatures

//Output
printf('The comparision of radiant emittance of a black body at 200 K and 2000 K is %3.0g ',R)
```

Scilab code Exa 10.65 Radiant

```
clc
clear
//Page number 505
//Input data
d=0.08;//The diameter of the black sphere in m
```

```
T=500;//The temperature of the black sphere in K
T0=300;//The temperature of the surroundings in K
s=6*10^-8;//The stefans constant in W m^-2 K^-4
pi=3.14;//The mathematical constant of pi

//Calculations
A=pi*d^2;//The area of the black sphere in m^2
e=1;//The emittance of the black body
R=s*A*e*(T^4-T0^4);//The rate at which energy is
    radiated in J/s or watts

//Output
printf('The rate at which energy is radiated R =  %3
    .2f J/s  (or) %3.2f watts',R,R)
```