Scilab Textbook Companion for Heat And Thermodynamics by D. S. Mathur[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 1

Heat And Temperature Thermometry

Scilab code Exa 1.1 chapter 1 example 1

```
clc
//initialisation of variables
n=2
//CALCULATIONS
t= 160/(5*n-9)
//RESULTS
printf ('Temperature of the fahrenheit scale= %f C
    ',t)
```

Scilab code Exa 1.2 chapter 1 example 2

```
clc
//initialisation of variables
n= 1/1000
T= 60 //degrees
T1= 100 //degrees
```

```
//CALCULATIONS
r= T-n*T^2
r1= T1-n*T1^2
tl= r*100/r1
//RESULTS
printf ('liquid temperature= % 1f C',tl)
```

Scilab code Exa 1.3 chapter 1 example 3

```
clc
//initialisation of variables
p=1.0//metres
p0=0.8//metres
p100=1.093//metres
//CALCULATIONS
t=((p-p0)*100/(p100-p0))
//RESULTS
printf('temperature of hot water= % 1f C',t)
```

Scilab code Exa 1.4 chapter 1 example 4

```
clc
//initialisation of variables
p0=0.70//metres
LC=0.1//millimetres
t= 100 //degrees
//CALCULATIONS
p100=p0*(1+(t/273))
T=(LC/(p100-p0))
//results
printf('accuracy we can expect= % 1f C',T)
```

Scilab code Exa 1.5 chapter 1 example 5

```
clc
//initialisation of variables
t=80//celsius
tp=80.2//celsius
T=120
//CALCULATIONS
s=(10000)*((t-tp)/(t*(t-100)))
Tp=T-((s*t*(T-100))/10000)
//results
printf(' temperature= %1f C',Tp)
```

Scilab code Exa 1.6 chapter 1 example 6

```
clc
//initialisation of variables
R100=5.93//ohms
Ro=5.0//ohms
P100=1.366//metres
Po=1//metres
Pt=1.3111//metres
Rt=5.795//ohms
//calculations
tp=(Rt-Ro)*100/(R100-Ro)
t=(Pt-Po)*100/(P100-Po)
//results
printf(' thermal on platinum scale= %2f C',tp)
printf(' thermal on gas scale= %1f C',t)
```

Scilab code Exa 1.7 chapter 1 example 7

```
clc
//initialisation
Rt=13.3//ohms
R100=7.0//ohms
R0=5.0//ohms
t=444.6//celsius
RT=9.1//ohms
//CALCULATIONS
tp=(Rt-R0)*100/(R100-R0)
Tp=(RT-R0)*100/(R100-R0)
s=(t-tp)*10000/(t*(t-100))
T=Tp+((s*(Tp*(Tp-100)))/10000)
Ts=Tp+((s*T*(T-100))/10000)
//results
printf(' platinum temperature of bath= % 2f C',T)
printf(' gas temperature of bath= % 2f C',Ts)
```

Scilab code Exa 1.8 chapter 1 example 8

```
clc
//initialisation
et=3.92//millivolts
e100=0.65//millivolts
e0=0//millivolts
e=2//volts
lp=1000//centimetres
ld=50.2//centimetres
rp=0.01//ohm per centimetre
rs=2500//ohms
j=5*10^-6
//CALCULATIONS
i=e/(rs+(lp*rp))
p=i*rp*lp/100
```

```
p1=p*ld
T=p1/j
t=(100*(et-e0))/(e100-e0)
//results
printf(' temperature= %1f C',t)
printf(' \n temperature= %1f C',T)
```

Scilab code Exa 1.9 chapter 1 example 9

```
clc
//initialisations
ht=65//cm
h0=-5//cm
t=273//c
//CALCULATIONAS
h100=h0+(100*(ht-h0)/t)
l=(1+(t/273))
H=(ht-(h0*l))/(l-1)
printf(' temperature= %1f cm',H)
```

Scilab code Exa 1.10 chapter 1 example 10

```
clc
//initialisations
T1=25//c
T2=15//c
r=1.035
//CALCULATIONS
s=(r-1)/(T1-(T2*r))
t=-1/s
//reults
printf(' absolute zero= %1f C',t)
```

Chapter 2

Thermal Expansion

Scilab code Exa 2.5 chapter 2 example 5

```
clc
//initialisation
t1=0//c
t2=20//c
g=0.000011//1/c
h=0.000019//1/c
l=41.628//cm
//CALCULATIONS
l20=l*(1+(h*(t2-t1)))
l0=l20/(1+(g*(t2-t1)))
//results
printf(' true length of rod at 20 c= % 1f C',l20)
printf(' true length of rod at 0 c= % 1f C',l0)
```

Scilab code Exa 2.6 chapter 2 example 6

```
clc
//initialisation
```

```
l=3//m
t1=0//c
t2=40//c
f=0.000012//1/c
b=0.000018//1/c
y=2.1*10^11//N/m^2
a=(3.14*(0.6*10^-3)^2)/4///m
//CALCULATIONS
lb40=l*(1+(b*(t2-t1)))
lf40=l*(1+f*(t2-t1))
dl=lb40-lf40
F=y*a*dl*0.01/l
//results
printf(' extra tension of the wire= %1f newton',F)
```

Scilab code Exa 2.7 chapter 2 example 7

```
clc
//initialisation of variables
l20=0.1//m
l1=0.0999//m
s=0.000011//1/c
t1=20
//CALCULATIONS
t=((l1-l20)/(l20*s))+20
//results
printf(' temperature the rod must be reduced is= %1
   f C',t)
```

Scilab code Exa 2.8 chapter 2 example 8

```
clc
//initialisation of variables
```

```
s=1.9*10^-5//1/c
t1=15//c
t2=20//c
//CALCULATIONS
g=(1+(s*(t2-t1)))^(0.5)
h=g-1
d=h*24*60*60
//results
printf(' per day difference= %1f sec',d)
```

Scilab code Exa 2.9 `chapter 2 example 9`

```
clc
//initialisations
e=6000*10^-10//m
p=25
l=1.5*10^-2
t2=40
t1=0
sx=13*10^-7//1/c
sy=231*10^-7//1/c
sz=231*10^-7//1/c
//CALCULATIONS
s=((p*e)/(2*l*(t2-t1)))
y=sx+sy+sz
//results
printf(' alpha of crystal= %1f 1/C',s)
printf(' coefficient of cubical expansion= %1f 1/C'
    ,y)
```

Scilab code Exa 2.10 `chapter 2 example 10`

```
clc
```

```
//initialisations
ym=1.8*10^-4
yg=2.5*10^-5
//CALCULATIONS
s=yg/ym
//results
printf(' volume of vessel to be filled= %1f 1/C',s)
```

Scilab code Exa 2.12 chapter 2 example 12

```
clc
//initialisation
l=1//m
ld1=0.7//m
ld2=0.78//m
d1=0
d2=30
vd1=l-(ld1*cosd(d1))
vd2=l-(ld2*cosd(d2))
//CALCULATIONS
H=((ld1*vd1)-(ld2*vd2))/(vd1-vd2)
//results
printf(' atmospheric pressure= %1f m',H)
```

Scilab code Exa 2.13 chapter 2 example 13

```
clc
//initialisation
r=1/1.035
t1=15//c
t2=25//c
//CALCULATIONS
x=-(t1-(t2*r))/(r-1)
```

```
//results
printf(' absolute zero on celsius scale for this gas
   = % 1f c',x)
```

Scilab code Exa 2.14 chapter 2 example 14

```
clc
//initialisation
p=0.76
t1=0//c
t2=100//c
T1=t1+273//k
T2=t2+273//k
//CALCULATIONS
p=(2*p*T2)/(T1+T2)
//results
printf(' pressure of the gas= % 1f m',p)
```

Scilab code Exa 2.15 chapter 2 example 15

```
clc
//initialisation
s=0.00018//1/c
dt=1//c
//CALCULATIONS
p=(s*dt)*100
//results
printf(' percentage change= % 1f',p)
```

Chapter 3

calorimetry

Scilab code Exa 3.2 `chapter 3 example 2`

```
clc
//initialisation of variables
cag=56
cpb=31
cal=220
//CALCULATIONS
mag=1000/cag
mpb=1000/cpb
mal=1000/cal
//results
printf(' mass of silver= % 1f kg',mag)
printf(' mass of lead= % 1f kg',mpb)
printf(' mass of aluminium= % 1f kg',mal)
```

Scilab code Exa 3.3 `chapter 3 example 3`

```
clc
//initialisations
```

```
m1=0.5//kg
m2=0.09//kg
t1=19//c
t2=15//c
t3=38//c
t4=50//c
s=1000
//CALCULATIONS
A=[4000 -15.5; 23000 11.5]
b=[-360;1080]
c=A\b
R1=c(1,1)
R2=c(2,1)
//results
printf(' water equivalent of mercury= % 1f kg',R1)
printf(' \n specific heat of mercury= % 1f c /kg/c',
   R2)
```

Scilab code Exa 3.4 chapter 3 example 4

```
clc
//initialisation of variables
c=10^6//calories
tw=100//sec
ta=74//sec
dw=1000//kg/m^3
da=800//Kg/m^3
t2=50//c
t1=40//c
//CALCULATIONS
hw=((dw*1000*10)+(c*(t2-t1)))
rw=hw/tw
C=(((rw*ta)/(t2-t1))-c)/da
printf(' specific heat of alcohol= % 1f calories/kg'
   ,C)
```

Scilab code Exa 3.5 chapter 3 example 5

```
clc
//initialisation of variables
mc=0.1//kg
vl1=150//cc
vl2=150//cc
hl1=600
gl1=1200
hl2=400
gl2=900
t1=50//c
t2=40//c
sc=100
r1=2
//CALCULATIIONS
m1=vl1*gl1/(10^6)
rc1=(m1*hl1+mc*sc)*r1
k= -rc1/t1
m2=vl2*gl2/(10^6)
b=(m2*hl2+mc*sc)
j=-k*t2
//results
printf(' rate of cooling= % 1f cal/min',j)
```

Scilab code Exa 3.6 chapter 3 example 6

```
clc
//initialistions
t1=80//c
t2=50//c
```

```
t3=60//c
t4=30//c
t=20
e=5
//CALCULATIONS
k=2.3026*log((t1-t)/(t2-t))/e
T=2.3026*log((t3-t)/(t4-t))/k
//results
printf(' time it will take = %1f min',T)
```

Scilab code Exa 3.7 chapter 3 example 7

```
clc
//initialisation of variables
e=1.586//v
i=0.1444//amp
t=4*60//sec
m=0.3963//kg
T=1.219//k
wt=206.4
//CALCULATIONS
hg=e*i*t
c=hg/(m*T*4.18)
a=c*wt
printf(' atomic heat of lead= %1f 1/k',a)
```

Scilab code Exa 3.8 chapter 3 example 8

```
clc
//initialisation if variables
m=1*10^-4//kg
v=0.0005//m^3
l=22.57*10^5//j
```

```
t1=15//c
p=6//kg/m^3
//calculations
H=m*l
h=v*p*(100-t1)*4.18
c=H/h
//results
printf(' specific heat of gas at constant volume= %
   1f j',c)
```

Scilab code Exa 3.9 chapter 3 example 9

```
clc
//initialisations
j1=21*10^5//j
j2=3.36*10^5//j
//calculations
x=j1*100/(j1+j2)
//results
printf(' percentage of water present will be frozen=
    % 1f',x)
```

Scilab code Exa 3.10 chapter 3 example 10

```
clc
//initialisations
m1=250//gm
m2=200//gm
l=336//j
w1=50//gm
m3=200//gm
t1=100//c
//calculations
```

```
M1=m1+m2+w1
J=t1*M1*4.2
k=l*m2
m=123.2
T=m1+m3+m
//results
printf(' total contents= %1f gm',T)
```

Scilab code Exa 3.12 chapter 3 example 12

```
clc
//initialisations
m1=10//kg
t1=80//c
t2=20//c
t3=150//c
t4=90//c
t=100//c
a=800//cal/kg
//calculations
h=m1*1000*(t1-t2)/1000
H=a*(t3-t)+540000+1000*(t-t4)
k=H/1000
x=h/k
//results
printf(' kg of steam required per hour= %1f kg/hr',
    x)
```

Scilab code Exa 3.13 chapter 3 example 13

```
clc
//initialisation
p1=6//atm
```

```
p2=2//atm
ph=89//kg/m^3
v=30/1000//ml
t1=10//c
t3=31.5//c
T1=273+t1
t2=150//c
w1=0.210//kg
//calculations
m=(p1-p2)*273*ph*v/(T1*1000)
t4=(t1+t3)/2
h=m*(t2-t4)
H=w1*1000*4.18*(t3-t1)
c=H/h
//results
printf(' specific heat= %1f j/kg*k',c)
```

Scilab code Exa 3.14 chapter 3 example 14

```
clc
//initialisations
po=101396.1
p=1.293
vo=1/p
t=273
cp=961.4
//calculations
R=po*vo/t
cv=cp-R
//results
printf(' specific heat at constant volume= %1f',cv)
```

Scilab code Exa 3.15 chapter 3 example 15

```
clc
//initialisations
m=5//kg
m1=2.09*10^8
val=10^7//cal/kg
p=0.12
//calculations
w=p*m1/(60*60)
H=w/746
//results
printf(' average horse power= % 1f',H)
```

Scilab code Exa 3.16 chapter 3 example 16

```
clc
//initialisations
po=101396.16//N/m^2
vo=22.4//l
t=273
m=4*1000//gm
//calculations
R=po*vo/t
c=R/m
//results
printf(' pressure of the gas= % 1f j',c)
```

Scilab code Exa 3.17 chapter 3 example 17

```
clc
//initialisation
p1=1
p2=0.8
t1=25//c
```

```
t2=10//c
p=0.4
t3=61//c
t4=12//c
//calculations
p1=p*(t3-t4)
m=(t1-t2)
c=m/p1
//results
printf(' specific heat of liquid= % 1f cal/gm*c',c)
```

Scilab code Exa 3.19 `chapter 3 example 19`

```
clc
//initialisation
p16=80//cm
v16=432//cc
t=273//k
po=76//cm
t=16//c
t16=273+t//k
T=273//k
poxy=0.0014
cfe=0.09
t1=15//c
t2=184//c
m1=2//gm
//calculations
v0=(p16*v16*T)/(po*t16)
m=poxy*v0
h=m1*cfe*(t1+t2)
l=h/m
//results
printf(' latent heat= % 1f cal',l)
```

Chapter 4

change of state

Scilab code Exa 4.2 example 4 chapter 2

```
clc
//initialisations
t1=20//c
m1=10//gm
t2=-80//c
t2=15//c
m2=10.77//gm
t3=10//c
c=0.5
//CALCULATIONS
A=[5 -10;5 -10.77]
b=[550;488.5]
c=A\b
R1=c(1,1)
R2=c(2,1)
//results
printf(' latent heat of fusion of ice= %1f cal/gm',
   R2)
```

Scilab code Exa 4.3 chapter 4 exampe 2

```
clc
//initialisations
c=0.58
m=4//gm
ms=5//gm
t=78//c
t1=80//c
x1=10//cm
x2=8.5//cm
c1=0.05
c2=0.048
t2=100//c
t3=27//c
//CALCULATIONS
Hal=m*c*t
m1=Hal/t1
m2=m1*x1/x2
Hp=m2*80
H1=ms*(t2-t3)*c1
H2=ms*c2*t3
L=(Hp-H1-H2)/ms
//results
printf(' latent heat of fusion= % 1f cal/gm',L)
```

Scilab code Exa 4.4 chapter 4 exampe 4

```
clc
//initialisation of variables
d=2*10^-3//m
x=0.07//m
m1=2.2*10^-3//gm
pice=920//kgm^-3
pwater=1000//kgm^-3
```

```
lice=80000//cal/kg
//CALCULATIONS
a=22*d*d/(4*7)
v=x*a
v1=1/pice
v2=1/pwater
dv=v1-v2
m2=v/dv
h=lice*m2
L=h/m1
printf(' latent heat of vapourisation= % 2f cal/kg',
   L)
```

Scilab code Exa 4.5 chapter 4 exampe 5

```
clc
//initialisation of variables
ms=0.0055//kg
t1=100//c
t2=15//c
t3=26.8//c
m1=250/1000//kg
m2=16.2/1000//kg
l=22.572*10^5//kg
//calculations
h=(m1+m2)/(t3-t2)
x=(h-(ms*l))/(t1-t3-l)
p=x*100/ms
//results
printf(' perecntage of water in steam= % 5f ',x)
```

Scilab code Exa 4.6 chapter 4 exampe 6

```
clc
//intialisation
r=1.7*10^-6//m^3/sec
t1=3.56//c
pw=1000//kg/m^3
r1=0.34*10^-6//m^3/sec
t2=15//c
bp=360//c
c=33
pl=13600//kg/m^3
//CALCCULATIONS
m=r*pw*60
h1=m*1000*t1
h2=r1*pl*(bp-t2)*c
L=(h1-h2)/(r1*pl)
//results
printf(' latent heat of vaporisation= % 1f cal/kg',L
   )
```

Scilab code Exa 4.7 chapter 4 exampe 7

```
clc
//initialisation
p1=75.5//cm
v1=123//cc
t0=273//k
t1=15//c
T1=t0+t1
p0=76//cm
r=1.43//gm/litre
l=51//cal/gm
t2=-183//c
m=0.495//gm
//calculations
v0=p1*v1*t0/(p0*T1)
```

```
h=r*v0*l/1000
c=(h/(m*(t1-t2)))
//results
printf(' mean specific heat = % 1f calC/gm/deg',c)
```

Scilab code Exa 4.8 chapter 4 exampe 8

```
clc
//initialisation
p=0.76
v=1650//cc
m=1//gm
r=13600//kg/m3
//CALCULATIONS
w=(p*9.81*r*(v-1)*10^-6)/4.18
ih=540-w
//results
printf(' internal latent heat of steam= % 1f cal',ih
   )
```

Scilab code Exa 4.9 chapter 4 exampe 9

```
clc
//initialisations
x1=17.5//mm
x2=9.2//mm
r=0.7
//CALCULATIONS
avp=x1*r
dsvp=avp-x2
f=dsvp*100/avp
//results
```

```
printf(' fraction of water vapour condensed= % 1f ',
   f)
```

Scilab code Exa 4.10 chapter 4 exampe 10

```
clc
//initialisations
r=52
svp=17.5//mm
//CALCULATIONS
p=(svp*r)/100
//results
printf(' SVP at dew point= % 1f mm',p)
```

Scilab code Exa 4.12 chapter 4 exampe 12

```
clc
//initialisation
p=4.60//mm
p1=0.34//mm
t=0.007//c
r=760//mm
//CALCULATIONS
P=(p+(p1*t))
fp=r-P
d=r*t/fp
//results
printf(' lowering of melting point of ice= % 5f C',d
   )
```

Scilab code Exa 4.14 chapter 4 exampe 14

```
clc
//initialisation
v2=1.677//m3
v1=0.001//m3
dp=0.76*13600*9.81
t=100//c
T=t+273//k
L=540000//cal//kg
//CALCULATIONS
dT=(dp*T*(v2-v1))/L
//results
printf(' increase in boiling point= % 1f C',dT)
```

Scilab code Exa 4.15 chapter 4 exampe 15

```
clc
//initialisation
t1=18//c
t2=19//c
t3=18.6//c
t4=23//c
t5=24//c
t6=23.7//c
svp1=15.46//mm
svp2=16.46//mm
svp4=21.02//mm
svp5=22.32//mm
//CALCULATIONS
svp3=svp1+((svp2-svp1)/(t2-t1))
svp6=svp4+((svp4-svp5)/(t4-t5))
rh=svp3*100/svp6
//results
printf(' relative humidity= % 1f ',rh)
```

Chapter 5

Kinetic theory of Heat

Scilab code Exa 5.1 chapter 5 example 1

```
clc
//initialisations
h=50//m
g=9.8//m/sec2
l=1000
j=4.2//j/cal
//calculations
q=h*g/j
t=q/l
//results
printf('difference in temperature of water= %1f C'
    ,t)
```

Scilab code Exa 5.2 chapter 5 example 2

```
clc
//initialisations
t1=327//c
```

```
t2=47.6//c
c=30//cal/kg
l=6000//cal/kg
j=4.2//j/cal
//CALCULATIONS
h=c*(t1-t2)+l
v=sqrt(2*j*h)
//results
printf(' velocity of bullet= % 1f m/sec',v)
```

Scilab code Exa 5.3 chapter 5 example 3

```
clc
//initialisation
e=3//v
i=2//amp
e1=3.75//v
i1=2.5//amp
t=2//c
m=30//gm/min
m1=48//gm/min
//CALCULATIONS
p=(e*i-e1*i1)/(t*(m-m1)/44.444)
//results
printf(' J= % 1f j/cal',p)
```

Scilab code Exa 5.4 chapter 5 example 4

```
clc
//initialisations
c=1000
t=1//c
f=1//f
```

```
J=4.18//j/cal
g=9.8//m/sec2
//CALCULATIONS
h=c*t*J/g
h1=h*f*5/9
//results
printf(' height pf waterfall to rasie 1 c= %1f m',h)
printf(' height of waterfall to raise 1 f= %1f m',h1)
```

Chapter 6

kinetic theory of gases

Scilab code Exa 6.2 chapter 6 example 2

```
clc
//initialisation
n=3
r=2
//CALCULATIONS
i=3*n-3
v=i-r
//results
printf(' vibratory degree of freedom= %1f ',v)
```

Scilab code Exa 6.5 chapter 6 example 5

```
clc
//initialisation
T=273//k
m=35.5//kg
r=8314.3//j/mol/k
//CALCULATIONs
```

```
c=sqrt(3*T*r/(2*m))
//results
printf(' rms velocity = % 1f m/sec',c)
```

Scilab code Exa 6.6 chapter 6 example 6

```
clc
//initialisation
m=2//kg
T=273//k
r=8314.3//j/mol/k
//CALCULATIONS
c=sqrt(3*r*T/m)
Ti=(4*c*c*m/(3*r))
C=Ti-273
//results
printf(' temperature at which rms speed will double
    is= % 1f c',C)
```

Scilab code Exa 6.7 chapter 6 example 7

```
clc
//initialisation
p=1.013*10^5//newton/m2
d=0.09//kg/m3
t1=27//c
T=273
T1=t1+T//k
//CALCULATIONS
c1=sqrt(3*p/d)
c2=c1*sqrt(T1/T)
cb=c2*8/(3*%pi)
cm=c2*sqrt(2/3)
```

```
//results
printf(' avg velocity= %1f m/sec',cb)
printf(' \nmost probable velocity= %1f m/sec',cm)
```

Scilab code Exa 6.8 chapter 6 example 8

```
clc
//initialisations
e=4*10^-3//erg
p=1*13.6*981
//calculations
kt=2*e/3//erg
n=p/kt
//results
printf(' number of molecules = %1f',kt)
```

Scilab code Exa 6.9 chapter 6 example 9

```
clc
//initialisation
r=8.32//j/mol/k
N=6.06*10^23
t=723
T=t+273
//calculations
ke=(3*r*T)/(2*N)
ke1=ke*N
//results
printf(' mean translational kinetic energy= %1f J',
   ke1)
```

Scilab code Exa 6.10 chapter 6 example 10

```
clc
//initialisations
r=8.3//j/mol/k
J=4.2//j/cal
T=273
m=2//gm
//CALCULATIONS
ke=(3*r*T/(2*m*J))
//results
printf(' ke of one gm of hydrogen= %1f calories',ke
)
```

Scilab code Exa 6.11 chapter 6 example 11

```
clc
//initialisation
p0=0.76*13600*9.81
m=1.785*10^-4//kg
v0=0.001/m
T0=273//k
g=1.67
cp=1250
//CALCULATIONS
r=p0*v0/T0
J=r*g/((g-1)*cp)
//results
printf(' mechanical equivalent of heat= %1f joules/
cal',J)
```

Scilab code Exa 6.12 chapter 6 example 12

```
clc
//initialisation
n=1.7*10^-5//newton/m2/unit vel gradient
p=10^5//newton//m2
d=1.2//kg/m3
//CALCULATIONS
l=n*sqrt(3/(d*p))
f=p/n
//results
printf('.mean free path= %1e m',l)
printf(' \ncollision frequency= %1f per second',f)
```

Scilab code Exa 6.13 chapter 6 example 13

```
clc
//initialisation
n=166*10^-7//kg/m/sec
k=2.7*10^25//m^-3
d=1.25//kg/m^3
c=450//m/sec
//CALCULATIONS
l=3*n/(d*c)
f=c/l
di=sqrt(1/(sqrt(2)*%pi*k*l))
//results
printf(' mean free path= %1e m',l)
printf(' \ncollision frequency= %1e c',f)
printf(' \navg velocity= %1e m',di)
```

Scilab code Exa 6.14 chapter 6 example 14

```
clc
//initialisation
```

```
m=40//kg
v=22.4//m^-3
n=2.1*10^-5
r=8314//j/mol/k
T=273//k
//CALCULATIONS
d=m/v
c=sqrt(3*r*T/m)
l=(3*n)/(d*c)
f=c/l
//results
printf(' mean freepath= %1e m',l)
printf(' \ncollision frequency= %1f ',f)
```

Scilab code Exa 6.15 `chapter 6 example 15`

```
clc
//initialisation
l1=23*10^-6
l0=19*10^-6
d=0.1785
p=10^5//n
//CALCULATIONS
df=(l1-l0)*sqrt(3/(p*d))/0.4
//results
printf(' difference in mean free path= %1e m',df)
```

Scilab code Exa 6.19 `chapter 6 example 19`

```
clc
//initialisation
f=5
r=2
```

```
//CALCULATIONS
e=f/2
g=r/2
p=g*100/e
//results
printf(' fraction used to increase rotational energy
   = % 1f ',p)
```

Scilab code Exa 6.20 chapter 6 example 20

```
clc
//initialisation
s1=1//m/sec
s2=2//m/sec
s3=3//m/sec
s4=4//m/sec
s5=5//m/sec
n1=4
n2=2
n3=8
n4=6
n5=5
//CALCULATIONS
u=(n1*s1+n2*s2+n3*s3+n4*s4+n5*s5)/(n1+n2+n3+n4+n5)
v=sqrt((n1*s1*s1+n2*s2*s2+n3*s3*s3+n4*s4*s4+n5*s5*s5
   )/(n1+n2+n3+n4+n5))
//results
printf(' mean speed of molecules= % 1f m/sec',u)
printf(' \nrms speeed of molecules= % 1f m/sec',v)
```

Chapter 7

continuity of state

Scilab code Exa 7.1 chapter 7 example 1

```
clc
//initialisation
R=82.07//cm3.atmos.per k
t=132//k
p=37.2//atm
//CALCULATIONS
a=(27*R*R*t*t)/(64*p)
b=(R*t)/(8*p)
//results
printf(' a= % 1f atmos cm ^6',a)
printf(' \nb= % 1f cm^3',b)
```

Scilab code Exa 7.2 chapter 7 example 2

```
clc
//initialisation
p=2.26//atmos
m=1.014*10^6*4
```

```
R=8.3*10^7
d=0.069//gm/cm3
//CALCULATIONS
t=(8*p*m)/(3*R*d)
//results
printf(' critical temperature of helium= % 1f K',t)
```

Scilab code Exa 7.7 chapter 7 example 7

```
clc
//initialisation
a=0.0072
b=0.002
p=1
v=1
t=273//k
//CALCULATIONS
R=((p+(a/(v*v)))*(v-b))/t
Tc=(8*a)/(27*R*b)
TC=Tc-t
Tb=3.375*Tc
TB=Tb-t
//results
printf(' critical temperature of Co2= % 1f c',TC)
printf(' \nboyle temperature of Co2= % 1f k',Tb)
```

Scilab code Exa 7.8 chapter 7 example 8

```
clc
//initialisation
a=0.0072//pa cc^2
b=0.002
p1=76*13.6*980
```

```
p2=0.76*13600*9.8
//CALCULATIONS
a1=a*p2/p1
//results
printf(' value of a in MKS/SI units= %1f pa m^6',a1
  )
printf(' \nvalue of b in MKS/SI units= %1f ',b)
```

Scilab code Exa 7.9 chapter 7 example 9

```
clc
//initialisation
a=1.64*10^-2//pa m^6 /mole^2
b=2.17*10^-5//m^3/mole
t=300//k
v=10^-3//m^3/mole
R=8.31//j/mole/k
tc=33.2
pc=1.295*10^6
vc=6.5*10^-5
//CALCULATIONS
p=(((R*t)/(v-b))-(a/(v*v)))
p1=(R*t)/v
r=(8*pc*vc)/(3*tc)
p2=(((r*t)/(v-b))-(a/(v*v)))
p3=(r*t)/v
//results
printf(' value of pressure at 300k= %1f pa',p)
printf(' \n pressure using ideal gas condition= %1f
    pa',p1)
printf(' \nvalue of R at critical point= %1f J/mole
  /k',r)
printf(' \n using r value in vanderwaals equation p
  = %1f pa',p2)
```

Scilab code Exa 7.10 chapter 7 example 10

```
clc
//initialisation
m=2*10^-3//kg
R=8.31//j/mol/k
p=2*10^5
v=8.2*10^-4
a=0.136//pa m^6
M=28*10^-3//kg/
//CALCULATIONS
t=(p*v*M)/(R*m)
T=(M/(m*R))*(p+(m*m*a/(M*M*v*v)))*(v-(m*b/M))
//results
printf(' \n temperature for a perfect gas= %1f k',t)
printf(' \n temperature for vanderwaals gas= %1f k',T)
```

Scilab code Exa 7.11 chapter 7 example 11

```
clc
//initialisation
a=0.132//nm^4/mole^2
b=3.12*10^-5//m^3/mole^2
p=5*10^5//Nm^-2
v=20*10^-3//m3
R=8.4//j/mole/k
v2=2*10^-3//m3
p1=5//pa
//CALCULATIONS
t=((p+(a/(v*v)))*(v-b))/(5*R)
```

```
p2=(p1*v)/v2
//results
printf(' \n temperature = % 1f k',t)
printf(' \n pressure= % 1f pa',p2)
```

Scilab code Exa 7.12 `chapter 7 example 12`

```
clc
//initialisation
t1=273//k
p1=1*10^5//N/m2
p2=2*10^5//N/m2
v=10^-6//m3
a=2.73*10^-10//m4 N
b=1.03*10^-9//m3
//CALCULATIONS
t2=t1+(t1*(p2-p1))/(p1+(a/(v*v)))
//results
printf(' \n temperature of gas if pressure is
    doubled= % 1f k',t2)
```

Chapter 8

thermodynamics

Scilab code Exa 8.1 chapter 8 example 1

```
clc
//initialisation of variables
Q=50//cal
W=20//cal
Qi=36//cal
Wi=-13//cal
ui=10//cal
ub=22//cal
//CALCULATIONS
du=Q-W
Wibf=Qi-du
Qfi=du+Wi
Uf=du+ui
Qbf=Uf-ub
//results
printf(' \n Wibf= %1f cal',Wibf)
printf(' \n Qfi= %1f cal',Qfi)
printf(' \n Uf= %1f cal',Uf)
printf(' \n Qbf= %1f cal',Qbf)
```

Scilab code Exa 8.2 chapter 8 example 2

```
clc
//initialisation of variables
g=1.4
T1=15+273//k
r=2
p=2//atm
r1=0.5
//CALCULATIONS
T2=T1*r^(g-1)
t2=T1*r1^((g-1)/g)
//results
printf(' \n final temperature= % 1f k',T2)
printf(' \n temperature= % 1f k',t2)
```

Scilab code Exa 8.3 chapter 8 example 3

```
clc
//initialisation of variables
r=1/20
p1=1//atm
g=1.4
T1=273//k
//CALCULATIONS
p2=p1/r
pad=p2^g
T2=T1*((1/r)^(g-1))
dt=T2-T1
//RESULTS
printf(' \n pressure required= % 1f atm',p2)
```

```
printf(' \n pressure for adiabatic conditions= % 1f
   atm',pad)
printf(' \n rise in temperature= % 1f c',dt)
```

Scilab code Exa 8.4 chapter 8 example 4

```
clc
//initialisation of variables
R=8400//j/mole
T1=273//k
g=1.66
r=2
//CALCULATIONS
T2=T1*r^(g-1)
w=(R*(T1-T2))/(22400*(g-1))
wi=R*T1*log(1/r)/22400
//results
printf(' \n amount of work done= % 1f J',w)
printf(' \n isothermal work done= % 1f J',wi)
```

Scilab code Exa 8.5 chapter 8 example 5

```
clc
//initialisation of variables
r1=2
r=2
rv=0.75
//CALCULATIONS
g=log(r1/rv)/log(r)
//results
printf(' \n gamma value= % 1f ',g)
```

Scilab code Exa 8.6 chapter 8 example 6

```
clc
//initialisation of variables
t0=273//k
d0=1.29//kg/m^3
p=0.75//m
t=273+17//k
p0=0.76//m
v=342.15//m/sec
//CALCULATIONS
d=t0*d0*p/(t*p0)
g=(v*v*d)/(p*13600*9.81)
//results
printf(' \n gamma value= % 1f ',g)
```

Scilab code Exa 8.7 chapter 8 example 7

```
clc
//initialisation of variables
n=0.5
n1=0.6
T2=27+273//k
//CALCULATIONS
T1=T2/(1-n)
T=T2/(1-n1)
dt=T-T1
//results
printf(' \n source tempperature must be raised by= %
    1f c',dt)
```

Scilab code Exa 8.8 chapter 8 example 8

```
clc
//initialisation of variables
w=100//watt
T2=100+273//k
T1=273//k
L=80000//cal/kg
//CALCULATIONS
dt=T2-T1
Q1=T2*w/dt
m=(Q1-w)*60/(4.2*L)
//results
printf(' \n mass of ice melts in 1 min= % 1f kg',m)
```

Scilab code Exa 8.9 chapter 8 example 9

```
clc
//initialisation of variables
L=80000//cal/kg
T1=27+273//k
T2=0+273//k
//CALCULATIONS
Q1=T1*L/T2
w=4.2*(Q1-L)
c=L/(Q1-L)
//results
printf(' \n coefficient of performance= % 1f ',c)
```

Scilab code Exa 8.10 chapter 8 example 10

```
clc
//initialisation of variables
T1=20+273//k
T2=273//k
m=2//kg
L=80000//cal/kg
//CALCULATIONS
Q2=m*L/3600
w=(T1-T2)*Q2*4.2/(T2)
//results
printf(' \n minimum power output of the motor= %1f
    H.P',w/746)
```

Scilab code Exa 8.11 chapter 8 example 11

```
clc
//initialisation of variables
T1=20+273//k
T2=273//k
m=2//kg
L=80000//cal/kg
//CALCULATIONS
Q2=m*L/3600
w=(T1-T2)*Q2*4.2/(T2)
//results
printf(' \n minimum power output of the motor= %1f
    H.P',w/746)
```

Scilab code Exa 8.12 chapter 8 example 12

```
clc
```

```
//initialisation of variables
p=10^5//N/m^2
l=1//m
a=0.2//m^2
n=5
//CALCULATIONS
power=2*p*l*a*n/746
//results
printf('\n horse power of engine= %1f H P',power)
```

Scilab code Exa 8.13 chapter 8 example 13

```
clc
//initialisation of variables
dp=1//atm
L=80000//cal
T=273//k
r=11/10
//CALCULATIONS
dv=(1-r)/1000
dt=T*dv*(13600*9.81*0.76)/(L*4.2)
//results
printf('\n depression in melting point of ice= %1f
   c',-dt)
```

Scilab code Exa 8.14 chapter 8 example 14

```
clc
//initialisation of variables
dt=0.5//c
L=80000*4.2//J/kg
T=273//k
dv=0.000091//m^3
```

```
//CALCULATIONS
dp=(L*dt)/(T*dv*100000)
//results
printf(' \n pressure= %1f atm',dp)
```

Scilab code Exa 8.15 `chapter 8 example 15`

```
clc
//initialisation of variables
dp=1.01*10^5//Nm^-2
L=4563000*4.2//J
dv=18.7*10^-3//m^3
T=353//k
//CALCULATIONS
dT=(dp*T*dv)/L
//results
printf(' \n change in melting point= %1f c',dT)
```

Scilab code Exa 8.16 `chapter 8 example 16`

```
clc
//initialisation of variables
T=373//k
L=537000*4.2//J
dp=0.0212*13600*9.81
dv=1.673//m^3
//CALCULATIONS
dT=dp*T*dv/L
//results
printf(' \n change in temperature of boiling water=
   %1f c',dT)
```

Scilab code Exa 8.17 chapter 8 example 17

```
clc
//initialisation of variabes
dp=(100-1)*1.01*10^5
L=24500//J
T=600//k
d2=11010
d1=10650
//CALCULATIONS
dv=(1/d2)-(1/d1)
dT=dp*T*dv/L
mp=T+(-dT)
//results
printf(' \n new melting point= %1f c',mp)
```

Scilab code Exa 8.18 chapter 8 example 18

```
clc
//initialisation of variables
p=1.5//kg/cm2
T=373//k
v=1600//cc
L=2240000//J/kg
//CALCULATIONS
dp=((p*1000*980)-(1.01*10^6))/10
dv=(v-1)/1000
dT=dp*T*dv/L
T1=dT+T-273
//results
printf(' \n new temperature of cooker= %1f c',T1)
```

Scilab code Exa 8.19 `chapter 8 example 19`

```
clc
//initialisation of variables
c1=1000
T=373//k
L=539300//cal
r=604// cal/kg/deg
//CALCULATIONS
c2=c1-(r)-(L/T)
//results
printf(' \n specific heat of saturated steam= %1f
    cal/kg',c2)
```

Scilab code Exa 8.20 `chapter 8 example 20`

```
clc
//initialisation of variables
m=0.1//kg
v=1.01*10^-4//m^3
vs=0.167404//m^3
t1=101//c
t2=99//c
p1=0.788//m
p2=0.7337//m
T=373//k
//CALCULATIONS
v1=v/m
v2=vs/m
dv=v2-v1
dt=t1-t2
dp=p1-p2
```

```
dP=dp*13600*9.81
L=dP*T*dv/(dt*4.2)
//results
printf(' \n latent heat of steam= % 1f cal/kg',L)
```

Scilab code Exa 8.21 chapter 8 example 21

```
clc
//initialisation of variables
T1=1100//k
T3=200//k
r=0.5
//CALCULATIONS
T=(T1-(T3*r))/(1+r)
//results
printf(' \n value of T= % 1f k',T)
```

Scilab code Exa 8.22 chapter 8 example 22

```
clc
//initialisation of variables
T2=500//k
T1=1000//k
//CALCULATIONS
r=1-(T2/T1)
x=T1/r
//results
printf(' \n value of x= % 1f k',x)
```

Scilab code Exa 8.23 chapter 8 example 23

```
clc
//initialisation of variables
T1=900//k
T2=300//k
Q1=10^6//cal
//CALCULATIONS
r=(1-(T2/T1))
r1=r*100
w=r*Q1
w1=w*4.2//J
w2=w1/(3.6*10^6)
w3=w1/(1.609*10^-19)
//results
printf(' \n efficiency= % 1f ',r1)
printf(' \n work in KWH= % 1f KWH',w2)
printf(' \n work in ev= % 1e ev',w3)
```

Scilab code Exa 8.24 chapter 8 example 24

```
clc
//initialisation of variables
T2=300///k
T1=900//k
T3=600//k
Q2=15000//k.cal
Q1=12000//k.cal
//CALCULATIONS
na=1-(T2/T1)
nb=1-(T2/T3)
w1=Q1*na
w2=Q2*nb
//results
printf(' \n w1= % 1f kcal',w1)
printf(' \n w2= % 1f kcal',w2)
```

Scilab code Exa 8.25 chapter 8 example 25

```
clc
//initialisation of variab;es
l=420//m
g=9.81//m/sec^2
c=1000
//CALCULATIONS
dt=(g*l)/(c*4.2)
//results
printf(' \n difference in temperature= %1f c',dt)
```

Scilab code Exa 8.26 chapter 8 example 26

```
clc
//initialisation of variables
m=0.005//kg
c=0.17//kcal/kg/c
t1=12.4//c
t2=10.2//c
//CALCULATIONS
du=m*c*(t1-t2)*4.2*1000
//results
printf(' \n change in internal energy= %1f J',du)
```

Scilab code Exa 8.27 chapter 8 example 27

```
clc
//initialisation of variables
```

```
dq=-80
dv=0.091*10^-6//m^3
p=1.013*10^5//n/m^2
//CALCULATIONS
du=dq-(p*dv/46)
//results
printf(' \n change in internal energy= %1f cal',du)
```

Scilab code Exa 8.28 chapter 8 example 28

```
clc
//initialisation of variables
p=1*10^5//n/m^2
v2=2.6//litre
v1=2.2//litre
dq=250//j
//CALCULATIONS
dv=(v2-v1)*10^-3
dw=p*dv
du=dq-dw
//results
printf(' \n change in internal energy= %1f J',du)
```

Scilab code Exa 8.29 chapter 8 example 29

```
clc
//initialisation of variables
v2=6//lit
v1=2//lit
r=3/2
p1=1.01*10^5//n/m^2
//CALCULATIONS
g=(r+1)/r
```

```
p2=p1*(v2/v1)^g
w=(1/(g-1))*((p1*v2*10^-3)-(p2*v1*10^-3))
//results
printf(' \n work done= % 1f J',w)
```

Chapter 9

entropy

Scilab code Exa 9.1 chapter 9 example 1

```
clc
//initialisation
m=10//gm
l=80//
t=273//k
//CALCULATIONS
dq=m*l
ds=dq/t
//results
printf(' \n change in entropy= % 1f cal/k',ds)
```

Scilab code Exa 9.2 chapter 9 example 2

```
clc
//initialisation of variables
m=0.001//kg
l=80000//cal/kg
T1=273//k
```

```
T2=373//k
s=1000
l1=540000//cal/kg
//CALCULATIONS
ds=(m*l/T1)+(m*s*log(T2/T1))+(m*l1/T2)
//results
printf(' change in entropy = % 1f cal/k',ds)
```

Scilab code Exa 9.3 chapter 9 example 3

```
clc
//initialisation of variables
m=0.001//kg
s=500//cal/kg
li=80000//cal/kg
l1=540000//cal/kg
T1=273//k
T2=263//k
T3=373//k
s1=1000//cal/kg
//CALCULATIONS
d1=m*s*log(T1/T2)
d2=m*li/T1
d3=m*s1*log(T3/T1)
d4=m*l1/T3
d5=d4+d3+d2+d1
//results
printf(' increase in entropy = % 1f cal/k',d5)
```

Scilab code Exa 9.4 chapter 9 example 4

```
clc
//initialisation of variables
```

```
m1=0.08//kg
m2=0.12//kg
t1=20//c
t2=50//c
T1=t1+273//k
T2=t2+373//k
s=1000//cal/kg
//CALCULATIONS
t=(m2*t2+m1*t1)/(m1+m2)
T3=t+273
s1=m1*s*log(T3/T1)
s2=m2*s*log(T3/T2)
ds=s1+s2
//results
printf(' change in entropy of universe = %1f cal/k'
   ,ds)
```

Scilab code Exa 9.6 chapter 9 example 6

```
clc
//initialisation of variables
r=4
//CALCULATIONS
w=log(r)
//results
printf(' change in entropy = %1f R/J cal for each',
   w)
```

Scilab code Exa 9.7 chapter 9 example 7

```
clc
//initialisation of variables
m=1//kg
```

```
c=1000
T1=273//k
T2=50+273//k
l=571700//cal/kg
//CALCULATIONS
ds=m*c*log(T2/T1)+m*l/T2
//results
printf(' difference in entropy = %1f cal per degree
    c',ds)
```

Scilab code Exa 9.8 chapter 9 example 8

```
clc
//initialisation of variables
m=0.01//kg
T1=800//k
T2=500//k
T3=400//k
s1=60//cal/kg/k
s2=70//cal/kg/k
l=14000//cal/kg
//CALCULATIONS
ds=m*s1*log(T2/T3)+m*l/T2+m*s2*log(T1/T2)
//results
printf(' change in entropy = %1f cal/k',ds)
```

Scilab code Exa 9.9 chapter 9 example 9

```
clc
//initialisation of variables
c1=0.08
c2=0.003
c3=0.1
```

```
T2=100//k
T1=50//k
//CALCULATIONS
r1=c1*(T2-T1)
r2=(c2/2)*(T2^2-T1^2)
r3=c3*log(T2/T1)
ds=5*(r1-r2-r3)
//results
printf(' change in entropy = % 1f cal/k',ds)
```

Scilab code Exa 9.10 chapter 9 example 10

```
clc
//initialisation
st=1.75
sw=0.30
t=100//c
T=273+t//k
//CALCULATIONS
L=T*(st-sw)
//results
printf(' \n specific latent heat of steam= % 1f cal/gm',L)
```

Scilab code Exa 9.11 chapter 9 example 11

```
clc
//initialisation
r=3
n=2
R=8314
//CALCULATIONS
ds=2.3026*n*R*log(r)
```

```
//results
printf(' \n change in entropy= % 1f j/k',ds)
```

Scilab code Exa 9.13 chapter 9 example 13

```
clc
//initialisation of variables
m1=90//gm
m2=10//gm
T1=373//k
T2=273//k
T3=331.2//k
l=540
//CALCULATIONS
ds=(m1+m2)*log(T3/T2)-m2*l/T1+m2*log(T3/T1)
//results
printf(' change in entropy = % 1f cal/k',ds)
```

Scilab code Exa 9.14 chapter 9 example 14

```
clc
//initialisation of variables
m1=3//gm
m2=28
ds=0.621//J/k
//CALCULATIONS
r=ds*m2/(m1*8.31)
a=2.3026^r
//results
printf(' change in volume = % 1f ',a)
```

Scilab code Exa 9.15 chapter 9 example 15

```
clc
//initialisation
e=0.31
e1=1.76//cal/gm/k
t=100//c
T=273+t//k
//-CALCULATIONS
ds=e1-e
dq=ds*T
//results
printf(' \n heat of vaporisation at this temperature
   = % 1f cal/gm',dq)
```

Scilab code Exa 9.16 chapter 9 example 16

```
clc
//initialisation
i=3//amp
r=10//ohm
t=27//c
T=273+t//k
//CALCULATIONS
dq1=0
ds1=dq1/T
dq2=i*i*r
ds2=dq2/T
//results
printf(' \n change in entropy of resistor= % 1f j/k'
   ,ds1)
printf(' \n change in entropy of universe= % 1f j/k'
   ,ds2)
```

Scilab code Exa 9.17 chapter 9 example 17

```
clc
//initialisation of variables
m1=1//gm
m2=28
cv=0.18
T2=373//k
T1=323//k
//CALCULATIONS
ds=m1*cv*log(T2/T1)/m2
//results
printf(' change in entropy = % 1f cal/k',ds)
```

Scilab code Exa 9.18 chapter 9 example 18

```
clc
//initialisation of variables
T1=40//k
T2=120//k
c1=0.076
c2=0.00026
c3=0.15
//CALCULATIONS
r1=c1*(T2-T1)
r2=(c2/2)*(T2^2-T1^2)
r3=c3*log(T2/T1)
ds=5*(r1-r2-r3)
//results
printf(' change in entropy = % 1f cal/k',ds)
```

Chapter 10

thermodynamic relations

Scilab code Exa 10.7 `chapter 10 example 7`

```
clc
//initialisation
T=5+273//k
v=10^-6//m3
a=15*10^-6//k^-1
cp=1005//cal/kg/k
dp=(1000-0)*10^5//N/m2
//CALCULATIONS
dt=(T*a*v*dp)/(cp*4.2)
//results
printf(' \n temperature of water rises by= % 1f k',
   dt)
```

Scilab code Exa 10.8 `chapter 10 example 8`

```
clc
//initialisation
T=5+273//k
```

```
v=10^-6//m3
a=15*10^-6//k^-1
cp=1005//cal/kg/k
dp=(1000-0)*10^5//N/m2
//CALCULATIONS
q=(T*a*v*dp)/4.2
//results
printf(' \n quantity of heat given= %1f cal',q)
```

Scilab code Exa 10.13 `chapter 10 example 13`

```
clc
//initialisation
dq=540000
dv=1.676
T1=373//k
T2=423//k
p1=1//pa
//CALCULATIONS
dt=T2-T1
dp=(dt*dq*4.2)/(dv*T1)
p2=p1+(dp/10^5)
//results
printf(' \n required pressure= %1f pa',p2)
```

Chapter 11

production of low temperature

Scilab code Exa 11.2 `chapter 11 example 2`

```
clc
//initialisation
a=0.245
b=2.67*10^-2
dp=50//pa
t1=300//k
R=8.4//j
//CALCULATIONS
cp=7*R/5
l=((2*a)/(R*t1))-b
dt=(dp*l)/cp
//results
printf(' \n drop in temperature= %1f k',dt)
```

Scilab code Exa 11.3 `chapter 11 example 3`

```
clc
//initialisation
```

```
k=6*10^-5
B=5000
c=420//J
T=2//k
//CALCULATIONS
dt=-(k*B*B)/(2*c*T)
T1=T+dt
//results
printf(' \n final temperature= % 1f k',T1)
```

Chapter 12

transmission of heat

Scilab code Exa 12.1 `chapter 12 example 1`

```
clc
//initialisation
cu=390
al=226
lal=0.05//m
//CALCULATIONS
lcu=((cu/al)^0.5)*lal
//results
printf(' \n wax melts up to= % 1f m',lcu)
```

Scilab code Exa 12.2 `chapter 12 example 2`

```
clc
//initialisation
m=96//gm
m1=5//gm
t1=37//c
t2=10//c
```

```
l=10//cm
t=4*60//s
a=5//cm^2
dt=24//c
//CALCULATIONS
k=m*(t1-t2)/(a*t*dt)
h1=m1*540
h2=m*(t1-t2)
dh=h1-h2
p=dh*100/h1
//results
printf(' \n thermal conductivity= % 1f cgs units',k)
printf(' \n percentage of heat loss= % 1f ',p)
```

Scilab code Exa 12.3 chapter 12 example 3

```
clc
//initialisation
cu=90
fe=12
t1=200//c
t2=0//c
l=0.3//m
a=5*10^-4//m^2
//CALCULATIONS
t=(t1*cu+fe*t2)/(cu+fe)
dt=t1-t
rh=cu*a*dt/0.15
//results
printf(' \n rate of heat flow= % 1f cal/sec',rh)
```

Scilab code Exa 12.4 chapter 12 example 4

```
clc
//initialisation
a=25//sq.mt
aw=5//sq.mt
dt=30//c
t=60*60//sec
l=0.3//m
br=0.12
gl=0.25
l1=0.03//cm
//CALCULATIONS
A=4*a-aw
hb=(br*A*dt*t)/(l*1000)
hw=(gl*aw*dt*t)/(l1*100)
tot=hb+hw
//results
printf(' \n total heat passing per hour= %1f k.cal'
    ,tot)
```

Scilab code Exa 12.5 `chapter 12 example 5`

```
clc
//initialisation
k1=0.252
k2=0.05
t1=273//k
t2=285//k
l1=0.0175//m
l2=0.02//m
//CALCULATIONS
t=((k1/l1)*t1+(k2/l2)*t2)/(k1/l1+k2/l2)
//results
printf(' \n temperature of interface= %1f k',t)
```

Scilab code Exa 12.6 chapter 12 example 6

```
clc
//initialisation
cu=104
w=0.14
l1=50//cm
t=0.0001//m
t1=100//c
t2=0//c
//CALCULATIONS
x=cu*t*100/w
l=l1+2*x
dt=t1-t2
dg=dt/l
d1=x*dg
d2=t1-d1
//results
printf(' \n temperature gradient= % 1f c/cm',dg)
printf(' \n  temperature of one end= % 1f c',d1)
printf(' \n temperature of other end= % 1f c',d2)
```

Scilab code Exa 12.7 chapter 12 example 7

```
clc
//initialisation
m=4800//g
lice=80//cal/g
a=3600//sq.cm
t1=100//c
t2=0//c
t=10//cm
```

```
//CALCULATIONS
h=(m*lice)/(a*t)
dt=t1-t2
k=(h*t)/(a*dt)
//results
printf(' \n thermal conductivity of stone= %1f cal/
   cm s c',k)
```

Scilab code Exa 12.8 chapter 12 example 8

```
clc
//initialisation
t1=100//c
t2=4//c
k=0.5//cal/cm s c
a=12//cm^2
l=8//cm
r=36//cal/s
//CALCULATIONS
T=(((r*l)/(k*a))+t1+t2)*0.5
//results
printf(' \n equilibrium temperature of inner surface
   = %1f c',T)
```

Scilab code Exa 12.9 chapter 12 example 9

```
clc
//initialisation
r2=0.5
r1=0.4
l=30//cm
q=(500*10)/60
t=100//c
```

```
t1=20//c
t2=30//c
dt=t-(t1+t2)/2
//CALCULATIONS
k=(q*log((r2)/(r1)))/(2*3.14*dt*l)
//results
printf('\n thermal conductivity of glass tube= %1f
    cgs units',k)
```

Scilab code Exa 12.10 `chapter 12 example 10`

```
clc
//initialisations
t2=162//c
t1=62//c
l=0.15//m
d=0.02//m
k=226//watt per kelvin metre
//CALCULATIONS
r=d/2
a=3.14*r*r
p=2*3.14*r
x=(log(t2/t1))/l
e=(x*x*k*a)/p
//results
printf('\n surface emissivity of rod= %1f ',e)
```

Scilab code Exa 12.11 `chapter 12 example 11`

```
clc
//initialisation
t1=5.6//c
t2=2.8//c
```

```
t3=0.7//c
d1=2//m
d2=4//m
d3=8//m
w=(2*3.14)/365
//CALCULATIONS
d=(log(t1/t2))/(d2/d1)
k=w*1000/(d*d)
//results
printf(' \n diffusity= % 1f m^2 per day',k)
```

Scilab code Exa 12.12 `chapter 12 example 12`

```
clc
//initialisation
kcu=0.93//cal per sec per cm per c
t=700
//CALCULATIONS
khell=t*kcu
kmks=khell*100
ksi=4.2*khell
//results
printf(' \n conductivity= % 1f cal per sec per cm
    per c',khell)
printf(' \n conductivity= % 1f cal per sec per m per
     c',kmks)
printf(' \n conductivity= % 1f watt per m per k',ksi
    )
```

Chapter 14

radiation of heat

Scilab code Exa 14.1 `chapter 14 example 1`

```
clc
//initialisation
si=5.735*10^-8//j m^-2 sec ^-1 deg^-4
t=1227+273//k
r=0.003//m
//CALCULATIONS
e=3.14*r*r*si*t^4*60/4.2
//results
printf(' \n energy= % 1f cal',e)
```

Scilab code Exa 14.2 `chapter 14 example 2`

```
clc
//initialisation
t1=573//k
t2=273//k
m=0.032//kg
s=100
```

```
r=0.35//c/sec
a=0.0008//sq.mt
e=1
//CALCULATIONS
E=m*s*r
si=E/(a*e*((t1^4)-(t2^4)))
//results
printf(' \n stefans constant= %1e j m^-2 sec^-1 deg
    ^-4',si)
```

Scilab code Exa 14.3 chapter 14 example 3

```
clc
//initialisations
E=40//j/sec
a=0.66*10^-4//sq.mt
e=0.31
t=273+2170//k
//CALCULATIONS
si=E/(e*a*t^4)
//results
printf(' \n stefans constant= %1e j m^-2 sec^-1 deg
    ^-4',si)
```

Scilab code Exa 14.4 chapter 14 example 4

```
clc
//initialisation
t1=500//k
t2=300//k
m=10//kg
s=100//cal/kg/k
r=0.07//m
```

```
//CALCULATIONS
a=4*3.14*r*r
E=a*((t1*t1*t1*t1)-(t2*t2*t2*t2))
r=E/(m*s)
//results
printf('\n maximum rate at which temperature will
   fall= % 1f c/sec',E)
```

Scilab code Exa 14.5 chapter 14 example 5

```
clc
//initialisation
t1=700//k
t2=290//k
E=10000//w m^-2
si=5.7*10^-8
//CALCULATIONS
t=(t1^4+t2^4)/2
T=t^0.25
t1=E/si
T1=t1^0.25
//results
printf('\n temperature its rate will be halved= % 1
   f k',T)
printf('\n temperature of body= % 1f k',T1)
```

Scilab code Exa 14.6 chapter 14 example 6

```
clc
//initialisation
E=40//w
r=0.00005//m
l=0.1//m
```

```
si=5.67*10^-8
T=2773//k
//CALCULATIONS
a=2*3.14*r*l
e=E/(a*si*(T^4))
//results
printf('\n relative emittance= %1f ',e)
```

Scilab code Exa 14.7 chapter 14 example 7

```
clc
//initialisation
r=0.02//m
t1=120+273//k
t2=100+273//k
si=5.67*10^-8
//CALCULATIONS
a=4*3.14*r*r
E=a*si*(t1^4-t2^4)
//results
printf('\n rate at which energy must be supplied= %
    1f watts',E)
```

Scilab code Exa 14.8 chapter 14 example 8

```
clc
//initialisation
t=6000//k
r=17000
//CALCULATIONS
T=6000*17000^0.25
//results
printf('\n temperature of the star= %1f k',T)
```

Scilab code Exa 14.9 `chapter 14 example 9`

```
clc
//initialisation
l=4753*10^-8//cm
w=0.293
t=10^7//k
//CALCULATIONS
T=w/l
lm=w/(t*100)
//results
printf(' \n effective temperature of sun= % 1f k',T)
printf(' \n wavelength of max energy= % 1e m',lm)
```

Scilab code Exa 14.10 `chapter 14 example 10`

```
clc
//initialisations
r=15*10^10//m
R=7*10^8//m
si=6.72*10^-8//j m^-2 sec^-1 deg^-4
s=81350 //j m^-2 min^-1
//CALCULATIONS
t=(r*r*s)/(R*R*si*60)
T=t^0.25
//results
printf(' \n value of temperature= % 1f k',T)
```

Scilab code Exa 14.11 `chapter 14 example 11`

```
clc
//initialisation
s=8.2*10^4
si=5.67*10^-8//j m^-2 sec^-1 deg ^-4
a=32
//CALCULATIONS
r2=a/2
r1=(r2*3.14)/(60*180)
r=r1^2
t=s/(r*60*si)
T=t^0.25
//results
printf(' \n surface temperature of sun= % 1f k',T)
```

Scilab code Exa 14.12 chapter 14 example 12

```
clc
//initialisation
s=1.5//cal cm^-2 min^-1
k=0.0027
//CALCULATIONS
td=-(s/(k*60))
//results
printf(' \n temperature gradient= % 1f c cm^-1',td)
```

Chapter 15

elements of statistical mechanics

Scilab code Exa 15.1 chapter 15 example 1

```
clc
//initialisations
c=8
h=3
t=5
//CALCULATIONS
a=factorial(8)/(factorial(3)*factorial(5)*2^8)
//results
printf(' \n probability of 3 heads and 5 tails= %1f
    ',a)
```

Scilab code Exa 15.2 chapter 15 example 2

```
clc
//initialisation
n=5
```

```
h=2
p=1/6
//CALCULATIONS
t=1-p
a=((factorial(n))/(factorial(h)*factorial(n-h)))*(p^
   h)*(t^(n-h))
//results
printf(' \n probability of apperance of 4 in two
   dices= % 1f ',a)
```

Scilab code Exa 15.3 `chapter 15 example 3`

```
clc
//initialisation
n=12
p=2
//CALCULATIONS
t=n/p
a=factorial(n)/(factorial(t)*factorial(n-t)*p^n)
//results
printf(' \n probability= % 1f ',a)
```

Scilab code Exa 15.4 `chapter 15 example 4`

```
clc
//initialisation
n=10
a=0.6
h=0
//CALCULATIONS
b=1-a
p=factorial(n)*a^10/(factorial(n-h)*factorial(h))
//results
```

```
printf(' \n probability of heads occurence= % 1f ',a
    *10)
printf(' \n probability of occuring head only in 10
    throws= % 1f ',p)
```

Scilab code Exa 15.5 chapter 15 example 5

```
clc
//initialisation
n=400
a1=300
b1=100
a2=200
b2=200
r=2
//CALCULATIONS
p1=factorial(n)/(factorial(a1)*factorial(b1)*r^n)
p2=factorial(n)/(factorial(a2)*factorial(b2)*r^n)
w=p1/p2
//results
printf(' \n ratio of probabilities= % 1e ',w)
```

Scilab code Exa 15.6 chapter 15 example 6

```
clc
//initialisation
a1=2
a2=6
a3=16
a4=2
b1=1
b2=3
b3=4
```

```
b4=7
//CALCULATIONS
a=a1+a2+a3+a4
x=a1*b1+a2*b2+a3*b3+a4*b4
p2=a1/a
p6=a2/a
p16=a3/a
d=x/a
//results
printf(' \n probability of state 2= % 1f ',p2)
printf(' \n probability of state 6= % 1f ',p6)
printf(' \n probability of state 16= % 1f ',p16)
printf(' \n value of <x>= % 1f ',d)
```

Scilab code Exa 15.9 chapter 15 example 9

```
clc
//initialisation
dx=10^-11//m
c=10^7//m/sec
h=6.6*10^-34
//CALCULATIONS
dp=(9.1*10^-31*c)
n=(2*dx*dp*100)/h
//results
printf(' \n number of quantum states available= % 1f
    ',n)
```

Scilab code Exa 15.10 chapter 15 example 10

```
clc
//initialisation
t1=301//k
```

```
t2=300//k
f=5*(10^30)
fa=f/2
//CALCULATIONS
r=t1/t2
i=r^fa
//results
printf(' \sigma(E) increases by a factor r^fa ')
printf(' \n r= % 1f ',r)
printf(' \n fa= % 1f ',fa)
```

Scilab code Exa 15.11 chapter 15 example 11

```
clc
//initialisation
de=5.52*10^-21//j
k=1.38*10^-23
//CALCULATIONS
t=de/(2*k)
//results
printf(' \n temperature of system= % 1f k',t)
```

Scilab code Exa 15.14 chapter 15 example 14

```
clc
//initialisation
p=0.76*9.81*13600
dv=10^-5//m3
k=1.38*10^-23
t=300//k
//CALCULATIONS
r=(p*dv)/(k*t)
//results
```

```
printf(' \n factor by which number of accessible
   states increases is exp(r) ')
printf(' \n r= % 1e ',r)
```

Chapter 16

classical and quantum statistics

Scilab code Exa 16.2 chapter 16 example 2

```
clc
//initialisations
h=6.6*10^-34
c=3*10^8//m/sec
k=1.38*10^-23
t=1000//k
//CALCULATIONS
l=(h*c)/(5*k*t)
///results
printf(' \n wavelength associated with maximum
    radiation= % 1e ',l)
```

Scilab code Exa 16.5 chapter 16 example 5

```
clc
//initialisation
h=6.6*10^-34//j sec
r=5.86*10^28
```

```
m=9.1*10^-31//kg
gs=2
//CALCULATIONS
a=(h*h/(2*m))*((3*r/(4*3.14*gs))^(2/3))
//resullts
printf(' \n fermi energy= %1e',a)
```

Scilab code Exa 16.10 chapter 16 example 10

```
clc
//initialisation
t=300//k
e=0.01//v
//CALCULATIONS
a=1/((exp(e/t))+1)
//results
printf(' \n NFD= %1f ',a)
```

Scilab code Exa 16.11 chapter 16 example 11

```
clc
//initialisation
n=6.06*10^26
p=2.7*10^3
h=6.6*10^-34
m=9.1*10^-31//kg
gs=2
ml=26.98*10^-3
//CALCULATIONS
a=(h*h/(2*m*100))*((3*3*n*p/(4*3.14*gs*ml))^(2/3))
r=a/(1.609*10^-19)
//results
printf(' \n fermi energy= %1f ev',r)
```