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

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May 26, 2016

Book Description

Title: Heat And Thermodynamics

Author: A. Manna

Publisher: Dorling Kindersley (India) Pvt. Ltd., Noida

Edition: 1

Year: 2011

ISBN: 9788131754009

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.

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Chapter 2

Thermometry

Scilab code Exa 2.1 Temperature

```
1  clc
2  clear
3
4  //INPUT
5  li=1.23;//length of melting ice in mm
6  lf=18.56;//length of melting ice reading in pressure
       of 74.24cm of mercury in mm
7  l=10.75;//length of melting ice at which temperature
       to be calculated
8  mp=0;//melting point in deg.C
9  T=50;//temperature of melting ice at which length to
       be calculated in deg.C
10 //boiling point of water changes by 1 deg.C for
       change of pressure of 27mm of mercury
11
12 //CALCULATIONS
13 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
14 t=(l-li)*(sp-mp)/(lf-li);//temperature at 10.75mm of
       melting ice in deg.C
```

8

```
15 lt=((T*(lf-li))/(sp-mp))+li;//length of ice at 50
      deg.C
16
17 //OUTPUT
18 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

```
1 clc
2 clear
3
4 //INPUT
5 p1=23.5;//pressure when immersed in liquid air in cm
6 p2=75;//pressure when immersed in ice in cm
7 p3=102.4;//pressure when immersed in steam in cm
8 T=100;//boiling point of temperature in deg.C
9
10 //CALCULATIONS
11 t=(p1-p2)*T/(p3-p2);//temperature of the liquid air
      in deg.C
12
13 //OUTPUT
14 mprintf('the temperature of liquid of air is %3.2f
      deg.C',t)
```

Scilab code Exa 2.3 Height of the barometer

```
1 clc
2 clear
3
4 //INPUT
```

```
5  t1=283;//temperature of bulb when pressure is h-2cm
       of hg in k
6  t2=546;//temperature of bulb when pressure is h-22cm
        of hg in k
7  h1=2;//differnce of mercury level at 283k in cm
8  h2=22;//differnce of mercury level at 546k in cm
9  //let h is the barometer height,then h-2cm at 283k
       and h-22 at 546k
10
11 //CALCULATIONS
12 h=((h2*t1)+(h1*t2))/(t2-t1);//height of the
       barometer in cm
13
14 //OUTPUT
15 mprintf('height of the barometer is %3.2f cm',h)
```

Scilab code Exa 2.4 Temperature of the furnace

```
1  clc
2  clear
3
4  //INPUT
5  p0=76;//pressure at 0 deg.C in cm of hg
6  p1=228;//pressure (76+152) at T deg.C in cm of hg
7  t0=273;//temperature of bulb in K
8
9  //CALCULATIONS
10 T=p1*t0/p0;//temperature at 228 cm of hg pressure in
       K
11
12 //OUTPUT
13 mprintf('the temperature of bulb is %3.2f K',T)
```

Scilab code Exa 2.5 The temperature of the bath

```
1  clc
2  clear
3
4  //INPUT
5  t1=0;//temperature in deg.C
6  t2=100;//temperature in deg.C
7  t3=208;//temperature in deg.C
8  r1=3.5;//resistance in ohms
9  r2=5.2;//resistance in ohms
10 r3=6.9;//resistance in ohms
11 r4=9.4;//resistance in ohms
12
13 //CALCULATIONS
14 t4=(r3-r1)*100/(r2-r1);//temperature in deg.C
15 d=(t3-t4)/(2.08*1.08);//deflection
16 t5=(r4-r1)*100/(r2-r1);//temperature in deg.C
17 t6=(d*(((t5/100)^2)-t5/100))+t5;//temperature in deg
      .C
18 t7=(d*(((t6/100)^2)-t6/100))+t5;//temperature in deg
      .C
19 t8=(d*(((t7/100)^2)-t7/100))+t5;//temperature in deg
      .C
20 t9=(d*(((t8/100)^2)-t8/100))+t5;//temperature in deg
      .C
21
22 //CALCULATIONS
23 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

```scilab
1  clc
2  clear
3
4  //INPUT DATA
5  m=20;//calorimeter of water equivalent in gm
6  n=1030;//weight of water in gm
7  p=2;//no.of paddles
8  a=10;//weight of each paddle in kg
9  s=80;//distance between paddles in m
10 g=980;//accelaration due to gravity in cm/sec^2
11
12 //CALCULATIONS
13 E=(p*a*1000*g*s*100);//potential energy in dyne cm
14 T=(E)/(1050*4.18*10^7);//rise in temperature in deg.
      C
15 //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)
16
```

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

Scilab code Exa 3.2 The mechanical equivalent of heat

```
 1 clc
 2 clear
 3
 4 //INPUT DATA
 5 cp=0.1;//specific heat of copper in kj/kg-K
 6 w=120;//weight of copper calorimeter in gm
 7 a=1400;//weight of paraffin oil in gm
 8 cp1=0.6;//specific of parafin oil in kj/kg-K
 9 b=10^8;//force to rotate the paddle in dynes
10 T=16;//rise in temperature in deg.C
11 n=900;//no.of revolutions stirred
12 pi=3.14;//value of pi
13
14 //CALCULATIONS
15 c=2*pi*b;//work done by a rotating paddle per
      rotation in dyne cm per rotation
16 d=c*n;//total work done in dyne cm
17 hc=w*cp*16;//heat gained by calorimeter in calories
18 hp=a*cp1*16;//heat gaained by paraffin oil in
      calories
19 J=d/(hc+hp);//mecanical equivalent of heat in erg/
      cal
20
21 //OUTPUT
22 mprintf('mecanical equivalent of heat is %3.0f erg/
      cal',J)
```

Scilab code Exa 3.3 The mechanical equivalent of heat

```
1  clc
2  clear
3
4  //INPUT DATA
5  cp=0.12;//specific heat of iron in kj/kg-K
6  m=25;//mass of iron in lb
7  h=0.4;//horse power developed in 3 min
8  t=3;//time taken to develop the horse power in min
9  T=17;//raise in temp in deg.C
10
11  //CALCULATIONS
12  w=h*33000*t;//total work done in ft-lb
13  H=m*cp*T;//aount of heat developed in B.Th.U
14  J=(w)/H;//the value of mechanical equivalent of heat
15
16  //OUTPUT
17  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

```
1  clc
2  clear
3
4  //INPUT DATA
5  n=2;//no.of lead blocks
6  m=210;//mass of each lead block in gm
7  v=20000;//velocity of block relative to earth in cm/
         sec
8  J=4.2*10^7;//mechanical equivalent of heat in ergs/
         calorie
9  cp=0.03;//specific heat of lead in kj/kg-K
```

14

```
10
11  //CALCULATIONS
12  E=(m*v^2)/2;//kinetic energy of each block in ergs
13  E2=n*E;//total kinetic energy in ergs
14  T=E2/(J*m*n*cp);//mean rise in temperature in T
15
16  //OUTPUT
17  mprintf('the mean rise in temperature is %3.1f deg.C
        ',T)
```

Scilab code Exa 3.5 Rise of temperature

```
1   clc
2   clear
3
4   //INPUT DATA
5   h=150;//height froom which ball fallen in ft
6   cp=0.03;//specific heat of lead in kj/kg-K
7   J=778;//mechanical equivalent of heat in ft lb/B.Th.
        U
8
9   //CALCULATIONS
10  //assume m be the mass of the lead
11  //work done in falling through 160 feet in ft-lb w
        =160*m
12  //heat absorbed by the ball in B.Th.U h=m*cp*T
13  //work done in falling is equal to heat absorbed by
        the ball
14  T=160/(J*cp)*(5/9);//the raise in temperature in T
15
16  //OUTPUT
17  mprintf('the raise in temperature is %3.1f deg.C',T)
```

Scilab code Exa 3.6 The rate at which the horse worked

```
1  clc
2  clear
3
4  //INPUT DATA
5  w=26.6;//work done one horse in to raise the
       temperature in lb
6  T1=32;//temperature at initial in deg.F
7  T2=212;//temperature at final in deg.F
8  t=2.5;//time to raise the tmperature in hrs
9  p=25;//percentage of heat lossed
10
11 //CALCULATIONS
12 //let x ft-lb per min be the rate at which horse
       worked//total work done in ft-lb wt W=x*150
13 //amount of heat generated in lb deg.F H=W/778
14 //only 75% of heat is utilised
15 x=w*180*100*778/((100-p)*150);//the rate at which
       horse worked
16
17 //OUTPUT
18 mprintf('the rate at which horse worked is %3.0f ft-
       lb wt/min',x)
```

Scilab code Exa 3.7 The rise in temperature

```
1  clc
2  clear
3
4  //INPUT DATA
5  l=100;//length of glass tube in cm
6  m=500;//mass of mercury in glass tube in gm
7  n=20;//number of times inverted i succession
8  cp=0.03;//specific heat of mercury in cal/gm/deg.C
```

16

```
9  J=4.2;//joule's equivalent in j/cal
10 g=981;//accelaration due to gravity in cm/s^2
11
12 //CALCULATIONS
13 PE=m*g*l;//potential energy for each time in ergs
14 TE=PE*n;//total loss in ergs
15 T=TE/(m*cp*J*10^7);//rise in temperature in deg.C
16 //if T is the rise in temperature,then heat
       devoloped is m*cp*T
17
18 //OUTPUT
19 mprintf('the rise in temperature is %3.2f deg.C',T)
```

Scilab code Exa 3.8 Calories emitted per second

```
1  clc
2  clear
3
4  //INPUT DATA
5  d=0.02;//diameter of the copper wire in cm
6  i=1;//current in amp
7  T=100;//maximum steady temperature in deg.C
8  r=2.1;//resistance of the wire in ohm cm
9  J=4.2;//mechanical equivalent of heat in j/cal
10 a=3.14*d^2/4;//area of the copper wire in sq.cm
11 a2=1;//area of the copper surface in sq.cm
12
13 //CALCULATIONS
14 //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
15 l=1/(2*3.14*d/2);//length corresponding to the area
       in cm
16 R=r*l/a;//resistance of the copper wirein ohm
17 w=R*a2^2;//work done in joule
```

```
18  h=w/J;//heat devoleped in cal
19
20  //OUTPUT
21  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

```
1   clc
2   clear
3
4   //INPUT DATA
5   h=10000;//vertical height of water fall in cm
6   v=5;//volume disharged per sec in litres
7   J=4.18;//joule's constant in j/cal
8   g=981;//accelaration due to gravity in cm/sec^2
9
10  //CALCULATIONS
11  m=v*1000;//mass of water disharged per sec in gm
12  w=m*h*g;//work done in falling through 100m in erg
13  H=w/(J*10^7);//quantity of heat produced in cal
14  T=H/m;//rise in temperature in deg.C
15
16  //OUTPUT
17  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

```
1   clc
2   clear
3
4   //INPUT DATA
```

```scilab
 5  cp=0.03;//specific heat of lead in kj/kg.k
 6  v=10000;//initial velocity of bullet in cm/sec
 7  J=4.2*10^7;//joules constant in ergs/cal
 8
 9  //CALCULATIONS
10  //let mass of the bullet in gm
11  ke=(v^2)/2;//kinetic energy of the bullet per unit
         mass in (cm/sec)^2
12  //T is the rise in temperature,then heat produced is
         m*cp*T
13  //95% of kinetic energy is converted to heat
14  T=ke*95/(cp*J*100);//rise in temperature in deg.C
15
16  mprintf('the rise in temperature is %3.1f deg.C',T)
```

Scilab code Exa 3.11 The difference in temperature

```scilab
 1  clc
 2  clear
 3
 4  //INPUT DATA
 5  h=5000;//height of the niagara falls in cm
 6  J=4.2*10^7;//joules constant in ergs per cal
 7  g=981;//accelaration due to gravity in cm/sec^2
 8
 9  //CALCULATIIONS
10  w=h*g;//work done per unit mass in ergs/gn
11  T=w/J;//rise in temperature in deg.C
12
13  //OUTPUT
14  mprintf('the rise in temperature is %3.2f deg.C',T)
```

Scilab code Exa 3.12 The value of J

```
1  clc
2  clear
3
4  //INPUT DATA
5  //callender and barnes continous flow method
6  V1=3;//potential difference in v
7  V2=3.75;//potential differnce in v
8  i1=2;//current in amp
9  i2=2.5;//current in amp
10 T=2.7;//the rise in temperature of the water in deg.
      C
11 m1=30;//water flow rate at 3 volts in gm/min
12 m2=48;//water flow rate at 3.75volts in gm/min
13 s=1;//specific heat of the water kj/kg-K
14
15 //CALCULATIONS
16 J=(V1*i1-V2*i2)/(s*T*(m1-m2)/60);//the mechanical
      equivalent in j/cal
17
18 //OUTPUT
19 mprintf('the mechanical equivalent is %3.3f j/cal',J
      )
```

Scilab code Exa 3.13 The rise in temperature

```
1  clc
2  clear
3
4  //INPUT DATA
5  R=64*10^7;//mean radius of the earth in cm
6  cp=0.15;//specific heat of earth in kj/kg-K
7  J=4.2*10^7;//joules constant in erg/cal
8
9  //CALCULATIONS
10 i=2/5*R^2;//moment of inertia of the earth per unit
```

```
       mass in joules
11  w=(2*3.14)/(24*60*60);//angular velocity of the
       earth in rad/sec
12  T=(i*w^2)/(2*J*cp);//rise in temperature in deg.C
13
14  //OUTPUT
15  mprintf('the rise in the temperature is %3.1f deg,C'
       ,T)
```

Scilab code Exa 3.14 The mechanical equivalent of heat

```
1  clc
2  clear
3
4  //INPUT DATA
5  cp=1.25;//specific heat of helium inkj/kg-K
6  v=1000;//volume of the gas in ml
7  w=0.1785;//mass of the gas at N.T.P in gm
8  p=76*13.6*981;//pressure of the gas at N.T.P in
       dynes
9  T=273;//temperature at N.T.P in K
10
11  //CALCULATIONS
12  V=1000/w;//volume occupied by the 1gm of helium gas
       in cc
13  cv=cp/1.66;//specific heat at constant volume it is
       monatomuc gas kj/kg-K
14  r=p*V/T;//gas constant in cm^3.atm./K.mol
15  J=r/(cp-cv);//mechanical equivalent of heat in erg/
       cal
16
17  //OUTPUT
18  mprintf('the mechanical equivalent of heat is %3.2f
       ergs/calories',J)
```

Scilab code Exa 3.15 The mechanical equivalent of heat

```
1  clc
2  clear
3
4  //INPUT DATA
5  n=1/273;//coefficent of expaaansion of air
6  a=0.001293;//density of air in gm/cc
7  cp=0.2389;//specific heat at constant pressure in kj
      /kg.K
8  p=76*13.6*981;//pressure at 0 deg.C in dynes
9
10 //CALCULATIONS
11 J=(p*n)/(a*(cp-(cp/1.405)));//mechanical equivalent
      of heat
12
13 //OUTPUT
14 mprintf('mechanical equivalent of heat is %3.2f ergs
      /cal',J)
```

Scilab code Exa 3.16 The value of J

```
1  clc
2  clear
3
4  //INPUT DATA
5  //continous flow calorimeter
6  r=120/60;//rate of flow of water in gm/sec
7  T1=27.30;//temperature at initial in deg.C
8  T2=33.75;//temperature at final in deg.C
9  v=12.64;//potential drop in volts
10 s=1;//specific heat of water in kj/kg–K
```

```
11  i =4.35;//current  through  the  heating  element  in  amp
12
13  //CALCULATIONS
14  J=(v*i)/(r*s*(T2-T1));//the  mechanical  equivalent  of
        heat  in  joule/calorie
15
16  //OUTPUT
17  mprintf('the  mechanical  equivalent  of  heat  is  %3.2 f
        j/cal',J)
```

Scilab code Exa 3.17 the value of J

```
1  clc
2  clear
3
4  //INPUT DATA
5  cp=6.865;//molar  specific  heat  of  hydrogen  at
        constant  pressure  in  kj/kg–K
6  cv=4.880;//molar  specific  heat  of  hydrogen  at
        constant  volume  in  kj/kg–K
7  p=1.013*10^6;//atmospheric  pressure  in  dynes/cm^2
8  v=22.4*10^3;//gram  molar  volume  in  ml
9  T=273;//temperature  at  N.T.P  in  kelvins
10
11  //CALCULATIONS
12  J=(p*v)/(T*(cp-cv));//mechanical  equivalent  of  heat
13
14  //OUTPUT
15  mprintf('the  mechanical  equivalent  of  heat  is  %3.2 f
        j/cal',J)
```

Scilab code Exa 3.18 The value of J

```
1  clc
2  clear
3
4  //INPUT DATA
5  v=1000;//volume of hydrogen in ml
6  t=273;//tempature of hydrogen in kelvin
7  p=760;//pressure of hydrogen in mm of hg
8  w=0.0896;//weigh of hydrogen in gm
9  cp=3.409;//specific heat of hydogen in kj/kg-K
10 cv=2.411;//specific heat of hydrogen in kj/kg-K
11 g=981;//accelaration due to gravity in cm/sec^2
12 a=13.6;//density of mercury in gm/cm^2
13
14 //CALCULATIONS
15 J=(p*v*g*a)/(w*t*(cp-cv));//mechanical equivalent of
       heat in ergs/cals
16 //OUTPUT
17 printf('mechanical equivalent of heat is %3.2f ergs/
       calorie',J)
```

Scilab code Exa 3.19 The specific heat at constant volume

```
1  clc
2  clear
3
4  //INPUT DATA
5  cp=0.23;//specific heat at constant pressure in kj/
      kg-K
6  a=1.18;//density of air in gm/lit
7  J=4.2*10^7;//mechanical equivalent of heat in ergs/
      cal
8  t=300;//temperature of air in kelvin
9  p=73*13.6*981;//pressure of air in dynes
10 //cp-cv=(r/J)=pv/(tj)
11
```

```
12 //CALCULATON
13 cv=cp-(p*1000/(a*t*J));//specific heat at constant
      volume in calories
14
15 //OUTPUT
16 mprintf('the specific heat at constant volume is %3
      .5f calories',cv)
```

Scilab code Exa 3.20 The height from which it fallen

```
1 clc
2 clear
3
4 //INPUT
5 t1=0;//temperature of water in deg.C
6 t2=0;//temperature of ice in deg.C
7 J=4.18*10^7;//the joules thomson coefficent in erg/
      cal
8 l=80;//latent heat og fusion kj/kg
9 g=981;//accelaration due to gravity in cm/sec^2
10
11 //CALCULATIONS
12 h=l*J/(15*g);//height from which ice has fallen
13 //1/15 ice has been melted
14
15 //OUTPUT
16 mprintf('the height from which ice has fallen is %3
      .2f cm',h)
```

Scilab code Exa 3.21 The velocity of bullet

```
1 clc
2 clear
```

```
3
4  //INPUT DATA
5  T=80;//temperature of bullet in deg.C
6  cp=0.03;//specific heat of lead in kj/kg-K
7  J=4.2;//mechanical equivalent of heat in j/cal
8
9  //CALCULATIONS
10 //90 percent of kinetic energy is converted to heat
11 h=T*cp;//heat developed per unit mass in calorie
12 v=(J*10^7*h*2/0.9)^0.5;//velocity of bullet in cm/
      sec
13
14 //OUTPUT
15 mprintf('the velocity of bullet is %3.2f cm/sec',v)
```

Scilab code Exa 3.22 The rise in temperature

```
1  clc
2  clear
3
4  //INPUT DATA
5  w=5.0;//weight of lead ball in lb
6  cp=0.032;//specific heat of lead in Btu/lbdeg.F
7  h=50;//height at which ball thrown in feets
8  v=20;//vertical speed in ft/sec
9  g=32;//accelararion due to gravity in ft/sec^2
10
11 //CALCULATIONS
12 //half the kinetic energy is converted into heat
      after instant impact with ground
13 u=(v^2)+2*g*h
14 ke=(w/2*(u));//kinetic energy of the ball at ground
15 T=ke/(2*32*778*w*cp);//rise of temperature in deg.F
16
17 //OUTPUT
```

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

Chapter 4

Kinetic theory of gases

Scilab code Exa 4.1 The temperature

```
1  clc
2  clear
3
4  //INPUT
5  t=273;//temperture of the oxygen molecule in K
6  m=32;//molecular mass of the gas in gm
7  r=8.32*10^7;//molar gas constant in ergs per mole
8  v2=33200;//velocity of the gas in cm/sec
9
10 //CALCULATIONS
11 v1=((3*r*t)/m)^(1/2);//rms velocity of the molecule
      in cm/s
12 T=((v2*v2*m)/(3*r));//temperature of the molecule
      with sound has velocity in K
13
14 //OUTPUT
15 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

```
1 clc
2 clear
3
4 //INPUT
5 t1=308;//temperature of the nitrogen molecule in K
6 m1=28;//molecular mass of the nitrogen in gm
7 m2=2;//molecular mass of the hydrogen molecule in gm
8
9 //CALCULATIONS
10 t2=(t1*m2/m1);//temperature of the hydrogen molecule
       in K
11 //GIVEN avg.speed of both the molecules are same
12
13 //OUTPUT
14 mprintf('the temperature of the hydrogen molecule is
       %3.0fK',t2)
```

Scilab code Exa 4.3 The RMS velocity at NTP

```
1 clc
2 clear
3
4 //INPUT
5 y=0.00129;//density of the air in gm/cc
6 p=76;//pressure of the nitrogen molecule in cm
7 g=981;//accelaration due to gravity in cm/sec^2
8 m=13.6;//density of the mercury in gm/cc
9
10 //CALCULATIONS
```

```
11  v=((3*p*g*m)/y)^(1/2);//rms velocity of air at ntp
        in cm/sec
12
13  //OUTPUT
14  mprintf('the rms velocity of the air is %3.2fcm/sec'
        ,v)
```

Scilab code Exa 4.4 The rms velocity

```
1  clc
2  clear
3
4  //INPUT
5  d=16*0.000089;//density of the oxygen molecule in gm
        /cc
6  p=76;//pressure of the air in cm
7  g=981;//gravitaitonal accelaration in cm/sec^2
8  m=13.6;//density of the mercury in gm/cc
9
10  //CALCULATIONS
11  v=((3*p*g*m)/d)^(1/2);//velocuty of the oxygen
        molecule in cm/sec
12
13  //OUTPUT
14  mprintf('velocity of oxygen molecule is %3.2fcm/sec'
        ,v)
```

Scilab code Exa 4.5 The kinetic energy of hydrogen molecule

```
1  clc
2  clear
3
4  //INPUT
```

```
5  t=273;//temperature of the hydrogen molecule in K
6  n=6.03*10^23;//1 mole of hydrogen molecules
7  r=8.31*10^7;//universal gas constant in erg/K/mole
8
9  //CALCULATIONS
10 e=(1.5*r*t)/n;//kinetic energy of the hydrogen
        molecule in erg
11
12 //OUTPUT
13 mprintf('the kinetic energy of the hydrogen molecule
        is %3.16ferg',e)
```

Scilab code Exa 4.6 The kinetic energy

```
1  clc
2  clear
3
4  //INPUT
5  m=1;//mass of the oxygen in gm
6  r=8.31*10^7;//universal gas constant in erg/K/mole
7  t=320;//temperature of the oxygen in K
8  //for 1gm mole k.e is 1.5rt then for 1 gm oxygen
      (1/32)(k.e)
9
10 //CALCULATIONS
11 e=(m/32)*(3*r*t/2);//kinetic energy of the oxygen in
        erg
12
13 //OUTPUT
14 mprintf('the kinetic energy of the oxygen is %3.2
      ferg',e)
```

Scilab code Exa 4.7 The temperature

```
1  clc
2  clear
3
4  //INPUT
5  t=273;//temperature at ntp in K
6  //rms velocity of oxygen is 3/2 times its rms
      velocity at ntp then e1=(3/2)*e
7
8  //CALCULATIONS
9  t1=(9*t/4);//temperature of the oxygen molecule in K
10
11 //OUTPUT
12 mprintf('temperature of the oxygen in %3.2fK',t1)
```

Scilab code Exa 4.8 The kinetic energy

```
1  clc
2  clear
3
4  //INPUT
5  p=10;//pressure of the gas in atm
6  v=5000;//volume of the gas in ml
7  l=76;//length of the mercury in barometer in cm
8  g=981;//accelaration due to gravity in cm/sec^2
9  d=13.6;//density of the mercury in gm/cc
10
11 //CALCULATIONS
12 e=3*p*v*l*g*d;//kinetic energy of the molecule in
      ergs
13
14 //OUTPUT
15 mprintf('the kinetic energy of the molecule is %3.2
      fergs',e)
```

Scilab code Exa 4.9 The molecular energy

```
1  clc
2  clear
3
4  //INPUT
5  t =323; // temperature of the hydrogen molecule in K
6  m1 =1; // mass of the hydrogen molecule in gm
7  m2 =2; // molecular weight of the hydrogen in gm
8  r =8.3*10^7; // universal gas constant in erg/K/mole
9
10 //CALCULATIONS
11 e =( m1*r*t*3/( m2*2));// kinetic enrgy of the hydrogen
       molecule in ergs
12
13 //OUTPUT
14 mprintf ('the kinetic energy of the molecule is %3.2
       fergs ',e)
```

Scilab code Exa 4.10 The temperature

```
1  clc
2  clear
3
4  //INPUT
5  t1 =273; // temperature of the hydrogen molecule at n.t
       .p in K
6  //rms value of hydrogen molecule is double to its
       rms value at n.t.p, so 3rt/m=4(3rt/m)
7
8  //CALCULATIONS
9  t2 =4*t1; // temperature of the hydrogen molecule in K
```

```
10
11  //OUTPUT
12  mprintf('the temperature of the hydrogen molecule is
        %3f',t2)
```

Scilab code Exa 4.11 The RMS velocity

```
1  clc
2  clear
3
4  //INPUT
5  t1=273;//temperature of the hydrogen molecule in K
6  t2=373;//temperature of the hydrogen molecule in K
7  d=0.0000896;//density of the hydrogen molecule in gm
        /cc
8  p=76*13.6*981;//pressure of the hydrogen molecule in
        gm/cm/sec^2
9
10  //CALCULATIONS
11  v0=(3*p/d)^(0.5);//rms velocity at 0deg.C
12  v100=v0*(t2/t1)^(0.5);//rms velocity at 100deg.C
13
14  //OUTPUT
15  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

```
1  clc
2  clear
3
4  //INPUT
```

```
5  cp=6.84;//specific heat at constant pressure in cal/
      gm mole/deg.C
6  r=8.31*10^7;//universal gas constant in ergs/gm mole
      /deg.C
7  v=130000;//velocity of sound in cm/sec
8  j=4.2*10^7;//joules constant in ergs/cal
9
10 //CALCULATION
11 cv=cp-(r/j);//specific heat at constant volume in gm
      -mole/deg.C
12 y=(cp/cv);//index of co-efficient
13 v1=(3/y)^(0.5)*v;//rms velocity in cm/sec
14
15 //OUTPUT
16 mprintf('the rms velocity of gas molecule is %3fcm/
      sec',v1)
```

Scilab code Exa 4.13 The average velocity of the molecule

```
1  clc
2  clear
3
4  //INPUT
5  t=300;//temperature of the oxygen molecule in K
6  n=6.02*10^23;//avagdrao's number
7  m=32/n;//mass of each molecule in oxygen
8  k=1.38*10^(-16);//boltzmann constant in erg/deg
9
10 //OUTPUT
11 v=(8*k*t/(3.14*m))^(0.5);//average velocity of
      oxygen molecule in cm/sec
12 v2=v*0.022384;//velocity in miles/hrs
13
14 mprintf('the avg velocity of  oxygen molecule is %3
      .1f miles/hour',v2)
```

35

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

```
1  clc
2  clear
3
4  //INPUT
5  v1=2.4;//velocity of first particle in km/sec
6  v2=2.6;//velocity of second particle in km/sec
7  v3=3.7;//velocity of third particle in km/sec
8
9  //CALCULATIONS
10 rv=((v1^2+v2^2+v3^2)/(3))^(0.5);//rms velocity of
      the particles in km/sec
11 mv=(v1+v2+v3)/(3);//mean velocity of the particles
      in km/sec
12 r=rv/mv;//ratio of the rms to mean velocity
13
14 mprintf('the ratio of rms to mean velocity is %3.3f'
      ,r)
```

Scilab code Exa 4.15 The mean free path

```
1  clc
2  clear
3
4  //INPUT
5  n=2.76*10^19;//no.of molecules per cc
6  d=3.36*10^(-8);//diameter of the helium molecule in
      cm
7
8  //CALCULATIONS
```

```
9   mf =1/(( 2^ (0.5) ) *3.14*( d ^2) * n )
10
```
```
12  mprintf ( 'the  mean  free  path  of  the  hydrogen  molecue
        is  %3.8 f  cm ', mf )
```

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

```
1   clc
2   clear
3
```
```
5   n =85*10^ ( -6) ;// coefficent  of  viscosity  in  dynes / cm
        ^2/ velocity  gradient
6   c =16*10^4 ;// velocity  in  cm/ sec
7   p =0.000089 ;// density  in  gm/ cc
8   N =6.06*10^23/22400 ;// avagadro  number
9   a =(2) ^ (0.5) *(22/7) ;// constant
10
```
```
12  mf =(3* n /( p * c ) ) ;// mean  free  path  in  cm
13  cr = c / mf ;// collision  rate
14  d =(1/( a * N * mf ) ) ^ (0.5) ;// molecular  diameter  of
        hydrogen  gas  in  cm
15
16  mprintf ( 'the  mean  free  path  is  %3.6 fcm  \n  hte
        collision  rate  is  %3.2 f  \n  the  molecular  diameter
         of  hydrogen  gas  is  %3.10 fcm ', mf , cr , d )
```

Scilab code Exa 4.17 The mean free path

```
1   clc
```

```
2 clear
3
4 //INPUT
5 d=2*10^(-8);//diameter of the molecule in cm
6 k=1.38*10^(-6);//boltzmann constant in ergs/deg
7 t=273;//temperature at ntp in K
8 p=76*13.6*981;//pressure at ntp in gm/cm/sec^2
9
10 //CALCULATIONS
11 mf=((k*t)/(2^(0.5)*3.14*(d^2)*p));//mean free path
      in cm
12 //since p=nkt
13
14 //OUTPUT
15 mprintf('mean free path at ntp is %3.6fcm',mf)
```

Scilab code Exa 4.18 The diameter

```
1 clc
2 clear
3
4 //INPUT
5 t=288;//temperature in K
6 k=1.38*10^(-16);//boltzmann constant in erg/deg
7 N=6.02*10^23;//avagadro number
8 m=32/N;//mass of each oxygen molecule in gm
9 v=196*10^-6;//viscosity in poise
10
11 //CALCULATIONS
12 av=((8*k*t/(3.14*m))^0.5);//average velocity in cm/
      sec
13 d=(m*av/(3*3.14*2^(0.5)*v))^0.5;//diameter of the
      molecule in cm
14
15 mprintf('diameter of the molecule is %3.10f cm',d)
```

Scilab code Exa 4.19 The pressure

```
1  clc
2  clear
3
4  //INPUT
5  mf =15; // mean  free  path  in  cm
6  t =300; // temperature  of  oxygen  molecule  in  K
7  d =3*10^( -8) ; // diameter  of  the  molecule  in  cm
8  N =6.02*10^23; // avagadro  number
9  r =8.32*10^7; // universal  gas  constant  in  ergs / mole /
        deg
10 a =(2^(0.5) ) *(22/7) ;
11
12 //CSLCULATIONS
13 p =( r*t ) /( N*a*( d^2) *mf ) ; // pressure  of  the  oxygen
        molecule  in  dynes / sq . cm
14
15 //OUTPUT
16 mprintf ( 'the  pressure  of  the  oxygen  molecule  is  %3.3
        f  dynes / sq . cm ' ,p )
```

Scilab code Exa 4.20 The avagadro number

```
1  clc
2  clear
3
4  //INPUT
5  k =5.64*10^ -14; // kinetic  energy  of  the  hydrogen
        molecule  ergs
6  t =273; // temperature  of  the  oxygen  molecule  in  K
```

```
7  r=8.32*10^7;//universal gas constant in ergs
8
9  //CALCULATIONS
10 N=(3/2)*(r*t/k);//avagadro number
11
12 //OUTPUT
13 mprintf('the avagadro number is %3.2f',N)
```

Scilab code Exa 4.21 The number which will be travelling undeflected

```
1  clc
2  clear
3
4  //INPUT
5  q=5000;//total number of molecules
6  e=2.7183;//constant value
7  t1=0.5;//distance travled to the mean free path
8  t2=1;//distance travelled to the mean free path
9
10 //CALCULATONS
11 p1=q*(e^-t1);//n0.of molecules having no collision
        in traversing a distance t1
12 p2=q*(e^-t2);//n0.of molecules having no collision
        in traversing a distance t2
13
14 //OUPUT
15 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

```
1  clc
2  clear
3
4  //INPUT
5  t=38380;//temperature of the molecule in K
6  k=1.38*10^-16;//boltzman constant of one electron in
         ergs/K
7  e=1.6*10^-12;//charge of one electron volts
8
9  //CALCULATIOS
10 mk=1.5*k*t/e;//mean kinetic energy per atom in ev
11
12 //OUTPUT
13 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

```
1  clc
2  clear
3
4  //INPUT
5  v=1.7*10^-4;//viscosity of the air molecule in cgs
6  d=0.00129;//density of the molecule in gm/ml
7  p=76*13.6*981;//pressure of the molecule in gm/cm/
       sec^2
8
9  //CALCULATIONS
10 r=(3*p/d)^(0.5);//rms velocity of the molecule in cm
       /sec
11 mf=(3*v/(d*r));//mean free path in cm
12 cf=r/mf;//collision frequency
13
14 //OUTPUT
15 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

```
1  clc
2  clear
3
4  //INPUT
5  t2=296.4; // temperature  of  the  first  plate  in  K
6  t1=304.7; // temperature  of  the  second  plate  in  K
7  f=1.6*10^-2; // force  repelled  cold  is  dynes/sq.cm
8
9  //CALCULATIONS
10 p=(4*f*t2/(t1-t2)); // pressure  of  the  gas  in  dynes/sq
      .cm
11
12 //OUTPUT
13 mprintf('the  pressure  of  the  gas  is  %3.3f  dynes/sq.
      cm',p)
```

Scilab code Exa 4.25 The size of helium atom

```
1  clc
2  clear
3
4  //INPUT
5  mf=28.5*10^-6; // mean  free  path  in  cm
6  d=0.000178; // density  of  helium  in  gm/ml
7  m=6*10^-24; // mass  of  the  helium  atom  in  gm
8  a=(2^(0.5))*3.14; // constant
9
10 //CALCULATIONS
11 d=(m/(a*d*mf))^(0.5); // diameter  of  the  size  in  cm
```

```
12
13  //OUTPUT
14  mprintf('the size of the helium atom is %3.10f cm',d
        )
```

Scilab code Exa 4.26 The value avagadro number

```
 1  clc
 2  clear
 3
 4  //INPUT
 5  a1=0*10^-4;//first horizontal displacement in cm
 6  a2=5.6*10^-4;//second horizontal displacement in cm
 7  a3=-4.7*10^-4;//third horzontal displacement in cm
 8  a4=-10.8*10^-4;//fourth horizontal displacement in
        cm
 9  a5=6.6*10^-4;//fifth horizontal displacement
        displacement in cm
10  a6=-9.8*10^-4;//sixth horizontal displacement in cm
11  a7=-11.2*10^-4;//7th horizontal displacement in cm
12  a8=-4.0*10^-4;//8th horizontal displacement in cm
13  a9=15.0*10^-4;//9thhorizontal displacement in cm
14  a10=19.1*10^-4;//10th horizontal displacement in cm
15  a11=16.0*10^-4;//11ht horizontal displacement in cm
16  T=293;//temperature of the particle in K
17  v=0.01;//viscosity in cgs
18  r=1.15*10^-5;//radius of the particle in cm
19  R=8.32*10^7;//universal gas constant in kj/kg mole
20  t=30;//time for observation of each in sec
21
22  //CALCULATIONS
23  x=(a1^2+a2^2+a3^2+a4^2+a5^2+a6^2+a7^2+a8^2+a9^2+a10
        ^2+a11^2)/11
24  n=R*T*t/(x*3*3.14*v*r);//no.of molecules in the
        observation
```

```
25
26  //OUTPUT
27  mprintf('the value of n is %3f',n)
```

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

```
 1  clc
 2  clear
 3
 4  //INPUT
 5  m=6*10^-24;//mass of the helium atom in gm
 6  k= 1.38*10^-16;//boltzmann constant in erg
 7  t1=100;//temperature in K
 8  t2=900;//temperature in K
 9
10  //CALCULATIONS
11  r=(t1/t2)^(3/2)*(2.7183^(m*(1/(2*k))*10^8*(1-(1/9))))
        );//fractional change in the no.of helium atoms
12
13  //OUPUT
14  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

```
1  clc
2  clear
3
4  //INPUT
5  t=304;//temperature of the gas in k
6  p=73;//pressure of the gas in atm
7  r=0.00366;//universal gas constant in j/K/mole
8  //ct=8a/27br;cp=a/27b^2
9
10 //CALCULATIONS
11 b=(t*r/(8*p));
12 a=p*27*b^2;
13
14 //OUTPUT
15 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

```
1 clc
2 clear
3
4 //INPUT
5 tc=132;//critical temperature in K
6 pc=37.2;//critical pressure in atm
7 r=82.07;//universal gas constant in cm^3atm/mole/K
8
9 //CALCULATIONS
10 a=27*(r^2)*(tc^2)/(64*pc);//value of a in atm/cm^6/
     mol^2
11 b=r*tc/(8*pc);//value of b in cm^3/mol
12
13 //OUTPUT
14 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

```
1 clc
2 clear
3
4 //INPUT
5 p=2.26*1.013*10^5;//critical pressure in N/m^2
6 v=4/69;//critical volume in m^3/kmol
7 r=8.31*10^3;//universal gas constant in J/kmol.K
8
9 //CALCULATIONS
10 t=(8*p*v/(3*r));//critical temperature in K
11
12 //OUTPUT
13 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

```
1  clc
2  clear
3
4  //INPUT
5  vl=1;//volume of water in cc
6  vs=1.0908;//volume of ice in cc
7  t=273;//temperature in k
8  p=76*13.6*981;//pressure in dynes/sq.cm
9  l=80;//latent heat of fusion in cal
10 j=4.2*10^7;//joules constant in erg/cal
11
12 //CALCULATIONS
13 v=vl-vs;//change in volume
14 T=(v*t*p)/(j*l);//change in melting point of water
15
16 //OUTPUT
17 mprintf('the change in melting point of water is %3
     .11f',T)
```

Scilab code Exa 6.2 The latent heat of vapourisation

```
1  clc
2  clear
3
4  //INPUT
5  vv=1674;//volume of vapour in cc
6  vl=1;//volume of liquid in cc
7  p=760;//pressure of steam and water in mm
8  t=373;//temperature in K
9  p1=27.12;//superincumbent pressure in mm
10
11  //CALCULATIONS
12  v=vv-vl;//change in volume
13  l=(v*p1*t*0.024203/(p));//latent heat of
       vapourisation in cal
14
15  //OUTPUT
16  mprintf('the latent heat of vapourisation is %3.1f
       cal',l)
```

Scilab code Exa 6.3 The value of K

```
1  clc
2  clear
3
4  //INPUT
5  m=1/(342*100);//molar concentration of water
6  t=289;//temperature in K
7  p=53.5*13.6*981;//pressure in dynes/sq.cm
8
9  //CALCULATIONS
10  k=p/(t*m);//the value of k in ergs/mol.deg
11
12  //OUTPUT
```

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

Scilab code Exa 6.4 The temperature for the triple point

```
1 clc
2 clear
3
4 //INPUT
5 p1=4.60;//presure at 0deg.C in mm per deg.C
6 p2=4.94;//pressure at 1deg.C in mm per deg.C
7 t=0.0072;//lowering the melting point in deg.C
8 t1=7.1563979*10^(-3);//rise in melting point in deg.
     C
9 p=760;//atmospheric pressure in mm hg
10
11 //CALCULATIONS
12 dp=p2-p1;//rate of increase of pressure in mm per
     deg.C
13 p3=(t1*p)/t;//pressure in mm
14 dt=(755.4-p3)/dp;//tmperature for the triple point
     in deg.C
15
16 //OUTPUT
17 mprintf('temperature for the triple point is %3.6f
     deg.C',dt)
```

Scilab code Exa 6.5 The slopes of vapourisation

```
1 clc
2 clear
3
4 //INPUT
```

```
5  v=21*10^4;//change  in  volume  from  vapour  to  liquid
       in  cc
6  Ls=687;//latent  heat  of  sublimation  in  cal
7  lv=607;//latent  heat  of  vapourisation  in  cal
8  t=273;//temperature  of  water  in  deg.C
9  j=4.2*10^7;//joules  constant  in  ergs/cal
10
11 //CALCULATIONS
12 sv=lv*j/(t*(v));//slope  of  vapourisation  curve  at  0
       deg.C  in  dyne/sq.cm/deg.C
13 ss=Ls*j/(t*(v));//slope  of  sublimation  curve  at  0
       deg.C  in  dyne/sq.cm/deg.C
14
15 //OUTPUT
16 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

```
1 clc
2 clear
3
4 //INPUT
5 t=33.18;// critical temperature in K
6 pc=12.80*76*981*13.6;// critical pressure in dynes/sq
      .cm
7 r=83.15;// universal gas constant in kj/kg.K
8 d=0.08987;// density of hydrogen in gm/lit
9 v=2000/0.08987;// gram molecular volune of hydrogen
      in cc
10
11 //CALCULATIONS
12 b=r*10^6*t/(8*pc);// vanderwaal constant in cm^3/mol
13 to=2*27*t*(1-(b/v))/8;// inversion temperature of the
      hydrogen in K
14
15 //OUTPUT
16 mprintf('the inversion temperature of hydrogen is %3
      .2 f K',to)
```

Scilab code Exa 7.2 The change of temperature

```
1  clc
2  clear
3
4  //INPUT
5  b=0.00136;//vanderwaal constant in suv/gm
6  a=0.011;//vanderwaal constant in atm(suv)^2/gm^2
7  r=0.003696;//universal gas constant in atm(suv)/gm.
       deg
8  t=423;//temperature of steam in K
9  cp=-0.674/0.024205;//specific heat at 423K in atm(cc
       )gm(deg)
10
11 //CALCULATIONS
12 dt=(-b+(2*a/(r*t)))/cp;//change of temperature per
       atm drop of pressure in deg/atm
13
14 //OUTPUT
15 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

```
1  clc
2  clear
3
4  //INPUT
5  r=8.3*10^7;//universal gas constant in ergs/deg.C
6  a=1.36*10^6*76*13.6*981;//vanderwaal constant in atm
       .(suv^2)/(gm^2)
7  b=32;//vanderwaal constant in cc
```

```
8  cp=7.03;//specific heat at constant pressure in cal
9  j=4.18*10^7;//joules constant in ergs/cal
10 t=273;//temperature of the gas in K
11
12 //CALCULATIONS
13 dt=((2*a/(r*t))-b)*10^6/(cp*j);//change of
      temperature in atmosphere drop of pressure in deg
      /atm/cm^3
14
15 //OUTPUT
16 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

```
1  clc
2  clear
3
4  //INPUT
5  u=1.08;
6  cp=8.6;//specific heat in kj/kg.K
7  j=4.2;//joules constant in j/cal
8  p1=1*1.013*10^6;//pressure at intial in N/sq.m
9  p2=20*1.013*10^6;//pressure at final in N/sq.m
10
11 //CALCULATIONS
12 dh=-u*cp*j*(p1-p2);//change in enthalpy in joules
13
14 //OUTPUT
15 mprintf('the change in enthalpy is %3.2fjoules',dh)
```

Scilab code Exa 7.5 The inversion temperature

```
1  clc
2  clear
3
4  //INPUT
5  tc=5.26;//critical temperature of the helium in K
6
7  //CALCULATIONS
8  ti=27*tc/4;//inversion temperature of the helium in
     K
9
10 //OUTPUT
11 mprintf('the inversion temperature of the helium is
     %3.2f K',ti)
```

Scilab code Exa 7.6 The temperature of inversion

```
1  clc
2  clear
3
4  //INPUT
5  a=0.245*10^6*10^6;//vanderwaal constant in cm^4.dyne
     /mole^2
6  b=2.67*10;//vanderwaal constant in cc/mole
7  r=2*4.2*10^7;//universal gas constant in ergs/mole.K
8
9  //CALCULATIONS
10 ti=2*a/(b*r);//inversion temperature in K
11
12 //OUTPUT
13 mprintf('inversion temperature of hydrogen is %3.2f
     K',ti)
```

Scilab code Exa 7.7 The drop in temperature

```
1 clc
2 clear
3
4 //INPUT
5 dp=50*10^6;//change in pressure in dynes/sq.cm
6 cp=7*4.2*10^7;//specific heat constant pressure in
       ergs/mole.K
7 a=1.32*10^12;//vanderwaal constant in cm^4.dyne/mole
       ^2
8 b=31.2;//vanderwaal constant in cm^2/mole
9 t=300;//inital temperature in K
10 r=2*4.2*10^7;//ergs/mole.K
11
12 //CALCULATIONS
13 dt=((2*a/(r*t))-b)*dp/cp;//change in temperature in
       K
14
15 //OUTPUT
16 mprintf('the change in temperature is %3.2f K',dt)
```

Scilab code Exa 7.8 The drop in temperature

```
1 clc
2 clear
3
4 //INPUT
5 p1=1;//inital pressure in atm
6 p2=51;//final pressure in atm
7 t1=300;//inital temperature in K
8 y=1.4;//coefficient of expansion
9
10 //CALCULATIONS
11 t2=t1*(p2/p1)^((1-y)/y);//final temperature in K
12 dt=t1-t2;//drop in temperature in K
13
```

```
14  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

```
1  clc
2  clear
3
4  //INPUT
5  l=80;//latent heat of fusion in cal
6  j=4.2*10^7;//joules constant in ergs/cal
7  w=-0.092*10^6;//work done in changing phase change
       in ergs
8
9  //CALCULATIONS
10 q=l*j;//heat added in ergs
11 du=q-w;//internal energy in ergs
12
13 //OUTPUT
14 mprintf('the change in internal energy is %3.2f ergs
       ',du)
```

Scilab code Exa 8.2 The change in internal energy

```
1 clc
2 clear
3
4 //INPUT
5 m=1;//mass in gm
6 l=536;//latent heat in cal/gm
7 j=4.2*10^7;//joules constant in ergs/cal
8 v=1649;//volume of water in cc
9 p=76*13.6*981;//pressure of water in dynes/sq.cm
10
11 //CALCULATIONS
12 dq=m*l*j;//heat supplied in ergs
13 dw=p*v;//work done in ergs
14 du=dq-dw;//internal energy developed in ergs
15
16 //OUTPUT
17 mprintf('internal energy of water is %3.2f ergs',du)
```

Scilab code Exa 8.3 The temperature immediately after the compression

```
1 clc
2 clear
3
4 //INPUT
5 dv=10;//ratio of original volume to final volume
6 t1=293;//inital temperature in K
7 y=1.41;//coefficent of expansion
8
9 //CALCULATIONS
10 t2=t1*(dv)^(y-1);//final temperature in K
11
12 //OUTPUT
13 mprintf('the final temperature is %3.2f K',t2)
```

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Scilab code Exa 8.4 The change in temperature

```
1  clc
2  clear
3
4  //INPUT
5  t=273;//temperature of earth at height h in K
6  p=760;//pressure in mm of hg
7  dp=1;//change in pressure in mm of hg
8  y=1.418;//coefficient of expansion
9
10 //CALCULATIONS
11 dt=((y-1)/y)*dp*t/p;//change in temperature in deg.C
12
13 //OUTPUT
14 mprintf('the change in temperature is %3.3f deg.C',
     dt)
```

Scilab code Exa 8.5 The resulting drop in temperature

```
1  clc
2  clear
3
4  //INPUT
5  p1=2;//pressure initial in atm
6  p2=1;//pressure final in atm
7  t1=288;//inital temperature in K
8  y=1.4;//coefficent of expansion
9
10 //CALCULATIONS
11 t2=t1*(p2/p1)^((y-1)/y);//final temperature in K
12 dt=t1-t2;//drop in temperature in K
```

```
13
14 //OUTPUT
15 mprintf('drop in temperature is %3.2f K',dt)
```

Scilab code Exa 8.6 The resultant temperature

```
1  clc
2  clear
3
4  //INPUT
5  t1=288;//inital temperature in K
6  dv=1/2;//ratio of inital to final volume
7  y=1.4;//coefficient of expansion
8
9  //CALCULATIONS
10 t2=t1*(dv)^(y-1);//final temperature in K
11
12 //OUTPUT
13 mprintf('the final temperature is %3.1f K',t2)
```

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

```
1  clc
2  clear
3
4  //INPUT
5  y=1.4;//coefficent of exapnsion
6  p1=1;//standard pressure in atm
7  dv=50;//ratio of initial volume to final volume
8  t1=273;//standard temperature in K
9
10 //CALCULATIONS
```

```
11  p2=p1*dv;//final pressure when slowly compressed in
       atm
12  p3=p1*(dv)^(y);//final pressure when suddenly
       compressed in atm
13  t2=t1*(dv)^(y-1);//rise in temperature when it is
       suddenly compressed in K
14
15  //OUTPUT
16  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

```
1  clc
2  clear
3
4  //INPUT
5  y=1.5;//coefficient of expansion
6  dp=1/8;//ratio of inital pressure to final pressure
7  t1=300;//inital tempreature in K
8
9  //CALCULATIONS
10 t2=t1*(dp)^((1-y)/y);//change in temperature in K
11 t3=t2-t1;//rise in temperature in K
12
13 //OUTPUT
14 mprintf('the rise in temperature is %3.2f K',t3)
```

Scilab code Exa 8.9 The amount of work done

```
1  clc
2  clear
3
4  //INPUT
5  t1=400;//inital temperature in K
6  dv=2;//ratio of volumes final and inital
7  r=8.31*10^7;//universal gas constant in ergs/kg.K
8
9  //CALCULATIONS
10 w=r*t1*log(2);//work done in expanding isothermally
      in ergs
11
12 //OUTPUT
13 mprintf('the work done in expanding isothermally is
      %3.2f ergs',w)
```

Scilab code Exa 8.10 The final temperature and pressure

```
1  clc
2  clear
3
4  //INPUT
5  p1=76;//inital pressure in cm
6  t1=290;//inital temperature in K
7  y=1.4;//coefficent of expansion
8  dv=2;//ratio of inital to fianl volume when air
      expands isothermally
9  dv1=2;//ratio of inital to final volume when air
      expands adiabatically
10
11 //CALCULATIONS
12 p2=p1/dv;//final pressure when air expands
      isothermally in cm of hg
13 t2=t1;//final temperature when air expands
      isothermally in K
```

```
14  t3=t2*(1/dv1)^(y-1);//temprature when air expands
       adiabatically in K
15  p3=p2*(1/dv1)^(y);//final pressure when air expands
       adiabatically in mm of hg
16
17  //OUTPUT
18  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

```
1  clc
2  clear
3
4  //INPUT
5  p=76*13.6*981;//pressure of air in dynes/sq.cm
6  v=11100;//volume expanded in ml
7  t1=273;//inital temperature in K
8  t2=274;//final temperature in K
9  cv=2.411;//specific heat at constant volume in cal/K
10 j=4.2*10^7;//joules constant in ergs/cal
11 //CALCULATIONS
12 w=p*v*log(t2/t1);//work done in ergs
13 h=cv*(t2-t1)+w/j;//heat supplied in cal
14
15 //OUTPUT
16 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

```
1  clc
2  clear
3
4  //INPUT
5  p=10^6;//pressure of air in dynes
6  d=0.0001293;//density of air in gm/cc
7  t1=273;//inital temperature in K
8  dv=2;//ratio of inital volume to final volume
9  y=1.4;//coefficient of expansion
10
11 //CALCULATIONS
12 r=p/(d*t1);//universal gas constant in dynes.cc/gm.K
13 t2=t1*(dv)^(y-1);//final temperature in K
14 w=r*(t2-t1)/(y-1);//work done in adiabatic
      compression in ergs
15
16 //OUTPUT
17 mprintf('work done in adiabatic compression is %3.2f
       ergs',w)
```

Scilab code Exa 8.13 The change in internal energy

```
1  clc
2  clear
3
4  //INPUT
5  m=5;//mass of air in gm
6  cv=0.172;//specific heat at constant volume cal/gm
7  dt=10;//changi in temperature in K
8
9  //CALCULATIONS
10 ie=m*cv*dt;//change in internal energy in cal
11
```

Scilab code Exa 8.14 The heat supplied

```
1  clc
2  clear
3
4  //INPUT
5  v1=10^3;//inital volume in cc
6  v2=2*v1;//final volume in cc
7  p1=76*13.6*981;//pressure in dyne/sq.cm
8  t1=273;//intial temperature in K
9  d=1.29;//density of the gas gm/lit
10 cv=0.168;//specific heat at constant volume in cal/
     gm
11
12 //CALCULATIONS
13 t2=(v2/v1)*t1;//final temperature in K
14 r=0.068;//universal gas constant in cal
15 cp=cv+r;//specific heat at constant pressure in cal
16 q=d*cp*(t2-t1);//heat supplied in cal
17
18 //OUTPUT
19 mprintf('the heat supplied to the gas is %3.2f cal',
     q)
```

Scilab code Exa 8.15 The maximum work done

```
1  clc
2  clear
3
4  //INPUT
```

```
5  t=303;//temperature of the one mole of the argon in
       K
6  v1=1;//intial volume in litres
7  v2=10;//final volume in litres
8  r=8.31*10^7;//universal gas constant in ergs/K.mol
9
10 //CALCULATIONS
11 w=r*t*log(v2/v1);//work done in isothermal expansion
        in ergs
12
13 //OUTPUT
14 mprintf('the work done in isothermal expansion is %3
       .2f ergs',w)
```

Scilab code Exa 8.16 The amount of heat absorbed

```
1  clc
2  clear
3
4  //INPUT
5  dv=4;//final volume of neon in lit
6  t=273;//temperature of the gas in K
7  n=2.6/22.4;//the no.of moles of neon
8  r=1.98;//universal gas constant in cal/K.mol
9
10 //CALCULATIONS
11 w=n*t*r*log(dv);//work done by gas in ergs
12
13 //OUTPUT
14 mprintf('the work done by 2.6 lit of neon is %3.2f
       ergs',w)
```

Scilab code Exa 8.18 The temperature

```
1  clc
2  clear
3
4  //INPUT
5  dv=10^(-3);//ratio of initial and final volume
6  t1=10^5;//initial temperature in K
7  y=1.66;//coefficient of expansion
8
9  //CALCULATIONS
10 t2=t1*(dv)^(y-1);//final temperature in K
11
12 //OUTPUT
13 mprintf('final temperature of the gas is %3.2f K',t2
      )
```

Scilab code Exa 8.19 The value coefficient of expansion

```
1  clc
2  clear
3
4  //INPUT
5  p1=8;//intial pressure in cm of hg
6  p2=6;//final pressure in cm of hg
7  v1=1000;//intial volume in cc
8  v2=1190;//final volume in cc
9
10 //CALCULATIONS
11 y=log(p1/p2)/log(v2/v1);//coefficient of expansion
12
13 //OUTPUT
14 mprintf('the coeffcent of expansion is %3.2f',y)
```

Chapter 9

Second law of thermodynamics

Scilab code Exa 9.1 The temperature

```
1  clc
2  clear
3
4  //INPUT
5  t2=300;//temperature of the sink in K
6  n1=0.4;//efficiency of the engine
7  n2=0.6;//efficiency of the engine
8
9  //CALCULATIONS
10 t1=t2/(1-n1);//temperature of the source in K
11 t3=t2/(1-n2);//temperature of the source in K
12
13 //OUTPUT
14 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

```
1  clc
2  clear
3
4  //INPUT
5  t2=273;//temperature of the sink in K
6  t1=373;//temperature of the source in K
7  q1=840;//heat supplied in joules
8  j=4.2;//joukes constant in erg/cal
9
10 //CALCULATIONS
11 w=(q1/t1)*(t1-t2);//work done in joules
12 q2=(q1/j)*(t2/t1);//heat rejected in calories
13 n=1-(t2/t1);//efficiency of the engine
14
15 //OUTPUT
16 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

```
1  clc
2  clear
3
4  //INPUT
5  t1=90;//temperature of the oxygen boils in K
6  t2=20;//temperature of the liquid hydrogen in K
7  t3=300;//temperature of the sink in K
8
9  //CALCULATIONS
10 n=(t1-t2)/t1;//efficiency of the engine
11 t4=t3/(1-n);//temperature of the source in K
12
13 //OUTPUT
14 mprintf('the efficiency of the engine is %3.2f \n
```

Scilab code Exa 9.4 The quantity of heat

```
1  clc
2  clear
3
4  //INPUT
5  t1=373;//temperature of the source in K
6  t2=273;//temperature of the sink in K
7  w=1200*10^5*980;//work done in ergs
8  j=4.18*10^7;//joules constant in ergs/cal
9
10 //CALCULATIONS
11 q=(w/j)*(t1/(t1-t2));//heat added in cal
12
13 //OUTPUT
14 mprintf('the heat added is %3.2f cal',q)
```

Scilab code Exa 9.5 The efficiency and energy to be supplied

```
1  clc
2  clear
3
4  //INPUT
5  t1=273;//temperature of the source in K
6  t2=290;//temperature of the sink in K
7  l=8*10^11;//latent of fusion in ergs/cal
8
9  //CALCULATIONS
10 n=(t2-t1)/t1;//efficiency of the engine
11 w=n*l;//energy to be supplied in ergs
12
```

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```
13 //OUTPUT
14 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

```
1 clc
2 clear
3
4 //INPUT
5 t1=373;//temperature in K
6 t2=273;//temperature of sink in K
7 q=10^4;//heat taken at higher temperature in cal
8 j=4.2*10^7;//joules constant in ergs/cal
9
10 //CALCULATIONS
11 w=q*j*(t1-t2)/t1;//work done in ergs
12
13 //OUTPUT
14 mprintf('work done is %3.2f ergs',w)
```

Scilab code Exa 9.7 The heat supplied rejected and efficiency

```
1 clc
2 clear
3
4 //INPUT
5 p=100*746/4.2;//power developed in cal/sec
6 t1=300;//temperature of the sink in K
7 t2=500;//temperature of the source in K
8
9 //CALCULATIONS
10 n=1-(t1/t2);//efficiency of the engine
```

```
11  q1=p/n;//heat supplied in cal/sec
12  q2=q1*(1-n);//heat rejected to the sink in cal/sec
13
14  //OUTPUT
15  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

```
1   clc
2   clear
3
4   //INPUT
5   y=1.4;//coefficent of expansion
6   t1=600;//intial temperature in K
7   dv=1/6;//ratio of intial to final volume
8   p=12*1.013*10^6;//pressure in dyne/sq.cm
9   v=1000;//intial voluume in cc
10
11  //CALCULATIONS
12  t2=t1*(dv)^(y-1);//final temperature in K
13  r=(p*v)/t1;//universal gas constant in ergs/kg.K
14  w=r*(t1-t2)*log(1/dv);//work done in ergs
15  n=1-(t2/t1);//efficiency of the engine
16
17  //OUTPUT
18  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

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```
1  clc
2  clear
3
4  //INPUT
5  l=964.8;//latent heat of steam in B.Th.U per lb
6  q=4*15*l*778;//heat developed in ft lbs
7  w=30000*60;//work done is ft lbs
8
9  //CALCULATIONS
10 n=(w/q)*100;//efficiency of the engine
11 p=100-n;//percentage of heat wasted
12
13 //OUTPUT
14 mprintf('the percentage of the heat wasted is %3.2f'
       ,p)
```

Scilab code Exa 9.10 The indicated thermal efficiency

```
1  clc
2  clear
3
4  //INPUT
5  ip=16.3*500*778/33000;//input power of the engine in
       HP
6  me=0.72;//mechanical efficiency of the engine
7  bhp=31;//brake horse power in b.h.p
8  ihp=bhp/me;//indicated horse power in HP
9
10 //CALCULATIONS
11 i=ihp/ip;//indicated thermal efficiency
12
13 //OUTPUT
14 mprintf('the indicted thermal efficiency is %3.3f',i
       )
```

Scilab code Exa 9.11 The horse power of the steam engine

```
1 clc
2 clear
3
4 //INPUT
5 p=200;//horse power of steam engine in lbs coal per
      hour
6 j=770;//joules constant in ft lbs per B.Th.U
7
8 //CALCULATIONS
9 w=12500*p*j;//equivalent work in ft.lb.per.hr
10 hp=w/(60*33000);//horse power
11
12 //OUTPUT
13 mprintf('hoose power of the engine is %3.2f',hp)
```

Scilab code Exa 9.12 The maximum pressure

```
1 clc
2 clear
3
4 //INPUT
5 t1=340;//temperature of the atmosphere in K
6 t2=612;//temperature of the compression stroke in K
7 y=1.39;//adiabatic expansion
8 t3=2040;//temperature after constant volume ignition
      in K
9
10 //CALCULATIONS
11 d=(t2/t1)^(1/(y-1));//density in gm/cc
12 n=1-(1/d)^(y-1);//efficiency of the engine
```

```
13 p=((d)^(y))*(t3/t2);//maximum temperature of the
       temperature in atm
14
15 //OUTPUT
16 mprintf('the maximum pressure of the engine is %3.2f
        atm',p)
```

Scilab code Exa 9.13 The efficiency of the engine

```
1 clc
2 clear
3
4 //INPUT
5 t1=915;//temperature at the beggining in K
6 t2=2040;//temperature at the end in K
7 d=12.6;//adiabatic expansion ratio
8 y=1.39;//coefficent of expansion
9
10 //CALCULATIONS
11 x=t2/t1;//ratio temparatures
12 n=1-(1/d)^(y-1)*((x^y)-1)/(y*(x-1));//efficiency of
      the engine
13
14 //OUTPUT
15 mprintf('the efficiency of the engine is %3.3f',n)
```

Scilab code Exa 9.14 The pressure and temperature

```
1 clc
2 clear
3
4 //INPUT
5 p1=15;//intial pressure in lb/sq.inch
```

```scilab
6  dv=15;//ratio of intial to final volume
7  t1=520;//temperature at intial in K
8  y=1.4;//coefficient of expansion
9
10 //CALCULATIONS
11 p2=p1*(dv)^(y);//final pressure in lb/sq.inch
12 t2=t1*(dv)^(y-1);//final temperatire in K
13
14 //OUTPUT
15 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

```
1  clc
2  clear
3
4  //INPUT
5  t=289.6;//temperature in K
6  dt=0.0244;//raise in temperature in deg.C
7  v1=0.00095;//volume occupied in liquid state in
      litres
8  v2=0.00079;//volume occupied in solid state in
      litres
9
10 //CALCULATIONS
11 l=t*(v1-v2)/dt;//latent heat of fusion in lit.atm
12
13 //OUTPUT
14 mprintf('the latent heat of fusion is %3.2f lit.atm'
      ,l)
```

Scilab code Exa 10.2 The value of specific heat

```
1  clc
2  clear
3
4  //INPUT
5  t=295;//temperature of water in K
6  dp=10^6;//cahnge in pressure in dyne/sq.cm
7  j=4.2*10^7;//joules constant in ergs/cal
8
9  //CALCULATIONS
10 dc=-t*10^-5*dp/j;//change in specific heat
11
12 //OUTPUT
13 mprintf('the change in specific heat is %3.7f cal/
      degree',dc)
```

Scilab code Exa 10.3 The specific heat of copper

```
1  clc
2  clear
3
4  //INPUT
5  cp=0.0909;//specific heat at constant pressure in
      cal/degree
6  t=273;//temperature in K
7  v=0.112;//specific volume in lit/deg.C
8  a=5.01*10^(-6);//coefficient of linear expansion
9  k=8*10^-7;//compressibility of copper in per atoms
10
11 //CALCULATIONS
12 cv=cp+(9*a^2*v*t*0.024142*10^3/k);//specific heat at
      constant volume in cal/deg.C
13
14 mprintf('specific heat at constant volume is %3.2f
      cal/deg.C',cv)
```

Scilab code Exa 10.5 The latent heat of fusion

```
1  clc
2  clear
3
4  //INPUT
5  t=289.6;//temperature in K
6  dt=0.0244;//raise in temperature in deg.C
7  v1=0.00095;//volume occupied in liquid state in
       litres
8  v2=0.00079;//volume occupied in solid state in
       litres
9
10 //CALCULATIONS
11 l=t*(v1-v2)/dt;//latent heat of fusion in lit.atm
12
13 //OUTPUT
14 mprintf('the latent heat of fusion is %3.2f lit.atm'
       ,l)
```

Scilab code Exa 10.6 The rate of change of saturation pressure

```
1  clc
2  clear
3
4  //INPUT
5  l=539;//latent heat of water at 100deg.C in cal
6  j=4.2*10^7;//joules constant in ergs/cal
7  t=373;//temperature of water in K
8  v2=1670;//volume of steam formed in cc
9  v1=1;//intial volume in cc
10 g=981;//acceleration due to gravity in cm/sec^2
```

```
11  d=13.6; //specific gravity of hg
12
13  //CALCULATIONS
14  dp=l*j/(t*(v2-v1)*g*d); //rate of change of
        saturation pressure in cm of mercury
15
16  //OUTPUT
17  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

```
1  clc
2  clear
3
4  //INPUT
5  p1=77.371; //pressure at 100.5deg.C in cm of hg
6  p2=74.650; //pressure at 99.5deg.C in cm of hg
7  g=981; //universal gas constant in cm/sec^2
8  d=13.6; //specific gravity
9  l=537; //latent heat of vapourisation in cal/gm
10  t=373; //temperature of water in K
11  j=4.2*10^7; //joules constant in ergs/cal
12  v1=1; //intial volume in cc
13
14  //CALCULATIONS
15  v2=v1+(l*j/(t*(p1-p2)*g*d)); //volume of gram of
        steam at 100deg.C in cc
16
17  //OUTPUT
18  mprintf('volume of gram of steam at 100deg.C is %3.2
        f cc',v2)
```

Scilab code Exa 10.8 The specific volume

```
1  clc
2  clear
3
4  //INPUT
5  t=350;//boiling point temperature in K
6  l=46;//latent heat of vapourisation in cal/gm
7  v1=1/1.6;//intial volume in cc
8  dp=2.3;//change in pressure with temperature in cm
       of hg/deg.C
9  d=13.6;//specific gravity of mercury
10 g=981;//acceleration due to gravity in cm/sec^2
11 j=4.2*10^7;//joukes constant in ergs/cal
12
13 //CALCULTIONS
14 v2=v1+(l*j)/(t*dp*d*g);//specific volume in cc
15
16 //OUTPUT
17 mprintf('specific volume of vapour of carbon is %3.3
       f cc',v2)
```

Scilab code Exa 10.9 The change in temperature

```
1  clc
2  clear
3
4  //INPUT
5  l=536;//latent heat of vapourisation in cal/gm
6  v1=1;//volume of 1 gm of water in cc
7  v2=1600;//volume of steam in cc
8  t=373;//boiling point of water in K
9  p=1;//pressure in cm of hg
10 d=13.6;//specific gravity of mercury
11 g=981;//gravitational constant in cm/sec^2s/cal
```

```
12  j=4.2*10^7;//joules  constant  in  erg/cal
13
14  //CALCULATIONS
15  dt=(t*(v2-v1)*d*g)/(l*j);//change  in  temperature  in
        deg.C
16
17  //OUTPUT
18  mprintf('change  in  temperature  is  %3.2f  deg.C',dt)
```

Scilab code Exa 10.10 The change in melting point

```
1   clc
2   clear
3
4   //INPUT
5   t=353;//temperature  in  K
6   p=76*13.6*981;//pressure  in  dynes/sq.cm
7   v=0.146;//specific  volume  in  cc/kg
8   l=35.6;//latent  heat  of  fusion  in  cal/gm
9   j=4.18*10^7;//joules  constant  in  ergs/cal
10
11  //CALCULATIONS
12  dt=t*p*v/(l*j);//change  in  melting  point  per
        atmosphere
13
14  //OUTPUT
15  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

```
1   clc
2   clear
```

```
3
4  //INPUT
5  l=79.6*4.18*10^7;//latent heat of water in ergs/gm
6  t=273.16;//temperature of water in K
7  v1=1.0001;//specific volume of water at 0deg.C in cc
8  v2=1.0908;//specific volume of ice at 0deg.C in cc
9  p=1.013*10^6;//pressure of atmosphere in dyne/sq.cm
10
11 //CALCULATIONS
12 dt=t*(v1-v2)*p/l;//change in freezing point of water
       in deg.C
13
14 //OUTPUT
15 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

```
1  clc
2  clear
3
4  //INPUT
5  k=0.12;//thermal conductivity in cgs unit
6  t1=200;//temperature at one side in deg.C
7  t2=50;//temperature at other side in deg.C
8  t=3600;//time in sec
9  a=1;//area in sq.cm
10 t3=3;//thickness of the plate in cm
11
12 //CALCULATIONS
13 q=k*a*(t1-t2)*t/t3;//amount of heat conducted in cal
14
15 //OUTPUT
16 mprintf('the amount of heat conducted is %3.2f cal',
      q)
```

Scilab code Exa 11.2 The rate of flow of water

```
1  clc
2  clear
3
4  //INPUT
5  k=0.9;//thermal conductivity in cgs unit
6  a=10;//area of the copper bar in sq.cm
7  t1=100;//hot side temperature in deg.C
8  t2=20;//cool side temperature in deg.C
9  d=25;//thickness of the bar in cm
10 t3=14;//temperature of water when entering in deg.C
11
12 //CALCULATIONS
13 m=k*a*(t1-t2)/(d*(t2-t3));//rate flow of water in gm
      /sec
14
15 //OUTPUT
16 mprintf('rate flow of water is %3.2f gm/sec',m)
```

Scilab code Exa 11.3 The thermal conductivity of cork

```
1  clc
2  clear
3
4  //INPUT
5  i=1.18;//current in amperes
6  e=20;//potential difference across its ends in volts
7  j=4.2;//joules constant in joule/cal
8  a=2*10^4;//area of the slab in sq.cm
9  t=5;//thickness of the plate in cm
10 t1=12.5;//temperature at hot side in K
11 t2=0;//temperature at cold side in k
12
13 //CALCULATIONS
14 k=e*i*t/(j*a*(t1-t2));//thermal conductivity in cgs
      unit
```

```
15
16 //OUTPUT
17 mprintf('thermal conductivity of slab is %3.5f cgs
      unit',k)
```

Scilab code Exa 11.4 The thermal conductivity of glass

```
1 clc
2 clear
3
4 //INPUT
5 l=30;//length of the tube in cm
6 t=100;//temperature at outside in deg.C
7 t1=40;//tempertaure of water when leaving tube in
      deg.C
8 t2=20;//temperature of water when entering tube in
      deg.C
9 m=165/60;//mass flow rete of water in cc/sec
10 r1=6;//internal radii in mm
11 r2=8;//external radii in mm
12
13 //CALCULATIONS
14 k=m*(t1-t2)*log(r2/r1)/(2*3.14*l*(t-((t1+t2)/2)));//
      thermal conductivity in cgs unit
15
16 //OUTPUT
17 mprintf('thermal conductivity of the tube is %3.4f
      cgs unit',k)
```

Scilab code Exa 11.5 The thermal conductivity of nickel

```
1 clc
2 clear
```

```
3
4  //INPUT
5  l1=1.9;//length of the first bar in cm
6  l2=5;//length of the second bar in cm
7  k2=0.92;//thermal conductivity in cgs unit
8
9  //CALCULATIONS
10 k1=k2*(l1/l2)^2;//thermal conductivity if first bar
       in cgs unit
11
12 //OUTPUT
13 mprintf('thermal conductivity of first bar is %3.3f
       cgs unit',k1)
```

Scilab code Exa 11.6 The temperature of the welded interface

```
1  clc
2  clear
3
4  //INPUT
5  k1=0.92;//thermal conductivity of copper in cgs unit
6  k2=0.5;//thermal conductivity of alluminium in cgs
       unit
7  t1=100;//temperature of copper in deg.C
8  t2=0;//temperature of alluminium in deg.C
9
10 //CALCULATIONS
11 t=k1*t1/(k1+k2);//welded teperature in deg.C
12
13 //OUTPUT
14 mprintf('welded temperature is %3.2f deg.C',t)
```

Scilab code Exa 11.7 The conductivity of rubber

```
1  clc
2  clear
3
4  //INPUT
5  w=23;//thermal capacity of calorimeter in cal
6  m=440;//mass of water in gm
7  l=14.6;//lenght of the rubber tube in cm
8  dt=0.019;//rate of change in temperature in deg.C/
       sec
9  t=100;//temperature of steam in deg.C
10 t1=22;//temperature of the water in deg.C
11 t2=t1;//temperature of calorimeter in deg.C
12 r1=1;//external radii in cm
13 r2=0.75;//internal radii in cm
14
15 //CALCULATIONS
16 k=(w+m)*dt*log(r1/r2)/(2*3.14*l*(t-((t1+t2)/2)));//
       thermal conductivity in cgs unit
17
18 //OUTPUT
19 mprintf('thermal cnductivity of rubber tube is %3.5f
       cgs unit',k)
```

Scilab code Exa 11.8 Heat lost per hour

```
1  clc
2  clear
3
4  //INPUT
5  ti=18;//inside temperature in deg.C
6  to=4;//outside temperature in deg.C
7  k1=0.008;//thermal conductivity of stone in cgs unit
8  k2=0.12;//thermal conductivity of steel in cgs unit
9  t=3600;//time in sec
10 t1=25;//thickness of the stone in cm
```

```
11  t2=2;//thickness of the steel in cm
12  a=10^4;//area of the cottage in sq.cm
13
14  //CALCULATIONS
15  q1=k1*a*(ti-to)*t/(t1);//heat lost by stone per hour
       in cal
16  q2=k2*a*(ti-to)*t/t2;//heat lost by steel per hour
      in cal
17
18  //OUTPUT
19  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

```
1  clc
2  clear
3
4  //INPUT
5  l1=4;//length of the slab1 in cm
6  l2=2;//length of the slab2 in cm
7  k1=0.5;//thermal conductivity in cgs unit
8  k2=0.36;//thermal conductivity in cgs unit
9  t1=100;//temperature of the slab1 in deg.C
10 t2=0;//temperature of the slab2 in deg.C
11
12 //CALCULATIONS
13 t=k1*l2*t1/((k2*l1)+(k1*l2));//temperature of the
      commaon surface in deg.C
14
15 //OUTPUT
16 mprintf('the temperature of the common surface is %3
      .0f deg.C',t)
```

Scilab code Exa 11.10 The distance

```
1  clc
2  clear
3
4  //INPUT
5  t1 =15; //temperature of the one end of the slab in
        deg.C
6  t2 =45; //temperature of the other end of the slab in
        deg.C
7  k =0.3; //thermal conductivity in cgs unit
8  d =7; //density of the material in gm/cc
9  cp =1; //specific heat of the material in kj/kg.K
10 t =5*3600; //time in sec
11 dt =1/10; //thermometer reading in deg.C
12
13 //CALCULATIONS
14 b =(3.14* d * cp /( t * k ))^(0.5) ;
15 x =( log (( t2 - t1 )/ dt ))/ b; //distance from which
        temparature variation can be detected in cm
16
17 //OUTPUT
18 mprintf ('the distance from which temparature
        variation can be detected is %3.1 f cm ',x)
```

Chapter 12

Radiation

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

```
1  clc
2  clear
3
4  //INPUT
5  t1 =300; // temperature of the surroundings in K
6  t2 =900; // temperature of the hot body p in K
7  t3 =500; // temperature of the hot body q in K
8  a =5.67*10^ -8; // stefan boltzmann constant in W/m^2.K
       ^4
9
10 //CALCULATIONS
11 q1=a*(t2^4 -t1^4); // heat lost from hot body p in w/m
       ^2
12 q2=a*(t3^4 -t1^4); // heat lost from hot body q in w/m
       ^2
13 q=q1/q2; // ratio of heat lost from two substances
14
15 //OUTPUT
16 mprintf ('ratio of heat lost from two substances is
       %3.2 f ',q)
```

Scilab code Exa 12.2 The stefan constant

```
1  clc
2  clear
3
4  //INPUT
5  t1=573;//temperature of the hot side in K
6  t2=273;//temperature of the coll side in K
7  m=82;//mass of the black body in gm
8  cp=0.1;//specific heat of the black body kj/kg.K
9  dt=0.35;//ice melting at a rate of temperature in
       deg.C/sec
10 a=8;//area of black body in sq.cm
11
12 //CALCULATIONS
13 s=m*cp*dt/(a*(t1^4-t2^4));//boltzmann constant in
       cal/sq.cm/sec/deg^4
14
15 //OUTPUT
16 mprintf('boltzmann constant is %3.13f cal/sq.cm/sec/
       deg^4',s)
```

Scilab code Exa 12.3 The ratio of intensities

```
1  clc
2  clear
3
4  //INPUT
5  r1=60;//distance of first black body in cm
6  r2=30;//distance of second black body in cm
7  t1=873;//temperature of first black body in K
8  t2=573;//temperature of the second black body in K
```

```
 9
10  //CALCULATIONS
11  i=(t2^4/t1^4)*(r1^2/r2^2);//ratio of intensity of
       radition
12
13  //OUTPUT
14  mprintf('ratio of intensity of radition is %3.2f',i)
```

Scilab code Exa 12.4 The heat radiated per second

```
 1  clc
 2  clear
 3
 4  //INPUT
 5  t1=1373;//temperature of the sphere in K
 6  t2=283;//temperature of the black body in K
 7  r=4.17*10^5;//rate of heat radiate in ergs/sq.cm/sec
 8  a=4*3.14*(6^2);//surface area of the sphere in sq.cm
 9
10  //CALCULATIONS
11  tr=r*a*(t1^4/t2^4)*(2.39005736*10^(-8));//total heat
       radiated in cal/sec
12
13  //OUTPUT
14  mprintf('total heat radiated is %3.2f cal/sec',tr)
```

Scilab code Exa 12.5 The time for sun rays to fall

```
 1  clc
 2  clear
 3
 4  //INPUT
```

```
5  h=2*3.14*100;//heat received by the lens per min in
       cal
6  m=25;//mass of the ice in gm
7  l=80;//latent heat of ice in cal/gm
8
9  //CALCULATIONS
10 t=m*l/h;//time for which the sun rays falls in min
11
12 //OUTPUT
13 mprintf('time for which the sun rays falls is %3.2f
      min',t)
```

Scilab code Exa 12.6 The amount of heat reeived

```
1  clc
2  clear
3
4  //INPUT
5  d=0.35;//diameter of the mirror in m
6  t=5;//time in min
7  T=16;//temperature of water found to be in deg.C
8  m=60;//mass of water in gm
9  mc=30;//mass of calorimeter in gm
10 cp=0.1;//specific heat of copper in cal/gm/deg.C
11
12 //CALCULATIONS
13 q=(m+cp*mc)*T*4/(5*3.14*d^2);//amount of heat
      received by earth in cal
14
15 //OUTPUT
16 mprintf('amount of heat received by earth is %3.2f
      cal',q)
```

Scilab code Exa 12.7 Rate of heat lost

```
1 clc
2 clear
3
4 //INPUT
5 r1=5;//radius of first sphere in cm
6 r2=10;//radius of second sphere in cm
7 t1=700;//temperature of the first sphere in K
8 t2=500;//temperature of the second sphere in K
9 t=300;//temperature of the enclousure in K
10
11 //CALCULATIONS1
12 dc=(r2/r1)*(t1^4-t^4)/(t2^4-t^4);//ratio of c1/c2
13 r=r1^3*dc/r2^3;//rate of heat loss
14
15 //OUTPUT
16 mprintf('rate of loss of heat is %3.2f',r)
```

Scilab code Exa 12.8 The temperature

```
1 clc
2 clear
3
4 //INPUT
5 t1=600;//temperature of the black body in K
6 t0=300;//temperature of the surroundings in K
7 d=6;//deflections in galvanometer
8 d1=400;//deflection in divisions
9
10 //CALCULATIONS
11 dt=(d1/d)*(t1^4-t0^4);//change of temperature
12 t2=(dt+t0^4)^(1/4);//end temperature in K
13
14 //OUTPUT
```

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

Scilab code Exa 12.9 The temperature of the regel

```
1 clc
2 clear
3
4 //INPUT
5 n=17000;//luminosity of star compared to sun
6 t=6000;//temperature of the sun in K
7
8 //CALCULATIONS
9 t1=(n*t^4)^(1/4);//temperature of the star in K
10
11 //OUTPUT
12 mprintf('the temperature of the star is %3.2f K',t1)
```

Chapter 13

Introduction to statistical thermodynamics

Scilab code Exa 13.1 The probability

```
1 clc
2 clear
3
4 //INPUT
5 p1=1/6;//probability for the first throw gives 6
6 p2=1/6;//probability for the first throw gives 5
7 n=2;//the no.of dice are two
8
9 //CALCULATIONS
10 p=p1*p2*n;//the required probability is
11
12 //OUTPUT
13 mprintf('the required probability is %3.2f',p)
```

Scilab code Exa 13.2 The probability of drawing four aces

```
1 clc
2 clear
3
4 //INPUT
5 p1=4/52;//the probability for getting ace in first
     draw is
6 p2=3/51;//the probability for getting ace in second
     draw is
7 p3=2/50;//the probability for getting ace in third
     draw is
8 p4=1/49;//the probability for getting ace in fourth
     draw is
9
10 //CALCULATIONS
11 p=p1*p2*p3*p4;//total probability is
12
13 //OUTPUT
14 mprintf('total probability is %3.7f',p)
```

Scilab code Exa 13.3 The probability of distribution

```
1 clc
2 clear
3
4 //INPUT
5 n=12;//no.of particles
6 n1=8;
7 n2=4;
8
9 //CALCULATIONS
10 p=n*(n-1)*(n-2)*(n-3)/(n2*(n2-1)*(n2-2)*(2^n));//
     probability of distribution (8,4)
11
12 //OUTPUT
13 mprintf('probability of distribution (8,4) is %3.5f'
```

```
    ,p)
```

Scilab code Exa 13.4 The probability

```
1  clc
2  clear
3
4  //INPUT
5  m=32;//mass of the oxygen molecule in gm
6  n=1.67*10^-27;//mass of one electron
7  k=1.38*10^-23;//boltzzmann constant in ergs/cal
8  t=200;//temperature of the oxygen in K
9  c=(100+101)/2;//average speed of the oxygen molecule
        in m/s
10
11  //CALCULATIONS
12  a=m*n/(2*3.14*k*t);
13  p=4*3.14*(a^(3/2))*(c^2)*(2.303^(-a));//probability
        that the oxygen speed is lies between in m/sec
14
15  //OUTPUT
16  mprintf('probability that the oxygen speed is lies
        between is %3.16f m/sec',p)
```