

R Textbook Companion for  
Thermodynamics And Heat Power  
by I. Granet And M. Bluestein<sup>1</sup>

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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 deltah = 0.8*122
4 h1 = 1270
5 h2 = h1-deltah
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 temprature

```
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 tmperature

```
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(pC02);
21 pN2 = xN2*100;
22 print(pN2);
23 MWm = (xair*29) + (xC02*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 temprature

```

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 deltas = deltaS/(196+160);
18 print(deltas);
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 ;
7 print(W1);
8 work = ((1505-1228.6)*1)+((1-W2)*(1228.6-1168))+((1-
9 W1-W2)*(1168-922));
10 print(work);
11 qin = 1505-298.61;
12 print(qin);
13 n = work/qin;
14 print(n*100);
15 W2 = (298.61-250.24)/(1228.6-250.24);
16 print(W2);
17 W1 = ((1228.6-298.61)*(250.24-69.74))/((1168-69.74)*
18 (1228.6-250.24));
19 print(W1);
20 n = 1-(((922-69.74)*(1228.6-298.61)*(1168-250.24))/
21 ((1505-298.61)*(1228.6-250.24)*(1168-69.74)));
22 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);

```

---