R Textbook Companion for Thermodynamics And Heat Power by I. Granet And M. Bluestein[1]

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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.

Contents

List of R Codes

Chapter 1

Fundamental Concepts

R code Exa 1.1 Determine the Temprature

```
# page no. 8

func <- function(x) {a <- 5/9*(x-32)-x}
root = uniroot(func, c(160,161), extendInt = "yes")
print(root[1])
```

R code Exa 1.2 Weight on Moon

```
# page no. 18

Mm = 0.0123
Me = 1
Dm = 0.273
De = 1
Rm = Dm/2
Re = De/2

F = (Me/Mm)*(Rm/Re)^2;
print(format(F,digits=3))
```

R code Exa 1.3 Weight on Earth

```
# page no. 20

M = 5;
g = 9.81;
W = M*g;
print(W);
```

R code Exa 1.4 Determine its Weight and horizontal acceleration

```
# page no. 21

M = 10
g = 9.5
W = M*g;
print(W);

F = 10;
a = F/M;
print(a);
```

R code Exa 1.5 Derive the convesion Factor

```
# page no: 25

in1 = 12;
m = 2.54/100;
l = ((m*in1)**2);
```

```
print(l)
```

R code Exa 1.7 Determine the Pressure

```
# page no. 33

Gamma = (1.0/454)*(2.54*12)^3;
print(format(Gamma,digits=3))
p = (1/12)*(Gamma*13.6);
p = (1/12)*Gamma*13.6*(1/144)
print(format(p,digits=3));

P = p+14.7;
print(format(P,digits=4));
```

R code Exa 1.8 Determine the pressure

```
# page no. 34

Rho = 13.595
h = 25.4
g = 9.806
p = Rho*g*h
print(p);
```

R code Exa 1.9 Determine the pressure

```
# page no. 34

Patm = 30.0
```

```r
Vacuum = 26.5
Pabs = Patm-Vacuum
p = Pabs*0.491
print(format(p,digits=3))
```

R code Exa 1.10 Determine the pressure

```r
# page no. 35

Rho = 2000
h = -10
g = 9.6
p = -Rho*g*h
print(p/1000)
```

R code Exa 1.11 Determine the pressure

```r
# page no. 35

Patm = 30.0
Vacuum = 26.5
Pabs = Patm-Vacuum
p = (3.5*(1/12)*13.6*62.4*(1/2.2)*9.806)/(12^2*
   0.0254^2*1000)
print(p)
```

Chapter 2

Work Energy and Heat

R code Exa 2.2 How much work done

```
# page no. 62

k = 100
l = 2
work = (1.0/2)*k*l^2
print(work)
```

R code Exa 2.3 How much work done

```
# page no. 62

k = 20*1000
l = 0.075
work = (1/2)*k*l^2
print(work)
```

R code Exa 2.4 How much work done

```
# page no. 66

Z = 600
gc = 32.174
g = gc
m = 1
PE = (m*g*Z)/gc
print(PE)
```

R code Exa 2.5 Determine the change

```
# page no. 66

m = 1
g =  9.81
Z = 50
PE = m*g*Z
print(PE)
```

R code Exa 2.6 Determine the change

```
# page no. 66

Rho = 62.4
A = 10000
V = (231/1728)

Z = 600
gc = 32.174
g = gc
m = 1
```

```
PE = (m*g*Z)/gc
print(PE)

M = Rho*A*V
Power = M*PE
print(Power)
print(Power/33000)

# The answer may slightly vary due to rounding off
  values
```

R code Exa 2.7 Determine the horsepower

```
# page no. 67

m = 1
g =  9.81
Z = 50
PE = m*g*Z
print(PE)

M = 1000
Power = PE*M*(1/60)
print(Power)
print(Power/745)
```

R code Exa 2.8 Determine the change

```
# page no. 69

m = 10
V1 = 88
V2 = 10
```

```
gc = 32.174

KE1 = m*V1^2/(2*gc)
print(KE1)

KE2 = m*V2^2/(2*gc)
print(KE2)

KE = KE1-KE2
print(KE)
```

R code Exa 2.9 Determine the change

```
# page no. 70

m = 1500
V1 = 50
KE1 = (m*(V1*1000)^2/3600^2)/2
V2 = 30
KE2 = (m*(V2*1000)^2/3600^2)/2
KE = KE1-KE2
print(KE/1000)
```

R code Exa 2.10 what will kinetic Energy

```
# page no. 70

m = 10
Z = 10
g =  9.81
PE1 = m*g*Z
v = (PE1*2)/m
V = sqrt(v)
```

```
print(V)
KE2 = PE1
print(PE1)
```

R code Exa 2.11 Determine the Flow work term

```
# page no. 74

p1 = 100
Rho1 = 62.4
v1 = 144*(1/Rho1)
J = 778
FW1 = (p1*v1)/J
print(FW1)

p2 = 50
Rho2 = 30
v2 = 144*(1/Rho2)
J = 778
FW2 = (p2*v2)/J
print(FW2)
```

R code Exa 2.12 Determine the Flow work

```
# page no. 75

p1 = 200*1000
Rho1 = 1000
v1 = 1/Rho1
FW1 = p1*v1
print(FW1)

p2 = 100*1000
```

```
Rho2 = 250
v2 = 1/Rho2
FW2 = p2*v2
print(FW2)
```

R code Exa 2.14 How much work done

```
# page no. 78

p1 = 100*144
v1 = 2
v2 = 1
w = p1*v1*log(v2/v1)
print(w)
print(w/778)

# The answer provided in the textbook is wrong
```

R code Exa 2.15 Determine the work done

```
# page no. 79

p1 = 200*1000
p2 = 800*1000
v1 = 0.1
v2 = (p1/p2)*v1
w = p1*v1*log(v2/v1)
print(w/1000)
```

Chapter 3

The first law of Thermodynamics

R code Exa 3.4 Determine the change

```
# page no. 94

m = 10
Heat = 100
deltaU = Heat/m
print(deltaU)
```

R code Exa 3.5 Determine the mass flow rate

```
# page no. 96

P1 = 100
Rho1 = 62.4
A1V1 = 10000
A2 = 2
m = Rho1*A1V1
```

```
print(m)

Rho2 = Rho1
V2 = m/(Rho2*A2)
print(V2)
```

R code Exa 3.6 Determine the mass flow rate

```
# page no. 97

Rho1 = 1000
A1V1 = 2000
A2 = 0.5
m = Rho1*A1V1
print(m)

Rho2 = Rho1
V2 = m/(Rho2*A2)
print(V2)
```

R code Exa 3.7 Determine the mass flow rate

```
# page no. 97

Rho = 62.4
V = 100
d = 1
A = (pi*d^2)/(4*144)
m = Rho*A*V
print(m)
```

R code Exa 3.8 Determine the Velocity

```
# page no. 98

m1 = 50000
v1 = 0.831
d1 = 6
A1 = (pi*d1^2)/(4*144)
V1 = (m1*v1)/(A1*60*60)
print(V1)

m2 = m1
v2 = 1.825
d2 = 8
A2 = (pi*d2^2)/(4*144)
V2 = (m1*v2)/(A2*60*60)
print(V2)
```

R code Exa 3.9 Determine the inlet

```
# page no. 99

m1 = 10000
v1 = 0.05
d1 = 0.1
A1 = (pi/4)*d1^2
V1 = (m1*v1)/(A1*60*60)
print(V1)

m2 = m1
v2 = 0.10
d2 = 0.2
A2 = (pi/4)*(d2^2)
V2 = (m1*v2)/(A2*60*60)
print(V2)
```

R code Exa 3.10 Determine the final gas Temprature

```
# page no. 105

Cp = 0.22
Cv = 0.17
q = 800/10
T1 = 100

deltaT = q/Cp
T2 = deltaT+T1
w = -(Cv*(T2-T1)-q)
print(w)
```

R code Exa 3.11 Determine the Power produced

```
# page no. 111

Z1 = 10
V1 = 125
h1 = 1505.4
Z2 = 0
V2 = 430
h2 = 940.0

q = 0
J = 778
gc = 32.174
g = gc
W1 = ((Z1/J)*(g/gc)) + (V1^2/(2*gc*J)) + h1 + q - ((
    Z2/J)*(g/gc)) - (V2^2/(2*gc*J)) - h2
```

```
print(W1)
print(W1*150000)
print((W1*150000*778)/(60*33000))
print(((W1*150000*778)/(60*33000))*0.746)

q = 50000/150000
W2 = ((Z1/J)*(g/gc)) + (V1^2/(2*gc*J)) + h1 - q - ((Z2/J)*(g/gc)) - (V2^2/(2*gc*J)) - h2
print(W2)

# The answer may slightly vary due to rounding off values.
```

R code Exa 3.12 Determine the work output

```
# page no. 112

Z1 = 2
g = 9.81
V1 = 40
h1 = 3433.8
q = 1
Z2 = 0
V2 = 162
h2 = 2675.5

w =  ((Z1*g)/1000) + ((V1^2/2)/1000) + h1 - q - ((Z2*g)/1000) - ((V2^2/2)/1000) - h2
print(w)
```

R code Exa 3.13 Determine the work output

```
# page no. 113
```

```r

p1 = 150
T1 = 1000
p2 = 15
T2 = 600
Cp = 0.24
v1 = 2.47
v2 = 14.8

W = Cp*(T1-T2)
print(W)
```

R code Exa 3.14 Determine the work output

```r
# page no. 114

p1 = 150
T1 = 1000
p2 = 15
T2 = 600
Cp = 0.24
v1 = 2.47
v2 = 14.8

W = Cp*(T1-T2)
print(W)

q = 1.1
W1 = -q+W
print(W1);
```

R code Exa 3.15 Determine the magnitude and Direction

```
# page no. 115

p1 = 100
t1 = 950
p2 = 76
t2 = 580
v1 = 4
v2 = 3.86
Cv = 0.32

T1 = t1+460
T2 = t2+460
J = 778
q = Cv*(T2-T1) + (p2*v2*144)/J - (p1*v1*144)/J
print(q)
```

R code Exa 3.16 Determine the direction and magnitude

```
# page no. 116

p1 = 100
t1 = 950
p2 = 76
t2 = 580
v1 = 4
v2 = 3.86
Cv = 0.32

T1 = t1+460
T2 = t2+460
J = 778
gc = 32.174
g = gc

Z2 = 100
```

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

R code Exa 3.17 How much energy has been added

```
# page no. 117

p1 = 1000
t1 = 100
p2 = 1000
t2 = 1000
h1 = 70.68
h2 = 1505.9
T1 = t1+460
T2 = t2+460
J = 778
q = h2-h1
print(q);
print(q*10000)
```

R code Exa 3.18 Determine the Velocity

```
# page no. 119

h1 = 1220
h2 = 1100

J = 778
gc = 32.174
V2 = sqrt((2*gc*J)*(h1-h2))
print(V2)

```

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

R code Exa 3.19 Determine the Velocity

```
# page no. 120

h1 = 3450*1000
h2 = 2800*1000

V2 = sqrt(2*(h1-h2))
print(V2)
```

R code Exa 3.21 Determine the Flow rate

```
# page no. 125

m = 400
Cp = 0.85
T1 = 215
T2 = 125
DeltaT = T2-T1
Qoil = m*Cp*DeltaT
print(Qoil)

Cpw = 1.0
T3 = 60
T4 = 90
DeltaTw = T4-T3
Mw = Qoil/(Cpw*DeltaTw)
print(abs(Mw))
```

Chapter 4

The second law of Thermodynamics

R code Exa 4.1 What is the Efficiency of the cycle

```
# page no. 148

t1 = 1000
t2 = 80
T1 = t1+460
T2 = t2+460

ans = ((T1-T2)/T1)*100
print(ans)

T1 = 2000+460
T2 = t2+460
ans = ((T1-T2)/T1)*100
print(ans)

T1 = t1+460
T2 = 160+460
ans = ((T1-T2)/T1)*100
print(ans)
```

R code Exa 4.2 Determine The amount of Work

```
# page no. 149

Qin = 100
t1 = 1000
t2 = 80

T1 = t1+460
T2 = t2+460
print(((T1-T2)/T1)*100)

W = 0.63*Qin
W = Qin*(W/Qin)
Qr = Qin-W
print(Qr)
```

R code Exa 4.3 what is the minimum horsepower input

```
# page no. 149

t1 = 70
t2 = 15
Qin = 125000
T1 = t1+460
T2 = t2+460
Qr = Qin*(T2/T1)
print(Qr)
work = Qin-Qr
print(work)
print(work*778/(60*33000))
```

R code Exa 4.4 Determine the heat supplied

```
# page no. 150

W = (50*33000)/778
print(W)

t1 = 1000
t2 = 100
T1 = t1+460
T2 = t2+460
n = (1-(T2/T1))*100
print(n)

Qin = W/(n/100)
print(Qin)
Qr = Qin*(1-(n/100))
print(Qr)

# The answer may slightly vary due to rounding off
    values
```

R code Exa 4.5 Determine the heat supplied

```
# page no. 151

t1 = 700
t2 = 20
T1 = t1+273
T2 = t2+273
n = (T1-T2)/T1*100
print(n)
```

```r

output = 65
work = output*0.746
print(work)

Qin = work/(n/100)
print(Qin)

Qr = Qin*(1-(n/100))
print(Qr)
```

R code Exa 4.7 Determine the Temprature

```r
# page no. 152

t1 = 700
t2 = 200

T1 = t1+460
T2 = t2+460

Ti = sqrt(T1*T2)
print(Ti)
print(Ti-460)

# The answer may slightly vary due to rounding off
    values
```

R code Exa 4.8 What is the change

```r
# page no. 157

q = 843.7
```

```
t = 381.86
T = t+460
deltaS = (q/T)
print(deltaS)
```

R code Exa 4.9 How much work is done

```
# page no. 158

q = 843.7
t = 381.86
T = t+460
deltaS = (q/T)
t1 = 381.86
t2 = 50
T1 = t1+460
T2 = t2+460
qin = q
n = (1-(T2/T1))*100
print(n)
wbyJ = qin*n*0.01
print(wbyJ)
Qr = qin-wbyJ
print(Qr)
qin = T1*deltaS
Qr = T2*deltaS
print(Qr)

wbyJ = qin-Qr
print(wbyJ)

n = (wbyJ/qin)*100
print(n)
```

R code Exa 4.10 Compare your answer

```
# page no. 159

hfg = 1959.7
T = 195.07+273
deltaS = hfg/T
print(deltaS)
```

R code Exa 4.11 how much of this energy unavailable

```
# page no. 159

t = 1000
T1 = t+460;

Qin = 100
deltaS = Qin/T1
T2 = 50+460
Qr = T2*deltaS
print(Qr)
T2 = 0+460
Qr = T2*deltaS
print(Qr)
```

R code Exa 4.12 How much energy

```
# page no. 160

```

```
Qin = 1000
t = 500

T1 = t+273
deltaS = Qin/T1
T2 = 20+273
Qr = T2*deltaS
print(Qr)

T2 = 0+273
Qr = T2*deltaS
print(Qr)
```

R code Exa 4.13 Determine the temprature

```
# page no. 161

m = 6
Cp = 0.361
DeltaS = -0.7062
t = 1440

T1 = t+460
T2 = T1*exp(DeltaS/(m*Cp))
print(T2)
print(T2-460)
```

R code Exa 4.14 specific heat

```
# page no. 162

m1 = 1
m2 = 1
```

```
c1 = 1
c2 = 1
t1 = 500
t2 = 100
cmix = 1

t = ((m1*c1*t1)+(m2*c2*t2))/((m1+m2)*cmix)
print(t)

deltas = cmix*log((t+460)/(t1+460))
deltaS = cmix*log((t+460)/(t2+460))
print(deltaS+deltas)
```

R code Exa 4.15 answer in F

```
# page no. 163

m1 = 1
m2 = 1
c1 = 1
c2 = 1
t1 = 500
t2 = 100
cmix = 1
t = ((m1*c1*t1)+(m2*c2*t2))/((m1+m2)*cmix)
print(t)

deltas = cmix*log((t1+460)/(0+460))
s = cmix*log((t2+460)/(0+460))
s1 = cmix*log((t+460)/(0+460))
print(s1-deltas)

s2 = cmix*log((t+460)/(0+460))
print(s2-s)
print(s1-deltas+s2-s)
```

Chapter 5

Properties of liquids and Gases

R code Exa 5.1 Compare your answer

```
# page no. 182

p = 0.6988
vg = 467.7
ug = 1040.2
J = 778
hg = ug+((p*vg*144)/J)
print(hg)
```

R code Exa 5.2 Compare your answer

```
# page no. 187

p = 4.246
vg = 32.894
ug = 2416.6
J = 778
hg = ug+(p*vg)
print(hg)
```

R code Exa 5.3 Compare the Results

```
# page no. 188

hg = 1190.4+(3/5)*(1191.1-1190.4)
print(hg)

vg = 3.884-(3/5)*(3.884-3.730)
print(vg)

sg = 1.5921-(3/5)*(1.5921-1.5886)
print(sg)

ug = 1107.7-(3/5)*(1108.3-1107.7)
print(ug)

# The answer may slightly vary due to rounding off
    values
```

R code Exa 5.4 Determine Hfg

```
# page no.189

p = 115
ufg = 798.8
ug = 3.884
vf = 0.017850
J = 778
hfg = ufg+(p*144*(ug-vf))/J
print(hfg)
```

R code Exa 5.5 Determine the hfg

```
# page no. 190

p = 1000
ufg = 1822.0
vf = 0.0011273
vg = 0.19444
vfg = vg-vf
hfg = ufg+(p*vfg)
print(hfg)
```

R code Exa 5.6 Determine Hfg

```
# page no. 190

a = 388.12;
b = 460;
c = 1.1042
hfg = (a+b)*(c)
print(hfg)

# The answer provided in the textbook is wrong.
```

R code Exa 5.7 Determine its entropy

```
# page no. 192

x = 0.8
```

```
sf = 0.49201
sfg = 1.0966
hf = 312.67
hfg = 878.5
uf = 312.27
ufg = 796.0
vf = 0.017886
vfg = (3.730-0.017886)
sx = sf+(x*sfg)
print(sx);
hx = hf+(x*hfg)
print(hx)
ux = uf+(x*ufg)
print(ux)
vx = vf+(x*vfg)
print(vx)

J = 778
px = 120
ux = hx-((px*vx*144)/J)
print(ux)
```

R code Exa 5.8 Determine its entropy

```
# page no. 193

x = 0.85
sf = 2.1387
sfg = 4.4487
hf = 762.81
hfg = 2015.3
uf = 761.68
ufg = 1822.0
vf = 1.1273
vfg = (194.44-1.1273)
```

```
sx = sf+(x*sfg)
print(sx)

hx = hf+(x*hfg)
print(hx)

ux = uf+(x*ufg)
print(ux)
vx = (vf+(x*vfg))*(0.001)
print(vx)

px = 10^6
ux = hx-((px*vx)/10^3)
print(ux)
```

R code Exa 5.9 What is its quality

```
# page no. 193

hx = 900
hf = 58.07
hfg = 1042.7
x = (hx-hf)/hfg
print(x*100)
```

R code Exa 5.10 Determine its quality

```
# page no. 194

hx = 2000
hf = 125.79
hfg = 2430.5
x = (hx-hf)/hfg
```

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

R code Exa 5.13 Determine the Specific Volume

```
#  page no. 197

v=1.4691+(1/2)*(1.4945-1.4691)
print(v);

u=1131.8+(1/2)*(1137.0-1131.8)
print(u);

h=1221.5+(1/2)*(1228.2-1221.5)
print(h);

s=1.5219+(1/2)*(1.5293-1.5219)
print(s);
```

R code Exa 5.14 Determine the Specific Volume

```
# page no. 198

v = 1.4696-(2/5)*(1.4693-1.4448);
h = 1227.5-(2/5)*(1227.5-1226.7);

v = 1.4640-(2/5)*(1.4640-1.4693);
h = 1234.2-(2/5)*(1234.2-1233.4);

v = 1.4595+(1/2)*(1.4841-1.4595);
h = 1227.5+(1/2)*(1233.9-1227.5);
print(v)
print(h)
```

R code Exa 5.16 Determine the enthalpy

```
# page no. 202

pf = 66.98
vf = 0.017448
hf = 269.73
p = 1000
J = 778
h = hf+((p-pf)*vf*144)/J
print(h)
percentoferror = (h-271.46)/271.46;
print(percentoferror*100)
```

R code Exa 5.27 Compare he result

```
# page no. 213

moisture = 0.192
a = 1
q = (a-moisture)*100
print(q);
```

R code Exa 5.35 Determine the moisture

```
# page no. 218

hx=1168.8;
hf=330.75;
```

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

R code Exa 5.36 Determine the pressure

```
# page no. 219

u2 = 1093.0
u1 = 117.95
q = u2-u1
print(q)
```

R code Exa 5.37 Determine the Heat added

```
# page no. 220

Vf = 45
vf = 0.016715
Vg = 15
vg = 26.80
mf = Vf/vf
mg = Vg/vg
total = mf+mg
ug = 1077.6;
uf = 180.1;
Ug = mg*ug
Uf = mf*uf
Total = Ug+Uf
print(Total)
vx = (Vf+Vg)/(mf+mg)
vx = 0.022282;
```

```
vf = 0.02087;
vfg = 0.5691-0.02087;
x = (vx-vf)/vfg;
print(x*total)

mg = x*total;
print(total-(x*total))
mf = total-(x*total)
ug = 1115.0
uf = 506.6
Ug = mg*ug
Uf = mf*uf
Total1 = Ug+Uf
difference = Total1-Total
print(difference/total)
```

R code Exa 5.38 Determine the change

```
# page no. 222

h1 = 1270.4
sx = 1.4861
sf = 0.5440
sfg = 1.0025
hf = 355.6
hfg = 843.7;
x = (sx-sf)/sfg
hx = hf+(x*hfg)
print(hx)
print(h1-hx)
```

R code Exa 5.39 Determine the final state of steam

```
# page no. 226

deltah = 0.8*122
h1 = 1270
h2 = h1-deltah
print(h2)
```

R code Exa 5.40 Determine the change

```
# page no. 226

h1 = 2942
h2 = 2512
print(h1-h2)
```

R code Exa 5.41 Determine the change

```
# page no. 226

h1minush2 = 122
J = 778
gc = 32.17
V2 = sqrt(2*gc*J*(h1minush2))
print(V2)
```

R code Exa 5.42 Determine the Velocity

```
# page no. 227

h1 = 1270
```

```
h2 = 1199
J = 778
gc = 32.17
V2 = sqrt(2*gc*J*(h1-h2))
print(V2)
```

R code Exa 5.43 How much Heat per pound

```
# page no. 229

h2 = 1412.1
h1 = 1205.3
q = h2-h1
print(q)
```

R code Exa 5.44 how much heat removed

```
# page no. 229

hf = 69.74
hfg = 1036.0
hg = 1105.8
x = 0.97
hx = hf+(x*hfg)
print(hx)

deltah = hx-hf
print(deltah)

# 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

```
# page no. 241

P1 = 100
V1 = 100
P2 = 30
V2 = (P1*V1)/P2
print(V2)
```

R code Exa 6.2 What volume will gas occupy

```
# page no. 241

P1  =  10^6
V1  =  2
P2  =  8*10^6
V2  =  (P1*V1)/P2
print(V2)
```

R code Exa 6.3 Determine the volume

```
# page no. 242

T1 = 32+460
V1 = 150
T2 = 100+460
V2 = (T2*V1)/T1
print(V2)
```

R code Exa 6.5 Determine the volume

```
# page no. 242

V1 = 4
T2 = 0+273
T1 = 100+273
V2 = V1*(T2/T1)
print(V2)
```

R code Exa 6.6 How much gas is there in container

```
# page no. 245

p = (200+14.7)*(144)
T = (460+73)
V = 120/1728
R = 1545/28
v = (R*T)/p
```

```
print(v)
print(V/v)
m = (p*V)/(R*T)
print(m)
```

R code Exa 6.7 what is the pressure

```
# page no. 245

p1 = 200+14.7
T2 = 460+200
T1 = 460+73
p2 = p1*(T2/T1)
print(p2)
```

R code Exa 6.8 Determine the mass of gas

```
# page no. 246

R = 8.314/44
p = 500
V = 0.5
T = (100+273)
m = (p*V)/(R*T)
print(m)
```

R code Exa 6.9 Determine the mean specific heat

```
# page no. 252

```

```
T2    =   500+460
T1    =   80+460
Adash    =   0.338
Bdash    =   -1.24*10^2
Ddash    =   4.15*10^4
cpbar    =   Adash+((Bdash*log(T2/T1))/(T2-T1))+(Ddash/(T2*T1))
print(cpbar)
```

R code Exa 6.10 Solve the answer

```
# page no. 252

hbar540 = 3729.5+(3/63)*(4167.9-3729.5)
hbar960 = 6268.1+(60/100)*(6977.9-6268.1)
h2 = 6694.0
h1 = 3750.4
T2 = 500+460
T1 = 80+460
cbar = (h2-h1)/(28*(T2-T1))
print(cbar);
```

R code Exa 6.11 Determine the heat

```
# page no. 253

T2 = 500+460
T1 = 80+460
A = 0.219
B = 3.42*10^-5
D = 2.93*10^-9
cpbar = A+((B/2)*(T2+T1))+((D/3)*(T2^2+(T2*T1)+T1^2))
```

```
print(cpbar)
```

R code Exa 6.12 Determine cu

```
# page no. 255

R = 1545/32
J = 778
cp = 0.24
cv = cp-(R/J)
print(cv)
```

R code Exa 6.13 Determine the cp

```
# page no. 255

R = 8.314/32
k = 1.4
cv = R/(k-1)
print(cv)
cp = k*cv
print(cp)
```

R code Exa 6.14 Determine k cv and cp

```
# page no. 255

R = 60
deltah = 500
deltau = 350
```

```
J = 778
k = deltah/deltau
print(k);
cv = R/(J*(k-1))
print(cv)
cp = k*cv
print(cp)
```

R code Exa 6.15 find the specific heat

```
# page no. 256

Q = 0.33
V = 60
m = 0.0116
p1 = 90
T1 = 460+40
V = 60
m = 0.0116
p2 = 108
T2 = 460+140
cv = Q/(m*(T2-T1))
print(cv)

R = (144*p1*(V/1728))/(m*T1)
print(R)

J = 778
cp = cv+(R/J)
print(cp)
```

R code Exa 6.16 Determine the change

```
# page no. 260

cp = 0.24
p2 = 15
p1 = 100
T2 = 460+0
T1 = 460+100
J = 778
R = 1545/29
deltas = (cp*(log(T2/T1)))-((R/J)*(log(p2/p1)))
print(deltas)
```

R code Exa 6.17 solve the problem

```
# page no. 261

cp=0.24;
p2=15;
p1=100;
T2=460+0;
T1=460+100;
J=778;
R=1545/29;

k=(cp*J)/((cp*J)-R);
print(k);

cv=cp/k;
print(cv);
v2byv1=(T2*p1)/(T1*p2);
deltas=(cv*log(p2/p1))+(cp*log(v2byv1));
print(deltas);
```

R code Exa 6.18 Determine the change

```
# page no. 261

cp = 0.9093
p2 = 150
p1 = 500
T2 = 273+0
T1 = 273+100
R = 8.314/32
deltas = (cp*(log(T2/T1)))-((R)*(log(p2/p1)))
deltaS = 2*deltas
print(deltaS)
```

R code Exa 6.19 what was the increase in pressure

```
# page no. 262

k=1.4
v2=1/2
v1=1
p2byp1=exp((1/4)-(k*log(v2/v1)))
print(p2byp1)
```

R code Exa 6.20 Determine the change

```
# page no. 264

T2  =  460+270
T1  =  460+70
cv  =  0.17
deltas  =  cv*log(T2/T1)
deltaS  =  (1/2)*deltas
```

```
print(deltaS)
```

R code Exa 6.21 Determine the change

```
# page no. 264

T2 = 100+273
T1 = 20+273
cv = 0.7186
deltas = cv*log(T2/T1)
deltaS = (0.2)*deltas
print(deltaS)
```

R code Exa 6.22 Determine the higher temprature

```
# page no. 264

deltas = 0.0743
T1 = 460+100
cv = 0.219
T2 = T1*exp(deltas/cv)
print(T2)
```

R code Exa 6.23 Determine the initial tmeprature

```
# page no. 265

deltaS = 0.4386
T2 = 273+425
cv = 0.8216
```

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

R code Exa 6.24 Determine the heat transferred

```
# page no. 267

T2  =  460+400
T1  =  460+70
cp  =  0.24
J  =  778
R  =  1545/29
deltah  =  cp*(T2-T1)
print(deltah)
deltas  =  cp*log(T2/T1)
print(deltas)
flowworkchange  =  (R/J)*(T2-T1)
print(flowworkchange)
```

R code Exa 6.25 Determine the heat transferred

```
# page no. 268

T2  =  500+273
T1  =  20+273
cp  =  1.0062
deltah  =  cp*(T2-T1)
print(deltah)
deltas  =  cp*log(T2/T1)
print(deltas)
```

R code Exa 6.26 Determine the Heat added

```
# page no. 270

v2 = 2;
v1 = 1;
T = 460+200;
J = 778;
R = 1545/28;
q = ((R*T)/J)*log(v2/v1);
Q = 0.1*q;
print(Q*10);
WbyJ = Q;
print(WbyJ);
```

R code Exa 6.27 Determine the Heat added

```
# page no. 270

T = 50+273;
v2 = 1/2;
v1 = 1;
R = 8.314/32;
q = R*T*log(v2/v1);
print(q);
W = q;
print(W);
```

R code Exa 6.28 Determine the change

```
# page no. 271

T = 50+273;
v2 = 1/2;
v1 = 1;
R = 8.314/32;
q = R*T*log(v2/v1);
print(q);
deltas = q/T;
print(deltas);
```

R code Exa 6.29 Determine the final state

```
# page no. 274

T1 = 1000;
p2 = 1;
p1 = 5;
J = 778;
R = 1545/29;
k = 1.4;
T2 = T1*((p2/p1)^((k-1)/k));
print(T2);
work = (R*(T2-T1))/(J*(1-k));
print(work)
```

R code Exa 6.30 Determine the final state

```
# page no. 274

T1 = 500+273;
p2 = 1;
p1 = 5;
```

```
J = 778;
R = 8.314/29;
k = 1.4;
T2 = T1*((p2/p1)^((k-1)/k));
print(T2-273);
work = (R*(T2-T1))/((1-k));
print(work)
```

R code Exa 6.31 Determine k ofr this gas

```
# page no. 275

library(MASS)
T1 = 800+273;
T2 = 500+273;
p2 = 1;
p1 = 5;
k = ginv(1-((log(T2/T1)/log(p2/p1))))[1];
print(k[1]);
```

R code Exa 6.32 Determine the heat transferred

```
# page no. 279

n = 1.3;
k = 1.4;
cp = 0.24;
T2 = 600;
T1 = 1500;
R = 53.3;
J = 778;
cv = cp/k;
cn = cv*((k-n)/(1-n));
```

```
print(cn);
q = cn*(T2-T1);
print(q);
w = (R*(T2-T1))/(J*(1-n));
print(w);
deltas = cn*log(T2/T1)
print(deltas)
```

R code Exa 6.33 Determine the ratio inlet

```
# page no. 279

n = 1.3;
k = 1.4;
cp = 0.24;
T2 = 600;
T1 = 1500;
R = 53.3;
J = 778;
p1byp2 = exp(log(T1/T2)/((n-1)/n));
print(p1byp2);

# The answer may slightly vary due to rounding off
   values
```

R code Exa 6.34 Determine the change

```
# page no. 284

h2 = 240.98;
h1 = 119.48;
u2 = 172.43;
u1 = 85.20;
```

```
fy2 = 0.75042;
fy1 = 0.58233;
deltah = h2-h1;
deltau = u2-u1;
print(deltah)
print(deltau);
deltas = fy2-fy1;
print(deltas);
```

R code Exa 6.35 solve the problem

```
# page no. 285

pr = 12.298;
h = 240.98;
pr = 12.298/5;
T = 620+(((2.4596-2.249)/(2.514-2.249))*20);
print(T);
u1 = 172.43;
u2 = 108.51;
work = u1-u2;
print(work)
```

R code Exa 6.36 Determine the Velocity

```
# page no. 288

T = 1000+460;
Va = 49.0*sqrt(T);
print(Va);
khydrogen = 1.41;
kair = 1.40;
Rhydrogen = 766.53;
```

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

R code Exa 6.37 what is the mach number

```
# page no. 288

T = 200+460;
V = 1500;
Va = 49.0*sqrt(T);
print(Va);
M = V/Va;
print(M);
```

R code Exa 6.38 Determine its total enthalpy

```
# page no. 290

V = 1000;
gc = 32.17;
J = 778;
h = 1204.4;
h0 = h+((V^2)/(2*gc*J));
print(h0);
```

R code Exa 6.39 Calculate the pressure

```
# page no. 297
```

```r

library(MASS)
k = 1.4
M = 1
T0 = 800
gc = 32.17
R = 53.35
p0 = 300
Tstar = T0*0.8333
print(Tstar)
Vat = round(sqrt(gc*R*Tstar*k))
print(Vat)
M1 = 0.3
print(M1)
pstar = p0*0.52828
T1 = round(T0*0.982332,1)
print(T1)
p1 = p0*0.93947
print(p1)
Va1 = sqrt(gc*k*R*T1)
V1 = round(M1*Va1)
print(V1)
v = (R*T1)/(p1*144)
rho = ginv(v)
A = 2.035
m = round(rho[1]*A*V1)
print(m)
```

R code Exa 6.40 Determine the Temprature

```r
# page no. 299

k = 1.4;
R = 53.3;
M = 2.5;
```

```
T0 = 560;
T = T0/(1+((1/2)*(k-1)*M^2));
print(T);
p = 0.5;
p0 = p*14.7*((T0/T)^(k/(k-1)));
print(p0);
gc = 32.17;
Va = sqrt(gc*k*R*T);
V = M*Va;
print(V);
v = (R*T)/(p*14.7*144);
print(v);
print(V/v);
M = 2.5;
T0 = 560;
T = T0*0.44444;
print(T)
p = 0.5;
p0 = (p*14.7)/0.05853;
print(p0);
print(V)
print(v)
print(V/v)
```

R code Exa 6.41 Determine the specific Volume

```
# page no. 304

p = 500;
pc = 674;
T = 50+460;
Tc = 343;
R = 1545/16;
pr = p/pc;
Tr = T/Tc;
```

```
Z = 0.93;
v = Z*((R*T)/(p*144));
print(v);
v = (R*T)/(p*144);
print(v);
```

Chapter 7

Mixture of Ideal Gases

R code Exa 7.1 Determine the number of moles

```
# page no. 322

nO2 = 0.2315/32;
print(nO2);
nN2 = 0.7685/28.02;
print(nN2);
nm = nO2+nN2;
print(nm);
xO2 = nO2/nm;
xN2 = nN2/nm;
print(xO2);
print(xO2+xN2);

pO2 = xO2*14.7;
print(pO2);
pN2 = xN2*14.7;
print(pN2);

MWm = (xO2*32) + (xN2*28.02);
print(MWm);
Rm = 1545/MWm;
```

```
print(Rm);
```

R code Exa 7.2 what is the mole fraction

```
# page no. 323

print(1000-14.7)
print(14.7/1000)
print((1000-14.7)/1000)
MWm = ((14.7/1000)*29) + (((1000-14.7)/1000)*120.9);
print(MWm);
```

R code Exa 7.3 Determine the moles

```
# page no. 323

nair = 10/29;
print(nair);
nCO2 = 1/44;
print(nCO2);
nN2 = 5/28;
print(nN2);
nm = nair+nCO2+nN2;
print(nm);
xair = nair/nm
xCO2 = nCO2/nm;
xN2 = nN2/nm;
print(xair);
print(xCO2)
print(xN2);
pair = xair*100;
print(pair);
pCO2 = xCO2*100;
```

```
print(pCO2);
pN2 = xN2*100;
print(pN2);
MWm = (xair*29) + (xCO2*44) + (xN2*28);
print(MWm);
Rm = 1545/MWm;
print(Rm);
```

R code Exa 7.4 Determine the mixture volume

```
# page no. 325

xO2 = 5/15;
xH2 = 10/15;
print(((5/15)*32)+((10/15)*2.016));
R = 1545/32;
T = 460+70;
p = 14.7;
vO2 = (R*T)/(p*144);
VO2 = vO2*5*32;
print(VO2);
Vm = 3*VO2;
print(Vm);
VH2 = Vm-VO2;
print(VH2);
R = 1545/2.016;
vH2 = (R*T)/(p*144);
VH2 = vH2*10*2.016;
print(VH2);
print(358*((460+70)/(460+32)));
VO2 = 5*358*((460+70)/(460+32));
print(VO2);
VH2 = 10*358*((460+70)/(460+32));
print(VH2);
```

R code Exa 7.5 Determine the mixture volume

```
# page no. 326

nCO2 = 10/44;
nN2 = 5/28.02;
print(nCO2+nN2);
xCO2 = nCO2/(nCO2+nN2);
xN2 = nN2/(nCO2+nN2);
print(xCO2+xN2);
MWm = (xCO2*44) + (xN2*28.02);
print(MWm);
pm = 100;
Tm = 460+70;
Rm = 1545/37.0;
mm = 15;
Vm = (mm*Rm*Tm)/(pm*144);
print(Vm);
VCO2 = Vm*xCO2;
print(VCO2);
VN2 = Vm*xN2;
print(VN2);
pCO2 = pm*xCO2;
print(pCO2);
pN2 = pm*xN2;
print(pN2);
```

R code Exa 7.6 Determine the mass fraction

```
# page no. 327

print((0.40*44.0))
```

```
print((0.40*44.0)/33.4)
print((28.02*0.10))
print((28.02*0.10)/33.4)
print((0.10*2.016))
print((0.10*2.016)/33.4)
print((0.40*32.0))
print((0.40*32.0)/33.4)
```

R code Exa 7.7 Determine the fraction by volume

```
# page no. 328

moles = c(1.2, 0.3, 0.3, 1.2)
s = sum(moles)
volume = vector(length = 4)
for (i in 1:4) {
  v = moles[i]/s;
  volume[i] = v*100;
  print(v)
}
MWm = sum(volume)/s
print(MWm)
```

R code Exa 7.8 Determine the volumetric analysis

```
# page no. 329

moles = c(0.724, 2.693, 0.033)
s = sum(moles)
volume = vector(length = 3)
for (i in 1:3) {
  v = moles[i]/s;
  volume[i] = v*100;
```

```
  print(v)
}
MWm = sum(volume)/s
print(MWm)

# The answer may slightly vary due to rounding off
    values.
```

R code Exa 7.9 Determine the final Temperature

```
# page no. 331

a = 500;
b = 160;
oxygen = 0.164;
Cv = 0.25;
nitr = 196;
tm = ((a*b*0.23)+(nitr*Cv*200))/((nitr*Cv)+(b*0.23))
    ;
print(tm);
cpm = ((b/(b+nitr))*0.23)+((nitr/(b+nitr))*Cv);
print(cpm);
tm = ((b*0.23*a)+(nitr*Cv*200))/(cpm*(b+nitr));
print(tm);

# The answer may vary due to the change in units.
```

R code Exa 7.10 Determine the final temprature

```
# page no. 332

a = 500;
b = 160;
```

```
oxygen = 0.164;
Cv = 0.178;
nitr = 196;
tm = ((a*b*oxygen)+(nitr*Cv*200))/((nitr*Cv)+(b*
   oxygen));
print(tm);
```

R code Exa 7.12 Determine the change in entropy

```
# page no : 334

cp = 0.23;
T2 = 328.7+460;
T1 = 500+460;
deltas = (cp*log(T2/T1));
DeltaS = 160*deltas;
print(DeltaS);
cp = 0.25;
T2 = 328.7+460;
T1 = 200+460;
deltas = (cp*log(T2/T1));
deltaS = 196*deltas;
print(deltaS);
deltaS = deltaS+DeltaS;
print(deltaS);
deltasm = deltaS/(196+160);
print(deltasm);
cp = 0.23;
T2 = 500+460;
T1 = 0+460;
deltas = cp*log(T2/T1);
print(deltas);
T2 = 328.7+460;
T1 = 0+460;
Deltas = cp*log(T2/T1);
```

```
print(Deltas);
deltaS = Deltas-deltas;
print(deltaS);
cp = 0.25;
T2 = 200+460;
T1 = 0+460;
deltas = cp*log(T2/T1);
print(deltas);
T2 = 328.7+460;
T1 = 0+460;
Deltas = cp*log(T2/T1);
print(Deltas);
deltaS = Deltas-deltas;
print(deltaS);

# The answer may slightly vary due to rounding off
    values.
```

R code Exa 7.14 Determine the partial pressure

```
# page no : 338

pres1 = 14.7;
pres2 = 0.6988;
vol = 467.7
RT = 1545;
mole = 0.00799
ratio = 0.0477
p_dry_air = 28.966
R = RT/p_dry_air;
T = 90+460;
pdryair = 14.0;
vdryair = (R*T)/(pdryair*144);
print(pres1-pres2);
print(vol/vdryair);
```

```
print((mole/ratio)*100);
print((mole/ratio)*pres2);
print(pres1-((mole/ratio)*pres2));
print((mole/ratio)*pres2);

# The answer may slightly vary due to rounding off
    values.
```

R code Exa 7.15 solve the problem

```
# page no. 343

W = 0.005;
pm = 14.7;
pv = (W*pm)/(0.622+W);
print(pv);
pa = pm-pv;
print(pa);
pvs = 0.6988;
print(pvs);
phy = pv/pvs;
print(phy*100);
```

R code Exa 7.16 how much water was removed

```
# page no. 343

pm = 14.7;
phy = 0.7;
pvs = 0.6988;
pv = phy*pvs;
pa = pm-pv;
W = 0.622*(pv/pa);
```

```
phy = 0.4;
pvs = 0.5073;
pv = phy*pvs;
pa = pm-pv;
w = 0.622*(pv/pa);
print(W-w);
```

R code Exa 7.18 Solve the problem

```
# page no. 347

total_pres = 14.7;
pres = 0.12;
print(total_pres-pres);
```

R code Exa 7.19 Solve the problem

```
# page no. 348

w1 = 150;
w2 = 61;
print(w1-w2);
print((w1-w2)/7000);
```

R code Exa 7.20 how much heat is required

```
# page no. 349

t_heat1 = 23.4
t_heat2 = 16.1
print(t_heat1-t_heat2)
```

R code Exa 7.23 Determine the amount of water

```
# page no. 358

h100F = 68.05;
h70F = 38.09;
h = 20.4;
w = 38.2;
H = 52.1;
W = 194.0;
ma = (200000*(h100F-h70F))/((H-h)-(h70F*((W-w)/7000)
   ));
print(ma);
print(ma*((W-w)/7000));

# The answer may slightly vary due to rounding off
   values.
```

Chapter 8

Vapor Power Cycles

R code Exa 8.1 Determine the thermal Efficiency

```
# page no. 380

hf = 340.49;
h1 = hf;
h4 = 3230.9;
h5 = 2407.4;
nR = (h4-h5)/(h4-h1);
print(nR*100);
p2 = 3000;
p1 = 50;
vf = 0.001030;
Pumpwork = (p2-p1)*vf;
nR = ((h4-h5)-Pumpwork)/((h4-h1)-Pumpwork);
print(nR*100);
```

R code Exa 8.2 solve the problem

```
# page no. 381
```

```
hf = 340.49;
h1 = hf;
h2 = h1;
h4 = 3230.9;
h5 = 2407.4;
nR = (h4-h5)/(h4-h2);
print(nR*100);
Pumpwork = 343.59-340.54;
nR = ((h4-h5)-Pumpwork)/((h4-h1)-Pumpwork);
print(nR*100);
```

R code Exa 8.3 Sketch the cycle

```
# page no. 382

h1 = 180.15;
h2 = h1;
h4 = 1515;
h5 = 1150.5;
nR = (h4-h5)/(h4-h2);
print(nR*100);
p2 = 400;
p1 = 14.696;
vf = 0.01167;
J = 778;
Pumpwork = ((p2-p1)*vf*144)/J;
nR = ((h4-h5)-Pumpwork)/((h4-h1)-Pumpwork);
print(nR*100);
```

R code Exa 8.4 solve the problem

```
# page no. 383
```

```
h5 = 1150.4;
h2 = 180.17;
h1 = h2;
h4 = 1514.0;
t = 982.07;
h = 181.39;
nR = (h4-h5)/(h4-h2);
print(nR*100);
Pumpwork = h-h2;
nR = ((h4-h5)-Pumpwork)/((h4-h2)-Pumpwork);
print(nR*100);
```

R code Exa 8.5 what is the type of efficiency

```
# page no. 385

T1 = 982.4+460;
T2 = 212+460;
nc = ((T1-T2)/T1)*100;
print(nc);
nR = 27.3;
typen = (nR/nc)*100;
print(typen);
```

R code Exa 8.6 Calculate the type Efficiency

```
# page no. 385

T1 = 400+273;
T2 = 81.33+273;
nc = ((T1-T2)/T1)*100;
print(nc);
```

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

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

```
# page no. 386

work = 1515-1150.5;
available = 364.5-50;
n = available/(1515-180.15);
print(n*100);
```

R code Exa 8.8 Determine the Heat Rate

```
# page no. 387

heatrate = 3413/0.273;
print(round(heatrate));
print(3413/(1515-1150.5));
```

R code Exa 8.9 Determine the Efficiency

```
# page no. 388

h4 = 1515;
h5 = 1205;
h7 = 1413;
h1 = 180.15;
nreheat = ((h4-h5)+(h4-h7))/((h4-h1)+(h4-h7));
print(nreheat*100);
```

R code Exa 8.10 solve the problem

```
# page no. 389

h7 = 1413.6;
h4 = 1514.0;
h5 = 1205.2;
h1 = 180.17;
nreheat = ((h4-h5)+(h4-h7))/((h4-h1)+(h4-h7));
print(nreheat*100);
```

R code Exa 8.11 Determine the Efficiency

```
# page no. 394

h4 = 1505;
h5 = 922;
h6 = h5;
h1 = 69.74;
nR = (h4-h5)/(h4-h1);
print(nR*100);

h5 = 1168;
h7 = 69.74;
h1 = 250.24;
W = ((1*h1)-h7)/(h5-h7);
print(W);
work = (1-W)*(h4-922) + W*(h4-h5);
print(work);
qin = h4-h1;
n = work/qin;
```

```
print(n*100);
n = 1-(((h5-h1)*(h6-h7))/((h4-h1)*(h5-h7)));
W = (h1-h7)/(h5-h7);
print(n*100);
```

R code Exa 8.12 Compare the Results

```
# page no. 396

W2 = ((1*298.61)-250.24)/(1228.6-250.24);
print(W2);
W1 = (((1-W2)*250.24)-69.74+(W2*69.74))/(1168-69.74);
print(W1);
work = ((1505-1228.6)*1)+((1-W2)*(1228.6-1168))+((1-W1-W2)*(1168-922));
print(work);
qin = 1505-298.61;
print(qin);
n = work/qin;
print(n*100);
W2 = (298.61-250.24)/(1228.6-250.24);

print(W2);
W1 = ((1228.6-298.61)*(250.24-69.74))/((1168-69.74)*(1228.6-250.24));
print(W1);
n = 1-(((922-69.74)*(1228.6-298.61)*(1168-250.24))/((1505-298.61)*(1228.6-250.24)*(1168-69.74)));
print(n*100);
```

R code Exa 8.13 Compare the Results

```
# page no. 398

W1 = ((1*(280.06-250.24)))/(1228-298.61);
print(W1);
W2 = ((1*250.24)-(W1*268.61)-69.74+(W1*69.74))/
   (1168-69.74);
print(W2);
workoutput = (1*(1505-1228))+((1-W1)*(1228-1168))
   +((1-W1-W2)*(1168-922));
print(workoutput);
heatinput = 1505-280.06;
print(heatinput);
n = workoutput/heatinput;
print(n*100);
```

R code Exa 8.14 Determine the conventional thermal efficiency

```
# page no. 426

h5 = 1168;
h4 = 1505;
h6 = 922;
h1 = 69.74;
h7 = 69.74;
h2 = 250.24;
W = ((1*h2)-h7)/(h5-h7);
liquidleaving = (W*h2)+(1-W)*h1;
heatin = h4-liquidleaving;
print(heatin);
workout = ((1-W)*(h4-h6))+(W*(h4-h5));
print(workout);
n = workout/heatin;
print(n*100);
qout = W*(h5-h2);
n = (workout+qout)/heatin;
```

```
print(n*100);

# The answer may slightly vary due to rounding off
    values
```

Chapter 9

Gas power Cycles

R code Exa 9.1 Compare the Results

```
# page no. 462

Rc = 7;
k = 1.4;
notto = (1-(1/Rc)^(k-1))*100;
print(notto);
T2 = 70+460;
T4 = 700+460;
nc = (1-(T2/T4))*100;
print(nc);
T4 = 1000+460;
nc = (1-(T2/T4))*100;
print(nc);
T4 = 3000+460;
nc = (1-(T2/T4))*100;
print(nc);
```

R code Exa 9.2 Determine the efficiency

```
# page no. 463

library(MASS)
cv = 0.172;
Rc = 7;
k = 1.4;
T2 = 70+460;
T4 = 1000+460;
T3byT2 = Rc^(k-1);
T3 = T3byT2*T2;
qin = cv*(T4-T3);
Qr = (ginv(Rc)[1])^(k-1);
T5 = T4*Qr;
Qr = cv*(T5-T2);
print(qin-Qr);
notto = ((qin-Qr)/qin)*100;
print(notto);

# The answer may slightly vary due to rounding off
    values.
```

R code Exa 9.3 Determine the peak temprature

```
# page no. 464

cv = 0.7186;
Rc = 8;
k = 1.4;
T2 = 20+273;
qin = 50;
T3byT2 = Rc^(k-1);
T3 = T3byT2*T2;
T4 = (qin/cv)+T3;
print(T4-273);
```

R code Exa 9.4 Calculate the Efficiency

```
# page no. 465

rc = 7;
q = 50;
p2 = 14.7;
T2 = 60+460;
cp = 0.24;
cv = 0.171;
R = 53.3;
k = 1.4;
v2 = (R*T2)/(p2*144);
print(v2);
p3 = p2*rc^k;

print(p3);
v3 = v2/rc;
print(v3);
T3 = (p3*v3*144)/R;
print(T3);
v4 = v3;
print(v4);
T4 = T3+(q/cv);
print(T4);
p4 = (R*T4)/(144*v4);
print(p4);
v5 = v2;
print(v5);
p5 = p4*(v4/v5)^k;
print(p5);
T5 = (p5*v5*144)/(R);
print(T5);
n = (((T4-T3)-(T5-T2))/(T4-T3))*100;
```

```
print(n);
```

R code Exa 9.7 Determine the horsepower

```
# page no. 468

pm = 1000;
N = 4000/2;
LA = 2
hp = (pm*LA*N)/44760;
print(hp);
```

R code Exa 9.9 What is its compression ratio

```
# page no. 469

c = 0.2;
rc = (1+c)/c;
print(rc);
```

R code Exa 9.10 Determine the mean Effective pressure

```
# Page No : 470

hp = 100;
L = 4/12;
A = (pi/4)*(3)^2*6;
N = 4000/2;
pm = (hp*33000)/(L*A*N);
print(pm);
```

R code Exa 9.11 Determine the mean Effective pressure

```
# page no. 470

hp = 230;
LA = 3.3*1000*(1/2.54)^3;
N = 5500/2;
pm = (hp*33000*12)/(LA*N);
print(pm);
```

R code Exa 9.12 Find the efficiency

```
# page no. 478

library(MASS)
rc = 16;
v4byv3 = 2;
k = 1.4;
T2 = 100+460;
ndiesel = 1-((ginv(rc)[1])^(k-1)*(((v4byv3)^k-1)/(k*
    (v4byv3-1))));
print(ndiesel*100);
T5 = T2*(v4byv3)^k;
print(T5)
print(round(T5-460));

# The answer may slightly vary due to rounding off
    values.
```

R code Exa 9.13 Determine the network per pound

```
# page no. 479

rc = 16;
v4byv3 = 2;
k = 1.4;
T2 = 100;
T5 = 1018;
ndiesel = 0.614
cp = 0.24;
cv = 0.172;
Qr = cv*(T5-T2);
qin = Qr/(1-ndiesel);
J = 778;
networkout = J*(qin-Qr);
print(networkout);
mep = networkout/((16-1)*144);
print(mep);

# The answer may slightly vary due to rounding off
   values.
```

R code Exa 9.14 Determine the heat in

```
# page no. 489

library(MASS)
rc = 7;
k = 1.4;
cp = 0.24;
T3 = 1500;
p1 = 14.7;
T1 = 70+460;
R = 53.3;
```

```
nBrayton = 1-((ginv(rc)[1])^(k-1));
print(nBrayton*100);
v1 = (R*T1)/p1;
v2 = v1/rc;
T2 = T1*(v1/v2)^(k-1);
T2 = T2-460;
qin = cp*(T3-T2);
print(qin);
wbyJ = nBrayton*qin;
print(wbyJ);
print(qin-wbyJ);

# The answer may slightly vary due to rounding off
   values.
```

Chapter 10

Refrigeration

R code Exa 10.1 Calculate the heat removal

```
# page no. 503

T1 = 70+460;
T2 = 32+460;

COP = T2/(T1-T2);
print(COP);

Qremoved = 1000;
WbyJ = Qremoved/COP;
print(WbyJ);

Qrej = Qremoved+WbyJ;
print(Qrej);
```

R code Exa 10.2 Determine the COP of the Cycle

```
# page no. 504
```

```
T1 = 20+273;
T2 = -5+273;
COP = T2/(T1-T2);
print(COP);

Qremoved = 30;
W = Qremoved/COP;
print(W);
Qrej = Qremoved+W;
print(round(Qrej,2));
```

R code Exa 10.3 Determine the maximum COP for the cycle

```
# page no. 505

T1 = 70+460;
T2 = 20+460;
COP = T2/(T1-T2);
print(COP);

HPperTOR = 4.717/COP;
COPactual = 2;
HPperTORactual = 4.717/COPactual;
print(HPperTORactual-HPperTOR);
```

R code Exa 10.4 Determine the power required

```
# page no. 506

library(MASS)
COP = 4.5;
HPperTOR = 4.717/COP;
```

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

R code Exa 10.5 Determine the power required

```
# page no. 506

COP = 10.72;
P = 2.8;
COPactual = 3.8;
power = P*COP/COPactual;
print(power)
```

R code Exa 10.6 Compute the problem

```
# page no. 509

h1 = 116.0;
h2 = 116.0;
h3 = 602.4;
s3 = 1.3938;
t4 = 237.4;
h4 = 733.4;

COP = (h3-h1)/(h4-h3);
print(COP);
print(h4-h3);
print(h3-h1);

tons = 30;
```

```
print((200*tons)/(h3-h1));

print(4.717*((h4-h3)/(h3-h1)));
```

R code Exa 10.7 solve the problem

```
# page no. 510

h1 = 30.14;
h2 = 30.14;
h3 = 75.110;
s3 = 0.17102;
h4 = 89.293;

COP = (h3-h1)/(h4-h3);
print(COP);
print(h4-h3);
print(h3-h1);

tons = 30;
print((200*tons)/(h3-h1));
print(4.717*((h4-h3)/(h3-h1)));
```

R code Exa 10.8 Determine the COP of the Cycle

```
# page no. 517

h1 = 28.713;
h2 = 28.713;
h3 = 78.335;
s3 = 0.16798;
s = 0.16798;
h4 = 87.192;
```

```
print(h3-h1);
print(h4-h3);
COP = (h3-h1)/(h4-h3);
print(COP);
```

R code Exa 10.9 solve the problem

```
# page no. 518

h1 = 41.6;
h2 = 41.6;
h3 = 104.6;
s3 = 0.2244;
h4 = 116.0;
print(h3-h1);
print(h4-h3);
COP = (h3-h1)/(h4-h3);
print(COP);
```

R code Exa 10.10 Find the horse power required

```
# page no. 518

T = -20;
h1 = 26.542;
n = 0.8;
h4 = 100.5;
h3 = 75.886;
m = (200*5)/(75.886-h1);
h4dashminush3 = (h4-h3)/n;
J = 778;
work = (h4dashminush3*m*J)/33000;
print(work);
```

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

R code Exa 10.11 solve the problem

```
# page no. 521

h3 = 76.2;
h4 = 100.5;
n = 0.8;
work = (h4-h3)/n;
m = (200*5)/(h3-26.1);
J = 778;
totalwork = (m*work*J)/33000;
print(totalwork);
h4dash = h3+work;
mdot = (m*(h4dash-26.5))/(70-60);
print(mdot/8.3);
```

R code Exa 10.12 Determine the airflow required

```
# page no. 526

COP = 2.5;
cp = 0.24;
T1 = -100+460;
T3 = 150+460;
T4 = (3.5*T1)/COP;
T2 = (COP*T3)/3.5;
print(cp*(T4-T1));
print(cp*(T3-T2));
```

```
print((cp*(T3-T2))-(cp*(T4-T1)));
print(200/(cp*(T2-T1)));

# The answer may slightly vary due to rounding off
    values
```

R code Exa 10.13 Calculate the mass of water

```
# page no. 536

h1 = 58.07;
h2 = 13.04;
h3 = 1081.1;
m1 = 1;
m3 = (m1*h1-h2)/(h3+h2);
print(m3);
```

R code Exa 10.14 solve the problem

```
# page no. 536

h1 = 58.07;
h2 = 13.04;
h3 = 1081.1;
m1 = 1;
m3 = (m1*h1-h2)/(h3+h2);
m2 = 1-m3;
print(m3);
print(m3*(h3-h1));
print(m2*(h1-h2));
```

R code Exa 10.15 Determine the COP

```r
# page no. 539

T1 = 70+460;
T2 = 32+460;
COP = T1/(T1-T2);
print(COP);
print(1077.2/77.2);
```

R code Exa 10.16 determine the work

```r
# page no. 539

T1 = 70+460;
T2 = 0+460;
COP = T2/(T1-T2);
print(COP);
Qremoved = 1000;
WbyJ = Qremoved/COP;
print(WbyJ);
Qrej = Qremoved+WbyJ;
print(Qrej);
print(Qrej/WbyJ);
```

Chapter 11

Heat transfer

R code Exa 11.1 Determine the heat transferred

```
# page no. 553

deltaX = 6/12;
k = 0.40;
T1 = 150;
T2 = 80;
deltaT = T2-T1;
Q = (-k*deltaT)/deltaX;
print(Q);
```

R code Exa 11.2 Determine the heat transfer

```
# page no. 555

deltaX = 0.150;
k = 0.692;
T1 = 70;
T2 = 30;
```

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

R code Exa 11.3 Determine the heat transferred

```
# page no. 556

deltaX = 6/12;
A = 1;
k = 0.40;
Rt = deltaX/(k*A);
deltaE = 9;
T1 = 150;
T2 = 80;
deltaT = T2-T1;
Re = (100*deltaE*Rt)/deltaT;
print(abs(Re));
i = deltaE/Re;
Q = 100*i;
print(abs(Q));
```

R code Exa 11.4 Determine the heat transferred

```
# page no. 558

deltaX = 6/12;
A = 1;
k = 0.40;
R = deltaX/(k*A);

print(R);
R1 = R;
```

```
deltaX = (1/2)/12;
A = 1;
k = 0.80;
R = deltaX/(k*A);

print(R);
R2 = R;
deltaX = (1/2)/12;
A = 1;
k = 0.30;
R = deltaX/(k*A);

print(R);
R3 = R;
Rot = R1+R2+R3;
print(Rot);
T1 = 70;
T2 = 30;
deltaT = T2-T1;
Q = deltaT/Rot;
print(abs(Q));

# The answer provided in the textbook is wrong
```

R code Exa 11.5 Calculate the temprature

```
# page no. 558

deltaX = 6/12;
A = 1;
k = 0.40;
R = deltaX/(k*A);

print(R);
R1 = R;
```

```
deltaX = (1/2)/12;
A = 1;
k = 0.80;
R = deltaX/(k*A);

print(R);
R2 = R;
deltaX = (1/2)/12;
A = 1;
k = 0.30;
R = deltaX/(k*A);

print(R);
R3 = R;
Rot = R1+R2+R3;
print(Rot);
T1 = 70;
T2 = 30;
deltaT = T2-T1;
Q = deltaT/Rot;
print(abs(Q));

deltaT = R*Q
deltaT = Q*R1;
t1 = deltaT;
deltaT = Q*R2;
t2 = deltaT;
deltaT = Q*R3;
t3 = deltaT;
deltaTo = t1+t2+t3;
print(abs(deltaTo));

print(abs(T2)+abs(t1));
print(abs(T2)+abs(t1)+abs(t2));
```

R code Exa 11.6 Determine the heat transferred

```
# page no. 559

deltaX = 0.150;
A = 1;
k = 0.692;
R = deltaX/(k*A);

print(R);
R1 = R;
deltaX = 0.012;
A = 1;
k = 1.385;
R = deltaX/(k*A);

print(R);
R2 = R;
deltaX = 0.0120;
A = 1;
k = 0.519;
R = deltaX/(k*A);

print(R);
R3 = R;
Ro = R1+R2+R3;
print(Ro);
T1 = 0;
T2 = 20;
deltaT = T2-T1;
Q = deltaT/Ro;
print(abs(Q));
```

R code Exa 11.7 Determine the temperature

```
# page no. 560

deltaX = 0.150;
A = 1;
k = 0.692;
R = deltaX/(k*A);

print(R);
R1 = R;
deltaX = 0.012;
A = 1;
k = 1.385;
R = deltaX/(k*A);

print(R);
R2 = R;
deltaX = 0.0120;
A = 1;
k = 0.519;
R = deltaX/(k*A);

print(R);
R3 = R;
Ro = R1+R2+R3;
print(Ro);
T1 = 0;
T2 = 20;
deltaT = T2-T1;
Q = deltaT/Ro;
print(abs(Q));

deltaT = Q*R1;
t1 = deltaT;
deltaT = Q*R2;
t2 = deltaT;
deltaT = Q*R3;
t3 = deltaT;
deltaTo = t1+t2+t3;
```

```
print(abs(deltaTo));

print(abs(deltaTo)-abs(t1));
print(abs(deltaTo)-abs(t1)-abs(t2));
print(round(abs(deltaTo)-abs(t1)-abs(t2)-abs(t3)));
```

R code Exa 11.8 Determine the heat loss

```
# page no. 561

library(MASS)
deltaX = 4/12;
A = 7*2;
k = 0.090;
Rfir = deltaX/(k*A);
print(Rfir);
deltaX = 4/12;
A = 7*2;
k = 0.065;
Rpine = deltaX/(k*A);
print(Rpine);
deltaX = 4/12;
A = 7*2;
k = 0.025;
Rcorkboard = deltaX/(k*A);
print(Rcorkboard);
Roverall = ginv(ginv(Rfir)+ginv(Rpine)+ginv(
   Rcorkboard))[1];
print(Roverall);
T1 = 60;
T2 = 80;
deltaT = T2-T1;
Qtotal = deltaT/Roverall;
print(abs(Qtotal));
Qfir = deltaT/Rfir;
```

```
print(abs(Qfir));
Qpine = deltaT/Rpine;
print(abs(Qpine));
Qcorkboard = deltaT/Rcorkboard;
print(abs(Qcorkboard));
Qtotal = Qfir+Qpine+Qcorkboard;
print(abs(Qtotal));
```

R code Exa 11.9 Determine the Heat loss

```
# page no. 565

ro = 3.50;
ri = 3.00;
Ti = 240;
To = 120;
L = 5;
deltaT = Ti-To;
k = 26
Q = (2*pi*k*L*deltaT)/log(ro/ri);
print(Q);

# The answer may slightly vary due to rounding off
    values
```

R code Exa 11.10 Determine the Heat loss

```
# page no. 566

ro = 90;
ri = 75;
Ti = 110;
To = 40;
```

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

R code Exa 11.11 Determine the heat loss

```
# page no. 567

library(MASS)
r2 = 3.50;
r1 = 3.00;
Ti = 240;
L = 5;
k1 = 26;
ans1 = (ginv(k1)[1]*log(r2/r1));
r3 = 5.50;
r2 = 3.50;
To = 85;
deltaT = Ti-To;
k2 = 0.026
ans2 = (ginv(k2)[1]*log(r3/r2));
Q = (2*pi*L*deltaT)/(ans1+ans2);
print(Q);
```

R code Exa 11.12 Determine the heat transfer

```
# page no. 569

library(MASS)
r2 = 3.50;
r1 = 3.00;
```

```
Ti = 240;
L = 5;
k = 26;
Rpipe = log(r2/r1)/(2*pi*k*L);
print(Rpipe);
To = 70;
deltaT = Ti-To;
h = 0.9;
A = (pi*r2)/12*L;
Rconvection = ginv(h*A)[1];
print(Rconvection);
Rtotal = Rpipe+Rconvection;
print(Rtotal);
Q = deltaT/Rtotal;
print(Q);

# The answer may slightly vary due to rounding off
    values.
```

R code Exa 11.15 Determine the Heat loss

```
# page no. 574

D = 3.5/12;
Ti = 120;
To = 70;
deltaT = Ti-To;
h = 0.9;
L = 5;
A = (pi*D)*L;
Q = h*A*deltaT;
print(Q);
```

R code Exa 11.16 Determine the heat transfer

```
# page no. 575

library(MASS)
h = 1/2;
R = (3/12)/0.07;
Roverall = ginv(1/2)[1]+ginv(1/2)[1]+R;
print(Roverall);
Ti = 80;
To = 50;
deltaT = Ti-To;
Q = deltaT/Roverall;
print(Q);

print(Q/(1/2));
print(Q*R);
print(Q/(1/2));
h = 0.42;
Roverall = ginv(h)[1]+ginv(h)[1]+R;
print(Roverall);
Q = deltaT/Roverall;
print(Q);
print(Q/h);
print(Q*R);
print(Ti-(Q/h));
print(To+(Q/h));
print(Ti-(Q/h)-(To+(Q/h)));

# The answer may slightly vary due to rounding off
   values.
```

R code Exa 11.17 Determine the heat transferred

```
# page no. 578
```

```

G = ((20*60)*(4*144)/(pi*0.87^2));
mu = 0.33;
D = 0.87/12;
Re = (D*G)/mu;
print(Re);
h1 = 630;
F = 1.25;
h = h1*F;
print(h);
```

R code Exa 11.18 Determine the inside film coefficient

```
# page no. 579

G = ((20*60)*(4*144))/(pi*(0.87^2));
mu = 0.062;
D = 0.87/12;
Re = (D*G)/mu;
print(Re);
h1 = 135;
F = 1.25;
h = h1*F;
print(h);
```

R code Exa 11.19 Determine the Heat loss

```
# page no. 586

Fe = 0.79;
FA = 1;
sigma = 0.173*10^-8;
T1 = 120+460;
```

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

R code Exa 11.20 Determine the heat transferred

```
# page no. 588

Ti = 120;
To = 70;
deltaT = 120-70;
hrdash = 1.18;
Fe = 1;
FA = 0.79;
hr = Fe*FA*hrdash;
print(hr);
D = 3.5/12;
L = 5;
A = (pi*D)*L;
Q = 214.5;
hr = Q/(A*deltaT);
print(hr);
```

R code Exa 11.21 solve the problem

```
# page no. 589

Qtotal = 206.2+214.5;
print(Qtotal);
hcombined = 0.9+0.94;
```

```
D = 3.5/12;
Ti = 120;
To = 70;
deltaT = Ti-To;
L = 5;
A = (pi*D)*L;
Qtotal = hcombined*A*deltaT;

print(Qtotal);
```

R code Exa 11.22 Determine the over all heat transfer

```
# page no. 595

library(MASS)
A = 1;
deltax = 6/12;
k = 0.40;
brickResistance = deltax/(k*A);

print(brickResistance);
deltax = (1/2)/12;
k = 0.80;
concreteResistance = deltax/(k*A);

print(concreteResistance);
deltax = (1/2)/12;
k = 0.30;
plasterResistance = deltax/(k*A);

print(plasterResistance);
h = 0.9;
hotfilmResistance = ginv(h*A)[1];

print(hotfilmResistance);
```

```
h = 1.5;
coldfilmResistance = ginv(h*A)[1];

print(coldfilmResistance);
totalResistance = brickResistance+concreteResistance
   +plasterResistance+hotfilmResistance+
   coldfilmResistance;
print(totalResistance);
U = ginv(totalResistance)[1];
print(U);
```

R code Exa 11.23 Determine the heat transferred

```
# page no. 596

hi = 45;
r1 = 3.0/2;
k1 = 26;
r2 = 3.5/2;
k2 = 0.026;
r3 = 5.50/2;
ho = 0.9;
Ui = 1/((1/hi)+((r1/(k1*12))*log(r2/r1))+((r1/(k2*
   12))*log(r3/r2))+(1/(ho*(r3/r1))));
print(Ui);
Uo = Ui*(r1/r3);
print(Uo);
```

R code Exa 11.24 Determine the outside tube surfaced

```
# page no. 601

thetaA = 215-90;
```

```
thetaB = 125-60;
deltaTm = (thetaA-thetaB)/log(thetaA/thetaB);
m = 400*60;
Cp = 0.85;
deltaT = 215-125;
Q = m*Cp*deltaT
U = 40;
A = Q/(U*deltaTm);
print(A)

# The answer may slightly vary due to rounding off
   values.
```

R code Exa 11.25 Determine the outside tube surfaced

```
# page no. 602

thetaA = 215-60;
thetaB = 125-90;
deltaTm = (thetaA-thetaB)/log(thetaA/thetaB);
m = 400*60;
Cp = 0.85;
deltaT = 215-125;
Q = m*Cp*deltaT
U = 40;
A = Q/(U*deltaTm);
print(A);
```

R code Exa 11.26 Calculate the surface required

```
# page no. 603

library(MASS)
```

```
U = 40;
Roil = 0.005;
Rwater = 0.001;
Rcleanunit = ginv(U)[1];
Roverall = Roil+Rwater+Rcleanunit;
Uoverall = ginv(Roverall)[1];
A = 569*(U/Uoverall);
print(A);
```

R code Exa 11.27 Determine the temprature

```
# page no. 605

t2 = 140;
t1 = 280;
T1 = 85;
T2 = 115;
P = (t2-t1)/(T1-t1);
R = (T1-T2)/(t2-t1);
F = 0.91;
LMTD = ((t1-T2)-(t2-T1))/log((t1-T2)/(t2-T1));
TMTD = F*LMTD;
print(TMTD);
```