

R Textbook Companion for
Thermodynamics And Heat Power
by I. Granet And M. Bluestein¹

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Book Description

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R 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)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means an R code whose theory is explained in Section 2.3 of the book.

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Chapter 1

Fundamental Concepts

R code Exa 1.1 Determine the Temperature

```
1 # page no. 8
2
3 func <- function(x) {a <- 5/9*(x-32)-x}
4 root = uniroot(func, c(160,161), extendInt = "yes")
5 print(root[1])
```

R code Exa 1.2 Weight on Moon

```
1 # page no. 18
2
3 Mm = 0.0123
4 Me = 1
5 Dm = 0.273
6 De = 1
7 Rm = Dm/2
8 Re = De/2
9
10 F = (Me/Mm)*(Rm/Re)^2;
11 print(format(F,digits=3))
```

R code Exa 1.3 Weight on Earth

```
1 # page no. 20
2
3 M = 5;
4 g = 9.81;
5 W = M*g;
6 print(W);
```

R code Exa 1.4 Determine its Weight and horizontal acceleration

```
1 # page no. 21
2
3 M = 10
4 g = 9.5
5 W = M*g;
6 print(W);
7
8 F = 10;
9 a = F/M;
10 print(a);
```

R code Exa 1.5 Derive the conversion Factor

```
1 # page no: 25
2
3 in1 = 12;
4 m = 2.54/100;
5 l = ((m*in1)**2);
```

```
6 print(1)
```

R code Exa 1.7 Determine the Pressure

```
1 # page no. 33
2
3 Gamma = (1.0/454)*(2.54*12)^3;
4 print(format(Gamma,digits=3))
5 p = (1/12)*(Gamma*13.6);
6 p = (1/12)*Gamma*13.6*(1/144)
7 print(format(p,digits=3));
8
9 P = p+14.7;
10 print(format(P,digits=4));
```

R code Exa 1.8 Determine the pressure

```
1 # page no. 34
2
3 Rho = 13.595
4 h = 25.4
5 g = 9.806
6 p = Rho*g*h
7 print(p);
```

R code Exa 1.9 Determine the pressure

```
1 # page no. 34
2
3 Patm = 30.0
```

```
4 Vacuum = 26.5
5 Pabs = Patm-Vacuum
6 p = Pabs*0.491
7 print(format(p,digits=3))
```

R code Exa 1.10 Determine the pressure

```
1 # page no. 35
2
3 Rho = 2000
4 h = -10
5 g = 9.6
6 p = -Rho*g*h
7 print(p/1000)
```

R code Exa 1.11 Determine the pressure

```
1 # page no. 35
2
3 Patm = 30.0
4 Vacuum = 26.5
5 Pabs = Patm-Vacuum
6 p = (3.5*(1/12)*13.6*62.4*(1/2.2)*9.806)/(12^2*
      0.0254^2*1000)
7 print(p)
```

Chapter 2

Work Energy and Heat

R code Exa 2.2 How much work done

```
1 # page no. 62
2
3 k = 100
4 l = 2
5 work = (1.0/2)*k*l^2
6 print(work)
```

R code Exa 2.3 How much work done

```
1 # page no. 62
2
3 k = 20*1000
4 l = 0.075
5 work = (1/2)*k*l^2
6 print(work)
```

R code Exa 2.4 How much work done

```
1 # page no. 66
2
3 Z = 600
4 gc = 32.174
5 g = gc
6 m = 1
7 PE = (m*g*Z)/gc
8 print(PE)
```

R code Exa 2.5 Determine the change

```
1 # page no. 66
2
3 m = 1
4 g = 9.81
5 Z = 50
6 PE = m*g*Z
7 print(PE)
```

R code Exa 2.6 Determine the change

```
1 # page no. 66
2
3 Rho = 62.4
4 A = 10000
5 V = (231/1728)
6
7 Z = 600
8 gc = 32.174
9 g = gc
10 m = 1
```



```
11 PE = (m*g*Z)/gc
12 print(PE)
13
14 M = Rho*A*V
15 Power = M*PE
16 print(Power)
17 print(Power/33000)
18
19 # The answer may slightly vary due to rounding off
    values
```

R code Exa 2.7 Determine the horsepower

```
1 # page no. 67
2
3 m = 1
4 g = 9.81
5 Z = 50
6 PE = m*g*Z
7 print(PE)
8
9 M = 1000
10 Power = PE*M*(1/60)
11 print(Power)
12 print(Power/745)
```

R code Exa 2.8 Determine the change

```
1 # page no. 69
2
3 m = 10
4 V1 = 88
5 V2 = 10
```

```

6 gc = 32.174
7
8 KE1 = m*V1^2/(2*gc)
9 print(KE1)
10
11 KE2 = m*V2^2/(2*gc)
12 print(KE2)
13
14 KE = KE1-KE2
15 print(KE)

```

R code Exa 2.9 Determine the change

```

1 # page no. 70
2
3 m = 1500
4 V1 = 50
5 KE1 = (m*(V1*1000)^2/3600^2)/2
6 V2 = 30
7 KE2 = (m*(V2*1000)^2/3600^2)/2
8 KE = KE1-KE2
9 print(KE/1000)

```

R code Exa 2.10 what will kinetic Energy

```

1 # page no. 70
2
3 m = 10
4 Z = 10
5 g = 9.81
6 PE1 = m*g*Z
7 v = (PE1*2)/m
8 V = sqrt(v)

```

```
9 print(V)
10 KE2 = PE1
11 print(PE1)
```

R code Exa 2.11 Determine the Flow work term

```
1 # page no. 74
2
3 p1 = 100
4 Rho1 = 62.4
5 v1 = 144*(1/Rho1)
6 J = 778
7 FW1 = (p1*v1)/J
8 print(FW1)
9
10 p2 = 50
11 Rho2 = 30
12 v2 = 144*(1/Rho2)
13 J = 778
14 FW2 = (p2*v2)/J
15 print(FW2)
```

R code Exa 2.12 Determine the Flow work

```
1 # page no. 75
2
3 p1 = 200*1000
4 Rho1 = 1000
5 v1 = 1/Rho1
6 FW1 = p1*v1
7 print(FW1)
8
9 p2 = 100*1000
```

```
10 Rho2 = 250
11 v2 = 1/Rho2
12 FW2 = p2*v2
13 print(FW2)
```

R code Exa 2.14 How much work done

```
1 # page no. 78
2
3 p1 = 100*144
4 v1 = 2
5 v2 = 1
6 w = p1*v1*log(v2/v1)
7 print(w)
8 print(w/778)
9
10 # The answer provided in the textbook is wrong
```

R code Exa 2.15 Determine the work done

```
1 # page no. 79
2
3 p1 = 200*1000
4 p2 = 800*1000
5 v1 = 0.1
6 v2 = (p1/p2)*v1
7 w = p1*v1*log(v2/v1)
8 print(w/1000)
```

Chapter 3

The first law of Thermodynamics

R code Exa 3.4 Determine the change

```
1 # page no. 94
2
3 m = 10
4 Heat = 100
5 deltaU = Heat/m
6 print(deltaU)
```

R code Exa 3.5 Determine the mass flow rate

```
1 # page no. 96
2
3 P1 = 100
4 Rho1 = 62.4
5 A1V1 = 10000
6 A2 = 2
7 m = Rho1*A1V1
```

```
8 print(m)
9
10 Rho2 = Rho1
11 V2 = m/(Rho2*A2)
12 print(V2)
```

R code Exa 3.6 Determine the mass flow rate

```
1 # page no. 97
2
3 Rho1 = 1000
4 A1V1 = 2000
5 A2 = 0.5
6 m = Rho1*A1V1
7 print(m)
8
9 Rho2 = Rho1
10 V2 = m/(Rho2*A2)
11 print(V2)
```

R code Exa 3.7 Determine the mass flow rate

```
1 # page no. 97
2
3 Rho = 62.4
4 V = 100
5 d = 1
6 A = (pi*d^2)/(4*144)
7 m = Rho*A*V
8 print(m)
```

R code Exa 3.8 Determine the Velocity

```
1 # page no. 98
2
3 m1 = 50000
4 v1 = 0.831
5 d1 = 6
6 A1 = (pi*d1^2)/(4*144)
7 V1 = (m1*v1)/(A1*60*60)
8 print(V1)
9
10 m2 = m1
11 v2 = 1.825
12 d2 = 8
13 A2 = (pi*d2^2)/(4*144)
14 V2 = (m1*v2)/(A2*60*60)
15 print(V2)
```

R code Exa 3.9 Determine the inlet

```
1 # page no. 99
2
3 m1 = 10000
4 v1 = 0.05
5 d1 = 0.1
6 A1 = (pi/4)*d1^2
7 V1 = (m1*v1)/(A1*60*60)
8 print(V1)
9
10 m2 = m1
11 v2 = 0.10
12 d2 = 0.2
13 A2 = (pi/4)*(d2^2)
14 V2 = (m1*v2)/(A2*60*60)
15 print(V2)
```

R code Exa 3.10 Determine the final gas Temperature

```
1 # page no. 105
2
3 Cp = 0.22
4 Cv = 0.17
5 q = 800/10
6 T1 = 100
7
8 deltaT = q/Cp
9 T2 = deltaT+T1
10 w = -(Cv*(T2-T1)-q)
11 print(w)
```

R code Exa 3.11 Determine the Power produced

```
1 # page no. 111
2
3 Z1 = 10
4 V1 = 125
5 h1 = 1505.4
6 Z2 = 0
7 V2 = 430
8 h2 = 940.0
9
10 q = 0
11 J = 778
12 gc = 32.174
13 g = gc
14 W1 = ((Z1/J)*(g/gc)) + (V1^2/(2*gc*J)) + h1 + q - ((
      Z2/J)*(g/gc)) - (V2^2/(2*gc*J)) - h2
```



```

15 print(W1)
16 print(W1*150000)
17 print((W1*150000*778)/(60*33000))
18 print(((W1*150000*778)/(60*33000))*0.746)
19
20 q = 50000/150000
21 W2 = ((Z1/J)*(g/gc)) + (V1^2/(2*gc*J)) + h1 - q - ((
      Z2/J)*(g/gc)) - (V2^2/(2*gc*J)) - h2
22 print(W2)
23
24 # The answer may slightly vary due to rounding off
    values.

```

R code Exa 3.12 Determine the work output

```

1 # page no. 112
2
3 Z1 = 2
4 g = 9.81
5 V1 = 40
6 h1 = 3433.8
7 q = 1
8 Z2 = 0
9 V2 = 162
10 h2 = 2675.5
11
12 w = ((Z1*g)/1000) + ((V1^2/2)/1000) + h1 - q - ((Z2
      *g)/1000) - ((V2^2/2)/1000) - h2
13 print(w)

```

R code Exa 3.13 Determine the work output

```

1 # page no. 113

```

```
2
3 p1 = 150
4 T1 = 1000
5 p2 = 15
6 T2 = 600
7 Cp = 0.24
8 v1 = 2.47
9 v2 = 14.8
10
11 W = Cp*(T1-T2)
12 print(W)
```

R code Exa 3.14 Determine the work output

```
1 # page no. 114
2
3 p1 = 150
4 T1 = 1000
5 p2 = 15
6 T2 = 600
7 Cp = 0.24
8 v1 = 2.47
9 v2 = 14.8
10
11 W = Cp*(T1-T2)
12 print(W)
13
14 q = 1.1
15 W1 = -q+W
16 print(W1);
```

R code Exa 3.15 Determine the magnitude and Direction

```

1 # page no. 115
2
3 p1 = 100
4 t1 = 950
5 p2 = 76
6 t2 = 580
7 v1 = 4
8 v2 = 3.86
9 Cv = 0.32
10
11 T1 = t1+460
12 T2 = t2+460
13 J = 778
14 q = Cv*(T2-T1) + (p2*v2*144)/J - (p1*v1*144)/J
15 print(q)

```

R code Exa 3.16 Determine the direction and magnitude

```

1 # page no. 116
2
3 p1 = 100
4 t1 = 950
5 p2 = 76
6 t2 = 580
7 v1 = 4
8 v2 = 3.86
9 Cv = 0.32
10
11 T1 = t1+460
12 T2 = t2+460
13 J = 778
14 gc = 32.174
15 g = gc
16
17 Z2 = 100

```

```
18 q = Cv*(T2-T1) + (p2*v2*144)/J - (p1*v1*144)/J + ((
    Z2/J)*(g/gc))
19 print(q);
```

R code Exa 3.17 How much energy has been added

```
1 # page no. 117
2
3 p1 = 1000
4 t1 = 100
5 p2 = 1000
6 t2 = 1000
7 h1 = 70.68
8 h2 = 1505.9
9 T1 = t1+460
10 T2 = t2+460
11 J = 778
12 q = h2-h1
13 print(q);
14 print(q*10000)
```

R code Exa 3.18 Determine the Velocity

```
1 # page no. 119
2
3 h1 = 1220
4 h2 = 1100
5
6 J = 778
7 gc = 32.174
8 V2 = sqrt((2*gc*J)*(h1-h2))
9 print(V2)
10
```

```
11 V1 = 1000
12 V2 = sqrt(((h1-h2)*(2*gc*J)) + V1^2 )
13 print(V2)
```

R code Exa 3.19 Determine the Velocity

```
1 # page no. 120
2
3 h1 = 3450*1000
4 h2 = 2800*1000
5
6 V2 = sqrt(2*(h1-h2))
7 print(V2)
```

R code Exa 3.21 Determine the Flow rate

```
1 # page no. 125
2
3 m = 400
4 Cp = 0.85
5 T1 = 215
6 T2 = 125
7 DeltaT = T2-T1
8 Qoil = m*Cp*DeltaT
9 print(Qoil)
10
11 Cpw = 1.0
12 T3 = 60
13 T4 = 90
14 DeltaTw = T4-T3
15 Mw = Qoil/(Cpw*DeltaTw)
16 print(abs(Mw))
```

Chapter 4

The second law of Thermodynamics

R code Exa 4.1 What is the Efficiency of the cycle

```
1 # page no. 148
2
3 t1 = 1000
4 t2 = 80
5 T1 = t1+460
6 T2 = t2+460
7
8 ans = ((T1-T2)/T1)*100
9 print(ans)
10
11 T1 = 2000+460
12 T2 = t2+460
13 ans = ((T1-T2)/T1)*100
14 print(ans)
15
16 T1 = t1+460
17 T2 = 160+460
18 ans = ((T1-T2)/T1)*100
19 print(ans)
```

R code Exa 4.2 Determine The amount of Work

```
1 # page no. 149
2
3 Qin = 100
4 t1 = 1000
5 t2 = 80
6
7 T1 = t1+460
8 T2 = t2+460
9 print(((T1-T2)/T1)*100)
10
11 W = 0.63*Qin
12 W = Qin*(W/Qin)
13 Qr = Qin-W
14 print(Qr)
```

R code Exa 4.3 what is the minimum horsepower input

```
1 # page no. 149
2
3 t1 = 70
4 t2 = 15
5 Qin = 125000
6 T1 = t1+460
7 T2 = t2+460
8 Qr = Qin*(T2/T1)
9 print(Qr)
10 work = Qin-Qr
11 print(work)
12 print(work*778/(60*33000))
```

R code Exa 4.4 Determine the heat supplied

```
1 # page no. 150
2
3 W = (50*33000)/778
4 print(W)
5
6 t1 = 1000
7 t2 = 100
8 T1 = t1+460
9 T2 = t2+460
10 n = (1-(T2/T1))*100
11 print(n)
12
13 Qin = W/(n/100)
14 print(Qin)
15 Qr = Qin*(1-(n/100))
16 print(Qr)
17
18 # The answer may slightly vary due to rounding off
    values
```

R code Exa 4.5 Determine the heat supplied

```
1 # page no. 151
2
3 t1 = 700
4 t2 = 20
5 T1 = t1+273
6 T2 = t2+273
7 n = (T1-T2)/T1*100
8 print(n)
```



```
9
10 output = 65
11 work = output*0.746
12 print(work)
13
14 Qin = work/(n/100)
15 print(Qin)
16
17 Qr = Qin*(1-(n/100))
18 print(Qr)
```

R code Exa 4.7 Determine the Temperature

```
1 # page no. 152
2
3 t1 = 700
4 t2 = 200
5
6 T1 = t1+460
7 T2 = t2+460
8
9 Ti = sqrt(T1*T2)
10 print(Ti)
11 print(Ti-460)
12
13 # The answer may slightly vary due to rounding off
    values
```

R code Exa 4.8 What is the change

```
1 # page no. 157
2
3 q = 843.7
```

```
4 t = 381.86
5 T = t+460
6 deltaS = (q/T)
7 print(deltaS)
```

R code Exa 4.9 How much work is done

```
1 # page no. 158
2
3 q = 843.7
4 t = 381.86
5 T = t+460
6 deltaS = (q/T)
7 t1 = 381.86
8 t2 = 50
9 T1 = t1+460
10 T2 = t2+460
11 qin = q
12 n = (1-(T2/T1))*100
13 print(n)
14 wbyJ = qin*n*0.01
15 print(wbyJ)
16 Qr = qin-wbyJ
17 print(Qr)
18 qin = T1*deltaS
19 Qr = T2*deltaS
20 print(Qr)
21
22 wbyJ = qin-Qr
23 print(wbyJ)
24
25 n = (wbyJ/qin)*100
26 print(n)
```

R code Exa 4.10 Compare your answer

```
1 # page no. 159
2
3 hfg = 1959.7
4 T = 195.07+273
5 deltaS = hfg/T
6 print(deltaS)
```

R code Exa 4.11 how much of this energy unavailable

```
1 # page no. 159
2
3 t = 1000
4 T1 = t+460;
5
6 Qin = 100
7 deltaS = Qin/T1
8 T2 = 50+460
9 Qr = T2*deltaS
10 print(Qr)
11 T2 = 0+460
12 Qr = T2*deltaS
13 print(Qr)
```

R code Exa 4.12 How much energy

```
1 # page no. 160
2
```

```

3 Qin = 1000
4 t = 500
5
6 T1 = t+273
7 deltaS = Qin/T1
8 T2 = 20+273
9 Qr = T2*deltaS
10 print(Qr)
11
12 T2 = 0+273
13 Qr = T2*deltaS
14 print(Qr)

```

R code Exa 4.13 Determine the temprature

```

1 # page no. 161
2
3 m = 6
4 Cp = 0.361
5 DeltaS = -0.7062
6 t = 1440
7
8 T1 = t+460
9 T2 = T1*exp(DeltaS/(m*Cp))
10 print(T2)
11 print(T2-460)

```

R code Exa 4.14 specific heat

```

1 # page no. 162
2
3 m1 = 1
4 m2 = 1

```

```

5 c1 = 1
6 c2 = 1
7 t1 = 500
8 t2 = 100
9 cmix = 1
10
11 t = ((m1*c1*t1)+(m2*c2*t2))/((m1+m2)*cmix)
12 print(t)
13
14 deltas = cmix*log((t+460)/(t1+460))
15 deltaS = cmix*log((t+460)/(t2+460))
16 print(deltaS+deltas)

```

R code Exa 4.15 answer in F

```

1 # page no. 163
2
3 m1 = 1
4 m2 = 1
5 c1 = 1
6 c2 = 1
7 t1 = 500
8 t2 = 100
9 cmix = 1
10 t = ((m1*c1*t1)+(m2*c2*t2))/((m1+m2)*cmix)
11 print(t)
12
13 deltas = cmix*log((t1+460)/(0+460))
14 s = cmix*log((t2+460)/(0+460))
15 s1 = cmix*log((t+460)/(0+460))
16 print(s1-deltas)
17
18 s2 = cmix*log((t+460)/(0+460))
19 print(s2-s)
20 print(s1-deltas+s2-s)

```


Chapter 5

Properties of liquids and Gases

R code Exa 5.1 Compare your answer

```
1 # page no. 182
2
3 p = 0.6988
4 vg = 467.7
5 ug = 1040.2
6 J = 778
7 hg = ug+((p*vg*144)/J)
8 print(hg)
```

R code Exa 5.2 Compare your answer

```
1 # page no. 187
2
3 p = 4.246
4 vg = 32.894
5 ug = 2416.6
6 J = 778
7 hg = ug+(p*vg)
8 print(hg)
```

R code Exa 5.3 Compare the Results

```
1 # page no. 188
2
3 hg = 1190.4+(3/5)*(1191.1-1190.4)
4 print(hg)
5
6 vg = 3.884-(3/5)*(3.884-3.730)
7 print(vg)
8
9 sg = 1.5921-(3/5)*(1.5921-1.5886)
10 print(sg)
11
12 ug = 1107.7-(3/5)*(1108.3-1107.7)
13 print(ug)
14
15 # The answer may slightly vary due to rounding off
    values
```

R code Exa 5.4 Determine Hfg

```
1 # page no.189
2
3 p = 115
4 ufg = 798.8
5 ug = 3.884
6 vf = 0.017850
7 J = 778
8 hfg = ufg+(p*144*(ug-vf))/J
9 print(hfg)
```

R code Exa 5.5 Determine the hfg

```
1 # page no. 190
2
3 p = 1000
4 ufg = 1822.0
5 vf = 0.0011273
6 vg = 0.19444
7 vfg = vg-vf
8 hfg = ufg+(p*vfg)
9 print(hfg)
```

R code Exa 5.6 Determine Hfg

```
1 # page no. 190
2
3 a = 388.12;
4 b = 460;
5 c = 1.1042
6 hfg = (a+b)*(c)
7 print(hfg)
8
9 # The answer provided in the textbook is wrong.
```

R code Exa 5.7 Determine its entropy

```
1 # page no. 192
2
3 x = 0.8
```

```

4 sf = 0.49201
5 sfg = 1.0966
6 hf = 312.67
7 hfg = 878.5
8 uf = 312.27
9 ufg = 796.0
10 vf = 0.017886
11 vfg = (3.730-0.017886)
12 sx = sf+(x*sfg)
13 print(sx);
14 hx = hf+(x*hfg)
15 print(hx)
16 ux = uf+(x*ufg)
17 print(ux)
18 vx = vf+(x*vfg)
19 print(vx)
20
21 J = 778
22 px = 120
23 ux = hx-((px*vx*144)/J)
24 print(ux)

```

R code Exa 5.8 Determine its entropy

```

1 # page no. 193
2
3 x = 0.85
4 sf = 2.1387
5 sfg = 4.4487
6 hf = 762.81
7 hfg = 2015.3
8 uf = 761.68
9 ufg = 1822.0
10 vf = 1.1273
11 vfg = (194.44-1.1273)

```

```
12 sx = sf+(x*sfg)
13 print(sx)
14
15 hx = hf+(x*hfg)
16 print(hx)
17
18 ux = uf+(x*ufg)
19 print(ux)
20 vx = (vf+(x*vfg))*(0.001)
21 print(vx)
22
23 px = 10^6
24 ux = hx-((px*vx)/10^3)
25 print(ux)
```

R code Exa 5.9 What is its quality

```
1 # page no. 193
2
3 hx = 900
4 hf = 58.07
5 hfg = 1042.7
6 x = (hx-hf)/hfg
7 print(x*100)
```

R code Exa 5.10 Determine its quality

```
1 # page no. 194
2
3 hx = 2000
4 hf = 125.79
5 hfg = 2430.5
6 x = (hx-hf)/hfg
```

```
7 print(x*100)
```

R code Exa 5.13 Determine the Specific Volume

```
1 # page no. 197
2
3 v=1.4691+(1/2)*(1.4945-1.4691)
4 print(v);
5
6 u=1131.8+(1/2)*(1137.0-1131.8)
7 print(u);
8
9 h=1221.5+(1/2)*(1228.2-1221.5)
10 print(h);
11
12 s=1.5219+(1/2)*(1.5293-1.5219)
13 print(s);
```

R code Exa 5.14 Determine the Specific Volume

```
1 # page no. 198
2
3 v = 1.4696-(2/5)*(1.4693-1.4448);
4 h = 1227.5-(2/5)*(1227.5-1226.7);
5
6 v = 1.4640-(2/5)*(1.4640-1.4693);
7 h = 1234.2-(2/5)*(1234.2-1233.4);
8
9 v = 1.4595+(1/2)*(1.4841-1.4595);
10 h = 1227.5+(1/2)*(1233.9-1227.5);
11 print(v)
12 print(h)
```

R code Exa 5.16 Determine the enthalpy

```
1 # page no. 202
2
3 pf = 66.98
4 vf = 0.017448
5 hf = 269.73
6 p = 1000
7 J = 778
8 h = hf+((p-pf)*vf*144)/J
9 print(h)
10 percentoferror = (h-271.46)/271.46;
11 print(percentoferror*100)
```

R code Exa 5.27 Compare the result

```
1 # page no. 213
2
3 moisture = 0.192
4 a = 1
5 q = (a-moisture)*100
6 print(q);
```

R code Exa 5.35 Determine the moisture

```
1 # page no. 218
2
3 hx=1168.8;
4 hf=330.75;
```

```
5 hfg=864.2;
6 x=(hx-hf)/hfg;
7 print((1-x)*100);
8 print(x);
```

R code Exa 5.36 Determine the pressure

```
1 # page no. 219
2
3 u2 = 1093.0
4 u1 = 117.95
5 q = u2-u1
6 print(q)
```

R code Exa 5.37 Determine the Heat added

```
1 # page no. 220
2
3 Vf = 45
4 vf = 0.016715
5 Vg = 15
6 vg = 26.80
7 mf = Vf/vf
8 mg = Vg/vg
9 total = mf+mg
10 ug = 1077.6;
11 uf = 180.1;
12 Ug = mg*ug
13 Uf = mf*uf
14 Total = Ug+Uf
15 print(Total)
16 vx = (Vf+Vg)/(mf+mg)
17 vx = 0.022282;
```

```

18 vf = 0.02087;
19 vfg = 0.5691-0.02087;
20 x = (vx-vf)/vfg;
21 print(x*total)
22
23 mg = x*total;
24 print(total-(x*total))
25 mf = total-(x*total)
26 ug = 1115.0
27 uf = 506.6
28 Ug = mg*ug
29 Uf = mf*uf
30 Total1 = Ug+Uf
31 difference = Total1-Total
32 print(difference/total)

```

R code Exa 5.38 Determine the change

```

1 # page no. 222
2
3 h1 = 1270.4
4 sx = 1.4861
5 sf = 0.5440
6 sfg = 1.0025
7 hf = 355.6
8 hfg = 843.7;
9 x = (sx-sf)/sfg
10 hx = hf+(x*hfg)
11 print(hx)
12 print(h1-hx)

```

R code Exa 5.39 Determine the final state of steam

```
1 # page no. 226
2
3 deltax = 0.8*122
4 h1 = 1270
5 h2 = h1-delta
6 print(h2)
```

R code Exa 5.40 Determine the change

```
1 # page no. 226
2
3 h1 = 2942
4 h2 = 2512
5 print(h1-h2)
```

R code Exa 5.41 Determine the change

```
1 # page no. 226
2
3 h1minush2 = 122
4 J = 778
5 gc = 32.17
6 V2 = sqrt(2*gc*J*(h1minush2))
7 print(V2)
```

R code Exa 5.42 Determine the Velocity

```
1 # page no. 227
2
3 h1 = 1270
```



```
4 h2 = 1199
5 J = 778
6 gc = 32.17
7 V2 = sqrt(2*gc*J*(h1-h2))
8 print(V2)
```

R code Exa 5.43 How much Heat per pound

```
1 # page no. 229
2
3 h2 = 1412.1
4 h1 = 1205.3
5 q = h2-h1
6 print(q)
```

R code Exa 5.44 how much heat removed

```
1 # page no. 229
2
3 hf = 69.74
4 hfg = 1036.0
5 hg = 1105.8
6 x = 0.97
7 hx = hf+(x*hfg)
8 print(hx)
9
10 deltah = hx-hf
11 print(deltah)
12
13 # The answer may slightly vary due to rounding off
    values
```

Chapter 6

The Ideal Gas

R code Exa 6.1 What volume will gas occupy

```
1 # page no. 241
2
3 P1 = 100
4 V1 = 100
5 P2 = 30
6 V2 = (P1*V1)/P2
7 print(V2)
```

R code Exa 6.2 What volume will gas occupy

```
1 # page no. 241
2
3 P1 = 10^6
4 V1 = 2
5 P2 = 8*10^6
6 V2 = (P1*V1)/P2
7 print(V2)
```

R code Exa 6.3 Determine the volume

```
1 # page no. 242
2
3 T1 = 32+460
4 V1 = 150
5 T2 = 100+460
6 V2 = (T2*V1)/T1
7 print(V2)
```

R code Exa 6.5 Determine the volume

```
1 # page no. 242
2
3 V1 = 4
4 T2 = 0+273
5 T1 = 100+273
6 V2 = V1*(T2/T1)
7 print(V2)
```

R code Exa 6.6 How much gas is there in container

```
1 # page no. 245
2
3 p = (200+14.7)*(144)
4 T = (460+73)
5 V = 120/1728
6 R = 1545/28
7 v = (R*T)/p
```

```
8 print(v)
9 print(V/v)
10 m = (p*V)/(R*T)
11 print(m)
```

R code Exa 6.7 what is the pressure

```
1 # page no. 245
2
3 p1 = 200+14.7
4 T2 = 460+200
5 T1 = 460+73
6 p2 = p1*(T2/T1)
7 print(p2)
```

R code Exa 6.8 Determine the mass of gas

```
1 # page no. 246
2
3 R = 8.314/44
4 p = 500
5 V = 0.5
6 T = (100+273)
7 m = (p*V)/(R*T)
8 print(m)
```

R code Exa 6.9 Determine the mean specific heat

```
1 # page no. 252
2
```

```

3 T2    =    500+460
4 T1    =    80+460
5 Adash =    0.338
6 Bdash =   -1.24*10^2
7 Ddash =    4.15*10^4
8 cpbar =  Adash+((Bdash*log(T2/T1))/(T2-T1))+
           Ddash/(T2*T1))
9 print(cpbar)

```

R code Exa 6.10 Solve the answer

```

1 # page no. 252
2
3 hbar540 = 3729.5+(3/63)*(4167.9-3729.5)
4 hbar960 = 6268.1+(60/100)*(6977.9-6268.1)
5 h2 = 6694.0
6 h1 = 3750.4
7 T2 = 500+460
8 T1 = 80+460
9 cbar = (h2-h1)/(28*(T2-T1))
10 print(cbar);

```

R code Exa 6.11 Determine the heat

```

1 # page no. 253
2
3 T2 = 500+460
4 T1 = 80+460
5 A = 0.219
6 B = 3.42*10^-5
7 D = 2.93*10^-9
8 cpbar = A+((B/2)*(T2+T1))+((D/3)*(T2^2+(T2*T1)+T1^2)
           )

```

```
9 print(cpbar)
```

R code Exa 6.12 Determine cu

```
1 # page no. 255
2
3 R = 1545/32
4 J = 778
5 cp = 0.24
6 cv = cp-(R/J)
7 print(cv)
```

R code Exa 6.13 Determine the cp

```
1 # page no. 255
2
3 R = 8.314/32
4 k = 1.4
5 cv = R/(k-1)
6 print(cv)
7 cp = k*cv
8 print(cp)
```

R code Exa 6.14 Determine k cv and cp

```
1 # page no. 255
2
3 R = 60
4 deltah = 500
5 deltau = 350
```

```
6 J = 778
7 k = deltah/deltau
8 print(k);
9 cv = R/(J*(k-1))
10 print(cv)
11 cp = k*cv
12 print(cp)
```

R code Exa 6.15 find the specific heat

```
1 # page no. 256
2
3 Q = 0.33
4 V = 60
5 m = 0.0116
6 p1 = 90
7 T1 = 460+40
8 V = 60
9 m = 0.0116
10 p2 = 108
11 T2 = 460+140
12 cv = Q/(m*(T2-T1))
13 print(cv)
14
15 R = (144*p1*(V/1728))/(m*T1)
16 print(R)
17
18 J = 778
19 cp = cv+(R/J)
20 print(cp)
```

R code Exa 6.16 Determine the change

```

1 # page no. 260
2
3 cp = 0.24
4 p2 = 15
5 p1 = 100
6 T2 = 460+0
7 T1 = 460+100
8 J = 778
9 R = 1545/29
10 deltas = (cp*(log(T2/T1))) - ((R/J)*(log(p2/p1)))
11 print(deltas)

```

R code Exa 6.17 solve the problem

```

1 # page no. 261
2
3 cp=0.24;
4 p2=15;
5 p1=100;
6 T2=460+0;
7 T1=460+100;
8 J=778;
9 R=1545/29;
10
11 k=(cp*J)/((cp*J)-R);
12 print(k);
13
14 cv=cp/k;
15 print(cv);
16 v2byv1=(T2*p1)/(T1*p2);
17 deltas=(cv*log(p2/p1))+(cp*log(v2byv1));
18 print(deltas);

```

R code Exa 6.18 Determine the change

```
1 # page no. 261
2
3 cp = 0.9093
4 p2 = 150
5 p1 = 500
6 T2 = 273+0
7 T1 = 273+100
8 R = 8.314/32
9 deltas = (cp*(log(T2/T1))) - ((R)*(log(p2/p1)))
10 deltaS = 2*deltas
11 print(deltaS)
```

R code Exa 6.19 what was the increase in pressure

```
1 # page no. 262
2
3 k=1.4
4 v2=1/2
5 v1=1
6 p2byp1=exp((1/4) - (k*log(v2/v1)))
7 print(p2byp1)
```

R code Exa 6.20 Determine the change

```
1 # page no. 264
2
3 T2 = 460+270
4 T1 = 460+70
5 cv = 0.17
6 deltas = cv*log(T2/T1)
7 deltaS = (1/2)*deltas
```

```
8 print(deltaS)
```

R code Exa 6.21 Determine the change

```
1 # page no. 264
2
3 T2 = 100+273
4 T1 = 20+273
5 cv = 0.7186
6 deltas = cv*log(T2/T1)
7 deltaS = (0.2)*deltas
8 print(deltaS)
```

R code Exa 6.22 Determine the higher temperature

```
1 # page no. 264
2
3 deltas = 0.0743
4 T1 = 460+100
5 cv = 0.219
6 T2 = T1*exp(deltas/cv)
7 print(T2)
```

R code Exa 6.23 Determine the initial temperature

```
1 # page no. 265
2
3 deltaS = 0.4386
4 T2 = 273+425
5 cv = 0.8216
```

```
6 m = 1.5
7 T1 = T2/(exp(deltaS/(m*cv)))
8 print(T1)
9 print(T1-273)
```

R code Exa 6.24 Determine the heat transferred

```
1 # page no. 267
2
3 T2 = 460+400
4 T1 = 460+70
5 cp = 0.24
6 J = 778
7 R = 1545/29
8 deltah = cp*(T2-T1)
9 print(deltah)
10 deltas = cp*log(T2/T1)
11 print(deltas)
12 flowworkchange = (R/J)*(T2-T1)
13 print(flowworkchange)
```

R code Exa 6.25 Determine the heat transferred

```
1 # page no. 268
2
3 T2 = 500+273
4 T1 = 20+273
5 cp = 1.0062
6 deltah = cp*(T2-T1)
7 print(deltah)
8 deltas = cp*log(T2/T1)
9 print(deltas)
```

R code Exa 6.26 Determine the Heat added

```
1 # page no. 270
2
3 v2 = 2;
4 v1 = 1;
5 T = 460+200;
6 J = 778;
7 R = 1545/28;
8 q = ((R*T)/J)*log(v2/v1);
9 Q = 0.1*q;
10 print(Q*10);
11 WbyJ = Q;
12 print(WbyJ);
```

R code Exa 6.27 Determine the Heat added

```
1 # page no. 270
2
3 T = 50+273;
4 v2 = 1/2;
5 v1 = 1;
6 R = 8.314/32;
7 q = R*T*log(v2/v1);
8 print(q);
9 W = q;
10 print(W);
```

R code Exa 6.28 Determine the change

```

1 # page no. 271
2
3 T = 50+273;
4 v2 = 1/2;
5 v1 = 1;
6 R = 8.314/32;
7 q = R*T*log(v2/v1);
8 print(q);
9 deltas = q/T;
10 print(deltas);

```

R code Exa 6.29 Determine the final state

```

1 # page no. 274
2
3 T1 = 1000;
4 p2 = 1;
5 p1 = 5;
6 J = 778;
7 R = 1545/29;
8 k = 1.4;
9 T2 = T1*((p2/p1)^((k-1)/k));
10 print(T2);
11 work = (R*(T2-T1))/(J*(1-k));
12 print(work)

```

R code Exa 6.30 Determine the final state

```

1 # page no. 274
2
3 T1 = 500+273;
4 p2 = 1;
5 p1 = 5;

```

```

6 J = 778;
7 R = 8.314/29;
8 k = 1.4;
9 T2 = T1*((p2/p1)^((k-1)/k));
10 print(T2-273);
11 work = (R*(T2-T1))/((1-k));
12 print(work)

```

R code Exa 6.31 Determine k ofr this gas

```

1 # page no. 275
2
3 library(MASS)
4 T1 = 800+273;
5 T2 = 500+273;
6 p2 = 1;
7 p1 = 5;
8 k = ginv(1-((log(T2/T1)/log(p2/p1))))[1];
9 print(k[1]);

```

R code Exa 6.32 Determine the heat transferred

```

1 # page no. 279
2
3 n = 1.3;
4 k = 1.4;
5 cp = 0.24;
6 T2 = 600;
7 T1 = 1500;
8 R = 53.3;
9 J = 778;
10 cv = cp/k;
11 cn = cv*((k-n)/(1-n));

```

```
12 print(cn);
13 q = cn*(T2-T1);
14 print(q);
15 w = (R*(T2-T1))/(J*(1-n));
16 print(w);
17 deltas = cn*log(T2/T1)
18 print(deltas)
```

R code Exa 6.33 Determine the ratio inlet

```
1 # page no. 279
2
3 n = 1.3;
4 k = 1.4;
5 cp = 0.24;
6 T2 = 600;
7 T1 = 1500;
8 R = 53.3;
9 J = 778;
10 p1byp2 = exp(log(T1/T2)/((n-1)/n));
11 print(p1byp2);
12
13 # The answer may slightly vary due to rounding off
    values
```

R code Exa 6.34 Determine the change

```
1 # page no. 284
2
3 h2 = 240.98;
4 h1 = 119.48;
5 u2 = 172.43;
6 u1 = 85.20;
```

```
7 fy2 = 0.75042;
8 fy1 = 0.58233;
9 deltah = h2-h1;
10 deltau = u2-u1;
11 print(deltah)
12 print(deltau);
13 deltas = fy2-fy1;
14 print(deltas);
```

R code Exa 6.35 solve the problem

```
1 # page no. 285
2
3 pr = 12.298;
4 h = 240.98;
5 pr = 12.298/5;
6 T = 620+(((2.4596-2.249)/(2.514-2.249))*20);
7 print(T);
8 u1 = 172.43;
9 u2 = 108.51;
10 work = u1-u2;
11 print(work)
```

R code Exa 6.36 Determine the Velocity

```
1 # page no. 288
2
3 T = 1000+460;
4 Va = 49.0*sqrt(T);
5 print(Va);
6 khydrogen = 1.41;
7 kair = 1.40;
8 Rhydrogen = 766.53;
```



```
9 Rair = 53.36;
10 Vahydrogen = Va*sqrt((Rhydrogen*khydrogen)/(Rair*
    kair));
11 print(Vahydrogen);
```

R code Exa 6.37 what is the mach number

```
1 # page no. 288
2
3 T = 200+460;
4 V = 1500;
5 Va = 49.0*sqrt(T);
6 print(Va);
7 M = V/Va;
8 print(M);
```

R code Exa 6.38 Determine its total enthalpy

```
1 # page no. 290
2
3 V = 1000;
4 gc = 32.17;
5 J = 778;
6 h = 1204.4;
7 h0 = h+((V^2)/(2*gc*J));
8 print(h0);
```

R code Exa 6.39 Calculate the pressure

```
1 # page no. 297
```

```

2
3 library(MASS)
4 k = 1.4
5 M = 1
6 T0 = 800
7 gc = 32.17
8 R = 53.35
9 p0 = 300
10 Tstar = T0*0.8333
11 print(Tstar)
12 Vat = round(sqrt(gc*R*Tstar*k))
13 print(Vat)
14 M1 = 0.3
15 print(M1)
16 pstar = p0*0.52828
17 T1 = round(T0*0.982332,1)
18 print(T1)
19 p1 = p0*0.93947
20 print(p1)
21 Va1 = sqrt(gc*k*R*T1)
22 V1 = round(M1*Va1)
23 print(V1)
24 v = (R*T1)/(p1*144)
25 rho = ginv(v)
26 A = 2.035
27 m = round(rho[1]*A*V1)
28 print(m)

```

R code Exa 6.40 Determine the Temperature

```

1 # page no. 299
2
3 k = 1.4;
4 R = 53.3;
5 M = 2.5;

```

```

6 T0 = 560;
7 T = T0/(1+((1/2)*(k-1)*M^2));
8 print(T);
9 p = 0.5;
10 p0 = p*14.7*((T0/T)^(k/(k-1)));
11 print(p0);
12 gc = 32.17;
13 Va = sqrt(gc*k*R*T);
14 V = M*Va;
15 print(V);
16 v = (R*T)/(p*14.7*144);
17 print(v);
18 print(V/v);
19 M = 2.5;
20 T0 = 560;
21 T = T0*0.444444;
22 print(T)
23 p = 0.5;
24 p0 = (p*14.7)/0.05853;
25 print(p0);
26 print(V)
27 print(v)
28 print(V/v)

```

R code Exa 6.41 Determine the specific Volume

```

1 # page no. 304
2
3 p = 500;
4 pc = 674;
5 T = 50+460;
6 Tc = 343;
7 R = 1545/16;
8 pr = p/pc;
9 Tr = T/Tc;

```

```
10 Z = 0.93;
11 v = Z*((R*T)/(p*144));
12 print(v);
13 v = (R*T)/(p*144);
14 print(v);
```

Chapter 7

Mixture of Ideal Gases

R code Exa 7.1 Determine the number of moles

```
1 # page no. 322
2
3 nO2 = 0.2315/32;
4 print(nO2);
5 nN2 = 0.7685/28.02;
6 print(nN2);
7 nm = nO2+nN2;
8 print(nm);
9 xO2 = nO2/nm;
10 xN2 = nN2/nm;
11 print(xO2);
12 print(xO2+xN2);
13
14 pO2 = xO2*14.7;
15 print(pO2);
16 pN2 = xN2*14.7;
17 print(pN2);
18
19 MWm = (xO2*32) + (xN2*28.02);
20 print(MWm);
21 Rm = 1545/MWm;
```

```
22 print(Rm);
```

R code Exa 7.2 what is the mole fraction

```
1 # page no. 323
2
3 print(1000-14.7)
4 print(14.7/1000)
5 print((1000-14.7)/1000)
6 MWm = ((14.7/1000)*29) + (((1000-14.7)/1000)*120.9);
7 print(MWm);
```

R code Exa 7.3 Determine the moles

```
1 # page no. 323
2
3 nair = 10/29;
4 print(nair);
5 nCO2 = 1/44;
6 print(nCO2);
7 nN2 = 5/28;
8 print(nN2);
9 nm = nair+nCO2+nN2;
10 print(nm);
11 xair = nair/nm
12 xCO2 = nCO2/nm;
13 xN2 = nN2/nm;
14 print(xair);
15 print(xCO2)
16 print(xN2);
17 pair = xair*100;
18 print(pair);
19 pCO2 = xCO2*100;
```

```

20 print(pCO2);
21 pN2 = xN2*100;
22 print(pN2);
23 MWm = (xair*29) + (xCO2*44) + (xN2*28);
24 print(MWm);
25 Rm = 1545/MWm;
26 print(Rm);

```

R code Exa 7.4 Determine the mixture volume

```

1 # page no. 325
2
3 xO2 = 5/15;
4 xH2 = 10/15;
5 print(((5/15)*32)+((10/15)*2.016));
6 R = 1545/32;
7 T = 460+70;
8 p = 14.7;
9 vO2 = (R*T)/(p*144);
10 VO2 = vO2*5*32;
11 print(VO2);
12 Vm = 3*VO2;
13 print(Vm);
14 VH2 = Vm-VO2;
15 print(VH2);
16 R = 1545/2.016;
17 vH2 = (R*T)/(p*144);
18 VH2 = vH2*10*2.016;
19 print(VH2);
20 print(358*((460+70)/(460+32)));
21 VO2 = 5*358*((460+70)/(460+32));
22 print(VO2);
23 VH2 = 10*358*((460+70)/(460+32));
24 print(VH2);

```

R code Exa 7.5 Determine the mixture volume

```
1 # page no. 326
2
3 nCO2 = 10/44;
4 nN2 = 5/28.02;
5 print(nCO2+nN2);
6 xCO2 = nCO2/(nCO2+nN2);
7 xN2 = nN2/(nCO2+nN2);
8 print(xCO2+xN2);
9 MWm = (xCO2*44) + (xN2*28.02);
10 print(MWm);
11 pm = 100;
12 Tm = 460+70;
13 Rm = 1545/37.0;
14 mm = 15;
15 Vm = (mm*Rm*Tm)/(pm*144);
16 print(Vm);
17 VCO2 = Vm*xCO2;
18 print(VCO2);
19 VN2 = Vm*xN2;
20 print(VN2);
21 pCO2 = pm*xCO2;
22 print(pCO2);
23 pN2 = pm*xN2;
24 print(pN2);
```

R code Exa 7.6 Determine the mass fraction

```
1 # page no. 327
2
3 print((0.40*44.0))
```



```
4 print((0.40*44.0)/33.4)
5 print((28.02*0.10))
6 print((28.02*0.10)/33.4)
7 print((0.10*2.016))
8 print((0.10*2.016)/33.4)
9 print((0.40*32.0))
10 print((0.40*32.0)/33.4)
```

R code Exa 7.7 Determine the fraction by volume

```
1 # page no. 328
2
3 moles = c(1.2, 0.3, 0.3, 1.2)
4 s = sum(moles)
5 volume = vector(length = 4)
6 for (i in 1:4) {
7   v = moles[i]/s;
8   volume[i] = v*100;
9   print(v)
10 }
11 MWm = sum(volume)/s
12 print(MWm)
```

R code Exa 7.8 Determine the volumetric analysis

```
1 # page no. 329
2
3 moles = c(0.724, 2.693, 0.033)
4 s = sum(moles)
5 volume = vector(length = 3)
6 for (i in 1:3) {
7   v = moles[i]/s;
8   volume[i] = v*100;
```

```

9   print(v)
10  }
11  MWm = sum(volume)/s
12  print(MWm)
13
14  # The answer may slightly vary due to rounding off
    values.

```

R code Exa 7.9 Determine the final Temperature

```

1  # page no. 331
2
3  a = 500;
4  b = 160;
5  oxygen = 0.164;
6  Cv = 0.25;
7  nitr = 196;
8  tm = ((a*b*0.23)+(nitr*Cv*200))/((nitr*Cv)+(b*0.23))
    ;
9  print(tm);
10 cpm = ((b/(b+nitr))*0.23)+((nitr/(b+nitr))*Cv);
11 print(cpm);
12 tm = ((b*0.23*a)+(nitr*Cv*200))/(cpm*(b+nitr));
13 print(tm);
14
15 # The answer may vary due to the change in units.

```

R code Exa 7.10 Determine the final temperature

```

1  # page no. 332
2
3  a = 500;
4  b = 160;

```

```

5 oxygen = 0.164;
6 Cv = 0.178;
7 nitr = 196;
8 tm = ((a*b*oxygen)+(nitr*Cv*200))/((nitr*Cv)+(b*
  oxygen));
9 print(tm);

```

R code Exa 7.12 Determine the change in entropy

```

1 # page no : 334
2
3 cp = 0.23;
4 T2 = 328.7+460;
5 T1 = 500+460;
6 deltas = (cp*log(T2/T1));
7 DeltaS = 160*deltas;
8 print(DeltaS);
9 cp = 0.25;
10 T2 = 328.7+460;
11 T1 = 200+460;
12 deltas = (cp*log(T2/T1));
13 deltaS = 196*deltas;
14 print(deltaS);
15 deltaS = deltaS+DeltaS;
16 print(deltaS);
17 deltasm = deltaS/(196+160);
18 print(deltasm);
19 cp = 0.23;
20 T2 = 500+460;
21 T1 = 0+460;
22 deltas = cp*log(T2/T1);
23 print(deltas);
24 T2 = 328.7+460;
25 T1 = 0+460;
26 Deltas = cp*log(T2/T1);

```

```

27 print(Deltas);
28 deltaS = Deltas-deltas;
29 print(deltaS);
30 cp = 0.25;
31 T2 = 200+460;
32 T1 = 0+460;
33 deltas = cp*log(T2/T1);
34 print(deltas);
35 T2 = 328.7+460;
36 T1 = 0+460;
37 Deltas = cp*log(T2/T1);
38 print(Deltas);
39 deltaS = Deltas-deltas;
40 print(deltaS);
41
42 # The answer may slightly vary due to rounding off
    values.

```

R code Exa 7.14 Determine the partial pressure

```

1 # page no : 338
2
3 pres1 = 14.7;
4 pres2 = 0.6988;
5 vol = 467.7
6 RT = 1545;
7 mole = 0.00799
8 ratio = 0.0477
9 p_dry_air = 28.966
10 R = RT/p_dry_air;
11 T = 90+460;
12 pdryair = 14.0;
13 vdryair = (R*T)/(pdryair*144);
14 print(pres1-pres2);
15 print(vol/vdryair);

```

```
16 print((mole/ratio)*100);
17 print((mole/ratio)*pres2);
18 print(pres1-((mole/ratio)*pres2));
19 print((mole/ratio)*pres2);
20
21 # The answer may slightly vary due to rounding off
    values.
```

R code Exa 7.15 solve the problem

```
1 # page no. 343
2
3 W = 0.005;
4 pm = 14.7;
5 pv = (W*pm)/(0.622+W);
6 print(pv);
7 pa = pm-pv;
8 print(pa);
9 pvs = 0.6988;
10 print(pvs);
11 phy = pv/pvs;
12 print(phy*100);
```

R code Exa 7.16 how much water was removed

```
1 # page no. 343
2
3 pm = 14.7;
4 phy = 0.7;
5 pvs = 0.6988;
6 pv = phy*pvs;
7 pa = pm-pv;
8 W = 0.622*(pv/pa);
```

```
9 phy = 0.4;
10 pvs = 0.5073;
11 pv = phy*pvs;
12 pa = pm-pv;
13 w = 0.622*(pv/pa);
14 print(W-w);
```

R code Exa 7.18 Solve the problem

```
1 # page no. 347
2
3 total_pres = 14.7;
4 pres = 0.12;
5 print(total_pres-pres);
```

R code Exa 7.19 Solve the problem

```
1 # page no. 348
2
3 w1 = 150;
4 w2 = 61;
5 print(w1-w2);
6 print((w1-w2)/7000);
```

R code Exa 7.20 how much heat is required

```
1 # page no. 349
2
3 t_heat1 = 23.4
4 t_heat2 = 16.1
5 print(t_heat1-t_heat2)
```

R code Exa 7.23 Determine the amount of water

```
1 # page no. 358
2
3 h100F = 68.05;
4 h70F = 38.09;
5 h = 20.4;
6 w = 38.2;
7 H = 52.1;
8 W = 194.0;
9 ma = (200000*(h100F-h70F))/((H-h)-(h70F*((W-w)/7000)
   ));
10 print(ma);
11 print(ma*((W-w)/7000));
12
13 # The answer may slightly vary due to rounding off
   values.
```

Chapter 8

Vapor Power Cycles

R code Exa 8.1 Determine the thermal Efficiency

```
1 # page no. 380
2
3 hf = 340.49;
4 h1 = hf;
5 h4 = 3230.9;
6 h5 = 2407.4;
7 nR = (h4-h5)/(h4-h1);
8 print(nR*100);
9 p2 = 3000;
10 p1 = 50;
11 vf = 0.001030;
12 Pumpwork = (p2-p1)*vf;
13 nR = ((h4-h5)-Pumpwork)/((h4-h1)-Pumpwork);
14 print(nR*100);
```

R code Exa 8.2 solve the problem

```
1 # page no. 381
```



```

2
3 hf = 340.49;
4 h1 = hf;
5 h2 = h1;
6 h4 = 3230.9;
7 h5 = 2407.4;
8 nR = (h4-h5)/(h4-h2);
9 print(nR*100);
10 Pumpwork = 343.59-340.54;
11 nR = ((h4-h5)-Pumpwork)/((h4-h1)-Pumpwork);
12 print(nR*100);

```

R code Exa 8.3 Sketch the cycle

```

1 # page no. 382
2
3 h1 = 180.15;
4 h2 = h1;
5 h4 = 1515;
6 h5 = 1150.5;
7 nR = (h4-h5)/(h4-h2);
8 print(nR*100);
9 p2 = 400;
10 p1 = 14.696;
11 vf = 0.01167;
12 J = 778;
13 Pumpwork = ((p2-p1)*vf*144)/J;
14 nR = ((h4-h5)-Pumpwork)/((h4-h1)-Pumpwork);
15 print(nR*100);

```

R code Exa 8.4 solve the problem

```

1 # page no. 383

```

```

2
3 h5 = 1150.4;
4 h2 = 180.17;
5 h1 = h2;
6 h4 = 1514.0;
7 t = 982.07;
8 h = 181.39;
9 nR = (h4-h5)/(h4-h2);
10 print(nR*100);
11 Pumpwork = h-h2;
12 nR = ((h4-h5)-Pumpwork)/((h4-h2)-Pumpwork);
13 print(nR*100);

```

R code Exa 8.5 what is the type of efficiency

```

1 # page no. 385
2
3 T1 = 982.4+460;
4 T2 = 212+460;
5 nc = ((T1-T2)/T1)*100;
6 print(nc);
7 nR = 27.3;
8 typen = (nR/nc)*100;
9 print(typen);

```

R code Exa 8.6 Calculate the type Efficiency

```

1 # page no. 385
2
3 T1 = 400+273;
4 T2 = 81.33+273;
5 nc = ((T1-T2)/T1)*100;
6 print(nc);

```

```
7 nR = 28.5;
8 typen = (nR/nc)*100;
9 print(typen);
```

R code Exa 8.7 What is the thermal Efficiency of this cycle

```
1 # page no. 386
2
3 work = 1515-1150.5;
4 available = 364.5-50;
5 n = available/(1515-180.15);
6 print(n*100);
```

R code Exa 8.8 Determine the Heat Rate

```
1 # page no. 387
2
3 heatrate = 3413/0.273;
4 print(round(heatrate));
5 print(3413/(1515-1150.5));
```

R code Exa 8.9 Determine the Efficiency

```
1 # page no. 388
2
3 h4 = 1515;
4 h5 = 1205;
5 h7 = 1413;
6 h1 = 180.15;
7 nreheat = ((h4-h5)+(h4-h7))/((h4-h1)+(h4-h7));
8 print(nreheat*100);
```

R code Exa 8.10 solve the problem

```
1 # page no. 389
2
3 h7 = 1413.6;
4 h4 = 1514.0;
5 h5 = 1205.2;
6 h1 = 180.17;
7 nreheat = ((h4-h5)+(h4-h7))/((h4-h1)+(h4-h7));
8 print(nreheat*100);
```

R code Exa 8.11 Determine the Efficiency

```
1 # page no. 394
2
3 h4 = 1505;
4 h5 = 922;
5 h6 = h5;
6 h1 = 69.74;
7 nR = (h4-h5)/(h4-h1);
8 print(nR*100);
9
10 h5 = 1168;
11 h7 = 69.74;
12 h1 = 250.24;
13 W = ((1*h1)-h7)/(h5-h7);
14 print(W);
15 work = (1-W)*(h4-922) + W*(h4-h5);
16 print(work);
17 Qin = h4-h1;
18 n = work/Qin;
```

```

19 print(n*100);
20 n = 1-(((h5-h1)*(h6-h7))/((h4-h1)*(h5-h7)));
21 W = (h1-h7)/(h5-h7);
22 print(n*100);

```

R code Exa 8.12 Compare the Results

```

1 # page no. 396
2
3 W2 = ((1*298.61)-250.24)/(1228.6-250.24);
4 print(W2);
5 W1 = (((1-W2)*250.24)-69.74+(W2*69.74))/(1168-69.74)
;
6 print(W1);
7 work = ((1505-1228.6)*1)+((1-W2)*(1228.6-1168))+((1-
W1-W2)*(1168-922));
8 print(work);
9 qin = 1505-298.61;
10 print(qin);
11 n = work/qin;
12 print(n*100);
13 W2 = (298.61-250.24)/(1228.6-250.24);
14
15 print(W2);
16 W1 = ((1228.6-298.61)*(250.24-69.74))/((1168-69.74)*
(1228.6-250.24));
17 print(W1);
18 n = 1-(((922-69.74)*(1228.6-298.61)*(1168-250.24))/
((1505-298.61)*(1228.6-250.24)*(1168-69.74)));
19 print(n*100);

```

R code Exa 8.13 Compare the Results

```

1 # page no. 398
2
3 W1 = ((1*(280.06-250.24)))/(1228-298.61);
4 print(W1);
5 W2 = ((1*250.24)-(W1*268.61)-69.74+(W1*69.74))/
      (1168-69.74);
6 print(W2);
7 workout = (1*(1505-1228))+((1-W1)*(1228-1168))
      +((1-W1-W2)*(1168-922));
8 print(workout);
9 heatinput = 1505-280.06;
10 print(heatinput);
11 n = workout/heatinput;
12 print(n*100);

```

R code Exa 8.14 Determine the conventional thermal efficiency

```

1 # page no. 426
2
3 h5 = 1168;
4 h4 = 1505;
5 h6 = 922;
6 h1 = 69.74;
7 h7 = 69.74;
8 h2 = 250.24;
9 W = ((1*h2)-h7)/(h5-h7);
10 liquidleaving = (W*h2)+(1-W)*h1;
11 heatin = h4-liquidleaving;
12 print(heatin);
13 workout = ((1-W)*(h4-h6))+(W*(h4-h5));
14 print(workout);
15 n = workout/heatin;
16 print(n*100);
17 qout = W*(h5-h2);
18 n = (workout+qout)/heatin;

```

```
19 print(n*100);  
20  
21 # The answer may slightly vary due to rounding off  
    values
```

Chapter 9

Gas power Cycles

R code Exa 9.1 Compare the Results

```
1 # page no. 462
2
3 Rc = 7;
4 k = 1.4;
5 notto = (1-(1/Rc)^(k-1))*100;
6 print(notto);
7 T2 = 70+460;
8 T4 = 700+460;
9 nc = (1-(T2/T4))*100;
10 print(nc);
11 T4 = 1000+460;
12 nc = (1-(T2/T4))*100;
13 print(nc);
14 T4 = 3000+460;
15 nc = (1-(T2/T4))*100;
16 print(nc);
```

R code Exa 9.2 Determine the efficiency


```

1 # page no. 463
2
3 library(MASS)
4 cv = 0.172;
5 Rc = 7;
6 k = 1.4;
7 T2 = 70+460;
8 T4 = 1000+460;
9 T3byT2 = Rc^(k-1);
10 T3 = T3byT2*T2;
11 qin = cv*(T4-T3);
12 Qr = (ginv(Rc)[1])^(k-1);
13 T5 = T4*Qr;
14 Qr = cv*(T5-T2);
15 print(qin-Qr);
16 notto = ((qin-Qr)/qin)*100;
17 print(notto);
18
19 # The answer may slightly vary due to rounding off
    values.

```

R code Exa 9.3 Determine the peak temprature

```

1 # page no. 464
2
3 cv = 0.7186;
4 Rc = 8;
5 k = 1.4;
6 T2 = 20+273;
7 qin = 50;
8 T3byT2 = Rc^(k-1);
9 T3 = T3byT2*T2;
10 T4 = (qin/cv)+T3;
11 print(T4-273);

```

R code Exa 9.4 Calculate the Efficiency

```
1 # page no. 465
2
3 rc = 7;
4 q = 50;
5 p2 = 14.7;
6 T2 = 60+460;
7 cp = 0.24;
8 cv = 0.171;
9 R = 53.3;
10 k = 1.4;
11 v2 = (R*T2)/(p2*144);
12 print(v2);
13 p3 = p2*rc^k;
14
15 print(p3);
16 v3 = v2/rc;
17 print(v3);
18 T3 = (p3*v3*144)/R;
19 print(T3);
20 v4 = v3;
21 print(v4);
22 T4 = T3+(q/cv);
23 print(T4);
24 p4 = (R*T4)/(144*v4);
25 print(p4);
26 v5 = v2;
27 print(v5);
28 p5 = p4*(v4/v5)^k;
29 print(p5);
30 T5 = (p5*v5*144)/(R);
31 print(T5);
32 n = (((T4-T3)-(T5-T2))/(T4-T3))*100;
```

```
33 print(n);
```

R code Exa 9.7 Determine the horsepower

```
1 # page no. 468
2
3 pm = 1000;
4 N = 4000/2;
5 LA = 2
6 hp = (pm*LA*N)/44760;
7 print (hp);
```

R code Exa 9.9 What is its compression ratio

```
1 # page no. 469
2
3 c = 0.2;
4 rc = (1+c)/c;
5 print(rc);
```

R code Exa 9.10 Determine the mean Effective pressure

```
1 # Page No : 470
2
3 hp = 100;
4 L = 4/12;
5 A = (pi/4)*(3)^2*6;
6 N = 4000/2;
7 pm = (hp*33000)/(L*A*N);
8 print (pm);
```

R code Exa 9.11 Determine the mean Effective pressure

```
1 # page no. 470
2
3 hp = 230;
4 LA = 3.3*1000*(1/2.54)^3;
5 N = 5500/2;
6 pm = (hp*33000*12)/(LA*N);
7 print(pm);
```

R code Exa 9.12 Find the efficiency

```
1 # page no. 478
2
3 library(MASS)
4 rc = 16;
5 v4byv3 = 2;
6 k = 1.4;
7 T2 = 100+460;
8 ndiesel = 1-((ginv(rc)[1])^(k-1)*(((v4byv3)^k-1)/(k*
   (v4byv3-1)))));
9 print(ndiesel*100);
10 T5 = T2*(v4byv3)^k;
11 print(T5)
12 print(round(T5-460));
13
14 # The answer may slightly vary due to rounding off
   values.
```

R code Exa 9.13 Determine the network per pound

```
1 # page no. 479
2
3 rc = 16;
4 v4byv3 = 2;
5 k = 1.4;
6 T2 = 100;
7 T5 = 1018;
8 ndiesel = 0.614
9 cp = 0.24;
10 cv = 0.172;
11 Qr = cv*(T5-T2);
12 qin = Qr/(1-ndiesel);
13 J = 778;
14 networkout = J*(qin-Qr);
15 print(networkout);
16 mep = networkout/((16-1)*144);
17 print(mep);
18
19 # The answer may slightly vary due to rounding off
    values.
```

R code Exa 9.14 Determine the heat in

```
1 # page no. 489
2
3 library(MASS)
4 rc = 7;
5 k = 1.4;
6 cp = 0.24;
7 T3 = 1500;
8 p1 = 14.7;
9 T1 = 70+460;
10 R = 53.3;
```

```
11 nBrayton = 1-((ginv(rc)[1])^(k-1));
12 print(nBrayton*100);
13 v1 = (R*T1)/p1;
14 v2 = v1/rc;
15 T2 = T1*(v1/v2)^(k-1);
16 T2 = T2-460;
17 Qin = cp*(T3-T2);
18 print(Qin);
19 wbyJ = nBrayton*Qin;
20 print(wbyJ);
21 print(Qin-wbyJ);
22
23 # The answer may slightly vary due to rounding off
    values.
```

Chapter 10

Refrigeration

R code Exa 10.1 Calculate the heat removal

```
1 # page no. 503
2
3 T1 = 70+460;
4 T2 = 32+460;
5
6 COP = T2/(T1-T2);
7 print(COP);
8
9 Qremoved = 1000;
10 WbyJ = Qremoved/COP;
11 print(WbyJ);
12
13 Qrej = Qremoved+WbyJ;
14 print(Qrej);
```

R code Exa 10.2 Determine the COP of the Cycle

```
1 # page no. 504
```

```

2
3 T1 = 20+273;
4 T2 = -5+273;
5 COP = T2/(T1-T2);
6 print(COP);
7
8 Qremoved = 30;
9 W = Qremoved/COP;
10 print(W);
11 Qrej = Qremoved+W;
12 print(round(Qrej,2));

```

R code Exa 10.3 Determine the maximum COP for the cycle

```

1 # page no. 505
2
3 T1 = 70+460;
4 T2 = 20+460;
5 COP = T2/(T1-T2);
6 print(COP);
7
8 HPperTOR = 4.717/COP;
9 COPactual = 2;
10 HPperTORactual = 4.717/COPactual;
11 print(HPperTORactual-HPperTOR);

```

R code Exa 10.4 Determine the power required

```

1 # page no. 506
2
3 library(MASS)
4 COP = 4.5;
5 HPperTOR = 4.717/COP;

```



```
6 Qremoved = 1000;
7 HPrequired = HPperTOR*5;
8 print(HPrequired);
9 print(77.2*778*ginv(33000)[1]);
10 print((COP/12.95)*HPrequired);
```

R code Exa 10.5 Determine the power required

```
1 # page no. 506
2
3 COP = 10.72;
4 P = 2.8;
5 COPactual = 3.8;
6 power = P*COP/COPactual;
7 print(power)
```

R code Exa 10.6 Compute the problem

```
1 # page no. 509
2
3 h1 = 116.0;
4 h2 = 116.0;
5 h3 = 602.4;
6 s3 = 1.3938;
7 t4 = 237.4;
8 h4 = 733.4;
9
10 COP = (h3-h1)/(h4-h3);
11 print(COP);
12 print(h4-h3);
13 print(h3-h1);
14
15 tons = 30;
```

```
16 print((200*tons)/(h3-h1));
17
18 print(4.717*((h4-h3)/(h3-h1)));
```

R code Exa 10.7 solve the problem

```
1 # page no. 510
2
3 h1 = 30.14;
4 h2 = 30.14;
5 h3 = 75.110;
6 s3 = 0.17102;
7 h4 = 89.293;
8
9 COP = (h3-h1)/(h4-h3);
10 print(COP);
11 print(h4-h3);
12 print(h3-h1);
13
14 tons = 30;
15 print((200*tons)/(h3-h1));
16 print(4.717*((h4-h3)/(h3-h1)));
```

R code Exa 10.8 Determine the COP of the Cycle

```
1 # page no. 517
2
3 h1 = 28.713;
4 h2 = 28.713;
5 h3 = 78.335;
6 s3 = 0.16798;
7 s = 0.16798;
8 h4 = 87.192;
```

```
9 print(h3-h1);
10 print(h4-h3);
11 COP = (h3-h1)/(h4-h3);
12 print(COP);
```

R code Exa 10.9 solve the problem

```
1 # page no. 518
2
3 h1 = 41.6;
4 h2 = 41.6;
5 h3 = 104.6;
6 s3 = 0.2244;
7 h4 = 116.0;
8 print(h3-h1);
9 print(h4-h3);
10 COP = (h3-h1)/(h4-h3);
11 print(COP);
```

R code Exa 10.10 Find the horse power required

```
1 # page no. 518
2
3 T = -20;
4 h1 = 26.542;
5 n = 0.8;
6 h4 = 100.5;
7 h3 = 75.886;
8 m = (200*5)/(75.886-h1);
9 h4dashminush3 = (h4-h3)/n;
10 J = 778;
11 work = (h4dashminush3*m*J)/33000;
12 print(work);
```

```
13
14 h4dash = h4dashminush3+h3;
15 mdot = (m*(h4dash-h1))/(70-60);
16 print(mdot/8.3);
```

R code Exa 10.11 solve the problem

```
1 # page no. 521
2
3 h3 = 76.2;
4 h4 = 100.5;
5 n = 0.8;
6 work = (h4-h3)/n;
7 m = (200*5)/(h3-26.1);
8 J = 778;
9 totalwork = (m*work*J)/33000;
10 print(totalwork);
11 h4dash = h3+work;
12 mdot = (m*(h4dash-26.5))/(70-60);
13 print(mdot/8.3);
```

R code Exa 10.12 Determine the airflow required

```
1 # page no. 526
2
3 COP = 2.5;
4 cp = 0.24;
5 T1 = -100+460;
6 T3 = 150+460;
7 T4 = (3.5*T1)/COP;
8 T2 = (COP*T3)/3.5;
9 print(cp*(T4-T1));
10 print(cp*(T3-T2));
```

```
11 print((cp*(T3-T2))-(cp*(T4-T1)));
12 print(200/(cp*(T2-T1)));
13
14 # The answer may slightly vary due to rounding off
    values
```

R code Exa 10.13 Calculate the mass of water

```
1 # page no. 536
2
3 h1 = 58.07;
4 h2 = 13.04;
5 h3 = 1081.1;
6 m1 = 1;
7 m3 = (m1*h1-h2)/(h3+h2);
8 print(m3);
```

R code Exa 10.14 solve the problem

```
1 # page no. 536
2
3 h1 = 58.07;
4 h2 = 13.04;
5 h3 = 1081.1;
6 m1 = 1;
7 m3 = (m1*h1-h2)/(h3+h2);
8 m2 = 1-m3;
9 print(m3);
10 print(m3*(h3-h1));
11 print(m2*(h1-h2));
```

R code Exa 10.15 Determine the COP

```
1 # page no. 539
2
3 T1 = 70+460;
4 T2 = 32+460;
5 COP = T1/(T1-T2);
6 print(COP);
7 print(1077.2/77.2);
```

R code Exa 10.16 determine the work

```
1 # page no. 539
2
3 T1 = 70+460;
4 T2 = 0+460;
5 COP = T2/(T1-T2);
6 print(COP);
7 Qremoved = 1000;
8 WbyJ = Qremoved/COP;
9 print(WbyJ);
10 Qrej = Qremoved+WbyJ;
11 print(Qrej);
12 print(Qrej/WbyJ);
```

Chapter 11

Heat transfer

R code Exa 11.1 Determine the heat transferred

```
1 # page no. 553
2
3 deltaX = 6/12;
4 k = 0.40;
5 T1 = 150;
6 T2 = 80;
7 deltaT = T2-T1;
8 Q = (-k*deltaT)/deltaX;
9 print(Q);
```

R code Exa 11.2 Determine the heat transfer

```
1 # page no. 555
2
3 deltaX = 0.150;
4 k = 0.692;
5 T1 = 70;
6 T2 = 30;
```

```
7 deltaT = T2-T1;
8 Q = (-k*deltaT)/deltaX;
9 print(Q);
```

R code Exa 11.3 Determine the heat transferred

```
1 # page no. 556
2
3 deltaX = 6/12;
4 A = 1;
5 k = 0.40;
6 Rt = deltaX/(k*A);
7 deltaE = 9;
8 T1 = 150;
9 T2 = 80;
10 deltaT = T2-T1;
11 Re = (100*deltaE*Rt)/deltaT;
12 print(abs(Re));
13 i = deltaE/Re;
14 Q = 100*i;
15 print(abs(Q));
```

R code Exa 11.4 Determine the heat transferred

```
1 # page no. 558
2
3 deltaX = 6/12;
4 A = 1;
5 k = 0.40;
6 R = deltaX/(k*A);
7
8 print(R);
9 R1 = R;
```



```

10 deltaX = (1/2)/12;
11 A = 1;
12 k = 0.80;
13 R = deltaX/(k*A);
14
15 print(R);
16 R2 = R;
17 deltaX = (1/2)/12;
18 A = 1;
19 k = 0.30;
20 R = deltaX/(k*A);
21
22 print(R);
23 R3 = R;
24 Rot = R1+R2+R3;
25 print(Rot);
26 T1 = 70;
27 T2 = 30;
28 deltaT = T2-T1;
29 Q = deltaT/Rot;
30 print(abs(Q));
31
32 # The answer provided in the textbook is wrong

```

R code Exa 11.5 Calculate the temprature

```

1 # page no. 558
2
3 deltaX = 6/12;
4 A = 1;
5 k = 0.40;
6 R = deltaX/(k*A);
7
8 print(R);
9 R1 = R;

```

```

10 deltaX = (1/2)/12;
11 A = 1;
12 k = 0.80;
13 R = deltaX/(k*A);
14
15 print(R);
16 R2 = R;
17 deltaX = (1/2)/12;
18 A = 1;
19 k = 0.30;
20 R = deltaX/(k*A);
21
22 print(R);
23 R3 = R;
24 Rot = R1+R2+R3;
25 print(Rot);
26 T1 = 70;
27 T2 = 30;
28 deltaT = T2-T1;
29 Q = deltaT/Rot;
30 print(abs(Q));
31
32 deltaT = R*Q
33 deltaT = Q*R1;
34 t1 = deltaT;
35 deltaT = Q*R2;
36 t2 = deltaT;
37 deltaT = Q*R3;
38 t3 = deltaT;
39 deltaTo = t1+t2+t3;
40 print(abs(deltaTo));
41
42 print(abs(T2)+abs(t1));
43 print(abs(T2)+abs(t1)+abs(t2));

```

R code Exa 11.6 Determine the heat transferred

```
1 # page no. 559
2
3 deltaX = 0.150;
4 A = 1;
5 k = 0.692;
6 R = deltaX/(k*A);
7
8 print(R);
9 R1 = R;
10 deltaX = 0.012;
11 A = 1;
12 k = 1.385;
13 R = deltaX/(k*A);
14
15 print(R);
16 R2 = R;
17 deltaX = 0.0120;
18 A = 1;
19 k = 0.519;
20 R = deltaX/(k*A);
21
22 print(R);
23 R3 = R;
24 Ro = R1+R2+R3;
25 print(Ro);
26 T1 = 0;
27 T2 = 20;
28 deltaT = T2-T1;
29 Q = deltaT/Ro;
30 print(abs(Q));
```

R code Exa 11.7 Determine the temperature

```

1 # page no. 560
2
3 deltaX = 0.150;
4 A = 1;
5 k = 0.692;
6 R = deltaX/(k*A);
7
8 print(R);
9 R1 = R;
10 deltaX = 0.012;
11 A = 1;
12 k = 1.385;
13 R = deltaX/(k*A);
14
15 print(R);
16 R2 = R;
17 deltaX = 0.0120;
18 A = 1;
19 k = 0.519;
20 R = deltaX/(k*A);
21
22 print(R);
23 R3 = R;
24 Ro = R1+R2+R3;
25 print(Ro);
26 T1 = 0;
27 T2 = 20;
28 deltaT = T2-T1;
29 Q = deltaT/Ro;
30 print(abs(Q));
31
32 deltaT = Q*R1;
33 t1 = deltaT;
34 deltaT = Q*R2;
35 t2 = deltaT;
36 deltaT = Q*R3;
37 t3 = deltaT;
38 deltaTo = t1+t2+t3;

```

```

39 print(abs(deltaTo));
40
41 print(abs(deltaTo)-abs(t1));
42 print(abs(deltaTo)-abs(t1)-abs(t2));
43 print(round(abs(deltaTo)-abs(t1)-abs(t2)-abs(t3)));

```

R code Exa 11.8 Determine the heat loss

```

1 # page no. 561
2
3 library(MASS)
4 deltaX = 4/12;
5 A = 7*2;
6 k = 0.090;
7 Rfir = deltaX/(k*A);
8 print(Rfir);
9 deltaX = 4/12;
10 A = 7*2;
11 k = 0.065;
12 Rpine = deltaX/(k*A);
13 print(Rpine);
14 deltaX = 4/12;
15 A = 7*2;
16 k = 0.025;
17 Rcorkboard = deltaX/(k*A);
18 print(Rcorkboard);
19 Roverall = ginv(ginv(Rfir)+ginv(Rpine)+ginv(
    Rcorkboard))[1];
20 print(Roverall);
21 T1 = 60;
22 T2 = 80;
23 deltaT = T2-T1;
24 Qtotal = deltaT/Roverall;
25 print(abs(Qtotal));
26 Qfir = deltaT/Rfir;

```

```
27 print(abs(Qfir));
28 Qpine = deltaT/Rpine;
29 print(abs(Qpine));
30 Qcorkboard = deltaT/Rcorkboard;
31 print(abs(Qcorkboard));
32 Qtotal = Qfir+Qpine+Qcorkboard;
33 print(abs(Qtotal));
```

R code Exa 11.9 Determine the Heat loss

```
1 # page no. 565
2
3 ro = 3.50;
4 ri = 3.00;
5 Ti = 240;
6 To = 120;
7 L = 5;
8 deltaT = Ti-To;
9 k = 26
10 Q = (2*pi*k*L*deltaT)/log(ro/ri);
11 print(Q);
12
13 # The answer may slightly vary due to rounding off
    values
```

R code Exa 11.10 Determine the Heat loss

```
1 # page no. 566
2
3 ro = 90;
4 ri = 75;
5 Ti = 110;
6 To = 40;
```

```
7 L = 2;
8 deltaT = Ti-To;
9 k = 45
10 Q = (2*pi*k*L*deltaT)/log(ro/ri);
11 print(Q);
```

R code Exa 11.11 Determine the heat loss

```
1 # page no. 567
2
3 library(MASS)
4 r2 = 3.50;
5 r1 = 3.00;
6 Ti = 240;
7 L = 5;
8 k1 = 26;
9 ans1 = (ginv(k1)[1]*log(r2/r1));
10 r3 = 5.50;
11 r2 = 3.50;
12 To = 85;
13 deltaT = Ti-To;
14 k2 = 0.026
15 ans2 = (ginv(k2)[1]*log(r3/r2));
16 Q = (2*pi*L*deltaT)/(ans1+ans2);
17 print(Q);
```

R code Exa 11.12 Determine the heat transfer

```
1 # page no. 569
2
3 library(MASS)
4 r2 = 3.50;
5 r1 = 3.00;
```

```

6 Ti = 240;
7 L = 5;
8 k = 26;
9 Rpipe = log(r2/r1)/(2*pi*k*L);
10 print(Rpipe);
11 To = 70;
12 deltaT = Ti-To;
13 h = 0.9;
14 A = (pi*r2)/12*L;
15 Rconvection = ginv(h*A)[1];
16 print(Rconvection);
17 Rtotal = Rpipe+Rconvection;
18 print(Rtotal);
19 Q = deltaT/Rtotal;
20 print(Q);
21
22 # The answer may slightly vary due to rounding off
    values.

```

R code Exa 11.15 Determine the Heat loss

```

1 # page no. 574
2
3 D = 3.5/12;
4 Ti = 120;
5 To = 70;
6 deltaT = Ti-To;
7 h = 0.9;
8 L = 5;
9 A = (pi*D)*L;
10 Q = h*A*deltaT;
11 print(Q);

```

R code Exa 11.16 Determine the heat transfer

```
1 # page no. 575
2
3 library(MASS)
4 h = 1/2;
5 R = (3/12)/0.07;
6 Roverall = ginv(1/2)[1]+ginv(1/2)[1]+R;
7 print(Roverall);
8 Ti = 80;
9 To = 50;
10 deltaT = Ti-To;
11 Q = deltaT/Roverall;
12 print(Q);
13
14 print(Q/(1/2));
15 print(Q*R);
16 print(Q/(1/2));
17 h = 0.42;
18 Roverall = ginv(h)[1]+ginv(h)[1]+R;
19 print(Roverall);
20 Q = deltaT/Roverall;
21 print(Q);
22 print(Q/h);
23 print(Q*R);
24 print(Ti-(Q/h));
25 print(To+(Q/h));
26 print(Ti-(Q/h)-(To+(Q/h)));
27
28 # The answer may slightly vary due to rounding off
    values.
```

R code Exa 11.17 Determine the heat transferred

```
1 # page no. 578
```

```

2
3 G = ((20*60)*(4*144)/(pi*0.87^2));
4 mu = 0.33;
5 D = 0.87/12;
6 Re = (D*G)/mu;
7 print(Re);
8 h1 = 630;
9 F = 1.25;
10 h = h1*F;
11 print(h);

```

R code Exa 11.18 Determine the inside film coefficient

```

1 # page no. 579
2
3 G = ((20*60)*(4*144))/(pi*(0.87^2));
4 mu = 0.062;
5 D = 0.87/12;
6 Re = (D*G)/mu;
7 print(Re);
8 h1 = 135;
9 F = 1.25;
10 h = h1*F;
11 print(h);

```

R code Exa 11.19 Determine the Heat loss

```

1 # page no. 586
2
3 Fe = 0.79;
4 FA = 1;
5 sigma = 0.173*10^-8;
6 T1 = 120+460;

```

```

7 T2 = 70+460;
8 D = 3.5/12;
9 L = 5;
10 A = (pi*D)*L;
11 Q = sigma*Fe*FA*A*(T1^4-T2^4);
12 print(Q);

```

R code Exa 11.20 Determine the heat transferred

```

1 # page no. 588
2
3 Ti = 120;
4 To = 70;
5 deltaT = 120-70;
6 hrdash = 1.18;
7 Fe = 1;
8 FA = 0.79;
9 hr = Fe*FA*hrdash;
10 print(hr);
11 D = 3.5/12;
12 L = 5;
13 A = (pi*D)*L;
14 Q = 214.5;
15 hr = Q/(A*deltaT);
16 print(hr);

```

R code Exa 11.21 solve the problem

```

1 # page no. 589
2
3 Qtotal = 206.2+214.5;
4 print(Qtotal);
5 hcombined = 0.9+0.94;

```

```

6 D = 3.5/12;
7 Ti = 120;
8 To = 70;
9 deltaT = Ti-To;
10 L = 5;
11 A = (pi*D)*L;
12 Qtotal = hcombined*A*deltaT;
13
14 print(Qtotal);

```

R code Exa 11.22 Determine the over all heat transfer

```

1 # page no. 595
2
3 library(MASS)
4 A = 1;
5 deltax = 6/12;
6 k = 0.40;
7 brickResistance = deltax/(k*A);
8
9 print(brickResistance);
10 deltax = (1/2)/12;
11 k = 0.80;
12 concreteResistance = deltax/(k*A);
13
14 print(concreteResistance);
15 deltax = (1/2)/12;
16 k = 0.30;
17 plasterResistance = deltax/(k*A);
18
19 print(plasterResistance);
20 h = 0.9;
21 hotfilmResistance = ginv(h*A)[1];
22
23 print(hotfilmResistance);

```

```

24 h = 1.5;
25 coldfilmResistance = ginv(h*A)[1];
26
27 print(coldfilmResistance);
28 totalResistance = brickResistance+concreteResistance
    +plasterResistance+hotfilmResistance+
    coldfilmResistance;
29 print(totalResistance);
30 U = ginv(totalResistance)[1];
31 print(U);

```

R code Exa 11.23 Determine the heat transferred

```

1 # page no. 596
2
3 hi = 45;
4 r1 = 3.0/2;
5 k1 = 26;
6 r2 = 3.5/2;
7 k2 = 0.026;
8 r3 = 5.50/2;
9 ho = 0.9;
10 Ui = 1/(((1/hi)+((r1/(k1*12))*log(r2/r1))+((r1/(k2*
    12))*log(r3/r2)))+(1/(ho*(r3/r1)))));
11 print(Ui);
12 Uo = Ui*(r1/r3);
13 print(Uo);

```

R code Exa 11.24 Determine the outside tube surfaced

```

1 # page no. 601
2
3 thetaA = 215-90;

```

```

4 thetaB = 125-60;
5 deltaTm = (thetaA-thetaB)/log(thetaA/thetaB);
6 m = 400*60;
7 Cp = 0.85;
8 deltaT = 215-125;
9 Q = m*Cp*deltaT
10 U = 40;
11 A = Q/(U*deltaTm);
12 print(A)
13
14 # The answer may slightly vary due to rounding off
    values.

```

R code Exa 11.25 Determine the outside tube surfaced

```

1 # page no. 602
2
3 thetaA = 215-60;
4 thetaB = 125-90;
5 deltaTm = (thetaA-thetaB)/log(thetaA/thetaB);
6 m = 400*60;
7 Cp = 0.85;
8 deltaT = 215-125;
9 Q = m*Cp*deltaT
10 U = 40;
11 A = Q/(U*deltaTm);
12 print(A);

```

R code Exa 11.26 Calculate the surface required

```

1 # page no. 603
2
3 library(MASS)

```

```
4 U = 40;
5 Roil = 0.005;
6 Rwater = 0.001;
7 Rcleanunit = ginv(U)[1];
8 Roverall = Roil+Rwater+Rcleanunit;
9 Uoverall = ginv(Roverall)[1];
10 A = 569*(U/Uoverall);
11 print(A);
```

R code Exa 11.27 Determine the temprature

```
1 # page no. 605
2
3 t2 = 140;
4 t1 = 280;
5 T1 = 85;
6 T2 = 115;
7 P = (t2-t1)/(T1-t1);
8 R = (T1-T2)/(t2-t1);
9 F = 0.91;
10 LMTD = ((t1-T2)-(t2-T1))/log((t1-T2)/(t2-T1));
11 TMTD = F*LMTD;
12 print(TMTD);
```
