Scilab Textbook Companion for Heat And Thermodynamics by A. Manna[1]

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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 2

Thermometry

Scilab code Exa 2.1 Temperature

```
clc
clear

//INPUT
li=1.23;//length of melting ice in mm
lf=18.56;//length of melting ice reading in pressure
    of 74.24cm of mercury in mm
l=10.75;//length of melting ice at which temperature
    to be calculated
mp=0;//melting point in deg.C
T=50;//temperature of melting ice at which length to
    be calculated in deg.C
//boiling point of water changes by 1 deg.C for
   change of pressure of 27mm of mercury

//CALCULATIONS
sp=100-(76-74.24)/(2.7);//76cm of mercury steam
   point is 100 deg.C so at 74.24cm of mercury the
   steam point in deg.C
t=(l-li)*(sp-mp)/(lf-li);//temperature at 10.75mm of
    melting ice in deg.C
```

```
lt=((T*(lf-li))/(sp-mp)+li;//length of ice at 50 deg.C

//OUTPUT
mprintf('the temperature of melting ice at 10.75mm of hg is %3.2f deg.C \n the length of ice corresponding to 50 deg.C is %3.2f mm',t,lt)
```

Scilab code Exa 2.2 Temperature of the liquid air

```
clc
clear

//INPUT
p1=23.5;//pressure when immersed in liquid air in cm
p2=75;//pressure when immersed in ice in cm
p3=102.4;//pressure when immersed in steam in cm
T=100;//boiling point of temperature in deg.C

//CALCULATIONS
t=(p1-p2)*T/(p3-p2);//temperature of the liquid air in deg.C

//OUTPUT
mprintf('the temperature of liquid of air is %3.2f deg.C',t)
```

Scilab code Exa 2.3 Height of the barometer

```
clc
clear

//INPUT
```

```
t1=283;//temperature of bulb when pressure is h-2cm
    of hg in k
t2=546;//temperature of bulb when pressure is h-22cm
     of hg in k
h1=2;//differnce of mercury level at 283k in cm
h2=22;//differnce of mercury level at 546k in cm
//let h is the barometer height,then h-2cm at 283k
    and h-22 at 546k

//CALCULATIONS
h=((h2*t1)+(h1*t2))/(t2-t1);//height of the
    barometer in cm

//OUTPUT
mprintf('height of the barometer is %3.2f cm',h)
```

Scilab code Exa 2.4 Temperature of the furnace

```
clc
clear

//INPUT
p0=76;//pressure at 0 deg.C in cm of hg
p1=228;//pressure (76+152) at T deg.C in cm of hg
t0=273;//temperature of bulb in K

//CALCULATIONS
T=p1*t0/p0;//temperature at 228 cm of hg pressure in
     K

//OUTPUT
mprintf('the temperature of bulb is %3.2f K',T)
```

Scilab code Exa 2.5 The temperature of the bath

```
clc
clear

//INPUT
t1=0;//temperature in deg.C
t2=100;//temperature in deg.C
t3=208;//temperature in deg.C
r1=3.5;//resistance in ohms
r2=5.2;//resistance in ohms
r3=6.9;//resistance in ohms
r4=9.4;//resistance in ohms

//CALCULATIONS
t4=(r3-r1)*100/(r2-r1);//temperature in deg.C
d=(t3-t4)/(2.08*1.08);//deflection
t5=(r4-r1)*100/(r2-r1);//temperature in deg.C
t6=(d*(((t5/100)^2)-t5/100))+t5;//temperature in deg.C
t7=(d*(((t6/100)^2)-t6/100))+t5;//temperature in deg.C
t8=(d*(((t7/100)^2)-t7/100))+t5;//temperature in deg.C
t9=(d*(((t8/100)^2)-t8/100))+t5;//temperature in deg.C

//CALCULATIONS
mprintf('the temperature of the bath is %3.2f deg.C',t9)
```

Chapter 3

The mechanical equivalent of heat

Scilab code Exa 3.1 Rise in temperature

```
clc
clear

//INPUT DATA
m=20;//calorimeter of water equivalent in gm
n=1030;//weight of water in gm
p=2;//no.of paddles
a=10;//weight of each paddle in kg
s=80;//distance between paddles in m
g=980;//accelaration due to gravity in cm/sec^2

//CALCULATIONS
E=(p*a*1000*g*s*100);//potential energy in dyne cm
T=(E)/(1050*4.18*10^7);//rise in temperature in deg.
    C
//if the rise in temp be T,then heat gained by the
    calorimeter and its contets is 1050T so J=(E)
    /(1050*T) where (j=4.18*10^7erg/cal)

```

```
//OUTPUT
mprintf('the rise in temperature of water is %3.2f
    deg.C',T)
```

Scilab code Exa 3.2 The mechanical equivalent of heat

```
clc
clear

//INPUT DATA
cp=0.1;//specific heat of copper in kj/kg-K
w=120;//weight of copper calorimeter in gm
a=1400;//weight of paraffin oil in gm
cp1=0.6;//specific of parafin oil in kj/kg-K
b=10^8;//force to rotate the paddle in dynes
T=16;//rise in temperature in deg.C
n=900;//no.of revolutions stirred
pi=3.14;//value of pi

//CALCULATIONS
c=2*pi*b;//work done by a rotating paddle per
    rotation in dyne cm per rotation
d=c*n;//total work done in dyne cm
hc=w*cp*16;//heat gained by calorimeter in calories
hp=a*cp1*16;//heat gaained by paraffin oil in
    calories
J=d/(hc+hp);//mecanical equivalent of heat in erg/
    cal

//OUTPUT
mprintf('mecanical equivalent of heat is %3.0f erg/
    cal',J)
```

Scilab code Exa 3.3 The mechanical equivalent of heat

```
clc
clear

//INPUT DATA
cp=0.12;//specific heat of iron in kj/kg-K
m=25;//mass of iron in lb
h=0.4;//horse power developed in 3 min
t=3;//time taken to develop the horse power in min
T=17;//raise in temp in deg.C

//CALCULATIONS
w=h*33000*t;//total work done in ft-lb
H=m*cp*T;//aount of heat developed in B.Th.U
J=(w)/H;//the value of mechanical equivalent of heat

//OUTPUT
mprintf('the mechanical equivalent of water is %3.1f ft-lb/B.Th.U',J)
```

Scilab code Exa 3.4 Kinetic energy of each block and Mean rise of temperature

```
clc
clear

//INPUT DATA
n=2;//no.of lead blocks
m=210;//mass of each lead block in gm
v=20000;//velocity of block relative to earth in cm/sec
J=4.2*10^7;//mechanical equivalent of heat in ergs/calorie
cp=0.03;//specific heat of lead in kj/kg-K
```

```

//CALCULATIONS
E=(m*v^2)/2;//kinetic energy of each block in ergs
E2=n*E;//total kinetic energy in ergs
T=E2/(J*m*n*cp);//mean rise in temperature in T

//OUTPUT
mprintf('the mean rise in temperature is %3.1f deg.C
    ',T)
```

Scilab code Exa 3.5 Rise of temperature

```
clc
clear

//INPUT DATA
h=150;//height froom which ball fallen in ft
cp=0.03;//specific heat of lead in kj/kg-K
J=778;//mechanical equivalent of heat in ft lb/B.Th.
    U

//CALCULATIONS
//assume m be the mass of the lead
//work done in falling through 160 feet in ft-lb w
    =160*m
//heat absorbed by the ball in B.Th.U h=m*cp*T
//work done in falling is equal to heat absorbed by
    the ball
T=160/(J*cp)*(5/9);//the raise in temperature in T

//OUTPUT
mprintf('the raise in temperature is %3.1f deg.C',T)
```

Scilab code Exa 3.6 The rate at which the horse worked

```
clc
clear

//INPUT DATA
w=26.6;//work done one horse in to raise the temperature in lb
T1=32;//temperature at initial in deg.F
T2=212;//temperature at final in deg.F
t=2.5;//time to raise the tmperature in hrs
p=25;//percentage of heat lossed

//CALCULATIONS
//let x ft-lb per min be the rate at which horse worked//total work done in ft-lb wt W=x*150
//amount of heat generated in lb deg.F H=W/778
//only 75% of heat is utillised
x=w*180*100*778/((100-p)*150);//the rate at which horse worked

//OUTPUT
mprintf('the rate at which horse worked is %3.0f ft-lb wt/min',x)
```

Scilab code Exa 3.7 The rise in temperature

```
clc
clear

//INPUT DATA
l=100;//length of glass tube in cm
m=500;//mass of mercury in glass tube in gm
n=20;//number of times inverted i succession
cp=0.03;//specific heat of mercury in cal/gm/deg.C
```

```
J=4.2;//joule's equivalent in j/cal
g=981;//accelaration due to gravity in cm/s^2

//CALCULATIONS
PE=m*g*l;//potential energy for each time in ergs
TE=PE*n;//total loss in ergs
T=TE/(m*cp*J*10^7);//rise in temperature in deg.C
//if T is the rise in temperature,then heat
    devoloped is m*cp*T

//OUTPUT
mprintf('the rise in temperature is %3.2f deg.C',T)
```

Scilab code Exa 3.8 Calories emitted per second

```
clc
clear

//INPUT DATA
d=0.02;//diameter of the copper wire in cm
i=1;//current in amp
T=100;//maximum steady temperature in deg.C
r=2.1;//resistance of the wire in ohm cm
J=4.2;//mechanical equivalent of heat in j/cal
a=3.14*d^2/4;//area of the copper wire in sq.cm
a2=1;//area of the copper surface in sq.cm

//CALCULATIONS
//we know that if r is the resistance of the wire
    through which current i flows,then the electrical
     energy spent =i^2*r j/sec
l=1/(2*3.14*d/2);//length corresponding to the area
    in cm
R=r*l/a;//resistance of the copper wirein ohm
w=R*a2^2;//work done in joule
```

```
h=w/J;//heat devoleped in cal

//OUTPUT
mprintf('the heat developed is %3f calories',h)
```

Scilab code Exa 3.9 The quantity of heat produced and The rise in temperature of water

```
clc
clear

//INPUT DATA
h=10000;//vertical height of water fall in cm
v=5;//volume disharged per sec in litres
J=4.18;//joule's constant in j/cal
g=981;//accelaration due to gravity in cm/sec^2

//CALCULATIONS
m=v*1000;//mass of water disharged per sec in gm
w=m*h*g;//work done in falling through 100m in erg
H=w/(J*10^7);//quantity of heat produced in cal
T=H/m;//rise in temperature in deg.C

//OUTPUT
mprintf('the quantity of heat produced is %3f cal \n
    the rise in temperature is %3.2f deg.C',H,T)
```

Scilab code Exa 3.10 The rise in temperature

```
clc
clear

//INPUT DATA
```

```
cp=0.03;//specific heat of lead in kj/kg.k
v=10000;//initial velocity of bullet in cm/sec
J=4.2*10^7;//joules constant in ergs/cal

//CALCULATIONS
//let mass of the bullet in gm
ke=(v^2)/2;//kinetic energy of the bullet per unit
    mass in (cm/sec)^2
//T is the rise in temperature,then heat produced is
    m*cp*T
//95% of kinetic energy is converted to heat
T=ke*95/(cp*J*100);//rise in temperature in deg.C

mprintf('the rise in temperature is %3.1f deg.C',T)
```

Scilab code Exa 3.11 The difference in temperature

```
clc
clear

//INPUT DATA
h=5000;//height of the niagara falls in cm
J=4.2*10^7;//joules constant in ergs per cal
g=981;//accelaration due to gravity in cm/sec^2

//CALCULATIIONS
w=h*g;//work done per unit mass in ergs/gn
T=w/J;//rise in temperature in deg.C

//OUTPUT
mprintf('the rise in temperature is %3.2f deg.C',T)
```

Scilab code Exa 3.12 The value of J

```
clc
clear

//INPUT DATA
//callender and barnes continous flow method
V1=3;//potential difference in v
V2=3.75;//potential differnce in v
i1=2;//current in amp
i2=2.5;//current in amp
T=2.7;//the rise in temperature of the water in deg.
    C
m1=30;//water flow rate at 3 volts in gm/min
m2=48;//water flow rate at 3.75volts in gm/min
s=1;//specific heat of the water kj/kg-K

//CALCULATIONS
J=(V1*i1-V2*i2)/(s*T*(m1-m2)/60);//the mechanical
    equivalent in j/cal

//OUTPUT
mprintf('the mechanical equivalent is %3.3f j/cal',J
    )
```

Scilab code Exa 3.13 The rise in temperature

```
clc
clear

//INPUT DATA
R=64*10^7;//mean radius of the earth in cm
cp=0.15;//specific heat of earth in kj/kg-K
J=4.2*10^7;//joules constant in erg/cal

//CALCULATIONS
i=2/5*R^2;//moment of inertia of the earth per unit
```

```
mass in joules
w=(2*3.14)/(24*60*60);//angular velocity of the earth in rad/sec
T=(i*w^2)/(2*J*cp);//rise in temperature in deg.C

//OUTPUT
mprintf('the rise in the temperature is %3.1f deg,C',T)
```

Scilab code Exa 3.14 The mechanical equivalent of heat

```
clc
clear

//INPUT DATA
cp=1.25;//specific heat of helium inkj/kg-K
v=1000;//volume of the gas in ml
w=0.1785;//mass of the gas at N.T.P in gm
p=76*13.6*981;//pressure of the gas at N.T.P in dynes
T=273;//temperature at N.T.P in K

//CALCULATIONS
V=1000/w;//volume occupied by the 1gm of helium gas in cc
cv=cp/1.66;//specific heat at constant volume it is monatomuc gas kj/kg-K
r=p*V/T;//gas constant in cm^3.atm./K.mol
J=r/(cp-cv);//mechanical equivalent of heat in erg/cal

//OUTPUT
mprintf('the mechanical equivalent of heat is %3.2f ergs/calories',J)
```

Scilab code Exa 3.15 The mechanical equivalent of heat

```
clc
clear

//INPUT DATA
n=1/273;//coefficent of expaaansion of air
a=0.001293;//density of air in gm/cc
cp=0.2389;//specific heat at constant pressure in kj
    /kg.K
p=76*13.6*981;//pressure at 0 deg.C in dynes

//CALCULATIONS
J=(p*n)/(a*(cp-(cp/1.405)));//mechanical equivalent
    of heat

//OUTPUT
mprintf('mechanical equivalent of heat is %3.2f ergs
    /cal',J)
```

Scilab code Exa 3.16 The value of J

```
clc
clear

//INPUT DATA
//continous flow calorimeter
r=120/60;//rate of flow of water in gm/sec
T1=27.30;//temperature at initial in deg.C
T2=33.75;//temperature at final in deg.C
v=12.64;//potential drop in volts
s=1;//specific heat of water in kj/kg-K
```

```
i=4.35;//current through the heating element in amp

//CALCULATIONS
J=(v*i)/(r*s*(T2-T1));//the mechanical equivalent of heat in joule/calorie

//OUTPUT
mprintf('the mechanical equivalent of heat is %3.2f j/cal',J)
```

Scilab code Exa 3.17 the value of J

```
clc
clear

//INPUT DATA
cp=6.865;//molar specific heat of hydrogen at constant pressure in kj/kg-K
cv=4.880;//molar specific heat of hydrogen at constant volume in kj/kg-K
p=1.013*10^6;//atmospheric pressure in dynes/cm^2
v=22.4*10^3;//gram molar volume in ml
T=273;//temperature at N.T.P in kelvins

//CALCULATIONS
J=(p*v)/(T*(cp-cv));//mechanical equivalent of heat

//OUTPUT
mprintf('the mechanical equivalent of heat is %3.2f j/cal',J)
```

Scilab code Exa 3.18 The value of J

```
clc
clear

//INPUT DATA
v=1000;//volume of hydrogen in ml
t=273;//tempature of hydrogen in kelvin
p=760;//pressure of hydrogen in mm of hg
w=0.0896;//weigh of hydrogen in gm
cp=3.409;//specific heat of hydogen in kj/kg-K
cv=2.411;//specific heat of hydrogen in kj/kg-K
g=981;//accelaration due to gravity in cm/sec^2
a=13.6;//density of mercury in gm/cm^2

//CALCULATIONS
J=(p*v*g*a)/(w*t*(cp-cv));//mechanical equivalent of heat in ergs/cals
//OUTPUT
printf('mechanical equivalent of heat is %3.2f ergs/calorie',J)
```

Scilab code Exa 3.19 The specific heat at constant volume

```
clc
clear

//INPUT DATA
cp=0.23;//specific heat at constant pressure in kj/kg-K
a=1.18;//density of air in gm/lit
J=4.2*10^7;//mechanical equivalent of heat in ergs/cal
t=300;//temperature of air in kelvin
p=73*13.6*981;//pressure of air in dynes
//cp-cv=(r/J)=pv/(tj)

```

```
//CALCULATON
cv=cp-(p*1000/(a*t*J));//specific heat at constant volume in calories

//OUTPUT
mprintf('the specific heat at constant volume is %3.5f calories',cv)
```

Scilab code Exa 3.20 The height from which it fallen

```
clc
clear

//INPUT
t1=0;//temperature of water in deg.C
t2=0;//temperature of ice in deg.C
J=4.18*10^7;//the joules thomson coefficent in erg/cal
l=80;//latent heat og fusion kj/kg
g=981;//accelaration due to gravity in cm/sec^2

//CALCULATIONS
h=l*J/(15*g);//height from which ice has fallen
//1/15 ice has been melted

//OUTPUT
mprintf('the height from which ice has fallen is %3.2f cm',h)
```

Scilab code Exa 3.21 The velocity of bullet

```
clc
clear
```

```

//INPUT DATA
T=80;//temperature of bullet in deg.C
cp=0.03;//specific heat of lead in kj/kg-K
J=4.2;//mechanical equivalent of heat in j/cal

//CALCULATIONS
//90 percent of kinetic energy is converted to heat
h=T*cp;//heat developed per unit mass in calorie
v=(J*10^7*h*2/0.9)^0.5;//velocity of bullet in cm/
    sec

//OUTPUT
mprintf('the velocity of bullet is %3.2f cm/sec',v)
```

Scilab code Exa 3.22 The rise in temperature

```
clc
clear

//INPUT DATA
w=5.0;//weight of lead ball in lb
cp=0.032;//specific heat of lead in Btu/lbdeg.F
h=50;//height at which ball thrown in feets
v=20;//vertical speed in ft/sec
g=32;//accelararion due to gravity in ft/sec^2

//CALCULATIONS
//half the kinetic energy is converted into heat
    after instant impact with ground
u=(v^2)+2*g*h
ke=(w/2*(u));//kinetic energy of the ball at ground
T=ke/(2*32*778*w*cp);//rise of temperature in deg.F

//OUTPUT
```

```
mprintf('the rise in temperature is %3.2f deg.F',T)
```

Chapter 4

Kinetic theory of gases

Scilab code Exa 4.1 The temperature

```
clc
clear

//INPUT
t=273;//temperture of the oxygen molecule in K
m=32;//molecular mass of the gas in gm
r=8.32*10^7;//molar gas constant in ergs per mole
v2=33200;//velocity of the gas in cm/sec

//CALCULATIONS
v1=((3*r*t)/m)^(1/2);//rms velocity of the molecule
   in cm/s
T=((v2*v2*m)/(3*r));//temperature of the molecule
   with sound has velocity in K

//OUTPUT
mprintf('the rms velocity of the molecule is %3.2fcm
   /s \n the temperature of the molecule is %3.0fK',
   v1,T)
```

Scilab code Exa 4.2 The temperature

```
clc
clear

//INPUT
t1=308;//temperature of the nitrogen molecule in K
m1=28;//molecular mass of the nitrogen in gm
m2=2;//molecular mass of the hydrogen molecule in gm

//CALCULATIONS
t2=(t1*m2/m1);//temperature of the hydrogen molecule
    in K
//GIVEN avg.speed of both the molecules are same

//OUTPUT
mprintf('the temperature of the hydrogen molecule is
    %3.0fK',t2)
```

Scilab code Exa 4.3 The RMS velocity at NTP

```
clc
clear

//INPUT
y=0.00129;//density of the air in gm/cc
p=76;//pressure of the nitrogen molecule in cm
g=981;//accelaration due to gravity in cm/sec^2
m=13.6;//density of the mercury in gm/cc

//CALCULATIONS
```

```
v=((3*p*g*m)/y)^(1/2);//rms velocity of air at ntp in cm/sec

//OUTPUT
mprintf('the rms velocity of the air is %3.2fcm/sec',v)
```

Scilab code Exa 4.4 The rms velocity

```
clc
clear

//INPUT
d=16*0.000089;//density of the oxygen molecule in gm/cc
p=76;//pressure of the air in cm
g=981;//gravitaitonal accelaration in cm/sec^2
m=13.6;//density of the mercury in gm/cc

//CALCULATIONS
v=((3*p*g*m)/d)^(1/2);//velocuty of the oxygen molecule in cm/sec

//OUTPUT
mprintf('velocity of oxygen molecule is %3.2fcm/sec',v)
```

Scilab code Exa 4.5 The kinetic energy of hydrogen molecule

```
clc
clear

//INPUT
```

```
t=273;//temperature of the hydrogen molecule in K
n=6.03*10^23;//1 mole of hydrogen molecules
r=8.31*10^7;//universal gas constant in erg/K/mole

//CALCULATIONS
e=(1.5*r*t)/n;//kinetic energy of the hydrogen
   molecule in erg

//OUTPUT
mprintf('the kinetic energy of the hydrogen molecule
    is %3.16ferg',e)
```

Scilab code Exa 4.6 The kinetic energy

```
clc
clear

//INPUT
m=1;//mass of the oxygen in gm
r=8.31*10^7;//universal gas constant in erg/K/mole
t=320;//temperature of the oxygen in K
//for 1gm mole k.e is 1.5rt then for 1 gm oxygen
   (1/32)(k.e)

//CALCULATIONS
e=(m/32)*(3*r*t/2);//kinetic energy of the oxygen in
    erg

//OUTPUT
mprintf('the kinetic energy of the oxygen is %3.2
   ferg',e)
```

Scilab code Exa 4.7 The temperature

```
clc
clear

//INPUT
t=273;//temperature at ntp in K
//rms velocity of oxygen is 3/2 times its rms velocity at ntp then e1=(3/2)*e

//CALCULATIONS
t1=(9*t/4);//temperature of the oxygen molecule in K

//OUTPUT
mprintf('temperature of the oxygen in %3.2fK',t1)
```

Scilab code Exa 4.8 The kinetic energy

```
clc
clear

//INPUT
p=10;//pressure of the gas in atm
v=5000;//volume of the gas in ml
l=76;//length of the mercury in barometer in cm
g=981;//accelaration due to gravity in cm/sec^2
d=13.6;//density of the mercury in gm/cc

//CALCULATIONS
e=3*p*v*l*g*d;//kinetic energy of the molecule in ergs

//OUTPUT
mprintf('the kinetic energy of the molecule is %3.2fergs',e)
```

Scilab code Exa 4.9 The molecular energy

```
clc
clear

//INPUT
t=323;//temperature of the hydrogen molecule in K
m1=1;//mass of the hydrogen molecule in gm
m2=2;//molecular weight of the hydrogen in gm
r=8.3*10^7;//universal gas constant in erg/K/mole

//CALCULATIONS
e=(m1*r*t*3/(m2*2));//kinetic enrgy of the hydrogen
    molecule in ergs

//OUTPUT
mprintf('the kinetic energy of the molecule is %3.2
    fergs',e)
```

Scilab code Exa 4.10 The temperature

```
clc
clear

//INPUT
t1=273;//temperature of the hydrogen molecule at n.t
    .p in K
//rms value of hydrogen molecule is double to its
    rms value at n.t.p, so 3rt/m=4(3rt/m)

//CALCULATIONS
t2=4*t1;//temperature of the hydrogen molecule in K
```

```

//OUTPUT
mprintf('the temperature of the hydrogen molecule is
    %3f',t2)
```

Scilab code Exa 4.11 The RMS velocity

```
clc
clear

//INPUT
t1=273;//temperature of the hydrogen molecule in K
t2=373;//temperature of the hydrogen molecule in K
d=0.0000896;//density of the hydrogen molecule in gm
   /cc
p=76*13.6*981;//pressure of the hydrogen molecule in
    gm/cm/sec^2

//CALCULATIONS
v0=(3*p/d)^(0.5);//rms velocity at 0deg.C
v100=v0*(t2/t1)^(0.5);//rms velocity at 100deg.C

//OUTPUT
mprintf('the rms velocity at 0deg.C is %3f cm/sec \n
    the rms velocity at 100deg.C is %3f cm/sec',v0,
   v100)
```

Scilab code Exa 4.12 The RMS velocity

```
clc
clear

//INPUT
```

```
cp=6.84;//specific heat at constant pressure in cal/
    gm mole/deg.C
r=8.31*10^7;//universal gas constant in ergs/gm mole
    /deg.C
v=130000;//velocity of sound in cm/sec
j=4.2*10^7;//joules constant in ergs/cal

//CALCULATION
cv=cp-(r/j);//specific heat at constant volume in gm
    -mole/deg.C
y=(cp/cv);//index of co-efficient
v1=(3/y)^(0.5)*v;//rms velocity in cm/sec

//OUTPUT
mprintf('the rms velocity of gas molecule is %3fcm/
    sec',v1)
```

Scilab code Exa 4.13 The average velocity of the molecule

```
clc
clear

//INPUT
t=300;//temperature of the oxygen molecule in K
n=6.02*10^23;//avagdrao's number
m=32/n;//mass of each molecule in oxygen
k=1.38*10^(-16);//boltzmann constant in erg/deg

//OUTPUT
v=(8*k*t/(3.14*m))^(0.5);//average velocity of
    oxygen molecule in cm/sec
v2=v*0.022384;//velocity in miles/hrs

mprintf('the avg velocity of  oxygen molecule is %3
    .1f miles/hour',v2)
```

Scilab code Exa 4.14 The ratio of RMS velocity to average velocity

```
clc
clear

//INPUT
v1=2.4;//velocity of first particle in km/sec
v2=2.6;//velocity of second particle in km/sec
v3=3.7;//velocity of third particle in km/sec

//CALCULATIONS
rv=((v1^2+v2^2+v3^2)/(3))^(0.5);//rms velocity of the particles in km/sec
mv=(v1+v2+v3)/(3);//mean velocity of the particles in km/sec
r=rv/mv;//ratio of the rms to mean velocity

mprintf('the ratio of rms to mean velocity is %3.3f',r)
```

Scilab code Exa 4.15 The mean free path

```
clc
clear

//INPUT
n=2.76*10^19;//no.of molecules per cc
d=3.36*10^(-8);//diameter of the helium molecule in cm

//CALCULATIONS
```

```
mf=1/((2^(0.5))*3.14*(d^2)*n)

//OUTPUT
mprintf('the mean free path of the hydrogen molecue
   is %3.8f cm',mf)
```

Scilab code Exa 4.16 The mean free path collision rate molecular diameter

```
clc
clear

//INPUT
n=85*10^(-6);//coefficent of viscosity in dynes/cm
   ^2/velocity gradient
c=16*10^4;//velocity in cm/sec
p=0.000089;//density in gm/cc
N=6.06*10^23/22400;//avagadro number
a=(2)^(0.5)*(22/7);//constant

//CALCULATIONS
mf=(3*n/(p*c));//mean free path in cm
cr=c/mf;//collision rate
d=(1/(a*N*mf))^(0.5);//molecular diameter of
   hydrogen gas in cm

mprintf('the mean free path is %3.6fcm \n hte
   collision rate is %3.2f \n the molecular diameter
    of hydrogen gas is %3.10fcm',mf,cr,d)
```

Scilab code Exa 4.17 The mean free path

```
clc
```

```
clear

//INPUT
d=2*10^(-8);//diameter of the molecule in cm
k=1.38*10^(-6);//boltzmann constant in ergs/deg
t=273;//temperature at ntp in K
p=76*13.6*981;//pressure at ntp in gm/cm/sec^2

//CALCULATIONS
mf=((k*t)/(2^(0.5)*3.14*(d^2)*p));//mean free path in cm
//since p=nkt

//OUTPUT
mprintf('mean free path at ntp is %3.6fcm',mf)
```

Scilab code Exa 4.18 The diameter

```
clc
clear

//INPUT
t=288;//temperature in K
k=1.38*10^(-16);//boltzmann constant in erg/deg
N=6.02*10^23;//avagadro number
m=32/N;//mass of each oxygen molecule in gm
v=196*10^-6;//viscosity in poise

//CALCULATIONS
av=((8*k*t/(3.14*m))^0.5);//average velocity in cm/sec
d=(m*av/(3*3.14*2^(0.5)*v))^0.5;//diameter of the molecule in cm

mprintf('diameter of the molecule is %3.10f cm',d)
```

Scilab code Exa 4.19 The pressure

```
clc
clear

//INPUT
mf=15;//mean free path in cm
t=300;//temperature of oxygen molecule in K
d=3*10^(-8);//diameter of the molecule in cm
N=6.02*10^23;//avagadro number
r=8.32*10^7;//universal gas constant in ergs/mole/
    deg
a=(2^(0.5))*(22/7);

//CSLCULATIONS
p=(r*t)/(N*a*(d^2)*mf);//pressure of the oxygen
    molecule in dynes/sq.cm

//OUTPUT
mprintf('the pressure of the oxygen molecule is %3.3
    f dynes/sq.cm',p)
```

Scilab code Exa 4.20 The avagadro number

```
clc
clear

//INPUT
k=5.64*10^-14;//kinetic energy of the hydrogen
    molecule ergs
t=273;//temperature of the oxygen molecule in K
```

```
r=8.32*10^7;//universal gas constant in ergs

//CALCULATIONS
N=(3/2)*(r*t/k);//avagadro number

//OUTPUT
mprintf('the avagadro number is %3.2f',N)
```

Scilab code Exa 4.21 The number which will be travelling undeflected

```
clc
clear

//INPUT
q=5000;//total number of molecules
e=2.7183;//constant value
t1=0.5;//distance travled to the mean free path
t2=1;//distance travelled to the mean free path

//CALCULATONS
p1=q*(e^-t1);//n0.of molecules having no collision
   in traversing a distance t1
p2=q*(e^-t2);//n0.of molecules having no collision
   in traversing a distance t2

//OUPUT
mprintf('the no. of molecules having no collision in
    traversing a distance o.5 is %3f \n the no. of
   molecules having no collision in traversing a
   distance 1 is %3f',p1,p2)
```

Scilab code Exa 4.22 The mean kinetic energy

```
clc
clear

//INPUT
t=38380;//temperature of the molecule in K
k=1.38*10^-16;//boltzman constant of one electron in
    ergs/K
e=1.6*10^-12;//charge of one electron volts

//CALCULATIOS
mk=1.5*k*t/e;//mean kinetic energy per atom in ev

//OUTPUT
mprintf('the mean kinetic energy of the molecule is
   %3.3f ev',mk)
```

Scilab code Exa 4.23 The mean free path and the collision frequency

```
clc
clear

//INPUT
v=1.7*10^-4;//viscosity of the air molecule in cgs
d=0.00129;//density of the molecule in gm/ml
p=76*13.6*981;//pressure of the molecule in gm/cm/
   sec^2

//CALCULATIONS
r=(3*p/d)^(0.5);//rms velocity of the molecule in cm
   /sec
mf=(3*v/(d*r));//mean free path in cm
cf=r/mf;//collision frequency

//OUTPUT
mprintf('the mean free path is %3.7f cm \n the
```

```
collision frequency is %3f',mf,cf)
```

Scilab code Exa 4.24 The pressure of the gas

```
clc
clear

//INPUT
t2=296.4;//temperature of the first plate in K
t1=304.7;//temperature of the second plate in K
f=1.6*10^-2;//force repelled cold is dynes/sq.cm

//CALCULATIONS
p=(4*f*t2/(t1-t2));//pressure of the gas in dynes/sq
    .cm

//OUTPUT
mprintf('the pressure of the gas is %3.3f dynes/sq.
    cm',p)
```

Scilab code Exa 4.25 The size of helium atom

```
clc
clear

//INPUT
mf=28.5*10^-6;//mean free path in cm
d=0.000178;//density of helium in gm/ml
m=6*10^-24;//mass of the helium atom in gm
a=(2^(0.5))*3.14;//constant

//CALCULATIONS
d=(m/(a*d*mf))^(0.5);//diameter of the size in cm
```

```
//OUTPUT
mprintf('the size of the helium atom is %3.10f cm',d
    )
```

Scilab code Exa 4.26 The value avagadro number

```
clc
clear

//INPUT
a1=0*10^-4;//first horizontal displacement in cm
a2=5.6*10^-4;//second horizontal displacement in cm
a3=-4.7*10^-4;//third horzontal displacement in cm
a4=-10.8*10^-4;//fourth horizontal displacement in
    cm
a5=6.6*10^-4;//fifth horizontal displacement
    displacement in cm
a6=-9.8*10^-4;//sixth horizontal displacement in cm
a7=-11.2*10^-4;//7th horizontal displacement in cm
a8=-4.0*10^-4;//8th horizontal displacement in cm
a9=15.0*10^-4;//9thhorizontal displacement in cm
a10=19.1*10^-4;//10th horizontal displacement in cm
a11=16.0*10^-4;//11ht horizontal displacement in cm
T=293;//temperature of the particle in K
v=0.01;//viscosity in cgs
r=1.15*10^-5;//radius of the particle in cm
R=8.32*10^7;//universal gas constant in kj/kg mole
t=30;//time for observation of each in sec

//CALCULATIONS
x=(a1^2+a2^2+a3^2+a4^2+a5^2+a6^2+a7^2+a8^2+a9^2+a10
    ^2+a11^2)/11
n=R*T*t/(x*3*3.14*v*r);//no.of molecules in the
    observation
```

```
//OUTPUT
mprintf('the value of n is %3f',n)
```

Scilab code Exa 4.27 The fractional change in the number of helium atoms

```
clc
clear

//INPUT
m=6*10^-24;//mass of the helium atom in gm
k= 1.38*10^-16;//boltzmann constant in erg
t1=100;//temperature in K
t2=900;//temperature in K

//CALCULATIONS
r=(t1/t2)^(3/2)*(2.7183^(m*(1/(2*k))*10^8*(1-(1/9)))
   );//fractional change in the no.of helium atoms

//OUPUT
mprintf('the fractional change in the no.of helium
   atoms %3.4f',r)
```

Chapter 5

Equations of state

Scilab code Exa 5.1 The values of constant a and b in vanderwaal equation

```
clc
clear

//INPUT
t=304;//temperature of the gas in k
p=73;//pressure of the gas in atm
r=0.00366;//universal gas constant in j/K/mole
//ct=8a/27br;cp=a/27b^2

//CALCULATIONS
b=(t*r/(8*p));
a=p*27*b^2;

//OUTPUT
mprintf('the value of the constant b is %3.7f \n the
    value of the constant a is %3.5f',b,a)
```

Scilab code Exa 5.4 Vanderwaal constants

```
clc
clear

//INPUT
tc=132;//critical temperature in K
pc=37.2;//critical pressure in atm
r=82.07;//universal gas constant in cm^3atm/mole/K

//CALCULATIONS
a=27*(r^2)*(tc^2)/(64*pc);//value of a in atm/cm^6/
   mol^2
b=r*tc/(8*pc);//value of b in cm^3/mol

//OUTPUT
mprintf('the value of is %3.2f atm/cm^6/mol^2 \n the
    value of b is %3.2f cm^3/mol',a,b)
```

Scilab code Exa 5.5 Temperature of the gas

```
clc
clear

//INPUT
p=2.26*1.013*10^5;//critical pressure in N/m^2
v=4/69;//critical volume in m^3/kmol
r=8.31*10^3;//universal gas constant in J/kmol.K

//CALCULATIONS
t=(8*p*v/(3*r));//critical temperature in K

//OUTPUT
mprintf('critical temperature of the given problem
   is %3.2f K',t)
```

Chapter 6

Change of state

Scilab code Exa 6.1 The change in melting point

```
clc
clear

//INPUT
vl=1;//volume of water in cc
vs=1.0908;//volume of ice in cc
t=273;//temperature in k
p=76*13.6*981;//pressure in dynes/sq.cm
l=80;//latent heat of fusion in cal
j=4.2*10^7;//joules constant in erg/cal

//CALCULATIONS
v=vl-vs;//change in volume
T=(v*t*p)/(j*l);//change in melting point of water

//OUTPUT
mprintf('the change in melting point of water is %3
    .11f',T)
```

Scilab code Exa 6.2 The latent heat of vapourisation

```
clc
clear

//INPUT
vv=1674;//volume of vapour in cc
vl=1;//volume of liquid in cc
p=760;//pressure of steam and water in mm
t=373;//temperature in K
p1=27.12;//superincumbent pressure in mm

//CALCULATIONS
v=vv-vl;//change in volume
l=(v*p1*t*0.024203/(p));//latent heat of
    vapourisation in cal

//OUTPUT
mprintf('the latent heat of vapourisation is %3.1f
    cal',l)
```

Scilab code Exa 6.3 The value of K

```
clc
clear

//INPUT
m=1/(342*100);//molar concentration of water
t=289;//temperature in K
p=53.5*13.6*981;//pressure in dynes/sq.cm

//CALCULATIONS
k=p/(t*m);//the value of k in ergs/mol.deg

//OUTPUT
```

```
mprintf('the value of k is %3.2f ergs/mol.deg',k)
```

Scilab code Exa 6.4 The temperature for the triple point

```
clc
clear

//INPUT
p1=4.60;//presure at 0deg.C in mm per deg.C
p2=4.94;//pressure at 1deg.C in mm per deg.C
t=0.0072;//lowering the melting point in deg.C
t1=7.1563979*10^(-3);//rise in melting point in deg.C
p=760;//atmospheric pressure in mm hg

//CALCULATIONS
dp=p2-p1;//rate of increase of pressure in mm per deg.C
p3=(t1*p)/t;//pressure in mm
dt=(755.4-p3)/dp;//tmperature for the triple point in deg.C

//OUTPUT
mprintf('temperature for the triple point is %3.6f deg.C',dt)
```

Scilab code Exa 6.5 The slopes of vapourisation

```
clc
clear

//INPUT
```

```
v=21*10^4;//change in volume from vapour to liquid in cc
Ls=687;//latent heat of sublimation in cal
lv=607;//latent heat of vapourisation in cal
t=273;//temperature of water in deg.C
j=4.2*10^7;//joules constant in ergs/cal

//CALCULATIONS
sv=lv*j/(t*(v));//slope of vapourisation curve at 0 deg.C in dyne/sq.cm/deg.C
ss=Ls*j/(t*(v));//slope of sublimation curve at 0 deg.C in dyne/sq.cm/deg.C

//OUTPUT
mprintf('the slope of vapourisation curve is %3.2f dyne/sq.cm/deg.C \n the slope of sublimation curve is %3.2f dyne/sq.cm/deg.C',sv,ss)
```

Chapter 7

The joule thomson cooling efect

Scilab code Exa 7.1 The temperature of inversion

```
clc
clear

//INPUT
t=33.18;//critical temperature in K
pc=12.80*76*981*13.6;//critical pressure in dynes/sq
    .cm
r=83.15;//universal gas constant in kj/kg.K
d=0.08987;//density of hydrogen in gm/lit
v=2000/0.08987;//gram molecular volune of hydrogen
    in cc

//CALCULATIONS
b=r*10^6*t/(8*pc);//vanderwaal constant in cm^3/mol
to=2*27*t*(1-(b/v))/8;//inversion temperature of the
     hydrogen in K

//OUTPUT
mprintf('the inversion temperature of hydrogen is %3
    .2f K',to)
```

Scilab code Exa 7.2 The change of temperature

```
clc
clear

//INPUT
b=0.00136;//vanderwaal constant in suv/gm
a=0.011;//vanderwaal constant in atm(suv)^2/gm^2
r=0.003696;//universal gas constant in atm(suv)/gm.deg
t=423;//temperature of steam in K
cp=-0.674/0.024205;//specific heat at 423K in atm(cc)gm(deg)

//CALCULATIONS
dt=(-b+(2*a/(r*t)))/cp;//change of temperature per atm drop of pressure in deg/atm

//OUTPUT
mprintf('the change of temperature per atmosphere drop of pressure is %3.7f deg/atm',dt)
```

Scilab code Exa 7.3 The change in temperature

```
clc
clear

//INPUT
r=8.3*10^7;//universal gas constant in ergs/deg.C
a=1.36*10^6*76*13.6*981;//vanderwaal constant in atm.(suv^2)/(gm^2)
b=32;//vanderwaal constant in cc
```

```
cp=7.03;//specific heat at constant pressure in cal
j=4.18*10^7;//joules constant in ergs/cal
t=273;//temperature of the gas in K

//CALCULATIONS
dt=((2*a/(r*t))-b)*10^6/(cp*j);//change of
    temperature in atmosphere drop of pressure in deg
    /atm/cm^3

//OUTPUT
mprintf('the change of temperature in atmosphere
    drop of pressure is %3.2f deg/atm/cm^3',dt)
```

Scilab code Exa 7.4 The change in enthalpy

```
clc
clear

//INPUT
u=1.08;
cp=8.6;//specific heat in kj/kg.K
j=4.2;//joules constant in j/cal
p1=1*1.013*10^6;//pressure at intial in N/sq.m
p2=20*1.013*10^6;//pressure at final in N/sq.m

//CALCULATIONS
dh=-u*cp*j*(p1-p2);//change in enthalpy in joules

//OUTPUT
mprintf('the change in enthalpy is %3.2fjoules',dh)
```

Scilab code Exa 7.5 The inversion temperature

```
clc
clear

//INPUT
tc=5.26;//critical temperature of the helium in K

//CALCULATIONS
ti=27*tc/4;//inversion temperature of the helium in
    K

//OUTPUT
mprintf('the inversion temperature of the helium is
    %3.2f K',ti)
```

Scilab code Exa 7.6 The temperature of inversion

```
clc
clear

//INPUT
a=0.245*10^6*10^6;//vanderwaal constant in cm^4.dyne
    /mole^2
b=2.67*10;//vanderwaal constant in cc/mole
r=2*4.2*10^7;//universal gas constant in ergs/mole.K

//CALCULATIONS
ti=2*a/(b*r);//inversion temperature in K

//OUTPUT
mprintf('inversion temperature of hydrogen is %3.2f
    K',ti)
```

Scilab code Exa 7.7 The drop in temperature

```
clc
clear

//INPUT
dp=50*10^6;//change in pressure in dynes/sq.cm
cp=7*4.2*10^7;//specific heat constant pressure in
   ergs/mole.K
a=1.32*10^12;//vanderwaal constant in cm^4.dyne/mole
   ^2
b=31.2;//vanderwaal constant in cm^2/mole
t=300;//inital temperature in K
r=2*4.2*10^7;//ergs/mole.K

//CALCULATIONS
dt=((2*a/(r*t))-b)*dp/cp;//change in temperature in
   K

//OUTPUT
mprintf('the change in temperature is %3.2f K',dt)
```

Scilab code Exa 7.8 The drop in temperature

```
clc
clear

//INPUT
p1=1;//inital pressure in atm
p2=51;//final pressure in atm
t1=300;//inital temperature in K
y=1.4;//coefficient of expansion

//CALCULATIONS
t2=t1*(p2/p1)^((1-y)/y);//final temperature in K
dt=t1-t2;//drop in temperature in K

```

```
mprintf('the drop in temperature is %3.2f K',dt)
```

Chapter 8

First law of thermodynamics

Scilab code Exa 8.1 The change in internal energy

```
clc
clear

//INPUT
l=80;//latent heat of fusion in cal
j=4.2*10^7;//joules constant in ergs/cal
w=-0.092*10^6;//work done in changing phase change
   in ergs

//CALCULATIONS
q=l*j;//heat added in ergs
du=q-w;//internal energy in ergs

//OUTPUT
mprintf('the change in internal energy is %3.2f ergs
   ',du)
```

Scilab code Exa 8.2 The change in internal energy

```
clc
clear

//INPUT
m=1;//mass in gm
l=536;//latent heat in cal/gm
j=4.2*10^7;//joules constant in ergs/cal
v=1649;//volume of water in cc
p=76*13.6*981;//pressure of water in dynes/sq.cm

//CALCULATIONS
dq=m*l*j;//heat supplied in ergs
dw=p*v;//work done in ergs
du=dq-dw;//internal energy developed in ergs

//OUTPUT
mprintf('internal energy of water is %3.2f ergs',du)
```

Scilab code Exa 8.3 The temperature immediately after the compression

```
clc
clear

//INPUT
dv=10;//ratio of original volume to final volume
t1=293;//inital temperature in K
y=1.41;//coeffecent of expansion

//CALCULATIONS
t2=t1*(dv)^(y-1);//final temperature in K

//OUTPUT
mprintf('the final temperature is %3.2f K',t2)
```

Scilab code Exa 8.4 The change in temperature

```
clc
clear

//INPUT
t=273;//temperature of earth at height h in K
p=760;//pressure in mm of hg
dp=1;//change in pressure in mm of hg
y=1.418;//coefficient of expansion

//CALCULATIONS
dt=((y-1)/y)*dp*t/p;//change in temperature in deg.C

//OUTPUT
mprintf('the change in temperature is %3.3f deg.C',
   dt)
```

Scilab code Exa 8.5 The resulting drop in temperature

```
clc
clear

//INPUT
p1=2;//pressure initial in atm
p2=1;//pressure final in atm
t1=288;//inital temperature in K
y=1.4;//coefficent of expansion

//CALCULATIONS
t2=t1*(p2/p1)^((y-1)/y);//final temperature in K
dt=t1-t2;//drop in temperature in K
```

```
//OUTPUT
mprintf('drop in temperature is %3.2f K',dt)
```

Scilab code Exa 8.6 The resultant temperature

```
clc
clear

//INPUT
t1=288;//inital temperature in K
dv=1/2;//ratio of inital to final volume
y=1.4;//coefficient of expansion

//CALCULATIONS
t2=t1*(dv)^(y-1);//final temperature in K

//OUTPUT
mprintf('the final temperature is %3.1f K',t2)
```

Scilab code Exa 8.7 The resultant rise in temperatures in both the cases

```
clc
clear

//INPUT
y=1.4;//coefficent of exapnsion
p1=1;//standard pressure in atm
dv=50;//ratio of initial volume to final volume
t1=273;//standard temperature in K

//CALCULATIONS
```

```
p2=p1*dv;//final pressure when slowly compressed in atm
p3=p1*(dv)^(y);//final pressure when suddenly compressed in atm
t2=t1*(dv)^(y-1);//rise in temperature when it is suddenly compressed in K

//OUTPUT
mprintf('the final pressure when it is compressed slowly is %3fatm \n the final pressure when it is compressed suddenly is %3.2fatm \n the rise in temperature when it is suddenly compressed is %3.0fK',p2,p3,t2)
```

Scilab code Exa 8.8 The rise in temperature

```
clc
clear

//INPUT
y=1.5;//coefficient of expansion
dp=1/8;//ratio of inital pressure to final pressure
t1=300;//inital tempreature in K

//CALCULATIONS
t2=t1*(dp)^((1-y)/y);//change in temperature in K
t3=t2-t1;//rise in temperature in K

//OUTPUT
mprintf('the rise in temperature is %3.2f K',t3)
```

Scilab code Exa 8.9 The amount of work done

```
clc
clear

//INPUT
t1=400;//inital temperature in K
dv=2;//ratio of volumes final and inital
r=8.31*10^7;//universal gas constant in ergs/kg.K

//CALCULATIONS
w=r*t1*log(2);//work done in expanding isothermally
   in ergs

//OUTPUT
mprintf('the work done in expanding isothermally is
   %3.2f ergs',w)
```

Scilab code Exa 8.10 The final temperature and pressure

```
clc
clear

//INPUT
p1=76;//inital pressure in cm
t1=290;//inital temperature in K
y=1.4;//coefficent of expansion
dv=2;//ratio of inital to fianl volume when air
   expands isothermally
dv1=2;//ratio of inital to final volume when air
   expands adiabatically

//CALCULATIONS
p2=p1/dv;//final pressure when air expands
   isothermally in cm of hg
t2=t1;//final temperature when air expands
   isothermally in K
```

```
t3=t2*(1/dv1)^(y-1);//temprature when air expands
    adiabatically in K
p3=p2*(1/dv1)^(y);//final pressure when air expands
    adiabatically in mm of hg

//OUTPUT
mprintf('final pressure when air expands
    isothermally in cm of hg %3.2f mm of hg \n final
    temperature when air expands isothermally is %3.2
    f K \n temprature when air expands adiabatically
    is %3.2f K \n final pressure when air expands
    adiabatically is %3.2f mm of hg',p2,t2,t3,p3)
```

Scilab code Exa 8.11 The work done

```
clc
clear

//INPUT
p=76*13.6*981;//pressure of air in dynes/sq.cm
v=11100;//volume expanded in ml
t1=273;//inital temperature in K
t2=274;//final temperature in K
cv=2.411;//specific heat at constant volume in cal/K
j=4.2*10^7;//joules constant in ergs/cal
//CALCULATIONS
w=p*v*log(t2/t1);//work done in ergs
h=cv*(t2-t1)+w/j;//heat supplied in cal

//OUTPUT
mprintf('the work done is %3.2f erg \n the heat
    supplied is %3.3f cal',w,h)
```

Scilab code Exa 8.12 The work done

```
clc
clear

//INPUT
p=10^6;//pressure of air in dynes
d=0.0001293;//density of air in gm/cc
t1=273;//inital temperature in K
dv=2;//ratio of inital volume to final volume
y=1.4;//coefficient of expansion

//CALCULATIONS
r=p/(d*t1);//universal gas constant in dynes.cc/gm.K
t2=t1*(dv)^(y-1);//final temperature in K
w=r*(t2-t1)/(y-1);//work done in adiabatic compression in ergs

//OUTPUT
mprintf('work done in adiabatic compression is %3.2f ergs',w)
```

Scilab code Exa 8.13 The change in internal energy

```
clc
clear

//INPUT
m=5;//mass of air in gm
cv=0.172;//specific heat at constant volume cal/gm
dt=10;//changi in temperature in K

//CALCULATIONS
ie=m*cv*dt;//change in internal energy in cal

```

```
//OUTPUT
mprintf('change in internal energy is %3.2f cal',ie)
```

Scilab code Exa 8.14 The heat supplied

```
clc
clear

//INPUT
v1=10^3;//inital volume in cc
v2=2*v1;//final volume in cc
p1=76*13.6*981;//pressure in dyne/sq.cm
t1=273;//intial temperature in K
d=1.29;//density of the gas gm/lit
cv=0.168;//specific heat at constant volume in cal/gm

//CALCULATIONS
t2=(v2/v1)*t1;//final temperature in K
r=0.068;//universal gas constant in cal
cp=cv+r;//specific heat at constant pressure in cal
q=d*cp*(t2-t1);//heat supplied in cal

//OUTPUT
mprintf('the heat supplied to the gas is %3.2f cal',q)
```

Scilab code Exa 8.15 The maximum work done

```
clc
clear

//INPUT
```

```
t=303;//temperature of the one mole of the argon in
    K
v1=1;//intial volume in litres
v2=10;//final volume in litres
r=8.31*10^7;//universal gas constant in ergs/K.mol

//CALCULATIONS
w=r*t*log(v2/v1);//work done in isothermal expansion
     in ergs

//OUTPUT
mprintf('the work done in isothermal expansion is %3
    .2f ergs',w)
```

Scilab code Exa 8.16 The amount of heat absorbed

```
clc
clear

//INPUT
dv=4;//final volume of neon in lit
t=273;//temperature of the gas in K
n=2.6/22.4;//the no.of moles of neon
r=1.98;//universal gas constant in cal/K.mol

//CALCULATIONS
w=n*t*r*log(dv);//work done by gas in ergs

//OUTPUT
mprintf('the work done by 2.6lit of neon is %3.2f
    ergs',w)
```

Scilab code Exa 8.18 The temperature

```
clc
clear

//INPUT
dv=10^(-3);//ratio of initial and final volume
t1=10^5;//initial temperature in K
y=1.66;//coefficient of expansion

//CALCULATIONS
t2=t1*(dv)^(y-1);//final temperature in K

//OUTPUT
mprintf('final temperature of the gas is %3.2f K',t2)
```

Scilab code Exa 8.19 The value coefficient of expansion

```
clc
clear

//INPUT
p1=8;//intial pressure in cm of hg
p2=6;//final pressure in cm of hg
v1=1000;//intial volume in cc
v2=1190;//final volume in cc

//CALCULATIONS
y=log(p1/p2)/log(v2/v1);//coefficient of expansion

//OUTPUT
mprintf('the coefficent of expansion is %3.2f',y)
```

Chapter 9

Second law of thermodynamics

Scilab code Exa 9.1 The temperature

```
clc
clear

//INPUT
t2=300;//temperature of the sink in K
n1=0.4;//efficiency of the engine
n2=0.6;//efficiency of the engine

//CALCULATIONS
t1=t2/(1-n1);//temperature of the source in K
t3=t2/(1-n2);//temperature of the source in K

//OUTPUT
mprintf('the temperature of the source when 0.4
    efficiency is %3.2f K \n the temperature of the
    source when 0.6 efficiency is %3.2f K',t1,t3)
```

Scilab code Exa 9.2 The work done heat rejected and efficiency

```
clc
clear

//INPUT
t2=273;//temperature of the sink in K
t1=373;//temperature of the source in K
q1=840;//heat supplied in joules
j=4.2;//joukes constant in erg/cal

//CALCULATIONS
w=(q1/t1)*(t1-t2);//work done in joules
q2=(q1/j)*(t2/t1);//heat rejected in calories
n=1-(t2/t1);//efficiency of the engine

//OUTPUT
mprintf('work done is %3.2f j \n heat rejected is %3
   .2f cal \n the efficiency of the engine is %3.2f'
   ,w,q2,n)
```

Scilab code Exa 9.3 The temperature of the source

```
clc
clear

//INPUT
t1=90;//temperature of the oxygen boils in K
t2=20;//temperature of the liquid hydrogen in K
t3=300;//temperature of the sink in K

//CALCULATIONS
n=(t1-t2)/t1;//efficiency of the engine
t4=t3/(1-n);//temperature of the source in K

//OUTPUT
mprintf('the efficiency of the engine is %3.2f \n
```

```
the temperature of the source is %3.2f K',n,t4)
```

Scilab code Exa 9.4 The quantity of heat

```
clc
clear

//INPUT
t1=373;//temperature of the source in K
t2=273;//temperature of the sink in K
w=1200*10^5*980;//work done in ergs
j=4.18*10^7;//joules constant in ergs/cal

//CALCULATIONS
q=(w/j)*(t1/(t1-t2));//heat added in cal

//OUTPUT
mprintf('the heat added is %3.2f cal',q)
```

Scilab code Exa 9.5 The efficiency and energy to be supplied

```
clc
clear

//INPUT
t1=273;//temperature of the source in K
t2=290;//temperature of the sink in K
l=8*10^11;//latent of fusion in ergs/cal

//CALCULATIONS
n=(t2-t1)/t1;//efficiency of the engine
w=n*l;//energy to be supplied in ergs

```

```
//OUTPUT
mprintf('efficiency of the engine is %3.2f \n energy
    to be supplied is %3.2f ergs',n,w)
```

Scilab code Exa 9.6 The work done

```
clc
clear

//INPUT
t1=373;//temperature in K
t2=273;//temperature of sink in K
q=10^4;//heat taken at higher temperature in cal
j=4.2*10^7;//joules constant in ergs/cal

//CALCULATIONS
w=q*j*(t1-t2)/t1;//work done in ergs

//OUTPUT
mprintf('work done is %3.2f ergs',w)
```

Scilab code Exa 9.7 The heat supplied rejected and efficiency

```
clc
clear

//INPUT
p=100*746/4.2;//power developed in cal/sec
t1=300;//temperature of the sink in K
t2=500;//temperature of the source in K

//CALCULATIONS
n=1-(t1/t2);//efficiency of the engine
```

```
q1=p/n;//heat supplied in cal/sec
q2=q1*(1-n);//heat rejected to the sink in cal/sec

//OUTPUT
mprintf('the efficiency of the engine is %3.2f \n
   the heat supplied is %3.2f cal/sec \n the heat
   rejected is %3.2f cal/sec',n,q1,q2)
```

Scilab code Exa 9.8 The lowest temperature work done and efficiency

```
clc
clear

//INPUT
y=1.4;//coefficent of expansion
t1=600;//intial temperature in K
dv=1/6;//ratio of intial to final volume
p=12*1.013*10^6;//pressure in dyne/sq.cm
v=1000;//intial voluume in cc

//CALCULATIONS
t2=t1*(dv)^(y-1);//final temperature in K
r=(p*v)/t1;//universal gas constant in ergs/kg.K
w=r*(t1-t2)*log(1/dv);//work done in ergs
n=1-(t2/t1);//efficiency of the engine

//OUTPUT
mprintf('the lowest temperature is %3.2f K \n work
   done is %3.2f ergs \n the efficiency of the
   engine is %3.2f',t2,w,n)
```

Scilab code Exa 9.9 Percentage of heat produced wasted

```
clc
clear

//INPUT
l=964.8;//latent heat of steam in B.Th.U per lb
q=4*15*l*778;//heat developed in ft lbs
w=30000*60;//work done is ft lbs

//CALCULATIONS
n=(w/q)*100;//efficiency of the engine
p=100-n;//percentage of heat wasted

//OUTPUT
mprintf('the percentage of the heat wasted is %3.2f',p)
```

Scilab code Exa 9.10 The indicated thermal efficiency

```
clc
clear

//INPUT
ip=16.3*500*778/33000;//input power of the engine in HP
me=0.72;//mechanical efficiency of the engine
bhp=31;//brake horse power in b.h.p
ihp=bhp/me;//indicated horse power in HP

//CALCULATIONS
i=ihp/ip;//indicated thermal efficiency

//OUTPUT
mprintf('the indicted thermal efficiency is %3.3f',i)
```

Scilab code Exa 9.11 The horse power of the steam engine

```
clc
clear

//INPUT
p=200;//horse power of steam engine in lbs coal per
    hour
j=770;//joules constant in ft lbs per B.Th.U

//CALCULATIONS
w=12500*p*j;//equivalent work in ft.lb.per.hr
hp=w/(60*33000);//horse power

//OUTPUT
mprintf('hoose power of the engine is %3.2f',hp)
```

Scilab code Exa 9.12 The maximum pressure

```
clc
clear

//INPUT
t1=340;//temperature of the atmosphere in K
t2=612;//temperature of the compression stroke in K
y=1.39;//adiabatic expansion
t3=2040;//temperature after constant volume ignition
    in K

//CALCULATIONS
d=(t2/t1)^(1/(y-1));//density in gm/cc
n=1-(1/d)^(y-1);//efficiency of the engine
```

```
p=((d)^(y))*(t3/t2);//maximum temperature of the temperature in atm

//OUTPUT
mprintf('the maximum pressure of the engine is %3.2f atm',p)
```

Scilab code Exa 9.13 The efficiency of the engine

```
clc
clear

//INPUT
t1=915;//temperature at the beggining in K
t2=2040;//temperature at the end in K
d=12.6;//adiabatic expansion ratio
y=1.39;//coefficent of expansion

//CALCULATIONS
x=t2/t1;//ratio temparatures
n=1-(1/d)^(y-1)*((x^y)-1)/(y*(x-1));//efficiency of the engine

//OUTPUT
mprintf('the efficiency of the engine is %3.3f',n)
```

Scilab code Exa 9.14 The pressure and temperature

```
clc
clear

//INPUT
p1=15;//intial pressure in lb/sq.inch
```

```
dv=15;//ratio of intial to final volume
t1=520;//temperature at intial in K
y=1.4;//coefficient of expansion

//CALCULATIONS
p2=p1*(dv)^(y);//final pressure in lb/sq.inch
t2=t1*(dv)^(y-1);//final temperatire in K

//OUTPUT
mprintf('the final pressure is %3.2f lb/sq.inch \n
   the final temperature is %3.2f K',p2,t2)
```

Chapter 10

Thermodynamic relations

Scilab code Exa 10.1 The latent heat of fusion

```
clc
clear

//INPUT
t=289.6;//temperature in K
dt=0.0244;//raise in temperature in deg.C
v1=0.00095;//volume occupied in liquid state in
    litres
v2=0.00079;//volume occupied in solid state in
    litres

//CALCULATIONS
l=t*(v1-v2)/dt;//latent heat of fusion in lit.atm

//OUTPUT
mprintf('the latent heat of fusion is %3.2f lit.atm'
    ,l)
```

Scilab code Exa 10.2 The value of specific heat

```
clc
clear

//INPUT
t=295;//temperature of water in K
dp=10^6;//cahnge in pressure in dyne/sq.cm
j=4.2*10^7;//joules constant in ergs/cal

//CALCULATIONS
dc=-t*10^-5*dp/j;//change in specific heat

//OUTPUT
mprintf('the change in specific heat is %3.7f cal/
    degree',dc)
```

Scilab code Exa 10.3 The specific heat of copper

```
clc
clear

//INPUT
cp=0.0909;//specific heat at constant pressure in
    cal/degree
t=273;//temperature in K
v=0.112;//specific volume in lit/deg.C
a=5.01*10^(-6);//coefficient of linear expansion
k=8*10^-7;//compressibility of copper in per atoms

//CALCULATIONS
cv=cp+(9*a^2*v*t*0.024142*10^3/k);//specific heat at
     constant volume in cal/deg.C

mprintf('specific heat at constant volume is %3.2f
    cal/deg.C',cv)
```

Scilab code Exa 10.5 The latent heat of fusion

```
clc
clear

//INPUT
t=289.6;//temperature in K
dt=0.0244;//raise in temperature in deg.C
v1=0.00095;//volume occupied in liquid state in
    litres
v2=0.00079;//volume occupied in solid state in
    litres

//CALCULATIONS
l=t*(v1-v2)/dt;//latent heat of fusion in lit.atm

//OUTPUT
mprintf('the latent heat of fusion is %3.2f lit.atm'
    ,l)
```

Scilab code Exa 10.6 The rate of change of saturation pressure

```
clc
clear

//INPUT
l=539;//latent heat of water at 100deg.C in cal
j=4.2*10^7;//joules constant in ergs/cal
t=373;//temperature of water in K
v2=1670;//volume of steam formed in cc
v1=1;//intial volume in cc
g=981;//acceleration due to gravity in cm/sec^2
```

```
d=13.6;//specific gravity of hg

//CALCULATIONS
dp=l*j/(t*(v2-v1)*g*d);//rate of change of
   saturation pressure in cm of mercury

//OUTPUT
mprintf('the rate of change of saturation pressure
   is %3.2f cm of hg',dp)
```

Scilab code Exa 10.7 The volume of gram of steam

```
clc
clear

//INPUT
p1=77.371;//pressure at 100.5deg.C in cm of hg
p2=74.650;//pressure at 99.5deg.C in cm of hg
g=981;//universal gas constant in cm/sec^2
d=13.6;//specific gravity
l=537;//latent heat of vapourisation in cal/gm
t=373;//temperature of water in K
j=4.2*10^7;//joules constant in ergs/cal
v1=1;//intial volume in cc

//CALCULATIONS
v2=v1+(l*j/(t*(p1-p2)*g*d));//volume of gram of
   steam at 100deg.C in cc

//OUTPUT
mprintf('volume of gram of steam at 100deg.C is %3.2
   f cc',v2)
```

Scilab code Exa 10.8 The specific volume

```
clc
clear

//INPUT
t=350;//boiling point temperature in K
l=46;//latent heat of vapourisation in cal/gm
v1=1/1.6;//intial volume in cc
dp=2.3;//change in pressure with temperature in cm of hg/deg.C
d=13.6;//specific gravity of mercury
g=981;//acceleration due to gravity in cm/sec^2
j=4.2*10^7;//joukes constant in ergs/cal

//CALCULTIONS
v2=v1+(l*j)/(t*dp*d*g);//specific volume in cc

//OUTPUT
mprintf('specific volume of vapour of carbon is %3.3f cc',v2)
```

Scilab code Exa 10.9 The change in temperature

```
clc
clear

//INPUT
l=536;//latent heat of vapourisation in cal/gm
v1=1;//volume of 1 gm of water in cc
v2=1600;//volume of steam in cc
t=373;//boiling point of water in K
p=1;//pressure in cm of hg
d=13.6;//specific gravity of mercury
g=981;//gravitational constant in cm/sec^2s/cal
```

```
j=4.2*10^7;//joules constant in erg/cal

//CALCULATIONS
dt=(t*(v2-v1)*d*g)/(l*j);//change in temperature in
    deg.C

//OUTPUT
mprintf('change in temperature is %3.2f deg.C',dt)
```

Scilab code Exa 10.10 The change in melting point

```
clc
clear

//INPUT
t=353;//temperature in K
p=76*13.6*981;//pressure in dynes/sq.cm
v=0.146;//specific volume in cc/kg
l=35.6;//latent heat of fusion in cal/gm
j=4.18*10^7;//joules constant in ergs/cal

//CALCULATIONS
dt=t*p*v/(l*j);//change in melting point per
    atmosphere

//OUTPUT
mprintf('the rate of change in melting point is %3.3
    f per atmosphere',dt)
```

Scilab code Exa 10.11 The change in freezing point of water

```
clc
clear
```

```
//INPUT
l=79.6*4.18*10^7;//latent heat of water in ergs/gm
t=273.16;//temperature of water in K
v1=1.0001;//specific volume of water at 0deg.C in cc
v2=1.0908;//specific volume of ice at 0deg.C in cc
p=1.013*10^6;//pressure of atmosphere in dyne/sq.cm

//CALCULATIONS
dt=t*(v1-v2)*p/l;//change in freezing point of water
    in deg.C

//OUTPUT
mprintf('change inn freezing point of water is %3.4f
    deg.C',dt)
```

Chapter 11

Conduction of heat

Scilab code Exa 11.1 The amount of heat conducted

```
clc
clear

//INPUT
k=0.12;//thermal conductivity in cgs unit
t1=200;//temperature at one side in deg.C
t2=50;//temperature at other side in deg.C
t=3600;//time in sec
a=1;//area in sq.cm
t3=3;//thickness of the plate in cm

//CALCULATIONS
q=k*a*(t1-t2)*t/t3;//amount of heat conducted in cal

//OUTPUT
mprintf('the amount of heat conducted is %3.2f cal',
   q)
```

Scilab code Exa 11.2 The rate of flow of water

```
clc
clear

//INPUT
k=0.9;//thermal conductivity in cgs unit
a=10;//area of the copper bar in sq.cm
t1=100;//hot side temperature in deg.C
t2=20;//cool side temperature in deg.C
d=25;//thickness of the bar in cm
t3=14;//temperature of water when entering in deg.C

//CALCULATIONS
m=k*a*(t1-t2)/(d*(t2-t3));//rate flow of water in gm/sec

//OUTPUT
mprintf('rate flow of water is %3.2f gm/sec',m)
```

Scilab code Exa 11.3 The thermal conductivity of cork

```
clc
clear

//INPUT
i=1.18;//current in amperes
e=20;//potential difference across its ends in volts
j=4.2;//joules constant in joule/cal
a=2*10^4;//area of the slab in sq.cm
t=5;//thickness of the plate in cm
t1=12.5;//temperature at hot side in K
t2=0;//temperature at cold side in k

//CALCULATIONS
k=e*i*t/(j*a*(t1-t2));//thermal conductivity in cgs unit
```

```

//OUTPUT
mprintf('thermal conductivity of slab is %3.5f cgs
    unit',k)
```

Scilab code Exa 11.4 The thermal conductivity of glass

```
clc
clear

//INPUT
l=30;//length of the tube in cm
t=100;//temperature at outside in deg.C
t1=40;//tempertaure of water when leaving tube in
    deg.C
t2=20;//temperature of water when entering tube in
    deg.C
m=165/60;//mass flow rete of water in cc/sec
r1=6;//internal radii in mm
r2=8;//external radii in mm

//CALCULATIONS
k=m*(t1-t2)*log(r2/r1)/(2*3.14*l*(t-((t1+t2)/2)));//
    thermal conductivity in cgs unit

//OUTPUT
mprintf('thermal conductivity of the tube is %3.4f
    cgs unit',k)
```

Scilab code Exa 11.5 The thermal conductivity of nickel

```
clc
clear
```

```
//INPUT
l1=1.9;//length of the first bar in cm
l2=5;//length of the second bar in cm
k2=0.92;//thermal conductivity in cgs unit

//CALCULATIONS
k1=k2*(l1/l2)^2;//thermal conductivity if first bar in cgs unit

//OUTPUT
mprintf('thermal conductivity of first bar is %3.3f cgs unit',k1)
```

Scilab code Exa 11.6 The temperature of the welded interface

```
clc
clear

//INPUT
k1=0.92;//thermal conductivity of copper in cgs unit
k2=0.5;//thermal conductivity of alluminium in cgs unit
t1=100;//temperature of copper in deg.C
t2=0;//temperature of alluminium in deg.C

//CALCULATIONS
t=k1*t1/(k1+k2);//welded teperature in deg.C

//OUTPUT
mprintf('welded temperature is %3.2f deg.C',t)
```

Scilab code Exa 11.7 The conductivity of rubber

```
clc
clear

//INPUT
w=23;//thermal capacity of calorimeter in cal
m=440;//mass of water in gm
l=14.6;//lenght of the rubber tube in cm
dt=0.019;//rate of change in temperature in deg.C/
    sec
t=100;//temperature of steam in deg.C
t1=22;//temperature of the water in deg.C
t2=t1;//temperature of calorimeter in deg.C
r1=1;//external radii in cm
r2=0.75;//internal radii in cm

//CALCULATIONS
k=(w+m)*dt*log(r1/r2)/(2*3.14*l*(t-((t1+t2)/2)));//
    thermal conductivity in cgs unit

//OUTPUT
mprintf('thermal cnductivity of rubber tube is %3.5f
     cgs unit',k)
```

Scilab code Exa 11.8 Heat lost per hour

```
clc
clear

//INPUT
ti=18;//inside temperature in deg.C
to=4;//outside temperature in deg.C
k1=0.008;//thermal conductivity of stone in cgs unit
k2=0.12;//thermal conductivity of steel in cgs unit
t=3600;//time in sec
t1=25;//thickness of the stone in cm
```

```
t2=2;//thickness of the steel in cm
a=10^4;//area of the cottage in sq.cm

//CALCULATIONS
q1=k1*a*(ti-to)*t/(t1);//heat lost by stone per hour
    in cal
q2=k2*a*(ti-to)*t/t2;//heat lost by steel per hour
   in cal

//OUTPUT
mprintf('heat lost by stone is %3.2f cal \n heat
   lost by steel is %3.2f cal',q1,q2)
```

Scilab code Exa 11.9 The temperature of the surface

```
clc
clear

//INPUT
l1=4;//length of the slab1 in cm
l2=2;//length of the slab2 in cm
k1=0.5;//thermal conductivity in cgs unit
k2=0.36;//thermal conductivity in cgs unit
t1=100;//temperature of the slab1 in deg.C
t2=0;//temperature of the slab2 in deg.C

//CALCULATIONS
t=k1*l2*t1/((k2*l1)+(k1*l2));//temperature of the
   commaon surface in deg.C

//OUTPUT
mprintf('the temperature of the common surface is %3
   .0f deg.C',t)
```

Scilab code Exa 11.10 The distance

```
clc
clear

//INPUT
t1=15;//temperature of the one end of the slab in
   deg.C
t2=45;//temperature of the other end of the slab in
   deg.C
k=0.3;//thermal conductivity in cgs unit
d=7;//density of the material in gm/cc
cp=1;//specific heat of the material in kj/kg.K
t=5*3600;//time in sec
dt=1/10;//thermometer reading in deg.C

//CALCULATIONS
b=(3.14*d*cp/(t*k))^(0.5);
x=(log((t2-t1)/dt))/b;//distance from which
   temparature variation can be detected in cm

//OUTPUT
mprintf('the distance from which temparature
   variation can be detected is %3.1f cm',x)
```

Chapter 12

Radiation

Scilab code Exa 12.1 The ratio of rates at which heat lost

```
clc
clear

//INPUT
t1=300;//temperature of the surroundings in K
t2=900;//temperature of the hot body p in K
t3=500;//temperature of the hot body q in K
a=5.67*10^-8;//stefan boltzmann constant in W/m^2.K
    ^4

//CALCULATIONS
q1=a*(t2^4-t1^4);//heat lost from hot body p in w/m
    ^2
q2=a*(t3^4-t1^4);//heat lost from hot body q in w/m
    ^2
q=q1/q2;//ratio of heat lost from two substances

//OUTPUT
mprintf('ratio of heat lost from two substances is
    %3.2f',q)
```

Scilab code Exa 12.2 The stefan constant

```
clc
clear

//INPUT
t1=573;//temperature of the hot side in K
t2=273;//temperature of the coll side in K
m=82;//mass of the black body in gm
cp=0.1;//specific heat of the black body kj/kg.K
dt=0.35;//ice melting at a rate of temperature in
   deg.C/sec
a=8;//area of black body in sq.cm

//CALCULATIONS
s=m*cp*dt/(a*(t1^4-t2^4));//boltzmann constant in
   cal/sq.cm/sec/deg^4

//OUTPUT
mprintf('boltzmann constant is %3.13f cal/sq.cm/sec/
   deg^4',s)
```

Scilab code Exa 12.3 The ratio of intensities

```
clc
clear

//INPUT
r1=60;//distance of first black body in cm
r2=30;//distance of second black body in cm
t1=873;//temperature of first black body in K
t2=573;//temperature of the second black body in K
```

```

//CALCULATIONS
i=(t2^4/t1^4)*(r1^2/r2^2);//ratio of intensity of
    radition

//OUTPUT
mprintf('ratio of intensity of radition is %3.2f',i)
```

Scilab code Exa 12.4 The heat radiated per second

```
clc
clear

//INPUT
t1=1373;//temperature of the sphere in K
t2=283;//temperature of the black body in K
r=4.17*10^5;//rate of heat radiate in ergs/sq.cm/sec
a=4*3.14*(6^2);//surface area of the sphere in sq.cm

//CALCULATIONS
tr=r*a*(t1^4/t2^4)*(2.39005736*10^(-8));//total heat
    radiated in cal/sec

//OUTPUT
mprintf('total heat radiated is %3.2f cal/sec',tr)
```

Scilab code Exa 12.5 The time for sun rays to fall

```
clc
clear

//INPUT
```

```
h=2*3.14*100;//heat received by the lens per min in cal
m=25;//mass of the ice in gm
l=80;//latent heat of ice in cal/gm

//CALCULATIONS
t=m*l/h;//time for which the sun rays falls in min

//OUTPUT
mprintf('time for which the sun rays falls is %3.2f min',t)
```

Scilab code Exa 12.6 The amount of heat reeived

```
clc
clear

//INPUT
d=0.35;//diameter of the mirror in m
t=5;//time in min
T=16;//temperature of water found to be in deg.C
m=60;//mass of water in gm
mc=30;//mass of calorimeter in gm
cp=0.1;//specific heat of copper in cal/gm/deg.C

//CALCULATIONS
q=(m+cp*mc)*T*4/(5*3.14*d^2);//amount of heat received by earth in cal

//OUTPUT
mprintf('amount of heat received by earth is %3.2f cal',q)
```

Scilab code Exa 12.7 Rate of heat lost

```
clc
clear

//INPUT
r1=5;//radius of first sphere in cm
r2=10;//radius of second sphere in cm
t1=700;//temperature of the first sphere in K
t2=500;//temperature of the second sphere in K
t=300;//temperature of the enclousure in K

//CALCULATIONS1
dc=(r2/r1)*(t1^4-t^4)/(t2^4-t^4);//ratio of c1/c2
r=r1^3*dc/r2^3;//rate of heat loss

//OUTPUT
mprintf('rate of loss of heat is %3.2f',r)
```

Scilab code Exa 12.8 The temperature

```
clc
clear

//INPUT
t1=600;//temperature of the black body in K
t0=300;//temperature of the surroundings in K
d=6;//deflections in galvanometer
d1=400;//deflection in divisions

//CALCULATIONS
dt=(d1/d)*(t1^4-t0^4);//change of temperature
t2=(dt+t0^4)^(1/4);//end temperature in K

//OUTPUT
```

```
mprintf('end temperature of the temperature is %3.2f
    K',t2)
```

Scilab code Exa 12.9 The temperature of the regel

```
clc
clear

//INPUT
n=17000;//luminosity of star compared to sun
t=6000;//temperature of the sun in K

//CALCULATIONS
t1=(n*t^4)^(1/4);//temperature of the star in K

//OUTPUT
mprintf('the temperature of the star is %3.2f K',t1)
```

Chapter 13

Introduction to statistical thermodynamics

Scilab code Exa 13.1 The probability

```
clc
clear

//INPUT
p1=1/6;//probability for the first throw gives 6
p2=1/6;//probability for the first throw gives 5
n=2;//the no.of dice are two

//CALCULATIONS
p=p1*p2*n;//the required probability is

//OUTPUT
mprintf('the required probability is %3.2f',p)
```

Scilab code Exa 13.2 The probability of drawing four aces

```
clc
clear

//INPUT
p1=4/52;//the probability for getting ace in first
   draw is
p2=3/51;//the probability for getting ace in second
   draw is
p3=2/50;//the probability for getting ace in third
   draw is
p4=1/49;//the probability for getting ace in fourth
   draw is

//CALCULATIONS
p=p1*p2*p3*p4;//total probability is

//OUTPUT
mprintf('total probability is %3.7f',p)
```

Scilab code Exa 13.3 The probability of distribution

```
clc
clear

//INPUT
n=12;//no.of particles
n1=8;
n2=4;

//CALCULATIONS
p=n*(n-1)*(n-2)*(n-3)/(n2*(n2-1)*(n2-2)*(2^n));//
   probability of distribution (8,4)

//OUTPUT
mprintf('probability of distribution (8,4) is %3.5f'
```

```
,p)
```

Scilab code Exa 13.4 The probability

```
clc
clear

//INPUT
m=32;//mass of the oxygen molecule in gm
n=1.67*10^-27;//mass of one electron
k=1.38*10^-23;//boltzzmann constant in ergs/cal
t=200;//temperature of the oxygen in K
c=(100+101)/2;//average speed of the oxygen molecule in m/s

//CALCULATIONS
a=m*n/(2*3.14*k*t);
p=4*3.14*(a^(3/2))*(c^2)*(2.303^(-a));//probability that the oxygen speed is lies between in m/sec

//OUTPUT
mprintf('probability that the oxygen speed is lies between is %3.16f m/sec',p)
```