Scilab Textbook Companion for Textbook Of Engineering Chemistry by R. N. Goyal And H. Goel[1]

Created by
Jayaram.moningi
btech
Electronics Engineering
visvesvaraya national institute of technology
College Teacher
Prof K.surender
Cross-Checked by

May 23, 2016

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Textbook Of Engineering Chemistry

Author: R. N. Goyal And H. Goel

Publisher: Ane Books Pvt. Ltd., New Delhi

Edition: 1

Year: 2009

ISBN: 978-81-8052-063-1

Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

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

Contents

List of Scilab Codes

Chapter 2

acids and bases

Scilab code Exa 2.1 pH calculation

```
//acids and bases//
//example 2.1//
//(a)//
N1=1/1000;//normality of HCl//
a=100;//percentage of ionization//
C1=N1*a/100;
printf("The concentration of H+ ion in HCl solution
    is %fg.ion/lit",C1);
pH1=-log10(C1);
printf("\nThe pH of N/1000 HCl solution is %f",pH1);
N2=1/10000;//normality of NaOH solution//
C2=N2*a/100;
C2a=C2/10^-4;
printf("\nThe concentration of OH- ions in N/10000
    NaOH solution is %f*10^-4g.ion/lit",C2a);
k=10^-14;//dissociation constant of water//
H2=k/C2;
H2a=H2/10^-10;
printf("\nThe H+ concentration in N/10000 NaOH
    solution is %f*10^-10g.ion/lit",H2a);
pH2=-log10(H2);
```

```
printf("\nThe pH of the N/10000 solution is %f",pH2)
    ;
N3=1/1000;//normality of NaOH solution//
C3=N3*a/100;
C3a=C3/10^-3;
printf("\nThe concentration of OH- ions in N/1000
    NaOH solution is %f*10^-3g.ion/lit",C3a);
H3=k/C3;
H3a=H3/10^-11;
printf("\nThe H+ concentration in N/1000 NaOH
    solution is %f*10^-11g.ion/lit",H3a);
pH3=-log10(H3);
printf("\nThe pH of the N/1000 solution is %f",pH3);
//(b)//
N=0.1;//normality of given weak base//
pH=9;//pH of the base//
H=10^(-pH);
Ha=H/10^-9
printf("\nH+ concentration of the weak base is %f
    *10^-9g.ion/lit",Ha);
OH=k/H;
OHa=OH/10^-5;
printf("\nOH- concentration of the base is %f*10^-5g
    .ion/lt",OHa);
a1=OH/N;
a1b=a1/10^-4;
printf("\nDegree of ionization of given weak base is
     %f*10^-4",a1b);
```

Scilab code Exa 2.2 pH of solution

```
//acids and bases//
//example 2.2//
//(a)//
N=0.002;//normality of acetic acid solution//
```

```
a=2.3;//percentage of ionization//
H=N*a/100;//concentration of H+ ion//
printf('the concentration of H+ ions is %fg.ion/lit'
    ,H);
pH=-log10(H);
printf('\n pH value of acid solution is %f',pH);
//(b)(i)//
N1=0.01;//normality of acetic acid solution//
a1=60;//percentage of ionization//
H1=N1*a1/100;//concentration of H+ ion//
printf('\nthe concentration of H+ ions is %fg.ion/
    lit',H1);
pH1=-log10(H1);
printf('\n pH value of acid solution is %f',pH1);
//(b)(ii)//
N2=0.1;//normality of acetic acid solution//
a2=1.8;//percentage of ionization//
H2=N2*a2/100;//concentration of H+ ion//
printf('\nthe concentration of H+ ions is %fg.ion/
    lit',H2);
pH2=-log10(H2);
printf('\n pH value of acid solution is %f',pH2);
//(b)(iii)//
N3=0.04;//normality of HNO3//
a3=100;//percentage of ionization//
H3=N3*a3/100;
printf("\nthe concentration of H+ ions is %fg.ion/
    lit",H3);
pH3=-log10(H3);
printf("\n the pH of 0.04NHNO3 solution is %f",pH3);
N4=0.0001;//normality of Hcl//
a4=100;//percentage of ionization//
H4=N4*a4/100;
printf("\nthe concentration of H+ ions is %fg.ion/
    lit",H4);
pH4=-log10(H4);
printf("\n the pH of 0.0001NHcl solution is %f",pH4)
    ;
```

```
N5=1;//normality of Hcl//
a5=100;//percentage of ionization//
H5=N5*a5/100;
printf("\nthe concentration of H+ ions is %fg.ion/
    lit",H5);
pH5=-log10(H5);
printf("\n the pH of 1NHcl solution is %f",pH5);
N6=0.1;//normality of HNO3//
a6=100;//percentage of ionization//
OH6=N6*a6/100;
printf("\nthe concentration of OH- ions is %fg.ion/
    lit",OH6);
Kw=10^-14;
H6=Kw/OH6;
pH6=-log10(H6);
printf("\n the pH of 0.1N NaOH solution is %f",pH6);
N7=0.001;//normality of NaOH//
a7=100;//percentage of ionization//
OH7=N7*a7/100;
printf("\nthe concentration of OH- ions is %fg.ion/
    lit",OH7);
Kw=10^-14;
H7=Kw/OH7;
pH7=-log10(H7);
printf("\n the pH of 0.01NaOH solution is %f",pH7);
//(b)(iv)//
W=4;//weight of NaOH dissolved in water in grams//
EW=40;//equivalent weight weight of NaOH//
N8=W/EW;
printf("\nnormality of NaOH is %fN",N8);
a8=100;//percentage of ionization//
OH8=N8*a8/100;
printf("\nthe concentration of OH- ions is %fg.ion/
    lit",OH8);
Kw=10^-14;
H8=Kw/OH8;
pH8=-log10(H8);
printf("\n the pH of NaOH solution is %f",pH8);
```

Scilab code Exa 2.3 hydrogen ion concentration

```
//acida and bases//
//example 2.3//
//(a)//
N1=0.1;//normality of acetic acid//
a1=1.3;//percentage of ionization//
H1=N1*a1/100;
printf('the hydrogen ion concentration of solution is %fg.ion/lit',H1);
//(b)//
M1=10^-8;//molarity of hcl solution//
a=100;//percentage of ionization//
H=M1*a/100;

pH=-log10(H);
printf('\nthe pH of the Hcl solution is %f',pH);
disp("Theoretically the pH should be 8,however,the value will be close to 7 because H+ ions of water also plays a role");
//(c)//
N2=0.05;//normality of Hcl//
a2=100;//percentage of ionization//
pH2=-log10(N2*a2/100);
printf('\nthe pH of 0.05 Hcl solution is %f',pH2);
M3=0.05;//molarity os H2SO4//
N3=M3*2;//normality//
a3=100;//percentage of ionization//
pH3=-log10(N3*a3/100);
printf('\n the pH of 0.05M H2SO4 solution is %f',pH3);
```

Scilab code Exa 2.4 pH calculation

```
//acids and bases//
//example 2.4//
H1=0.005;//H+ ion concentration of solution in g.ion/lit//
pH1=-log10(H1);
printf("The pH value of solution whose H+ ion concentration is 0.005g.ion/lit is %f",pH1);
H2=3*10^-4;//H+ concentration of the solution//
pH2=-log10(H2);
printf("\nThe pH of a solution in which H+ is 3*10^-4 is %f",pH2);
pOH2=14-pH2;
printf("\npOH of the solution is %f",pOH2);
k=10^-14;//dissociation constant of water//
OH2=k/H2;
OH2a=OH2/10^-11;
printf("\nOH- concentration for a solution is %f*10^-11M",OH2a);
OH3=0.1//hydroxyl concentration of a solution//
H3=k/OH3;
pH3=-log10(H3);
printf("\npH of the solution whose hydroxyl concentration is N/10g.ion/lit is %f",pH3);
k4=1.8*10^-5//dissociation constant of acetic acid at 180C//
N4=0.1;//normality of acetic acid//
V4=1/N4;
a4=sqrt(k4*V4);//formula for degree of dissociation//
H4=N4*a4;//H+ ion concentration//
pH4=-log10(H4);
printf("\npH of 0.1N acetic acid solution is %f",pH4);
N5=0.01;//normality of acetic acid//
V5=1/N5;
a5=sqrt(k4*V5);//formula for degree of dissociation
```

```
    //
H5=N5*a5;//H+ ion concentration//
pH5=-log10(H5);
printf("\npH of 0.01N acetic acid solution is %f",
    pH5);
N6=0.001;//normality of acetic acid//
V6=1/N6;
a6=sqrt(k4*V6);//formula for degree of dissociation
    //
H6=N6*a6;//H+ ion concentration//
pH6=-log10(H6);
printf("\npH of 0.001N acetic acid solution is %f",
    pH6);
```

Scilab code Exa 2.5 pH calculation

```
//acids and bases//
//example 2.5//
K1=10^-8;//dissociation constant of weak mono basic
    acid//
N1=0.01;//normality of the acid//
V1=1/N1;
a1=sqrt(K1*V1);//degree of dissociation for weak
    acids//
H1=N1*a1;//H+ concentration of the solution//
pH1=-log10(H1);
printf("pH value of 0.01N solution of a weak mono
    basic acid is %f",pH1);
a2=4/100;//percentage of dissociation of acid at 20C
    //
N2=0.1;//normality of acid//
V2=1/N2;
K2=(a2^2)/V2;
K2a=K2/10^-4;
printf("\nThe dissociation constant of the acid is
```

```
    %f*10^-4",K2a);
N3=0.1;//normality of HCl//
pH3=-log10(N3);
printf("\nThe pH of the 0.1N HCl solution is %f",pH3
    );
N4=1/50;//normality of HCl//
pH4=-log10(N4);
printf("\nThe pH of the 1/50N HCl solution is %f",
    pH4);
N5=0.01;//normality of H2SO4//
pH5=-log10(N5);
printf("\nThe pH of the 0.01N H2SO4 solution is %f",
    pH5);
```

Scilab code Exa 2.6 pH of mixure

```
//acids and bases//
//example 2.6//
V1=50;//volume of Hcl in ml//
V2=30;//volume of NaOH in ml//
N1=1;//normality of Hcl//
N2=1;//nomality of NaOH//
V=V1+V2;//total volume of mixure of solutions//
a=100;//percentage of ionization//
N=(N1*V1-N2*V2)/V;
printf('The normality of resultant solution is %fg.
    equivalent/lit',N);
H=N*a/100;
printf('\n the H+ concentration of resultant
    solution is %fg.ion/lit',H);
pH=-log10(H);
printf('\n the pH of resultant solution is %f',pH);
```

Scilab code Exa 2.7 pH of the solution

```
//acids and bases//
//example 2.7//
N1=1/10;//normality of NaOH//
N2=1/20;//normality of HCl//
V1=1;//volume of NaOH in lit//
V2=1;//volume of HCl in lit//
printf("Since NaOH is stronger than HCl,the
    resultant solution will contain excess of NaOH");
V=V1+V2;//volume of resultant solution//
N=(N1*V1-N2*V2)/V;
printf("\nOH- ion concentration is %fg.ion/lit",N);
k=1*10^-14;//ionization constant of water//
H1=k/N;
H=H1/10^-13;
printf("\nH+ ion concentration is %f*10^-13g.ion/lit
    ",H);
pH=-log10(H1);
printf("\npH of the solution is %f",pH);
```

Scilab code Exa 2.8 pH of solution

```
//acids and bases//
//example 2.8//
W=2;//weight of NaOH dissolved in water in grams//
M=40;//molecular weight of NaOH//
N=W/M;//normality//
a=100;//percentage of ionization//
printf('the normality of NaOH solution is %fg.
    equivalent/lit',N);
OH=N*a/100;//the OH- ion concentration of solution//
Kw=10^-14;
H=Kw/OH;
pH=-log10(H);
```

```
printf('\n The pH of the NaOH solution is %f',pH);
```

Scilab code Exa 2.9 pH of benzoic acid

```
//acids and bases//
//example 2.9//
M=0.001;//molarity of benzoic acid//
N=M;//normality of benzoic acid//
V=1/N;
K=7.3*10^-5;//dissociation constant of benzoic acid //
a=sqrt(K*V);//since benzoic acid is very weak//
printf('the degree of ionization of the solution is %f',a);
H=N*a;
printf('\n The H+ concentration of the solution is %fg.ion/lit',H);
```

Scilab code Exa 2.10 hydrogen ion concentration

```
//acids and bases//
//example 2.10//
W=0.092;//weight of Formic acid per litre in grams//
M=46;//molecular weight of Formic acid//
N=W/M;
printf('The normality of Formic acid is %fg.equivalent/lit',N);
V=1/N;
K=2.4*10^-4;//Dissociation constant of Formic acid at 25C//
a=sqrt(K*V);//For weak acids//
printf('\nDegree of dissociation is %f',a);
H=a*N;
```

```
printf('\n The H+ concentration of the solution is
   %fg.ion/lit',H);
```

Scilab code Exa 2.11 concentration of hydroxyl ion

```
//acids and bases//
//example 2.11//
disp("In the presence of highly ionised NH4Cl,
   ammonium hydroxide is practically unionised.Thus
   all NH4+ ions are obtained from the dissociation
   of NH4Cl");
k=2.5*10^-5;//dissociation constant of NH4OH//
N=1/100;//normality of NH4OH//
C=N;//since volume of solution is one litre//
NH=C;
printf("NH4+ concentration is %fg.ion/lit",NH);
NHOH=C;
printf("\nNH4OH concentration is %fg.ion/lit",NHOH);
OH1=k*NHOH/NH;
OH=OH1/10^-5;
printf("\nHydroxyl ion concentration in the solution
    is %f*10^-5",OH);
a=OH1/N;
printf("\nDegree of dissociation of the solution is
   %f",a);
```

Scilab code Exa 2.12 concentration hydroxyl ion

```

//acids and bases//
//example 2.12//
K=1.7*10^-5;//Dissociation constant of NH4OH//
N=0.01;//Normality of NH4OH solution//
```

```
V=1/N;
a=sqrt(K*V);//since a is very small//
printf('percentage of ionization is %f',a);
OH=a*N;
printf('\n concentration of OH- ions before addition
    of NH4Cl is %fg.ion/lit',OH);
disp("concentration of hydroxyl ions after adding
   NH4Cl:");
disp(" In the presence of highly ionized NH4Cl,
   ammonium-hydroxide will remain practically
   unionized.Thus,all NH4+ ions will be obtained
   from dissociation of NH4Cl");
NH4=0.05;//concentration of NH4+ in g.ion/lit//
NH4OH=0.01;//concentration of NH4OH in g.mol/lit//
OH=K*NH4OH/NH4;
OH=OH/10^-6;
printf('\n the concentration of hydroxyl ions after
   adding NH4Cl is %fmg.ion/lit',OH);
disp(" A comparision of OH- concentration under two
   conditions indicate that hydroxyl ion
   concentration is decreased by addition of
   ammonium chloride");
```

Scilab code Exa 2.13 degree of dissociation

```
//acids and bases//
//example 2.13//
k=1.8*10^-5;//dissociation constant of acetic acid
   at 18C//
N=0.25;//normality of acetic acid solution//
V=1/N;
a=sqrt(k*V);//formula of degree of dissociation for
   weak acids//
a1=a/10^-3;
printf("Degree of dissociation of acetic acid is %f
```

```
    *10^-3",a1);
H=N*a;
H1=H/10^-3;
printf("\nH+ concentration of the solution is %f
    *10^-3g.ion/litre",H1);
N2=0.25//normality os sodium acetate added//
printf("\nIn presence of completely dissociated
    sodium acetate,acetic acid will be practically
    unionisad.Thus,all the acetate ions are obtained
    from dissociation of sodium acetate.");
CH3COO=N2;
printf("\nConcentration of CH3COO- is %fg.ion/litre"
    ,CH3COO);
CH3COOH=N2;
printf("\nConcentration of CH3COOH is %fg.ions/lit",
    CH3COOH);
H2=k*CH3COOH/CH3COO;
H3=H2/10^-5;
printf("\nH+ ion concentration after adding sodium
    acetate is %f*10^-5",H3);
a2=H2/N2;
a3=a2/10^-5;
printf("\nDegree of dissociation after adding sodium
     acetate is %f*10^-5",a3);
```

Scilab code Exa 2.14 pH of buffer solution

```
//acids and bases//
//example 2.14//
C1=0.06;//concentration od acetic acid in g.mol/lit
    //
C2=0.04;//concentration of sodium acetate in g.mol/
    li//
disp("Due to the fact sodium acetate being
    completely dissociated avd acetic acid in the
```

```
presence of former,the acetate ions are mainly obtained from the former");
printf("the concentration of acetate ions are %fg.ion/lit",C2);
K=1.8*10^-5;//dissociation constant of acetic acid//
H=K*C1/C2;
printf("\nthe H+ concentration of the solution is %fg.ion/lit",H);
pH=-log10(H);
printf("\nThe pH of solution is %f",pH);
```

Scilab code Exa 2.15 pH of buffer solution

```
//acids and bases//
//example 2.15//
M1=0.2;//molarity of acetic acid//
M2=0.2;//molarity of sodium acetate//
K=1.8*10^-5;
pH=-log10(K)+log10(M2/M1);//by using Henderson's equation//
printf("The pH value of buffer solution is %f",pH);
```

Scilab code Exa 2.16 hydrogen ion concentration

```
//acids and bases//
//example 2.16//
N=1/100;//normality of acetic acid//
V=1/N;
k=1.8*10^-5;//dissociation constant of acetic acid//
a=sqrt(k*V);//formula of degree of dissociation for weak acids//
H=a*N;
H=H/10^-4;
```

```
printf("H+ concentration of the solution is %f*10^-4",H);
n=0.01;//sodium acetate added in moles to one litre of acetic acid solution//
CH3COO=n;
printf("\nCH3COO- concentration is %fg.ion/lit",CH3COO);
CH3COOH=n;
printf("\nCH3COOH concentration is %fg.ion/lit",CH3COOH);
H1=k*CH3COOH/CH3COO;
printf("\nH+ ion concentration in the solution after adding the sodium acetate is %fg.ions/litre",H1);
```

Scilab code Exa 2.17 hydrogen ion concentration

```
//acids and bases//
//example 2.17//
V=10;//volume of water in litres//
N1=0.10;//moles of HCN added in solution//
N2=0.10;//moles of NaCN added in solution//
K=7.2*10^-10;//dissociation constant of HCN//
CN=0.1;//CN- concentration//
HCN=0.1;//HCN concentration//
H1=K*HCN/CN;
H=H1/10^-10;
k=1*10^-14;//ionization constant of water//
printf("H+ concentration in the solution is %f*10^-10",H);
OH=k/H1;
OH=OH/10^-5;
printf("\nOH- concentration in the solution is %f*10^-5",OH);
```

Scilab code Exa 2.18 ratio of salt to acid

```
//acids and bases//
//example 2.18//
K=1.7*10^-5;//dissociation constant of acid//
pH=3.77//pH value of buffer solution//
M=pH+log10(K);
N=10^M;//ratio of salt to acid//
L=1/N
printf("The ratio of salt to acid in buffer is %f",L);
```

Scilab code Exa 2.19 degree of dissociation and pH

```
//acids and bases//
//example 2.19//
k=1.8*10^-5;//dissociation constant of acetic acid//
M=0.01;//molarity of acetic acid//
N=M*1;//normality of acetic acid//
V=1/N;
a=sqrt(k*V)//degree of dissociation for weak acids//
printf("degree of dissociation of solution is %f",a);
H1=a/V;
H=H1/10^-4;
printf("\nH+ concentration in solution is %f*10^-4g.ion/lit",H);
pH=-log10(H1);
printf("\npH of the solution is %f",pH);
```

Scilab code Exa 2.20 pH of resultant liquid

```
//acids and bases//
//example 2.20//
N1=0.2//concentration of acetic acid in g.molecule/
    lit//
N2=0.25//concentration of sodium acetate in g.
    molecule/lit//
K=1.8*10^-5//ionization constant of acetic acid at
    room temparature//
pH1=-log10(K)+log10(N2/N1);
printf("pH value of the solution before adding HCl
    is %f",pH1);
N=1//normality of HCl added//
V=0.5*10^-3//amount of HCl added in lit//
M=N*V
printf("\nThe amount of HCl added in moles is %f",M)
    ;
printf("\nassuming HCl to be completely ionized,the
    amount of H+ ions added will be %f mole",M);
printf("\n due to addition of H+ ions the amount of
    acetic acid will increase and that of salt will
    correspondingly decrease by %f moles",M);
C1=N1+M//concentration of CH3COOH in moles/lit//
C2=N2-M//concentration of CH3COONa in moles/lit//
pH2=-log10(K)+log10(C2/C1);
printf("\nThe pH of the solution after adding HCl is
     %f",pH2);
pH=pH1-pH2;
printf("\nThe change of pH is %f",pH);
```

Scilab code Exa 2.21 hydroxyl ion concentration

```
//acids and bases//
//example 2.21//
```

```
K=18*10^-6;//dissociation constant of NH4OH//
N1=0.1;//normality of NH4OH solution//
V=1/N1;
a=sqrt(K*V)//since a is very small//
printf("degree of dissociation is %f",a);
OH=a/V;
printf("\nThe concentration of hydroxyl ion before adding of NH4Cl is %fg.ion/lit",OH);
W=2//weight of added NH4Cl in grams//
M=53//molecular weight of NH4Cl//
C=W/M;
printf("\nThe concentration of NH4+ ions is %fg.mol/lit",C);
C1=0.1;//concentration of NH4OH in g.mol/lit//
OH2=K*C1/C;
printf("\nThe concentration of hydroxyl ion after adding 2g of NH4Cl is %fg.ion/lit",OH2);
```

Scilab code Exa 2.22 dissociation constant and pH of aceticacid

```
//acids and bases//
//example 2.22//
ly=11.92;//equivalent conductvity of 0.02acetic acid solution in mho at 20C//
lih=360;//the equivalent ionic conductance of an infinite dillution of hydrogen ion in mho//
lic=40;//of acetate ion//
li=lih+lic;//of acetic acid//
a=ly/li;//degree of dissociation//
N=0.02;//normality of acetic acid//
V=1/N;
K=(a^2)/V;
Ka=K/10^-6;
printf("Dissociation constant of acetic acid is %f*10^-6",Ka);
```

```
W=82;//mol.wt of CH3COONa//
M=8.2//amount of sodium acetate added in g per litre solution//
printf("\nIn the presence of sodium acetate,all the acetate ions are obtained from sodium acetate only");
CH3COO=M/W;
printf("\nCH3COO- ion concentration is %fg.ion/lit",CH3COO);
printf("\nCH3COOH concentration is %fg.mol/lit",N);
H=K*N/CH3COO;
pH=-log10(K*N/CH3COO);
printf("\npH of the solution is %f",pH);
```

Scilab code Exa 2.23 hydrogen ion concentration in cleaning solution

```
//acids and bases//
//example 2.23//
OH=0.0025;//OH- concentration//
K=1*10^-14//water ionization constant//
H=K/OH;
H=H/10^-12;
printf("The concentration of H+ ions is %f*10^-12M",H);
printf("\nThe concentration of OH- ions is %fM",OH);
printf("\nAs concentration of H+ is lesser than the concentration of OH- the cleaning solution will be basic in nature");
```

Scilab code Exa 2.24 pH oh human blood

```
//acids and bases//
//example 2.24//
```

```
pH=7.3;//pH value of human blood//
H=10^-pH;
H1=H/10^-6
printf("H+ concentration of human blood is %f*10^-6M
   ",H1);
k=1*10^-14;//water ionization constant//
OH=k/H;
OH=OH/10^-6;
printf("\nOH- concentration of human blood is %f
   *10^-6M",OH);
```

Scilab code Exa 2.25 pH of HCl and NaOH solution

```
//acids and bases//
//example 2.25//
N1=0.2;//normality of HCl//
V1=25;//volume of HCl in ml//
M2=0.25;//molarity of NaOH//
N2=M2*1;//normality of NaOH//
V2=50;//volume of NaOH in ml//
V=V1+V2;//volume of resulting solution//
N=(N2*V2-N1*V1)/V;//normality of resulting solution
   //
printf("Concentration of OH- per litre in the mixure
    will be %fM",N);
K=1*10^-14;//ionization constant of water//
H=K/N;
H1=H/10^-13;
printf("\nH+ concentration of the solution is %f
   *10^-13M",H1);
pH=-log10(H);
printf("\npH of the mixure will be %f",pH)
```

Scilab code Exa 2.26 change in pH in buffer solution

```
//acids and bases//
//example 2.26//
S=0.2;//salt concentration//
A=0.2;//acid concentration//
k=1.8*10^-5;//dissociation constant of acetic acid//
pH=-log10(k)+log10(S/A);
printf("pH of the buffer solution before adding HCl is %f",pH);
v=1*10^-3;//amount of HCl added in lit//
M=1;//molarity of HCl added//
n=v*M;//no of moles of HCl added per litre//
A1=A+n;
printf("\nAcetic acid concentration after adding HCl will be %fM",A1);
S1=S-n;
printf("\nAcetate concentration after adding HCl will be %fM",S1);
pH2=-log10(k)+log10(S1/A1);
printf("\npH of the buffer solution after adding HCl is %f",pH2);
p=pH-pH2;
printf("\nChange in pH is %f",p);
```

Chapter 3

chemical kinetics and catalysis

Scilab code Exa 3.2 rate constant

```
//chemical kinetics and catalysis//
//example 3.2//
T1=10;//in min//
T2=20;//in min//
a=25;//amount of KMnO4 in ml at t=0min//
a1=20;//amount of KMnO4 in ml at t=10min or a-x
   value at t=10//
a2=15.7;//a-x value at t=20min//
k1=(2.303/T1)*log10(a/a1);//formula of rate constant
    for first order reaction//
printf("At t=10min rate constant k=%f/min",k1);
k2=(2.303/T2)*log10(a/a2);//rate constant formula//
printf("\nAt t=20min rate constant k=%f/min",k2);
printf("\nIf we calculate the rate constant at other
    t values we will see that k values are almost
   constnat");
```

Scilab code Exa 3.3 rate constant calculation

```
//chemical kinetics and catalysis//
//example 3.3//
T=40.5;//in min//
R1=25;//percentage of decomposed reactant//
R2=100-R1;//percentage of left out reactant which is
    a-x value//
R3=100/R2;//value of a/(a-x)//
K=(2.303/T)*log10(R3);//formula of rate constant for
    first order reaction//
printf("The rate constant of the reaction is %f/min"
    ,K);
```

Scilab code Exa 3.4 rate constant of first order reaction

```
//chemical kinetics and catalysis//
//example 3.4//
pi=0;//pressure of N2 at t=0//
t1=2;
t2=8;
t3=16;
t4=24;
t5=50;
pf=34;//pressure of N2 at infinity//
p1=1.6;//pressure of N2 at t=2min//
p2=6.2;//pressure of N2 at t=8min//
p3=11.2;//pressure Of N2 at t=16min//
p4=15.5;//pressure of N2 at t=24min//
p5=24.4;//pressure of N2 at t=50min//
a=pf-pi;//value of a//
a1=pf-p1;//a-x value at t=2min//
a2=pf-p2;//a-x value at t=8min//
a3=pf-p3;//a-x value at t=16min//
a4=pf-p4;//a-x value at t=24min//
a5=pf-p5;//a-x value at t=50min//
k1=(1/t1)*log(a/a1);//rate constant at t=2min//
```

```
printf("Rate constant at t=2min is %f/min",k1);
k2=(1/t2)*log(a/a2);//rate constant at t=8min//
printf("\nRate constant at t=8min is %f/min",k2);
k3=(1/t3)*log(a/a3);//rate constant at t=16min//
printf("\nRate constant at t=16min is %f/min",k3);
k4=(1/t4)*log(a/a4);//rate constant at t=24min//
printf("\nRate constant at t=24min is %f/min",k4);
k5=(1/t5)*log(a/a5);//rate constant at t=50min//
printf("\nRate constant at t=50min is %f/min",k5);
k=(k1+k2+k3+k4+k5)/5;
printf("\nAverage rate constant is %f/min",k);
```

Scilab code Exa 3.5 second order reaction

```
//chemical kinetics and catalysis//
//example 3.5//
t1=0;
t2=4.89;
t3=10.07;
t4=23.66;
v1=47.65;//ml of alkali used  at t=0min or a value//
v2=38.92;//ml of alkali used or a-x value at t=4.89
    min//
v3=32.62;//ml of alkali used or a-x value at t=10.07
    min//
v4=22.58;//ml of alkali used or a-x value at t=23.66
    min//
x2=v1-v2;//x value at t=4.89min//
x3=v1-v3;//x value at t=10.07min//
x4=v1-v4;//x value at t=23.66min//
k22=(1/t2)*(x2/(v1*v2));//rate constant for second
    order equation//
printf("Rate constant k2 value at t=4.89min is %f/
    min",k22);
k23=(1/t3)*(x3/(v1*v3));//rate constant for second
```

```
order equation//
printf("\nRate constant k2 value at t=10.07min is %f/min",k23);
k24=(1/t4)*(x4/(v1*v4));//rate constant for second order equation//
printf("\nRate constant k2 value at t=23.66min is %f/min",k24);
printf("\nAlmost constant values of k2 indicate that reaction is second order");
```

Scilab code Exa 3.6 value of decay constant

```
//chemical kinetics and catalysis//
//example 3.6//
t=1590;//half life of given radio active element in years//
k=0.693/t;//formula of decay constant for first order reactions//
printf("the value of decay constant is %f/year",k);
```

Scilab code Exa 3.8 rate constant of reaction

```
//chemical kinetics and catalysis//
//example 3.8//
t1=5;
t2=15;
t3=25;
t4=45;
a=37;//volume of KMnO4 in cm^3 at t=0 or value of a//
a1=29.8;//volume of KMnO4 in cm^3 or a-x value at t=5min//
```

```
a2=19.6;//volume of KMnO4 in cm^3 or a-x value at t
    =15min//
a3=12.3;//volume of KMnO4 in cm^3 or a-x value at t
    =25min//
a4=5;//volume of KMnO4 in cm^3 or a-x value at t=45
    min//
k1=(2.303/t1)*log10(a/a1);
printf("\nRate constant value at t=5min is %f/min",
    k1);
k2=(2.303/t2)*log10(a/a2);
printf("\nRate constant value at t=15min is %f/min",
    k2);
k3=(2.303/t3)*log10(a/a3);
printf("\nRate constant value at t=25min is %f/min",
    k3);
k4=(2.303/t4)*log10(a/a4);
printf("\nRate constant value at t=45min is %f/min",
    k4);
printf("\nAs the different values of k are nearly
    same,the reaction is of first oredr.");
k=(k1+k2+k3+k4)/4;
printf("\nThe average value of k is %f/min",k);
```

Scilab code Exa 3.9 rate constant and half life

```
//chemical kinetics and catalysis//
//example 3.9//
k=6*10^-4;//rate constant of first order
    decomposition of N2O5 in CCl4 in /min//
k1=k/60;
printf("Rate constant in terms of seconds is %f/s",
    k1);
t=0.693/k;
printf("\nHalf life of the reaction is %fmin",t);
```

Scilab code Exa 3.10 first order reaction

```
//chemical kinetics and catalysis//
//example 3.10//
t1=40;
t2=80;
t3=120;
t4=160;
t5=240;
vi=0;//volume of oxygen collected at constant
    pressure in ml at t=0//
v1=15.6;//volume of oxygen collected at constant
    pressure in ml at t=40//
v2=27.6;//volume of oxygen collected at constant
    pressure in ml at t=80//
v3=37.7;//volume of oxygen collected at constant
    pressure in ml at t=120//
v4=45.8;//volume of oxygen collected at constant
    pressure in ml at t=160//
v5=58.3;//volume of oxygen collected at constant
    pressure in ml at t=200//
vf=84.6;//volume of oxygen collected at constant
    pressure in ml at t=infinity//
a=vf-vi;//the initial concentration of N2O5 in
    solution i.e a//
a1=vf-v1;//a-x value at t=40min//
a2=vf-v2;//a-x value at t=80min//
a3=vf-v3;//a-x value at t=120min//
a4=vf-v4;//a-x value at t=160min//
a5=vf-v5;//a-x value at t=200min//
k1=(1/t1)*log(a/a1);
printf("Rate constant value at t=40min is %f/min",k1
    );
k2=(1/t2)*log(a/a2);
```

```
printf("\nRate constant value at t=80min is %f/min",
    k2);
k3=(1/t3)*log(a/a3);
printf("\nRate constant value at t=120min is %f/min"
    ,k3);
k4=(1/t4)*log(a/a4);
printf("\nRate constant value at t=160min is %f/min"
    ,k4);
k5=(1/t5)*log(a/a5);
printf("\nRate constant value at t=200min is %f/min"
    ,k5);
printf("\nAs k value is fairly constant the reaction
     is first oredr");
```

Scilab code Exa 3.11 second order rate constant

```
//chemical kinetics and catalysis//
//example 3.11//
t1=120;//time in sec//
t2=240;
t3=530;
t4=600;
a=0.05;//initial concentration//
x1=32.95;//extent of reaction or x value at t=120sce
    //
x2=48.8;//extent of reaction or x value at t=240sce
    //
x3=69;//extent of reaction or x value at t=530sce//
x4=70.35;//extent of reaction or x value at t=600sce
    //
a1=100-x1;//extent of left out or a-x value at t=120
    sec//
a2=100-x2;//extent of left out or a-x value at t=240
    sec//
a3=100-x3;//extent of left out or a-x value at t=530
```

```
sec//
a4=100-x4;//extent of left out or a-x value at t=600 sec//
k1=(1/(a*t1))*(x1/a1);
printf("Rate constant value at t=120sec is %fdm^3/mol.sec",k1);
k2=(1/(a*t2))*(x2/a2);
printf("\nRate constant value at t=240sec is %fdm^3/mol.sec",k2);
k3=(1/(a*t3))*(x3/a3);
printf("\nRate constant value at t=530sec is %fdm^3/mol.sec",k3);
k4=(1/(a*t4))*(x4/a4);
printf("\nRate constant value at t=600sec is %fdm^3/mol.sec",k4);
k=(k1+k2+k3+k4)/4;
printf("\nAverage value of rate constant is %fdm^3/mol.sec",k);
```

Scilab code Exa 3.13 first order reaction

```
//chemical kinetics and catalysis//
t1=75;//time in min//
t2=119;
t3=183;
vi=9.62;//volume of alkali used in ml at t=0min//
v1=12.10;//volume of alkali used in ml at t=75min//
v2=13.10;//volume of alkali used in ml at t=119min//
v3=14.75;//volume of alkali used in ml at t=183min//
vf=21.05;//volume of alkali used in ml at t=infinity//
k1=(1/t1)*log((vf-vi)/(vf-v1));//formula of rate constant for first order reactions//
printf("\nRate constant value at t=75min is %f/min",k1);
```

```
k2=(1/t2)*log((vf-vi)/(vf-v2));
printf("\nRate constant value at t=119min is %f/min"
    ,k2);
k3=(1/t3)*log((vf-vi)/(vf-v3));
printf("\nRate constant value at t=183min is %f/min"
    ,k3);
printf("\nAn almost constant value of k shows that
    the hydrolysis of ethyl acetateis a first order
    reaction");
```

Scilab code Exa 3.14 rate constant of first order rection

```
//chemical kinetics and catalysis//
//example 3.14//
t=15;//the half time of given first order reaction
    in min//
k=0.693/t;//formula of rate constant//
printf("The rate constant value of the given first
    order reaction is %f/min is",k);
a=100;//percentage of initial concentration//
x=80;//percentage of completed reaction//
a1=a-x;//percentage of left out concentration//
t1=(2.303/k)*(log10(a/a1));//formula to find time
    taken//
t2=t1*60;
printf("\nThe time taken to complete 80 percentage
    of the reaction is %fmin or %fsec",t1,t2);
```

Scilab code Exa 3.15 first order reaction optical rotation

```
//chemical kinetics and catalysis//
//example 3.15//
t1=6.18;//time in min//
```

```
t2=18;
t3=27.05;
ri=24.09;//rotation in degrees when t=0min//
r1=21.4;//rotation in degrees when t=6.18min//
r2=17.7;//rotation in degrees when t=18min//
r3=15.0;//rotation in degrees when t=27.05min//
rf=-10.74;//rotation in degrees when t=infinity//
a=ri-rf;//a value//
a1=r1-rf;//a-x value at t=6.18min//
a2=r2-rf;//a-x value at t=18min//
a3=r3-rf;//a-x value at t=27.05min//
k1=(2.303/t1)*log10(a/a1);
printf("Rate constant value at t=6.18min %f/min",k1)
   ;
k2=(2.303/t2)*log10(a/a2);
printf("\nRate constant value at t=18min %f/min",k2)
   ;
k3=(2.303/t3)*log10(a/a3);
printf("\nRate constant value at t=27.05min %f/min",
   k3);
printf("\nSince rate constant values are nearly same
   ,hence reaction is of first order");
```

Scilab code Exa 3.16 optical rotation of sucrose solution

```
//chemical kinetics and catalysis//
//example 3.16//
t1=10//time in min//
t2=20;
t3=30;
t4=40;
ri=32.4;//rotation in degrees when t=0min//
r1=28.8;//rotation in degrees when t=10min//
r2=25.5;//rotation in degrees when t=20min//
r3=22.4;//rotation in degrees when t=30min//
```

```
r4=19.6;//rotation in degrees when t=40min//
rf=-11.1;//rotation in degrees when t=0min//
a=ri-rf;//a value//
a1=r1-rf;//a-x value at t=10min//
a2=r2-rf;//a-x value at t=20min//
a3=r3-rf;//a-x value at t=30min//
a4=r4-rf;//a-x value at t=40min//
k1=(1/t1)*log(a/a1);
printf("Rate constant value at t=10min %f/min",k1);
k2=(1/t2)*log(a/a2);
printf("\nRate constant value at t=20min %f/min",k2);
k3=(1/t3)*log(a/a3);
printf("\nRate constant value at t=30min %f/min",k3);
k4=(1/t4)*log(a/a4);
printf("\nRate constant value at t=40min %f/min",k4);
printf("\nSince rate constant values are nearly same,hence inversion of sucrose is of first order");
```

Scilab code Exa 3.17 activation energy of the reaction

```
//chemical kinetics and catalysis//
//example 3.17//
T1=27;//initial temparature in C//
T1=T1+273;//in kelvin//
Tr=10;//rise in temparature//
T2=T1+Tr;//final temparature in kelvin//
r=2;//ratio of final to initial rates of chemical reactions(k1/k2)//
R=8.314;//value of constant R in J/K.mol//
E=log(r)*R*T1*T2/Tr;//from equation k=A*e^(-E/R*T)//
printf("Activation energy of the reaction is %fKJ/mol",E);
```

Scilab code Exa 3.18 temperature for given k

```
//chemical kinetics and catalysis//
//example 3.18//
k=4.5*10^3;//value of k in /sec of a first order
   reaction at 1C//
E=58*10^3;//activation energy in J/mol//
T=1;//temperature in C//
T1=T+273;//in kelvin//
R=8.314;//value of constant R in J/K.mol//
lA=log10(k)+(E/(2.303*R*T1));
k1=10^4;//value of k in /sec at some temperature//
a=log10(k1);
b=lA-a;
T2=E/(2.303*R*b);
printf("The temperature at which k=1*10^4/sec is %fK
   ",T2);
```

Scilab code Exa 3.19 energy of activation of the reaction

```
//chemical kinetics and catalysis//
//example 3.19//
T1=300;//temperature in kelvin//
t1=20;//half time of chemical reaction in min at T
   =300K//
k1=0.6932/t1;
printf("Rate constant of the reaction at T=300k is
   %f/min",k1);
T2=350;//temperature in kelvin//
t2=5;//half time of chemical reaction in min at T
   =350K//
```

```
k2=0.6932/t2;
printf("\nRate constant of the reaction at T=350k is %f/min",k2);
l=log10(k2/k1);
R=8.314;//value of constant R in J/K.mol//
E=l*2.303*R*T1*T2/(T2-T1);
printf("\nActivation energy of the reaction is %fJ/mol",E);
```

Scilab code Exa 3.20 rate of constant of first order reaction

```
//chemical kinetics and catalysis//
//example 3.20//
R=8.314;//value of constant R in J/K.mol//
H=1.25*10^4;//value of E/(2.303*R).It is given in the question//
E=H*2.303*R;
printf("activation energy is %fJ/mol or %fKJ/mol",E,E/1000);
la=14.34;//value of log(a)//
T=670;//temperature in kelvin//
lk=la-(H/T);
k=10^lk;
printf("\nRate constant at 670K is %f/s",k);
```

Scilab code Exa 3.21 activation energy of the reaction

```
//chemical kinetics and catalysis//
//example 3.21//
Ti=27;//given temperature in C//
T1=Ti+273;//in kelvin//
Tr=10;//rise in temperature//
T2=T1+Tr;
```

```
k=3;//value of k1/k2//
R=8.314;//value of constant R in J/K.mol//
E=log(k)*R*T1*T2/(T2-T1);
printf("Activation energy of the reaction is %fJ/mol
    or %fKJ/mol",E,E/1000);
```

Chapter 6

lubricants

Scilab code Exa 6.1 viscocity index

```
//lubricants//
//example 6.1//
d=760;//viscocity of Pennysylvanian oil in s at 37C
   //
a=528;//viscocity of lubricating oil in s at 37C//
c=480;//viscocity of Gulf oil in s at 37C//
V=((d-a)/(d-c))*(100);//formula of viscocity index//
printf("Viscocity index of the lubricating oil is %f
   ",V);
```

Scilab code Exa 6.2 API gravity

```
//lubricants//
//example 6.2//
s=0.86;//specific gravity of lubricating oil//
A=(141.5/s)-131.5;//formula of API gravity//
printf("The gravity of lubricating oil is %f",A);
```

Chapter 7

water chemistry

Scilab code Exa 7.1 hardness calculation

```
//water chemistry//
//example 7.1//
W1=16.2;//Ca(HCO3)2 in water in mg/lit//
W2=7.3;//MgHCO3 in water in mg/lit//
W3=13.6;//CaSO4 in water in mg/lit//
W4=9.5;//MgCl2 in water in mg/lit//
M1=100/162;//multiplication factor of Ca(HCO3)2//
M2=100/146;//multiplication factor of MgHCO3//
M3=100/136;//multiplication factor of CaSO4//
M4=100/95;//multiplication factor of MgCl2//
P1=W1*M1;//Ca(HCO3)2 in terms of CaCO3 or //
P2=W2*M2;//MgHCO3 in terms of CaCO3 or //
P3=W3*M3;//CaSO4  in terms of CaCO3 or //
P4=W4*M4;//MgCl2 in terms of CaCO3 or //
T=P1+P2;
printf("Temporary hardness is %fmg/l or ppm",T);
P=P3+P4;
printf("\nPermanant hardness is %fmg/l or ppm",P);
To=T+P;
printf("\nTotal hardness is %fmg/l or ppm",To);
```

Scilab code Exa 7.2 dissolved FeSO4

```
//water chemistry//
//example 7.2//
F=56;//atomic weight of ferrus//
S=32;//atomic weight of sulphur//
O=16;//atomic weight of oxygen//
Ca=40;//atomic weight of calsium//
C=12;//atomic weight of carbon//
W1=F+S+(4*O);//molecular weight of FeSO4//
W2=Ca+C+(3*O);//molecular weight of CaCO3//
A=(W1/W2)*100;
printf("Required FeSO4 for 100ppm of hardness is
    %fmg/lit",A);
P=210.5;//required ppm of hardness//
B=(A/100)*P;
printf("\nRequired FeSO4 for 210.5ppm of hardness is
    %fmg/lit or ppm of FeSO4",B);
```

Scilab code Exa 7.3 hardness calculation

```
//water chemistry//
//example 7.3//
W1=162;//Ca(HCO3)2 in water in mg/lit//
W2=73;//MgHCO3 in water in mg/lit//
W3=136;//CaSO4 in water in mg/lit//
W4=95;//MgCl2 in water in mg/lit//
W5=111;//CaCl2 in water in mg/lit//
W6=100;//NaCl in water in mg/lit//
M1=100/162;//multiplication factor of Ca(HCO3)2//
M2=100/146;//multiplication factor of MgHCO3//
M3=100/136;//multiplication factor of CaSO4//
```

```
M4=100/95;//multiplication factor of MgCl2//
M5=100/111;//multiplication factor of CaCl2//
M6=100/100;//multiplication factor of NaCl//
P1=W1*M1;//Ca(HCO3)2 in terms of CaCO3 or //
P2=W2*M2;//MgHCO3 in terms of CaCO3 or //
P3=W3*M3;//CaSO4  in terms of CaCO3 or //
P4=W4*M4;//MgCl2 in terms of CaCO3 or //
P5=W5*M5;//CaCl2 in terms of CaCO3 or //
printf("We do not take NaCl since it does not
   contribute to hardness");
T=P1+P2;
printf("\nTemporary hardness is %fmg/l or ppm",T);
P=P3+P4+P5;
printf("\nPermanant hardness is %fmg/l or ppm",P);
To=T+P;
printf("\nTotal hardness is %fmg/l or ppm",To);
```

Scilab code Exa 7.4 hardness calculation

```
//water chemistry//
//example 7.4//
N=0.08;//normality of MgSO4//
V1=12.5;//volume of MgSO4 in ml//
V2=100;//volume of water sample//
M=N/2;//molarity of MgSO4//
N1=(M*12.5)/1000;//no of moles of MgSO4 in 100 ml
   water//
N2=(N1*1000)/100;//no of moles of MgSO4 in one litre
    water//
W=100;//molecular weight of CaCO3
W1=N2*W*1000;//MgSO4 in terms of CaCO3 in mg/lit//
printf("\nThe hardness due to MgSO4 is %fmg/l CaCO3
   or ppm of CaCO3",W1);
```

Scilab code Exa 7.5 quantity of lime and soda

```
//water chemistry//
//example 7.5//
W1=144;//MgCO3 in water in mg/lit//
W2=25;//CaCO3 in water in mg/lit//
W3=111;//CaCl2 in water in mg/lit//
W4=95;//MgCl2 in water in mg/lit//
M1=100/84;//multiplication factor of MgCO3//
M2=100/100;//multiplication factor of CaCO3//
M3=100/111;//multiplication factor of CaCl2//
M4=100/95;//multiplication factor of MgCl2//
P1=W1*M1;//MgCO3 in terms of CaCO3 or ppm//
P2=W2*M2;//CaCO3 in terms of CaCO3 or ppm//
P3=W3*M3;//CaCl2  in terms of CaCO3 or ppm//
P4=W4*M4;//MgCl2 in terms of CaCO3 or ppm//
V=50000;//volume of water in lit//
L=0.74*(2*P1+P2+P4)*V;
printf("Requirement of lime is %fmg",L);
S=1.06*(P1+P3+P4)*V;
printf("\nRequirement of soda is %fmg",S);
```

Scilab code Exa 7.6 lime requirement

```
//water chemistry//
//example 7.6//
W1=12;//Mg2+ in water in ppm or mg/l//
W2=40;//Ca2+ in water in ppm or mg/l//
W3=164.7;//HCO3- in water in ppm or mg/l//
W4=30.8;//CO2 in water in ppm or mg/l//
M1=100/24;//multiplication factor of Mg2+//
M2=100/40;//multiplication factor of Mg2+//
```

```
M3=100/61;//multiplication factor of Mg2+//
M4=100/44;//multiplication factor of Mg2+//
P1=W1*M1;// in terms of CaCO3//
P2=W2*M2;// in terms of CaCO3//
P3=W3*M3;// in terms of CaCO3//
P4=W4*M4;// in terms of CaCO3//
V=50000//volume of water in lit//
L=0.74*(P1+P3+P4)*V;
printf("Lime required is %fmg",L);
```

Scilab code Exa 7.7 lime soda requirement

```
//water chemistry//
//example 7.7//
W1=160;//Ca2+ in water in mg/l or ppm//
W2=72;//Mg2+ in water in mg/l or ppm//
W3=732;//HCO3- in water in mg/l or ppm//
W4=44;//CO2 in water in mg/l or ppm//
W5=16.4;//NaAlO2 in water in mg/l or ppm//
W6=30;//(CO3)2- in water in mg/l or ppm//
W7=17;//OH- in water in mg/l or ppm//
M1=100/40;//multiplication factor of Ca2+//
M2=100/24;//multiplication factor of Ca2+//
M3=100/(61*2);//multiplication factor of Ca2+//
M4=100/44;//multiplication factor of Ca2+//
M5=100/(82*2);//multiplication factor of Ca2+//
M6=100/60;//multiplication factor of Ca2+//
M7=100/(17*2);//multiplication factor of Ca2+//
P1=W1*M1;//in terms of CaCO3//
P2=W2*M2;//in terms of CaCO3//
P3=W3*M3;//in terms of CaCO3//
P4=W4*M4;//in terms of CaCO3//
P5=W5*M5;//in terms of CaCO3//
P6=W6*M6;//in terms of CaCO3//
P7=W7*M7;//in terms of CaCO3//
```

```
V=200000;//volume of water in lit//
L=0.74*(P2+P3+P4-P5+P7)*V;
L=L/10^6;//in kgs//
printf("Lime required is %fkg",L);
S=1.06*(P1+P2-P3-P5-P6+P7)*V;
S=S/10^6;//in kgs//
printf("\nSoda required is %fkg",S);
```

Scilab code Exa 7.8 hardness of water

```
//water chemistry//
//example 7.8//
N=150;//amount of NaCl in solution in g/l//
V=8;//volume of NaCl solution//
M=N*V;
printf("The amount of NaCl in 8 lit of solution is
    %fgms",M);
V=10000;//volume of hard water//
W=58.5;//molecular weight of NaCl//
K=(M*100/(W*2))/V;
printf("\nfor 1 litre hardness is %fg/l",K);
J=K*1000;
printf("\nHardness of water is %fmg/l or ppm",J);
```

Scilab code Exa 7.9 total cost

```
//water chemistry//
//example 7.8//
W1=219;//amount of Mg(HCO3)2 in water in ppm//
W2=36;//amount of Mg2+ in water in ppm//
W3=18.3;//amount of (HCO3)- in water in ppm//
W4=1.5;//amount of H+_in water in ppm//
M1=100/146;//multiplication factor of Mg(HCO3)2//
```

```
M2=100/24;//multiplication factor of Mg(HCO3)2//
M3=100/122;//multiplication factor of Mg(HCO3)2//
M4=100/2;//multiplication factor of Mg(HCO3)2//
P1=W1*M1;//in terms of CaCO3//
P2=W2*M2;//in terms of CaCO3//
P3=W3*M3;//in terms of CaCO3//
P4=W4*M4;//in terms of CaCO3//
L=0.74*((2*P1)+P2+P3+P4);
printf("Lime required is %fmg/l",L);
R=1;//water supply rate in m^3/s//
D=R*60*60*24*L;
printf("\nLime required for one day is %fm^3/day",D)
  ;
K=D*1000;//in lit/day//
T=K/10^9;//in tonnes//
S=1.06*(P2+P4-P3);
printf("\nSoda required is %fmg/l",S);
D2=R*60*60*24*S;
printf("\nSoda required per day is %fm^3/day",D2);
A=D2*1000;//in lit/day//
B=A/10^9;//in tonnes//
J1=90/100;//purity of lime//
J2=95/100;//purity of soda//
C1=500;//cost of one tonne lime//
C2=7000;//cost of one tonne soda//
CL=T*C1/J1;
printf("\ncost of lime is %fRs",CL);
CS=B*C2/J2;
printf("\ncost of soda is %fRs",CS);
C=CL+CS;
printf("\ntotal cost is %fRs",C);
```

Scilab code Exa 7.10 alkalinity hardness salts

```
//water chemistry//
```

```
//example 7.10//
W1=40;//amount of Ca2+ in water in mg/l//
W2=24;//amount of Mg2+ in water in mg/l//
W3=8.05;//amount of Na+ in water in mg/l//
W4=183;//amount of (HCO3)- in water in mg/l//
W5=55.68;//amount of (SO4)2- in water in mg/l//
W6=6.74;//amount of Cl- in water in mg/l//
M1=100/40;//multiplication factor of Ca2+//
M2=100/24;//multiplication factor of Mg2+//
M3=100/(23*2);//multiplication factor of Na+//
M4=100/(61*2);//multiplication factor of (HCO3)-//
M5=100/96;//multiplication factor of (SO4)2-//
M6=100/(35.5*2);//multiplication factor of Cl-//
P1=W1*M1;//in terms of CaCO3//
P2=W2*M2;//in terms of CaCO3//
P3=W3*M3;//in terms of CaCO3//
P4=W4*M4;//in terms of CaCO3//
P5=W5*M5;//in terms of CaCO3//
P6=W6*M6;//in terms of CaCO3//


printf("magnesium alkalinity is %fppm",P4-P1);
printf("\ncalsium alkalinity is %fppm",P1);
printf("\ntotal alkalinity is %fppm",P1+P4-P1);
printf("\ntotal hardness is %fppm",P1+P2);
printf("\ncalsium temporary hardness is %fppm",P1);
printf("\nMagnesium temporary hardness id %fppm",P4-
   P1);
printf("\nMagnesium permanant hardness is %fppm",P2
   -(P4-P1));
printf("\n Ca(HCO3)2 salt is %fppm",P1);
printf("\nMg(HCO3)2 salt is %fppm",P4-P1);
printf("\nMgSO4 salt is %fppm",P2-(P4-P1));
printf("\nNaCl salt is %fppm",P6);
```

Scilab code Exa 7.11 type and amount of alkalinity

```
//water chemistry//
//example 7.11//
P=0;//phenolplthalein alkalinity in water sample//
V=16.9;//required HCl in ml for 100 ml water sample
   //
N=0.02;//normality of HCl//
printf("Since P=0 the alkalinity is due to HCO3-
   ions");
C=50;//equivalent of CaCO3 in mg for 1 ml 1N of HCl
   //
A=C*V*N;
printf("\nIn 100ml water sample the alkalinity is
   %fmg",A);
B=A*1000/100;
printf("\nFor 1 litre of water the alkalinity is
   %fmg/l",B);
```

Scilab code Exa 7.12 type and amount of alkalinity

```
//water chemistry//
//example 7.12//
P=4.7;//required HCl in ml using HpH indicator //
H=10.5;//required HCl im ml using MeOH indicator//
M=P+H;
N=0.02;//normality of HCl//
printf("M=%fml",M)
printf("\nSince P<0.5*M sample contain (CO3)2- and (
   HCO3)- alkalinity");
printf("\nVol of 0.02N HCl for (CO3)2- in 100 ml of
   water sample is %fml",2*P);
C=50;//equivalent of CaCO3 in mg for 1ml 1N HCl//
A=C*(2*P)*N;//amount of (CO3)2- alkalinity in mg in
   100 ml of water//
```

```
B=A*1000/100;
printf("\nThe amount of (CO3)2- alkalinity in 1
    litre water is %fppm",B);
printf("\nVol of 0.02N HCl for (HCO3)- in 100 ml of
    water sample is %fml",M-2*P);
D=C*(M-2*P)*N;//the amount of (HCO3)- alkalinity in
    mg in 100 ml of water//
E=D*1000/100;
printf("\nThe amount of (HCO3)- alkalinity in 1
    litre water is %fppm",E);
T=B+E;
printf("\nTotal alkalinity is %fmg/l or ppm",T);
```

Scilab code Exa 7.13 calculation of required lime and soda

```
//water chemistry//
//example 7.13//
W1=160;//amount of Ca2+ in ppm//
W2=88;//amount of Mg2+ in ppm//
W3=72;//amount of CO2 in ppm//
W4=488;//amount of (HCO3)- in ppm//
W5=139;//amount of (FeSO4).7H2O in ppm//
M1=100/40;//multiplication factor of Ca2+//
M2=100/24;//multiplication factor of Mg2+//
M3=100/44;//multiplication factor of CO2//
M4=100/(61*2);//multiplication factor of (HCO3)-//
M5=100/278;//multiplication factor of (FeSO4).7H2O//
P1=W1*M1;//in terms of CaCO3//
P2=W2*M2;//in terms of CaCO3//
P3=W3*M3;//in terms of CaCO3//
P4=W4*M4;//in terms of CaCO3//
P5=W5*M5;//in terms of CaCO3//
V=100000;//volume of water in litres//
L=0.74*(P2+P3+P4+P5)*V;//lime required in mg//
L=L/10^6;
```

```
printf("Lime required is %fkg",L);
S=1.06*(P1+P2+P5-P4)*V;//soda required in mg//
S=S/10^6;
printf("\nSoda required is %fkg",S);
```

Scilab code Exa 7.14 hardness of water

```
//water chemistry//
//example 7.14//
W=50;//amount of NaCl in g/l in NaCl solution//
V=200;//volume of NaCl solution in litres//
A=W*V;
V=10000;//volume of hard water passed through
    Zeolite softener//
printf("The amount of NaCl used for %f litres of
    water is %fg",V,A);
M=100/(58.5*2);//multiplication factor of NaCl//
P=M*A;
printf("\nIn terms of CaCO3=%fgCaCO3",P);
B=P*1000/V;
printf("\nFor 1 litre of hard water=%fmg/l or ppm",B
    );
```

Scilab code Exa 7.15 calculation of temporary and permanant hardness

```
//water chemistry//
//example 7.15//
W1=0.28;//amount of CaCO3 in grams dissolved in 1
    litre of water//
V1=28;//required EDTA in ml on titration of 100ml of
    CaCO3 solution//
V2=33;//required EDTA in ml for 100ml of unknown
    hard water sample//
```

```
V3=10;//required EDTA in ml for 100 ml of unknown sample after boiling and cooling//
M1=100/100;//multiplication factor of CaCO3//
C=W1*M1;
printf("1 litre sample have %fg in terms of CaCO3",C);
printf("\n1 ml sample have %fmgCaCO3",C);
A=C*100//for 100 ml of sample equivalent to 28 ml of EDTA//
B=A/V1;
printf("\n1ml of EDTA=%fmg CaCO3",B);
D=V2*B;//for 100 ml//
D=D*1000/100;
printf("\n1000ml of unknown water contains %fmgCaCO3",D);
printf("\nTotal hardness is %fmg/lCaCO3 or ppm",D);
E=V3*B;//for 100 ml//
E=E*1000/100;
printf("\n1000ml of boiled unknown water contains %fmgCaCO3",E);
printf("\nPermanant hardness is %fmg/l CaCO3 or ppm",E);
T=D-E;
printf("\nTemporary hardness is %fmg/l CaCO3 or ppm",T);
```

Chapter 8

Fuels and Combustion

Scilab code Exa 8.1 calorific value

```
//Fuels and Combustion//
//Example 8.1//
w=1500;//quantity of water in grams//
W=125;//Water equivalent of calorimeter in grams//
x=1.050;//quantity of fuel carried out in combustion
    in grams//
t1=25;//initial temperature of water in degree C//
t2=27.8;//final temperature of water in degree C//
Q=(w+W)*(t2-t1)/x;//calorific value of the fuel in
    cal per grams//
printf('Calorific value of the fuel=Q=%fcal/g',Q);
```

Scilab code Exa 8.2 Gross calorific value

```
//Fuels and Combustion//
//Example 8.2//
C=90;//percentage of carbon//
O=3.0;//percentage of oxygen//
```

```
S=0.5;//percentage of sulphur//
N=0.5;//percentage of nytrogen//
H=4.60;//percentage of hydrogen//
LCV=8500;//Law calorific value of the coal in Kcal/
    Kg//
printf('percentage of hydrogen=H=%f',H);
GCV=(8080*C+34500*(H-O/8)+2240*S)/100;//Gross
    calorific value of the sample in cal per grams//
printf('\nGross Calorific value of the fuel=GCV=
    %fcal/g',GCV);
```

Scilab code Exa 8.3 Gross and Net calorific value

```
//Fuels and Combustion//
//Example 8.3//
w=500;//quantity of water taken in grams//
W=2000;//Water equivalent of calorimeter in grams//
m=1.000;//weight of coal taken or mass of fuel in
    grams//
t1=24;//initial temperature of water in degree C//
t2=26.2;//final temperature of water in degree C//
AC=50;//Acid correction in calories//
FC=10;//Fuse wire correction in calories//
CC=0;//cooling correction in calories//
GCV=((w+W)*(t2-t1+CC)-(AC+FC))/m;//Gross calorific
    value of the sample in cal per grams//
printf('Gross Calorific value of the fuel=GCV=%fcal/
    g',GCV);
H=6;//percentage of hydrogen//
C=93;//percentage of carbon//
LCV=GCV-(9*H*580/100);//Net calorific value of the
    sample in cal per gram//
printf('\nNet calorific value of the sample=LCV=
    %fcal/g',LCV);
```

Scilab code Exa 8.4 percentage of contents in the sample

```
//Fuels and Combustion//
//Example 8.4//
WC=1.5642;//weight of coal sample in grams//
WH110=1.5022;//weight of sample after heating at 110
    degrees in grams//
m=WC-WH110;//weight of moisture in the sample//
printf('weight of moisture in the sample=m=%fg',m);
pm=m*100/WC;//percentage of moisture in the sample//
printf('\npercentage of moisture in the sample=pm=%f
   ',pm);
WH950=0.7628;//weight of sample after heating at 950
    degrees in grams//
vm=WH110-WH950;//volatile matter in grams//
printf('\nWeight of volatile matter in the sample=vm
   =%fg',vm);
pvm=vm*100/WC;//percentage of voltaile matter//
printf('\npercentage of volatile matter in the
   sample=pvm=%f',pvm);
ac=0.2140;//Ash content left in the last in grams//
pac=ac*100/WC;//percentage of Ash content laft//
printf('\npercentage of Ash content in the sample=
   pac=%f',pac);
pfc=100-(pm+pvm-pac);//percentage of fixaed carbon//
printf('\npercentage of fixed carbon in the sample=
   pfc=%f',pfc);
```

Scilab code Exa 8.5 percentage of sulphur

```
//Fuels and Combustion//
//Example 8.5//
```

```
WBaSO4=0.0482;//weight of BaSO4 in grams//
W=0.5248;//weight of sample in grams//
PS=32*WBaSO4*100/(233*W);//percentage of sulphur in the sample//
printf('percentage of sulphur in the sample=PS=%f',PS);
```

Scilab code Exa 8.6 Gross and Net calorific value

```
//Fuels and Combustion//
//Example 8.6//
W=10;//weight of Water heated of calorimeter in Kilograms//
V=0.1;//volume of gas used in metrecube//
t1=22;//inlet temperature of water in degree C//
t2=30;//outlet temperature of water in degree C//
GCV=W*(t2-t1)/V;//Gross calorific value of the sample in Kilocal per metre3//
printf('Gross Calorific value of the fuel=GCV=%fKcal/m3',GCV);
L=580;//latent heat of water in cal/g//
Ws=0.025;//weight of steam condensed in grams//
LCV=GCV-(Ws*L/V);//Net calorific value of the sample in Kcal per meter3//
printf('\nNet calorific value of the sample=LCV=%fKcal/m3',LCV);
```

Scilab code Exa 8.7 amount of air needed

```
//Fuels and Combustion//
//Example 8.7//
C=90;//percentage of carbon//
O=3.0;//percentage of oxygen//
```

```
S=0.5;//percentage of sulphur//
N=0.5;//percentage of nytrogen//
H=3.5;//percentage of hydrogen//
H2O=0.1;//percentage of H2O//
printf('12grams of carbon will need 32grams of
   oxygen\n2grams of hydrogen will need 16grams of
   oxygen\n32grams of sulphur will need 32grams of
   oxygen');
AO=900*32/12+35*16/2+5*32/32;//amount of oxygen
   required in grams//
printf('\nBut we already have 30grams of oxygen \nso
    amount of oxygen we require is 2655grams');
AN=2655*100/23;//amount of air needed in grams//
printf('\namount of air needed=AN=%fg',AN);
```

Scilab code Exa 8.8 Amount and Volume of Air and Oxygen needed

```
//Fuels and Combustion//
//Example 8.8//
CH4=0.14;//volume of CH4 in 1m3 volume of gaseous
   fuel in m3//
H2=0.32;//volume of H2 in 1m3 volume of gaseous fuel
    in m3//
N2=0.40;//volume of N2 in 1m3 volume of gaseous fuel
    in m3//
O2=0.14;//volume of O2 in 1m3 volume of gaseous fuel
    in m3//
printf('Volume of oxygen required for CH4
   =0.14*2=0.28m3');
printf('\nVolume of oxygen required for H2
   =0.32*0.5=0.16m3');
printf('\nTotal oxygen required=0.28+0.16=0.44m3');
printf('\nOxygen already present=0.14m3');
printf('\nNet oxygen required=0.44-0.14=0.30m3=300
   Letres');
```

```
printf('\nVolume of air required assuming 21percent
    oxygen in air by volume=300*(100/21)*(125/100)
    =1785.7Letres');
```

Scilab code Exa 8.9 Gross and Net calorific value

```
//Fuels and Combustion//
//Example 8.9//
C=750;//weight of carbon in 1kg of coal sample in
    grams//
O=121;//weight of oxygen in 1kg of coal sample in
    grams//
A=45;//weight of Ash in 1kg of coal sample in grams
    //
N=32;//weight of nytrogen in 1kg of coal sample in
    grams//
H=52;//weight of hydrogen in 1kg of coal sample in
    grams//
MO=C*32/12+H*16/2-O;//minimum weight of oxygen
    needed in grams//
printf('minimum weight of oxygen needed=MO=%fg',MO);
MA=MO*100/23;//minimum weight of air needed in grams
    //
printf('\nminimum amount of air needed=MA=%fg',MA);
GCV=(808*C+3450*(H-O/8))/100;//Gross calorific value
     of the sample in cal per grams//
printf('\nGross Calorific value of the fuel=GCV=
    %fcal/g',GCV);
LCV=GCV-0.09*H*0.1*587;//law calorific value of the
    sample in cal/gram//
printf('\nLaw calorific value of the sample=LCV=
    %fcal/g',LCV);
```

Scilab code Exa 8.10 percentage of contents in the sample

```
//Fuels and Combustion//
//Example 8.10//
C=810;//weight of carbon in 1kg of coal sample in
    grams//
O=80;//weight of oxygen in 1kg of coal sample in
    grams//
S=10;//weight of Sulphur in 1kg of coal sample in
    grams//
N=10;//weight of nytrogen in 1kg of coal sample in
    grams//
H=50;//weight of hydrogen in 1kg of coal sample in
    grams//
MO=C*32/12+H*16/2+S*32/32;//minimum weight of oxygen
     needed in grams//
printf('minimum weight of oxygen needed=MO=%fg',MO);
printf('\nOxygen already available in fuel=80grams\
    nNet oxygen needed=2490grams');
MA=2490*100/23;//minimum weight of air needed in
    grams//
printf('\nminimum amount of air needed=MA=%fg',MA);
printf('\nProducts of combustion are CO2 and SO2');
printf('\nFrom the equations written above,44grams
    of CO2 is obtained 12grams of carbon\nhence,
    weight of CO2 obtained from 810grams of carbon
    =810*44/12=2970grams');
printf('\nSimilarly,weight of SO2 obtained from 10
    grams of sulphur=10*64/32=20grams');
NF=10+MA*0.77;//weight of nitrogen present in the
    products in grams//
printf('\nWeight of nitrogen present in the products
    =NF=%fg',NF);
WD=2970+20+8346;//total weight of dry products in
    grams//
printf('\nTotal weight of dry products=WD=%fg',WD);
PCO2=2970*100/WD;//percentage composition of CO2//
printf('\nPercentage composition of CO2=PCO2=%f',
```

```
PCO2);
PSO2=20*100/WD;//percentage composition of SO2//
printf('\nPercentage composition of SO2=%f',PSO2);
PN2=8346*100/WD;//percentage composition of N2//
printf('\nPercentage composition of N2=PN2=%f',PN2);
```

Scilab code Exa 8.11 percentage of contents in the sample

```
//Fuels and Combustion//
//Example 8.11//
CO=0.205;//volume of carbon monoxide in 1kg of gas sample in m3//
CO2=0.060;//volume of CO2 in 1kg of gas sample in m3//
CH4=0.042;//volume of CH4 in 1kg of gas sample in m3//
N=0.501;//volume of nytrogen in 1kg of gas sample in m3//
H2=0.194;//volume of hydrogen in 1kg of gas sample in m3//
printf('Corresponding to Combustion reactions involved we will get\nVolume of H2 needed=0.194*0.5=0.097m3\nVolume of CO needed=0.205*0.5=0.102m3\nVolume of CH4 needed=0.042*2.0=0.084m3');
printf('\nTotal volume of gases needed=0.283m3');
VA=0.283*(100/21)*(130/100);//volume of air needed in m3//
printf('\nVolume of air needed=VA=%fm3',VA);
VDCO2=0.06+0.205*1+0.042*1;//volume of dry products containig CO2 formed in m3//
printf('\nVolume of dry products containing CO2 formed=VDCO2=%fm3',VDCO2);
VDN2=0.501+1.752*79/100;//volume of dry products containig N2 formed in m3//
```

```
printf('\nVolume of dry products containing N2 formed=VDN2=%fm3',VDN2);
VDO2=1.755*21/100;//volume of dry products containig O2 formed in m3//
printf('\nVolume of dry products containing O2 formed=VDO2=%fm3',VDO2);
TVD=VDCO2+VDN2+VDO2;//total volume of dry products formed in m3//
printf('\nTotal volume of dry products formed=TVD=%fm3',TVD);
PDCO2=VDCO2*100/TVD;//percentage of dry products containig CO2 formed//
printf('\nPercentage of dry products containing CO2 formed=PDCO2=%f',PDCO2);
PDN2=VDN2*100/TVD;//percentage of dry products containig N2 formed//
printf('\nPercentage of dry products containing N2 formed=PDN2=%f',PDN2);
PDO2=VDO2*100/TVD;//percentage of dry products containig O2 formed//
printf('\nPercentage of dry products containing O2 formed=PDO2=%f',PDO2);
```

Scilab code Exa 8.12 Amount of Air and Oxygen needed

```
//Fuels and Combustion//
//Example 8.12//
C=780;//weight of carbon in 1kg of coal sample in grams//
O=120;//weight of oxygen in 1kg of coal sample in grams//
S=12;//weight of Sulphur in 1kg of coal sample in grams//
N=21;//weight of nytrogen in 1kg of coal sample in grams//
```

```
H=41;//weight of hydrogen in 1kg of coal sample in grams//
MO=C*32/12+H*16/2+S*32/32-O;//minimum weight of oxygen needed in grams//
printf('minimum weight of oxygen needed=MO=%fg',MO);
MA=MO*100/23;//minimum weight of air needed in grams//
printf('\nminimum amount of air needed=MA=%fg',MA);
```

Scilab code Exa 8.13 Amount and Volume of Air and Oxygen needed

```
//Fuels and Combustion//
//Example 8.13//
C=1.5;//weight of carbon in 1kg of coal sample in Kilograms//
WO2=C*32/12;//weight of oxygen in carbon sample in Kilograms//
printf('weight of oxygen needed=WO2=%fKg',WO2);
WA=WO2*100/23;//weight of air in the carbon sample in Kilograms//
printf('\nweight of air in the carbon sample=WA=%fKg',WA);
printf('\nAs 32grams of oxygen occupies 22.4 litres at NTP\n4000grams of oxygen occupies =22.4*4000/32=2800 litres');
printf('\nHence volume of air is=100*2800/21=13333 litres=13.33m3');
```

Scilab code Exa 8.14 percentage of contents in the sample

```
//Fuels and Combustion//
//Example 8.14//
WC=1.508;//weight of coal sample in grams//
```

```
WH110=1.478;//weight of sample after heating at 110
    degrees in grams//
m=WC-WH110;//weight of moisture in the sample//
printf('weight of moisture in the sample=m=%fg',m);
pm=m*100/WC;//percentage of moisture in the sample//
printf('\npercentage of moisture in the sample=pm=%f
    ',pm);
WH950=1.068;//weight of sample after heating at 950
    degrees in grams//
vm=WH110-WH950;//volatile matter in grams//
printf('\nWeight of volatile matter in the sample=vm
    =%fg',vm);
pvm=vm*100/WC;//percentage of voltaile matter//
printf('\npercentage of volatile matter in the
    sample=pvm=%f',pvm);
```

Scilab code Exa 8.15 Efficiency of fuel

```
//Fuels and Combustion//
//Example 8.15//
CR=7.8;//compression ratio for first case//
E1=1-(1/CR)^0.258;//Energy efficiency corresponding
    to CR value 7.8//
printf('Efficiency of the engine in the first case=
    E1=%f',E1);
CR=9.5;//compreesion ratio for second case//
E2=1-(1/CR)^0.258;//Energy efficiency corresponding
    to CR value 9.5//
printf('\nEfficiency of the engine in the second
    case=E2=%f',E2);
IE=E2-E1;//Increase in efficiency//
printf('\nIncrease in efficiency=IE=%f',IE);
PIE=IE*100/E2;//percentage of increase in efficiency
    //
printf('\nPercentage of increase in efficiency=PIE=
```

```
%f',PIE);
```

Scilab code Exa 8.16 Amount and Volume of Air needed

```
//Fuels and Combustion//
//Example 8.16//
C=3;//weight of carbon in 1kg of coal sample in Kilograms//
WO2=C*32/12;//weight of oxygen in carbon sample in Kilograms//
WA=WO2*100/23;//weight of air in the carbon sample in Kilograms//
printf('weight of air required for combustion of carbon=WA=%fKg',WA);
MA=WA/28.92;//mol of air in kilograms//
VA=MA*22.4;//Volume of air required in m3 air//
printf('\nVolume of air required=VA=%fm3',VA);
```

Scilab code Exa 8.17 Amount and Volume of Air needed

```
//Fuels and Combustion//
//Example 8.17//
CO=0.46;//volume of carbon monoxide in 1kg of gas sample in m3//
C2H2=0.020;//volume of C2H2 in 1kg of gas sample in m3//
CH4=0.1;//volume of CH4 in 1kg of gas sample in m3//
N2=0.01;//volume of nytrogen in 1kg of gas sample in m3//
H2=0.40;//volume of hydrogen in 1kg of gas sample in m3//
printf('Corresponding to Combustion reactions involved we will get\nVolume of H2 needed
```

```
=0.4*0.5=0.20m3\nVolume of CO needed
=0.46*0.5=0.23m3\nVolume of CH4 needed
=0.1*2.0=0.20m3\nVolume of C2H2 needed
=0.02*2.5=0.05m3');
printf('\nTotal volume of gases needed=0.68m3');
VA=0.68*(100/21);//volume of air needed in m3//
printf('\nVolume of air needed=VA=%fm3',VA);
```

Scilab code Exa 8.18 weight of contents in the sample

```
//Fuels and Combustion//
//Example 8.18//
C=624;//weight of carbon in 1kg of coal sample in
grams//
O=69;//weight of oxygen in 1kg of coal sample in
grams//
S=8;//weight of Sulphur in 1kg of coal sample in
grams//
N=12;//weight of nytrogen in 1kg of coal sample in
grams//
H=41;//weight of hydrogen in 1kg of coal sample in
grams//
CO2=129;//weight of CO2 in 1kg of coal sample in
grams//
CO=2;//weight of CO in 1kg of coal sample in grams//
MO=C*32/12+H*16/2+S*32/32-O;//minimum weight of
oxygen needed in grams//
MA=MO*0.1/23;//minimum weight of air needed in
kilograms//
printf('minimum amount of air needed=MA=%fkg',MA);
WC=CO2*(12/44)+CO*(12/28);//weight of C in fuel gas/
kg//
printf('\nWeight of C in fuel gas/kg=WC=%fg',WC);
WF=C/WC;//Weight of fuel gas/kg of coal in g//
printf('\nweight of fuel gas/kg of coal=WF=%fg',WF);
```

```
O2=2*16/28;//O2 needed to convert CO to CO2 in Kg//
RWO2=(61-O2)/1000;//remaining weight of O2/kg of
    fuel gas in Kg//
printf('\nRemaining weight of O2/kg of fuel gas=RWO2
    =%fkg',RWO2);
WO2=WF*RWO2;//weight of O2 obtained by burning 1kg
    coal in kg//
printf('\nWeight of O2 obtained by burning coal=WO2=
    %fkg',WO2);
AR=WO2*100/23;//air required in kilograms//
printf('\nAir required=AR=%fkg',AR);
WAS=MA+AR;//weight of air actually supplied/kg coal
    burnt in kg//
printf('\nWeight of air actually supplied/kg coal
    burnt=WAS=%fkg',WAS);
```

Scilab code Exa 8.19 calorific value

```
//Fuels and Combustion//
//Example 8.19//
w=1080;//quantity of water in grams//
W=150;//Water equivalent of calorimeter in grams//
x=0.681;//quantity of fuel carried out in combustion
     in grams//
dt=3.61;//rise in temperature of water in degree C//
Q=(w+W)*(dt)/x;//calorific value of the fuel in cal
    per grams//
printf('Calorific value of the fuel=Q=%fcal/g',Q);
```

Scilab code Exa 8.20 Gross calorific value

```
//Fuels and Combustion//
//Example 8.20//
```

```
w=1080;//quantity of water taken in grams//
W=150;//Water equivalent of calorimeter in grams//
m=0.681;//weight of coal taken or mass of fuel in
    grams//
dt=3.61;//rise in temperature of water in degree C//
AC=50;//Acid correction in calories//
FC=5;//Fuse wire correction in calories//
CC=0.05;//cooling correction in calories//
GCV=((w+W)*(dt+CC)-(AC+FC))/m;//Gross calorific
    value of the sample in cal per grams//
printf('Gross Calorific value of the fuel=GCV=%fcal/
    g',GCV);
```

Scilab code Exa 8.21 Gross calorific value

```
//Fuels and Combustion//
//Example 8.21//
C=90.2;//percentage of carbon//
O=2.9;//percentage of oxygen//
H=2.40;//percentage of hydrogen//
GCV=(8080*C+34400*(H-O/8))/100;//Gross calorific
    value of the sample in cal per grams//
printf('\nGross Calorific value of the fuel=GCV=
    %fcal/g',GCV);
```

Scilab code Exa 8.22 Maximum temperature that can be achieved

```
//Fuels and Combustion//
//Example 8.22//
a=0.9;//absorptivity//
e=0.04;//emissivity//
P=750;//Sun light energy available in W/m2//
Q=5.67;//conductivity in 10^-8//
```

```
T4=a*P/(Q*e);
T=738;//maximum temperature that can be achieved//
printf('Maximum temeperature that can be achieved=T=
    %fK',T);
```

Chapter 10

polymer chemistry

Scilab code Exa 10.1 number average and weight average molecular mass

```
//polymer chemistry//
//example 10.1//
N1=5;//no of molecules//
N2=10;
N3=20;
N4=20;
N5=10;
M1=5000;//molecular mass of each molecule//
M2=6000;
M3=10000;
M4=15000;
M5=25000;
M=(M1*N1+M2*N2+M3*N3+M4*N4+M5*N5)/(N1+N2+N3+N4+N5);
    //formula for number average molecular mass//
printf("The number average molecular mass is %f",M);
Mw=(N1*M1^2+N2*M2^2+N3*M3^2+N4*M4^2+N5*M5^2)/(M1*N1+
    M2*N2+M3*N3+M4*N4+M5*N5);//formula of weight-
    average molecular mass//
printf("\nThe weight average molecular mass is %f",
    Mw);
```