Scilab Textbook Companion for Nuclear Chemistry through Problems by H. J. Arnikar and N. S. Rajurkar[1]

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November 22, 2014

[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: Nuclear Chemistry through Problems

Author: H. J. Arnikar and N. S. Rajurkar

Publisher: New Age International, New Delhi.

Edition: 1

Year: 1997

ISBN: 81-224-1036-7

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 1

Nuclear Chemistry through Problems

Scilab code Exa 1.1 P1 1

```
//Ex1_1

clc;
//Given:
v=1000;// potential
d=0.05;// distance
q=3.8*10^-9;// charge

//solution:
e=v/d;//electric field
f=e;// force
f1=f*q;// force on metal sphere
printf("\n The electric field in V/m is = %f ",e)
printf("\n The force in N/C is = %f ",f)
printf("\n The force on metal sphere in N is = %f ",
    f1)
```

Scilab code Exa 1.2 P1 2

```
//Ex1_2

clc;
//Given:
energy=2*10^-6;
c=2.5*10^-8;// velocity of light
//solution:
v=energy/c;// potential
printf("The potential in V is = %f ",v)
```

Scilab code Exa 1.3 P1 3

```
//Ex1_3

clc;
//Given:

energy=10; //in electron volts
m=9.1*10^-31;// mass of electron in kg
h=6.626*10^-34;// planck's constant J.s
c=3*10^8;// speed of light in m/s

//solution (a):
energy1=energy*1.6*10^-19;// energy in J
p=(2*m*energy1)^0.5;// momentum
wavelength=h/p*(10)^10;

printf("The wavelength in Angstroms is = %f ",
    wavelength)


//solution (b):
wavelength1=h*c/energy1*(10)^10;//photon wavelength
```

```
printf("\n The photon wavelength in Angstroms is =
    %f ",wavelength1)
```

Scilab code Exa 1.4 P1 4

```
//Ex1_4

clc;

//Given:

wavelength=10^-10;
m=9.1*10^-31;
h=6.626*10^-34;

//solution:

p=h/wavelength;
e=p*p/(2*m); // energy in J
e1=e/(1.6*10^-19);// energy in eV

printf("The energy in eV is = %f ",e1)
```

Scilab code Exa 1.5 P1 5

```
//Ex1_5

clc;

//Given:

m=1.66*10^-27;// 1u=1.66*10^-27 kg
```

```
h=6.6262*10^-34;//planck's constant in J.s
energy1=120;// in Mev for oxygen
energy2=140;// in MeV for nitrogen

//solution(a):

p=(2*m*16*energy1*(1.6022*10^-13))^0.5;
wavelength1=h/p*(10)^15;//wavelength in 10^-5
    Angstroms

printf("\n The wavelength in 10^-5 Angstroms is = %f
    ",wavelength1)

//solution (b):

p=(2*m*14*energy2*(1.6022*10^-13))^0.5;
wavelength2=h/p*(10)^15;//wavelength in 10^-5
    Angstroms

printf("\n The wavelength in 10^-5 Angstroms is = %f
    ",wavelength2)

// 1 Angstrom = 10^-10 m
```

Scilab code Exa 1.6 P1 6

```
//Ex1_6

clc;

//Given:

wavelength=1.5*10^-10;
h=6.62*10^-34;
c=3*10^8;
```

```
//solution:

e=(h*c)/wavelength;// energy in J
e1=e/(1.6*10^-19);// energy in eV

printf("The energy in eV is = %f ",e1)
```

Scilab code Exa 1.7 P1 7

```
//Ex1_7

clc;

//Given:

E=5.12*1.6*10^-19// energy in J
h=6.626*10^-34;
c=3*10^8;
wavelength=200*10^-9;
w=2.3;// in eV

//solution:

tf=E/h;// (part a)
printf("\n The threshold frequency in s^-1 is = %f "
   ,tf)

tl=c/tf*10^10;// (part b)
printf("\n The threshold wavelength in Angstroms is
   = %f ",tl)

e=(h*c)/(wavelength*1.6*10^-19)// photon energy in
   eV (part c)

```

```
pe=e-w;

printf("\n The energy of photoelectrone in eV is =
  %f ",pe)
```

Scilab code Exa 1.8 P1 8

```
//Ex1_8

clc;

//Given:
e1=1; // in MeV
e2=2; // in MeV
ma=4; // in u(amu)
md=2; // in u(amu)
mp=1; // in u(amu)

// 1u = 1.6*10^-27 Kg

//solution: part a)For alpha particles

v1a=((2*e1*10^6*1.6*10^-19)/(ma*1.6605*10^-27))^.5;
printf("\n The velocity of alpha particles for 1 MeV
    in m/s is = %f ",v1a)// For 1 MeV

v2a=((2*e2*10^6*1.6*10^-19)/(ma*1.6605*10^-27))^.5;
printf("\n The velocity of alpha particles for 2 MeV
    in m/s is = %f ",v2a)// For 2 MeV

//solution: part b)For deuteron particles

v1b=((2*e1*10^6*1.6*10^-19)/(md*1.6605*10^-27))^.5;
printf("\n The velocity of deuteron particles for 1
  MeV in m/s is = %f ",v1b) // For 1 MeV
```

```
v2b=((2*e2*10^6*1.6*10^-19)/(md*1.6605*10^-27))^.5;
printf("\n The velocity of deuteron particles for 2
   MeV in m/s is = %f ",v2b) // For 2 MeV

//solution: part c)For proton particles

v1p=((2*e1*10^6*1.6*10^-19)/(mp*1.6605*10^-27))^.5;
printf("\n The velocity of proton particles for 1
   MeV in m/s is = %f ",v1p) // For 1 MeV


v2p=((2*e2*10^6*1.6*10^-19)/(mp*1.6605*10^-27))^.5;
printf("\n The velocity of proton particles for 2
   MeV in m/s is = %f ",v2p) // For 2 MeV
```

Scilab code Exa 1.9 P1 9

```

//Ex1_9

clc;

//Given:

m=1/(6.023*10^23);//mass of 1 atom in g
m1=m*10^-3;//mass of 1 atom in Kg
c=3*10^8;// velocity in m/s
//solution:

e=m1*c*c; // energy in J
e1=e/(1.6*10^-13);// energy in MeV

printf("The energy in MeV is = %f ",e1)
```

Scilab code Exa 1.10 P1 10

```
//Ex1_10

clc;

//Given:

enthalpy=1278; // enthalpy of combustion in kJ/mol

//solution:

energy=(enthalpy*1000)/(6.022*10^23*1.6*10^-19);

printf("The energy in eV is = %f ",energy)
```

Scilab code Exa 1.11 P1 11

```
//Ex1_11

clc;

//Given:
mh=1.0078;
mn=1.0087;
ma=4.0026;
mo=15.9949;
Ah=4.0026; // atomic mass of helium
Ao=15.9949; // atomic mass of oxygen

```

```
//solution:

// part (a)

B1=(2*mh+2*mn-ma)*931; // in MeV
Bh=B1/Ah;
printf("\n The mean binding energy of helium atom in
    MeV is = %f ",Bh)

// part (b)

B2=(8*mh+8*mn-mo)*931; // in MeV
Bo=B2/Ao;
printf("\n The mean binding energy of oxygen atom in
    MeV is = %f ",Bo)
```

Scilab code Exa 1.12 P1 12

```

//Ex1_12

clc;

//Given:
mh=1.0078;
mn=1.0087;
ABe=8.0053; // atomic mass of beryllium

//solution:

B1=(4*mh+4*mn-ABe)*931; // in MeV
Bh=B1/ABe;
printf("\n The mean binding energy of Be atom in MeV
    is = %f ",Bh)

```

```
disp("From previous problem we have the avg. binding
    energy of helium atom is          7.08 MeV, Hence
   Be is unstable to fission into 2 alphas")
```

Scilab code Exa 1.13 P1 13

```

//Ex1_13

clc;

//Given:

e=200; // in Mev
m=0.235; // weight of uranium atom in Kg
enthalpy=393.5; // in KJ/mol
Na=6.02*10^23;


//solution:
e1=e*1.6*10^-19*10^6;
atoms=Na/m;
e2=atoms*e1;//energy released in J
m1=(e2*12)/(393.5*1000*1000);// in Kg
m2=m1/1000;// in tons
printf("\n The amount of coal required in Kg is = %f
   ", m2)
```

Scilab code Exa 1.14 P1 14

```

//Ex1_14

```

```
clc;

//Given:
H1=241.8; // in KJ/mol
H2=887.2; // in KJ/mol
// 1 KJ/mol = 0.0104 eV/atom

//solution: part (a)
e1=H1*0.0104;
printf("\n The energy release in part (a) in eV/
    molecule is = %f ",e1)

//solution: part (b)
e2=H2*0.0104;
printf("\n The energy release in part (b) in eV/
    molecule is = %f ",e2)
```

Scilab code Exa 1.15 P1 15

```

//Ex1_15

clc;

//Given:
H1=4.1; // in eV/molecule
H2=17.4; // in eV/molecule
H3=200;// in MeV/atom of U

// 1 eV/atom = 96.32 KJ/mol

//solution: part (a)
e1=H1*96.32;
printf("\n The energy release in part (a) in KJ/mol
    of carbondioxide is = %f ",e1)
```

```
//solution: part (b)
e2=H2*96.32;
printf("\n The energy release in part (b) in KJ/mol
   of alumina is = %f ",e2)

//solution: part (c)
e3=H3*1000*96.32;// in MJ/atom of U(235)
printf("\n The energy release in part (c) in MJ/atom
    of U(235) is = %f ",e3)
```

Scilab code Exa 1.16 P1 16

```

//Ex1_16

clc;

//Given:
e=200; //MeV/ atom of U
// 1 eV = 1.6*10^-19 J
Na=6.023*10^23;
M=0.235; // mass in Kg

//solution:

e1=e*1.6*10^-19*10^6;
A=Na/M;
e2=A*e1; // energy released in MJ/day
e3=e2/(24*3600);
printf("\n The rate of energy release in W is %f ",
   e3)
```

Scilab code Exa 1.17 P1 17

```
//Ex1_17

clc;

//Given:
e=26.03; // in MeV

//solution:

loss=e/931; //in atomic mass units (u)
// 1 u = 1.66*10^-27 Kg
m=(loss*1.66*10^-27)/(1*10^-27);
printf("\n The mass loss in 10^-27 Kg/He formed is =
    %f ",m)
```

Scilab code Exa 1.18 P1 18

```

//Ex1_18

clc;

//Given:
mh=1.007825;
mt=3.016049;
md=2.014102;

//solution:

m1=(mh+mt-2*md);
e=(-m1)*931; // in MeV
printf("\n The energy loss in MeV is = %f ",e)
```

Scilab code Exa 1.19 P1 19

```
//Ex1_19

clc;

//Given:
mh=1.007825;
mn=1.008665;
mt=3.016049; // atomic mass of Tritium
mNi=59.93528; // atomic mass of Nickel

//solution:

// part (a)

B1=(1*mh+2*mn-mt)*931; // in MeV
Bh=B1/mt;
printf("\n The mean binding energy of tritium atom
   in MeV is = %f ",Bh)

// part (b)

B2=(28*mh+32*mn-mNi)*931; // in MeV
Bo=B2/mNi;
printf("\n The mean binding energy of nickel atom in
    MeV is = %f ",Bo)
```

Scilab code Exa 1.20 P1 20

```
//Ex1_20

clc;

//Given:
mh=1.00783;
mn=1.00867;
m35=34.96885; // atomic mass of Cl (35)
m37=36.96590; // atomic mass of Cl (37)

//solution:

B1=(17*mh+18*mn-m35)*931; // in MeV
Bh=B1/m35;
printf("\n The mean binding energy of Cl (35) atom
    in MeV is = %f ",Bh)

B2=(17*mh+20*mn-m37)*931; // in MeV
Bo=B2/m37;
printf("\n The mean binding energy of Cl (37) atom
    in MeV is = %f ",Bo)

Bi=Bo-Bh;
printf("\n The increase in mean binding energy of Cl
     atom in MeV is = %f ",Bi)

// NOTE: The answer depends upon how much precise
    value you take for atomic masses.
```

Scilab code Exa 1.21 P1 21

```

//EX1_21

```

```
clc;

//Given:
mh=1.0078;
mn=1.0087;
m22=21.99431;// atomic mass of Na 22
m23=22.9898;// atomic mass of Na 23
m24=23.9909;// atomic mass of Na 24

//solution:

// part (a)

B1=((11*mh+11*mn)-m22)*931; // in MeV
Bh=B1/m22;
printf("\n The mean binding energy of Na(22) in MeV
   is = %f ",Bh)

// part (b)

B2=((11*mh+12*mn)-m23)*931; // in MeV
Bo=B2/m23;
printf("\n The mean binding energy of Na(23)in MeV
   is = %f ",Bo)

// part (c)

B3=((11*mh+13*mn)-m24)*931; // in MeV
Bs=B3/m24;
printf("\n The mean binding energy of Na(24) in MeV
   is = %f ",Bs)
```

Chapter 2

Nuclear Chemistry through Problems

Scilab code Exa 2.1 P2 1

```

//Ex2_1

clc;

//Given:
f=19;// atomic mass no. of F
a=197;// atomic mass no.of Au
p=239;// atomic mass no. of Pu
//solution:(a)

m1=f/(6.02*10^23);
Rf=1.4*(f^(1/3))*10^-13;// in cm
V1=1.3333*3.14*(Rf)^3;
df=m1/(V1*10^14);// density in 10^14 g cm^-3
printf("\n The density nucleus of F(19) in 10^14 g
    cm^-3 is = %f ",df)

//(b)
```

```
m2=a/(6.02*10^23);
Ra=1.4*(a^(1/3))*10^-13;// in cm
V2=1.3333*3.14*(Ra)^3;
da=m2/(V2*10^14);// density in 10^14 g cm^-3
printf("\n The density nucleus of Au(197) in 10^14 g
    cm^-3 is = %f ",da)


//(c)
m3=p/(6.02*10^23);
Rp=1.4*(p^(1/3))*10^-13;// in cm
V3=1.3333*3.14*(Rp)^3;
dp=m3/(V3*10^14);// density in 10^14 g cm^-3
printf("\n The density nucleus of P(239) in 10^14 g
    cm^-3 is = %f ",dp)

// Note: The density for Au(197) is not calculated
    correctly in the textbook.
```

Scilab code Exa 2.2 P2 2

```

//Ex2_2

clc;

// Given:
// (a) Be(8)= 2 He(4)
// (b) Kr(80)= 2 Ar(40)
// (c) Cd(108)= 2 Cr(54)


// Solution:
m1=8.0053-2*4.00260;
m2=79.81638-2*39.96238;
```

```
m3=107.90418-2*53.93888;


if m1>0 then
    printf("\n Case (a) Fission is possible since m1
       = %f",m1)
else
    printf("\n Case (a) Fission is not possiblesince
        m1= %f",m1)
end

if m2>0 then
  printf("\n Case (b) Fission is possible since m2=
     %f",m2)
 else
    printf("\n Case (b) Fission is not possible
       since m2= %f",m2)
end

if m3>0 then
    printf("\n Case (c) Fission is possible since m3
       = %f",m3)
else
    printf("\n Case (c) Fission is not possible
       since m3= %f",m3)
end
```

Scilab code Exa 2.3 P2 3

```

// Ex2_3

clc;

// Given:
```

```
l=3;
f=3;
s=1/2;

// Solution:
I=l-s;// total angulr momentum
P=(-1)^(l);//nuclear parity
mm=(I-2.293*(I/(I+1)));// in nuclear magneton

printf("\n Nuclear spin of the nucleus is %f",I)
if P>0 then
    printf(" (+) ")
else
    printf(" (-) ")
end

printf("\n Magnetic moment is = %f in nuclear
    magneton",mm)
```

Scilab code Exa 2.4 P2 4

```

// Ex2_4

clc;

// Given:

l=4;
g=4;
s=1/2;

// Solution:
I=l+s;// total angulr momentum
P=(-1)^(l);//nuclear parity
```

```
mm=(I+2.293);// for odd proton and I=l+s in nuclear
    magneton

printf("\n Nuclear spin of the nucleus is %f",I)
if P>0 then
    printf(" (+) ")
else
    printf(" (-) ")
end
printf("\n Magnetic moment is = %f in nuclear
    magneton",mm)
```

Scilab code Exa 2.5 P2 5

```

// Ex2_5

clc;

// Given:(a) Cs(55) (b) Kr(36)

// Solution: Part(a)
disp(" The odd nucleon is 55 proton in level 2 d 5/2
     (+). Hence spin is 5/2 and parity (+)")
mm=((5/2)+2.293);
printf("\n Magnetic moment is = %f in nuclear
    magneton",mm)
// Solution: Part(b)
printf("\n \n The odd nucleon is 47 neutron in level
     1 g 9/2 (+). Hence spin is 9/2 and parity (+)")
disp("Magnetic moment for neutron is m=-1.913 in
    nuclear magneton")
```

Scilab code Exa 2.7 P2 7

```
// Ex2_7

clc;

// Given:
h=6.6262*10^-34;// in J.s
f=17.24*10^6;// in Hz/T
m=5.05*10^-27;// in J/T
// Solution:

E=h*f;
g=E/(m)
printf("The nuclear g factor for P is = %f",g)
```

Scilab code Exa 2.8 P2 8

```
// Ex2_8

clc;
// Given:

h=6.6262*10^-34;// in J.s
f=17.24*10^6;// in Hz/T
m=5.05*10^-27;// in J/T
g=1.405;

// Solution:

E=g*m;
f=E/(h*10^6);// NMR frequency

```

```
printf("The NMR frequency is = %f MHz",f)
```

Scilab code Exa 2.9 P2 9

```

// Ex2_9
clc;

// Given:

h=6.6262*10^-34;// in J.s
f=30.256*10^6;// in Hz/T
m=5.05*10^-27;// in J/T
g1=5.585;
g2=1.405;

// Solution:
H1=(h*f)/(g1*m);
H2=(h*f)/(g2*m);
printf("\n Magnetic field required for a proton is =
    %f T",H1)
printf("\n Magnetic field required for C 13 is = %f
   T",H2)
```

Scilab code Exa 2.10 P2 10

```

// Ex2_10
clc;
// Given:

h=6.6262*10^-34;// in J.s
f=9.302*10^9;// in Hz/T
```

```
m=9.274*10^-24;// in J/T
g1=2.0025;


// Solution:

H1=(h*f)/(g1*m);
printf("\n Magnetic field required for a proton is =
    %f T",H1)
```

Scilab code Exa 2.11 P2 11

```

// Ex2_11
clc;

// Given:
mf=1.201;// In T
h=6.6262*10^-34;// in J.s
m=9.2741*10^-24;// in J/T
g=2.0025;
// Solution:
v=(g*m*mf)/(h*10^9);
printf("The frequency needed to bring in resonance
    is = %f GHz",v)
```

Scilab code Exa 2.12 P2 12

```

// Ex2_12
clc;

// Given:
```

```
mf=1.5;// In T
h=6.6262*10^-34;// in J.s
mb=9.2741*10^-24;// in J/T
mn=5.0504*10^-27;//in J/T
ge=2.002;
gp=5.5854;
// Solution: Part(a)
v1=(gp*mn*mf)/(h*10^6);
printf("\n The frequency needed to bring proton spin
    resonance is  = %f MHz",v1)
// Solution: Part(b)
v2=(ge*mb*mf)/(h*10^9);
printf("\n The frequency needed to bring electron
   spin resonance is  = %f GHz",v2)
```

Scilab code Exa 2.13 P2 13

```
// Ex2_13
clc;

// Given:
h=6.6262*10^-34;// in J.s
f=40.2*10^6;// in Hz/T
m=5.05*10^-27;// in J/T
g1=5.256;


// Solution:
H1=(h*f)/(g1*m);
printf("\n Magnetic field required for causing
   resonance is = %f T",H1)
```

Scilab code Exa 2.14 P2 14

```
//Ex2_14
clc;

//Given:
mf=1.0;// In T
h=6.6262*10^-34;// in J.s
mn=5.0504*10^-27;//in J/T
gB=5.4;
gN=4.01;
// Solution:
v1=(gB*mn*mf)/(h*10^6);

v2=(gN*mn*mf)/(h*10^6);

printf("\n The ratio of NMR frequencies of B/N is =
   %f",v1/v2)
```

Scilab code Exa 2.15 P2 15

```

// Ex2_15
clc;

// Given:
E=14.4*10^-3;// in MeV
m=57;
// Solution:
Er=(536*(E)^2)/(m*10^-3);
printf("The recoil energy is = %f meV",Er)
```

Scilab code Exa 2.16 P2 16

```
// Ex2_16
clc;

// Given:
Er=2.551;// in meV
m=119;// atomic wt of Sn

// Solution:
E=sqrt(2.551*10^-3*119/536);// energy emitted by
    nucleus
printf("The energy emtted by the nucleus is = %f MeV
    ",E)
```

Scilab code Exa 2.17 P2 17

```

// Ex2_17
clc;
// Given:
l=10^-10;// in m
m=100;// in u
h=6.6262*10^-34;// in J.s


// Solution:
v=h/(m*l*1.67*10^-27);// velocity
f=v/l;// frequency

printf("The doppler shift frequency is = %f Hz",f)
```

Scilab code Exa 2.18 P2 18

```

```

```
// Ex2_18
clc;
//Given:
// 1 ev=8065 cm^-1
E=14.4*10^3;// in eV
// Solution:
f1=E*8065;// frequency in cm^-1
printf("\n The frequency in cm^-1 is = %f",f1)
fr=f1*3*10^8*100;
printf("\n The frequency in Hz is = %f",fr)
```

Scilab code Exa 2.19 P2 19

```

// Ex2_19
clc;

// Given:
//Given:
// 1 ev=8065 cm^-1
E=14.4*10^3;// in eV
v1=2.2*10^-3;// in m/s
// Solution:
f1=E*8065;// frequency in cm^-1
fr=f1*3*10^8*100;
fr1=(fr*v1)/(3*10^8);

printf("The shift in frequency between the source
    and the sample is = %f Hz",fr1)
```

Scilab code Exa 2.20 P2 20

```

```

```
// Ex2_20
clc;

// Given:
E=1.6*14.4*10^3*10^-19;// energy in J
c=3*10^8;// in m/s
m=57*1.6*10^-27;
M=10^-4;
h=6.6262*10^-34;// in J.s
// Solution:
p=E/c;
v=p/m;
v1=(v*m)/(M);
v2=(v*m)/(M*10^-20);
f1=(E*v)/(h*c);
f2=(E*v1)/(h*c*10^-10);
printf("\n The recoil velocity of free atom is = %f
    m/s",v)
printf("\n The recoil velocity of atom that is part
    of crystal in 10^-20 = %f m/s",v2)
printf("\n The doppler shift for free atom is = %f
    Hz",f1)
printf("\n The doppler shift of atom that is part of
    crystal in 10^-10 Hz is = %f",f2)
```

Scilab code Exa 2.21 P2 21

```

// Ex2_21
clc;

// Given:
A=175;
R=1.4*10^-15*((A)^(1/3));
// Soluiton:
```

```
//Part a
sqrBMinusSqrA = (5.9 * (10^ (-28))) * 5 /(2 * 71);

BMinusA = sqrBMinusSqrA / (2 * R);

ellipticity = 2 * (BMinusA) / (2 * R);

printf("\n Ellipticity is = %f\n",ellipticity);

//Part B

b = (BMinusA + (2 * R)) /2;
a = (-BMinusA + (2 * R)) /2;

printf("\n b/a is = %f",b/a);
```

Scilab code Exa 2.22 P2 22

```

// Ex2_22
clc;

// Given:
A1=176;
A2=233;
R1=1.4*10^-15*((A1)^(1/3));
R2=1.4*10^-15*((A2)^(1/3));
// Soluiton:
//Part a

sqrBMinusSqrA = (5 * 7 * (10^ (-28))) /(2 * 71);

BMinusA = sqrBMinusSqrA / (2 * R1);

ellipticity = 2 * (BMinusA) / (2 * R1);
```

```
printf(" Ellipticity is = %f\n",ellipticity);

b = (BMinusA + (2 * R1)) /2;
a = (-BMinusA + (2 * R1)) /2;

printf("b/a is = %f\n",b/a);

//Part B


sqrBMinusSqrA = -(5 * 3 * (10^ (-28))) /(2 * 91);

BMinusA = sqrBMinusSqrA / (2 * R2);

ellipticity = 2 * (BMinusA) / (2 * R2);

printf(" Ellipticity is = %f\n",ellipticity);

b = (BMinusA + (2 * R2)) /2;
a = (-BMinusA + (2 * R2)) /2;

printf("b/a is = %f",b/a);
```

Scilab code Exa 2.23 P2 23

```


// Ex2_23
clc;

// Given:
e = 0.03;
A=75;
R=1.4*10^-15*((A)^(1/3));
```

```
// Soluiton:

BPlusA = 2 * R;

BMinusA = e * R;
sqrBMinusSqrA = BPlusA * BMinusA;

BMinusA = sqrBMinusSqrA / (2 * R);

Q = (2*33*sqrBMinusSqrA)/5;
q1=Q/10^-28;
printf("Quadrapole moment is = %f in barns",q1);
```

Chapter 3

Nuclear Chemistry through Problems

Scilab code Exa 3.1 P3 1

```
//Ex3_1

clc;

//Given in cgs units
m1=232;
m2=1;
m3=4;
z1=90;
z2=1;
z3=2;
e=4.8*10^-10;// in ergs
c=1.4;// nuclear radius constant

//Formula: E=(z1*z2*e^2)/(r1+r2)
r1=(m1)^(1/3);
r2=(m2)^(1/3);
r3=(m3)^(1/3);
E1=(z1*z2*e*e)/(c*(r1+r2)*10^-13*(1.6*10^-6));
```

```
printf("\n The coulomb barrier for the penetration
   of Th by proton is = %f MeV",E1)
E2=(z1*z3*e*e)/(c*(r1+r3)*10^-13*(1.6*10^-6));
printf("\n \n The coulomb barrier for the
   penetration of Th by alpha particle is = %f MeV",
   E2)
```

Scilab code Exa 3.2 P3 2

```
//Ex3_2

clc;

//Given in cgs units
m1=112;
m2=1;
m3=4;
m4=66;
z1=50;
z2=1;
z3=2;
z4=30;
e=4.8*10^-10;// in ergs
c=1.4;// nuclear radius constant

//Formula: E=(z1*z2*e^2)/(r1+r2)
r1=(m1)^(1/3);
r2=(m2)^(1/3);
r3=(m3)^(1/3);
r4=(m4)^(1/3);
E1=(z1*z2*e*e)/(c*(r1+r2)*10^-13*(1.6*10^-6));
printf("\n The coulomb barrier for the penetration
   of Th by proton is = %f MeV",E1)
E2=(z4*z3*e*e)/(c*(r4+r3)*10^-13*(1.6*10^-6));
printf("\n \n The coulomb barrier for the
```

```
penetration of Th by alpha particle is = %f MeV",
E2)
```

Scilab code Exa 3.3 P3 3

```

// Ex3_3
clc;
// Given:
E=6;// in MeV
z1=79;
z2=2;
q=4.8*10^-10;
// Solution:

// At the closest distance of approach, the kineic
   energy of the alpha particle balances the columb
   barrier energy.

r1=(z1*z2*q*q)/(E*1.6*10^-6);// distance in cm
r=r1*10^13;// distance in fm

printf("The closest distance of approach is = %f fm"
   ,r)
```

Scilab code Exa 3.4 P3 4

```

// Ex3_4
clc;
// Given:
A=180;

```

```
// Solution:
z=(40*A)/(0.6*(A^(2/3))+80);
printf("The stable nuclied of the isobaric series is
    Hf atomic no. = %d",z)
```

Scilab code Exa 3.5 P3 5

```

// Ex3_5
clc;

// Given:
A=87;

// Solution:
z=(40*A)/(0.6*(A^(2/3))+80);
printf("The stable nuclied of the isobaric series is
    Sr atomic no. = %f",z)
// nereast integer is 38

printf("\n Hence the nuclides of z<38 fall on the
   left of the limb of B vs Z parabola while the
   nuclides of z>38 fall on the right limb of the
   parabola.")
```

Scilab code Exa 3.7 P3 7

```

// Ex3_7

clc;

// Given:
```

```
B=11.009305;
C1=12;
C2=11.001433;
p=1.0078;
n=1.0087;
Al=26.981535;
Si1=27.976927;
Si2=26.986705;
// Solution:
m1=(B+p-C1);//(a)
E1=m1*931;// of last proton in C in MeV
printf("\n The binding energy for the last proton in 12C is = %f MeV",E1)

m2=(C2+n-C1);//(b)
E2=m2*931;// of last neutron in C in MeV
printf("\n The binding energy for the last neutron in 12C is = %f MeV",E2)

m3=(Al+p-Si1);//(c)
E3=m3*931;// of last proton in Si in MeV
printf("\n The binding energy for the last proton in 28Si is = %f MeV",E3)

m4=(Si2+n-Si1);//(d)
E4=m4*931;// of last neutron in Si in MeV
printf("\n The binding energy for the last neutron in 28Si is = %f MeV",E4)

// Note: There is a calculation error in the textbook for the (b) part.
```

Scilab code Exa 3.8 P3 8

```
// Ex3_8
```

```
clc;

// Given:
d=2.014102;
C=12;
a=4.002603;
N=14.003074;
O=15.994915;

// Solution:
m1=(C+d-N);
E1=m1*931;// The binding energy for N(14)
printf("\n The binding energy for N(14) is = %f MeV"
    ,E1)

m2=(C+a-O);
E2=m2*931;//The binding energy for O(16)
printf("\n The binding energy for O(16) is = %f MeV"
    ,E2)
```

Scilab code Exa 3.9 P3 9

```
// Ex3_9
clc;


// Given:
D=-1.997042;
n=1.0087;
// Solution:
m=(D+2*n);
E=m*931;
printf("\n The binding energy is = %f MeV",E)
```

Scilab code Exa 3.10 P3 10

```
// Ex3_10

clc;

// Given:
mH=1.007825;
mn=1.008665;
M1=207.97666;// mass of Pb 208
M2=206.97590;// mass of Pb 207
M3=206.97739;// mass of Tl 207

// Solution:

B1=((82*1.007825+126*1.008665)-207.97666)*931;//
    binding energy for Pb 208
B2=((82*1.007825+125*1.008665)-206.97590)*931;//
    binding energy for Pb 207
B3=((81*1.007825+126*1.008665)-206.97739)*931;//
    binding energy for Tl 207
Sn=B1-B2;// neutron seperation energy
Sp=B1-B3;// proton seperation energy

printf("\n The neutron seperation energy is = %f MeV
    ",Sn)
printf("\n The proton seperation energy is = %f MeV"
    ,Sp)
```

Scilab code Exa 3.11 P3 11

```
// Ex3_11

clc;

// Given:
mH=1.007825;
mn=1.008665;
M1=22.98977;// mass of Na 23
M2=21.994435;// mass of Na 22
M3=21.991385;// mass of Ne 22
// Solution:

m1=((11*1.007825+12*1.008665)-M1);
m2=((11*1.007825+11*1.008665)-M2);
m3=((10*1.007825+12*1.008665)-M3);
Sn=(m1-m2)*931;// neutron seperation energy
Sp=(m1-m3)*931;// proton seperation energy

printf("\n The neutron seperation energy is = %f MeV
    ",Sn)
printf("\n The proton seperation energy is = %f MeV"
    ,Sp)

// Note: The answers are given in the form of atomic
     mass units where as in the question its asked
    for energies.
```

Scilab code Exa 3.12 P3 12

```

// Ex3_12

clc;

// Given:
```

```
C=0.3;// in MeV^-1
a=2.0;// in MeV
E=8; // in MeV

// Solution:
d=C*(exp(2*((2*8)^(0.5))));// excited level density
s=(1/d)*1000;// level spacing
nT=(E/a)^(0.5);// nuclear temperature
printf("\n The excited level density is = %f MeV",d)
printf("\n The level spacing is = %f keV",s)
printf("\n The nuclear temperature is = %f MeV",nT)
```

Scilab code Exa 3.13 P3 13

```

// Ex3_13
clc;

// Given:
I0=3/2;// ground state of spin

// Solution:
I1=I0+1;
I2=I0+2;
I3=I0+3;
K=1;// Assumed as some constant
// Formula: E=(h^2/(2*I))*((I*(I+1))-I0*(I0+1))
// Consider  K=(h^2/(2*I))=1

E1=K*((I1*(I1+1))-(I0*(I0+1)));// For 1 excited state

E2=K*((I2*(I2+1))-(I0*(I0+1)));// For 2 excited state

```

```
E3=K*((I3*(I3+1))-(I0*(I0+1)));// For 3 excited
    state

printf("The expression for 1st, 2nd, and 3rd excited
    states are K times %f, %f & %f respectively.",E1
    ,E2,E3)
```

Scilab code Exa 3.14 P3 14

```

// Ex3_14
clc;
// Given:
E2=44;// in keV

// Solution:
E4=E2*((4*5)/(2*3));// for part (a)
E6=E2*((6*7)/(2*3));// for part (b)
E8=E2*((8*9)/(2*3));// for part (c)
E10=E2*((10*11)/(2*3));// for part (d)

printf("\n The energy of state 4 (+) is = %f keV",E4
    )
printf("\n The energy of state 6 (+) is = %f keV",E6
    )
printf("\n The energy of state 8 (+) is = %f keV",E8
    )
printf("\n The energy of state 10 (+) is = %f keV",
    E10)
```

Scilab code Exa 3.15 P3 15

```

```

```
// Ex3_15
clc;

// Given:
E2=44;// in keV
En=525;// in keV

// Solution:
n=(En)/E2;
//
printf("%f",n)
printf("\n For the required level of energy 525 keV
    nearest even integer is = %d & spin is (+)",n+1)
```

Scilab code Exa 3.16 P3 16

```
//Ex3_16
clc;
// Given:
E2=44;// in keV
En1=146;// in keV
En2=304;// in keV
En3=514;// in keV
// Solution:
n1=(En1)/E2;
n2=(En2)/E2;
n3=(En3)/E2;
printf("%f",n1)
printf("\n For the required level of energy 146 keV
    nearest even integer is = %d & spin is (+)",n1+1)
printf("\n \n %f",n2)
printf("\n For the required level of energy 304 keV
    nearest even integer is = %d & spin is (+)",n2)
printf("\n \n %f",n3)
printf("\n For the required level of energy 514 keV
```

```
    nearest even integer is = %d & spin is (+)",n3+1)

//Note: In the last part (c) the answer given in the
    textbook is 8(+). But the correct answer is
    12(+)
```

Chapter 4

Nuclear Chemistry through Problems

Scilab code Exa 4.1 P4 1

```

// Ex4_1

clc;

//Given:
t1=1600;// in year
a=11.6*10^17;// atoms
// Solution:
k=0.693/t1;// year^-1
L=(a*226)/k;// atomic mass of Radon is 226
printf("The value of avagadro constant is = %f atoms
    per mole",L)
```

Scilab code Exa 4.2 P4 2

```
// Ex4_2
clc;

// Given:
t1=1.3*10^9;// in years
w=0.0119;// wt %

// Solution:
N=(w*6.022*10^23)/(40*100);
k=(0.693*60)/(t1*3.16*10^7);
sa=N*k;// specific activity
printf("The specific activity is = %f dis min^-1 g
    ^-1",sa)
```

Scilab code Exa 4.3 P4 3

```
// Ex4_3

clc;

// Given:
L=6.022*10^23;
// Solution:
// 1 mCi= 3.7*10^7 dis/s
k1=0.693/(15*3600);
N1=3.7*10^7/k1;
m1=(24*N1*10^10)/L;
printf("\n The no. of atoms of Na(24) are = %f",N1)
printf("\n The mass of Na(24) is %f * 10^-10 g",m1)
k2=0.693/(14.3*24*3600);
N2=3.7*10^7/k2;
m2=(32*N2*10^9)/L;
printf("\n \n The no. of atoms of P(32) are = %f",N2
```

```
)
printf("\n The mass of P(32) is %f * 10^-9 g",m2)
k3=0.693/(1600*3.16*10^7);
N3=3.7*10^7/k3;
m3=(226*N3*10^3)/L;
printf("\n \n The no. of atoms of Ra(226) are = %f",N3)
printf("\n The mass of Ra(226) is %f * 10^-3 g",m3)
```

Scilab code Exa 4.4 P4 4

```

//Ex4_4

clc;

// Given:
t1=12.3;// in yrs
L=6.022*10^23;
// Solution:
k=.693/(t1*3.16*10^7);// in s^-1
A=(2*L)/(2.24*10^4);// no. of atoms
a1=A*k;// dis per s
a=a1/(3.7*10^10);// activity in Ci/cm^3
printf("The activity in Ci/cm^3 = %f",a)
```

Scilab code Exa 4.5 P4 5

```

// Ex4_5

clc;

```

```
// Given:
t=5736;// in years
Nk=16.1;// dis/min
L=6.022*10^23;
// Solution:
k=(0.693*60)/(t*3.16*10^7);
N1=Nk/k;// atoms per g for C14
N2=L/12;//

r=(N1*10^12)/N2;// ratio of C14/C12 in atmosphere

printf("The ratio of C14/C12 in atmosphere in 10^-12
    is = %f",r)
```

Scilab code Exa 4.7 P4 7

```

//Ex4_7
clc;

// Given:
dA = 206-238;
dA_Beta=0;
dA_Alpha = -4;

dZ_Alpha = -2;
dZ_Beta = 1;
nBeta=0; //random initialisation
dZ = 82 -92;
// Solution:
nAlpha = (dA- (dA_Beta* nBeta))/dA_Alpha;

nBeta = (dZ- (dZ_Alpha * nAlpha))/dZ_Beta;

printf("Number of alpha decays =%f and number of
```

```
beta decays = %f",nAlpha,nBeta);
```

Scilab code Exa 4.8 P4 8

```
// Ex4_8

clc;
// Given:
E1=0.059;
E2=2.5;
E3=1.33;
Ei=0;
Ef=0;

// Solution:
// delta E for 1,2 & 3 photon
dE1=E1-Ei;
dE2=E2-E3;
dE3=E3-Ef;
// delta I for 1,2 & 3 photon
dI1=2-5;
dI2=4-2;
dI3=2-0;
// EL/ML for 1,2 & 3 photon
ELML1=3+1+1
ELML2=2+1+1;
ELML3=2+1+1;
printf("\n For first photon, dE1=%f MeV, dI1=%f, since EL/ML1=%f & (L+PI+PF) is odd, M3",dE1,dI1,ELML1)
printf("\n For second photon, dE2=%f MeV, dI2=%f, since  EL/ML2=%f & (L+PI+PF) is even, E2",dE2,dI2,ELML2)
printf("\n For third photon, dE3=%f MeV, d3I=%f, since EL/ML3=%f & (L+PI+PF) is even, E2",dE3,dI3,
```

```
ELML3)
```

Scilab code Exa 4.9 P4 9

```
// Ex4_9
clc;

// Given:
E=2.5; // in MeV
// Solution:
// 1 Mev/atom=96.32GJ/mole
E1=E*96.32// GJ/mole
E2=0.1*E1;// for 0.1 mole
printf("The energy that would be released for 0.1
   mole of Co will be = %f GJ",E2)
```

Scilab code Exa 4.10 P4 10

```
// Ex4_10
clc;

// Given
E=2.5;// in MeV
// Solution:
k=0.693/(5.27*3.16*10^7);// decay constant
A=k*0.1*6.022*10^23;// atoms/s
A1=3.6*10^3*A;// atoms /hr

E1=A1*E*1.6*10^-13*10^-3;//Energy in KJ/hr

```

```
printf("The total energy dissipate per hour is = %f
   KJ",E1)
```

Scilab code Exa 4.11 P4 11

```

// Ex4_11
clc;

// Given:
Ma=4;//mass of alpha particle
Mr=228;// mass of Th
Ea=4; //in MeV


// Solution:
Er=(Ma/Mr)*Ea;// energy of recoil
Et=Ea+Er;// total energy of transition

dM=Et/931;// net mass loss in u

printf("The net mass loss is = %f u",dM)
```

Scilab code Exa 4.12 P4 12

```

// Ex4_12
clc;

// Given:
Ma=4;//mass of alpha particle
Mr1=222;// mass of
Mr2=208;
```

```
Ea1=4.863;
Ea2=6.082;
// Solution:

Er1=(Ma/Mr1)*Ea1;
Et1=Ea1+Er1;
printf("For Ra emitting alpha")
printf("\n\tEnergy of recoil is %f MeV",Er1)
printf("\n\tTotal transition energy is %f MeV",Et1)
Er2=(Ma/Mr2)*Ea2;
Et2=Ea2+Er2;
printf("\nFor Bi emitting alpha")
printf("\n\tEnergy of recoil is %f MeV",Er2)
printf("\n\tTotal transition energy is %f MeV",Et2)
```

Scilab code Exa 4.13 P4 13

```

// Ex4_13
clc;

// Given:
dm=0.006332;// in u
ma=4;
mCm=244;

// Solution:

E=dm*931;// in MeV
KE=E*(ma/mCm); // in MeV
v=sqrt((2*KE*1.6*10^-13)/(240*1.6605*10^-27));
printf("The Kinetic Energy and velocity are %f MeV
    and %f m/s respectively",KE,v)
```

Scilab code Exa 4.14 P4 14

```
// Ex4_14
clc;

// Given:
E0=1.7;// in MeV
// Solution:
// For E0<2.5 MeV; using Katz and Penfold empirical
    equation we have
R1=412*((E0)^(1.265-0.0954*log(E0)));// mg/cm^2
// Using feather's relation we have
R2=530*E0-106;// mg/cm^2

printf("The range in Al for beta radiation is %f mg/
   cm^2 using Katz and Penfold empirical equation
   and %f mg/cm^2 using feathers relation.",R1,R2)
```

Scilab code Exa 4.15 P4 15

```
// Ex4_15
clc;


// Solution:
L1=(5.5-3.5);// Case 1
L2=2-0;// Case 2
L3=1.5-.5;// Case 3
ELML1=1+0+2;
ELML2=1+1+2;
```

```
ELML3=0+1+1;
printf("The order for Case 1 is %f and emission is type (%f) M2,Case 2 is %f and emission is type (%f) E2,Case 3 is %f and emission is type (%f) E1,Case 4 is not possible.",L1,ELML1,L2,ELML2,L3,ELML3)
```

Scilab code Exa 4.16 P4 16

```

// Ex4_16
clc;

// Given:
m=4*10^-3;// in gms
M=210;
E=0.34;// in MeV
// Solution:

N=(m*6.022*10^23)/M;
k=0.693/(5*24*3600);// in s^-1
A=N*k;// in dis/s
// Energy released at 0.34 MeV per dis/s will be
E1=E*A;// in MeV/s
E2=E1*1.6*10^-13;// watts

printf("The rate of energy emission is %f W",E2)
```

Scilab code Exa 4.17 P4 17

```

// Ex4_17
clc;
```

```
// Given:
A=0.2506*10^15;// atoms/s re: Ex4_10
// Solution:
Strength=A/(3.7*10^10);// in kCi
S1=Strength*10^-3;// in KCi
printf("The strength in KCi is %f ",S1)
```

Scilab code Exa 4.18 P4 18

```

// Ex4_18
clc;

// Given:
N1=10^24;// atoms
N2=10^16;// atoms
N3=1000;// atoms
N4=80;// atoms

// Solution:
N11=N1*0.5;// 1st half life
N12=N11/2;// 2nd half life
N13=N12/2;// 3rd half life
printf("\n The 1st half life , 2nd half life , 3rd
    half life are %f, %f, %f respectively.",N11,N12,
    N13)
N21=N2/2;// 1st half life
N22=N21/2;// 2nd half life
N23=N22/2;// 3rd half life
printf("\n The 1st half life , 2nd half life , 3rd
    half life are %f, %f, %f respectively.",N21,N22,
    N23)
N31=N3/2;// 1st half life
N32=N31/2;// 2nd half life
N33=N32/2;// 3rd half life
```

```
printf("\n The 1st half life , 2nd half life , 3rd
   half life are %f, %f, %f respectively.",N31,N32,
   N33)
//Radiactivity is a statistical property. Decay
   kinetics are reliable only when initial number is
    large
```

Scilab code Exa 4.20 P4 20

```

// Ex4_20
clc;

// Given:
t1=1.28*10^9;// in years
// Solution:
k=0.693/(1.28*10^9);
// beta deay is 88.8%
k1=0.888*k;
// EC decay is 11.2%
k2=0.112*k;
tbeta=(0.693*10^-9)/(k1);// partial half life for
   beta decay in Gy
tEC=(0.693*10^-9)/(k2);// partial half life for EC
   decay in Gy

printf("The partial half life for beta decay is %f
   Gy and partial half life for EC decay is %f Gy.",
   tbeta,tEC)
```

Scilab code Exa 4.21 P4 21

```

```

```
// Ex4_21
clc;
// Given:
t=15.02;// in hours
// Solution:
ar=1000;// activity ratio given that 0.1% of intial
   activity
k=0.693/t;

t1=(log(ar))/k;
printf("The time required will be %f h",t1)
```

Scilab code Exa 4.22 P4 22

```

// Ex4_22
clc;
// Given:
t=6.01;// in hours
// Solution:
ar=100/5;// activity ratio given that 5% of intial
   activity
k=0.693/t;

t1=(log(ar))/k;
printf("The time required will be %f h",t1)
```

Scilab code Exa 4.23 P4 23

```

//Ex4_23
clc;

```

```
// Given:

t=1.83*10^9;// in years
// Solution:
// Part (a)
k=(0.693)/(t*3.16*10^7);
k1=(0.693*10^17)/(t*3.16*10^7);// in 10^-17 s^-1
printf("\n The overall decay constant will be %f
    *10^-17 s^-1",k1)
// Part (b)
a=(6.022*10^23)/40; // atoms of K(40)
A=a*k;// activity
printf("\n The activity for k(40) is %f beta/s",A)

// Part (c)
a1=(6.022*10^23*1.2*10^-4)/41; // atoms of K(41)
A1=a1*k;// activity
printf("\n The activity for k(41) is %f beta/s",A1)
```

Scilab code Exa 4.24 P4 24

```

// Ex4_24
clc;

// Given:
a1=6520;// c/min
a2=4820;//c/min
t=2;//min
// Solution:
k=log(a1/a2)/t;
t1=0.693/k;// half life
printf("The decay constant is %f min^-1 and the half
     life is %f min",k,t1)
```

Scilab code Exa 4.25 P4 25

```

// Ex4_25
clc;
// Given:
a=(1/32);// activity drop of its initial value
t1=7.5;//in h case(a)
t2=64.45;// in min case(b)
// Solution:
n=log(a)/log(0.5);
t11=t1/n;// half life
t12=t2/n;// half life
printf("The half life for case (a)is %f h and case(b
    ) is %f min",t11,t12)
```

Scilab code Exa 4.26 P4 26

```

// Ex4_26
clc;

// Given:
t238=4.5*10^9;// in y
t235=7.04*10^8;// in y
a0=0.72;// atoms per cent
t=7.04*10^8;
// Solution:

k1=0.693/(t238);//decay constant for U 238
N1=(100-a0)*exp(k1*t);

```

```
k2=0.693/(t235);//decay constant for U 235
N2=(a0)*exp(k2*t);

proportion=N2/N1;
printf("The proportion of U235 704 million years
   back is %f" ,proportion)
```

Scilab code Exa 4.27 P4 27

```

// Ex4_27
clc;

// Given:
t=110;// in min
a=10;//dpmg^-1
// Solution:
k=0.693/t;
N=a/k;// atoms of F18
mass=(N*18)/6.022*10^23;
mass1=(N*18*10^20)/(6.022*10^23);// in 10^-20 grams
printf("The no. of atoms produced is %f and its mass
    is %f*10^-20 grams",N,mass1)
```

Scilab code Exa 4.28 P4 28

```

// Ex4_28
clc;

// Given:
t=14.3;// half life in days
// Solution:
```

```
k=0.693/(t*24*3600);
N=(3.7*10^10)/(k);// No. of atoms in 1 Ci
N1=N*(1-(exp(-0.693/14.3)));// atoms of S32 produced
mass=(N1*32)/(6.022*10^23);

m1=mass*10^6;// in micro grams
printf("The mass in micro-grams is %f.",m1)
```

Scilab code Exa 4.29 P4 29

```

// Ex4_29
clc;

// Given:
t=3.82;// in days
// Solution:
// part(a)
days=1;
D1=(1-(exp(-0.693*days/t)))*100;
printf("\n The fraction decayed in 1 day will be %f.
    ",D1)
// part(b)
days=5;
D1=(1-(exp(-0.693*days/t)))*100;
printf("\n The fraction decayed in 5 days  will be
    %f.",D1)
// part(c)
days=10;
D1=(1-(exp(-0.693*days/t)))*100;
printf("\n The fraction decayed in 10 days  will be
    %f.",D1)
// part(d)
days=6*t;
D1=(1-(exp(-0.693*days/t)))*100;
```

```
printf("\n The fraction decayed in 6 half lives will
    be %f.",D1)
// part(e)
n=log(0.001)/log(0.5);
printf("\n Time needed for the decay of 99.9 percent
    is %f half lives i.e.%f days.",n,t*n)
```

Scilab code Exa 4.30 P4 30

```

// Ex4_30
clc;
// Given:
t=2.6;// years
// Solution:
k=0.693/t;// decay constant
//part(a)
kbeta=0.89*k;
printf("\n The decay constant is %f y^-1",kbeta)
kEC=0.11*k;
printf("\n The decay constant is %f y^-1",kEC)
//part(b)
tbeta=0.693/kbeta;
printf("\n The half life is %f y",tbeta)
tEC=0.693/kEC;
printf("\n The half life is %f y",tEC)
```

Scilab code Exa 4.31 P4 31

```

// Ex4_31
clc;
// Given:
```

```
t=12.8;// hours
// Solution:
k=0.693/t;// decay constant
//part(a)by EC
kEC=0.42*k;
printf("Decay by EC")
printf("\n\t The decay constant is %f h^-1",kEC)
tEC=0.693/kEC;
printf("\n\t The half life is %f h",tEC)

//part(b)by beta+
kbeta1=0.19*k;
printf("\nDecay by beta+")
printf("\n\t The decay constant is %f h^-1",kbeta1)
tbeta1=0.693/kbeta1;
printf("\n\t The half life is %f h",tbeta1)

//part(b)by beta+
kbeta2=0.39*k;
printf("\nDecay by beta-")
printf("\n\t The decay constant is %f h^-1",kbeta2)
tbeta2=0.693/kbeta2;
printf("\n\t The half life is %f h",tbeta2)
```

Scilab code Exa 4.32 P4 32

```

//Ex4_32
clc;

// Given:
tU=4.47*10^9;// y
tRa=1600;// y
tRn=3.82;// days
nU=1;
```

```
// Solution:
//under secular equilibrium we have
nRa=(tRa*365/tRn)*nU;
nRn=(tU*365/tRn)*nU;
printf("The proportion of U,Ra,Rn is 1: %f: %f .",
   nRa,nRn)
```

Scilab code Exa 4.33 P4 33

```

//Ex4_33
clc;

// Given:
ax0 =1; //assume
tx = 2; //hrs
ty = 1; //hrs
// Solution:
// general equation connecting Ax and Ay is
// Ax(n) = (ky * Ax(0) * (exp(-kx * t) - exp(-ky * t
   ))/ (ky - kx)) + Ay(0) * exp(-ky * t)
ax0 = 1;
ay4 = (ax0 * (0.693/1) * ((1/4)-(1/16)))/((0.693/1)
   -(0.693/2)) + ax0 * (1/16);

ax4 = (1* ax0)/4;

proportion = (ay4 * 100)/(ay4 + ax4);

printf("The proportion of ay4 at the end of 4 hrs is
    %f",proportion)
```

Scilab code Exa 4.34 P4 34

```
// Ex4_34
clc;

//Given:
Ax0 = 2000; //dps
//Solution:
//part a
ky = 0.693/10;
kx = 0.693/288;
// general equation connecting Ax and Ay is
 Ax12 = (ky * Ax0 * (0.5^(1/24) - 0.5^(1.2)))/ (ky -
     kx);

printf("\n Activity due to La(140) at the end of 12
   hrs will be %f dps",Ax12);
//part b
ky = 0.693/10;
kx = 0.693/288;
// general equation connecting Ax and Ay is
 Ax24 = (ky * Ax0 * (0.5^(2) - 0.5^(57.6)))/ (ky -
    kx);

printf("\n Activity due to La(140) at the end of 24
   d will be %f dps",Ax24);
```

Scilab code Exa 4.35 P4 35

```

// Ex4_35
clc;

// Given:

t1=2.7;// h
t2=3.6;// h
```

```
// Solution:
k1=0.693/t1;
k2=.693/t2;

tmax=(log(k2/k1))/(k2-k1);
printf("The time when daughter activity reaches
   maximum is %f and this is same when activities of
    both are equal.",tmax)
```

Scilab code Exa 4.36 P4 36

```

//Ex4_36
clc;
// Given:
tPo=138;// days
n=24.86;// days
// Solution:
kPo = 0.693/tPo;
// using simplification logx=2(x-1)/(x+1)
kBi=((2 * 2.303)-(n*kPo))/n;
tBi=0.693/kBi;

printf("The half life of Bi is %f days",tBi)
```

Scilab code Exa 4.37 P4 37

```

//Ex4_37
clc;

// Given:
a=10*10^7;// rate
```

```
t=15;// h
// Soution:
A30=a*(1-(0.5)^(2));// dps

A45=A30*((0.5)^(3));// dps

printf("The residual activity in the sample is %f
   dps",A45)
```

Chapter 5

Nuclear Chemistry through Problems

Scilab code Exa 5.1 P5 1

```

// Ex5_1
clc;

// Given:
mMg=23.985045;
md=2.014102;
mAl=25.986900;
mNe=19.99244;
mNa=21.944;
// Solution:
// for compound nucleus Al*(26)
KE1=(24/26)*8;
BE1=(mMg+md-mAl)*931;// in MeV
EE1=BE1+KE1;
// for compound nucleus Na*(22)
KE2=(20/22)*8;
BE2=(mNe+md-mNa)*931;// in MeV
EE2=BE2+KE2;
```

```
printf("The excitation energy for Al*(26) is = %f
    MeV and that of Na*(22) is = %f MeV",EE1,EE2)
```

Scilab code Exa 5.2 P5 2

```

// Ex5_2

clc;

// Given:
E0=5;// in MeV
m=1;
M=7

// Solution:

Erecoil=(4*5*m*M*((sin(45*3.14/180))^(2)))/((m+M)^2)
    ;
Escat=E0-Erecoil;

printf("\n The energy of protons scattered through
    an angle of 90 deg. is = %f MeV",Escat)
Eresi=E0-0.48;

Erecoil2=(14/64)*Eresi;
Escat2=Eresi-Erecoil2;
printf("\n \n The energy of proton observed at 90
    deg. after they have excited the lithium to a
    level of 0.48 MeV is = %f MeV",Escat2)
```

Scilab code Exa 5.3 P5 3

```

// Ex5_3

clc;
// Given:
th=2.4;// in Mev
z=0.0009;// mp-mn in atomic mass unit
// Solution:

x=-(2.4/931);//assuming no barrier operates
y=x+z;


printf("The mass difference between A & B is = %f u"
    , -y)
```

Scilab code Exa 5.4 P5 4

```

// Ex5_4
clc;
// Given:
mp=1.007277;

// Solution:

E1=2*mp*931;// in MeV / part(a)

E2=E1/2;// in MeV / part (b)

printf("The energy required for (a) & (b) are = %f &
    %f respectively in MeV",E1,E2)
```

Scilab code Exa 5.5 P5 5

```
// Ex5_5
clc;
//Given
E1=2.059;
E2=2.59;
M1=9;
M2=18;
m=1;

// Solution
Q1=-E1*(M1/(m+M1)); // part(a)
Q2=-E2*(M2/(m+M2)); // part(b)
printf("The Q-values are %f & %f in MeV for B(9) & F
    (19) reactions respectively",Q1,Q2)
```

Scilab code Exa 5.6 P5 6

```

// Ex5_6
clc;
// Given:
Q1=1.136;
Q2=3.236;
M1=11;
M2=13;
m1=2;
m2=1;
// Solution
E1=Q1*((m1+M1)/M1); // part(a)
E2=Q2*((m2+M2)/M2); // part(b)
printf("The thershold energies are %f & %f in MeV
    for B(12) & N(13) reactions respectively",E1,E2)
```

Scilab code Exa 5.7 P5 7

```
// Ex5_7
clc;

// Given:

Q1=9.28;// in Mev
Q2=0.21;// in Mev
Q3=7.25;// in Mev
Q4=3.63;// in Mev
mn=1.008665;
md=1.995311;// mass difference between Fe(56) & Fe
    (54)
// Solution:
E1=Q1+Q2+Q3+Q4;// part (a)
E2=(2*mn-md)*931;// part (b)

printf("The binding energy of last 2 neutron in part
    (a) and part(b) are = %f & %f in MeV respectively
    ",E1,E2)
```

Scilab code Exa 5.8 P5 8

```
// Ex5_8
clc;

// Given:
Q1=1.2;
M1=14;
```

```
m1=4;

// Solution:

E1=Q1*((m1+M1)/M1);
printf("The threshold energy is %f in MeV for O(17)
    reaction",E1)
```

Scilab code Exa 5.9 P5 9

```

//Ex5_9
clc;

// Given:
Q1=3.236;
M1=13;
m1=1;
// Solution:

E1=Q1*((m1+M1)/M1);
printf("The threshold energy is %f in MeV for C(13)
    reaction",E1)
```

Scilab code Exa 5.10 P5 10

```

// Ex5_10
clc;

// Given:
A1=3836;//in barns
E1=1;// in eV
```

```
E2=10^6// in eV

// Solution:
vr=sqrt(E2/E1);
A2=A1/vr;
printf("The cs area required will be = %f b", A2)
```

Scilab code Exa 5.11 P5 11

```

// Ex5_11
clc;

// Given:
a=0.56*10^-24; // area
flux=10^13;
// Solution:
A=6.022*10^23*10^-3*2.5/(58.5);
k=A*flux*0.56*10^-24;
y=(0.5)^(4/5);
activity=k*(1-y);
printf("The activity is = %f dis s^-1 g^-1 NaCl",
    activity)
```

Scilab code Exa 5.12 P5 12

```

// Ex5_12
clc;

// Given:
w=0.1189;
flux=10^16;
```

```
// Solution:
A=w/(flux*3.16*10^7);// in m^2
A1=A*10000/(10^-24);// in Barns
printf("The cros section area is = %d b", A1)
```

Scilab code Exa 5.13 P5 13

```

// Ex5_13
clc;

// Given:
w=8.52*10^-4;
flux=10^18;
// Solution:

A=w/(flux*24*3600);// in m^2
A1=A*10000/(10^-24);// in Barns
printf("The cros section area is = %f b", A1)
k=flux*A*6.022*10^23/197;
printf("\n \n The saturation activity possible is =
    %f dis s^-1 g^-1", k)
y=(0.5)^(0.3704);
activity=k*(1-y);
printf("\n \n The activity is = %f dis s^-1 g^-1 ",
    activity)
```

Scilab code Exa 5.14 P5 14

```

// Ex5_14
clc;

```

```
// Given:
a=98.7*10^-24; // area in cm ^2
flux=10^16;
d=19.3;// density
l=0.02;// thickness in cm
area=1;// in cm^2
// Solution:
V=area*l;
m=V*d;
A=(6.022*10^23*m)/(197);
k=A*flux*a;
y=exp((-0.693*5)/(2.7*24*60));
activity=k*(1-y);
printf("The activity is = %f dis s^-1 g^-1",activity
    )
// specific activity in Ci/cm^3

a1=activity/(3.7*10^10);// in Ci/gold foil
a2=a1/V;// in Ci/cm^3 of foil

printf("\n The activity in Ci/cm^3 of foil is = %f",
    a2)
```

Scilab code Exa 5.15 P5 15

```

// Ex5_15
clc;

// Given:
r0=1.4*10^-15;// in m
A1=88;
A2=87;
A3=136;
A4=135;
```

```
// Solution:

rSr1=(3.14*(r0*(A1)^(0.33333))^2)/10^-28;// in barns
rSr2=(3.14*(r0*(A2)^(0.33333))^2)/10^-28;// in barns
rXe1=(3.14*(r0*(A3)^(0.33333))^2)/10^-28;// in barns
rXe2=(3.14*(r0*(A4)^(0.33333))^2)/10^-28;// in barns

printf("The geometric cross-section area are %f, %f,
    %f & %f for Sr(88), Sr(87), Xe(136) & Xe(135)
   respectively",rSr1,rSr2,rXe1,rXe2)
```

Scilab code Exa 5.16 P5 16

```

// Ex5_16
clc;

// Given:
m=4*10^-3;// in gms
flux=1.3*10^14;
a=19.6*10^-24;// in cm^2
// Solution:
N=(m/59)*6.022*10^23;
A=N*flux*a*3600;// atoms
k=0.693/(5.25*3.16*10^7);// s^-1

A1=k*A;// Activity in dps

A2=(A1)/(3.7*10^10);// in Ci
A3=(A1*10^3)/(3.7*10^10);// in mCi
A4=A2*37*10^8;// in Bq

printf("\n The activity in mCi is = %f",A3)
printf("\n The activity in Bq is = %f",A4)
```

Scilab code Exa 5.17 P5 17

```
// Ex5_17
clc;

// Given:
a=2.44*1000*10^-24;// in barns

d=8.64;// g/cm^3

// Solution:
n=(d*6.02*10^23)/112;// atoms/cm^2

x=(log(100))/(n*a);// in cm
printf("The thickness of Cd foil is = %f cm",x)
```

Scilab code Exa 5.18 P5 18

```
// Ex5_18
clc;

// Given:
a=3.8*1000*10^-24;// in barns
Ir=0.004;// I0/Ix
d=2.55;// g/cm^3

// Solution:
n=(d*6.02*10^23)/10;// atoms/cm^2
y=(Ir)^-1;
x=log(y)/(n*a);// in cm
```

```
printf("The thickness of B foil is = %f cm",x)
```

Scilab code Exa 5.19 P5 19

```

// Ex5_19
clc;

// Given:
E1=6;// MeV
mAl=26.981535;
malpha=4.002604;
mP=30.973763;
// Solution:

KE=E1*(27/31);// in MeV

BE=(mAl+malpha-mP)*931;// in MeV

Ex=KE+BE;

printf("\n The excitation energy of compound nucleus
    is = %f MeV",Ex)
```

Scilab code Exa 5.20 P5 20

```

// Ex5_20
clc;
// Given:
E1=1.4;// MeV
mBi=208.980417;
mn=1.008665;
```

```
mBI=209.984110;
// Solution:part(a)

KE1=0;// in MeV
BE1=(mBi+mn-mBI)*931;// in MeV
Ex1=KE1+BE1;
printf("\n The excitation energy of compound nucleus
    is = %f MeV",Ex1)

// Solution:part(b)

KE2=E1*(209/210);// in MeV
BE2=(mBi+mn-mBI)*931;// in MeV
Ex2=KE2+BE2;
printf("\n The excitation energy of compound nucleus
    is = %f MeV",Ex2)
```

Scilab code Exa 5.21 P5 21

```

// Ex5_21
clc;
Ex=12.8;// MeV
mB=10.012939;
malpha=4.002604;
mN=14.003074;
mC=12.00;
md=2.014102;
// Solution:part(a)

BE1=(mB+malpha-mN)*931;// in MeV
KE1=Ex-BE1;
E1=KE1*(14/10);
printf("\n The resonance in part(a) will occur at =
  %f MeV",E1)
```

```
// Solution:part(b)


BE2=(mC+md-mN)*931;// in MeV
KE2=Ex-BE2;
E2=KE2*(14/12);

printf("\n The resonance in part(b) will occur at =
    %f MeV",E2)
```

Scilab code Exa 5.22 P5 22

```

// Ex5_22
clc;

// Given:
B=2.5;// tesla
q=1.6*10^-19;
m=1.66*10^-27;

// Solution:

f=(B*q*10^-6)/(2*3.14*2*m);

printf("The resonance frequency is = %f MHz",f)
```

Scilab code Exa 5.23 P5 23

```

// Ex5_23
clc;
```

```

// Given:
f=8.6*10^6;// in Hz
q1=1.6*10^-19;
q2=6*1.6*10^-19;
m1=1.66*10^-27;
m2=14*1.66*10^-27;
// Solution:
// for proton
B1=2*3.14*f*m1/q1;

printf("\n The magnetic field needed to accelerate protons is = %f T",B1)
// for N(14) ions
B2=2*3.14*f*m2/q2;

printf("\n The magnetic field needed to accelerate N(14) ions is = %f T",B2)
```

Scilab code Exa 5.24 P5 24

```

// Ex5_24

clc;

E1=2.75;// MeV
E2=14;// in MeV
mMg=23.985045;
malpha=4.00260;
mSi=27.9763;
mNe=19.99244;
mCo=58.93320;
mRb=78.9239
// Solution:
```

```

KE1=E1*(24/28);// in MeV

BE1=(mMg+malpha-mSi)*931;// in MeV

Ex1=KE1+BE1;

printf("\n The excitation energy of compound nucleus
    Si* is = %f MeV",Ex1)
KE2=E2*(59/79);// in MeV

BE2=(mNe+mCo-mRb)*931;// in MeV

Ex2=KE2+BE2;

printf("\n The excitation energy of compound nucleus
    Rb*  is = %f MeV",Ex2)
```

Chapter 6

Nuclear Chemistry through Problems

Scilab code Exa 6.1 P6 1

```
//Ex6_1
clc;
// Given:
d1=7.9;// density of Gd
d2=2.31;// Density of In
a1=49;// in Kb
a2=155;// in b
m1=157.25;
m2=114.8;
Na=6.02*10^23;
// Solution:
x1=log(1/(1/2))/((d1*Na*a1*10^-24*10^3)/m1);// half-
    thickness for Gd


x2=log(1/(1/2))/((d2*Na*a2*10^-24)/m2);// half-
    thickness for In

```

```
r=x2/x1;
printf("The half-thickness of In is %f times more
    than of Gd.",r)
```

Scilab code Exa 6.2 P6 2

```

// Ex6_2

clc;

// Given:
d1=12;// density of Gd
a1=43.11;// in b
m1=106.4;
Na=6.02*10^23;
i1=1;
i2=1/1000;
// Solution

x=log(i1/i2)/((d1*Na*a1*10^-24)/m1);// thickness for
    Pd foil

printf("The thickness of Pd foil which would reduce
    the intensity of a beam to excatly 1/1000 of its
    initial value is = %f cm",x)
```

Scilab code Exa 6.3 P6 3

```
// Ex6_3

clc;

```

```
// Given:
mTe=129.9067; // mol wt. of Te(52)
mCu=64.9278;// mol wt of Cu(29)
mFe=65;// mol wt of Fe(26)
// Solution
E1=(mTe-2*mCu)*931; // Fission Energy in MeV
printf("The fission energy of Te(130)in MeV is = %f",E1)
r=((65)^0.33333);
E2=(26*26*4.8*4.8*10^-20)/(2*1.5*1.6*10^-13*10^-6*r);// Barrier energy in MeV
printf("\n The barrier energy of Te(130) in MeV is = %f",E2)
E3=E2-E1;// Activation Energy in MeV
printf("\n The activation energy of Te(130) in MeV is = %f",E3)

// Since barrier energy is greater than fission energy, spontaneous fission is not possible unless the activation energy is provided.
```

Scilab code Exa 6.4 P6 4

```

// Ex6_4
clc;
// Given:
mSn=113.903; // mol wt. of Sn(50)
mMn=56.9383;// mol wt of Mn(25)
mFe=57;//mol wt of Fe(26)
// Solution
E1=(mSn-2*mMn)*931; // Fission Energy in MeV
printf("\n The fission energy in MeV is = %f",E1)
r=((mFe)^0.33333);
E2=(25*25*4.8*4.8*10^-20)/(2*1.5*1.6*10^-13*10^-6*r)
```

```
;// Barrier energy in MeV
printf("\n The barrier energy in MeV is = %f",E2)
E3=E2-E1;// Activation Energy in MeV
printf("\n The activation energy in MeV is = %f",E3)
```

Scilab code Exa 6.5 P6 5

```

// Ex6_5
clc;
// Given:
a1=94;// atomic no. of Pu
a2=42;//atomic no. of Mo
a3=56;// atomic no. of Ba
// Solution:
// By principle of equal charge displacement
z1=0.5*(a1+a2-a3);
printf("\n z1=%f",z1)
z2=0.5*(a1-a2+a3);
printf("\n z2=%f",z2)

//From z1 and z2 we have the primary fragments as Zr
    (40), atomic mass(100) and Xe(54), atomic mass
    (138).
```

Scilab code Exa 6.6 P6 6

```

// Ex6_6
clc;
// Given:
a1=92;// atomic no. of U
a2=40;//atomic no. of Zr
```

```
a3=58;// atomic no. of Ce
// Solution
// By principle of equal charge displacement
z1=0.5*(a1+a2-a3);
printf("\n z1=%f",z1)
z2=0.5*(a1-a2+a3);
printf("\n z2=%f",z2)
//From z1 and z2 we have the primary fragments are
   Rb(37), atomic mass(94) and Cs(55), atomic mass
   (140).
```

Scilab code Exa 6.7 P6 7

```


// Ex6_7
clc;
// Given:
a1=92;// atomic no. of U
a2=42;//atomic no. of Mo
a3=56;// atomic no. of Ba
// Solution
// By principle of equal charge displacement
z1=0.5*(a1+a2-a3);
printf("\n z1=%f",z1)
z2=0.5*(a1-a2+a3-4);
printf("\n z2=%f",z2)

// From z1 and z2 we have the primary fragments are
   Y(39), atomic mass(95) and Sb(51), atomic mass
   (137)
```

Scilab code Exa 6.8 P6 8

```
// Ex6_8
clc;
// Given:
mU=236.04533;
mU1=236.045733;
mU2=235.043933;
mY=94.912;
mSb=136.91782;
mn=1.0087;
Na=6.02*10^23;

// Solution:
E1=(mU-mY-mSb-4*mn)*931; // Fission Energy in MeV
printf("The fission energy in MeV is = %f",E1)
r1=((mY)^0.33333);
r2=((mSb)^0.33333);
E2=(39*51*4.8*4.8*10^-20)/(1.5*10^-13*(r1+r2)
    *1.6*10^-6);// Barrier energy in MeV
printf("\n The barrier energy in MeV is = %f",E2)
E3=E2-E1;// Activation Energy in MeV
printf("\n The activation energy in MeV is = %f",E3)
// Note : There is discrepancy in the final answer.
E4=(mU2+mn-mU1)*931; // Fission Energy in MeV
printf("\n The fission by thermal neutrons is not
    possible since excitation energy %f  is less than
     activation energy.",E4)
```

Scilab code Exa 6.9 P6 9

```
// Ex6_9
clc;
// Given:
nSr=38;
```

```
nY=39;


// Solution:

PSr=0.565*exp(-((nSr-40)^2)); //independent
   fractional chain yield of Sr
PY=0.565*exp(((nY-40)^2)); //independent fractional
   chain yield of Y

printf("The independent fractional chain yield of Sr
    is = %f",PSr)
printf("\n The independent fractional chain yield of
    Y is = %f",PY)
```

Scilab code Exa 6.10 P6 10

```

//Ex6_10

clc;
// Given:
mU=235.043091;
mn=1.0087;
mXe=138.9187;
mSn=94.919;

// Solution:
dm=(235.04309+1.0087-138.917-94.919-2.0174);// delta
    m
E=dm*931;// energy of given fission in MeV
printf("The energy for the given fission is = %f MeV
   ",E)
```

Scilab code Exa 6.11 P6 11

```
//Ex6_11
clc;
// Given:
mPu=239.052161;
mPd=107.903920;
mXe=128.904784;
mn=1.0087;
mGd=154.922010;
mBr=80.916344;

// Solution: Part (a)

dm1=(mPu-(mPd+mXe+2*mn));// delta m
E1=dm1*931;// energy of given fission in MeV
printf("The energy for the Pd(108)+Xe(129)+3n
   fission is = %f MeV",E1)

dm2=(mPu-(mGd+mBr+3*mn));// delta m
E2=dm2*931;// energy of given fission in MeV
printf("\n The energy for the Gd(155)+Br(81)+4n
   fission is = %f MeV",E2)
```

Scilab code Exa 6.12 P6 12

```
// Ex6_12
clc;
// Given:

```

```
mFm=250.079;
mSn=124.9077;
Na=6.02*10^23;

// Solution:
E1=(mFm-2*mSn)*931; // Fission Energy in MeV
printf("The fission energy in MeV is = %f",E1)

r=((mSn)^0.33333);
E2=(50*50*4.8*4.8*10^-20)/(2*1.5*10^-13*(r)
    *1.6*10^-6);// Barrier energy in MeV
printf("\n The barrier energy in MeV is = %f",E2)
```

Scilab code Exa 6.13 P6 13

```

// Ex6_13
clc;
// Given:
mTh1=232;
mTh2=233;
ETh1=6.4;// in MeV
ETh2=4.93;// in MeV
E=6.5;// fission barrier energy in MeV

// Solution: Part(a)
E1=0*mTh1/mTh2;
Ex1=E1+ETh2;
printf("\n (a) Excitation energy is = %f MeV",Ex1)
if (Ex1>E) then
    printf("\n Fission is possible")
else
    printf("\n Fission is not possible")
end

```

```
// Solution: Part(b)
E2=2*mTh1/mTh2;
Ex2=E2+ETh2;
printf("\n (b) Excitation energy is = %f MeV",Ex2)
if (Ex2>E) then
    printf("\n Fission is possible")
else
    printf("\n Fission is not possible")
end

// Solution: Part (c)
E3=10*mTh1/mTh2;
Ex3=E3+ETh2;
printf("\n (c) Excitation energy is = %f MeV",Ex3)
if (Ex3>E) then
    printf("\n Fission is possible")
else
    printf("\n Fission is not possible")
end
```

Scilab code Exa 6.14 P6 14

```

// Ex6_14

clc;

// Given:

mEs=249.0762;
mn=1.0087;
mGd=160.9286;
mBr=86.922;

// Solution:
```

```
dm=(mEs-(mGd+mBr+mn));// delta m
E=dm*931;// energy of given fission in MeV
printf("The energy for the given fission is = %f MeV
    ",E)
```

Scilab code Exa 6.15 P6 15

```

// Ex6_15

clc;

// Given:

m=1/6;// mass ratio of pair of fission product

// Solution:
// Velocities as well as energies are in inverse
    ratio of their masses.

v=(m)^(-1);// Velocity ratio
e=(m)^(-1);// Energy ratio
printf("The velocity will be related as %f and
    Energy will be related as %f",v,e)
```

Scilab code Exa 6.16 P6 16

```

// Ex6_16

clc;

// Given:
```

```
P=100;// in watts

// Solution:
P1=P*10^7;// in erg/s
P2=P1/(1.6*10^-6);// in MeV/s
// 1 ifssion generates 200 MeV of energy
f=P2/200;// no. of fissions

printf("The no. of fissions produced per second will
    be = %f",f)
```

Scilab code Exa 6.17 P6 17

```

// Ex6_17
clc;
// Given:
r0=1.4*10^-15;// nuclear radius constant in m
p=8.85*10^-12;// permittivity of free space in J^-1*
    C^2*m^-1
A=92;
e=1.6*10^-19;
mPd=118;
// Solution:
r=((mPd)^0.33333);
Eb=((A/2)^2)*(e^2)/(2*r0*r*4*3.14*p*1.6*10^-13);
printf("The fission barrier energy is = %f MeV",Eb)
```

Scilab code Exa 6.18 P6 18

```

// Ex6_18
clc;
```

```

// Given:
r0=1.37*10^-15;// nuclear radius constant in m
p=8.85*10^-12;// permittivity of free space in J^-1*C^2*m^-1
A=92;
e=1.6*10^-19;
mTe=140;
mZr=95;
// Solution:
r1=((mTe)^0.33333);
r2=((mZr)^0.33333);
Eb=(52*40)*(e^2)/(r0*(r1+r2)*4*3.14*p*1.6*10^-13);
printf("The fission barrier energy is = %f MeV",Eb)
```

Scilab code Exa 6.19 P6 19

```

// Ex6_19
clc;

// Given:
A=240;
Z=94;
//Solution:
Ecr=(0.89*(A^(2/3)))-(0.02*(Z*(Z-1)))/(A^(1/3));
printf("The critical deformation energy for the fission is = %f MeV",Ecr)
```

Chapter 7

Nuclear Chemistry through Problems

Scilab code Exa 7.1 P7 1

```
// Ex7_1

clc;

// Given:

f=1.03;// fast fission factor
n=1.32;// no. of fast neutrons generated per thermal
    radiations
ref=0.89;// resonance escape factor
tuf=0.87;// thermal utilization factor

// Solution

rf=f*n*ref*tuf;//reproduction factor

printf("The reproduction factor for the reactor is =
    %f",rf)
```

Scilab code Exa 7.2 P7 2

```

// Ex7_2

clc;

// Given:
k=1.04;
m=0.032;// in m^2 i.e., migration area M^2

// Solution: (a) Cubical reactor
a=3.14*sqrt(3*m/(k-1));

printf("\n The approximate critical dimensionsof a
    Pu 239 is = %f m",a)


// Solution: (a) Spherical reactor
r=a/sqrt(3);

printf("\n \n The radius of the reactor is = %f m",r
    )
```

Scilab code Exa 7.3 P7 3

```

// Ex7_3

clc;

// Given:
```

```
a1=687; // neutron absorption cross section for U
   235 in barns
a2=0.66 // neutron absorption cross section for H2O
   in barns
a3=0.0093; // neutron absorption cross section for
   D2O in barns
a4=0.0045; // neutron absorption cross section for C
    in barns

//Solution:

F1=1.07*a1/a2;//design parameter for H2O part(a)
printf("\n The design parameter for H2O is = %f",F1)

F2=1.07*a1/a3;//design parameter for D2O part(b)
printf("\n \n The design parameter for D2O is = %f",
   F2)

F3=1.07*a1/a4;//design parameter for C part(c)
printf("\n \n The design parameter for C is = %f",F3
   )
```

Scilab code Exa 7.4 P7 4

```
// Ex7_4

clc;

// Given:
P=10*10^6; // power in watts
E=200*10^6; // in eV

// Solution:
e=E*1.6*10^-19;// in joules
// Thus for 1 fission occurs per second, rate of
```

```
power generation is e
n=(P)/e;// no. of fissions
printf("The no. of fissions per second are = %f",n)
```

Scilab code Exa 7.5 P7 5

```

// Ex7_5

clc;

// Given:
density=19;// in g/cc
E1=200*10^6*(1.6*10^-19); // energy released per fission in J
flux1=10^12;// in cm^2/s
a1=590*10^-24;//fission cross-section in cm^2
Na1=6.02*10^23;

// Solution:

//Ntgt=volume of target*No.of atoms per cm^3

Ni=(30*((0.5)^2)*3.14*density*Na1*(0.72*10^-2))/238;

Np=Ni*a1*flux1;

E2=E1*Np;// Thermal energy generated in J

printf("\n The thermal energy generated is = %f J",E2)
// Note: There is discrepancy in answer given in the textbook. After calculations the answer comes out to be 153.850366 J
```

Chapter 8

Nuclear Chemistry through Problems

Scilab code Exa 8.1 P8 1

```

//Ex8_1
clc;

//Given:
e=1.6*10^-19;// electron charge
C=6*10^-12;// in F
N=10^5;// // electron multiplication
//Solution:
e1=N*e;
v=e1/(2*C);
v1=1000*v;
  printf("The potential signal recorded will be = %f
      mV",v1)
```

Scilab code Exa 8.2 P8 2

```
// Ex8_2
clc;

// Given:
N=10^5;// electron multiplication
v=10^-6;// in V
e=1.6*10^-19;// electron charge

// Solution:
e1=N*e;
C=e1/(2*v);
C1=C*10^9;
printf("The capacitance that would be required is =
   %f nF",C1)
```

Scilab code Exa 8.3 P8 3

```

// Ex8_3

clc;

// Given:
n0=1;// initial primary electrons
n=1.6*10^4;
x=2.2; //distance in cm

// Solution:
a=log(n/n0)/(x);

printf("The alpha coefficient is = %f electrons
   electron^-1 cm^-1",a)
```

Scilab code Exa 8.4 P8 4

```
// Ex8_4
clc;
// Given:
V=1600;// potential across the electrodes
di=3;// inner diameter
do=40;// outer diameter
a=1.5;//in mm
A=20;//in mm

// Solution:
// Part(a)At the inner surface
r1=1.5;// in mm
V1=V*(log(A/r1)/log(A/a));
X1=V/(r1*(log(A/a)));
printf("\n The potential at the inner surface is =
    %f V",V1)
printf("\n The field at the inner surface is = %f V/
    cm",X1)
// Part(b)At the outer surface
r2=20;// in mm
V2=V*(log(A/r2)/log(A/a));
X2=V/(r2*(log(A/a)));
printf("\n \n The potential at the outer surface is
    = %f V",V2)
printf("\n The field at the outer surface is = %f V/
    cm",X2)
// Part(c)In mid-way between the cylinder
r3=(A+a)/2;// in mm
V3=V*(log(A/r3)/log(A/a));
X3=V/(r3*(log(A/a)));
printf("\n \n The potential in mid-way between the
    cylinder is = %f V",V3)
printf("\n The field in mid-way between the
    cylinderis = %f V/cm",X3)
```

Scilab code Exa 8.5 P8 5

```
// Ex8_5
clc;
// Given:
ma1=3600;// counts in 3 min
mb1=2400;// counts in 5 min
mab1=9900;// counts in 6 min

// Solution:
ma=ma1/3;
mb=mb1/5;
mab=mab1/6;

t1=(ma+mb-mab)/(mab^2-ma^2-mb^2);
t2=t1*60;// in seconds
t=t2*1000000;// in microseconds
printf("The resolving time of the given system in
   microseconds is = %f",t)
```

Scilab code Exa 8.6 P8 6

```
// Ex8_6
clc;
// Given:
ma1=3321;// counts in 3 min
mb1=2862;// counts in 2 min
mab1=4798;// counts in 2 min
m=1080;// counts in 30 min
muk1=5126;// counts in 2 min
```

```
// Solution:
ma=ma1/3;
mb=mb1/2;
mab=mab1/2;
mbc=m/30;
muk=muk1/2;
t1=(ma+mb-mab-mbc)/(mab^2-ma^2-mb^2);// in min
t2=t1*60;// in seconds
t=t2*1000000;// in microseconds
printf("The resolving time of the given system in
    microseconds is = %f",t)

n=muk/(1-muk*t1);// true count rate

printf("\n The true count rate of unknown sample is
    = %f cpm",n)
```

Scilab code Exa 8.7 P8 7

```

// Ex8_7
clc;

// Given:

ma=9728;// cpm
mb=11008;// cpm
mab=20032;// cpm

// Solution:

t1=(ma+mb-mab)/(mab^2-ma^2-mb^2);// in min

t2=t1*60;// in seconds
t=t2*1000000;// in microseconds
```

```
printf("\n The resolving time of the given system in microseconds is = %f",t)

//From true count rate equation we have, n=muk/(1-muk*t).
// This implies, n-m=m^2*t where n-m corresponds to counting loss
na=ma^2*t1;// For sample A
nb=mb^2*t1;// For sample B
nab=mab^2*t1;// For sample AB

printf("\n \n The counting loss of sample A is = %f cpm",na)

printf("\n \n The counting loss of sample B is = %f cpm",nb)

printf("\n \n The counting loss of sample AB is = %f cpm",nab)
// NOTE: The resolving time of the given system in microseconds is give 222.7. This is a calculation error in the textbook.
```

Chapter 9

Nuclear Chemistry through Problems

Scilab code Exa 9.1 P9 1

```

//Ex9_1

clc;

//Give:
t=3600;// in seconds
F=96500;// in columbs
// Formula: m=0.0373fMit, Faraday's law: m=(itE)/F

//Solution:
constant=t/F;
printf("The value of numerical constant is = %f",
   constant)
```

Scilab code Exa 9.2 P9 2

```
//Ex9_2
clc;
// Given:
m1=24*10^-6;// g per day
m2=10^-2;// g per day
i1=10^-6;// in A

//Formula: i1*m2=m1*i2

//Solution:

i2=(i1*m2)/m1;
i=i2/10^-3;// in mA

printf("The ion current should be = %f mA",i)
```

Scilab code Exa 9.3 P9 3

```
//Ex9_3
clc;
//Given:
f=1.0014;// seperation factor
s=4;// series
p=6;// parallel

// Note: The global yield for s stages in series is(
   f)^s and each parallel stages simply multiplies
   the yield of the stage, Hence overall yield with
   p parallel stages (each with s stages in series)
   will be Y=p*(f)^s

//Solution:
Y=p*(f)^s;

```

```
printf("The net yield is = %f",Y)
```

Scilab code Exa 9.4 P9 4

```

// Ex9_4

clc;

// Given:
f=1.0014;// seperation factor

//Solution: Part (a)
A1=3.5/0.72;// total enrichment
n1=log(A1)/log(f);
printf("\n The no. of stages will be = %d", n1)

//Solution: Part (b)
A2=90/0.72;// total enrichment
n2=log(A2)/log(f);
printf("\n \n The no. of stages will be = %d", n2)
```

Scilab code Exa 9.5 P9 5

```
//Ex9_5

clc;

// Given:
f=1.01;// seperation factor
n=10;// plates
//Solution:

```

```
A=f^n;

printf("The overall seperation factor is = %f",A)
```

Scilab code Exa 9.6 P9 6

```
//Ex9_6

clc;

// Given:
f=1.01;// seperation factor
n=16;// plates
//Solution:

A=f^n;

printf("The overall seperation factor is = %f",A)
```

Scilab code Exa 9.7 P9 7

```
//Ex9_7

clc;

// Given:

k1=3.78;
k2=2.79;
t1=298;// in K
t2=353;// in K
R=8.314// Gas constant

```

```
// Formula: log(k1/k2)=(H/R)*((t2-t1)t1*t2)

// Solution:

H=R*log(k1/k2)/((t2-t1)/(t1*t2));

printf("The enthalpy for the exchange reaction is =
    %f J",H)
```

Scilab code Exa 9.8 P9 8

```

// Ex9_8

clc;

// Given:
a1=0.015;
a2=0.04;

// Solution: Defining the seperation factor f as
    approximately equal to (a2/a1) where a1, a2 are
    the relative abundances of the isotope of
    interest in the initial and final fractions, we
    have

f=(a2/a1);

printf("The single stage seperation factor is = %f",
    f)
```

Chapter 10

Nuclear Chemistry through Problems

Scilab code Exa 10.1 P10 1

```
//Ex10_1

clc;

// Given:
E=4.8;// in MeV
M=128;// molecular weight of I

//Formula:
// Er=(536*E^2)/M

// Solution:

Er=(536*E^2)/M;

printf("The energy of recoil of Iodine atom is = %f
   eV", Er)
```

Scilab code Exa 10.2 P10 2

```

//Ex10_2

clc;

// Given:
E=1.1;// in MeV
M=65;// molecular weight of zinc

//Formula:
// Er=(536*E^2)/M

// Solution:

Er=(536*E^2)/M;

printf("The energy of recoil of Zinc atom is = %f eV
    ", Er)
```

Scilab code Exa 10.3 P10 3

```
//Ex10_3

clc;

// Given:
M1=137.32;// moleular wt of barium
M2=32;// molecular weight of sulphur
M3=16;// molecular wt of oxygen
M4=233.32;// molecular wt of BaSO4
```

```
ai=40000;// specific initial activity in counts min
    ^-1 mg^-1
af=187/20;// specific final activity in counts min
    ^-1 0.1ml^-1

// Formula:
// (1)S1=(af/ai)*(10/M) in moles/lit
// (2)S2=(af/ai)*(10^4) in mg/lit

// Solution:

S1=(af/ai)*(10/M4); // solubility of BaSO4 in moles/
    lit
S2=(af/ai)*10^4;// solubility of BaSO4 in mg/lit
printf("\n The solubility of BaSO4 in moles/lit is =
    %f",S1)
printf("\n \n The solubility of BaSO4 in mg/lit is =
    %f",S2)
```

Scilab code Exa 10.4 P10 4

```
//Ex10_4

clc;

// Given:
conc=4;// 4 mg per 1 l
a1=1600;// labelled solution of PbSO4
a2=900;// activity of filtrate (in solution)
M=303.2;// molecular wt of PbSO4
l=6.022*10^23;
// Solution:
y=20*4/1000;// 20 ml will contain y mg
z=y*a2/a1;// final amount of PbSO4 in solution
a3=a1-a2;// activity on surface
```

```
// Let the total PbSO4 on surfaceof precipitate be x
// Asumming exchange equilibrium is established we have

x=a3*z/a2;// in mg
molecules=x*10^-3*(l)/M;
// Give that surface area of 1 PbSO4 = 18.4*10^-16 cm^2
A=molecules*18.4*10^-16;

printf("The surface area of 1 gm of precipitate sample is = %f cm^2/gm",A)
```

Scilab code Exa 10.5 P10 5

```
//Ex10_5

clc;

// Given:
ai=14000;// counts per min per 0.1 cm^3, initial activity of blood
Si=1.4*10^5;// c min^-1 cm^-3, initial specific activity
a=250;// 250 net counts in 10 min, this implies 25 net counts in a min

// Formula: Si/Sr = V

// Solution:
V=Si/25;// total blood in the patient in cm^3
V1=V/1000;// volume in lit
printf("The volume of blood in the patient is = %f lit",V1)
```

Scilab code Exa 10.6 P10 6

```
//Ex10_6

clc;

// Given:
y=5;// in mg labelled sample
V=2000;// volume of mixture in ml
// Formula: x=y*(Si-Sf)/Sf
//Solution:

Si=20000/(5*5);// initial specific activity in counts min^-1 mg^-1
Sf=3000/(.6*10);// final specific activity in counts min^-1 mg^-1
x=y*(Si-Sf)/Sf;// in mg for V amount of volume
//% of penicillin in mixture
p=x*100/V;

printf("The percentage of penicillin in mixture is = %f ",p)
```

Scilab code Exa 10.7 P10 7

```
//Ex10_7

clc;

// Given:
y=2;// in ml labelled sample
V=1000;// volume of mixture in ml
```

```
BC=100/20;// 100 counts for 20 min


// Formula: x=y*(Si-Sf)/Sf

//Solution:

Si=(2500-BC)/(2);// initial specific activity in
   counts min^-1 mg^-1
Sf=(600-BC)/(3);// final specific activity in counts
    min^-1 mg^-1
x=y*(Si-Sf)/Sf;// in mg for V amount of volume
//% of iodine in mixture
i=x*100/V;

printf("The percentage of iodine in mixture is = %f
   ",i)

//NOte: Backward counts are taken to be 100 counts
   for 10 min in the solution given in textbook
```

Scilab code Exa 10.8 P10 8

```
//Ex10_8

clc;

// Given:
flux=10^12;
s=15.9*10^-24;
m1=0.5;// weight of ruby in mg

//Soluton:

a1=35000;// measured activity in c/s
```

```

a2=350000;// corrected activity in )d/s

N=a2/(flux*s*(1-0.5^(1/27.7)));

m=50*N/(6.02*10^23);

Cr=(100*m)/4.35;// total Cr in in the Ruby

crp=(Cr*100)/0.5;// % cr in the ruby

printf("The percentage Cr content in the ruby is =
   %f ",crp)
```

Scilab code Exa 10.9 P10 9

```

//Ex10_9

clc;

// Given:

flux=10^12;
s=3.28*10^-27;
hf=1;// half life in min
//Soluton:

a1=2500;// measured activity in d/s

a2=5000;// corrected activity in d/s

N=a2/(flux*s);

m=76*N/(6.02*10^23);
```

```
Cr=(100*m)/7.8;// total mass of Ge atoms (isotopic
    abandunce is 7.8%)

printf("The total mass of Ge atoms present in sample
     is = %f g",Cr)
```

Scilab code Exa 10.10 P10 10

```

//Ex10_10

clc;

// Given:
M=55;// wt of Mn
m=0.1;// in g
t=90;// min irradated
flux=10^6;
t1=5; //in hours
cs=13.3*10^-24// in cm^2
hl=2.58;// in hours
Na=6.022*10^23;
r=100;// in %
// Solution:
s=1-(exp(-.693*t/(2.58*60)));
A=(m*Na*r*flux*cs*s)/(100*M);
x=exp(-0.693*5/2.58);
// activity after cooling period

A1=A*x*60;// in  dpm
printf("The activity of sample in dpm is = %f", A1)
```

Scilab code Exa 10.11 P10 11

```
//Ex10_11
clc;
// Given:
t1=12.7;// in hours
a=4.5*10^-24;// in cm^2
r=69.1;//in %
cf=10;// in %
flux=10^6;
Na=6.022*10^23;
cpm=1500;// activity in counts per min
M=63;
//Solution:
dpm=cpm*100/10;
dps=dpm/60;
x=exp(-0.693*5/t1);
A=dps/x;

s=1-(exp(-.693*10/(12.7)));
w=(A*M*100)/(Na*r*a*flux*s);// gms of Cu

// given that 5g Cu in 100g alloy , for wg amount of
    alloy will be

Y=100*w/5;// amount of alloy ing

printf("\n The weight of the sample that should be
    taken is = %f g",Y)
```

Scilab code Exa 10.12 P10 12

```

// Ex10_12
clc;
```

```
// Given:
vi=2.5;//titrant volume
V1=10; // vol of KBr in ml
N2=0.01;//normality of AgNO3
M1=119;// mol wt of KBr
// Solution:
ai=((12500/5)-10);
af=((6000/6)-10);
// deerease in activity due to addition of titrant 2.5ml
d=ai-af;
// volume corresponding to ai for AgNO3
V2=ai*vi/d;
N1=(N2*V2)/V1;// Normality of KBr solution

m=N1*M1/100;// mass of KBr in 10 ml solution

printf("\n The mass of potassium bromide in the original solution is = %f g",m)
```

Scilab code Exa 10.13 P10 13

```

// Ex10_13

clc;

// Given:
w=5;// in g
ai=55;// counts per 10 min
A0=15.8;// in dpm/g
// Solution:

cpm=55/10;
dpm=cpm*100/10; // 10% efficient counting
```

```
sa=dpm/w;// in dpm/g
t=5730*log(A0/sa)/(0.693); // Age determination

printf("The age of the sample is = %f years",t)
```

Chapter 11

Nuclear Chemistry through Problems

Scilab code Exa 11.1 P11 1

```
//Ex11_1

clc;

//Given:
density1=1.000;// for water in CGS units
density2=0.789;// for ethanol in CGS units
density3=0.793;// for methanol in CGS units
l=6.023*10^23;// avogadro constant
ue=0.211;// electron absorption coefficent in barn
    per electron
// 1 b=10^(-24) cm^2


//solution: (a) Water

z1=10;// no. of electrons
a1=18;// atomic mass of water
```

```
uw=ue*z1;//molecule absorption coefficient
umw=(uw*1*10^-24)/a1;//mass absorption coefficient
ulw=umw*density1;// linear absorption coefficient

printf("\n The molecule absorption coefficient of
    water in b/molecule is = %f ",uw)
printf("\n The mass absorption coefficient of water
    in cm^2/g is = %f ",umw)
printf("\n The linear absorption coefficient of
    water in cm^-1 is = %f ",ulw)

//solution: (b) ethanol

z2=26;// no. of electrons
a2=46;// atomic mass of water
ueth=ue*z2;//molecule absorption coefficient
umeth=(ueth*1*10^-24)/a2;//mass absorption
    coefficient
uleth=umeth*density2;// linear absorption
    coefficient

printf("\n \n The molecule absorption coefficient of
     ethanol in b/molecule is = %f ",ueth)
printf("\n The mass absorption coefficient of
    ethanol in cm^2/g is = %f ",umeth)
printf("\n The linear absorption coefficient of
    ethanol in cm^-1 is = %f ",uleth)

//solution: (c) methanol

z3=18;// no. of electrons
a3=32;// atomic mass of water
umet=ue*z3;//molecule absorption coefficient
ummet=(umet*1*10^-24)/a3;//mass absorption
    coefficient
ulmet=ummet*density3;// linear absorption
    coefficient

```

```
printf("\n \n The molecule absorption coefficient of
    methanol in b/molecule is = %f ",umet)
printf("\n The mass absorption coefficient of
   methanol in cm^2/g is = %f ",ummet)
printf("\n The linear absorption coefficient of
   methanol in cm^-1 is = %f ",ulmet)
```

Scilab code Exa 11.2 P11 2

```

//Ex11_2

clc;

//Given:

// for benzene in CGS units
density1=.879;
lac1=.06014; // linear absorption coefficient

// for cyclohexane in CGS units
density2=0.779;
lac2=.05656; // linear absorption coefficient
l=6.023*10^23;// avogadro constant
ue=0.211;// electron absorption coefficent in barn
   per electron
// 1 b=10^(-24) cm^2


//solution: (a)Benzene

a1=78;// atomic mass of benzene
mac1=lac1/density1; //mass absorption coefficient
mb=(mac1*a1)/(l*10^-24); //molecule absorption
   coefficient of benzene
```

```
printf("\n The molecule absorption coefficient of
    benzene in b/molecule is = %f ",mb)
printf("\n The mass absorption coefficient of
    benzene in cm^2/g is = %f ",mac1)


//solution: (b)cyclohexane

a2=84;// atomic mass of cyclohexane
mac2=lac2/density2; //mass absorption coefficient
mc=(mac2*a2)/(1*10^-24); //molecule absorption
    coefficient of cyclohexane

printf("\n \n The molecule absorption coefficient of
     cyclohexane in b/molecule is = %f ",mc)
printf("\n The mass absorption coefficient of
    cyclohexane in cm^2/g is = %f ",mac2)
```

Scilab code Exa 11.3 P11 3

```

//Ex11_3

clc;

//Given:
//Atomic absorption coefficients for diferent atoms
    in b/atom
O=1.69;
Na=2.32;
P=3.17;
Ca=4.22;
I=12.03
// 1 b=10^(-24) cm^2
```

```


//solution:
//mass absorption coefficient for the given atoms in cm^2/g

uO=(O*10^-24*6.022*10^23)/16;
uNa=(Na*10^-24*6.022*10^23)/23;
uP=(P*10^-24*6.022*10^23)/31;
uCa=(Ca*10^-24*6.022*10^23)/40;
uI=(I*10^-24*6.022*10^23)/127;

// The mass absorption coefficient for the given substance is the sum of the mass absorption coefficients of the atoms present, each atom being weighted in proportion to its mass in the molecule.

//(a) NaI(A1=150)
u1=(uNa*23+uI*127)/150;
//(b) NaIO3 (A2=198)
u2=(uNa*23+uI*127+uO*48)/198;
//(c) Ca(PO3)2 (A3=198)
u3=(uCa*40+uP*62+uO*96)/198;
//(d) Ca3(PO4)2 (A4=310)
u4=(uCa*120+uP*62+uO*128)/310;


printf("The mass absorption coefficient of NaI in cm^2/g is = %f ",u1)
printf("\n \n The mass absorption coefficient of NaIO3 in cm^2/g is = %f ",u2)
printf("\n \n The mass absorption coefficient of Ca(PO3)2 in cm^2/g is = %f ",u3)
printf("\n \n The mass absorption coefficient of Ca3(PO4)2 in cm^2/g is = %f ",u4)
```

Scilab code Exa 11.4 P11 4

```

//Ex11_1

clc;

//Given:
density1=3.123;// for KI in CGS units
density2=3.168;// for KIO3 in CGS units
l=6.023*10^23;// avogadro constant
ue=0.211;// electron absorption coefficent in barn
    per electron
// 1 b=10^(-24) cm^2

//Atomic absorption coefficients for diferent atoms
    in b/atom

K=ue*19;
I=ue*53;
O=ue*8;

//mass absorption coefficient for the given atoms in
     cm^2/g

uK=(6.022*10^23*K*10^-24)/39;
uI=(6.022*10^23*I*10^-24)/127;
uO=(6.022*10^23*O*10^-24)/16;

//solution: (a)KI

uKI=K+I;//molecular absorption coefficient
umKI=(39*uK+127*uI)/166;//mass absorption
    coefficient
```

```
ulKI=umKI*density1;// linear absorption coefficient

printf("\n The molecular absorption coefficient of KI in b/molecule is = %f ",uKI)
printf("\n The mass absorption coefficient of KI in cm^2/g is = %f ",umKI)
printf("\n The linear absorption coefficient of KI in cm^-1 is = %f ",ulKI)

//solution: (b)KIO3

uKIO4=(K+I+O*4);//molecule absorption coefficient
umKIO4=(39*uK+127*uI+64*uO)/230;//mass absorption coefficient
ulKIO4=umKIO4*density2;// linear absorption coefficient

printf("\n \n The molecular absorption coefficient of KIO4 in b/molecule is = %f ",uKIO4)
printf("\n The mass absorption coefficient of KIO4 in cm^2/g is = %f ",umKIO4)
printf("\n The linear absorption coefficient of KIO4 in cm^-1 is = %f ",ulKIO4)
```

Scilab code Exa 11.5 P11 5

```

//Ex11_5

clc;

//Given:
i1=4000;// initial intensity of radiaton
i2=2000;// final intensity of radiation
density1=8.96;// density of copper
```

```
l=6.022*10^23;// avogadro constant
ue=0.211;// electron absorption coefficent in barn per electron
// 1 b=10^(-24) cm^2

//solution:

uCu=ue*29;//atomic absorbtion coefficient in b/atom
umCu=(6.022*10^23*uCu*10^-24)/63; // mass absorbtion coefficient in cm^2/g
ulCu=umCu*density1;// linear absorption coefficient in cm^-1

// we know that, i2=i1*exp(ulCu*x)

x=log(i1/i2)/(ulCu);// thickness of the copper plate

printf("\n The thickness of copper nedded to reduce the intensity of the radiation in cm is =%f",x)
```

Scilab code Exa 11.6 P11 6

```

//Ex11_6

clc;

//Given:

// Relative biological effectiveness(RBE)
a7=10;// for alpha partical
a6=1;//for gamma radiations
tn=2.5;// for thermal neutrons
g=1;// for gamma radiation
rd=0.6;//radiation dose in gray
```

```
//Formulas
//1.The Rontgen equivalent mammal (REM)=RBE*rads
//2.The sievert is the SI unit for REM= RBE*grays
//3. 1 gray(Gy)=100 rads

//Solution:

// part (a) alpha particles
a1=a7*rd// biological efective dose in Sv
a2=a1*100;// biological efective dose in rem
printf("\n The biological efective dose for alpha
    particles in Sv is = %f",a1)
printf("\n The biological efective dose for alpha
    particles in rem is = %f",a2)

// part (b) thermal neutrons
tn1=tn*rd// biological efective dose in Sv
tn2=tn1*100;// biological efective dose in rem
printf("\n \n The biological efective dose for
    thermal neutrons in Sv is = %f",tn1)
printf("\n The biological efective dose for thermal
    neutrons in rem is = %f",tn2)

// part (c) gamma particles
g1=a6*rd// biological efective dose in Sv
g2=g1*100;// biological efective dose in rem
printf("\n \n The biological efective dose for gamma
     particles in Sv is = %f",g1)
printf("\n The biological efective dose for gamma
    particles in rem is = %f",g2)
```

Scilab code Exa 11.7 P11 7

```

//Ex11_7
```

```
clc;

//Given:
density1=11.35;// density of copper
l=6.022*10^23;// avogadro constant
ue=0.211;// electron absorption coefficent in barn per electron
// 1 b=10^(-24) cm^2

//solution:

uPb=ue*82;//atomic absorbtion coefficient in b/atom
umPb=(6.022*10^23*uPb*10^-24)/207.2; // mass absorbtion coefficient in cm^2/g
ulPb=umPb*density1;// linear absorption coefficient in cm^-1

// we know that, i2=i1*exp(ulCu*x)
// Case (i) from 0.1 Gy/min to 3.1 mGy/h
i1=6;// in Gy/h
i2=3.1*10^-3;//in Gy/h
x=log(i1/i2)/(ulPb);// thickness of the lead plate
printf("\n The thickness of lead nedded to reduce the intensity of the radiation in cm is =%f",x)

// Case (ii) from 100 Gy/min to 0.1 mGy/h
j1=6000;// in Gy/h
j2=0.1*10^-3;// in Gy/h
y=log(j1/j2)/(ulPb);// thickness of the lead plate
printf("\n \n The thickness of lead nedded to reduce the intensity of the radiation in cm is =%f",y)

// Case (iii) half thickness
z=(0.693)/ulPb;// thickness of the lead plate
printf("\n \n The thickness of lead nedded to reduce the intensity of the radiation in cm is =%f",z)
```

Scilab code Exa 11.8 P11 8

```
//Ex11_8

clc;

// To find:

//(a)Z/A value for Carbontetrachloride
//(b)Z/A value for acetic acid
//(c)Z/A value for Cyclohexane

//Formula:
//(Z/A) for  compound = (summation of Z of all the
    atoms)/ molecular weight of compound

//solution:

// Part (a) CCl4

z1=(6+4*17)/154;// Z/A value for Carbontetrachloride
z2=(2*6+4*1+2*8)/60;// Z/A value for acetic acid
z3=(6*6+12*1)/84;// Z/A value for Cyclohexane

printf("\n The Z/A value for Carbontetrachloride is
    = %f",z1)
printf("\n \n The Z/A value for acetic acid is = %f"
    ,z2)
printf("\n \n The Z/A value for Cyclohexane is = %f"
    ,z3)
```

Scilab code Exa 11.9 P11 9

```
//Ex11_9

clc;
//Given:
dose1=2.15// in Gy/min
// Z values
Na=11;
I=53;
O=8;
// A values
mNa=23;
mI=127;
mO=16;
z2=0.553;//Z/A for fricke solution

// Solution:
z1=(11+53+8*4)/(127+23+16*4);// Z/A value for sodium
    periodate(Z/A NaIO4)

// Formula : D(NaIo4)*(Z/A Fricke)=D(Fricke)*(Z/A
   NaIO4)

dose2=(dose1*z1)/z2;// in Gy/min
// for 3 hours

Dose=dose2*180;// in Gy
printf("The dose absorbed by sodium periodate in 3 h
    is = %f Gy",Dose)


// Note: There is correction in the value of (Z/A
   NaIO4) calculated in the book. The actual value
   comes out to be 0.44859
```

Scilab code Exa 11.10 P11 10

```
//Ex11_10

clc;
//Given:
dose=4.06// in Gy/min
z=0.553;//Z/A for fricke solution


// Formula : D(NaIo4)*(Z/A Fricke)=D(Fricke)*(Z/A
   NaIO4)

// Solution:

// Part(a) Chloroform
z1=58/119.5;// Z/A value for Chloroform
dose1=dose*z1/z;
Dose1=dose1*360;// for 6 hours // in Gy
printf("\n The dose absorbed by sodium periodate in
   6 h is = %f Gy",Dose1)
// Part(b) Bromoform
z2=112/253;// Z/A value for Bromoform
dose2=dose*z2/z;
Dose2=dose2*360;// for 6 hours // in Gy
printf("\n \n The dose absorbed by sodium periodate
   in 6 h is = %f Gy",Dose2)
// Part(c) Iodoform
z3=166/394;// Z/A value for Iodoform
dose3=dose*z3/z;
Dose3=dose3*360;// for 6 hours // in Gy
printf("\n \n The dose absorbed by sodium periodate
   in 6 h is = %f Gy",Dose3)
```

Scilab code Exa 11.11 P11 11

```
//Ex11_11

clc;

// To find:
//Fraction of the energy absorbed by ethanol

//Formula:
//(Z/A) for  compound = (summation of Z of all the atoms)/ molecular weight of compound

z1=26/46;// Z/A value for ethanl
z2=32/60;// Z/A value for acetic acid
Deth=z1/(z1+z2);
// Note that the dose absorbed by each component is proportional to its Z/A in the total
printf("The fraction of the energy absorbed by ethanol = %f",Deth)
```

Scilab code Exa 11.12 P11 12

```
// Ex11_12

clc;
//Given:
density1=1.48;// for chloroform
density2=1.024;// for fricke solution
mole=30*10^-6;// moles of HCl
l=6.023*10^23;// avogadro constant
e=2174;//extension coefficient
OD=0.5633;
d=1;// cell path in cm
// G(Fe+3)=15.5 ions/100 eV
// Solution:

```

```
//HCl produced
m1=mole*l;
conc=OD*d/e;// in moles/l
conc1=conc*l;// molecules in 100 min

//This implies amount (conc1) of molecules/l in 10
   min for CHCl3 solution will be
conc2=conc1/10;
// energy that would be absorbed by frickes solution
    to produce conc1 amount of molecules

e1=conc2*100/15.5;// eV/l
e2=e1/100;// eV per 10 ml

// we know that energy absorbed is proportional to
   its density

e3=e2*density1/density2;// in eV

//G(HCl)
g=m1*100/e3;

printf("The value of G(HCL) in the radiolysis of
   CHCl3 is = %f",g)
```