

Scilab Textbook Companion for
Heat And Thermodynamics
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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.

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Chapter 1

Heat And Temperature Thermometry

Scilab code Exa 1.1 chapter 1 example 1

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

Scilab code Exa 1.2 chapter 1 example 2

```
1 clc
2 //initialisation of variables
3 n= 1/1000
4 T= 60 //degrees
5 T1= 100 //degrees
```

```

6 //CALCULATIONS
7 r= T-n*T^2
8 r1= T1-n*T1^2
9 t1= r*100/r1
10 //RESULTS
11 printf (' liquid temperature= % 1f C',t1)

```

Scilab code Exa 1.3 chapter 1 example 3

```

1 clc
2 //initialisation of variables
3 p=1.0//metres
4 p0=0.8//metres
5 p100=1.093//metres
6 //CALCULATIONS
7 t=((p-p0)*100/(p100-p0))
8 //RESULTS
9 printf(' temperature of hot water= % 1f C',t)

```

Scilab code Exa 1.4 chapter 1 example 4

```

1 clc
2 //initialisation of variables
3 p0=0.70//metres
4 LC=0.1//millimetres
5 t= 100 //degrees
6 //CALCULATIONS
7 p100=p0*(1+(t/273))
8 T=(LC/(p100-p0))
9 //results
10 printf(' accuracy we can expect= % 1f C',T)

```

Scilab code Exa 1.5 chapter 1 example 5

```
1 clc
2 //initialisation of variables
3 t=80//celsius
4 tp=80.2//celsius
5 T=120
6 //CALCULATIONS
7 s=(10000)*((t-tp)/(t*(t-100)))
8 Tp=T-((s*t*(T-100))/10000)
9 //results
10 printf(' temperature= % 1f C',Tp)
```

Scilab code Exa 1.6 chapter 1 example 6

```
1 clc
2 //initialisation of variables
3 R100=5.93//ohms
4 Ro=5.0//ohms
5 P100=1.366//metres
6 Po=1//metres
7 Pt=1.3111//metres
8 Rt=5.795//ohms
9 //calculations
10 tp=(Rt-Ro)*100/(R100-Ro)
11 t=(Pt-Po)*100/(P100-Po)
12 //results
13 printf(' thermal on platinum scale= % 2f C',tp)
14 printf(' thermal on gas scale= % 1f C',t)
```

Scilab code Exa 1.7 chapter 1 example 7

```
1  clc
2  //initialisation
3  Rt=13.3//ohms
4  R100=7.0//ohms
5  R0=5.0//ohms
6  t=444.6//celsius
7  RT=9.1//ohms
8  //CALCULATIONS
9  tp=(Rt-R0)*100/(R100-R0)
10 Tp=(RT-R0)*100/(R100-R0)
11 s=(t-tp)*10000/(t*(t-100))
12 T=Tp+((s*(Tp*(Tp-100)))/10000)
13 Ts=Tp+((s*T*(T-100))/10000)
14 //results
15 printf(' platinum temperature of bath= % 2f C',T)
16 printf(' gas temperature of bath= % 2f C',Ts)
```

Scilab code Exa 1.8 chapter 1 example 8

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

```

15 p1=p*ld
16 T=p1/j
17 t=(100*(et-e0))/(e100-e0)
18 //results
19 printf(' temperature= % 1f C',t)
20 printf(' \n temperature= % 1f C',T)

```

Scilab code Exa 1.9 chapter 1 example 9

```

1 clc
2 //initialisations
3 ht=65//cm
4 h0=-5//cm
5 t=273//c
6 //CALCULATIONAS
7 h100=h0+(100*(ht-h0)/t)
8 l=(1+(t/273))
9 H=(ht-(h0*l))/(1-l)
10 printf(' temperature= % 1f cm',H)

```

Scilab code Exa 1.10 chapter 1 example 10

```

1 clc
2 //initialisations
3 T1=25//c
4 T2=15//c
5 r=1.035
6 //CALCULATIONS
7 s=(r-1)/(T1-(T2*r))
8 t=-1/s
9 //reults
10 printf(' absolute zero= % 1f C',t)

```

Chapter 2

Thermal Expansion

Scilab code Exa 2.5 chapter 2 example 5

```
1 clc
2 //initialisation
3 t1=0//c
4 t2=20//c
5 g=0.000011//1/c
6 h=0.000019//1/c
7 l=41.628//cm
8 //CALCULATIONS
9 l20=l*(1+(h*(t2-t1)))
10 l0=l20/(1+(g*(t2-t1)))
11 //results
12 printf(' true length of rod at 20 c= %1f C',l20)
13 printf(' true length of rod at 0 c= %1f C',l0)
```

Scilab code Exa 2.6 chapter 2 example 6

```
1 clc
2 //initialisation
```



```

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

```

Scilab code Exa 2.7 chapter 2 example 7

```

1 clc
2 //initialisation of variables
3 l20=0.1//m
4 l1=0.0999//m
5 s=0.000011//1/c
6 t1=20
7 //CALCULATIONS
8 t=((l1-l20)/(l20*s))+20
9 //results
10 printf(' temperature the rod must be reduced is= %1
      f C',t)

```

Scilab code Exa 2.8 chapter 2 example 8

```

1 clc
2 //initialisation of variables

```

```

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

```

Scilab code Exa 2.9 chapter 2 example 9

```

1 clc
2 //initialisations
3 e=6000*10^-10 //m
4 p=25
5 l=1.5*10^-2
6 t2=40
7 t1=0
8 sx=13*10^-7 //1/c
9 sy=231*10^-7 //1/c
10 sz=231*10^-7 //1/c
11 //CALCULATIONS
12 s=((p*e)/(2*l*(t2-t1)))
13 y=sx+sy+sz
14 //results
15 printf(' alpha of crystal= %1f 1/C',s)
16 printf(' coefficient of cubical expansion= %1f 1/C'
,y)

```

Scilab code Exa 2.10 chapter 2 example 10

```

1 clc

```

```

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

```

Scilab code Exa 2.12 chapter 2 example 12

```

1 clc
2 //initialisation
3 l=1//m
4 ld1=0.7//m
5 ld2=0.78//m
6 d1=0
7 d2=30
8 vd1=1-(ld1*cosd(d1))
9 vd2=1-(ld2*cosd(d2))
10 //CALCULATIONS
11 H=((ld1*vd1)-(ld2*vd2))/(vd1-vd2)
12 //results
13 printf(' atmospheric pressure= %1f m',H)

```

Scilab code Exa 2.13 chapter 2 example 13

```

1 clc
2 //initialisation
3 r=1/1.035
4 t1=15//c
5 t2=25//c
6 //CALCULATIONS
7 x=-((t1-(t2*r))/(r-1))

```

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

Scilab code Exa 2.14 chapter 2 example 14

```
1 clc
2 //initialisation
3 p=0.76
4 t1=0//c
5 t2=100//c
6 T1=t1+273//k
7 T2=t2+273//k
8 //CALCULATIONS
9 p=(2*p*T2)/(T1+T2)
10 //results
11 printf(' pressure of the gas= % 1f m',p)
```

Scilab code Exa 2.15 chapter 2 example 15

```
1 clc
2 //initialisation
3 s=0.00018//1/c
4 dt=1//c
5 //CALCULATIONS
6 p=(s*dt)*100
7 //results
8 printf(' percentage change= % 1f',p)
```

Chapter 3

calorimetry

Scilab code Exa 3.2 chapter 3 example 2

```
1 clc
2 //initialisation of variables
3 cag=56
4 cpb=31
5 cal=220
6 //CALCULATIONS
7 mag=1000/cag
8 mpb=1000/cpb
9 mal=1000/cal
10 //results
11 printf(' mass of silver= % 1f kg ',mag)
12 printf(' mass of lead= % 1f kg ',mpb)
13 printf(' mass of aluminium= % 1f kg ',mal)
```

Scilab code Exa 3.3 chapter 3 example 3

```
1 clc
2 //initialisations
```

```

3 m1=0.5//kg
4 m2=0.09//kg
5 t1=19//c
6 t2=15//c
7 t3=38//c
8 t4=50//c
9 s=1000
10 //CALCULATIONS
11 A=[4000 -15.5; 23000 11.5]
12 b=[-360;1080]
13 c=A\b
14 R1=c(1,1)
15 R2=c(2,1)
16 //results
17 printf(' water equivalent of mercury= %1f kg',R1)
18 printf('\n specific heat of mercury= %1f c /kg/c',
        R2)

```

Scilab code Exa 3.4 chapter 3 example 4

```

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

```

Scilab code Exa 3.5 chapter 3 example 5

```
1  clc
2  //initialisation of variables
3  mc=0.1//kg
4  v11=150//cc
5  v12=150//cc
6  h11=600
7  g11=1200
8  h12=400
9  g12=900
10 t1=50//c
11 t2=40//c
12 sc=100
13 r1=2
14 //CALCULATIONS
15 m1=v11*g11/(10^6)
16 rc1=(m1*h11+mc*sc)*r1
17 k= -rc1/t1
18 m2=v12*g12/(10^6)
19 b=(m2*h12+mc*sc)
20 j=-k*t2
21 //results
22 printf(' rate of cooling= %0 1f cal/min',j)
```

Scilab code Exa 3.6 chapter 3 example 6

```
1  clc
2  //initialitions
3  t1=80//c
4  t2=50//c
```

```

5 t3=60 //c
6 t4=30 //c
7 t=20
8 e=5
9 //CALCULATIONS
10 k=2.3026*log((t1-t)/(t2-t))/e
11 T=2.3026*log((t3-t)/(t4-t))/k
12 //results
13 printf(' time it will take = %1f min',T)

```

Scilab code Exa 3.7 chapter 3 example 7

```

1 clc
2 //initialisation of variables
3 e=1.586 //v
4 i=0.1444 //amp
5 t=4*60 //sec
6 m=0.3963 //kg
7 T=1.219 //k
8 wt=206.4
9 //CALCULATIONS
10 hg=e*i*t
11 c=hg/(m*T*4.18)
12 a=c*wt
13 printf(' atomic heat of lead= %1f 1/k',a)

```

Scilab code Exa 3.8 chapter 3 example 8

```

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

```



```

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

```

Scilab code Exa 3.9 chapter 3 example 9

```

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

```

Scilab code Exa 3.10 chapter 3 example 10

```

1 clc
2 // initialisations
3 m1=250 //gm
4 m2=200 //gm
5 l=336 //j
6 w1=50 //gm
7 m3=200 //gm
8 t1=100 //c
9 // calculations

```

```

10 M1=m1+m2+w1
11 J=t1*M1*4.2
12 k=1*m2
13 m=123.2
14 T=m1+m3+m
15 //results
16 printf(' total contents= % 1f gm',T)

```

Scilab code Exa 3.12 chapter 3 example 12

```

1 clc
2 //initialisations
3 m1=10//kg
4 t1=80//c
5 t2=20//c
6 t3=150//c
7 t4=90//c
8 t=100//c
9 a=800//cal/kg
10 //calculations
11 h=m1*1000*(t1-t2)/1000
12 H=a*(t3-t)+540000+1000*(t-t4)
13 k=H/1000
14 x=h/k
15 //results
16 printf(' kg of steam required per hour= % 1f kg/hr ',
        x)

```

Scilab code Exa 3.13 chapter 3 example 13

```

1 clc
2 //initialisation
3 p1=6//atm

```

```

4 p2=2//atm
5 ph=89//kg/m^3
6 v=30/1000//ml
7 t1=10//c
8 t3=31.5//c
9 T1=273+t1
10 t2=150//c
11 w1=0.210//kg
12 //calculations
13 m=(p1-p2)*273*ph*v/(T1*1000)
14 t4=(t1+t3)/2
15 h=m*(t2-t4)
16 H=w1*1000*4.18*(t3-t1)
17 c=H/h
18 //results
19 printf(' specific heat= % 1f j/kg*k',c)

```

Scilab code Exa 3.14 chapter 3 example 14

```

1 clc
2 //initialisations
3 po=101396.1
4 p=1.293
5 vo=1/p
6 t=273
7 cp=961.4
8 //calculations
9 R=po*vo/t
10 cv=cp-R
11 //results
12 printf(' specific heat at constant volume= % 1f',cv)

```

Scilab code Exa 3.15 chapter 3 example 15

```

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

```

Scilab code Exa 3.16 chapter 3 example 16

```

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

```

Scilab code Exa 3.17 chapter 3 example 17

```

1  clc
2  //initialisation
3  p1=1
4  p2=0.8
5  t1=25//c

```

```

6 t2=10 //c
7 p=0.4
8 t3=61 //c
9 t4=12 //c
10 // calculations
11 p1=p*(t3-t4)
12 m=(t1-t2)
13 c=m/p1
14 // results
15 printf(' specific heat of liquid= % 1f cal/gm*c ',c)

```

Scilab code Exa 3.19 chapter 3 example 19

```

1 clc
2 //initialisation
3 p16=80 //cm
4 v16=432 //cc
5 t=273 //k
6 po=76 //cm
7 t=16 //c
8 t16=273+t //k
9 T=273 //k
10 poxy=0.0014
11 cfe=0.09
12 t1=15 //c
13 t2=184 //c
14 m1=2 //gm
15 // calculations
16 v0=(p16*v16*T)/(po*t16)
17 m=poxy*v0
18 h=m1*cfe*(t1+t2)
19 l=h/m
20 // results
21 printf(' latent heat= % 1f cal ',l)

```

Chapter 4

change of state

Scilab code Exa 4.2 example 4 chapter 2

```
1  clc
2  //initialisations
3  t1=20//c
4  m1=10//gm
5  t2=-80//c
6  t2=15//c
7  m2=10.77//gm
8  t3=10//c
9  c=0.5
10 //CALCULATIONS
11 A=[5 -10;5 -10.77]
12 b=[550;488.5]
13 c=A\b
14 R1=c(1,1)
15 R2=c(2,1)
16 //results
17 printf(' latent heat of fusion of ice= %1f cal/gm',
        R2)
```

Scilab code Exa 4.3 chapter 4 exampe 2

```
1 clc
2 //initialisations
3 c=0.58
4 m=4//gm
5 ms=5//gm
6 t=78//c
7 t1=80//c
8 x1=10//cm
9 x2=8.5//cm
10 c1=0.05
11 c2=0.048
12 t2=100//c
13 t3=27//c
14 //CALCULATIONS
15 Hal=m*c*t
16 m1=Hal/t1
17 m2=m1*x1/x2
18 Hp=m2*80
19 H1=ms*(t2-t3)*c1
20 H2=ms*c2*t3
21 L=(Hp-H1-H2)/ms
22 //results
23 printf(' latent heat of fusion= %1f cal/gm',L)
```

Scilab code Exa 4.4 chapter 4 exampe 4

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

```

8 lice=80000 // cal/kg
9 //CALCULATIONS
10 a=22*d*d/(4*7)
11 v=x*a
12 v1=1/pice
13 v2=1/pwater
14 dv=v1-v2
15 m2=v/dv
16 h=lice*m2
17 L=h/m1
18 printf(' latent heat of vapourisation= % 2f cal/kg',
        L)

```

Scilab code Exa 4.5 chapter 4 exampe 5

```

1 clc
2 //initialisation of variables
3 ms=0.0055 //kg
4 t1=100 //c
5 t2=15 //c
6 t3=26.8 //c
7 m1=250/1000 //kg
8 m2=16.2/1000 //kg
9 l=22.572*10^5 //kg
10 //calculations
11 h=(m1+m2)/(t3-t2)
12 x=(h-(ms*l))/(t1-t3-l)
13 p=x*100/ms
14 //results
15 printf(' perecentage of water in steam= % 5f ',x)

```

Scilab code Exa 4.6 chapter 4 exampe 6


```

1  clc
2  // intialisation
3  r=1.7*10^-6 //m^3/sec
4  t1=3.56 //c
5  pw=1000 //kg/m^3
6  r1=0.34*10^-6 //m^3/sec
7  t2=15 //c
8  bp=360 //c
9  c=33
10 p1=13600 //kg/m^3
11 //CALCCULATIONS
12 m=r*pw*60
13 h1=m*1000*t1
14 h2=r1*p1*(bp-t2)*c
15 L=(h1-h2)/(r1*p1)
16 // results
17 printf(' latent heat of vaporisation= %1f cal/kg',L
    )

```

Scilab code Exa 4.7 chapter 4 exampe 7

```

1  clc
2  // initialisation
3  p1=75.5 //cm
4  v1=123 //cc
5  t0=273 //k
6  t1=15 //c
7  T1=t0+t1
8  p0=76 //cm
9  r=1.43 //gm/litre
10 l=51 // cal/gm
11 t2=-183 //c
12 m=0.495 //gm
13 // calculations
14 v0=p1*v1*t0/(p0*T1)

```

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

Scilab code Exa 4.8 chapter 4 exampe 8

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

Scilab code Exa 4.9 chapter 4 exampe 9

```
1 clc
2 //initialisations
3 x1=17.5//mm
4 x2=9.2//mm
5 r=0.7
6 //CALCULATIONS
7 avp=x1*r
8 dsvp=avp-x2
9 f=dsvp*100/avp
10 //results
```

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

Scilab code Exa 4.10 chapter 4 exampe 10

```
1 clc  
2 //initialisations  
3 r=52  
4 svp=17.5//mm  
5 //CALCULATIONS  
6 p=(svp*r)/100  
7 //results  
8 printf(' SVP at dew point= % 1f mm',p)
```

Scilab code Exa 4.12 chapter 4 exampe 12

```
1 clc  
2 //initialisation  
3 p=4.60//mm  
4 p1=0.34//mm  
5 t=0.007//c  
6 r=760//mm  
7 //CALCULATIONS  
8 P=(p+(p1*t))  
9 fp=r-P  
10 d=r*t/fp  
11 //results  
12 printf(' lowering of melting point of ice= % 5f C',d  
    )
```

Scilab code Exa 4.14 chapter 4 exampe 14

```
1 clc
2 //initialisation
3 v2=1.677//m3
4 v1=0.001//m3
5 dp=0.76*13600*9.81
6 t=100//c
7 T=t+273//k
8 L=540000//cal//kg
9 //CALCULATIONS
10 dT=(dp*T*(v2-v1))/L
11 //results
12 printf(' increase in boiling point= % 1f C',dT)
```

Scilab code Exa 4.15 chapter 4 exampe 15

```
1 clc
2 //initialisation
3 t1=18//c
4 t2=19//c
5 t3=18.6//c
6 t4=23//c
7 t5=24//c
8 t6=23.7//c
9 svp1=15.46//mm
10 svp2=16.46//mm
11 svp4=21.02//mm
12 svp5=22.32//mm
13 //CALCULATIONS
14 svp3=svp1+((svp2-svp1)/(t2-t1))
15 svp6=svp4+((svp4-svp5)/(t4-t5))
16 rh=svp3*100/svp6
17 //results
18 printf(' relative humidity= % 1f ',rh)
```


Chapter 5

Kinetic theory of Heat

Scilab code Exa 5.1 chapter 5 example 1

```
1 clc
2 //initialisations
3 h=50//m
4 g=9.8//m/sec2
5 l=1000
6 j=4.2//j/cal
7 //calculations
8 q=h*g/j
9 t=q/l
10 //results
11 printf(' difference in temperature of water= %1f C'
        ,t)
```

Scilab code Exa 5.2 chapter 5 example 2

```
1 clc
2 //initialisations
3 t1=327//c
```

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

Scilab code Exa 5.3 chapter 5 example 3

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

Scilab code Exa 5.4 chapter 5 example 4

```
1 clc
2 //initialisations
3 c=1000
4 t=1//c
5 f=1//f
```

```
6 J=4.18//j/cal
7 g=9.8//m/sec2
8 //CALCULATIONS
9 h=c*t*J/g
10 h1=h*f*5/9
11 //results
12 printf(' height pf waterfall to rasie 1 c= %1f m',h
   )
13 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

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

Scilab code Exa 6.5 chapter 6 example 5

```
1 clc
2 //initialisation
3 T=273//k
4 m=35.5//kg
5 r=8314.3//j/mol/k
6 //CALCULATIONs
```

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

Scilab code Exa 6.6 chapter 6 example 6

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

Scilab code Exa 6.7 chapter 6 example 7

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

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

Scilab code Exa 6.8 chapter 6 example 8

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

Scilab code Exa 6.9 chapter 6 example 9

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

Scilab code Exa 6.10 chapter 6 example 10

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

Scilab code Exa 6.11 chapter 6 example 11

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

Scilab code Exa 6.12 chapter 6 example 12

```

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

```

Scilab code Exa 6.13 chapter 6 example 13

```

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

```

Scilab code Exa 6.14 chapter 6 example 14

```

1  clc
2  //initialisation

```

```

3 m=40 //kg
4 v=22.4 //m^-3
5 n=2.1*10^-5
6 r=8314 //j/mol/k
7 T=273 //k
8 //CALCULATIONS
9 d=m/v
10 c=sqrt(3*r*T/m)
11 l=(3*n)/(d*c)
12 f=c/l
13 //results
14 printf(' mean freepath= %1e m',l)
15 printf(' \ncollision frequency= %1f ',f)

```

Scilab code Exa 6.15 chapter 6 example 15

```

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

```

Scilab code Exa 6.19 chapter 6 example 19

```

1 clc
2 //initialisation
3 f=5
4 r=2

```

```

5 //CALCULATIONS
6 e=f/2
7 g=r/2
8 p=g*100/e
9 //results
10 printf(' fraction used to increase rotational energy
    = % 1f ',p)

```

Scilab code Exa 6.20 chapter 6 example 20

```

1 clc
2 //initialisation
3 s1=1//m/sec
4 s2=2//m/sec
5 s3=3//m/sec
6 s4=4//m/sec
7 s5=5//m/sec
8 n1=4
9 n2=2
10 n3=8
11 n4=6
12 n5=5
13 //CALCULATIONS
14 u=(n1*s1+n2*s2+n3*s3+n4*s4+n5*s5)/(n1+n2+n3+n4+n5)
15 v=sqrt((n1*s1*s1+n2*s2*s2+n3*s3*s3+n4*s4*s4+n5*s5*s5
    )/(n1+n2+n3+n4+n5))
16 //results
17 printf(' mean speed of molecules= % 1f m/sec ',u)
18 printf(' \nrms speed of molecules= % 1f m/sec ',v)

```

Chapter 7

continuity of state

Scilab code Exa 7.1 chapter 7 example 1

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

Scilab code Exa 7.2 chapter 7 example 2

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



```

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

```

Scilab code Exa 7.7 chapter 7 example 7

```

1 clc
2 //initialisation
3 a=0.0072
4 b=0.002
5 p=1
6 v=1
7 t=273//k
8 //CALCULATIONS
9 R=((p+(a/(v*v)))*(v-b))/t
10 Tc=(8*a)/(27*R*b)
11 TC=Tc-t
12 Tb=3.375*Tc
13 TB=Tb-t
14 //results
15 printf(' critical temperature of Co2= %1f c',TC)
16 printf(' \nboyle temperature of Co2= %1f k',Tb)

```

Scilab code Exa 7.8 chapter 7 example 8

```

1 clc
2 //initialisation
3 a=0.0072//pa cc^2
4 b=0.002
5 p1=76*13.6*980

```

```

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

```

Scilab code Exa 7.9 chapter 7 example 9

```

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

```

Scilab code Exa 7.10 chapter 7 example 10

```
1  clc
2  //initialisation
3  m=2*10^-3 //kg
4  R=8.31 //j/mol/k
5  p=2*10^5
6  v=8.2*10^-4
7  a=0.136 //pa m^6
8  M=28*10^-3 //kg/
9  //CALCULATIONS
10 t=(p*v*M)/(R*m)
11 T=(M/(m*R))*(p+(m*m*a/(M*M*v*v)))*(v-(m*b/M))
12 //results
13 printf(' \n temperature for a perfect gas= %1f k',t
14        )
15 printf(' \n temperature for vanderwaals gas= %1f k'
16        ,T)
```

Scilab code Exa 7.11 chapter 7 example 11

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

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

Scilab code Exa 7.12 chapter 7 example 12

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

Chapter 8

thermodynamics

Scilab code Exa 8.1 chapter 8 example 1

```
1  clc
2  //initialisation of variables
3  Q=50//cal
4  W=20//cal
5  Qi=36//cal
6  Wi=-13//cal
7  ui=10//cal
8  ub=22//cal
9  //CALCULATIONS
10 du=Q-W
11 Wibf=Qi-du
12 Qfi=du+Wi
13 Uf=du+ui
14 Qbf=Uf-ub
15 //results
16 printf(' \n Wibf= % 1f cal',Wibf)
17 printf(' \n Qfi= % 1f cal',Qfi)
18 printf(' \n Uf= % 1f cal',Uf)
19 printf(' \n Qbf= % 1f cal',Qbf)
```

Scilab code Exa 8.2 chapter 8 example 2

```
1 clc
2 //initialisation of variables
3 g=1.4
4 T1=15+273//k
5 r=2
6 p=2//atm
7 r1=0.5
8 //CALCULATIONS
9 T2=T1*r^(g-1)
10 t2=T1*r1^((g-1)/g)
11 //results
12 printf(' \n final temperature= % 1f k',T2)
13 printf(' \n temperature= % 1f k',t2)
```

Scilab code Exa 8.3 chapter 8 example 3

```
1 clc
2 //initialisation of variables
3 r=1/20
4 p1=1//atm
5 g=1.4
6 T1=273//k
7 //CALCULATIONS
8 p2=p1/r
9 pad=p2^g
10 T2=T1*((1/r)^(g-1))
11 dt=T2-T1
12 //RESULTS
13 printf(' \n pressure required= % 1f atm',p2)
```

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

Scilab code Exa 8.4 chapter 8 example 4

```
1 clc
2 //initialisation of variables
3 R=8400//j/mole
4 T1=273//k
5 g=1.66
6 r=2
7 //CALCULATIONS
8 T2=T1*r^(g-1)
9 w=(R*(T1-T2))/(22400*(g-1))
10 wi=R*T1*log(1/r)/22400
11 //results
12 printf(' \n amount of work done= % 1f J ',w)
13 printf(' \n isothermal work done= % 1f J ',wi)
```

Scilab code Exa 8.5 chapter 8 example 5

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

Scilab code Exa 8.6 chapter 8 example 6

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

Scilab code Exa 8.7 chapter 8 example 7

```
1 clc
2 //initialisation of variables
3 n=0.5
4 n1=0.6
5 T2=27+273//k
6 //CALCULATIONS
7 T1=T2/(1-n)
8 T=T2/(1-n1)
9 dt=T-T1
10 //results
11 printf(' \n source temperature must be raised by= %1f c',dt)
```

Scilab code Exa 8.8 chapter 8 example 8

```
1 clc
2 //initialisation of variables
3 w=100 //watt
4 T2=100+273 //k
5 T1=273 //k
6 L=80000 //cal/kg
7 //CALCULATIONS
8 dt=T2-T1
9 Q1=T2*w/dt
10 m=(Q1-w)*60/(4.2*L)
11 //results
12 printf(' \n mass of ice melts in 1 min= % 1f kg ',m)
```

Scilab code Exa 8.9 chapter 8 example 9

```
1 clc
2 //initialisation of variables
3 L=80000 //cal/kg
4 T1=27+273 //k
5 T2=0+273 //k
6 //CALCULATIONS
7 Q1=T1*L/T2
8 w=4.2*(Q1-L)
9 c=L/(Q1-L)
10 //results
11 printf(' \n coefficient of performance= % 1f ',c)
```

Scilab code Exa 8.10 chapter 8 example 10

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

Scilab code Exa 8.11 chapter 8 example 11

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

Scilab code Exa 8.12 chapter 8 example 12

```
1 clc
```

```

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

```

Scilab code Exa 8.13 chapter 8 example 13

```

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

```

Scilab code Exa 8.14 chapter 8 example 14

```

1 clc
2 //initialisation of variables
3 dt=0.5//c
4 L=80000*4.2//J/kg
5 T=273//k
6 dv=0.000091//m^3

```

```

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

```

Scilab code Exa 8.15 chapter 8 example 15

```

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

```

Scilab code Exa 8.16 chapter 8 example 16

```

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

```

Scilab code Exa 8.17 chapter 8 example 17

```
1 clc
2 //initialisation of variables
3 dp=(100-1)*1.01*10^5
4 L=24500//J
5 T=600//k
6 d2=11010
7 d1=10650
8 //CALCULATIONS
9 dv=(1/d2)-(1/d1)
10 dT=dp*T*dv/L
11 mp=T+(-dT)
12 //results
13 printf(' \n new melting point= % f c ',mp)
```

Scilab code Exa 8.18 chapter 8 example 18

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

Scilab code Exa 8.19 chapter 8 example 19

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

Scilab code Exa 8.20 chapter 8 example 20

```
1 clc
2 //initialisation of variables
3 m=0.1//kg
4 v=1.01*10^-4//m^3
5 vs=0.167404//m^3
6 t1=101//c
7 t2=99//c
8 p1=0.788//m
9 p2=0.7337//m
10 T=373//k
11 //CALCULATIONS
12 v1=v/m
13 v2=vs/m
14 dv=v2-v1
15 dt=t1-t2
16 dp=p1-p2
```

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

Scilab code Exa 8.21 chapter 8 example 21

```
1 clc
2 //initialisation of variables
3 T1=1100//k
4 T3=200//k
5 r=0.5
6 //CALCULATIONS
7 T=(T1-(T3*r))/(1+r)
8 //results
9 printf(' \n value of T= % 1f k',T)
```

Scilab code Exa 8.22 chapter 8 example 22

```
1 clc
2 //initialisation of variables
3 T2=500//k
4 T1=1000//k
5 //CALCULATIONS
6 r=1-(T2/T1)
7 x=T1/r
8 //results
9 printf(' \n value of x= % 1f k',x)
```

Scilab code Exa 8.23 chapter 8 example 23

```

1  clc
2  //initialisation of variables
3  T1=900//k
4  T2=300//k
5  Q1=10^6//cal
6  //CALCULATIONS
7  r=(1-(T2/T1))
8  r1=r*100
9  w=r*Q1
10 w1=w*4.2//J
11 w2=w1/(3.6*10^6)
12 w3=w1/(1.609*10^-19)
13 //results
14 printf(' \n efficiency= % 1f ',r1)
15 printf(' \n work in KWH= % 1f KWH',w2)
16 printf(' \n work in ev= % 1e ev',w3)

```

Scilab code Exa 8.24 chapter 8 example 24

```

1  clc
2  //initialisation of variables
3  T2=300///k
4  T1=900//k
5  T3=600//k
6  Q2=15000//k.cal
7  Q1=12000//k.cal
8  //CALCULATIONS
9  na=1-(T2/T1)
10 nb=1-(T2/T3)
11 w1=Q1*na
12 w2=Q2*nb
13 //results
14 printf(' \n w1= % 1f kcal',w1)
15 printf(' \n w2= % 1f kcal',w2)

```

Scilab code Exa 8.25 chapter 8 example 25

```
1 clc
2 //initialisation of variables
3 l=420 //m
4 g=9.81 //m/sec^2
5 c=1000
6 //CALCULATIONS
7 dt=(g*l)/(c*4.2)
8 //results
9 printf(' \n difference in temperature= %1f c',dt)
```

Scilab code Exa 8.26 chapter 8 example 26

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

Scilab code Exa 8.27 chapter 8 example 27

```
1 clc
2 //initialisation of variables
```

```

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

```

Scilab code Exa 8.28 chapter 8 example 28

```

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

```

Scilab code Exa 8.29 chapter 8 example 29

```

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

```

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

Chapter 9

entropy

Scilab code Exa 9.1 chapter 9 example 1

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

Scilab code Exa 9.2 chapter 9 example 2

```
1  clc
2  //initialisation of variables
3  m=0.001//kg
4  l=80000//cal/kg
5  T1=273//k
```

```

6 T2=373//k
7 s=1000
8 l1=540000//cal/kg
9 //CALCULATIONS
10 ds=(m*l/T1)+(m*s*log(T2/T1))+(m*l1/T2)
11 //results
12 printf(' change in entropy = % 1f cal/k',ds)

```

Scilab code Exa 9.3 chapter 9 example 3

```

1 clc
2 //initialisation of variables
3 m=0.001//kg
4 s=500//cal/kg
5 li=80000//cal/kg
6 l1=540000//cal/kg
7 T1=273//k
8 T2=263//k
9 T3=373//k
10 s1=1000//cal/kg
11 //CALCULATIONS
12 d1=m*s*log(T1/T2)
13 d2=m*li/T1
14 d3=m*s1*log(T3/T1)
15 d4=m*l1/T3
16 d5=d4+d3+d2+d1
17 //results
18 printf(' increase in entropy = % 1f cal/k',d5)

```

Scilab code Exa 9.4 chapter 9 example 4

```

1 clc
2 //initialisation of variables

```

```

3 m1=0.08//kg
4 m2=0.12//kg
5 t1=20//c
6 t2=50//c
7 T1=t1+273//k
8 T2=t2+373//k
9 s=1000//cal/kg
10 //CALCULATIONS
11 t=(m2*t2+m1*t1)/(m1+m2)
12 T3=t+273
13 s1=m1*s*log(T3/T1)
14 s2=m2*s*log(T3/T2)
15 ds=s1+s2
16 //results
17 printf(' change in entropy of universe = % 1f cal/k'
,ds)

```

Scilab code Exa 9.6 chapter 9 example 6

```

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

```

Scilab code Exa 9.7 chapter 9 example 7

```

1 clc
2 //initialisation of variables
3 m=1//kg

```

```

4 c=1000
5 T1=273//k
6 T2=50+273//k
7 l=571700//cal/kg
8 //CALCULATIONS
9 ds=m*c*log(T2/T1)+m*l/T2
10 //results
11 printf(' difference in entropy = %1f cal per degree
        c ',ds)

```

Scilab code Exa 9.8 chapter 9 example 8

```

1 clc
2 //initialisation of variables
3 m=0.01//kg
4 T1=800//k
5 T2=500//k
6 T3=400//k
7 s1=60//cal/kg/k
8 s2=70//cal/kg/k
9 l=14000//cal/kg
10 //CALCULATIONS
11 ds=m*s1*log(T2/T3)+m*l/T2+m*s2*log(T1/T2)
12 //results
13 printf(' change in entropy = %1f cal/k',ds)

```

Scilab code Exa 9.9 chapter 9 example 9

```

1 clc
2 //initialisation of variables
3 c1=0.08
4 c2=0.003
5 c3=0.1

```

```

6 T2=100//k
7 T1=50//k
8 //CALCULATIONS
9 r1=c1*(T2-T1)
10 r2=(c2/2)*(T2^2-T1^2)
11 r3=c3*log(T2/T1)
12 ds=5*(r1-r2-r3)
13 //results
14 printf(' change in entropy = % 1f cal/k',ds)

```

Scilab code Exa 9.10 chapter 9 example 10

```

1 clc
2 //initialisation
3 st=1.75
4 sw=0.30
5 t=100//c
6 T=273+t//k
7 //CALCULATIONS
8 L=T*(st-sw)
9 //results
10 printf('\n specific latent heat of steam= % 1f cal/
gm',L)

```

Scilab code Exa 9.11 chapter 9 example 11

```

1 clc
2 //initialisation
3 r=3
4 n=2
5 R=8314
6 //CALCULATIONS
7 ds=2.3026*n*R*log(r)

```



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

Scilab code Exa 9.13 chapter 9 example 13

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

Scilab code Exa 9.14 chapter 9 example 14

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

Scilab code Exa 9.15 chapter 9 example 15

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

Scilab code Exa 9.16 chapter 9 example 16

```
1 clc
2 //initialisation
3 i=3//amp
4 r=10//ohm
5 t=27//c
6 T=273+t//k
7 //CALCULATIONS
8 dq1=0
9 ds1=dq1/T
10 dq2=i*i*r
11 ds2=dq2/T
12 //results
13 printf(' \n change in entropy of resistor= % 1f j/k',
    ,ds1)
14 printf(' \n change in entropy of universe= % 1f j/k',
    ,ds2)
```

Scilab code Exa 9.17 chapter 9 example 17

```
1 clc
2 //initialisation of variables
3 m1=1//gm
4 m2=28
5 cv=0.18
6 T2=373//k
7 T1=323//k
8 //CALCULATIONS
9 ds=m1*cv*log(T2/T1)/m2
10 //results
11 printf(' change in entropy = %1f cal/k',ds)
```

Scilab code Exa 9.18 chapter 9 example 18

```
1 clc
2 //initialisation of variables
3 T1=40//k
4 T2=120//k
5 c1=0.076
6 c2=0.00026
7 c3=0.15
8 //CALCULATIONS
9 r1=c1*(T2-T1)
10 r2=(c2/2)*(T2^2-T1^2)
11 r3=c3*log(T2/T1)
12 ds=5*(r1-r2-r3)
13 //results
14 printf(' change in entropy = %1f cal/k',ds)
```

Chapter 10

thermodynamic relations

Scilab code Exa 10.7 chapter 10 example 7

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

Scilab code Exa 10.8 chapter 10 example 8

```
1  clc
2  //initialisation
3  T=5+273//k
```

```

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

```

Scilab code Exa 10.13 chapter 10 example 13

```

1 clc
2 //initialisation
3 dq=540000
4 dv=1.676
5 T1=373//k
6 T2=423//k
7 p1=1//pa
8 //CALCULATIONS
9 dt=T2-T1
10 dp=(dt*dq*4.2)/(dv*T1)
11 p2=p1+(dp/10^5)
12 //results
13 printf('\n required pressure= %1f pa',p2)

```

Chapter 11

production of low temperature

Scilab code Exa 11.2 chapter 11 example 2

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

Scilab code Exa 11.3 chapter 11 example 3

```
1 clc
2 //initialisation
```

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

Chapter 12

transmission of heat

Scilab code Exa 12.1 chapter 12 example 1

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

Scilab code Exa 12.2 chapter 12 example 2

```
1 clc
2 //initialisation
3 m=96//gm
4 m1=5//gm
5 t1=37//c
6 t2=10//c
```



```

7 l=10 //cm
8 t=4*60 //s
9 a=5 //cm^2
10 dt=24 //c
11 //CALCULATIONS
12 k=m*(t1-t2)/(a*t*dt)
13 h1=m1*540
14 h2=m*(t1-t2)
15 dh=h1-h2
16 p=dh*100/h1
17 //results
18 printf(' \n thermal conductivity= % 1f cgs units ',k)
19 printf(' \n percentage of heat loss= % 1f ',p)

```

Scilab code Exa 12.3 chapter 12 example 3

```

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

```

Scilab code Exa 12.4 chapter 12 example 4

```

1  clc
2  //initialisation
3  a=25//sq.mt
4  aw=5//sq.mt
5  dt=30//c
6  t=60*60//sec
7  l=0.3//m
8  br=0.12
9  gl=0.25
10 l1=0.03//cm
11 //CALCULATIONS
12 A=4*a-aw
13 hb=(br*A*dt*t)/(1*1000)
14 hw=(gl*aw*dt*t)/(11*100)
15 tot=hb+hw
16 //results
17 printf(' \n total heat passing per hour= % 1f k.cal'
        ,tot)

```

Scilab code Exa 12.5 chapter 12 example 5

```

1  clc
2  //initialisation
3  k1=0.252
4  k2=0.05
5  t1=273//k
6  t2=285//k
7  l1=0.0175//m
8  l2=0.02//m
9  //CALCULATIONS
10 t=((k1/l1)*t1+(k2/l2)*t2)/(k1/l1+k2/l2)
11 //results
12 printf(' \n temperature of interface= % 1f k',t)

```

Scilab code Exa 12.6 chapter 12 example 6

```
1 clc
2 //initialisation
3 cu=104
4 w=0.14
5 l1=50//cm
6 t=0.0001//m
7 t1=100//c
8 t2=0//c
9 //CALCULATIONS
10 x=cu*t*100/w
11 l=l1+2*x
12 dt=t1-t2
13 dg=dt/l
14 d1=x*dg
15 d2=t1-d1
16 //results
17 printf(' \n temperature gradient= %1f c/cm',dg)
18 printf(' \n temperature of one end= %1f c',d1)
19 printf(' \n temperature of other end= %1f c',d2)
```

Scilab code Exa 12.7 chapter 12 example 7

```
1 clc
2 //initialisation
3 m=4800//g
4 lice=80//cal/g
5 a=3600//sq.cm
6 t1=100//c
7 t2=0//c
8 t=10//cm
```

```

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

```

Scilab code Exa 12.8 chapter 12 example 8

```

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

```

Scilab code Exa 12.9 chapter 12 example 9

```

1 clc
2 //initialisation
3 r2=0.5
4 r1=0.4
5 l=30//cm
6 q=(500*10)/60
7 t=100//c

```

```

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

```

Scilab code Exa 12.10 chapter 12 example 10

```

1 clc
2 //initialisations
3 t2=162 //c
4 t1=62 //c
5 l=0.15 //m
6 d=0.02 //m
7 k=226 //watt per kelvin metre
8 //CALCULATIONS
9 r=d/2
10 a=3.14*r*r
11 p=2*3.14*r
12 x=(log(t2/t1))/l
13 e=(x*x*k*a)/p
14 //results
15 printf(' \n surface emissivity of rod= %1f ',e)

```

Scilab code Exa 12.11 chapter 12 example 11

```

1 clc
2 //initialisation
3 t1=5.6 //c
4 t2=2.8 //c

```

```

5 t3=0.7 // c
6 d1=2 // m
7 d2=4 // m
8 d3=8 // m
9 w=(2*3.14)/365
10 //CALCULATIONS
11 d=(log(t1/t2))/(d2/d1)
12 k=w*1000/(d*d)
13 //results
14 printf( '\n diffusivity= % 1f m^2 per day',k)

```

Scilab code Exa 12.12 chapter 12 example 12

```

1 clc
2 //initialisation
3 kcu=0.93 //cal per sec per cm per c
4 t=700
5 //CALCULATIONS
6 khell=t*kcu
7 kmks=khell*100
8 ksi=4.2*khell
9 //results
10 printf( '\n conductivity= % 1f cal per sec per cm
           per c',khell)
11 printf( '\n conductivity= % 1f cal per sec per m per
           c',kmks)
12 printf( '\n conductivity= % 1f watt per m per k',ksi
           )

```

Chapter 14

radiation of heat

Scilab code Exa 14.1 chapter 14 example 1

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

Scilab code Exa 14.2 chapter 14 example 2

```
1 clc
2 //initialisation
3 t1=573//k
4 t2=273//k
5 m=0.032//kg
6 s=100
```

```

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

```

Scilab code Exa 14.3 chapter 14 example 3

```

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

```

Scilab code Exa 14.4 chapter 14 example 4

```

1 clc
2 //initialisation
3 t1=500//k
4 t2=300//k
5 m=10//kg
6 s=100//cal/kg/k
7 r=0.07//m

```



```

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

```

Scilab code Exa 14.5 chapter 14 example 5

```

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

```

Scilab code Exa 14.6 chapter 14 example 6

```

1 clc
2 //initialisation
3 E=40//w
4 r=0.00005//m
5 l=0.1//m

```

```

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

```

Scilab code Exa 14.7 chapter 14 example 7

```

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

```

Scilab code Exa 14.8 chapter 14 example 8

```

1 clc
2 //initialisation
3 t=6000//k
4 r=17000
5 //CALCULATIONS
6 T=6000*17000^0.25
7 //results
8 printf( '\n temperature of the star= %1f k',T)

```

Scilab code Exa 14.9 chapter 14 example 9

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

Scilab code Exa 14.10 chapter 14 example 10

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

Scilab code Exa 14.11 chapter 14 example 11

```

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

```

Scilab code Exa 14.12 chapter 14 example 12

```

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

```

Chapter 15

elements of statistical mechanics

Scilab code Exa 15.1 chapter 15 example 1

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

Scilab code Exa 15.2 chapter 15 example 2

```
1 clc
2 //initialisation
3 n=5
```

```

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

```

Scilab code Exa 15.3 chapter 15 example 3

```

1 clc
2 //initialisation
3 n=12
4 p=2
5 //CALCULATIONS
6 t=n/p
7 a=factorial(n)/(factorial(t)*factorial(n-t)*p^n)
8 //results
9 printf(' \n probability= % 1f ',a)

```

Scilab code Exa 15.4 chapter 15 example 4

```

1 clc
2 //initialisation
3 n=10
4 a=0.6
5 h=0
6 //CALCULATIONS
7 b=1-a
8 p=factorial(n)*a^10/(factorial(n-h)*factorial(h))
9 //results

```

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

Scilab code Exa 15.5 chapter 15 example 5

```
1 clc
2 //initialisation
3 n=400
4 a1=300
5 b1=100
6 a2=200
7 b2=200
8 r=2
9 //CALCULATIONS
10 p1=factorial(n)/(factorial(a1)*factorial(b1)*r^n)
11 p2=factorial(n)/(factorial(a2)*factorial(b2)*r^n)
12 w=p1/p2
13 //results
14 printf(' \n ratio of probabilities= % 1e ',w)
```

Scilab code Exa 15.6 chapter 15 example 6

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

```

10 b4=7
11 //CALCULATIONS
12 a=a1+a2+a3+a4
13 x=a1*b1+a2*b2+a3*b3+a4*b4
14 p2=a1/a
15 p6=a2/a
16 p16=a3/a
17 d=x/a
18 //results
19 printf( '\n probability of state 2= % 1f ',p2)
20 printf( '\n probability of state 6= % 1f ',p6)
21 printf( '\n probability of state 16= % 1f ',p16)
22 printf( '\n value of <x>= % 1f ',d)

```

Scilab code Exa 15.9 chapter 15 example 9

```

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

```

Scilab code Exa 15.10 chapter 15 example 10

```

1 clc
2 //initialisation
3 t1=301//k

```



```

4 t2=300//k
5 f=5*(10^30)
6 fa=f/2
7 //CALCULATIONS
8 r=t1/t2
9 i=r^fa
10 //results
11 printf(' \sigma(E) increases by a factor r^fa ')
12 printf(' \n r= % 1f ',r)
13 printf(' \n fa= % 1f ',fa)

```

Scilab code Exa 15.11 chapter 15 example 11

```

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

```

Scilab code Exa 15.14 chapter 15 example 14

```

1 clc
2 //initialisation
3 p=0.76*9.81*13600
4 dv=10^-5//m3
5 k=1.38*10^-23
6 t=300//k
7 //CALCULATIONS
8 r=(p*dv)/(k*t)
9 //results

```

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

Chapter 16

classical and quantum statistics

Scilab code Exa 16.2 chapter 16 example 2

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

Scilab code Exa 16.5 chapter 16 example 5

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

```

5 m=9.1*10^-31 //kg
6 gs=2
7 //CALCULATIONS
8 a=(h*h/(2*m))*((3*r/(4*3.14*gs))^(2/3))
9 //results
10 printf( '\n fermi energy= % 1e ',a)

```

Scilab code Exa 16.10 chapter 16 example 10

```

1 clc
2 //initialisation
3 t=300 //k
4 e=0.01 //v
5 //CALCULATIONS
6 a=1/((exp(e/t))+1)
7 //results
8 printf( '\n NFD= % 1f ',a)

```

Scilab code Exa 16.11 chapter 16 example 11

```

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

```

