

Scilab Textbook Companion for
Heat and Thermodynamics
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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 | 4 |
| 1 THERMOMETRY | 5 |
| 2 EXPANSION | 12 |
| 3 CALORIMETRY | 16 |
| 4 CHANGE OF STATE | 25 |
| 5 NATURE OF HEAT | 33 |
| 6 THERMODYNAMICS | 50 |
| 8 TRANSMISSION OF HEAT | 82 |
| 9 STATISTICAL THERMODYNAMICS | 91 |
| 10 Appendix 2 | 93 |

List of Scilab Codes

| | | |
|----------|----------------------------|----|
| Exa 1.1 | Temperature | 5 |
| Exa 1.2 | Temperature | 5 |
| Exa 1.3 | Temperature | 6 |
| Exa 1.4 | Temperature | 6 |
| Exa 1.5 | Temperature | 7 |
| Exa 1.6 | Temperature | 7 |
| Exa 1.7 | Temperature | 8 |
| Exa 1.8 | Temperature | 9 |
| Exa 1.9 | Temperature | 9 |
| Exa 1.10 | Temperature | 10 |
| Exa 1.11 | Temperature | 11 |
| Exa 2.1 | Expansion | 12 |
| Exa 2.2 | Stress | 13 |
| Exa 2.3 | Tension | 13 |
| Exa 2.4 | Energy | 14 |
| Exa 2.5 | Force | 15 |
| Exa 3.1 | Time | 16 |
| Exa 3.2 | Thermal capacity | 17 |
| Exa 3.3 | Temperature | 17 |
| Exa 3.4 | Time | 18 |
| Exa 3.5 | Temperature | 19 |
| Exa 3.6 | Temperature | 20 |
| Exa 3.7 | Thermal constant | 21 |
| Exa 3.8 | Gas constant | 21 |
| Exa 3.9 | Specific heat | 22 |
| Exa 3.10 | Specific heat | 23 |
| Exa 3.11 | Efficiency | 23 |
| Exa 4.1 | Heat required | 25 |

| | | |
|----------|-----------------------------|----|
| Exa 4.2 | Amount of ice | 26 |
| Exa 4.3 | Ice | 27 |
| Exa 4.4 | Latent heat | 27 |
| Exa 4.5 | Heat removed | 28 |
| Exa 4.6 | Specific heat | 29 |
| Exa 4.7 | Specific heat | 30 |
| Exa 4.8 | Relative humidity | 31 |
| Exa 4.9 | Dew point | 31 |
| Exa 5.1 | Temperature | 33 |
| Exa 5.2 | Energy | 34 |
| Exa 5.3 | Temperature | 34 |
| Exa 5.4 | Molecules | 35 |
| Exa 5.5 | Temperature | 36 |
| Exa 5.6 | Velocity | 36 |
| Exa 5.7 | Volume | 37 |
| Exa 5.9 | Molecules | 38 |
| Exa 5.10 | Molecules | 38 |
| Exa 5.11 | Molecules | 39 |
| Exa 5.12 | Kinetic energy | 40 |
| Exa 5.13 | Kinetic energy | 41 |
| Exa 5.14 | Kinetic energy | 41 |
| Exa 5.15 | Kinetic energy | 42 |
| Exa 5.16 | Kinetic energy | 42 |
| Exa 5.17 | Velocity | 43 |
| Exa 5.18 | Speed | 44 |
| Exa 5.19 | Temperature | 44 |
| Exa 5.20 | Temperature | 45 |
| Exa 5.21 | Mean free path | 45 |
| Exa 5.22 | Mean free path | 46 |
| Exa 5.23 | Mean free path | 47 |
| Exa 5.24 | Mean free path | 47 |
| Exa 5.25 | Van der Waals | 48 |
| Exa 6.1 | Heat | 50 |
| Exa 6.2 | Temperature | 51 |
| Exa 6.3 | Temperature | 52 |
| Exa 6.4 | Temperature | 52 |
| Exa 6.5 | Temperature | 53 |
| Exa 6.6 | Temperature | 53 |

| | | |
|----------|--------------------------------|----|
| Exa 6.7 | Pressure | 54 |
| Exa 6.8 | Efficiency | 55 |
| Exa 6.9 | Efficiency | 56 |
| Exa 6.10 | Temperature | 56 |
| Exa 6.11 | Work done | 57 |
| Exa 6.12 | Work done | 58 |
| Exa 6.13 | Performance | 58 |
| Exa 6.14 | Temperature | 59 |
| Exa 6.15 | Efficiency | 60 |
| Exa 6.16 | Power | 61 |
| Exa 6.17 | Temperature | 61 |
| Exa 6.18 | Temperature | 62 |
| Exa 6.19 | Temperature | 63 |
| Exa 6.20 | Temperature | 64 |
| Exa 6.21 | Temperature | 64 |
| Exa 6.22 | Temperature | 65 |
| Exa 6.23 | Temperature | 66 |
| Exa 6.24 | Pressure | 67 |
| Exa 6.25 | Latent heat | 68 |
| Exa 6.26 | Temperature | 69 |
| Exa 6.28 | Pressure | 70 |
| Exa 6.29 | Entropy | 70 |
| Exa 6.30 | Entropy | 71 |
| Exa 6.31 | Entropy | 72 |
| Exa 6.32 | Entropy | 73 |
| Exa 6.33 | Entropy | 73 |
| Exa 6.34 | Entropy | 74 |
| Exa 6.35 | Entropy | 75 |
| Exa 6.36 | Entropy | 76 |
| Exa 6.37 | Entropy | 77 |
| Exa 6.42 | Pressure | 78 |
| Exa 6.43 | Pressure | 79 |
| Exa 6.44 | Specific heat | 79 |
| Exa 6.45 | Specific heat | 80 |
| Exa 8.1 | Conductivity of iron | 82 |
| Exa 8.2 | Heat | 82 |
| Exa 8.3 | Heat | 83 |
| Exa 8.4 | Temperature | 84 |

| | | |
|-----------|-----------------------------------|-----|
| Exa 8.5 | Time | 84 |
| Exa 8.6 | Time | 85 |
| Exa 8.7 | Rate of energy transfer | 86 |
| Exa 8.8 | Radiant | 87 |
| Exa 8.9 | Emittance | 87 |
| Exa 8.10 | Rate of heat transfer | 88 |
| Exa 8.11 | Energy radiated | 89 |
| Exa 8.12 | Temperature | 89 |
| Exa 8.13 | Temperature | 90 |
| Exa 9.1 | Relative probabilities | 91 |
| Exa 10.1 | Kinetic energy | 93 |
| Exa 10.2 | Temperature | 93 |
| Exa 10.3 | Avogadro number | 94 |
| Exa 10.4 | Mean free path | 95 |
| Exa 10.6 | Mean free path | 95 |
| Exa 10.7 | Pressure | 96 |
| Exa 10.8 | Gas | 97 |
| Exa 10.9 | Work done | 97 |
| Exa 10.10 | temperature | 98 |
| Exa 10.11 | Temperature | 99 |
| Exa 10.12 | Efficiency | 99 |
| Exa 10.13 | Efficiency | 100 |
| Exa 10.14 | Work done | 101 |
| Exa 10.15 | Efficiency | 101 |
| Exa 10.16 | Entropy | 102 |
| Exa 10.17 | Entropy | 103 |
| Exa 10.18 | Entropy | 104 |
| Exa 10.19 | Entropy | 104 |
| Exa 10.20 | Entropy | 105 |
| Exa 10.21 | Temperature | 106 |
| Exa 10.22 | Entropy | 107 |
| Exa 10.23 | Entropy | 107 |
| Exa 10.24 | Temperature | 108 |
| Exa 10.25 | Specific heat | 108 |
| Exa 10.26 | Temperature | 109 |
| Exa 10.27 | Index | 110 |
| Exa 10.28 | Radius | 111 |
| Exa 10.29 | Temperature | 112 |

| | | |
|-----------|----------------|-----|
| Exa 10.30 | Temperature | 112 |
| Exa 10.31 | Temperature | 113 |
| Exa 10.32 | Energy | 113 |
| Exa 10.33 | Energy | 114 |
| Exa 10.34 | Pressure | 115 |
| Exa 10.35 | Energy | 116 |
| Exa 10.36 | Temperature | 116 |
| Exa 10.37 | Temperature | 117 |
| Exa 10.38 | Energy | 118 |
| Exa 10.39 | mass | 118 |
| Exa 10.40 | Speed | 119 |
| Exa 10.41 | Heat | 120 |
| Exa 10.42 | Fermi energy | 121 |
| Exa 10.43 | Heat | 121 |
| Exa 10.44 | Pressure | 122 |
| Exa 10.47 | Mean Free path | 123 |
| Exa 10.48 | Collision | 124 |
| Exa 10.49 | Entropy | 124 |
| Exa 10.50 | Temperature | 125 |
| Exa 10.51 | Work done | 126 |
| Exa 10.52 | Temperature | 126 |
| Exa 10.53 | Work done | 127 |
| Exa 10.54 | Power | 128 |
| Exa 10.55 | Temperature | 128 |
| Exa 10.56 | Temperature | 129 |
| Exa 10.57 | Temperature | 130 |
| Exa 10.58 | Entropy | 131 |
| Exa 10.59 | Entropy | 131 |
| Exa 10.60 | Entropy | 132 |
| Exa 10.61 | Time | 133 |
| Exa 10.62 | Temperature | 134 |
| Exa 10.63 | Heat | 135 |
| Exa 10.64 | Radiant | 136 |
| Exa 10.65 | Radiant | 136 |

Chapter 1

THERMOMETRY

Scilab code Exa 1.1 Temperature

```
1  clc
2  clear
3  //Input data
4  C=6500; //Temperature of the surface of the sun in
           degrees centigrade
5
6  //Calculations
7  K=((C/100)*(100))+273; //Temperature of the surface
           of the sun in Kelvin
8  R=((C/100)*180)+492; //Temperature of the surface of
           the sun in degree Rankine
9
10 //Output
11 printf('The temperature of the surface of the sun
           corresponding to 6500 degrees centigrade is \n\n
           (1)%3.0f Kelvin and (2)%3.0f degree Rankine',K,R)
```

Scilab code Exa 1.2 Temperature

```

1  clc
2  clear
3  //Input data
4  C=-183;//The normal boiling point of liquid oxygen
    in degrees centigrade
5
6  //Calculations
7  K=((C/100)*100)+273;//The normal boiling point of
    liquid oxygen in Kelvin
8  R=((C/100)*180)+492;//The normal boiling point of
    liquid oxygen in degree Rankine
9
10 //Output data
11 printf('The boiling point of liquid oxygen
    corresponding to -183 degree centigrade is \n\n
    (1)%3.0f Kelvin and (2)%3.1f degree Rankine',K,R)

```

Scilab code Exa 1.3 Temperature

```

1  clc
2  clear
3  //Calculations
4  x=((273*180) - (32*100))/80;//The temperature at which
    Kelvin and Fahrenheit scale coincide in Kelvin
    and degree Fahrenheit
5
6  //Output
7  printf('The temperature at which Kelvin and
    Fahrenheit coincide is %3.2f degree',x)

```

Scilab code Exa 1.4 Temperature

```

1  clc

```

```

2 clear
3 //Calculations
4 x=(-(32*100))/80;//The temperature at which degree
    centigrade and Fahrenheit scale coincide in
    degree centigrade and degree Fahrenheit
5
6 //Output
7 printf('The temperature at which degree centigrade
    and Fahrenheit coincide is %3.0f degree',x)

```

Scilab code Exa 1.5 Temperature

```

1 clc
2 clear
3 //Input data
4 K=20.2;//The normal boiling point of liquid hydrogen
    in Kelvin
5
6 //Calculations
7 R=((K-273)/100)*180+492;//The normal boiling point
    of liquid hydrogen in degree Rankine
8
9 //Output data
10 printf('The boiling point of liquid hydrogen
    corresponding to 20.2 Kelvin is %3.2f degree
    Rankine',R)

```

Scilab code Exa 1.6 Temperature

```

1 clc
2 clear
3 //Input data

```

```

4 V=1000; //Volume of the bulb of the callendar 's
    compensated constant pressure air thermometer in
    cm^3
5 v=100; //Volume of mercury drawn out of the reservoir
    in cm^3
6
7 //Calculations
8 t=((v)/(V-v))*273; //The temperature of the bath in
    degree centigrade
9
10 //Output data
11 printf('The temperature of the bath on the celsius
    scale is %3.2f degree centigrade',t)

```

Scilab code Exa 1.7 Temperature

```

1 clc
2 clear
3 //Input data
4 Pt=100; //Pressure of air when the bulb is placed in
    hot water in cm of Hg
5 P100=109.3; //Pressure of air in a constant volume
    thermometer at 100 degree centigrade in cm of Hg
6 P0=80; //Pressure of air in a constant volume
    thermometer at 0 degree centigrade in cm of Hg
7
8 //Calculations
9 t=((Pt-P0)/(P100-P0))*100; //The temperature of the
    hot water in degree centigrade
10
11 //Output data
12 printf('The temperature of the hot water is %3.2f
    degree centigrade',t)

```

Scilab code Exa 1.8 Temperature

```
1  clc
2  clear
3  //Input data
4  P0=76; //The pressure in the bulb at 0 degree
      centigrade in cm of Hg
5  Pt=152+P0; //The excess pressure in the bulb in cm of
      Hg
6  T0=273; //Temperature in K
7
8  //Calculations
9  T=(Pt/P0)*T0; //The temperature of the furnace in
      Kelvin
10 T1=T-273; //The temperature of the furnace in degree
      centigrade
11
12 //Output data
13 printf('The temperature of the furnace T = %3.0f
      Kelvin = %3.0f degree centigrade ',T,T1)
```

Scilab code Exa 1.9 Temperature

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

```

6 Rt=5.795; //The resistance of the platinum wire when
   both the thermometers are inserted in a hot bath
   in ohms
7 P0=100; //The pressure at ice point in cm of Hg
8 P100=136.6; //The pressure at steam point in cm of Hg
9 Pt=131.11; //The pressure of the gas in cm of Hg
10
11 //Calculations
12 Tp=((Rt-R0)/(R100-R0))*100; //The temperature of the
   bath on the platinum scale in degree centigrade
13 T=((Pt-P0)/(P100-P0))*100; //The temperature of the
   bath on the gas scale in degree centigrade
14
15 //Output data
16 printf('The temperature of the bath , \n (1)On the
   platinum scale is %3.2f degree centigrade \n (2)
   On the gas scale is %3.0f degree centigrade',Tp,T
   )

```

Scilab code Exa 1.10 Temperature

```

1 clc
2 clear
3 //Input data
4 t1=50; //Temperature on platinum scale in degree
   centigrade
5 t11=50.25; //Temperature on gas scale in degree
   centigrade
6 t2=150; //Temperature on gas scale in degree
   centigrade
7
8 //Calculations
9 g=(t1-t11)/((t1/100)^2-(t1/100));
10 x=t2-(g*((t2/100)^2-(t2/100))); //The temperature on
   the platinum scale corresponding to 150 degrees

```

```

    centigrade on gas scale in degree centigrade
11
12 //Output data
13 printf('The temperature on the platinum scale is %3
    .2f degree centigrade ',x)

```

Scilab code Exa 1.11 Temperature

```

1  clc
2  clear
3  //Input data
4  R0=5.5; //The resistance of a platinum wire at 0
    degree centigrade in ohms
5  R100=7.5; //The resistance of a platinum wire at 100
    degree centigrade in ohms
6  R444=14.5; //The resistance of a platinum wire at
    444.5 degree centigrade in ohms
7
8  //Calculations
9  b=((900-(2*444.6))/(5.5*444.6*100*344.6)); //The
    value of beta in per degree centigrade square
10 a=(2/(5.5*100))-(100*(b)); //The value of alpha in
    per degree centigrade
11
12 //Output
13 printf('The values are b = %3.4g /degree centigrade
    square \n    and a = %3g /degree centigrade ',b,a)

```

Chapter 2

EXPANSION

Scilab code Exa 2.1 Expansion

```
1  clc
2  clear
3  //Input data
4  l=1; //The thickness of the crystal in cm
5  w=5890d-8; //The wavelength of light used in cm
6  t2=50; //The final temperature of the crystal in
    degree centigrade
7  t1=20; //The initial temperature of the crystal in
    degree centigrade
8  p=14; //The number of fringes that crossed the field
    of view
9
10 //Calculations
11 t=t2-t1; //The temperature difference in degree
    centigrade
12 a=(p*w)/(2*l*t); //The coefficient of linear
    expansion of the crystal in per degree centigrade
13
14 //output
15 printf('The coefficient of linear expansion of the
    crystal is %3.4g /degree centigrade',a)
```

Scilab code Exa 2.2 Stress

```
1 clc
2 clear
3 //Input data
4 L=500;//The length of a steel rod in cm
5 t=40;//The increase in temperature in degree
   centigrade
6 y=2*1012;//The youngs modulus of elasticity of
   steel in dynes/cm2
7 e=12*10-6;//The coefficient of linear expansion of
   steel in per degree centigrade
8
9 //Calculations
10 S=y*e*t;//The stress in the rod in dynes/cm2
11
12 //Output
13 printf('The stress in the rod is %3g dynes/cm2',S)
```

Scilab code Exa 2.3 Tension

```
1 clc
2 clear
3 //Input data
4 L=800;//The length of the wire in cm
5 r=0.2;//The radius of the wire in cm
6 t=10;//The temperature fall in degree centigrade
7 a=12*10-6;//The coefficient of linear expansion of
   steel wire in per degree centigrade
8 y=2*1012;//The youngs modulus of elasticity of
   steel in dynes/cm2
```

```

9 pi=(22/7); //Mathematical constant pi
10
11 // Calculations
12 I=y*a*t*pi*r^2; //The increase in tension in dynes
13
14 //Output
15 printf('The increase in tension is %3g dynes',I)

```

Scilab code Exa 2.4 Energy

```

1 clc
2 clear
3 //Input data
4 A=2*10^-6; //The cross section area of a uniform rod
   in m^2
5 t=20; //The change in temperature in degree
   centigrade
6 y=10^11; //The youngs modulus of the rod in newtons/m
   ^2
7 a=12*10^-6; //The coefficient of linear expansion of
   rod in per degree centigrade
8
9 // Calculations
10 F=y*a*t*A; //The force required to prevent it from
   expanding in newtons
11 E=(1/2)*y*a*t*a*t; //The energy stored per unit
   volume in j/m^3
12
13 //Output
14 printf('The force required to prevent the rod from
   expanding is %3.0f newtons \n The Energy stored
   per unit volume is %3.0f j/m^3',F,E)

```

Scilab code Exa 2.5 Force

```
1  clc
2  clear
3  //Input data
4  d=10^-3; //The diameter of a steel wire in m
5  t=20; //The difference in the temperature in degree
      centigrade
6  y=2*10^11; //The youngs modulus of a steel wire in
      newtons/m^2
7  a=12*10^-6; //The coefficient of linear expansion of
      steel wire in per degree centigrade
8  pi=(22/7); //Mathematical constant value
9
10 //calculations
11 A=(pi*d^2)/4; //The cross sectional area of the steel
      wire in m^2
12 F=(y*a*t*A)/(9.8); //Force required to maintain the
      original length in kg wt
13
14 //output
15 printf('Force required to maintain the original
      length is %3.3f kg wt ',F)
```

Chapter 3

CALORIMETRY

Scilab code Exa 3.1 Time

```
1  clc
2  clear
3  //Input data
4  T=5; //Time taken for a liquid to cool from 80 to 50
      degree centigrade in minutes
5  t11=80; //The initial temperature of the liquid in
      degree centigrade
6  t12=50; //The final temperature of the liquid in
      degree centigrade
7  t21=60; //If the initial temperature of the liquid in
      degree centigrade
8  t22=30; //If the final temperature of the liquid in
      degree centigrade
9  ts=20; //The temperature of the surrounding in degree
      centigrade
10
11 // Calculations
12 T1=((log((t22-ts)/(t21-ts)))/(log((t12-ts)/(t11-ts)))
      )*T; //The time taken for the liquid to cool from
      60 to 30 degree centigrade in minutes
13
```

```

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

```

Scilab code Exa 3.2 Thermal capacity

```

1  clc
2  clear
3  //Input data
4  dw=1; //The density of water in g/cm^3
5  da=0.8; //The density of alcohol in g/cm^3
6  t1=100; //The time taken for the water to cool from
    50 to 40 degree centigrade in seconds
7  t2=74; //The time taken for the alcohol to cool from
    50 to 40 degree centigrade in seconds
8  V=1; //Let the volume of either liquid be in cm^3
9
10 //Calculations
11 m=V*dw; //The mass of water in g
12 M=V*da; //The mass of alcohol in g
13 w=V; //Water equivalent of each calorimeter in cm^3
14 C=(((m+w)*t2)/(M*t1))-(w/M); //The specific heat of
    alcohol in calorie/g-K
15
16 //Output
17 printf('The specific heat of alcohol is C = %3.1f
    calorie/g-K',C)

```

Scilab code Exa 3.3 Temperature

```

1  clc
2  clear

```

```

3 //Input data
4 t=5;//Time taken for a body to cool from 60 to 40
   degree centigrade in minutes
5 t11=60;//The initial temperature of the body in
   degree centigrade
6 t12=40;//The final temperature of the body in degree
   centigrade
7 ts=10;//The temperature of the surrounding in degree
   centigrade
8
9 //Calculations
10 K=log((t12-ts)/(t11-ts));//The constant value for
   the first case at ts
11 x=((exp(K))*(t12-ts))+ts;//The temperature after the
   next 5 minutes in degree centigrade
12
13 //Output
14 printf('The temperature after the next 5 minutes is
   x = %3.0f degree centigrade ',x)

```

Scilab code Exa 3.4 Time

```

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

```

```

9  ts=25; //The temperature of the surrounding in degree
    centigrade
10
11 //Calculations
12 T1=((log((t22-ts)/(t21-ts)))/(log((t12-ts)/(t11-ts)))
    ))*T; //The time taken for the liquid to cool from
    50 to 40 degree centigrade in minutes
13
14 //Output
15 printf('The time taken for a liquid to cool from 50
    to 40 degree centigrade is t = %3.3f minutes ',T1
    )

```

Scilab code Exa 3.5 Temperature

```

1  clc
2  clear
3  //Input data
4  t=6; //Time taken for a liquid to cool from 80 to 60
    degree centigrade in minutes
5  T=10; //To find the temperature after the time in
    minutes
6  t11=80; //The initial temperature of the liquid in
    degree centigrade
7  t12=60; //The final temperature of the liquid in
    degree centigrade
8  ts=30; //The temperature of the surrounding in degree
    centigrade
9
10 //Calculations
11 K=(log((t12-ts)/(t11-ts)))/(-t); //The constant value
    for the first case at ts
12 x=((exp(-T*K))*(t12-ts))+ts; //The temperature after
    the next 10 minutes in degree centigrade
13

```



```

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

```

Scilab code Exa 3.6 Temperature

```

1  clc
2  clear
3  //Input data
4  t=5; //The time taken for a body to cool from 80 to
    64 degree centigrade in minutes
5  t11=80; //The initial temperature of the body in
    degree centigrade
6  t12=64; //The final temperature of the body in degree
    centigrade
7  t21=52; //The temperature of the body after 10
    minutes in degree centigrade
8  T=10; //The time taken for a body to cool from 80 to
    52 degree centigrade in minutes
9  T1=15; //To find the temperature after the time in
    minutes
10
11 //Calculations
12 ts=((t21*t11)-(t12^2))/(t11+t21-(2*t12)); //The
    temperature of the surroundings in degree
    centigrade
13 K=(log((t21-ts)/(t12-ts))); //The constant value for
    the first case at ts
14 x=((exp(K))*(t21-ts))+ts; //The temperature after the
    next 15 minutes in degree centigrade
15
16 //Output
17 printf('(1)The temperature of the surroundings is %3
    .0f degree centigrade \n (2)The temperature after
    the 15 minutes is %3.0f degree centigrade ',ts,x)

```

)

Scilab code Exa 3.7 Thermal constant

```
1 clc
2 clear
3 //Input data
4 t2=2; //The time taken for the liquid to cool from 50
      to 40 degree centigrade in minutes
5 t11=50; //The initial temperature of the liquid in
      degree centigrade
6 t12=40; //The final temperature of the liquid in
      degree centigrade
7 t1=5; //The time taken for the water to cool from 50
      to 40 degree centigrade in minutes
8 m=100; //The mass of water in gms
9 M=85; //The mass of liquid in gms
10 w=10; //Water equivalent of the vessel in gms
11
12 //Calculations
13 C=((m+w)*(t2*60))/(M*(t1*60))-(w/M); //The specific
      heat of a liquid in calories/g-K
14
15 //Output
16 printf('The specific heat of a liquid is C = %3.1f
      calories/g-K',C)
```

Scilab code Exa 3.8 Gas constant

```
1 clc
2 clear
3 //Input data
```

```

4 V=22400; //The volume of One gram molecule of a gas
   at N.T.P in cm^3
5 p=76; //The pressure in cm of Hg
6 T=273; //The temperature in K
7
8 //Calculations
9 P=p*13.6*981; //The pressure in dynes/cm^2
10 R=(P*V)/T; //The universal gas constant for one gram
   molecule of a gas in ergs/mole-K
11
12 //Output
13 printf('The universal gas constant for one gram
   molecule of a gas is R = %3.4g ergs/mole-K',R)

```

Scilab code Exa 3.9 Specific heat

```

1 clc
2 clear
3 //Input data
4 Cp=0.23; //Specific heat of air at constant pressure
5 J=4.2*10^7; //The amount of energy in ergs/cal
6 d=1.293; //The density of air at N.T.P in g/litre
7 p=76; //The pressure in cm of Hg
8 T=273; //The temperature in K
9
10 //Calculations
11 P=p*13.6*980; //The pressure in dynes/cm^2
12 V=(1000/d); //Volume of one gram of air at N.T.P in
   cm^3
13 r=(P*V)/T; //The gas constant for one gram of a gas
   in ergs/g-K
14 Cv=Cp-(r/J); //Specific heat of air at constant
   volume
15
16 //Output

```

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

Scilab code Exa 3.10 Specific heat

```
1 clc
2 clear
3 //Input data
4 w=4;//The Molecular weight of helium
5 v=22400;//The volume of one gram molecule of a gas
    at N.T.P in cm^3
6 p=76;//The pressure in cm of Hg
7 T=273;//The temperature in K
8 J=4.2*10^7;//The amount of energy in ergs/cal
9
10 //Calculations
11 V=(v/w);//The volume of one gram of helium at N.T.P
    in cm^3
12 P=p*13.6*980;//The pressure in dynes/cm^2
13 r=(P*V)/T;//The gas constant for one gram of a gas
    in ergs/g-K
14 C=r/J;//The difference in the two specific heats of
    one gram of helium
15
16 //Output
17 printf('The difference in the two specific heats of
    one gram of helium is Cp-Cv = %3.4f ',C)
```

Scilab code Exa 3.11 Efficiency

```
1 clc
2 clear
3 //Input data
```

```
4 V=25; //Volume of gasoline consumed by an engine in
    litres/hour
5 cv=6*10^6; //The calorific value of gasoline in
    calories/litre
6 P=35; //The output of the engine in kilowatts
7
8 //Calculations
9 h=V*cv; //Total heat produced by gasoline in one hour
    in calories
10 H=h/3600; //Heat produced per second in cal/s
11 I=H*4.2; //Heat produced per second in joules/s or
    watts
12 E=((P*1000)/I)*100; //The efficiency in percent
13
14 //Output
15 printf('The efficiency of the engine is %3.0f
    percent ',E)
```

Chapter 4

CHANGE OF STATE

Scilab code Exa 4.1 Heat required

```
1  clc
2  clear
3  //Input data
4  m=1000; //Mass of Ice in gms
5  Sp=0.5; //Specific heat of Ice in cal/g-K
6  t1=-10; //Initial temperature of Ice in degree
   centigrade
7  t2=0; //The final temperature of Ice in degree
   centigrade
8  Li=80; //Latent heat of fusion of ice in cal per
   gram
9  Ls=540; //Latent heat of fusion of steam in cal per
   gram
10
11 //Calculations
12 h1=m*-t1*Sp; //Heat required to raise the temperature
   of Ice in cal
13 h2=m*Li; //Heat required to melt ice at 0 degree
   centigrade in cal
14 h3=m*100; //Heat required to raise the temperature of
   water from 0 to 100 degree centigrade in cal
```

```

15 h4=m*Lv; //Heat required to convert water into steam
    at 100 degree centigrade in cal
16 T=h1+h2+h3+h4; //Total quantity of heat required in
    cal
17
18 //Output
19 printf('Total quantity of heat required is %3.0f
    cal ',T)

```

Scilab code Exa 4.2 Amount of ice

```

1  clc
2  clear
3  //Input data
4  m=1; //Mass of steam in gms
5  Lv=537; //Latent heat of fusion of steam in cal per
    gram
6  mi=100; //mass of ice in gms
7  Li=80; //Latent heat of fusion of ice in cal per gram
8
9  //Calculations
10 h1=m*Lv; //Heat given out by one gram of steam when
    converted from steam into water at 100 degree
    centigrade in cal
11 h2=1*100; //Heat given out by one gram of water when
    cooled from 100 to 0 degree centigrade in cal
12 h=h1+h2; //Total quantity of heat given out by one
    gram of steam in cal
13 m=h/Li; //The amount of Ice melted in gms
14
15 //Output
16 printf('The amount of Ice melted is m = %3.2f gms ',
    m)

```

Scilab code Exa 4.3 Ice

```
1  clc
2  clear
3  //Input data
4  m=100; //Mass of water in gms
5  tw=40; //The temperature of water in degree
      centigrade
6  mi=52; //Mass of Ice in gms
7  Lw=100; //Latent heat of fusion of water in cal's per
      gram
8  Li=80; //Latent heat of fusion of Ice in cal's per
      gram
9
10 //Calculations
11 h=Lw*tw; //Heat lost by water when its temperature
      falls from 40 to 0 degree centigrade in cal's
12 hi=mi*Li; //Heat gained by Ice in cal's
13 hg=h; //The amount of heat gained by Ice in cal's
14 ml=(hg/Li); //The amount of Ice melted in gms
15 M=mi-ml; //The amount of ice remaining in gms
16 W=m+(mi-M); //The amount of water in gms
17
18 //Output
19 printf('The remaining Ice is %3.0f g \n Hence the
      result will be %3.0f g of Ice and %3.0f g of
      water at 0 degree centigrade ',M,M,W)
```

Scilab code Exa 4.4 Latent heat

```
1  clc
2  clear
```



```

3 //Input data
4 m=100; //Let the mass of water in gms
5 t=15; //Time taken for an electric kettle to heat a
      certain quantity of water from 0 to 100 degree
      centigrade in minutes
6 T=80; //Time taken to turn all the water at 100
      degree centigrade into steam in minutes
7 Lw=100; //Latent heat of fusion of water in cal/s per
      gram
8
9 //Calculations
10 h1=m*Lw; //Heat required to raise its temperature
      from 0 to 100 degree centigrade in cal/s
11 h2=h1; //Heat produced by electric kettle in 15
      minutes in cal/s
12 h3=h2/15; //Heat produced by electric kettle in 1
      minute in cal/s
13 h4=h3*80; //Heat produced by electric kettle in 80
      minutes in cal/s
14 L=h4/m; //Latent heat of steam in cal/g
15
16 //Output
17 printf('The latent heat of steam is L = %3.2f cal/g
      ',L)

```

Scilab code Exa 4.5 Heat removed

```

1 clc
2 clear
3 //Input data
4 m=50; //Mass of water in gms
5 t1=15; //Initial temperature in degree centigrade
6 t2=-20; //Final temperature in degree centigrade
7 Sp=0.5; //Specific heat of Ice in cal/g-K
8 Li=80; //Latent heat of fusion of Ice in cal/s per

```

```

        gram
9
10 // Calculations
11 h1=m*1*t1;//Heat removed in cooling water from 15 to
    0 degree centigrade in cal
12 h2=m*Li;//Heat removed in converting water into Ice
    at 0 degree centigrade in cal
13 h3=m*Sp*-t2;//Heat removed in cooling ice from 0 to
    -20 degree centigrade in cal
14 H=h1+h2+h3;//Total heat removed in one hour in cal
15 H1=H/60;//Heat removed per minute in cal/minute
16
17 //Output
18 printf('The Quantity of heat removed per minute is
    %3.1f cal/minute ',H1)

```

Scilab code Exa 4.6 Specific heat

```

1  clc
2  clear
3  //Input data
4  M=20;//Mass of the substance in g
5  t=100;//The temperature of the substance in degree
    centigrade
6  a=1/100;//Area of cross section in cm^2
7  l=5;//The length of the coloumn through which liquid
    moves in cm
8  V1=1000;//The volume of water in cm^3
9  V2=1090;//The volume of Ice from the volume of water
    on freezing in cm^3
10 Li=80;//Latent heat of Ice in cal per gram
11
12 // Calculations
13 V=V2-V1;//The decrease in volume of Ice in cm^3
14 Vi=V/1000;//The decrease in volume when one gram of

```

```

    ice melts in cm^3
15 v=l*a;//Decrease in volume in cm^3
16 S=(Li*v)/(Vi*M*t);//Specific heat of the substance
    incal/g degree centigrade
17
18 //Output
19 printf('The specific heat of the substance is %3.3f
    cal/g.degree centigrade ',S)

```

Scilab code Exa 4.7 Specific heat

```

1  clc
2  clear
3  //Input data
4  M=27;//The mass of the substance in g
5  t=100;//The temperature of the substance in degree
    centigrade
6  a=3/100;//Area of cross section in cm^2
7  l=10;//The length of the coloumn through which
    liquid moves in cm
8  Li=80;//Latent heat of Ice in cal per gram
9  V1=1000;//The volume of water in cm^3
10 V2=1090;//The volume of Ice from the volume of water
    on freezing in cm^3
11
12 //Calculations
13 v=l*a;//Decrease in volume in cm^3
14 V=V2-V1;//The decrease in volume of Ice in cm^3
15 Vi=V/1000;//The decrease in volume when one gram of
    ice melts in cm^3
16 S=(Li*v)/(Vi*M*t);//Specific heat of the substance
    incal/g degree centigrade
17
18 //Output
19 printf('The specific heat of the substance is %3.3f

```

cal/g.degree centigrade ',S)

Scilab code Exa 4.8 Relative humidity

```
1  clc
2  clear
3  //Input data
4  t=16.5; //The temperature of air in degree centigrade
5  d=6.5; //The dew point in degree centigrade
6  s1=7.05; //S.V.P at 6 degree centigrade in mm
7  s2=7.51; //S.V.P at 7 degree centigrade in mm
8  s3=13.62; //S.V.P at 16 degree centigrade in mm
9  s4=14.42; //S.V.P at 17 degree centigrade in mm
10
11 //Calculations
12 s5=(s1+s2)/2; //S.V.P at 6.5 degree centigrade in mm
13 s6=(s3+s4)/2; //S.V.P at 16.5 degree centigrade in mm
14 R=(s5/s6)*100; //Relative humidity of air in percent
15
16 //Output
17 printf('The percentage relative humidity of air is R
        .H = %3.1f percent ',R)
```

Scilab code Exa 4.9 Dew point

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

```
7 s2=9.2; //S.V.P of water at 10 degree centigrade in
   mm
8 s3=8.6; //S.V.P of water at 9 degree centigrade in mm
9
10 // Calculations
11 s4=(R/100)*s1; //S.V.P at dew point in mm
12 s5=s2-s3; //S.V.P for 1 degree centigrade difference
   in mm
13 d=9+((s4-s3)/(s2-s3)); //The dew point temperature in
   degree centigrade
14
15 //Output
16 printf('The dew point temperature is %3.2f degree
   centigrade ',d)
```

Chapter 5

NATURE OF HEAT

Scilab code Exa 5.1 Temperature

```
1  clc
2  clear
3  //Input data
4  v=480; //The velocity of a lead bullet in m/s
5  Sp=0.03; //Specific heat of lead cal/g-K
6
7  //Calculations
8  m=10; //Let us assume the mass of bullet in gms
9  V=v*100; //The velocity of the bullet in cm/s
10 W=(1/2)*m*(V^2); //The work done in ergs
11 J=4.2*10^7; //The mechanical equivalent of heat in
    ergs/calorie
12 H=W/J; //The amount of heat produced in cal
13 H1=H/2; //Half of the heat energy is used to raise
    the temperature of the bullet in cal
14 t=H1/(m*Sp); //The rise in the temperature in degree
    centigrade
15
16 //Output
17 printf('The rise in the temperature is t = %3.2f
    degree centigrade ',t)
```

Scilab code Exa 5.2 Energy

```
1 clc
2 clear
3 //Input data
4 t=1;//The increase in the temperature of a piece of
   aluminium in degree centigrade
5 a=6*10^23;//The number of atoms present in 27 g of
   aluminium in atoms
6 Sp=0.22;//The specific heat of aluminium in cal/g-K
7 m=27;//The amount of aluminium in g
8 J=4.2*10^7;//The mechanical equivalent of heat in
   ergs/calorie
9
10 //Calculations
11 H=m*Sp*t;//Heat required to raise the temperature of
   27 gms of aluminium by 1 degree centigrade in
   cal
12 E=m*Sp*J;//Energy gained by atoms of aluminium in
   ergs
13 E1=E/a;//Increase in energy per atom of aluminium in
   ergs
14
15 //Output
16 printf('The increase in energy per atom of aluminium
   is %3.4g ergs ',E1)
```

Scilab code Exa 5.3 Temperature

```
1 clc
2 clear
```

```

3 //Input data
4 h=50;//The height from which water falls in metres
5 m=100;//Let us assume the mass of the water in gms
6 g=980;//Gravitational constant in gms/s^2
7 J=4.2*10^7;//The mechanical equivalent of heat in
   ergs/calorie
8
9 //Calculations
10 h1=h*100;//The height from which water falls in cm
11 W=m*g*h1;//The work done in ergs
12 t=W/(J*m);//The rise in temperature of water in
   degree centigrade
13
14 //Output
15 printf('The rise in temperature of water is t = %3.3
   f degree centigrade ',t)

```

Scilab code Exa 5.4 Molecules

```

1 clc
2 clear
3 //Input data
4 v=1;//The volume of oxygen at N.T.P in cm^3
5 d=13.6;//The density of mercury in g/cm^3
6 r=4.62*10^4;//The R.M.S velocity of oxygen molecules
   at 0 degree centigrade in cm/s
7 m=52.8*10^-24;//Mass of one molecule of oxygen in g
8 g=980;//Gravitational constant in gms/s^2
9
10 //Calculations
11 P=76*g*d;//The pressure in dynes/cm^2
12 n=((3*P)/(m*r^2));//Number of molecules in 1 cc of
   oxygen at N.T.P
13
14 //Output

```



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

Scilab code Exa 5.5 Temperature

```
1 clc
2 clear
3 //Input data
4 t=-100;//The given temperature in degree centigrade
5
6 //Calculations
7 T1=t+273;//The given temperature in K
8 m1=1;//number of hydrogen molecules
9 m2=16;//number of oxygen molecules
10 m=m2/m1;//Number of oxygen molecules to the hydrogen
    molecules
11 T2=(T1*m)-273;//The temperature in degree centigrade
12
13 //Output
14 printf('The temperature at which the oxygen
    molecules have the same root mean square velocity
    \n as that of hydrogen molecules is T2 = %3.0 f
    degree centigrade ',T2)
```

Scilab code Exa 5.6 Velocity

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

```

8 D=0.000089; //The density of hydrogen at N.T.P in g/
  cc
9 T=273; //The temperature at N.T.P in K
10
11 //Calculations
12 P=76*g*d; //The pressure in dynes/cm^2
13 p=m1*D; //The density of oxygen at N.T.P in g/cc
14 C=((3*P)/(p))^(1/2); //The RMS velocity of oxygen
  molecule in cm/s
15 T1=t+T; //The given temperature in K
16 C1=C*(T1/T)^(1/2); //The RMS velocity of the
  molecules at 27 degree centigrade in cm/s
17
18 //Output
19 printf('The RMS velocity of the oxygen molecules at
  27 degree centigrade is C1 = %3.4g cm/s ',C1)

```

Scilab code Exa 5.7 Volume

```

1 clc
2 clear
3 //Input data
4 d=13.6; //The density of mercury in g/cm^3
5 g=980; //Gravitational constant in gms/s^2
6 m=3.2; //Mass of oxygen in gms
7 t=27; //The given temperature in degree centigrade
8 p=76; //The pressure in cm of Hg
9 R=8.31*10^7; //The Universal gas constant in ergs/g
  mol-K
10
11 //Calculations
12 P=p*g*d; //The given pressure in dynes/cm^2
13 T=t+273; //The given temperature in K
14 V=(T*R)/P; //Volume per g mol of oxygen in cc per g
  mol

```

```

15 m1=32; //Molecular weight of Oxygen
16 V1=V*(m/m1); //Volume of 3.2 g of oxygen in cc
17
18 //Output
19 printf('The Volume occupied by 3.2 gms of Oxygen is
      V = %3.0f cc ',V1)

```

Scilab code Exa 5.9 Molecules

```

1  clc
2  clear
3  //Input data
4  v=1; //The volume of an Ideal gas at N.T.P in m^3
5  d=13.6; //The density of mercury in g/cm^3
6  g=980; //Gravitational constant in gms/s^2
7  p=76; //The pressure in cm of Hg
8  R=8.31*10^7; //The Universal gas constant in ergs/g
      mol-K
9  N=6.023*10^23; //The Avogadro number
10 T=273; //The temperature at N.T.P in K
11
12 //Calculations
13 P=p*g*d; //The given pressure in dynes/cm^2
14 x=(P*N*10^6)/(R*T); //Number of molecules in one
      cubic metre volume
15
16 //Output
17 printf('The number of molecules in one cubic metre
      of an ideal gas at N.T.P is x = %3.4g ',x)

```

Scilab code Exa 5.10 Molecules

```

1  clc

```

```

2 clear
3 //Input data
4 v=1; //The volume of an ideal gas in litre
5 d=13.6; //The density of mercury in g/cm^3
6 g=980; //Gravitational constant in gms/s^2
7 p=76; //The pressure in cm of Hg
8 R=8.31*10^7; //The Universal gas constant in ergs/g
   mol-K
9 N=6.023*10^23; //The Avogadro number
10 T=273; //The temperature at N.T.P in K
11 t=136.5; //The given temperature in degree centigrade
12 p1=3; //The given atmospheric pressure in atm
   pressure
13
14 //Calculations
15 T1=T+t; //The given temperature in K
16 P=p*g*d; //The given pressure in dynes/cm^2
17 x=(p1*P*N*10^3)/(R*T1); //Number of molecules in one
   litre volume
18
19 //Output
20 printf('The number of molecules in one litre of an
   ideal gas volume is x = %3.4g ',x)

```

Scilab code Exa 5.11 Molecules

```

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

```

```

    mol-K
10 N=6.023*10^23; //The Avogadro number
11 T=273; //The temperature at N.T.P in K
12 n1=2.7*10^19; //The number of molecules per cc of gas
    at N.T.P
13 t2=0; //The given temperature in degree centigrade
14 t3=39; //The given temperature in degree centigrade
15
16 // Calculations
17 P1=p1*g*d; //The given pressure in dynes/cm^2
18 P2=p2*g*d; //The given pressure in dynes/cm^2
19 n2=n1*(P2/P1); //The number of molecules per cc of
    the gas at 0 degree centigrade
20 T2=t2+273; //The given temperature in K
21 T3=t3+273; //The given temperature in K
22 n3=n2*(T2/T3); //The number of molecules per cc of
    the gas at 398 degree centigrade
23
24 //Output
25 printf('The number of molecules per cc of the gas ,
    \n (1)at 0 degree centigrade and 10^-6 mm
    pressure of mercury is n2 = %3.4g \n (2)at 39
    degree centigrade and 10^-6 mm pressure of
    mercury is n3 = %3.4g',n2,n3)

```

Scilab code Exa 5.12 Kinetic energy

```

1 clc
2 clear
3 //Input data
4 T=300; //The given temperature in K
5 R=8.3*10^7; //The Universal gas constant in ergs/g
    mol-K
6
7 // Calculations

```

```

8 E=((3/2)*(R*T))/10^7;//The total random kinetic
   energy per gram -molecule of oxygen in joules
9
10 //Output
11 printf('The total random kinetic energy of one gm-
   molecule of oxygen at 300 K is K.E = %3.0f joules
   ',E)

```

Scilab code Exa 5.13 Kinetic energy

```

1 clc
2 clear
3 //Input data
4 T=300;//The given temperature in K
5 k=1.38*10^-16;//Boltzmann constant in erg/molecule-
   deg
6
7 //Calculations
8 E=(3/2)*k*T;//The average Kinetic energy of a
   molecule in ergs
9
10 //Output
11 printf('The Average Kinetic energy of a molecule of
   a gas at 300 K is K.E = %3.4g ergs ',E)

```

Scilab code Exa 5.14 Kinetic energy

```

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

```

```

7
8 // Calculations
9 T=273+t; //The given temperature in K
10 k=R/N; //Boltzmann constant in joules/mol-K
11 E=(3/2)*k*T; //Mean translational kinetic energy per
    molecule in joules
12
13 //Output
14 printf('The mean translational kinetic energy per
    molecule is K.E = %3.4g joule ',E)

```

Scilab code Exa 5.15 Kinetic energy

```

1 clc
2 clear
3 //Input data
4 T=300; //The given temperature in K
5 M=28; //Molecular weight of nitrogen in g
6 R=8.3*10^7; //The Universal gas constant in ergs/g
    mol-K
7
8 // Calculations
9 E=(3/2)*R*T; //The total random kinetic energy of
    nitrogen in ergs
10 E1=E/(M*10^7); //The total random kinetic energy of
    one gram of nitrogen at 300 K in joule
11
12 //Output
13 printf('The total random kinetic energy of one gram
    of nitrogen at 300 K is K.E = %3.1f joule ',E1)

```

Scilab code Exa 5.16 Kinetic energy

```

1  clc
2  clear
3  //Input data
4  T=200; //The given temperature in K
5  m=2; //Given mass of Helium in g
6  M=4; //Molecular weight of helium in g
7  R=8.3*10^7; //The Universal gas constant in ergs/g
      mol-K
8
9  //Calculations
10 E=(m*(3/2)*(R*T)/(M))/10^7; //The energy for 2 g of
      helium in joules
11
12 //Output
13 printf('The total random kinetic energy of 2 g of
      helium at 200 K is K.E = %3.0f joules ',E)

```

Scilab code Exa 5.17 Velocity

```

1  clc
2  clear
3  //Input data
4  T=300; //The given temperature in K
5  R=8.3*10^7; //The Universal gas constant in ergs/g
      mol-K
6  M=221; //The molecular weight of mercury
7
8  //Calculations
9  C=((3*R*T)/(M))^(1/2); //The root mean square
      velocity of a molecule of mercury vapour at 300 K
      in cm/s
10
11 //Output
12 printf('The root mean square velocity of a molecule
      of mercury vapour at 300 K is C = %3.4g cm/s ',C)

```

Scilab code Exa 5.18 Speed

```
1 clc
2 clear
3 //Input data
4 T=300;//The given temperature in K
5 M=32;//Molecular weight of oxygen
6 R=8.3*10^7;//The Universal gas constant in ergs/g
   mol-K
7
8 //Calculations
9 E=(3/2)*R*T;//Total random kinetic energy of 1 g
   molecule of oxygen in ergs
10 v=((E)*(2/M))^(1/2);//The required speed of one gram
   molecule of oxygen in cm/s
11
12 //Output
13 printf('The required speed of one gram molecule of
   oxygen is v = %3.2g cm/s ',v)
```

Scilab code Exa 5.19 Temperature

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

```

8 //Calculations
9 V=v*10^5;//The speed of the earths first satellite
   in cm/s
10 T=(M*V^2)/(3*R);//The temperature at which it
   becomes equal in K
11
12 //Output
13 printf('The temperature at which the r.m.s velocity
   of a hydrogen molecule \n will be equal to the
   speed of earths first satellite is T = %3.4g K',T
   )

```

Scilab code Exa 5.20 Temperature

```

1 clc
2 clear
3 //Input data
4 t1=0;//The given temperature in degree centigrade
5
6 //Calculations
7 T1=t1+273;//The given temperature in K
8 T2=(1/2)^2*T1;//The temperature at which the r.m.s
   velocity of a gas be half its value at 0 degree
   centigrade in K
9 T21=T2-273;//The required temperature in degree
   centigrade
10
11 //Output
12 printf('The required temperature is T2 = %3.2f K (
   or) %3.2f degree centigrade ',T2,T21)

```

Scilab code Exa 5.21 Mean free path

```

1  clc
2  clear
3  //Input data
4  n=1.66*10-4; //The viscosity of the gas in dynes/cm
      ^2
5  C=4.5*104; //The R.M.S velocity of the molecules in
      cm/s
6  d=1.25*10-3; //The density of the gas in g/cc
7  N=6.023*1023; //The Avogadro number
8  V=22400; //The volume of a gas at N.T.P in cc
9  pi=3.142; //The mathematical constant of pi
10
11 //Calculations
12 L=(3*n)/(d*C); //The mean free path of the molecules
      of the gas in cm
13 F=(C/L); //The frequency collision in per sec
14 n=N/V; //Number of molecules per cc
15 D=1/((1.414*pi*n*L)(1/2)); //Molecular diameter of
      the gas molecules in cm
16
17 //Output
18 printf('(1)The mean free path of the molecules of
      the gas is %3.0g cm \n (2)The frequency of
      collision is N = %3.0g /sec \n (3)Molecular
      diameter of the gas molecules is d = %3.0g cm ',L
      ,F,D)

```

Scilab code Exa 5.22 Mean free path

```

1  clc
2  clear
3  //Input data
4  n=2.25*10-4; //The viscosity of the gas in dynes/cm
      ^2
5  C=4.5*104; //The RMS velocity of the molecules in cm

```

```

        /s
6  d=10^-3; //The density of the gas in g/cc
7
8  // Calculations
9  L=(3*n)/(d*C); //The mean free path of the molecules
    in cm
10
11 //Output
12 printf('The mean free path of the molecules is %3g
    cm ',L)

```

Scilab code Exa 5.23 Mean free path

```

1  clc
2  clear
3  //Input data
4  d=2*10^-8; //The molecular diameter in cm
5  n=3*10^19; //The number of molecules per cc
6  pi=3.14; //Mathematical constant of pi
7
8  // Calculations
9  L=1/((pi*(d)^2*n)); //The mean free path of a gas
    molecule in cm
10
11 //Output
12 printf('The mean free path of a gas molecule is %3.0
    g cm ',L)

```

Scilab code Exa 5.24 Mean free path

```

1  clc
2  clear
3  //Input data

```

```

4 p=760; //The given pressure in mm of Hg
5 T=273; //The temperature of the chamber in K
6 V=22400; //The volume of the gas at N.T.P in cc
7 p1=10^-6; //The pressure in the chamber in mm of
    mercury pressure
8 N=6.023*10^23; //The Avogadro number
9 d=2*10^-8; //Molecular diameter in cm
10 pi=3.14; //Mathematical constant of pi
11
12 // Calculations
13 n=(N*p1)/(V*p); //The number of molecules per cm^3 in
    the chamber in molecules/cm^3
14 L=1/(pi*(d)^2*n); //The mean free path of the gas
    molecules in the chamber in cm
15
16 //Output
17 printf('The mean free path of gas molecules in a
    chamber is %3.4g cm ',L)

```

Scilab code Exa 5.25 Van der Waals

```

1 clc
2 clear
3 //Input data
4 Tc=132; //The given temperature in K
5 Pc=37.2; //The given pressure in atms
6 R=82.07; //Universal gas constant in cm^3 atoms K^-1
7
8 // Calculations
9 a=(27/64)*((R)^2*(Tc)^2)/Pc; //Vander Waals constant
    in atoms cm^6
10 b=((R*Tc)/(8*Pc)); //Vander Waals constant in cm^3
11
12 //Output
13 printf('The Van der Waals constants are , \n (1) a =

```

$\%3.4g \text{ atoms cm}^6 \setminus n (2) b = \%3.2f \text{ cm}^3 \text{ ', a, b)}$

Chapter 6

THERMODYNAMICS

Scilab code Exa 6.1 Heat

```
1  clc
2  clear
3  //Input data
4  H=80; //The Heat flows into the system in joules
5  W=30; //The Work done by the system in joules
6
7  //Calculations
8  U=H-W; //The internal energy of the system in joules
9  W1=10; //The work done along the path ADB in joules
10 H1=W1+U; //The heat flows into the system along the
    path ADB in joules
11 W2=-20; //The work done on the system from B to A in
    joules
12 H2=W2-U; //The heat liberated from B to A in joules
13 Ua=0; //Internal energy at A in joules
14 Ud=40; //Internal energy at D in joules
15 Wa=10; //Work done from A to D in joules
16 Wd=0; //Work done from D to B in joules
17 Uc=50; //Internal energy at C in joules
18 Had=(Ud-Ua)+Wa; //Heat absorbed in the process AD in
    joules
```

```

19 Hdb=Uc-Ud+Wd; //Heat absorbed in the process DB in
    joules
20
21 //Output
22 printf('(a)Heat flows into the system along the path
    ADB is H = %3.0f joules \n (b)The heat liberated
    by the system is H = %3.0f joules \n (c)The heat
    absorbed in the process AD is H = %3.0f joules
    and \n The heat absorbed in the process DB is
    H = %3.0f joules ',H1,H2,Had,Hdb)

```

Scilab code Exa 6.2 Temperature

```

1  clc
2  clear
3  //Input data
4  p=2; //Given Pressure of a motor car tyre in atms
5  t=27; //The room temperature in degree centigrade
6  g=1.4; //Adiabatic index
7
8  //Calculations
9  P1=p; //The pressure of a motor car tyre in atms
10 T1=t+273; //The room temperature in K
11 P2=1; //The surrounding pressure in atms
12 T2=((P2/P1)^((g-1)/g))*T1; //The resulting
    temperature in K
13 T21=T2-273; //The resulting temperature in degree
    centigrade
14
15 //Output
16 printf('The resulting temperature is T2 = %3.1f K (
    or) %3.1f degree centigrade ',T2,T21)

```

Scilab code Exa 6.3 Temperature

```
1  clc
2  clear
3  //Input data
4  t=27; //The room temperature of air in degree
        centigrade
5  g=1.4; //Adiabatic index
6
7  //Calculations
8  V1=1; //Let the Original volume in cc
9  V2=V1/2; //The final volume i.e half the original
        volume in cc
10 P1=1; //The atmospheric pressure in atms
11 P2=P1*(V1/V2)^g; //The final pressure in atms
12 T1=t+273; //The room temperature in K
13 T2=T1*(V1/V2)^(g-1); //The final temperature in K
14 T21=T2-273; //The final temperature in degree
        centigrade
15
16 //Output
17 printf('(1)The final pressure is P2 = %3.3f
        atmospheres \n (2)The final temperature is T2 =
        %3.1f K (or) %3.1f degree centigrade ',P2,T2,
        T21)
```

Scilab code Exa 6.4 Temperature

```
1  clc
2  clear
3  //Input data
4  g=1.4; //Adiabatic index
5
6  //Calculations
7  V1=1; //Let the initial volume be in cc
```

```

8 V2=V1/2; //The final volume is half the initial
   volume in cc
9 T1=1; //Let the initial temperature of air be in K
10 T2=T1*(V1/V2)^(g-1); //The final temperature of air
   in K
11 T=T2-T1; //The change in temperature of air in K
12
13 //Output
14 printf('The change in the temperature is %3.3fT1 K ',
   ,T)

```

Scilab code Exa 6.5 Temperature

```

1 clc
2 clear
3 //Input data
4 g=(5/3); //Adiabatic index for monoatomic
5 t=27; //The room temperature in degree centigrade
6 P1=1; //The initial pressure in atmosphere
7 P2=50; //The final pressure in atmosphere
8
9 //Calculations
10 T1=t+273; //The room temperature in K
11 T2=((P2/P1)^((g-1)/g))*T1; //The final temperature in
   K
12 T21=T2-273; //The final temperature in degree
   centigrade
13
14 //Output
15 printf('The Final temperature is T2 = %3.0f K (or)
   %3.0f degree centigrade ',T2,T21)

```

Scilab code Exa 6.6 Temperature

```

1  clc
2  clear
3  //Input data
4  t=27; //The temperature of dry air in degree
      centigrade
5  g=1.4; //Adiabatic index
6
7  //Calculations
8  V1=1; //Let us assume the initial volume in cc
9  V2=V1/3; //Then the final volume is 1/3 of the
      initial volume in cc
10 T1=t+273; //The initial temperature of dry air in K
11 T2=((V1/V2)^(g-1))*T1; //The final temperature of air
      in K
12 T21=T2-273; //The final temperature of air in degree
      centigrade
13 T=T21-t; //The change in temperature in degree
      centigrade
14
15 //Output
16 printf('(1)When the process is slow the temperature
      of the system remains constant so, there is no
      change in the temperature \n (2)When the
      compression is sudden then, \n The temperature of
      the air increases by T = %3.1f degree centigrade
      (or) %3.1f K',T,T)

```

Scilab code Exa 6.7 Pressure

```

1  clc
2  clear
3  //Input data
4  g=1.4; //Adiabatic index
5
6  //Calculations

```

```

7 V1=1; //Let the initial volume of the gas in cc
8 V2=3*V1; //Then the final volume of the gas is 3
    times the initial volume of the gas in cc
9 T1=273; //Initial temperature of the gas at NTP in K
10 T2=((V1/V2)^(g-1))*T1; //The resulting temperature in
    K
11 T21=T2-273; //The resulting temperature in degree
    centigrade
12 P1=1; //The atmospheric pressure in atms
13 P2=((V1/V2)^(g))*P1; //The resulting atmospheric
    pressure in atmosphere
14
15 //Output
16 printf('(1)The resulting temperature is T2 = %3.0f K
    (or) %3.0f degree centigrade \n (2)The
    resulting pressure is P2 = %3.4f atmosphere ',T2,
    T21,P2)

```

Scilab code Exa 6.8 Efficiency

```

1 clc
2 clear
3 //Input data
4 t1=100; //The temperature at steam point in degree
    centigrade
5 t2=0; //The temperature at ice point in degree
    centigrade
6
7 //Calculations
8 T1=t1+273; //The temperature at steam point in K
9 T2=t2+273; //The temperature at ice point in K
10 n=(1-(T2/T1))*100; //The efficiency of the carnots
    engine in percent
11
12 //Output

```

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

Scilab code Exa 6.9 Efficiency

```
1 clc
2 clear
3 //Input data
4 t1=127;//The temperature at initial point in degree
    centigrade
5 t2=27;//The temperature at final point in degree
    centigrade
6
7 //Calculations
8 T1=t1+273;//The temperature at initial point in K
9 T2=t2+273;//The temperature at final point in K
10 n=(1-(T2/T1))*100;//The efficiency of the carnots
    engine in percent
11
12 //Output
13 printf('The efficiency of the Carnot engine is %3.0f
    percent ',n)
```

Scilab code Exa 6.10 Temperature

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

```

7
8 // Calculations
9 T2=(H2/H1)*T1; //The temperature of the sink in K
10 n=(1-(T2/T1))*100; //The efficiency of the engine in
    percent
11
12 //output
13 printf('The temperature of the sink is T2 = %3.0f K
    \n The efficiency of the engine is %3.0f percent
    ',T2,n)

```

Scilab code Exa 6.11 Work done

```

1 clc
2 clear
3 //Input data
4 T1=450; //The temperature of the source in k
5 H1=1000; //The amount of heat taken by the engine at
    T1 in calories
6 T2=350; //The temperature of the sink in K
7
8 // Calculations
9 H2=(T2/T1)*H1; //The amount of heat rejected to the
    sink in each cycle in calories
10 n=(1-(T2/T1))*100; //The efficiency of the engine in
    percent
11 W=H1-H2; //The work done by the engine in each cycle
    in calories
12 W1=W*4.2; //The work done by the engine in each cycle
    in joules
13
14 //Output
15 printf('The amount of heat rejected to the sink in
    each cycle is H2 = %3.2f cal \n The efficiency
    of the engine is %3.2f percent \n The work done

```

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

Scilab code Exa 6.12 Work done

```
1  clc
2  clear
3  //Input data
4  T1=300; //The higher temperature of the reservoir in
      K
5  T2=260; //The lower temperature of the reservoir in K
6  H2=500; //The amount of heat from the reservoir at
      the lower temperature in calories
7
8  //Calculations
9  H1=(T1/T2)*H2; //The amount of heat rejected to the
      reservoir at the higher temperature in calories
10 W=(H1-H2)*4.2; //The amount of work done in each
      cycle to operate the refrigerator in joules
11
12 //Output
13 printf('The amount of heat rejected to the reservoir
      at the higher temperature is H1 = %3.2f cal \n
      The amount of work done in each cycle to operate
      the refrigerator is W = %3.2f joules ',H1,W)
```

Scilab code Exa 6.13 Performance

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

```

5 T1=27+273; //The higher temperature of the reservoir
   for a carnot refrigerator in K
6 H2=1000*80; //The amount of heat from the reservoir
   to the lower temperature in cal
7 J=4.2; //The one calorie in joules
8
9 //Calculations
10 H1=(T1/T2)*H2; //The amount of heat discarded to the
   room in calories
11 W=J*(H1-H2); //The work done by the refrigerator in
   joules
12 C=H2/(H1-H2); //The coefficient of performance
13
14 //output
15 printf('The amount of heat discarded to the room is
   H1 = %3.0f cal \n The work done by the
   refrigerator is W = %3.4g joules \n The
   coefficient of performance of the machine is %3.2
   f ',H1,W,C)

```

Scilab code Exa 6.14 Temperature

```

1 clc
2 clear
3 //Input data
4 t2=7; //The lower temperature of the reservoir in
   degree centigrade
5 n=50; //The efficiency of the carnot engine in
   percent
6 n1=70; //It is desired to increase the efficiency in
   percent
7
8 //Calculations
9 T2=t2+273; //The lower temperature of the reservoir
   in K

```



```

10 T1=T2/(1-(n/100));//The higher temperature of the
    reservoir for 50% efficiency of the engine in K
11 T11=T2/(1-(n1/100));//The higher temperature of the
    reservoir for 70% efficiency of the engine in K
12 T=T11-T1;//Increase in temperature for the change in
    efficiencies in K
13
14 //Output
15 printf('The temperature of the high temperature
    reservoir should be increased by %3.0f K ',T)

```

Scilab code Exa 6.15 Efficiency

```

1  clc
2  clear
3  //Input data
4  T1=600;//The higher temperature of the reservoir in
    K
5  T2=300;//The lower temperature of the reservoir in K
6  n1=52;//The efficiency claimed by the inventor in
    percent
7
8  //Calculations
9  n=(1-(T2/T1))*100;//The efficiency of the carnot
    engine in percent
10
11 //Output
12 printf('The efficiency of the carnot engine is %3.0f
    percent \n The efficiency claimed is %3.0f
    percent \n The efficiency of the engine is more
    than the efficiency of the carnot engine \n .But
    no engine can have an efficiency more than a
    carnots engine , \n so his claim is invalid ',n,n1)

```

Scilab code Exa 6.16 Power

```
1  clc
2  clear
3  //Input data
4  P=10^5; //The average pressure of the steam in a
      double acting steam engine in newtons/m^2
5  L=1; //The length of the stroke in m
6  A=0.15; //The area of the piston in m^2
7  N=5; //Number of strokes in strokes per second
8
9  //Calculations
10 P=(2*P*L*A*N)/1000; //The power of the engine in
      kilowatts
11
12 //Output
13 printf('The power of the engine is %3.0f kilowatts ',
      ,P)
```

Scilab code Exa 6.17 Temperature

```
1  clc
2  clear
3  //Input data
4  l=80; //The latent heat of ice in calories per gram
5  V1=1.091; //The specific volume of 1 gram of ice at 0
      degree centigrade in cm^3
6  V2=1.000; //The specific volume of 1 gram of water at
      0 degree centigrade in cm^3
7  p=1; //The pressure in atm
8  T=273; //The temperature at 0 degree centigrade in K
9
```

```

10 //Calculations
11 L=80*4.2*10^7; //The latent heat of ice in ergs
12 P=76*13.6*980; //The pressure in dynes/cm^2
13 T=(P*T*(V2-V1))/L; //The depression in the melting
    point of ice produced by one atmosphere increase
    of pressure in K
14 T1=-T; //The decrease in the melting point of ice
    with an increase in pressure of one atmosphere
15
16 //Output
17 printf('The decrease in the melting point of ice
    with an increase, \n in pressure of one
    atmosphere is %3.4f K (or) %3.4f degree
    centigrade ',T1,T1)

```

Scilab code Exa 6.18 Temperature

```

1 clc
2 clear
3 //input data
4 p=1; //The pressure in atm
5 V1=1.000; //The specific volume of one gram of water
    in cm^3
6 V2=1677; //The specific volume of one gram of steam
    in cm^3
7 l=540; //Latent heat of vaporisation of steam in cal/
    gram
8
9 //Calculations
10 P=76*13.6*980; //The pressure in dynes/cm^2
11 T=100+273; //The temperature at 100 degree centigrade
    in K
12 L=1*4.2*10^7; //The latent heat of vapourisation in
    ergs
13 T=(P*T*(V2-V1))/L; //The increase in the boiling

```

```

    point of water with an increase in pressure of
    one atmosphere in degree centigrade
14
15 //Output
16 printf('The increase in the boiling point of water
    with an increase , \n in pressure of one
    atmosphere is %3.2f degree centigrade (or) %3.2
    f K ',T,T)

```

Scilab code Exa 6.19 Temperature

```

1  clc
2  clear
3  //Input data
4  l=537; //Latent heat of steam in cal/g
5  V2=1674; //The specific volume of one gram of steam
    in cm^3
6  V1=1.000; //The specific volume of one gram of water
    in cm^3
7  p=2.712; //The increase in the pressure in cm of Hg
8  t=100; //The boiling point of water in degree
    centigrade
9
10 //Calculations
11 T=t+273; //The boiling point of water in K
12 P=p*13.6*980; //The increase in the pressure in dynes
    /cm^2
13 L=1*4.2*10^7; //Latent heat of steam in ergs
14 T1=(P*T*(V2-V1))/L; //The change in the temperature
    of the boiling water when the pressure is
    increased in K
15
16 //Output
17 printf('The change in temperature of boiling water
    is %3.0f K (or) %3.0f degree centigrade ',T1,T1)

```

)

Scilab code Exa 6.20 Temperature

```
1  clc
2  clear
3  //Input data
4  l=4563; //The latent heat of fusion of naphthalene in
        cal/mol
5  V=18.7; //The increase in volume of fusion in cm^3/
        mol
6  p=1; //The pressure in atm
7  t=80; //The melting point of naphthalene in degree
        centigrade
8
9  //Calculations
10 L=1*4.2*10^7; //The latent heat of fusion of
        naphthalene in ergs/mol
11 T=t+273; //The melting point of naphthalene in K
12 P=76*13.6*980; //The pressure in dynes/cm^2
13 T1=(P*T*(V))/L; //The increase in the melting point
        of naphthalene with an increase in pressure of
        one atmosphere in K
14
15 //Output
16 printf('The increase in the melting point of
        naphthalene with an increase,\n in pressure of
        one atmosphere is %3.5f K (or) %3.5f degree
        centigrade ',T1,T1)
```

Scilab code Exa 6.21 Temperature

```
1  clc
```

```

2 clear
3 //Input data
4 p1=80;//The under pressure of benzene in cm of Hg
5 t=80;//The normal boiling point of benzene in degree
   centigrade
6 l=380;//The latent heat of vapourisation in joules/g
7 d2=4;//Density of vapour at boiling point in g/litre
8 d1=0.9;//Density of liquid in g/cm^3
9
10 //Calculations
11 p=p1-76;//The change in pressure in cm of Hg
12 P=p*13.6*980;//The change in pressure in dynes/cm^2
13 T=t+273;//The normal boiling point of benzene in K
14 L=l*10^7;//Latent heat of vapourisation in ergs/g
15 V1=1/d1;//The specific volume of liquid in cm^3
16 V2=1000/d2;//The specific volume of vapour in cm^3
17 T1=(P*T*(V2-V1))/L;//The increase in the boiling
   point of benzene in K
18 T2=t+T1;//The boiling point of benzene at a pressure
   of 80 cm of Hg in degree centigrade
19
20 //Output
21 printf('The boiling point of benzene at a pressure
   of 80 cm of Hg is %3.3f degree centigrade ',T2)

```

Scilab code Exa 6.22 Temperature

```

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

```

```

    centigrade in cal/g
8  V1=1; //The specific volume of one gram of water in
    cm^3
9  V2=1676; //The specific volume of one gram of steam
    in cm^3
10
11 //Calculations
12 p=p2-p1; //The change in pressure in atm
13 P=p*76*13.6*980; //The change in pressure in dynes/cm
    ^2
14 T=t+273; //The boiling point of water in K
15 L=1*4.2*10^7; //The latent heat of water at 100
    degree centigrade in ergs/g
16 T1=(P*T*(V2-V1))/L; //The change in boiling point of
    water in K (or) degree centigrade
17
18 //Output
19 printf('The increase in the boiling point of water
    with an increase,\n of 0.1 atmosphere pressure is
    %3.3f K (or) %3.3f degree centigrade ',T1,T1)

```

Scilab code Exa 6.23 Temperature

```

1  clc
2  clear
3  //Input data
4  p1=1; //The atmospheric pressure in atm
5  p2=100; //The given pressure in atm
6  d1=0.917; //The density of ice in g/cm^3
7  l=336; //The latent heat of ice in j/g
8
9  //Calculations
10 p=p2-p1; //The change in pressure in atms
11 P=p*76*13.6*980; //The change in pressure in dynes/cm
    ^2

```

```

12 L=1*10^7; //The latent heat of ice in ergs/g
13 T=273; //The temperature of melting point of ice in K
14 V2=1; //The specific volume of one gram of water in
    cm^3
15 V1=1/d1; //The specific volume of ice in cm^3
16 T1=(T*P*(V2-V1))/L; //The change in the melting point
    of ice in K
17 T2=-T1; //The decrease in the melting point of ice in
    K (or) degree centigrade
18
19 //Output
20 printf('The decrease in the melting point of ice,\n
    with a pressure of 100 atmospheres is %3.4f
    degree centigrade ',T2)

```

Scilab code Exa 6.24 Pressure

```

1 clc
2 clear
3 //Input data
4 l=79.6; //latent heat of ice in cal/g
5 V2=1; //The specific volume of water at 0 degree
    centigrade in cm^3
6 V1=1.091; //The specific volume of ice at 0 degree
    centigrade in cm^3
7 p=1.013*10^6; //One atmospheric pressure in dynes/cm
    ^3
8 T=-1; //The change in temperature in K
9 T1=273; //The temperature of water at 0 degree
    centigrade in K
10 p1=1; //The atmospheric pressure in atm
11
12 //Calculations
13 L=1*4.18*10^7; //The latent heat of ice in ergs/g
14 P=((L*T)/(T1*(V2-V1)*p)); //The change in pressure in

```



```

        atmospheres
15 P1=P+p1; //The pressure required in atmospheres
16
17 //Output
18 printf('The pressure required to lower melting point
        of ice,\n by 1 degree centigrade is %3.1f
        atmospheres ',P1)

```

Scilab code Exa 6.25 Latent heat

```

1  clc
2  clear
3  //Input data
4  t=100; //The temperature at which water boils in
        degree centigrade
5  p2=787; //The pressure at which water boils in mm of
        Hg
6  J=4.2*10^7; //Joule in ergs/cal
7  p1=760; //The atmospheric pressure in mm of Hg
8  V2=1601; //The specific volume of 1 g of water at 100
        degree centigrade in cm^3
9  V1=1; //The specific volume of 1 g of water at 0
        degree centigrade in cm^3
10
11 //Calculations
12 T=t+273; //The temperature at which water boils in K
13 T1=1; //The difference in the temperature in K
14 p=p2-p1; //The difference in the pressure in mm of Hg
15 P=(p/10)*13.6*980; //The difference in the pressure
        in dynes/cm^2
16 L=(T*P*(V2-V1))/T1; //The latent heat of steam in
        ergs/g
17 L1=L/J; //The latent heat of steam in cal/g
18
19 //Output

```

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

Scilab code Exa 6.26 Temperature

```
1  clc
2  clear
3  //Input data
4  T=600; //The melting point of lead in K
5  d1=11.01; //Initial density of the lead in g/cm^3
6  d2=10.65; //The final density of the lead in g/cm^3
7  l=24.5; //The latent heat of fusion of lead in j/g
8  p1=1; //The atmospheric pressure in atmospheres
9  p2=100; //The given pressure in atmospheres
10
11 //Calculations
12 p=p2-p1; //The change in pressure in atmospheres
13 P=p*76*13.6*980; //The change in pressure in dynes/cm
    ^2
14 L=l*10^7; //The latent heat of fusion of lead in ergs
    /g
15 V1=1/d1; //The initial specific volume of the lead in
    cm^3
16 V2=1/d2; //The final specific volume of the lead in
    cm^3
17 T1=(T*P*(V2-V1))/L; //The change in the temperature
    in K
18 T2=T+T1; //Melting point of lead at 100 atmospheres
    pressure in K
19
20 //Output
21 printf('The melting point of lead at a pressure of
    100 atmospheres is %3.4f K ',T2)
```

Scilab code Exa 6.28 Pressure

```
1  clc
2  clear
3  //Input data
4  t2=120; //The given temperature for the water to boil
        in degree centigrade
5  t1=100; //The actual boiling point of water in degree
        centigrade
6  V=1676; //The change in specific volume in cm^3
7  l=540; //Latent heat of steam in cal/g
8  J=4.2*10^7; //joule in ergs/cal
9
10 //Calculations
11 T1=t2-t1; //The change in temperature in degree
        centigrade (or) K
12 T=t1+273; //The boiling point of water in K
13 L=l*J; //The latent heat of steam in ergs/g
14 p=1; //The atmospheric pressure in atmospheres
15 P=(L*T1)/(T*V); //The change in pressure in dynes/cm
        ^2
16 P1=P/10^6; //The change in pressure in atmospheres
17 P2=P1+p; //The required pressure in atmospheres
18
19 //Output
20 printf('The required pressure is %3.4f atmospheres ',
        ,P2)
```

Scilab code Exa 6.29 Entropy

```
1  clc
2  clear
```

```

3 //Input data
4 l=80; //Latent heat of ice in cal/g
5 m=10; //Mass of ice in g
6 T=273; //The temperature of ice in K
7
8 //Calculations
9 H=m*l; //Heat absorbed by 10 g of ice at 273 K when
    it is converted into water at 273 K in cal
10 S=H/T; //The gain in entropy in cal/K
11
12 //Output
13 printf('The gain in entropy is %3.2f cal/K',S)

```

Scilab code Exa 6.30 Entropy

```

1 clc
2 clear
3 //Input data
4 m=5; //Mass of water in kg
5 t=100; //The temperature of water in degree
    centigrade
6 l=540; //Latent heat of water at 100 degree
    centigrade in cal/g
7
8 //Calculations
9 T=t+273; //The temperature of water in K
10 M=m*1000; //Mass of water in g
11 H=M*l; //Heat absorbed by 5 kg of water at 100 degree
    centigrade when it is converted into steam at
    100 degree centigrade in cal
12 S=H/T; //The gain in entropy in cal/K
13
14 //Output
15 printf('The gain in entropy is %3.0f cal/K ',S)

```

Scilab code Exa 6.31 Entropy

```
1  clc
2  clear
3  //Input data
4  m=1; //mass of ice in g
5  t1=-10; //The given temperature of ice in degree
        centigrade
6  t2=100; //The given temperature of steam in degree
        centigrade
7  S=0.5; //Specific heat of ice
8  s=1; //Specific heat of water
9  l1=80; //Latent heat of ice in cal/g
10 l2=540; //Latent heat of steam in cal/g
11
12 //Calculations
13 T=273; //The temperature of ice at 0 degree
        centigrade in K
14 T1=t1+273; //The given temperature of ice in K
15 T2=t2+273; //The given temperature of steam in K
16 S1=m*S*2.3026*log10(T/T1); //Increase in entropy when
        the temperature of 1 gram of ice increases from
        -10 to 0 degree centigrade in cal/K
17 S2=l1/T; //Increase in entropy when 1 g of ice at 0
        degree centigrade is converted into water at 0
        degree centigrade in cal/K
18 S3=m*s*2.3026*log10(T2/T); //Increase in entropy when
        1 g of water raised from 0 to 100 degree
        centigrade in cal/K
19 S4=l2/T2; //Increase in entropy when 1g water at 100
        degree centigrade is converted into steam at 100
        degree centigrade in cal/K
20 S5=S1+S2+S3+S4; //Total increase in entropy in cal/K
21
```

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

Scilab code Exa 6.32 Entropy

```
1 clc
2 clear
3 //Input data
4 V1=1;//Let us assume the initial volume be one in cc
5 V2=4*V1;//Then the final volume is four times the
      initial volume in cc
6
7 //Calculations
8 S=2.3026*(log10(V2/V1));//The gain in entropy in
      terms of the gas constant in cal/K
9
10 //Output
11 printf('The gain in entropy in terms of the gas
      constant is %3.3f (R/J) cal/K',S)
```

Scilab code Exa 6.33 Entropy

```
1 clc
2 clear
3 //Input data
4 m1=50;//Mass of water at 0 degree centigrade in g
5 m2=50;//Mass of water at 83 degree centigrade in g
6 t1=0;//The temperature of water in degree centigrade
7 t2=83;//The temperature of water in degree
      centigrade
8
9 //Calculations
```

```

10 T1=t1+273; //Temperature of water in K
11 T2=t2+273; //Tempearture of water in K
12 s=1; //The specific heat of water
13 T=((m2*s*T2)+(m1*s*T1))/((m1+m2)*s); //The final
    temperature of the mixture in K
14 S1=(m1*s*log(T/T1)); //The change in entropy by 50 g
    of water when its temperature rises from 273 K to
    313 K in cal/K
15 S2=(m2*s*log(T/T2)); //The change in entropy by 50 g
    of water when its temperature falls from 353 K to
    313 K in cal/K
16 S3=S1+S2; //The total gain in the entropy of the
    system in cal/K
17
18 //Output
19 printf('The total gain in entropy of the system is
    %3.3f cal/K ',S3)

```

Scilab code Exa 6.34 Entropy

```

1 clc
2 clear
3 //Input data
4 m1=50; //Mass of water at 15 degree centigrade in g
5 m2=80; //Mass of water at 40 degree centigrade in g
6 t1=15; //The temperature of water in degree
    centigrade
7 t2=40; //The temperature of water in degree
    centigrade
8
9 //Calculations
10 T1=t1+273; //Temperature of water in K
11 T2=t2+273; //Tempearture of water in K
12 s=1; //The specific heat of water
13 T=((m2*s*T2)+(m1*s*T1))/((m1+m2)*s); //The final

```

```

    temperature of the mixture in K
14 S1=(m1*s*log(T/T1)); //The change in entropy by 50 g
    of water when its temperature rises from 288 K to
    303.4 K in cal/K
15 S2=(m2*s*log(T/T2)); //The change in entropy by 80 g
    of water when its temperature falls from 313 K to
    303.4 K in cal/K
16 S3=S1+S2; //The total gain in the entropy of the
    system in cal/K
17
18 //Output
19 printf('The net increase in the entropy of the
    system is %3.3f cal/K ',S3)

```

Scilab code Exa 6.35 Entropy

```

1  clc
2  clear
3  //Input data
4  m1=10; //Mass of steam in g
5  t1=100; //The temperature of the steam in degree
    centigrade
6  m=90; //mass of water in g
7  t2=0; //The temperature of water in degree centigrade
8  m2=m+m1; //The total mass of water in g
9  l=540; //The latent heat of steam in cal/g
10
11 //Calculations
12 T1=t1+273; //The temperature of the steam in K
13 T2=t2+273; //The temperature of the water in K
14 T=((m1*l)+(m1*T1)+(m2*T2))/(m1+m2); //The final
    temperature in K
15 S1=m2*log(T/T2); //The change in entropy when the
    temperature of water and calorimeter rises from
    273 K to 331.2 K in cal/K

```



```

16 S2=-(m1*1)/T1; //The change in entropy when 10 grams
    of steam at 373 K condenses to water at 373K in
    cal/K
17 S3=m1*log(T/T1); //Change in entropy when 10 g of
    water at 373 K is cooled to water at 331.2 K in
    cal/K
18 S4=S1+S2+S3; //Net change in entropy in cal/K
19
20 //Output
21 printf('The net increase in the entropy of the
    system is %3.3f cal/K ',S4)

```

Scilab code Exa 6.36 Entropy

```

1 clc
2 clear
3 //Input data
4 m=1; //Mass of water in g
5 t1=20; //The temperature of water in degree
    centigrade
6 t2=-10; //The temperature of ice in degree centigrade
7 s1=4.2; //Heat capacity for one gram of water in J/g-
    K
8 s2=2.1; //Heat capacity for ice in J/g-K
9 li=335; //Latent heat of fusion of ice at 0 degree
    centigrade in J/g
10
11 //Calculations
12 T=273; //The temperature of water at 0 degree
    centigrade in K
13 T1=t1+273; //The temperature of water in K
14 T2=t2+273; //The temperature of ice in K
15 S1=m*s1*log(T/T1); //Change in entropy when the
    temperature of 1 g of water at 293 K falls to 273
    K in J/K

```

```

16 S2=-(m*li)/T;//Change in entropy when 1 g of water
    at 273 K is converted into ice at 273 K in J/K
17 S3=m*s2*log(T2/T);//Change in entropy when the
    temperature of 1 g of ice at 273 K falls to 263 K
    in J/K
18 S4=S1+S2+S3;//The total change in entropy of the
    system in J/K
19
20 //Output
21 printf('The total change in the entropy of the
    system is %3.5f J/K \n (Negative sign indicates
    that there is decrease in the entropy of the
    system)',S4)

```

Scilab code Exa 6.37 Entropy

```

1  clc
2  clear
3  //Input data
4  M=1;//Mass of water in kg
5  m=M*1000;//Mass of water in g
6  T1=273;//The temperature of the water in K
7  T2=373;//The temperature of the heat reservoir in K
8  s=1;//Specific heat of water
9
10 //Calculations
11 S1=m*s*log(T2/T1);//Increase in entropy when the
    temperature of 1000 g of water is raised from 273
    K to 373 k in cal/K
12 S2=-(m*s*(T2-T1))/T2;//Change in entropy of the
    reservoir in cal/K
13 S=S1+S2;//Change in entropy of the universe in cal/K
14
15 //Output
16 printf('(1)The change in entropy of water when

```

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

Scilab code Exa 6.42 Pressure

```

1  clc
2  clear
3  //Input data
4  l=540; //Latent heat of vapourisation of steam in cal
      /g
5  L=1*4.2*10^7; //Latent heat of vapourisation of steam
      in ergs/g
6  V=1676; //The change in specific volume when 1 g of
      water is converted into steam in cc
7  t1=100; //The actual boiling temperature of water in
      degree centigrade
8  t2=150; //The given temperature at which water must
      boil in degree centigrade
9  p=1; //The atmospheric pressure in atmospheres
10
11 //Calculations
12 T1=t1+273; //The actual boiling temperature of water
      in K
13 T2=t2+273; //The given temperature at which water
      must boil in K
14 T=T2-T1; //The change in temperature in K
15 P=(L*T)/(T1*V); //The pressure in dynes/cm^2
16 P1=P/10^6; //The pressure in atmospheres
17 P2=P1+p; //The pressure at which water would boil at
      150 degree centigrade in atmospheres
18
19 //Output
20 printf('The pressure at which water would boil at

```

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

Scilab code Exa 6.43 Pressure

```
1  clc
2  clear
3  //Input data
4  l=80; //Latent heat of fusion of ice in cal/g
5  L=1*4.2*10^7; //Latent heat of fusion in ergs/g
6  V=0.091; //The change in specific volume when 1 g of
   water freezes into ice in cc
7  t1=0; //The actual freezing point of ice in degree
   centigrade
8  t2=-1; //The given temperature at which ice must
   freeze in degree centigrade
9  p=1; //The atmospheric pressure in atmospheres
10
11 //Calculations
12 T1=t1+273; //The actual freezing point of ice in K
13 T2=t2+273; //The given temperature at which ice must
   freeze in K
14 T=T1-T2; //The change in temperature in K
15 P=(L*T)/(V*T1); //The pressure in dynes/cm^2
16 P1=P/10^6; //The pressure in atmospheres
17 P2=P1+p; //The pressure under which ice would freeze
   in atmospheres
18
19 //Output
20 printf('The pressure under which ice would freeze at
   -1 degree centigrade is %3.1f atmospheres ',P2)
```

Scilab code Exa 6.44 Specific heat

```

1  clc
2  clear
3  //Input data
4  t=100; //The given temperature of water in degree
        centigrade
5  C1=1.01; //The specific heat of water at 100 degree
        centigrade in cal/g
6  L=-0.64; //The rate at which the latent heat of
        vapourisation decreases with rise in temperature
        in cal/K
7  l=540; //The latent heat of vapourisation of steam in
        cal
8
9  //Calculations
10 T=t+273; //The given temperature of water in K
11 C2=L-(l/T)+C1; //The specific heat of saturated steam
        in cal/g
12
13 //Output
14 printf('The specific heat of saturated steam is %3
        .3f cal/g \n (The specific heat of saturated
        steam is negative)',C2)

```

Scilab code Exa 6.45 Specific heat

```

1  clc
2  clear
3  //Input data
4  t=100; //The temperature of saturated steam in degree
        centigrade
5  L1=545.25; //The latent heat of saturated steam at 90
        degree centigrade in cal
6  L2=539.30; //The latent heat of saturated steam at
        100 degree centigrade in cal
7  L3=533.17; //The latent heat of saturated steam at

```

```
    110 degree centigrade in cal
8  C1=1.013;//The specific heat of water at 100 degree
    centigrade in cal/g
9
10 //Calculations
11 T=t+273;//The temperature of saturated steam in K
12 L=(L3-L1)/(110-90);//The rate at which the latent
    heat of saturated steam decreases with rise in
    temperature in cal/K
13 C2=C1+L-(L2/T);//The specific heat of saturated
    steam at 100 degree centigrade in cal/g
14
15 //Output
16 printf('The specific heat of saturated steam at 100
    degree centigrade is %3.3f cal/g',C2)
```

Chapter 8

TRANSMISSION OF HEAT

Scilab code Exa 8.1 Conductivity of iron

```
1  clc
2  clear
3  //Input data
4  l1=10; //Length of the copper rod in cm
5  l2=4; //Length of the iron rod in cm
6  K1=0.9; //The thermal conductivity of copper
7
8  //Calculations
9  K2=(l2^2/l1^2)*K1; //The Thermal conductivity of iron
10
11 //Output
12 printf('The thermal conductivity of iron is K2 = %3
        .3f ',K2)
```

Scilab code Exa 8.2 Heat

```
1  clc
2  clear
```

```

3 //Input data
4 K=0.2;//The thermal conductivity of the plate
5 d=0.2;//The thickness of the plate in cm
6 A=20;//The area of the plate in cm^2
7 T=100;//The temperature difference in degree
    centigrade
8 t=60;//The given time in seconds
9
10 //Calculations
11 Q=(K*A*T*t)/d;//The quantity of heat that will flow
    through the plate in one minute in cal
12
13 //Output
14 printf('The quantity of heat that will flow through
    the plate in one minute is Q = %3.4g cal ',Q)

```

Scilab code Exa 8.3 Heat

```

1 clc
2 clear
3 //Input data
4 l=30;//The length of the bar in cm
5 A=5;//The uniform area of cross section of a bar in
    cm^2
6 ta=200;//The temperature maintained at the end A in
    degree centigrade
7 tc=0;//The temperature maintained at the end C in
    degree centigrade
8 Kc=0.9;//The thermal conductivity of copper
9 Ki=0.12;//The thermal conductivity of iron
10
11 //Calculations
12 T=((Kc*A*ta)+(Ki*A*tc))/((Kc+Ki)*A);//The
    temperature after the steady state is reached in
    degree centigrade

```



```

13 Q=(Kc*A*(ta-T))/(1/2);//The rate of flow of heat
    along the bar when the steady state is reached in
    cal/sec
14
15 //Output
16 printf('The rate of flow of heat along the bar when
    the steady state is reached is Q = %3.2f cal/s ',
    Q)

```

Scilab code Exa 8.4 Temperature

```

1 clc
2 clear
3 //Input data
4 d1=1.75;//The thickness of the wood in cm
5 d2=3;//The thickness of the cork in cm
6 t2=0;//The temperature of the inner surface of the
    cork in degree centigrade
7 t1=12;//The temperature of the outer surface of the
    wood in degree centigrade
8 K1=0.0006;//The thermal conductivity of wood
9 K2=0.00012;//The thermal conductivity of cork
10
11 //Calculations
12 T=(((K1*t1)/d1)+((K2*t2)/d2))/((K1/d1)+(K2/d2));//
    The temperature of the interface in degree
    centigrade
13
14 //Output
15 printf('The temperature of the interface is T = %3.2
    f degree centigrade ',T)

```

Scilab code Exa 8.5 Time

```

1  clc
2  clear
3  //Input data
4  x1=3; //The thickness of the ice layer on the surface
      of a pond in cm
5  x=1; //The increase in the thickness of the ice when
      the temperature is maintained at -20 degree
      centigrade in mm
6  x2=x1+(x/10); //The increased thickness of the ice
      layer on the surface of a pond in cm
7  T=-20; //The temperature of the surrounding air in
      degree centigrade
8  d=0.91; //The density of ice at 0 degree centigrade
      in g/cm^3
9  L=80; //The latent heat of ice in cal/g
10 K=0.005; //The thermal conductivity of ice
11
12 //Calculations
13 t=((d*L)/(2*K*(-T)))*(x2^2-x1^2); //The time taken to
      increase its thickness by 1 mm in sec
14 t1=t/60; //The time taken to increase its thickness
      by 1 mm in min
15
16 //Output
17 printf('The time taken to increase its thickness by
      1 mm is t = %3.2f s',t)

```

Scilab code Exa 8.6 Time

```

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

```

```

    the temperature is maintained at -10 degree
    centigrade in cm
6  x2=x1+(x); //The increased thickness of the ice layer
    on the surface of a pond in cm
7  T=-10; //The temperature of the surrounding air in
    degree centigrade
8  d=0.90; //The density of ice at 0 degree centigrade
    in g/cm^3
9  L=80; //The latent heat of ice in cal/g
10 K=0.005; //The thermal conductivity of ice
11
12 // Calculations
13 t=((d*L)/(2*K*(-T)))*(x2^2-x1^2); //The time taken to
    increase its thickness by 5 cm in sec
14 t1=t/(60*60); //The time taken to increase its
    thickness by 5 cm in hours
15
16 //Output
17 printf('The time taken to increase its thickness by
    5 cm is t = %3.0g s (or) %3.0f hours',t,t1)

```

Scilab code Exa 8.7 Rate of energy transfer

```

1  clc
2  clear
3  //input data
4  T1=300; //The temperature maintained on one sphere (
    black body radiator) in K
5  T2=200; //The temperature maintained on another
    sphere (black body radiator) in K
6  s=5.672*10^-8; //Stefans constant in M.K.S units
7
8  // Calculations
9  R=s*(T1^4-T2^4); //The net rate of energy transfer
    between the two spheres in watts/m^2

```

```

10
11 //output
12 printf('The net rate of energy transfer between the
    two spheres is R = %3.2f watts/m^2',R)

```

Scilab code Exa 8.8 Radiant

```

1  clc
2  clear
3  //Input data
4  T1=400; //The given temperature of a black body in K
5  T2=4000; //The given temperature of a black body in K
6  s=5.672*10^-8; //Stefans constant in M.K.S units
7
8  //Calculations
9  R1=s*T1^4; //The radiant emittance of a black body at
    400 k in watts/m^2
10 R2=(s*T2^4)/1000; //The radiant emittance of a black
    body at 4000 k in kilo-watts/m^2
11
12 //Output
13 printf('The Radiant emittance of a black body at a
    temperature of ,\n (i) 400 K is R = %3.0f watts
    /m^2 \n (ii) 4000 K is R = %3.0f kilo-watts/m^2
    ',R1,R2)

```

Scilab code Exa 8.9 Emittance

```

1  clc
2  clear
3  //Input data
4  e=0.35; //The relative emittance of tungsten

```

```

5 A=10^-3; //The surface area of a tungsten sphere in m
  ^2
6 T1=300; //The temperature of the walls in K
7 T2=3000; //The temperature to be maintained by the
  sphere in K
8 s=5.672*10^-8; //Stefans constant in M.K.S units
9
10 //Calculations
11 R=s*A*e*(T2^4-T1^4); //The power input required to
  maintain the sphere at 3000 K in watts
12
13 //Output
14 printf('The power input required to maintain the
  sphere at 3000 K is R = %3.0f watts',R)

```

Scilab code Exa 8.10 Rate of heat transfer

```

1 clc
2 clear
3 //Input data
4 e=0.1; //The relative emittance of an aluminium foil
5 T1=300; //The temperature of one sphere in K
6 T2=200; //The temperature of another sphere in K
7 s=5.672*10^-8; //Stefans constant in M.K.S units
8
9 //Calculations
10 x=(((T1^4+T2^4)/2)^(1/4)); //The temperature of the
  foil after the steady state is reached in K
11 R=e*s*(T1^4-x^4); //The rate of energy transfer
  between one of the spheres and foil in watts/m^2
12
13 //Output
14 printf('(1)The temperature of the foil after the
  steady state reached is x = %3.1f K \n (2)The
  rate of energy transfer between the sphere and

```

the foil is $R = \%3.1f \text{ watts/m}^2$ ',x,R)

Scilab code Exa 8.11 Energy radiated

```
1  clc
2  clear
3  //Input data
4  A=5*10^-5;//The surface area of the filament in m^2
5  e=0.85;//The relative emittance of the filament
6  s=5.672*10^-8;//Stefans constant in M.K.S units
7  t=60;//The time in seconds
8  T=2000;//The temperature of the filament of an
   incandescent lamp in K
9
10 //Calculations
11 E=A*e*s*t*(T^4);//The energy radiated from the
   filament in joules
12
13 //Output
14 printf('The energy radiated from the filament is E =
   %3.0f joules ',E)
```

Scilab code Exa 8.12 Temperature

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

```

8 s=1.36*10^-8; //Stefans constant in cal/m^2-s-K^4
9
10 // Calculations
11 T=((E)/(A*e*s*t))^(1/4); //The temperature of the
    furnace in K
12
13 //Output
14 printf('The temperature of the furnace is T = %3.0f
    K ',T)

```

Scilab code Exa 8.13 Temperature

```

1 clc
2 clear
3 //Input data
4 S=2.3; //Solar constant in cal/cm^2/minute
5 r=7*10^10; //The radius of the sun in cm
6 R=1.5*10^13; //The distance between the sun and the
    earth in cm
7 s=1.37*10^-12; //Stefans constant in cal/cm^2/s
8
9 // Calculations
10 E=(S/60)*(R/r)^(2); //The energy radiated from the
    sun in cal/s
11 T=(E/s)^(1/4); //The black body temperature of the
    sun in K
12
13 //Output
14 printf('The black body temperature of the sun is T =
    %3.0f K ',T)

```

Chapter 9

STATISTICAL THERMODYNAMICS

Scilab code Exa 9.1 Relative probabilities

```
1  clc
2  clear
3  //Input data
4  N=6000; //Number of particles in a system
5  e=3; //The number of energy states with equal spacing
6  n1=3000; //Number of particles in the lower level
7  n2=2500; //Number of particles in the middle level
8  n3=500; //Number of particles in the upper level
9  n11=3001; //Number of particles in the lower level in
   the second case
10 n22=2498; //Number of particles in the middle level
   in the second case
11 n33=501; //Number of particles in the upper level in
   the second case
12 g=1; //Let us assume the probability of locating a
   particle in a certain energy state is one
13
14 //Calculations
15 P1=1/(2500*2499); //The probability in the first case
```



```
16 P2=1/(3001*501);//The probability in the second case
17 P=P2/P1;//Comparing the relative probabilities
18
19 //Output
20 printf('By comparing the relative probabilities P =
    %3.1f \n (It means the transfer of one particle
    from the middle to the\n upper and the lower
    state has changed the probability by a factor %3
    .1f \n Hence both the distributions are not near
    the equilibrium state)',P,P)
```

Chapter 10

Appendix 2

Scilab code Exa 10.1 Kinetic energy

```
1  clc
2  clear
3  //page number 470
4  //Input data
5  T=300; //The given temperature in K
6  R=8.31; //Universal gas constant in J/mole-K
7
8  //Calculations
9  U=(3/2)*R*T; //The total random kinetic energy of one
   gram mole of oxygen in J
10
11 //Output
12 printf('The total random kinetic energy of one gram
   mole of oxygen is U = %3.0f J ',U)
```

Scilab code Exa 10.2 Temperature

```
1  clc
```

```

2 clear
3 //Page number 470
4 //Input data
5 a=0.245;//Van der Waals constant in atoms-litre^2-
    mole^-2
6 b=2.67*10^-2;//Van der Waals constant in litre-mole
    ^-1
7 R=8.314*10^7;//Universal gas constant in ergs/mole-K
8
9 //Calculations
10 a1=a*76*13.6*980*10^6;//Van der Waals constant in
    dynes-cm^4-mole^-2
11 b1=b*10^3;//Van der Waals constant in cm^3mole^-1
12 Tc=(8/27)*(a1/b1)*(1/R);//The critical temperature
    in K
13 Tc1=Tc-273;//The critical temperature in degree
    centigrade
14
15 //Output
16 printf('The critical temperature is Tc = %3.2f K (
    or) %3.2f degree centigrade ',Tc,Tc1)

```

Scilab code Exa 10.3 Avogadro number

```

1 clc
2 clear
3 //Page number 470
4 //Input data
5 t=0;//The given temperature in degree centigrade
6 E=5.64*10^-21;//The mean kinetic energy of molecules
    of hydrogen in J
7 R=8.32;//Universal gas constant in J/mole-K
8
9 //Calculations
10 T=t+273;//The given temperature in K

```

```

11 N=(3/2)*(R/E)*(T); //Avogadros number
12
13 //Output
14 printf('The Avogadro number is N = %3.4g ',N)

```

Scilab code Exa 10.4 Mean free path

```

1  clc
2  clear
3  //Page number 471
4  //Input data
5  d=2*10^-8; //The diameter of the molecule of a gas in
      cm
6  k=1.38*10^-23; //Boltzmanns constant in J/K
7  T=273; //The temperature at NTP in K
8  pi=3.14; //The mathematical constant of pi
9
10 //Calculations
11 d1=d/100; //The diameter of the molecule of a gas in
      m
12 P=0.76*13.6*9.8*1000; //The pressure at NTP
13 n=P/(k*T); //The number of molecules per cubic meter
14 l=1/(pi*d1^2*n); //The mean free path in m
15
16 //Output
17 printf('The mean free path at NTP is %3.4g m ',l)

```

Scilab code Exa 10.6 Mean free path

```

1  clc
2  clear
3  //Page number 472
4  //Input data

```

```

5 n=3*10^25; //The number of molecules per cubic metre
6 d=3.6*10^-10; //The diameter of oxygen molecule in m
7 M=32; //Molecular weight of oxygen
8 N=6.023*10^26; //Avogadro number
9 k=1.38*10^-23; //Boltzmanns constant in J/K
10 T=273; //The temperature at NTP in K
11 pi=3.14; //The mathematical constant of pi
12
13 // Calculations
14 m=M/N; //The mass of oxygen atom in kg
15 V=((8*k*T)/(pi*m))^(1/2); //Average speed of oxygen
    molecule at 273K in m/s
16 c=pi*d^2*V*n; //The collision frequency of the
    molecules
17 l=1/(pi*d^2*n); //The mean free path in m
18
19 //Output
20 printf('(a)The collision frequency of the molecules
    is %3.2g collisions/second \n (b)The mean free
    path is %3.4g m ',c,l)

```

Scilab code Exa 10.7 Pressure

```

1 clc
2 clear
3 //Page number 472
4 //Input data
5 d=9000; //The density of copper in kg/m^3
6 w=63.5; //The atomic weight of copper in kg
7 N=6.023*10^26; //Avogadros number
8 pi=3.14; //Mathematical constant of pi
9 h=6.624*10^-34; //Planks constant in Js
10
11 // Calculations
12 V=w/d; //The volume of copper in m^3

```

```

13 Ef=((h^2/(8*9*10^-31))*((3/pi)*(N/V))^(2/3))
    /(1.6*10^-19);//The fermi energy in eV
14 P=(2/3)*(N/V)*Ef;//The pressure at absolute zero for
    copper in N/m^2
15
16 //Output
17 printf('(a)The Fermi energy is E = %3.3f eV \n (b)
    The pressure at absolute zero for copper is P =
    %3.6g N/m^2 ',Ef,P)

```

Scilab code Exa 10.8 Gas

```

1  clc
2  clear
3  //Page number 473
4  //Input data
5  p1=80;//The initial pressure of a gas in cm of Hg
6  p2=60;//The final pressure of a gas in cm of Hg
7  v2=1190;//The final volume occupied by a gas in cc
8  v1=1000;//The initial volume occupied by a gas in cc
9
10 //Calculations
11 g=(log10(p1/p2))/(log10(v2/v1));//The adiabatic
    index
12
13 //Output
14 printf('The adiabatic index is %3.3f ',g)

```

Scilab code Exa 10.9 Work done

```

1  clc
2  clear
3  //Page number 473

```

```

4 //Input data
5 t=27;//The given temperature in degree centigrade
6 R=8.3;//Universal gas constant in J/deg mole
7
8 //Calculations
9 T=t+273;//The given temperature in K
10 v1=1;//Let the original volume be in cc
11 v2=2*v1;//The final volume in cc
12 W=R*T*log(v2/v1);//The work done in J
13
14 //Output
15 printf('The work done is W = %3.1f J ',W)

```

Scilab code Exa 10.10 temperature

```

1 clc
2 clear
3 //Page number 474
4 //Input data
5 t1=27;//The initial temperature of the gas in degree
   centigrade
6 T1=t1+273;//The initial temperature of the gas in K
7 g=1.5;//The adiabatic index
8 p=8;//The ratio of final pressure to the initial
   pressure
9
10 //Calculations
11 T2=((p)^((g-1)/g))*T1;//The final temperature of the
   gas in K
12 T21=T2-273;//The final temperature of the gas in
   degree centigrade
13
14 //Output
15 printf('The final temperature of the gas is T2 = %3
   .0f K (or) %3.0f degree centigrade ',T2,T21)

```

Scilab code Exa 10.11 Temperature

```
1 clc
2 clear
3 //Page number 475
4 //Input data
5 n=0.3; //The efficiency of a carnot engine
6 t=27; //The temperature of the sink in degree
    centigrade
7 n1=0.5; //The increased efficiency of a carnot engine
8
9 //Calculations
10 T2=t+273; //The temperature of the sink in K
11 T1=T2/(1-n); //The temperature of the source for 0.3
    efficiency in K
12 T11=T2/(1-n1); //The temperature of the source for
    0.5 efficiency in K
13 T=T11-T1; //The increase in temperature in K
14
15 //Output
16 printf('The increase in temperature is T = %3.2f K ',
    ,T)
```

Scilab code Exa 10.12 Efficiency

```
1 clc
2 clear
3 //Page number 475
4 //Input data
5 T1=2100; //One of the operating temperature in K
6 T2=700; //One of the another operating temperature in
    K
```



```

7  n1=40; //The actual efficiency of the engine in
    percent
8
9  //Calculations
10 n=(1-(T2/T1))*100; //The efficiency of the engine in
    percent
11 n2=(n1/n)*100; //The percentage of actual efficiency
    to the maximum possible efficiency in percent
12
13 //Output
14 printf('The percentage of actual efficiency to the
    maximum possible efficiency is %3.0f percent ',n2
    )

```

Scilab code Exa 10.13 Efficiency

```

1  clc
2  clear
3  //Page number 475
4  //Input data
5  T1=600; //The working temperature of the engine in K
6  T2=300; //The another working temperature of the
    engine in K
7  n=52; //Efficiency of the engine claimed by the
    inventor in percent
8
9  //Calculations
10 n1=(1-(T2/T1))*100; //The carnot efficiency of the
    engine in percent
11
12 //Output
13 printf('The efficiency of the engine claimed by
    inventor is n = %3.0f percent\nThe carnot
    efficiency of the engine is n = %3.0f percent \n
    (The efficiency claimed is more than the carnots

```

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

Scilab code Exa 10.14 Work done

```
1  clc
2  clear
3  //Page number 476
4  //Input data
5  H1=10^4; //The heat absorbed by a carnots engine in
   calories
6  t1=627; //The temperature from a reservoir in degree
   centigrade
7  t2=27; //The temperature of the sink in degree
   centigrade
8
9  //Calculations
10 T1=t1+273; //The temperature of the reservoir in K
11 T2=t2+273; //The temperature of the sink in K
12 n=(1-(T2/T1))*100; //The efficiency of the engine in
   percent
13 H2=H1*(T2/T1); //The heat rejected to the sink in
   calories
14 W=(H1-H2)*4.2; //The work done by the engine in J
15
16 //Output
17 printf('The efficiency of the engine is n = %3.2f
   percent \n The work done by the engine is W = %3
   .2g J ',n,W)
```

Scilab code Exa 10.15 Efficiency

```

1  clc
2  clear
3  //Page number 476
4  //Input data
5  w=100;//The given power of an engine in kW
6  t1=117;//The operating temperature of an engine in
    degree centigrade
7  t2=17;//The another operating temperature of an
    engine in degree centigrade
8
9  //Calculations
10 T1=t1+273;//The operating temperature of an engine
    in K
11 T2=t2+273;//The another operating temperature of an
    engine in K
12 W=w*1000;//The given power of an engine in J/s
13 n=(1-(T2/T1))*100;//The efficiency of an engine in
    percent
14 H=(T1/T2);//The amount of heat absorbed to the
    amount of heat rejected
15 H2=W/(H-1);//The amount of heat rejected per second
    in J/s
16 H1=H*H2;//The amount of heat absorbed per second in
    J/s
17
18 //Output
19 printf('(i)The amount of heat absorbed is %3.0g J/s
    \n (ii)The amount of heat rejected is %3.0g J/s \
    n (iii)The efficiency of the engine is %3.1f
    percent ',H1,H2,n)

```

Scilab code Exa 10.16 Entropy

```

1  clc
2  clear

```

```

3 //Page number 477
4 //Input data
5 m1=10; //The mass of water at 60 degree centigrade in
   g
6 m2=30; //The mass of water at 20 degree centigrade in
   g
7 t1=60; //The temperature of 10 g water in degree
   centigrade
8 t2=20; //The temperature of 30 g water in degree
   centigrade
9
10 //Calculations
11 T1=t1+273; //The temperature of 10g water in K
12 T2=t2+273; //The temperature of 30g water in K
13 T=((m1*T1)+(m2*T2))/(m1+m2); //The final temperature
   of water in K
14 s1=m1*log(T/T1); //The change in entropy of 10g water
   from 333 to 303 K in cal/K
15 s2=m2*log(T/T2); //The change in entropy of 30g water
   from 293 to 303 K in cal/K
16 s=s1+s2; //The total gain in the entropy of the
   system in cal/K
17
18 //Output
19 printf('The change in entropy is %3.4f cal/K ',s)

```

Scilab code Exa 10.17 Entropy

```

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

```

```

        cal
7
8 // Calculations
9 m1=m*1000; //The given amount of water in g
10 T1=t1+273; //The temperature of water in K
11 S=(m1*L)/T1; //The increase in entropy in cal/K
12
13 //Output
14 printf('The increase in entropy is %3.0f cal/K ',S)

```

Scilab code Exa 10.18 Entropy

```

1 clc
2 clear
3 //Page number 478
4 //Input data
5 m=50; //The given amount of water in g
6 t1=10; //The initial temperature of water in degree
        centigrade
7 t2=90; //The final temperature of water in degree
        centigrade
8
9 // Calculations
10 T1=t1+273; //The initial temperature of water in K
11 T2=t2+273; //The final temperature of water in K
12 S=m*log(T2/T1); //The increase in entropy in cal/K
13
14 //Output
15 printf('The increase in entropy is %3.3f cal/K ',S)

```

Scilab code Exa 10.19 Entropy

```

1 clc

```

```

2 clear
3 //Page number 479
4 //Input data
5 m=10;//The given amount of ice in g
6 T1=273;//The initial temperature of ice in K
7 T2=373;//The final temperature of steam in K
8 L1=80;//The latent heat of ice in cal/g
9 L2=540;//The latent heat of vapourisation of steam
   in cal
10
11 //Calculations
12 s1=(m*L1)/T1;//Increase in entropy from ice at 273K
   to water at 273K in cal/K
13 s2=(m)*log(T2/T1);//Increase in entropy from water
   at 273K to water at 373K in cal/K
14 s3=(m*L2)/T2;//Increase in entropy from water at 373
   K to steam at 373K in cal/K
15 s=s1+s2+s3;//The total increase in entropy in cal/K
16
17 //Output
18 printf('The total increase in entropy is %3.2f cal/K
   ',s)

```

Scilab code Exa 10.20 Entropy

```

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

```

```

9 w=28; //Molecular weight of nitrogen
10
11 // Calculations
12 T1=t1+273; //The initial temperature of nitrogen in K
13 T2=t2+273; //The final temperature of nitrogen in K
14 S=(Cv/w); //The Specific heat of nitrogen
15 s=m*S*log(T2/T1); //The change in entropy in cal/K
16
17 //Output
18 printf('The change in entropy is %3.4g cal/K ',s)

```

Scilab code Exa 10.21 Temperature

```

1 clc
2 clear
3 //Page number 480
4 //Input data
5 p=135.2; //The given increase in the pressure in
   atmospheres
6 V=-0.091; //The given increase in the specific volume
   when 1g of water freezes into ice in cm^3
7 L=80; //Latent heat of fusion of ice in cal/gram
8 T=273; //The temperature of ice in K
9
10 // Calculations
11 L1=L*4.18*10^7; //The latent heat of fusion of ice in
   ergs/g
12 P=p*1.013*10^6; //The given increase in the pressure
   in dynes/cm^2
13 t=(P*T*V)/L1; //The temperature at which ice will
   freeze in degree centigrade
14 t1=t+273; //The temperature at which ice will freeze
   in K
15
16 // Calculations

```

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

Scilab code Exa 10.22 Entropy

```
1 clc
2 clear
3 //Page number 480
4 //Input data
5 m=1;//The given amount of water in kg
6 s=1000;//The specific heat of water in cal/kg-K
7 T1=273;//The initial temperature of water in K
8 T2=373;//The temperature of the heat reservoir in K
9
10 //Calculations
11 S=m*s*log(T2/T1);//The increase in entropy in cal/K
12
13 //Output
14 printf('The increase in the entropy of water is %3.0
    f cal/K',S)
```

Scilab code Exa 10.23 Entropy

```
1 clc
2 clear
3 //Page number 480
4 //input data
5 m=0.0273;//The given amount of ice in kg
6 L=80;//The latent heat of fusion of ice in cal/gram
7 T=273;//The temperature of ice in K
8
9 //Calculations
```



```

10 L1=L*1000; //The latent heat of fusion of ice in cal/
    kg
11 S=(m*L1*4.2)/T; //The change in entropy in J/K
12
13 //Output
14 printf('The change in entropy is %3.1f J/K',S)

```

Scilab code Exa 10.24 Temperature

```

1  clc
2  clear
3  //Page number 481
4  //Input data
5  t1=27; //The given initial temperature in degree
    centigrade
6  p=50; //The reduce in the pressure in atmospheres
7  a=13.2*10^-2; //Van der Waals constant in Nm^4mole^-2
8  b=31.2*10^-6; //Van der Waals constant in mole^-1m^3
9  R=8.3; //Universal gas constant in JK^-1(mole)^-1
10 Cp=3.5; //The specific heat at constant pressure
11 M=32; //Molecular weight of oxygen
12
13 //Calculations
14 T=t1+273; //The given initial temperature in K
15 P=p*0.76*13.6*1000*9.8; //The reduce in the pressure
    in N/m^2
16 T1=((P)/(4.2*M*Cp*R))*(((2*a)/(R*T))-b); //The drop
    in the temperature in K
17
18 //Output
19 printf('The drop in the temperature is %3.4f K ',T1)

```

Scilab code Exa 10.25 Specific heat

```

1  clc
2  clear
3  //Page number 481
4  //Input data
5  T=300; //The temperature of the metallic copper disc
        in K
6  Cp=24.5; //The specific heat at constant pressure in
        J/mol K
7  a=50.4*10^-6; //The coefficient of thermal expansion
        in K^-1
8  K=7.78*10^-12; //Isothermal compressibility in N/m^2
9  V=7.06*10^-6; //The specific volume in m^3/mol
10
11 // Calculations
12 C=(T*V*a^2)/K; //The change in specific heats in J/
        mol K
13 Cv=Cp-C; //The specific heat at constant volume in J/
        mol K
14
15 //Output
16 printf('The specific heat at constant volume is Cv =
        %3.4 f J/mol-K ', Cv)

```

Scilab code Exa 10.26 Temperature

```

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

```

```

9 Cp=7; //The specific heat at constant pressure in cal
    /mole-K
10
11 // Calculations
12 P=p*76*13.6*980; //The reduced pressure in dynes/cm^2
13 Cp1=Cp*4.2*10^7; //The specific heat at constant
    pressure in ergs/mole-K
14 T=t+273; //The initial temperature of the gas in K
15 R=8.31*10^7; //The real gas constant in ergs/mole-K
16 dT=(P/Cp1)*(((2*a)/(R*T))-b); //The drop in
    temperature in K or degree centigrade
17
18 //Output
19 printf('The drop in temperature produced by
    adiabatic throttling process is %3.3f K (or) %3
    .3f degree centigrade ',dT,dT)
20
21 //Error . There is a change in the result compared
    to the textbook because the final calculations
    did in the textbook went wrong , so the final
    result varied from the textbook

```

Scilab code Exa 10.27 Index

```

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

```

```

10 k=3.89*10^-11; //The given compressibility in pa^-1
11
12 // Calculations
13 T=t+273; //The initial temperature of mercury in K
14 Cv=Cp-((T*V*b^2)/k); //The specific heat at constant
    volume in J/mol K
15 g=Cp/Cv; //The adiabatic index
16
17 //Output
18 printf('The adiabatic index is %3.0f ',g)

```

Scilab code Exa 10.28 Radius

```

1  clc
2  clear
3  //Page number 483
4  //Input data
5  K=24*10^-3; //The coefficient of thermal conductivity
    of an oxygen molecule in J/m.s.K
6  Cv=20.9*10^3; //The specific heat at constant volume
    in J/kilo.mole.K
7  k=1.38*10^-23; //The boltzmanns constant in J/K
8  m=5.31*10^-26; //The mass of an oxygen molecule in kg
9  T=273; //The temperature of the molecule in K
10 pi=3.142; //Mathematical constant of pi
11
12 // Calculations
13 C=((3*k*T)/m)^(1/2); //The velocity of the molecule
    in m
14 r=(((3*k*T*m)^(1/2)*Cv)/(3*2^(1/2)*pi*K))^(1/2); //
    The radius of an oxygen molecule in m
15
16 //Output
17 printf('The radius of an oxygen molecule is %3.4g m
    ',r)

```

```
18
19 //Error . There is a change in the result compared
    to the textbook because the final calculations
    did in the textbook went wrong , so the final
    result varied from the textbook
```

Scilab code Exa 10.29 Temperature

```
1  clc
2  clear
3  //Page number 483
4  //Input data
5  b=0.3;//The given wiens constant in cm-K
6  l=5500;//The given wavelength in A units
7
8  //Calculations
9  L=1*10^-8;//The given wavelength in cm
10 T=b/L;//The temperature of the sun in K
11
12 //Output
13 printf('The temperature of the sun is %3.0f K ',T)
```

Scilab code Exa 10.30 Temperature

```
1  clc
2  clear
3  //Page number 483
4  //Input data
5  R=1*10^4;//The rate at which black body loses
    thermal energy in watts/m^2
6  s=5.672*10^-8;//Stefans constant in SI units
7
8  //Calculations
```

```

9 T=(R/s)^(1/4); //The temperature of the black body in
  K
10
11 //Output
12 printf('The temperature of the black body is %3.0f
  K',T)

```

Scilab code Exa 10.31 Temperature

```

1 clc
2 clear
3 //Page number 484
4 //Input data
5 T=6174; //The temperature of the black body in K
6 l=4700; //The wavelength of the black body emitting
  in amstrong units
7 l1=1.4*10^-5; //The wavelength to be emitted by the
  black body in m
8
9 //Calculations
10 L=1*10^-10; //The wavelength of the black body
  emitted at 6174 K in m
11 L1=l1; //The wavelength to be emitted by the black
  body in m
12 T1=(L*T)/L1; //The temperature to be maintained by
  the black body in K
13
14 //Output
15 printf('The temperature to be maintained by the
  black body is %3.2f K ',T1)

```

Scilab code Exa 10.32 Energy

```

1  clc
2  clear
3  //Page number 484
4  //Input data
5  T=5800; //The temperature of the sun in K
6
7  //Calculations
8  r=7*10^8; //The radius of the sun in m
9  pi=3.142; //The mathematical constant of pi
10 A=4*pi*r^2; //The surface area of the sun in m^2
11 s=5.672*10^-8; //Stefans constant in SI units
12 U=A*s*T^4; //The total energy emitted by sun per
    second in J
13 r1=1.5*10^11; //The distance of the earths atmosphere
    from the sun in m
14 R=(U/(4*pi*r1^2))/1000; //Energy reaching the top of
    earths atmosphere in kW/m^2
15
16 //Output
17 printf('The total radiant energy emitted by sun per
    second is %3.4g J \n The rate at which energy is
    reaching earths atmosphere is %3.1f kW/m^2 ',U,
    R)

```

Scilab code Exa 10.33 Energy

```

1  clc
2  clear
3  //Page number 485
4  //Input data
5  n=5; //The molecules of ozone in grams
6  t=27; //The temperature of ozone in degree centigrade
7  R=8.3; //The universal gas constant in J/g-mol/K
8
9  //Calculations

```

```

10 T=t+273; //The temperature of ozone in K
11 U=n*((3/2)*R*T); //The energy of ozone in J
12
13 //Output
14 printf('The energy of 5 gms molecules of ozone at 27
        degree centigrade is %3.6g J ',U)

```

Scilab code Exa 10.34 Pressure

```

1  clc
2  clear
3  //Page number 485
4  //Input data
5  t=-1; //The pressure required to lower the melting
        point of ice in K
6  l=79.6; //The latent heat of ice in cal/g
7  V1=1; //The specific volumes of water at 0 degree
        centigrade in cm^2
8  V2=1.091; //The specific volumes of ice at 0 degree
        centigrade in cm^2
9  p=1.013*10^6; //One atmospheric pressure in dyne/cm^2
10
11 //Calculations
12 T=273; //The temperature of water in K
13 L=1*4.18*10^7; //The latent heat of ice in ergs/g
14 p1=(L*t)/(T*(V1-V2)); //The obtained pressure in
        dynes/cm^2
15 P=p1/p; //The obtained pressure in atmospheres
16 P1=P+1; //The required pressure in atmospheres
17
18 //Output
19 printf('The pressure required is %3.2f atmospheres
        ',P1)

```

Scilab code Exa 10.35 Energy

```
1  clc
2  clear
3  //Page number 485
4  //Input data
5  t1=127; //The temperature of the black body in degree
        centigrade
6  t2=27; //The temperature of the walls maintained in
        degree centigrade
7  s=5.672*10^-8; //Stefans constant in SI units
8
9  //Calculations
10 T1=t1+273; //The temperature of the black body in K
11 T2=t2+273; //The temperature of the walls maintained
        in K
12 R=s*(T1^4-T2^4); //The net amount of energy lost by
        body in W/m^2
13
14 //Output
15 printf('The net amount of energy lost by body per
        sec per unit area is %3.1f watts/m^2',R)
```

Scilab code Exa 10.36 Temperature

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

```

6 n1=50; //The efficiency of the carnots engine in
  percentage
7 n2=70; //The increased efficiency of the carnots
  engine in percentage
8
9 //Calculations
10 T2=t2+273; //The low temperature of the reservoir in
  K
11 T1=T2/(1-(n1/100)); //The temperature of the source
  reservoir in K
12 T11=T2/(1-(n2/100)); //The temperature to be
  maintained by the source reservoir in K
13 T=T11-T1; //The increase in temperature of the source
  in K or degree centigrade
14
15 //Output
16 printf('The increase in temperature of the source is
  %3.1f K (or) %3.1f degree centigrade ',T,T)

```

Scilab code Exa 10.37 Temperature

```

1 clc
2 clear
3 //Page number 486
4 //Input data
5 T1=6174; //The temperature of the black body in K
6 l1=4700; //The wavelength emitted by the black body
  in amstrong units
7 l2=1400; //The wavelength to be emitted by the black
  body in amstrong units
8
9 //Calculations
10 T2=(l1*T1)/l2; //The temperature to be maintained by
  the black body in K
11

```

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

Scilab code Exa 10.38 Energy

```
1 clc
2 clear
3 //Page number 487
4 //Input data
5 e=8.5*10^28;//The given energy density of electrons
    in copper in electrons/m^3
6 k=1.38*10^-23;//The boltzmann constant in J/K
7 h=6.62*10^-34;//Planks constant in J.s
8 m=9.1*10^-31;//The given mass of electrons in kg
9 pi=3.14;//The mathematical constant of pi
10
11 //Calculations
12 E=(((3*e)/pi)^(2/3))*(h^2)*(1/8)*(1/m);//The fermi
    energy for copper in J
13 EF=E/(1.6*10^-19);//The fermi energy for copper in
    eV
14
15 //Output
16 printf('The fermi energy for copper at absolute zero
    is %3.3f eV ',EF)
```

Scilab code Exa 10.39 mass

```
1 clc
2 clear
3 //Page number 487
4 //Input data
```

```

5 t1=100; //The temperature of the source in degree
   centigrade
6 t2=0; //The temperature of the sink in degree
   centigrade
7 P=100; //The power of the engine in watts (or) J/s
8 l=80; //The latent heat of ice in cal/g
9
10 // Calculations
11 T1=t1+273; //The temperature of the source in K
12 T2=t2+273; //The temperature of the sink in K
13 L=l*4.2*10^3; //The latent heat of ice in ergs/kg
14 W=P*60; //The amount of work done in one minute in J
15 H2=(W*T2)/(T1-T2); //The amount of heat at the sink
   in J
16 m=(H2/L); //The amount of ice melts in kg
17
18 //Output
19 printf('The amount of ice that will melt in one
   minute is %3.5f kg ',m)

```

Scilab code Exa 10.40 Speed

```

1 clc
2 clear
3 //Page number 488
4 //Input data
5 C1=1.84; //The RMS speed of molecules of hydrogen at
   NTP in km/s
6 p1=2; //The molecular weight of hydrogen
7 p2=32; //The molecular weight of oxygen
8
9 // Calculations
10 C2=C1*(p1/p2)^(1/2); //The RMS speed of oxygen at NTP
   in km/s
11 C21=C2*1000; //The RMS speed of oxygen at NTP in m/s

```

```

12
13 //Output
14 printf('The RMS speed of oxygen at NTP is %3.2f km/
      s (or) %3.0f m/s ',C2,C21)

```

Scilab code Exa 10.41 Heat

```

1  clc
2  clear
3  //Page number 488
4  //Input data
5  t=101;//The temperature at which water boils in
      degree centigrade
6  p=787;//The pressure maintained at water boils in mm
      of Hg
7  t1=100;//Normal boiling point of water in degree
      centigrade
8  T=t1+273;//Normal boiling point of water in K
9  p1=760;//The normal maintained pressure in mm of Hg
10 V2=1601;//The specific volume of water evaporation
      in cm^3
11 V1=1;//The specific volume of water in cm^3
12
13 //Calculations
14 V=V2-V1;//The change in specific volume in cm^3
15 dT=t-t1;//The change in temperature in degree
      centigrade or K
16 dP=(p-p1)/10;//The change in pressure in cm of Hg
17 L=(T*dP*13.6*980*V)/dT;//Latent heat of steam in
      ergs/g
18 L1=L/(4.2*10^7);//The latent heat of steam in cal/g
19
20 //Output
21 printf('The latent heat of steam is %3.4g ergs/g (
      or) %3.2f cal/g ',L,L1)

```

Scilab code Exa 10.42 Fermi energy

```
1 clc
2 clear
3 //Page number 488
4 //Input data
5 d=7.7*10^3; //The density of aluminium in kg/m^3
6 w=27; //The atomic weight of Al in kg/k.mol
7 N=6.023*10^26; //The number of free electrons in Al
8 k=1.38*10^-23; //The boltzmann constant in J/K
9 h=6.62*10^-34; //Planks constant in J.s
10 m=9.1*10^-31; //The given mass of electrons in kg
11 pi=3.14; //The mathematical constant of pi
12
13 //Calculations
14 V=w/d; //The volume occupied by Al in m^3/k.mol
15 E=(((3*(N/V))/pi)^(2/3))*(h^2)*(1/8)*(1/m); //The
    fermi energy for aluminium in J
16 EF=E/(1.6*10^-19); //The fermi energy for aluminium
    in eV
17 p=(2/3)*(N/V)*(E); //The pressure of electrons in
    aluminium at absolute zero in N/m^2
18
19 //Output
20 printf('The fermi energy for aluminium at absolute
    zero is %3.3f eV \n The pressure of electrons in
    aluminium at absolute zero is %3.4g N/m^2',EF,p
    )
```

Scilab code Exa 10.43 Heat

```

1  clc
2  clear
3  //Page number 489
4  //Input data
5  t2=20; //The temperature of room in degree centigrade
6  t1=37; //The skin temperature of the boy in degree
      centigrade
7  t=10; //The given time in min
8  A=3; //The surface area of the student in m^2
9  e=0.9; //The emissivity of the student
10
11 //Calculations
12 T2=t2+273; //The temperature of the room in K
13 T1=t1+273; //The skin temperature of the boy in K
14 t1=t*60; //The given time in sec
15 s=5.67*10^-8; //Stefans constant in W/m^2-K^4
16 R=e*A*s*(T1^4-T2^4); //Heat loss by the skin in one
      second in J/s
17 Q=R*t1; //Total heat loss by the skin in 10 minutes
      in J
18
19 //Output
20 printf('The total heat loss by the skin in 10
      minutes is %3.4g J ',Q)

```

Scilab code Exa 10.44 Pressure

```

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

```

```

7 V1=8*10^-4; //The initial volume of the air in m^3
8 V2=6*10^-5; //The final volume of the air in m^3
9 g=1.4; //The adiabatic index
10
11 //Calculations
12 T1=t1+273; //The temperature of the air in K
13 p2=p1*(V1/V2)^(g); //The final pressure of the gas in
    atmospheres
14 T2=(p2/p1)*(V2/V1)*T1; //The final temperature of the
    gas in K
15 T21=T2-273; //The final temperature of the gas in
    degree centigrade
16
17 //Output
18 printf('The final pressure of the gas is %3.1f
    atmospheres \n The final temperature of the gas
    is %3.1f K (or) %3.1f degree centigrade ',p2,T2
    ,T21)

```

Scilab code Exa 10.47 Mean Free path

```

1 clc
2 clear
3 //Page number 491
4 //Input data
5 d=2*10^-10; //The molecular diameter of an ideal gas
    in m
6 t=20; //The temperature of the gas in degree
    centigrade
7 p=1; //The pressure of the gas in atmosphere
8 pi=3.142; //The mathematical constant of pi
9
10 //Calculations
11 T=t+273; //The temperature of the gas in K
12 P=1.01*10^5; //The pressure of the gas in N/m^2

```



```

13 v=511; //The velocity of the molecules at 20 degree
    centigrade in m/s
14 k=1.38*10^-23; //Boltzman constant in J/K
15 n=P/(k*T); //The number of molecules per m^3
16 l=1/(1.414*pi*d^2*n); //The mean free path in m
17 f=v/l; //The collision frequency in per second
18
19 //Output
20 printf('(a)The mean free path is %3.4g m \n (b)The
    collision frequency is %3.4g per second ',l,f)

```

Scilab code Exa 10.48 Collision

```

1 clc
2 clear
3 //Page number 492
4 //Input data
5 l=1.876*10^-7; //The mean free path of the gas in m
6 v=511; //The average speed of the molecule in m/s
7
8 //Calculations
9 f=v/l; //The collision frequency in per second
10
11 //Output
12 printf('The collision frequency is %3.4g per second
    ',f)

```

Scilab code Exa 10.49 Entropy

```

1 clc
2 clear
3 //Page number 492
4 //Input data

```

```

5 s=1; //The specific heat of water in kcal/kg C
6 m=1; //The mass of ice in kg
7 H=80; //The latent heat of ice in kcal/kg
8 H1=540; //The latent heat of steam in kcal/kg
9 T=273; //The temperature of the ice in K
10 T1=373; //The temperature of water at 100 degree
    centigrade in K
11
12 // Calculations
13 S1=H/T; //The increase in entropy when 1 kg of ice at
    273 K is converted into water at 273 K in kcal/K
14 S2=m*s*log(T1/T); //The increase in entropy when 1 kg
    of water at 273 K is converted into water at 373
    K in kcal/K
15 S3=H1/T1; //The increase in entropy when 1 kg of
    water at 373 K is converted into steam at 373 K
    in kcal/K
16 S=S1+S2+S3; //The total increase in entropy in kcal/K
17
18 //Output
19 printf('The total increase in entropy is %3.3f kcal
    /K ',S)

```

Scilab code Exa 10.50 Temperature

```

1 clc
2 clear
3 //Page number 493
4 //Input data
5 t1=27; //The initial temperature of the gas in degree
    centigrade
6 g=1.4; //The adiabatic index
7 p1=1; //Let the initial pressure in atmospheres
8 p2=2*p1; //The final pressure in atmospheres
9

```

```

10 //Calculations
11 T1=t1+273;//The initial temperature of the gas in K
12 T2=(((p2/p1)^(g-1))*(T1^g)^(1/g));//The final
    temperature of the gas in K
13 T=T2-T1;//The rise in temperature of a gas in K or
    degree centigrade
14
15 //Output
16 printf('The rise in temperature is %3.1f degree
    centigrade ',T)

```

Scilab code Exa 10.51 Work done

```

1 clc
2 clear
3 //Page number 493
4 //Input data
5 V1=10^-3;//One litre of monoatomic perfect gas at
    NTP in m^3
6 V2=(V1/2);//The final volume in m^3
7 g=1.67;//The adiabatic index
8
9 //Calculations
10 W=(1/(g-1))*((1/(V2)^(g-1))-(1/(V1)^(g-1)));//The
    work done on the gas in J
11
12 //Output
13 printf('The work done on the gas is %3.1f J ',W)

```

Scilab code Exa 10.52 Temperature

```

1 clc
2 clear

```

```

3 //Page number 494
4 //Input data
5 T1=1200;//The temperature at which first engine
   receives heat in K
6 T2=300;//The temperature at which second engine
   rejects to heat reservoir in K
7
8 //Calculations
9 Tw=(T1+T2)/2;//The temperature when the work outputs
   of two engines are equal in K
10 Te=(T1*T2)^(1/2);//The temperature when the
   efficiency of two engines are equal in K
11
12 //Output
13 printf('(a)The temperature when the work outputs of
   two engines are equal is %3.0f K \n (b)The
   temperature when the efficiency of two engines
   are equal is %3.0f K ',Tw,Te)

```

Scilab code Exa 10.53 Work done

```

1 clc
2 clear
3 //Page number 495
4 //Input data
5 t1=27;//The temperature of the source in degree
   centigrade
6 t2=-73;//The temperature of the sink in degree
   centigrade
7 H2=300;//The amount of heat released by the sink in
   cal
8
9 //Calculations
10 T1=t1+273;//The temperature of the source in K
11 T2=t2+273;//The temperature of the sink in K

```

```

12 H1=H2*(T1/T2); //The amount of heat released by the
    source in cal
13 W=H1-H2; //The work performed per cycle in cal
14 W1=W*4.2; //The work performed per cycle in J
15
16 //Output
17 printf('The work performed by the engine per cycle
    is %3.0f J ',W1)

```

Scilab code Exa 10.54 Power

```

1 clc
2 clear
3 //Page number 495
4 //Input data
5 m=3; //The rate at which ice melts in kg/hour
6 t=28; //The external temperature in degree centigrade
7 Li=3.3*10^5; //Specific latent heat of ice fusion in
    Jkg^-1
8 s=4.2*10^3; //The specific heat in Jkg^-1.C
9
10 //Calculations
11 Q=(m*Li)+(m*s*t); //The heat taken by the ice to melt
    into water in J
12 P=Q/3600; //To prevent melting of ice ,the
    refrigerator should have the power out in J/s
13
14 //Output
15 printf('The minimum power output of the motor is %3
    .0f watts ',P)

```

Scilab code Exa 10.55 Temperature

```

1  clc
2  clear
3  //Page number 496
4  //Input data
5  Li=3.3*10^5;//Specific latent heat of ice fusion in
    Jkg-1
6  V1=1.090*10-3;//The specific volume of one kg of
    ice in m3
7  V2=10-3;//The specific volume of one kg of water in
    m3
8  T=273;//The temperature maintained in K
9  dP=1.01*105;//The increase in pressure in N/m2
10
11 //Calculations
12 dT=-(dP*T*(V2-V1))/Li;//The depression in the
    melting point of ice in K (or) degree centigrade
13
14 //Output
15 printf('The depression of melting point of ice is
    %3.2g K (or) %3.2g degree centigrade ',dT,dT)

```

Scilab code Exa 10.56 Temperature

```

1  clc
2  clear
3  //Page number 497
4  //Input data
5  dp=100;//The change in mercury pressure in cm of Hg
6  v2=1601;//Specific volume of steam in cm3/gram
7  v1=1;//Specific volume of water in cm3/gram
8  l=536;//Latent heat in cal/gram
9  t=100;//The temperature of the steam in degree
    centigrade
10
11 //calculations

```

```

12 dP=1*13.6*10^3*9.8; //The change in mercury pressure
    in N/m^2
13 V2=v2*10^-3; //Specific volume of steam in m^3/kg
14 V1=v1*10^-3; //Specific volume of water in m^3/kg
15 L=1*4.2*10^3; //Latent heat in J/kg
16 T=t+273; //The temperature of the steam in K
17 dT=(dP*T*(V2-V1))/L; //The increase in boiling point
    of water in K or degree centigrade
18
19 //Output
20 printf('The increase in boiling point of water is
    %3.2f K (or) %3.2f degree centigrade ',dT,dT)

```

Scilab code Exa 10.57 Temperature

```

1  clc
2  clear
3  //Page number 497
4  //Input data
5  L=80; //The latent heat of fusion of ice in cal/gm
6  Li=3.3*10^5; //Specific latent heat of ice fusion in
    Jkg^-1
7  dp=1; //The increase in pressure in atmospheres
8  t=0; //The given temperature in degree centigrade
9  v=-0.1; //The change in specific volume in cm^3/gm
10
11 //Calculations
12 dP=0.76*13.6*10^3*9.8; //The increase in pressure in
    N/m^2
13 V=v*10^-3; //The change in specific volume in m^3/kg
14 T=t+273; //The given temperature in K
15 dT=-(dP*T*(V))/Li; //The decrease in the melting
    point of ice with increase in the pressure of one
    atmosphere in K
16

```

```

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

```

Scilab code Exa 10.58 Entropy

```

1  clc
2  clear
3  //Page number 498
4  //Input data
5  R=8.4; //The universal gas constant in J.mol-1.K-1
6  Cv=21; //The specific heat at constant volume in J.
    mol-1.K-1
7  P1=2*105; //The initial pressure of gas in N/m2
8  V1=20; //The initial volume of the gas occupied in
    litres
9  P2=5*105; //The final pressure of the gas in N/m2
10 V2=50; //The final volume of the gas occupied in
    litres
11
12 //Calculations
13 T=(P2*V2)/(P1*V1); //The ratio of final temperature
    to the initial temperature for perfect gas
14 V=V2/V1; //The ratio of final volume to the initial
    volume for perfect gas
15 S=(Cv*log(T))+(R*log(V)); //The change of entropy in
    J/K
16
17 //Output
18 printf('The increase in entropy is %3.2f J/K ',S)

```

Scilab code Exa 10.59 Entropy


```

1  clc
2  clear
3  //Page number 499
4  //Input data
5  s=4.2*10^3;//The specific heat of water is J/kg.C
6  m1=0.1;//The mass of water at 15 degree centigrade
   in kg
7  m2=0.16;//The mass of water at 40 degree centigrade
   in kg
8  t1=15;//The temperature of the first water in degree
   centigrade
9  t2=40;//The temperature of the second water in
   degree centigrade
10
11 //Calculations
12 T1=t1+273;//The temperature of the first water in K
13 T2=t2+273;//The temperature of the second water in K
14 T=((m1*T1)+(m2*T2))/(m1+m2);//The final mixed
   temperature in K
15 s1=m1*s*2.3026*log10(T/T1);//The change in entropy
   for 0.1 kg of water in J/K
16 s2=m2*s*2.3026*log10(T/T2);//The change in entropy
   for 0.16 kg of water in J/K
17 S=s1+s2;//The net change in the entropy of the
   system in J/K
18
19 //Output
20 printf('The net increase in entropy is %3.2f J/K ',
   S)

```

Scilab code Exa 10.60 Entropy

```

1  clc
2  clear
3  //Page number 500

```

```

4 //Input data
5 m=12.5*10^-3; //The amount of ice in kg
6 li=80; //Latent heat of ice in cal/gram
7 l=536; //Latent heat of steam in cal/gram
8 si=0.5; //Specific heat of ice in cal/gram-K
9 sw=1; //Specific heat of water in cal/gram-K
10 T1=-24+273; //The initial temperature of ice in K
11 T2=0+273; //The final temperature of ice in K
12 T3=100+273; //The final temperature of water in K
13
14 //Calculations
15 Li=li*10^3*4.2; //The latent heat of ice in J/kg
16 Ls=l*10^3*4.2; //The latent heat of water in J/kg
17 Si=si*10^3*4.2; //The specific heat of ice in J/kg-K
18 Sw=sw*10^3*4.2; //The specific heat of water in J/kg-
    K
19 s1=m*Si*log(T2/T1); //The increase in entropy of ice
    from 249 K to 273 K in J/K
20 s2=(m*Li)/T2; //The increase in entropy from 273 K
    ice to 273 K water in J/K
21 s3=m*Sw*log(T3/T2); //The increase in entropy of
    water from 273 K to 373 K in J/K
22 s4=(m*Ls)/T3; //The increase in entropy from water at
    373 K to steam at 373 K in J/K
23 S=s1+s2+s3+s4; //The total increase in entropy in J/K
24
25 //Output
26 printf('The total increase in entropy is %3.2f J/K
    ',S)

```

Scilab code Exa 10.61 Time

```

1 clc
2 clear
3 //Page number 502

```

```

4 //Input data
5 x1=20;//The initial thickness of the layer in cm
6 x2=30;//The final thickness of the layer in cm
7 t1=-15;//The temperature of the surroundings in
    degree centigrade
8 L=80;//The latent heat of ice in cal/gram
9 d=0.9;//The given density of ice in g/cm^3
10 K=0.005;//The coefficient of thermal conductivity in
    C.G.S units
11
12 //Calculations
13 t=((d*L)/(2*K*t1))*(x1^2-x2^2);//The time taken in
    sec
14
15 //Output
16 printf('The time taken for a layer of ice to
    increase the thickness is %3.2g sec ',t)

```

Scilab code Exa 10.62 Temperature

```

1 clc
2 clear
3 //Page number 502
4 //Input data
5 t1=121;//The temperature of solid copper sphere in
    degree centigrade
6 dt1=2.6;//The rate of cooling of copper sphere in
    degree centigrade per minute
7 t2=195;//The temperature of another solid sphere in
    degree centigrade
8 t=30;//The surrounding temperature in degree
    centigrade
9
10 //Calculations
11 T1=t1+273;//The temperature of solid copper sphere

```

```

    in K
12 T2=t2+273; //The temperature of another solid copper
    sphere in K
13 T0=t+273; //The surrounding temperature in K
14 R1=1; //Let the radius of the first sphere in m
15 R2=2*R1; //The radius of the second sphere in m
16 dt2=(dt1)*(R1/R2)*((T2^4-T0^4)/(T1^4-T0^4)); //The
    rate at which solid copper sphere cools in degree
    centigrade per minute
17
18 //Output
19 printf('The rate at which solid copper sphere cools
    is %3.3f degree centigrade per minute ',dt2)

```

Scilab code Exa 10.63 Heat

```

1  clc
2  clear
3  //Page number 504
4  //Input data
5  dt=250; //The temperature gradient of an insulated
    copper rod in degree centigrade per metre
6  x=0.05; //The distance between the two points in m
7  K=384; //The thermal conductivity of copper in W.m
    ^-1.K^-1
8  A=1; //The surface area of the copper rod in m^2
9  t=1; //The given time in seconds
10
11 //Calculations
12 T=dt*x; //The temperature difference in degree
    centigrade
13 Q=K*A*(dt)*t; //The amount of heat crossed per unit
    area per sec in J/s
14
15 //Output

```

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

Scilab code Exa 10.64 Radiant

```
1 clc
2 clear
3 //Page number 505
4 //Input data
5 T1=200;//The first temperature of the black body in
    K
6 T2=2000;//The second temperature of the black body
    in K
7 s=5.672*10^-8;//Stefans constant in M.K.S units
8
9 //Calculations
10 R=(s*T1^4)/(s*T2^4);//The comparision of radiant
    emittance of a black body for given temperatures
11
12 //Output
13 printf('The comparision of radiant emittance of a
    black body at 200 K and 2000 K is %3.0g ',R)
```

Scilab code Exa 10.65 Radiant

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

```
6 T=500; //The temperature of the black sphere in K
7 T0=300; //The temperature of the surroundings in K
8 s=6*10^-8; //The stefans constant in W m^-2 K^-4
9 pi=3.14; //The mathematical constant of pi
10
11 //Calculations
12 A=pi*d^2; //The area of the black sphere in m^2
13 e=1; //The emittance of the black body
14 R=s*A*e*(T^4-T0^4); //The rate at which energy is
    radiated in J/s or watts
15
16 //Output
17 printf('The rate at which energy is radiated R = %3
    .2f J/s (or) %3.2f watts',R,R)
```
