Scilab Textbook Companion for Modern Physics by B.L.Theraja[1]

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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.

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Chapter 1

ELECTRIC AND MAGNETIC FIELD

Scilab code Exa 1.1 CALCUALTION OF ELECTROSTATIC FORCE

```
1  clc; clear;
2  //Example 1.1
3  //Comparision of electrostatic force of replusion
      between two particles with the gravitational
      forces between them
4
5  //given values
6  q1=3.2*10^-19;
7  q2=q1; //q1 and q2 are the values of charge on alpha-
      particle in C
8  d=10^-13; //distance between two alpha-particles in m
9  m1=6.68*10^-27;
10 m2=m1; //m1 and m2 are masses of alpha-particles in
      kg
11 G=6.67*10^-11; //Gravitational constant in N-(m^2)/(
      kg^2)
12
13 //calculation
14 F1=(9*10^9)*(q1*q2)/(d^2); //calculation of
```

```
          e l e c t r o s t a t i c   f o r c e
15  disp ( F1 , 'The  e l e c t r o s a t i c  f o r c e ( in  N)  is ' ) ;
16  F2=G*( m1 * m2 ) / ( d ^2 ) ;// c a l c u l a t i o n  o f  e l e c t r o s t a t i c
          f o r c e
17  disp ( F2 , 'The  g r a v i t a t i o n a l  f o r c e  ( in  N)  is ' )
```

Scilab code Exa 1.2 CALCUALTION OF DISTANCE OF SEPARATION

```
 1  clc ; clear ;
 2  // Example  1.2
 3  // Calculation  of  the  distance  of  separation  between
          two  electrons
 4
 5  //  given  values
 6  m=9.1*10^-31;// mass  of  elctron  in  kg
 7  q=1.6*10^-19;// charge  on  electron  in  C
 8  g=9.81;// acceleration  due  to  gravity  in  m/( s ^2)
 9
10  // calculation
11  Fg=m*g ;// gravitational  force  in  N
12  d=sqrt ((9*10^9*q^2)/Fg) ;// equating  gravitational
          force  with  electrosatic  force  for  calculating
          distance
13  disp ( d , 'The  distance  of  separation ( in  m)  is ' )
```

Scilab code Exa 1.3 CALCULATE FIELD INTENSITY AND FORCE

```
 1  clc ; clear ;
 2  // Example  1.3
 3  // Calculation  of  electric  intensity  between  plates
          and  force  on  proton
 4
 5  // given  values
```

```
6  d=0.02//distance between plates in m
7  V=400;//potential differnce of plates in V
8  q=1.6*10^-19;//charge on a proton in C
9
10 //calculation
11 E=V/d;//
12 disp(E,'The electric field intensity(in V/m) between
        plates is ');
13 F=q*E;//
14 disp(F,'The force(in N) on proton is ')
```

Scilab code Exa 1.4 CALCULATE MASS OF OIL DROP

```
1  clc;clear;
2  //Example 1.4
3  //calculation of mass of oil drop
4
5  //given values
6  d=0.02//distance between plates in m
7  q=1.6*10^-19;//charge on oil drop in C
8  V=6000;//potential differnce of plates in V
9  g=9.81;//acceleration due to gravity in m/(s^2)
10
11 //calculation
12 E=V/d;//electric field intensity between plates in V
        /m
13 F=q*E;//electrostatic force on oil drop in N
14 m=F/g;//equating the weight of oil drop to the
        electrostatic force on it
15 disp(m,'The mass(in kg) of oil drop')
```

Scilab code Exa 1.5 CALCULATE VELOCITY OF ELECTRON

11

```
1  clc ; clear ;
2  //Example 1.5
3  //Calculation of velocity of an electron
4
5  //given values
6  V=150; //potential difference between anode and
       cathode in V
7  m=9.31*10^-31; //mass of an electron in kg
8  q=1.6*10^-19; //charge on an electron in C
9
10 //Calculation
11 E=q*V; //energy (in J) gained by electron during
       speeding from cathode to anode
12 vel=sqrt(E*2/m); //equating with kinetic energy of
       electron i.e m(v^2)/2
13 disp(vel, 'The velocity (in m/s) is ')
```

Scilab code Exa 1.6 CALCULATE ENERGY

```
1  clc ; clear ;
2  //Example 1.6
3  //Calculation of energy in eV,MeV,J
4
5  //given values
6  V=5*10^6; //potential differnce through which alpha−
       particle is accelerated
7  e=1.6*10^-19; //charge on electron in C
8
9  //calculation
10 E1=2*V; //electronic charge on alpha−particle is 2e
       Coulombs
11 disp(E1, 'The energy in eV is ');
12 E2=E1/10^6; //energy in MeV
13 disp(E2, 'The energy in MeV is ');
14 E3=E1*e; //energy in Joules
```

```
15 disp(E3,'The energy in J is')
```

Scilab code Exa 1.7 CALCULATE TOTAL ENERGY

```
1  clc;clear;
2  //Example 1.7
3  //Calculation of the total energy
4
5  //given values
6  r=0.528*10^-10;//radius of the orbit in m
7  q=-1.6*10^-19;//charge on electron in C
8  Q=1.6*10^-19;//charge on Hydrogen nucleus in C
9  Eo=8.854*10^-12;//permittivity in free space in F/m
10
11 //calculation
12 E=(q*Q)/(8*3.14*Eo*r);//
13 disp(E,'The total energy(in J) is');
14 E1=E/(1.6*10^-19);//
15 disp(E1,'The total energy(in eV) is')
```

Scilab code Exa 1.8 CALCULATE FORCE AND RADIUS

```
1  clc;clear;
2  //Example 1.8
3
4  //given values
5  Q=3.2*10^-19;//charge on alpha-particle in C
6  m=6.68*10^-27;//mass on alpha-particle in kg
7  B=1.5;//transverse magnetic field of flux density in
      Wb/(m^2)
8  v=5*10^6;//velocity of alpha-particle in m/s
9
10 //Calculation
```

13

```
11  F=B*Q*v;//
12  disp(F,'The force(in N) on particle is');
13  R=m*v/(Q*B);//
14  disp(R,'The radius(in m) of its circular path')
```

Chapter 2

THE ELECTRON

Scilab code Exa 2.1 CALCULATE FORCE ACCELERATION AND KI-
NETIC ENERGY

```scilab
1  clc;clear;
2  //Example 2.1
3
4  //given values
5  E=2400;//electric field intensity in V/m
6  V=90;//potential difference in V
7  e=1.6*10^-19;//the charge on electron in C
8  m=9.12*10^-31;//mass of electron in kg
9
10 //Calculation
11 F=e*E;
12 disp(F,'The force(in N) on electron is');
13 a=F/m;
14 disp(a,'Its acceleration (in m/s^2)');
15 KE=e*V;
16 disp(KE,'The Kinetic Energy(in J) of particle is');
17 v=sqrt(2*KE/m);
18 disp(v,'The velocity(in m/s) of the electron')
```

Scilab code Exa 2.2 CALCULATE LINEAR VELOCITY AND RADIUS

```
1  clc;clear;
2  //Example 2.2
3
4  //given values
5  V=900;//potential difference in V
6  B=0.01;//uniform magnetic field in Wb/m^2
7  em=1.76*10^11;//value of e/m in C/kg
8
9  //calculation
10 v=sqrt(2*em*V);
11 disp(v,'The linear velocity(in m/s) of electron is')
      ;
12 R=v/(em*B);
13 disp(R,'The radius(in m) of the circular path is')
```

Scilab code Exa 2.3 CALCULATE MASS

```
1  clc;clear;
2  //Example 2.3
3
4  //given values
5  d=6*10^-3;//distance between plates in m
6  V=900;//potential difference in V
7  B=0.5;//uniform magnetic field in Wb/m^2
8  Q=1.6*10^-19;//the charge on electron in C
9  R=10.6*10^-2;//circular track radius in m
10
11 //calculation
12 v=V/(B*d);
13 m=R*Q*B/v;
```

```
14  disp(m, 'The mass(in kg) of particle')
```

Scilab code Exa 2.4 CALCULATE RADIUS AND CHARGE ON OIL DROP

```
 1  clc;clear;
 2  //Example 2.4
 3
 4  //given values
 5  V=6920;//potential difference in V
 6  d=1.3*10^-3;//distance between in m
 7  v=1.9*10^-4;//velocity in m/s
 8  p=0.9*10^3;//density of oil in kg/m^3
 9  n=1.81*10^-5;//coefficient of viscosity in N-s/m^2
10  g=9.81;//accelaration due to gravity in m/s^2
11  pi=3.14;//standard constant
12
13  //calculation
14  a=sqrt((9*n*v)/(2*g*p));
15  disp(a, 'The radius(in m) of the drop is');
16  E=V/d;
17  Q=4*pi*(a^3)*p*g/(3*E);
18  disp(Q, 'The value of charge(in C) on oil drop is')
```

Chapter 3

THE ATOMIC STRUCTURE

Scilab code Exa 3.1 CALCULATE DISTANCE OF CLOSEST APPROACH

```scilab
1  clc; clear;
2  //Example 3.1
3
4  //given values
5  Z=79; //atomic number of gold
6  e=1.6*10^-19; //electron charge in C
7  Eo=8.854*10^-12; //absolute permitivity of free space
       in F/m
8  K=7.68*1.6*10^-13; //kinectic energy in J
9  pi=3.14; //standard constant
10
11 //calculations
12 D=(2*Z*e^2)/(4*pi*Eo*K);
13 disp(D,'The closest distance(in m) of approach is ')
```

Scilab code Exa 3.2 CALCULATE VELOCITY RADIUS TIME TAKEN
AND RYDBERG CONST

```
1  clc;clear;
2  //Example 3.2
3
4  //given values
5  Z=1;//atomic number of hydrogen
6  e=1.6*10^-19;//electron charge in C
7  pi=3.14;//standard constant
8  h=6.625*10^-34;//plank's constant in J-s
9  m=9.1*10^-31;//mass of an electron in kg
10 Eo=8.854*10^-12;//absolute permitivity of free space
        in F/m
11 c=3*10^8;//speed of light in m/s
12 n=1;//ground state
13
14 //calculation
15 v=9*10^9*(2*pi*Z*e^2)/(n*h);
16 disp(v,'velocity(in m/s) of ground state');
17 r=(Eo*n^2*h^2)/(pi*m*e^2);
18 disp(r,'radius(in m) of Bohr orbit in ground state')
19 t=(2*pi*r)/v;
20 disp(t,'time taken(in s) by electron to traverse the
        bohr first orbit');
21 R=(m*e^4)/(8*Eo^2*h^3*c);
22 disp(R,'Rhydberg contstant (in  m^-1)')
```

Scilab code Exa 3.3 CALCULATE FREQUENCY

```
1  clc;clear;
2  //Example 3.3
3
4  //given values
5  B=2.179*10^-16;//a constant in J
6  h=6.625*10^-34;//plank's constant in J-s
7
8  //calculation
```

```
9  E3=-B/3^2;
10 E2=-B/2^2;
11 f=(E3-E2)/h;
12 disp(f,'frequency(in Hz) of radiation')
```

Scilab code Exa 3.4 CALCULATE FREQUENCY IN FIRST ORBIT

```
1  clc;clear;
2  //Example 3.4
3
4  //given values
5  Z=1;//atomic number of hydrogen
6  e=1.6*10^-19;//electron charge in C
7  h=6.625*10^-34;//plank's constant in J-s
8  m=9.1*10^-31;//mass of an electron in kg
9  Eo=8.854*10^-12;//absolute permitivity of free space
       in F/m
10 n=1;//ground state
11
12 //Calculations
13 f=(m*Z^2*e^4)/(4*Eo^2*h^3);
14 disp(f,'the frequency(in Hz) is')
```

Scilab code Exa 3.5 AT WHAT SPEED MUST ELECTRON

```
1  clc;clear;
2  //Example 3.5
3
4  //given data
5  Z=1;
6  n=1;
7  e=1.6*10^-19;//the charge on electron in C
8  h=6.625*10^-34;//Plank's constant
```

```
9  Eo=8.854*10^-12;//absolute permitivity of free space
       in F/m
10 m=9.12*10^-31;//mass of electron in kg
11
12 //calculations
13 v=Z*e^2/(2*Eo*n*h);
14 disp(v,'velcocity in m/s');
15 E=-m*Z^2*e^4/(8*(Eo*n*h)^2);
16 disp(E,'energy of hydrogen atom in J');
17 f=m*Z^2*e^4/(4*Eo^2*(n*h)^3);
18 disp(f,'frequecy in Hz')
```

Scilab code Exa 3.8 CALCULATE PRINCIPAL QUANTUM NO AND
WAVELENGTH

```
1  clc;clear;
2  //Example 3.8
3
4  //given data
5  h=6.625*10^-34;//Plank's constant
6  c=3*10^8;//speed of light in m/s
7  E1=10.2;//in eV energy
8  E2=12.09;//in eV energy
9  e=1.6*10^-19;//the charge on electron in C
10
11 //calcualtion
12 //principal quantum no are 2 & 3 respectively
13 W=c*h/(E1*e)*10^10;
14 disp(W,'wavelength in angstrom is for 10.2 eV');
15 W=c*h/(E2*e)*10^10;
16 disp(W,'wavelength in angstrom is for 12.09 eV')
```

Scilab code Exa 3.9 CALCULATE WAVELENGTH FOR LYMAN SE-RIES

```
1  clc;clear;
2  //Example 3.9
3
4  //given data
5  R=10967700;//Rydberg constant in 1/m
6
7  //calculation
8  W1=4/(3*R);//as n1=1 and n2=2
9  disp((W1*10^10),'Long wavelength in angstrom');
10 W2=1/R;//as n1=1 and n2=infinity
11 disp((W2*10^10),'Short wavelength in angstrom')
```

Chapter 4

CRYSTALLOGRAPHY

Scilab code Exa 4.2 CALCULATE DISTANCE BETWEEN ADJACENT ATOMS

```
1  clc;clear;
2  //Example 4.2
3
4  //given data
5  d=2180;//density of NaCl
6  M=23.5+35.5;//Molecular weight
7  Na=6.02*10^26;//Avgraodo no. in 1/kg mole
8  n=4;//for f.c.c
9
10 //calculations
11 a=(n*M/(Na*d))^(1/3);
12 d=a/2;
13 disp((d*10^10),'distance between to adajcent atoms
       in angstrom')
```

Scilab code Exa 4.3 CALCULATE SPACING

```
1  clc ; clear ;
2  //Example  4.3
3
4  //given  data
5  d=2.163;// density  in  gm/cm^3
6  M=58.45;
7  Na =6.02*10^23;// Avgraodo  no.  in  1/gm  mole
8
9  // calcualtions
10 n=Na/M;//no.  of  molecules/gram
11 n=n*d;//no.  of  molecules/cm^3
12 n=2*n;//no.  of  atom/cm^3;
13 n=n^(1/3);//no.  of  atoms  in  a  row  1cm  long
14 d1 =1/n ;
15 disp ((d1*10^8),'Spacing  in  angstrom ')
```

Scilab code Exa 4.4 CALCULATE DENSITY OF Cu

```
1  clc ; clear ;
2  //Example  4.4
3
4  //given  data
5  r=1.278;// radius  in  A.U
6  n=4;// structure  is  f.c.c
7  M=63.54;
8  Na =6.02*10^23;// Avgraodo  no.  in  1/gm  mole
9
10 // calculations
11 a=4*r/( sqrt (2));
12 V=a^3;
13 d=n*M/(Na*V);
14 disp ((d*(10^8)^3),'Density  in  g/cm^3 ')
```

Scilab code Exa 4.10 CALCULATION OF INTERPLANAR SPACING

```
1  clc ; clear ;
2  // Example  4.10
3
4  // given  data
5  r =1.746;// atomic  radius  in  angstrom
6
7  // calulations
8  a =4* r / sqrt (2) ;
9  // for  ( i )
10 h =2; k =0; l =0;
11 d = a / sqrt ( h ^2+ k ^2+ l ^2) ;
12 disp ( d , ' distace  for  (200)  in  A . U ') ;
13 // for  ( ii )
14 h =2; k =2; l =0;
15 d = a / sqrt ( h ^2+ k ^2+ l ^2) ;
16 disp ( d , ' distace  for  (220)  in  A . U  ')
17 // for  ( iii )
18 h =1; k =1; l =1;
19 d = a / sqrt ( h ^2+ k ^2+ l ^2) ;
20 disp ( d , ' distace  for  (111)  in  A . U ')
```

Scilab code Exa 4.11 CALCULATION OF ANGLE BETWEEN PAIR OF PLANES

```
1  clc ; clear ;
2  // Example  4.11
3
4  // calculations
5  // for  ( i )
6  l =1; m =0; n =0;
7  p =0; q =1; r =0;
8  d = acosd (( l * p + m * q + n * r ) /( sqrt ( l ^2+ m ^2+ n ^2) * sqrt ( p ^2+ q
       ^2+ r ^2) ) ) ;
```

```
 9  disp(d,'angle b/w pair of miller incdices in (i)');
10  //for (ii)
11  l=1;m=2;n=1;
12  p=1;q=1;r=1;
13  d=acosd((l*p+m*q+n*r)/(sqrt(l^2+m^2+n^2)*sqrt(p^2+q
       ^2+r^2)));
14  disp(d,'angle b/w pair of miller incdices in (ii)')
```

Scilab code Exa 4.13 CALCUALTION OF NO OF ATOMS PER SQMM

```
 1  clc;clear;
 2  //Example 4.13
 3
 4  //given data
 5  a=3.61*10^-7;//lattice constant in mm
 6
 7  //calcualtions
 8  //for (i) plane (100)
 9  SA=a*a;
10  tamc=2;//total atoms included according to sketch
11  ans=tamc/SA;
12  disp(ans,'atoms per mm^2 for (i)');
13  //for (ii) plane (110)
14  A=a*(sqrt(2)*a);
15  tamc=2;//total atoms included according to sketch
16  ans=tamc/A;
17  disp(ans,'atoms per mm^2 for (ii)');
18  //for (iii) plane (111)
19  A=0.866*a*a;
20  tamc=2;//total atoms included according to sketch
21  ans=tamc/A;
22  disp(ans,'atoms per mm^2 for (iii)')
```

Chapter 5

QUANTUM THEORY

Scilab code Exa 5.1 CALCULATE ENERGY

```
1  clc; clear;
2  //Example 5.1
3
4  //given values
5  W1=4; //wavelength in Angstrom
6  W2=1; //wavelength in Angstrom
7  e=1.6*10^-19; //the charge on electron in C
8  m=9.12*10^-31; //mass of electron in kg
9
10 //calculation
11 disp("Part (i)");
12 E=12400/W1;
13 disp(E,'The energy in eV is');
14 v=sqrt(E*e*2/m);
15 disp(v,'The velocity in m/s is');
16 disp("Part (ii)");
17 E=12400/W2;
18 disp(E,'The energy in eV is');
19 v=sqrt(E*e*2/m);
20 disp(v,'The velocity in m/s is')
```

Scilab code Exa 5.2 HOW MANY PHOTONS

```
1  clc;clear;
2  //Example 5.2
3
4  //given values
5  f=880*10^3;//frequency in Hz
6  P=10*10^3;//Power in W
7  h=6.625*10^-34;//Plank's constant
8
9  //calculation
10 E=h*f;
11 n=P/E;
12 disp(n,'The number of photons emitted per second are
       ')
```

Scilab code Exa 5.3 HOW MANY LIGHT QUANTA

```
1  clc;clear;
2  //Example 5.3
3
4  //given values
5  P=200;//power in W
6  W=6123*10^-10;//wavelength in m
7  c=3*10^8;//speed of light in m/s
8  h=6.625*10^-34;//Plank's constant
9
10 //calculation
11 Op=0.5*P;//radiant o/p
12 E=h*c/W;
13 n=2/E;
14 disp(n,'No. of Quanta emitted/s')
```

Scilab code Exa 5.4 FIND THE NO OF PHOTOELECTRONS

```
1  clc; clear;
2  //Example 5.4
3
4  //given values
5  N=5*10^4;//no. of photons
6  W=3000*10^-10;//wavelength in A
7  J=5*10^-3;//senstivity for W in A/W
8  h=6.625*10^-34;//Plank's constant
9  c=3*10^8;//speed of light in m/s
10 e=1.6*10^-19;//the charge on electron in C
11
12 //calculation
13 E=h*c/W;//energy content of each photon
14 TE=N*E;//total energy
15 I=J*TE;//current produced
16 n=I/e;
17 disp(n,'no. photoelectrons emitted are')
```

Scilab code Exa 5.5 HOW MANY PHOTONS AND AT WHAT RATE

```
1  clc; clear;
2  //Example 5.5
3
4  //given values
5  W=5*10^-7;//wavelength in m
6  F=10^-5;//force in N
7  h=6.625*10^-34;//Plank's constant
8  m=1.5*10^-3;//mass in kg
9  c=3*10^8;//speed of light in m/s
```

```
10  S=0.1//specific heat
11
12  //calculation
13  n=F*W/h;
14  disp(n,'no. of photons');
15  E=F*c/4200;//in kcal/s
16  T=E/(m*S);
17  disp(T,'the rate of temperature rise')
```

Scilab code Exa 5.6 HOW MANY PHOTONS EMITTED BY LAMP

```
1  clc;clear;
2  //Example 5.6
3
4  //given values
5  W=4500*10^-10;//wavelength in m
6  V=150;//rated voltage in W
7  h=6.625*10^-34;//Plank's constant
8  c=3*10^8;//speed of light in m/s
9
10  //calculation
11  P=V*8/100;//lamp power emitted
12  E=h*c/W;
13  n=P/E;
14  disp(n,'No. photons emitted/s')
```

Scilab code Exa 5.7 CALCULATE NUMBER OF PHOTONS

```
1  clc;clear;
2  //Example 5.7
3
4  //given values
5  f=1*10^12;//frequency in Hz
```

```
6  h=6.625*10^-34;//Plank's constant
7
8  //calculation
9  E=h*f;
10 n=E/6.625;
11 disp(n,'the no. of photons required ')
```

Scilab code Exa 5.8 WITH WHAT VELOCITY

```
1  clc;clear;
2  //Example 5.8
3
4  //given values
5  W=5200*10^-10;//wavelength in m
6  h=6.625*10^-34;//Plank's constant
7  m=9.12*10^-31;//mass of electron in kg
8
9  //calculations
10 p=h/W;
11 v=p/m;
12 disp(v,'the velocity in m/s')
```

Scilab code Exa 5.9 CALCULATE THRESHOLD FREQUENCY

```
1  clc;clear;
2  //Example 5.9
3
4  //given data
5  v=7*10^5;//maximum speed in m/sec
6  f=8*10^14;//frequency in Hz
7  h=6.625*10^-34;//Plank's constant
8  c=3*10^8;//speed of light in m/s
9  m=9.12*10^-31;//mass of electron in kg
```

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```
10
11  //calulations
12  E=0.5*m*v*v;
13  fo=f-(E/h);
14  disp(fo,'the threshold frequency in Hz is')
```

Scilab code Exa 5.10 CALCULATE MAXIMUM ENERGY AND WORK
FUNCTION

```
1  clc;clear;
2  //Example 5.10
3
4  //given data
5  Wo=2300*10;//threshold wavelength in Angstrom
6  W=1800*10;//incident light wavelength in Angstrom
7
8  //calculations
9  w=124000/Wo;
10 disp(w,'The work function in eV is');
11 E=124000*((1/W)-(1/Wo));
12 disp(E,'The maximum energy in eV')
```

Scilab code Exa 5.11 WHAT IS THRESHOLD WAVELENGTH

```
1  clc;clear;
2  //Example 5.11
3
4  //given data
5  W=6000;//wavelegth in Angstrom
6  v=4*10^5;//velocity in m/sec
7  m=9.12*10^-31;//mass of electron in kg
8  e=1.6*10^-19;//the charge on electron in C
9
```

```
10  // calculations
11  KE =0.5* m * v ^2/ e ;
12  disp ( KE ,'The  Kinetic  energy  in  eV  is ');
13  WF =12400/ W ;
14  Wo =12400/( WF - KE ) ;
15  disp ( Wo ,'The  threshold  wavelength  in  Angstrom  is ')
```

Scilab code Exa 5.12 CALCULATE THRESHOLD FREQUENCY

```
1  clc ; clear ;
2  // Example  5.12
3
4  // given  data
5  Wo =4.8; // work  function  in  eV
6  W =2220; // wavelength  in  angstrom
7
8  // calculations
9  E =12400/ W ;
10  Emax = E - Wo ;
11  disp ( Emax ,'The  maximum  Kinetic  energy  in  eV  is ')
```

Scilab code Exa 5.13 WHEN VIOLET LIGHT

```
1  clc ; clear ;
2  // Example  5.13
3
4  // given  data
5  W =4000*10^ -10; // wavelength  in  m
6  Vs =0.4; // retarding  potential  in  eV
7  h =6.625*10^ -34; // Plank 's  constant
8  c =3*10^8; // speed  of  light  in  m / s
9  e =1.6*10^ -19; // the  charge  on  electron  in  C
10
```

```
11 //calculations
12 f=c/W;
13 disp(f,'The light frequency in Hz');
14 E=h*f/e;
15 disp(E,'The photon energy in eV');
16 Wo=E-Vs;
17 disp(Wo,'The work function in eV');
18 fo=Wo/h*e;
19 disp(fo,'The threshold frequency in Hz');
20 NE=(E-Wo)*e;
21 disp(NE,'The net energy in J')
```

Scilab code Exa 5.14 CALCULATE THRESHOLD WAVELENGTH AND
PLANKS CONSTANT

```
1 clc;clear;
2 //Example 5.14
3
4 //given data
5 W1=3310*10^-10;//photon wavelength in m
6 W2=5000*10^-10;//photon wavelength in m
7 E1=3*10^-19;//electron energy in J
8 E2=0.972*10^-19;//electron energy in J
9 c=3*10^8;//speed of light in m/s
10
11 //given values
12 h=(E1-E2)*(W1*W2)/(c*(W2-W1));
13 disp(h,'the plancks const in Js');
14 Wo=c*h/E1;
15 disp(Wo,'The threshold wavelength in m')
```

Scilab code Exa 5.15 A CERTAIN METAL

```
1 clc;clear;
2 //Example 5.15
3
4 //given data
5 W=6525;//wavelength in angstrom
6
7 //calcualation
8 Vo=12400*((1/4000)-(1/W));
9 disp(Vo,'Stopping potential in (a) in volts');
10 Vo=12400*((1/2000)-(1/W));
11 disp(Vo,'Stopping potential in (b) in volts');
12 Vo=12400*((1/2000)-(2/W));
13 disp(Vo,'Stopping potential in (c) in volts')
```

Scilab code Exa 5.16 FIND UNKNOWN WAVELENGTH

```
1 clc;clear;
2 //EXample 5.16
3
4 //given data
5 Wo=5000;//wavelength in angstrom
6 V=3.1;//stopping potential in V
7
8 //calcualtion
9 W=1/((V/12400)+(1/Wo));
10 disp(W,'The unknown wavelength in Angstrom')
```

Scilab code Exa 5.17 LIGHT OF WAVELENGTH 2000 ANGSTROM

```
1 clc;clear;
2 //Example 5.17
3
4 //given values
```

```
5  W=2000;//wavelength in Angstrom
6  Vs=4.2;//Work Function in eV
7  e=1.6*10^-19;//the charge on electron in C
8
9  //calculations
10 E=12400/W;
11 Emax=(E-Vs)*e;
12 disp(Emax,'KE of fastest photoelectron in J');
13 Emin=0;
14 disp(Emin,'KE of slowest moving electron in J');
15 Vo=Emax/e;
16 disp(Vo,'Stopping potential in V');
17 Wo=12400/Vs;
18 disp(Wo,'The cutoff wavelength in Angstrom')
```

Scilab code Exa 5.18 CALCULATE PLANKS CONSTANT

```
1  clc;clear;
2  //Example 5.18
3
4  //given values
5  Vs1=4.6;//Stopping Potential in V
6  Vs2=12.9;//Stopping Potential in V
7  f1=2*10^15;//frequency in Hz
8  f2=4*10^15;//frequency in Hz
9  e=1.6*10^-19;//the charge on electron in C
10
11 //calculations
12 h=((Vs2-Vs1)*e)/(f2-f1)
13 disp(h,'The Plancks const in Js')
```

Chapter 7

CLASSIFICATION OF SOLIDS

Scilab code Exa 7.1 CALCULATE ENERGY GAP

```
1 clc ; clear ;
2 // Example 7.1
3
4 // given data
5 W =11000; // wavelength in angrstrom
6
7 // calcuations
8 Eg = W /12400;
9 disp ( Eg , ' Energy Gap in eV ')
```

Scilab code Exa 7.2 FIND MOBILITY OF ELECTRONS

```
1 clc ; clear ;
2 // Example 7.2
3
4 // given data
```

```
5  p=1.7*10^-6;//resistivity in ohm-cm
6  d=8.96;//density in gm/cc
7  W=63.5;
8  Na=6.02*10^23;//Avgraodo no. in 1/g mole
9  e=1.6*10^-19;//the charge on electron in C
10
11 //calcualtions
12 n=8.96*Na/W;
13 ue=1/(p*e*n);
14 disp(ue,'mobilty of electrons in cm^2/V-s');
```

Scilab code Exa 7.3 FIND RESISTIVITY

```
1  clc;clear;
2  //Example 7.3
3
4  //given data
5  d1=2.5*10^19;//density of charge carries in 1/m^3
6  d2=4.2*10^28;//density of germanium atoms
7  ue=0.36;//mobilty of electrons in m^2/V-s
8  Na=6.02*10^23;//Avgraodo no. in 1/g mole
9  e=1.6*10^-19;//the charge on electron in C
10
11 //calcualtions
12 Nd=d2/10^6;
13 cn=Nd*e*ue;
14 pn=1/cn;
15 disp(pn,'resistivity of doped germanium in ohm-m')
```

Scilab code Exa 7.4 CALCULATE WAVELENGTH

```
1  clc;clear;
2  //Example 7.4
```

```
3
4 // given data
5 Eg =0.75; // energy gap in eV
6
7 // calcualtions
8 W=12400/ Eg ;
9 disp (W, 'wavelength in angstrom ')
```

Chapter 8

X RAYS

Scilab code Exa 8.1 CALCULATE WAVELENGTH

```
1 clc;clear;
2 //Example 8.1
3
4 //given data
5 V=60000;//working voltage in V
6
7 //calculation
8 Wmin=12400/V;
9 disp(Wmin,'Wavelength emitted in Angstrom')
```

Scilab code Exa 8.2 CALCULATE NUMBER OF ELECTRONS STRIK-ING PER SECOND

```
1 clc;clear;
2 //Example 8.2
3
4 //given data
5 V=12400;//Volatage applied in V
```

```
6  I =0.002;// current  drop  in  A
7  e =1.6*10^ -19;// the  charge  on  electron  in  C
8
9  // calculations
10 n=I/e;
11 disp (n,'No.  of  electrons ');
12 v =(5.93*10^5) *( sqrt (V));
13 disp (v,'the  speed  with  which  they  strike  in  m/s');
14 Wmin =12400/V;
15 disp (Wmin ,'shortest  wavelength  in  Angstrom ')
```

Scilab code Exa 8.3 CALCULATE MIN APPLIED POTENTIAL

```
1  clc ; clear ;
2  // Example  8.3
3
4  // given  values
5  Wmin =1;// shortest  wavelength  in  Angstrom
6
7  // calculations
8  V =(12400/ Wmin )/1000;
9  disp (V,'The  minimum  applied  voltage  in  kV')
```

Scilab code Exa 8.4 CALCULATE MAX SPEED

```
1  clc ; clear ;
2  // Exmaple  8.4
3
4  // given  data
5  I =0.005;// current  in  A
6  V =100000;// potential  difference  in  V
7
8  // calcualtions
```

```
9  v=(5.98*10^5)*(sqrt(V));
10 disp(v,'Maximum speed in m/s');
11 IP=V*I;//incident power in W
12 P=.999*IP;//power converted into heat in W
13 H=P/4.18;
14 disp(H,'The heat produced/second in cal/s');
```

Scilab code Exa 8.5 CALCULATE PLANKS CONSTANT

```
1  clc;clear;
2  //Example 8.5
3
4  //given data
5  V=30000;//potential difference in V
6  Wmin=0.414*10^-10;//short wavelength limit in m
7  e=1.602*10^-19;//the charge on electron in C
8  c=3*10^8;//speed of light in m/s
9
10 //calcualtions
11 h=(e*V*Wmin)/c;
12 disp(h,'The Plancks const in Js')
```

Scilab code Exa 8.6 CALCULATE SCREENING CONST

```
1  clc;clear;
2  //Example 8.6
3
4  //given data
5  W=1.43*10^-10;//wavelength in m
6  Z=74;//atomic no
7  R=10.97*10^6;//Rydberg constant in 1/m
8
9  //calcualation
```

```
10  b=74-sqrt(36/(5*R*W));//Transition  from  to M to L
11  disp(b,'the  screening  const.')
```

Scilab code Exa 8.9 CALCULATE LINEAR ADSORPTION COEFF

```
1  clc;clear;
2  //Example  8.9
3
4  //given  data
5  um=0.6;//mass  adsoption  coeffcient  in  cm^2/g
6  p=2.7;//density  of  aluminium  in  g/cm^3
7
8  //calculations
9  u=p*um;
10  disp(u,'linear  adsorption  coefficent  of  aluminium  in
        1/cm');
11  T=0.693/u
12  disp(T,'the  hvl  in  cm');
13  x=(log(20))*(1/u);
14  disp(x,'the  thickness  in  cm')
```

Scilab code Exa 8.10 CALCULATE ANGLE OF THIRD ORDER RE-
FLECTION NOTE CALCUALTION MISTAKE IN BOOK

```
1      clc;clear;
2  //Example  8.10
3
4  //given  values
5  D=12;//glancing  angle  in  Degree
6  n=1;
7  d=3.04*10^-10;//grating  space  in  m
8
9  //calculation
```

```
10  W=(2*d*sind(D));
11  disp((W/(10^-10)),'the wavelength in Angstrom');
12  D3=asind((3*W)/(2*d));
13  disp(D3,'the angle for third order reflection in
        degrees')
```

Scilab code Exa 8.11 HOW MANY ORDERS OF BRAGG RELFLEC-TION

```
1  clc;clear;
2  //Example 8.11
3
4  //given data
5  d=1.181;//distance of seperation in Angstrom
6  W=1.540;//wavelength in Angstrom
7
8  //calculations
9  n=2*d/W;//sin(D) = 1 for max value
10  disp(n,'the orders of bragg reflection')
```

Scilab code Exa 8.12 CALCULATE INTERPLANAR SPACING

```
1  clc;clear;
2  //Example 8.12
3
4  //given data
5  W=0.6;//wavelength in angstrom
6  D1=6.45;
7  D2=9.15;
8  D3=13;//angles in degree
9
10  //calculation
11  d=W/(2*sind(D1));
```

```
12 disp(d,'interplanar spacing for (a) in angstrom');
13 d=W/(2*sind(D2));
14 disp(d,'interplanar spacing for (b) in angstrom');
15 d=W/(2*sind(D3))*2;//n=2 for (c)
16 disp(d,'interplanar spacing for (c) in angstrom')
```

Scilab code Exa 8.13 DETERMINE THE SPACING

```
1 clc;clear;
2 //Example 8.13
3
4 //given data
5 W=3*10^-10;//wavelength in m
6 D=40;//angle in degree
7 n=1;
8
9 //calculation
10 d=n*W/(2*sind(D));
11 disp((d/10^-10),'spacing in AU')
12 a=2*d;
13 v=a^3;
14 disp(v,'the volumne in m^3 is')
```

Scilab code Exa 8.14 DETERMINE THE TYPE OF CRYSTAL POSS-ESED

```
1 clc;clear;
2 //Example 8.14
3
4 //given data
5 D1=5.4;
6 D2=7.6;
7 D3=9.4;//angles in degree
```

```
 8
 9  //calcualtion
10  d1=1/(2*sind(D1));
11  d2=1/(2*sind(D2));
12  d3=1/(2*sind(D3));
13  m=min(d1,d2,d3);
14  d1=d1/m;
15  d2=d2/m;
16  d3=d3/m;
17  disp(d1,d2,d3,'d1:d2:d3 =')
```

Scilab code Exa 8.15 CALCULATE SHORT WAVELENGTH AND GAL-
NCING ANGLE

```
 1  clc;clear;
 2  //Example 8.15
 3
 4  //given data
 5  V=50000;//applied voltage in V
 6  p=1.99*10^3;//density in kg/m^3
 7  n=4;
 8  Na=6.02*10^26;//Avgraodo no. in 1/kg mole
 9  M=74.6;//molecular mass
10  W=0.248*10^-10;//wavelength in m
11
12  //calculation
13  Wmin=12400/V;
14  disp(Wmin,'short wavelength limit');
15  a=(n*M/(Na*p))^(1/3);
16  d=a/2;
17  D=asind(W/(2*d));
18  disp(D,'glancing angle in degree')
```

Scilab code Exa 8.16 CALCULATE LATTICE SPACING OF NaCl

```
1  clc;clear;
2  //Example 8.16
3
4  //given data
5  W=1.54;//wavelength in angstrom
6  D=15.9;//angle in degree
7  M=58.45//molecular weight
8  p=2164*10^3;//density in kg/m^3
9  n=2;//for NaCl molecule
10
11 //calculation
12 d=W/(2*sind(D));
13 disp(d,'lattice spacing in angstrom');
14 d=d*10^-10;
15 Na=M/(2*d^3*p);
16 disp(Na,'Avogrado number in 1/gm mole')
```

Scilab code Exa 8.17 WHAT IS PRIMARY WAVELENGTH

```
1  clc;clear;
2  //Example 8.17
3
4  //given data
5  D=60;//angle in degree
6  W=0.254;//wavelength in angstrom
7
8  //calcualtion
9  dW=0.024*(1-cosd(D));
10 W1=W-dW;
11 disp(W1,'primary X-ray wavelength in angstrom')
```

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Scilab code Exa 8.18 WHAT IS LATTICE PARAMETER

```scilab
1  clc;clear;
2  //Example 8.18
3
4  //given data
5  D=32;//angle in degree
6  W=1.54*10^-10;//wavelength in angstrom
7  h=2;k=2;l=0;//lattice consts
8
9  //calcualtions
10 d=W/(2*sind(D));
11 a=d*sqrt(h^2+k^2+l^2);
12 disp(a,'lattice parameter in m');
13 r=sqrt(2)*a/4;
14 disp(r,'radius of atom in m')
```

Chapter 9

WAVES AND PARTICLES

Scilab code Exa 9.1 WHAT IS DE BROGLIE WAVELENGTH

```
1 clc;clear;
2 //Example 9.1
3
4 //given data
5 V=20000;//applied voltage in V
6
7 //calculation
8 W=12.25/(sqrt(V));
9 disp(W,'de broglie wavelength in angstrom')
```

Scilab code Exa 9.2 CALCULATE MOMENTUM DE BROGLIE WAVELENGTH AND WAVE NUMBER

```
1 clc;clear;
2 //Example 9.2
3
4 //given data
5 V=5000;//applied voltage in V
```

```
 6 e=1.602*10^-19;//the charge on electron in C
 7 m=9.12*10^-31;//mass of electron in kg
 8 d=2.04*10^-10;//distance in m
 9
10 //calculations
11 p=sqrt(2*m*e*V);
12 disp(p,'momentum in kg-m/s^2');
13 W=12.25/sqrt(V);
14 disp(W,'de broglie wavelength in angstrom');
15 v=1/(W*10^-10);
16 disp(v,'the wave number in m');
17 D=asind((W*10^-10)/(2*d));
18 disp(D,'the Bragg angle in degrees')
```

Scilab code Exa 9.3 AN ELECTRON INTIALLY AT REST

```
 1 clc;clear;
 2 //Example 9.3
 3
 4 //given data
 5 V=54;//applied voltage in V
 6 e=1.602*10^-19;//the charge on electron in C
 7 m=9.12*10^-31;//mass of electron in kg
 8 h=6.625*10^-34;//Plank's constant
 9
10 //calcualtions
11 v=sqrt(2*e*V/m);
12 disp(v,'velocity of electron in m/s');
13 W=12.25/sqrt(V);
14 disp(W,'de broglie wavelength in angstrom');
15 u=h/(2*m*W*10^-10);
16 disp(u,'phase velocity in m/s')
```

Scilab code Exa 9.4 COMPUTE DE BROGLIE WAVELENGTH

```
1  clc;clear;
2  //Example 9.4
3
4  //given data
5  e=1.6*10^-19;//the charge on electron in C
6  m=9.12*10^-31;//mass of electron in kg
7  c=3*10^8;//speed of light in m/s
8  h=6.625*10^-34;//Plank's constant
9
10 //calculations
11 E=m*c^2;
12 mp=1836*m;
13 //(0.5*m*v^2)=E
14 mv=sqrt(E*2*mp);
15 W=h/mv;
16 disp((W/10^-10),'de broglie wavelength in Angstrom')
```

Scilab code Exa 9.5 WHAT IS DE BROGLIE WAVELENGTH OF NEU-TRON

```
1  clc;clear;
2  //Example 9.5
3
4  //given data
5  e=1.6*10^-19;//the charge on electron in C
6  m=1.676*10^-27;//mass of neutron in kg
7  c=3*10^8;//speed of light in m/s
8  h=6.625*10^-34;//Plank's constant
9
10 //calculations
11 E=1;//in eV
12 E=1*e;//in V
13 mv=sqrt(2*E*m);
```

```
14  W=h/mv;
15  disp((W/10^-10),'de broglie wavelength in Angstrom')
```

Scilab code Exa 9.6 CALCULATE THE SCATTERED WAVELENGTH

```
1  clc;clear;
2  //Example 9.6
3
4  //calculations
5  W=0.09;//wavelength in Angstrom
6  D=54;//scattering angle in degree
7  h=6.625*10^-34;//Plank's constant
8  c=3*10^8;//speed of light in m/s
9  e=1.6*10^-19;//the charge on electron in C
10
11  //calculations
12  dW=0.0243*(1-cosd(D));
13  W1=W+dW;
14  disp(W1,'wavelegth of scattered X-ray in Angstrom');
15  E=h*c/(W*10^-10);
16  disp((E/(e*10^6)),'Energy of incident photon in MeV'
      );
17  E=h*c/(W1*10^-10);
18  disp((E/(e*10^6)),'Energy of scattered photon in MeV
      ')
```

Scilab code Exa 9.7 COMPUTE ENERGY DIFFERENCE

```
1  clc;clear;
2  //Example 9.7
3
4  //given data
5  h=6.625*10^-34;//Plank's constant
```

```
 6 m=9.12*10^-31;//mass of electron in kg
 7
 8 //calculations
 9 //for (a)
10 nx=1;
11 ny=1;
12 nz=1;
13 L=1;
14 E=h^2*(nx^2+ny^2+nz^2)/(8*m*L^2);
15 disp(E,'energy in first quantum state in J');
16 //for (b) (nx^2+ny^2+nz^2)=6
17 L=1;
18 E=h^2*6/(8*m*L^2);
19 disp(E,'energy in second quantum state in J')
```

Scilab code Exa 9.8 CALCULATE THE LOWEST THREE PREMISSIBLE ENERGIES

```
 1 clc;clear;
 2 //Example 9.8
 3
 4 //given data
 5 h=6.625*10^-34;//Plank's constant
 6 m=9.12*10^-31;//mass of electron in kg
 7 L=2.5*10^-10;
 8 e=1.6*10^-19;//the charge on electron in C
 9
10 //calcualtions
11 n=1;
12 E1=n^2*h^2/(8*m*L^2*e);
13 disp(E1,'E1 in eV');
14 n=2;
15 E2=4*E1;
16 disp(E2,'E2 in eV');
17 n=3;
```

```
18  E3 =9* E1 ;
19  disp (E3 , 'E3 in eV ') ;
```

Chapter 10

THE ATOMIC NUCLEUS

Scilab code Exa 10.1 COMPARE DENSITIES OF WATER AND NUCLEUS

```
1  clc;clear;
2  //Example 10.1
3
4  //given data
5  R=1.2*10^-15;//radius in A^(1/3)-m *A is mass number
6  mp=1.008;
7  mn=mp;//mass of proton and neutron in a.m.u
8  pi=3.14;//const
9  Dw=1000;///density of water in kg/m^3
10
11  //calculation
12  Vn=4/3*pi*R^3;
13  mp=mp*1.66*10^-27;//conversion in kg
14  mn=mp;
15  m=mn;//m is combined mass in A-kg
16  Dn=m/Vn;
17  R=Dn/Dw;
18  disp(R,'the ratio is')
```

Scilab code Exa 10.2 CALCULATE ENERGY EQUIVALENCE FOR MeV

```
1  clc ; clear ;
2  // Example  10.2
3
4  // calculations
5  amu =1.66*10^ -27; //1  amu  in  kg
6  c =3*10^8; // speed  of  light  in  m/s
7  m= amu ;
8  E=m*c^2;
9  kWh =1.6*10^ -13; // conversion  of  kWh  in  J
10 E=E/ kWh ;
11 disp (E ,'energy  equivalence  in  MeV ')
```

Scilab code Exa 10.3 CALCULATE ENERGY EQUIVALENCE FOR kWh

```
1  clc ; clear ;
2  // Example  10.3
3
4  // calculations
5  gm =10^ -3; //1  gram  in  kg
6  m= gm ;
7  c =3*10^8; // speed  of  light  in  m/s
8  E=m*c^2;
9  kWh =36*10^5; //1  kWh  in  J
10 EE=E/ kWh ;
11 disp (EE ,'energy  equivalence  in  kWh ')
```

Scilab code Exa 10.4 CALCULATE BINDING ENERGY

```
1  clc ; clear ;
2  //Example 10.4
3
4  //given data
5  mn=1.00893;//mass of neutron in a.m.u
6  mp=1.00813;//mass of proton in a.m.u
7  md=2.01473;//mass of deuteron in a.m.u
8  ma=4.00389;//mass of alpha−particle in a.m.u
9
10 //calculations
11 dm=md-(mn+mp);
12 disp((-dm*931),'binding energy in MeV');
13 dm=ma-2*(mn+mp);
14 disp((-dm*931),'binding energy in MeV')
```

Scilab code Exa 10.5 CALCULATE BINDING ENERGY OF 17Cl35

```
1  clc ; clear ;
2  //Example 10.5
3
4  //given data
5  m1=1.008665;//mass of 0n1 in a.m.u
6  m2=1.007825;//mass of 1H1 in a.m.u
7  m3=34.9800;//mass 17Cl35 in a.m.u
8  n=17+18;
9
10 //calculations
11 dm=(17*m2)+(18*m1)-m3;
12 Q=dm*931;
13 disp(Q,'Binding energy in MeV');
14 BEn=Q/n;
15 disp(BEn,'Binding energy per nucleon in MeV')
```

Scilab code Exa 10.6 CALCULATE BINDING ENERGY FOR LITHIUM
NUCLEUS

```
 1  clc; clear;
 2  //Example in 10.6
 3
 4  //given data
 5  m1=1.00814;//mass of proton in a.m.u
 6  m2=1.00893;//mass of neutron in a.m.u
 7  m3=7.01822;//mass of lithium in a.m.u
 8
 9  //calculations
10  dm=(3*m1)+(4*m2)-m3;
11  Q=dm*931;
12  disp(Q,'Binding energy in MeV')
```

Chapter 11

NATURAL RADIOACTIVTIY

Scilab code Exa 11.1 CALCUALTE HOW MUCH RADIUM

```
1  clc ; clear ;
2  // Example  11.1
3
4  // given  data
5  ttg =8378 -1898; // total  time  gap  in  yrs
6  hf =1620; // half  life  in  yrs
7  n=ttg/hf; // no  of  half −periods
8  Mo =200; // amt  of  radium  in  mg
9
10 // calculations
11 M=Mo *(0.5) ^n ;
12 disp (M,'radium  left  in  mg')
```

Scilab code Exa 11.2 CALCULATE RADIOACTIVE DISINTEGRATING CONST

```
1  clc ; clear ;
2  // Example  11.2
```

```
 3
 4 //given data
 5 hf=30;// half life in days
 6 //M is intial conc.
 7
 8 // calcualtions
 9 k=0.693/hf;
10 disp(k,'radioactive disintegration constant in 1/day
      ');
11 //M/4 is left
12 t=-log(1/4)/k;
13 disp(t,'time taken for (ii) in days');
14 //M/8 is left
15 t=-log(1/8)/k;
16 disp(t,'time taken for (iii) in days')
```

Scilab code Exa 11.3 COMPUTE DECAY CONST AND HALF LIFE

```
 1 clc;clear;
 2 //Example 11.3
 3
 4 //given data
 5 No=4750;
 6 N=2700;// rate in counts/minute
 7 t=5;//time in minutes
 8
 9 // calculation
10 k=log(No/N)/t;
11 disp(k,'radioactive disintegration constant in 1/min
      ');
12 hf=0.693/k;
13 disp(hf,'half life in minutes')
```

Scilab code Exa 11.4 ESTIMATE HALF LIFE OF PLUTONIUM

```
1  clc ; clear ;
2  // Example 13.4
3
4  // given data
5  m =4.00387; // mass of alpha particle in a.m.u
6  M =10^ -6; // mass of Pu−239 in kg
7
8  // calculations
9  m = m *1.66*10^ -24; // conversion in gm
10 Mo =2300* m ;
11 k =( Mo /1) / M ;
12 hf =0.693/ k ;
13 hf = hf /(365*24*3600) ; // conversion in yrs
14 disp ( hf , ' half life in yrs ')
```

Scilab code Exa 11.5 CALCULATE ACTIVITY

```
1  clc ; clear ;
2  // Example 11.5
3
4  // given data
5  hf =2.48*10^5; // half life in yrs
6  k =8.88*10^ -14 // decay const in 1/s
7  Mo =4; // intial mass in mg
8  Na =6.02*10^23; // Avgraodo no . in 1/gm mole
9
10 // calculations
11 kt =0.693/ hf *62000;
12 M = Mo *( exp ( - kt ));
13 disp ( M , ' mass remain unchanged in mg ');
14 N = M *10^ -3* Na /234;
15 A = k * N ;
16 disp ( A , ' Activity in disintegrations / second ')
```

Scilab code Exa 11.6 HALF LIFE OF RADIUM IS 1620 YRS

```
1  clc;clear;
2  //Example 11.6
3
4  //given data
5  hf=1620;//half life in yrs
6  Mo=1/100;//mass in gm
7
8  //calculations
9  k=0.693/hf;
10 M=(1-Mo);
11 t=log(1/M)/k;
12 disp(t,'time reqd for (i) in yrs');
13 M=Mo;
14 t=log(1/M)/k;
15 disp(t,'time reqd for (ii) in yrs')
```

Chapter 12

ARTIFICAL RADIOACTIVTIY

Scilab code Exa 12.1 ESTIMATE ITS AGE

```scilab
1  clc ; clear ;
2  // Example 12.1
3
4  // given data
5  r =0.5;// ratio of mass of Pb206 and mass of U238
6  t =4.5*10^9;// half life in years
7
8  // calculation
9  T =( log (1+ r ) ) *( t /0.693) ;
10 disp (T , ' age in years ')
```

Chapter 13

NUCLEAR REACTIONS

Scilab code Exa 13.1 CALCULATE THE ENERGY AVAILABLE

```scilab
1  clc ; clear ;
2  // Example 13.1
3
4  // given data
5  m1 =7.0183; // mass of 3Li7 in a.m.u
6  m2 =4.0040; // mass of 2He4 in a.m.u
7  m3 =1.0082; // mass of 1H1 in a.m.u
8  Na =6.02*10^26; // Avgraodo no. in 1/kg mole
9  // rxn = 3Li7 + 1H1 = 2He4 + 2He4
10
11  // calculations
12  dm = m1 + m3 -(2* m2 );
13  E = dm *931;
14  n =0.1* Na /7; // no of atoms in 100 gm of lithium
15  TE = n * E ;
16  disp ( TE , ' Total energy available in MeV ')
```

Scilab code Exa 13.2 CALCULATE THE ENERGY RELEASED

```
1  clc ; clear ;
2  // Example  13.2
3
4  // given  data
5  m1=6.015126; // mass  of  3Li7  in  a.m.u
6  m2=4.002604; // mass  oh  2He4  in  a.m.u
7  m3=1.00865; // mass  of  0n1  in  a.m.u
8  m4=3.016049; // mass  of  1H3  in  a.m.u
9  // rxn = 3Li7 + 0n1 = 2He4 + 1H3 + Q
10
11 // calcualtions
12 dm=m1+m3 -(m2+m4);
13 Q=dm*931;
14 disp (Q, 'energy  released  in  MeV')
```

Scilab code Exa 13.3 WHAT IS THE Q VALUE OF THE REACTION

```
1  clc ; clear ;
2  // Example  13.3
3
4  // given  data
5  m1=14.007515; // mass  of  7N14  in  a.m.u
6  m2=4.003837; // mass  oh  2He4  in  a.m.u
7  m3=17.004533; // mass  of  8O17  in  a.m.u
8  m4=1.008142; // mass  of  1H1  in  a.m.u
9  // rxn = 7N14 + 2He14 = 8O17 + 1H1
10
11 // calculations
12 dm=m3+m4 -(m1+m2);
13 Q=dm*931;
14 disp (Q, 'energy  released  in  MeV')
```

Scilab code Exa 13.4 FIND THE MASS

65

```
1  clc ; clear ;
2  // Example 13.3
3
4  // given data
5  m1 =14.007520; // mass of 7N14 in a.m.u
6  m2 =1.008986; // mass oh 0n1 in a.m.u
7  // m3=mass of 6C14 in a.m.u
8  m4 =1.008145; // mass of 1H1 in a.m.u
9  // rxn = 7N14 + 0n1 = 6C14 + 1H1 + 0.55 MeV
10
11 // calculations
12 Q =0.55;
13 dm =Q/931;
14 m3 =dm+m1+m2-m4 ;
15 disp (m3 ,'mass of 6C14 in a.m.u ')
```

Scilab code Exa 13.6 EXPLAIN MASS DEFECT

```
1  clc ; clear ;
2  // Example 13.6
3
4  // given data
5  m0 =11.01280; // mass 5B11 in a.m.u
6  m1 =4.00387; // mass of alpha particle in a.m.u
7  m2 =14.00752; // mass of 7N14 in a.m.u
8  // m3=mass of neutron
9  E1 =5.250; // energy of alpha particle in MeV
10 E2 =2.139; // energy of 7N14 in MeV
11 E3 =3.260; // energy of 0n1 in MeV
12
13 // calculations
14 m3 =(m0*931) +((m1*931) +E1) -((m2*931) +E2) -E3;
15 disp ((m3/931) ,'mass of neutron in a.m.u ')
```

Chapter 14

NUCLEUR FISSION AND FUSION

Scilab code Exa 14.1 COMPUTE FISSION ENERGY

```
1  clc;clear;
2  //Example 14.1
3
4  //given data
5  E1=7.8;//avg. B.E per nucleon in MeV
6  E2=8.6;//for fissin fragments in MeV
7
8  //calculations
9  FER=(234*E2)-(236*E1);
10 disp(FER,'Fission energy released in MeV')
```

Scilab code Exa 14.2 FIND ELEMENTARY PARTICLES RELEASED
IN BINARY FISSION OF 92U235

```
1  clc;clear;
2  //Example 14.2
```

```
 3
 4  //given data
 5  m1=235.044;//mass of 92U235 in a.m.u
 6  m2=97.905;//mass of 42Mo98 in a.m.u
 7  m3=135.917;//mass of 54Xe136 in a.m.u
 8  //rxn = 0n1 + 92U235 = 42Mo98 + 54Xe136 + 4 -1e0 + 2
        0n1
 9
10  //calculation
11  LHSm=1.009+m1;
12  RHSm=m2+m3+(4*0.00055)+(2*1.009);
13  dm=LHSm-RHSm;
14  disp(dm,'mass defect in a.m.u');
15  E=dm*931;
16  disp(E,'energy released in MeV')
```

Scilab code Exa 14.3 HOW MUCH HYDROGEN MUST BE CONVERTED INTO HELIUM

```
 1  clc;clear;
 2  //Example 14.3
 3
 4  //given data
 5  m1=1.00813;//mass of 1H1 in a.m.u
 6  m2=4.00386;//mass of 2He4 in a.m.u
 7  SC=1.35;//solar constant in kW/m^2
 8  d=1.5*10^11;//dist b/w earth and sum in m
 9  e=1.6*10^-19;//the charge on electron in C
10  Na=6.02*10^26;//Avgraodo no. in 1/kg mole
11  pi=3.14;//const
12  //rxn = 4 1H1 = 2He4 + 2 1e0
13
14  //calculations
15  dm=(4*m1)-m2
16  E=dm*931;//energy produced in MeV
```

```
17  EP=E/4;//energy produced per atom
18  EP=EP*10^6*e;//conversion in J
19  EPkg=EP*Na;//energy produced by 1 kg of hydrogen
20  SC=SC*1000;//conversion in J/s-m^2
21  SA=4*pi*d^2;//surface area of sphere
22  ER=SC*SA;//energy recieved per second
23  m=ER/EPkg;
24  disp((m/10^3),'mass of hydrogen consumed in tonnes/
        second')
```

Scilab code Exa 14.4 CALCULATE THE ENERGY LIBERATED

```
1   clc;clear;
2   //Example 14.4
3
4   //given data
5   m1=2.01478;//mass of 1H2 in a.m.u
6   m2=4.00388;//mass of 2He4 in a.m.u
7   //rxn 1H2 + 1H2 = 2He4 + Q
8
9   //calculations
10  Q=2*m1-m2;
11  Q=Q*931;//conversion in MeV
12  disp(Q,'energy liberated in MeV')
```

Chapter 15

NUCLEUR ENERGY SOURCES

Scilab code Exa 15.1 CALCULATE THE MAXIMUM FRACTION OF THE KE

```
1 clc;clear;
2 //Example 15.1
3
4 //given data
5 ma=1;
6 Ma=2;
7 mb=1;
8 Mb=12;
9 mc=1;
10 Mc=238;//m is mass of neutron and M is mass of other
         neucleus
11
12 //calculation
13 n=(4*ma*Ma/(ma+Ma)^2)*100;
14 disp(n,'Maximum fraction of KE lost by a neutron for
        (a)');
15 n=(4*mb*Mb/(mb+Mb)^2)*100;
16 disp(n,'Maximum fraction of KE lost by a neutron for
```

```
      (a)');
17  n=(4*mc*Mc/(mc+Mc)^2)*100;
18  disp(n,'Maximum fraction of KE lost by a neutron for
      (a)')
```

Scilab code Exa 15.2 CALCULATE THE FISSION RATE

```
1  clc;clear;
2  //Example 15.2
3
4  //given data
5  E=200;//energy released per fission in MeV
6  e=1.6*10^-19;//the charge on electron in C
7  Na=6.02*10^26;//Avgraodo no. in 1/kg mole
8
9  //calculations
10 CE=E*e*10^6;//conversion in J
11 RF=1/CE;
12 disp(RF,'fission rate of one watt in fissions/second
      ');
13 Ekg=CE*Na/235;
14 disp(Ekg,'Energy realeased in complete fission of 1
      kg in J')
```

Scilab code Exa 15.3 HOW MANY KG OF U 235

```
1  clc;clear;
2  //Example 15.3
3
4  //given data
5  R=3*10^7;//rate of energy development in J s
6  E=200;//energy released per fission in MeV
7  e=1.6*10^-19;//the charge on electron in C
```

```scilab
 8  t=1000;//time is hours
 9  Ekg=8.2*10^13;//energy released per kg of U-235
10
11  //calculation
12  CE=E*e*10^6;//conversion in J
13  n=R/CE;
14  disp(n,'no of atoms undergo fission/second ');
15  TE=R*t*3600;//energy produced in 1000 hours
16  MC=TE/Ekg;
17  disp(MC,'mass consumed in kg')
```

Scilab code Exa 15.4 HOW MUCH U 235 WOULD BE CONSUMED IN THE RUN

```scilab
 1  clc;clear;
 2  //Example 15.4
 3
 4  //given data
 5  EPF=180;//Energy consumed per disintegration in MeV
 6  E=1200;//average power in kW
 7  t=10;//time in hours
 8  Na=6.02*10^26;//Avgraodo no. in 1/kg mole
 9  e=1.6*10^-19;//the charge on electron in C
10
11  //calculation
12  TE=E*t;//energy consumed in kWh
13  TE=TE*36*10^5;//conversion in J
14  EE=TE/0.2;//efficient energy
15  CE=EPF*e*10^6;//conversion in J
16  n=EE/CE;
17  m=235*n/Na*1000;
18  disp(m,'mass consumed in gram')
```

Scilab code Exa 15.5 NUCLEUR REACTOR PRODUCES 200MW

```
1  clc;clear;
2  //Example 15.5
3
4  //given data
5  OE=200;//o/p power in MW
6  E=200;//energy released per fission in MeV
7  WF=3.1*10^10;//fission rate in fissions/second
8  Na=6.02*10^26;//Avgraodo no. in 1/kg mole
9
10 //calculations
11 IE=OE/0.3*10^6;//reactor input in W
12 TFR=WF*IE;
13 n=TFR*24*3600;//no. of U-235 for one day
14 m=235*n/Na;
15 disp((m*100/0.7),'amt of natural uranium conumed/day
        in kg')
```

Scilab code Exa 15.6 A CITY REQUIRES 100 MW

```
1  clc;clear;
2  //Example 15.6
3
4  //given data
5  AE=100;//electrical power in MW
6  E=200;//energy released per fission in MeV
7  e=1.6*10^-19;//the charge on electron in C
8  Na=6.02*10^26;//Avgraodo no. in 1/kg mole
9
10 //calculations
11 TE=AE*10^6*24*3600;//energy consumed in city in one
     day in J
12 EE=TE/0.2;
13 CE=E*e*10^6;//conversion in J
```

```
14  n=EE/CE;
15  m=235*n/Na;
16  disp(m,'amt of fuel required in kg')
```

Scilab code Exa 15.7 BOMBAY REQUIRES 300 MWh

```
1  clc;clear;
2  //Example 15.7
3
4  //given data
5  OE=3000;//output power in MWh
6  E=200;//energy released per fission in MeV
7  e=1.6*10^-19;//the charge on electron in C
8  Na=6.02*10^26;//Avgraodo no. in 1/kg mole
9
10 //calculations
11 IE=OE/0.2;
12 TE=IE*36*10^8;//conversion in J
13 CE=E*e*10^6;//conversion in J
14 n=TE/CE;
15 m=235*n/Na;
16 disp(m,'daily fuel requirement in kg')
```

Scilab code Exa 15.8 THE MOTOR OF AN ATOMIC ICE BREAKER

```
1  clc;clear;
2  //Example 15.8
3
4  //given data
5  OP=32824;//o/p power in kW
6  E=200;//energy released per fission in MeV
7  Ekg=8.2*10^13;//energy released per kg of U-235
8
```

```
 9  //calculations
10  DOP=OP*1000*24*3600;//daily o/p power in J
11  IP=DOP/0.2;
12  DFC=IP/Ekg;//daily fuel cosumption
13  disp(DFC,'daily fuel cosumption in kg');
14  DI=DOP/(0.8*4186);//daily input at 80% efficiency
15  Crqd=DI/(7*10^3);
16  disp(Crqd,'Coal reqd/day in tonnes')
```

Chapter 16

PARTICLE ACCELERATORS

Scilab code Exa 16.1 WHAT MUST BE THE FLUX DENSITY

```
1  clc;clear;
2  //Example 16.1
3
4  //given data
5  fo=9*10^6;//frequency in Hz
6  m=6.643*10^-27;//mass in kg
7  pi=3.14;//constant
8  e=1.6*10^-19;//the charge on electron in C
9
10 //calculations
11 Q=2*e;
12 B=fo*2*pi*m/Q;
13 disp(B,'magnetic flux density in Wb/m^2')
```

Scilab code Exa 16.2 WHAT IS FREQUENCY OF ALTERNATING PO-
TENTIAL

```
1  clc;clear;
```

```
2  //Example 16.2
3
4  //given data
5  B=0.7;//magnetic flux intensity in Wb/m^2
6  m=3.34*10^-27;//mass in Kg
7  e=1.6*10^-19;//the charge on electron in C
8  pi=3.14;//const
9
10 //calculations
11 Q=e;
12 fo=B*Q/(2*pi*m*10^6);
13 disp(fo,'The cyclotron frquency in MHz ')
```

Scilab code Exa 16.3 A CYCLOTRON OF DEES OF RADIUS 2 METERES

```
1  clc;clear;
2  //Example 16.3
3
4  //given data
5  B=0.75;//magnetic flux intensity in Wb/m^2
6  m1=1.67*10^-27;//mass in Kg
7  m2=3.31*10^-27;//mass in Kg
8  e=1.6*10^-19;//the charge on electron in C
9  Rm=2;//radius in m
10
11 //calculations
12 Q=e;
13 Emax=3.12*10^12*B^2*Q^2*Rm^2/m1;
14 disp(Emax,'Maximum energies in Mev for proton');
15 Emax=3.12*10^12*B^2*Q^2*Rm^2/m2;
16 disp(Emax,'Maximum energies in Mev for deuteron')
```

Scilab code Exa 16.4 CALCULATE THE RATIO

```
1  clc ; clear ;
2  // Example 16.4
3
4  // given data
5  mo =9.1*10^ -31;// mass of electron in kg
6  m =1.67*10^ -27;// mass of proton in kg
7  c =3*10^8;// speed of light in m/s
8  E =1;// given energy in MeV
9
10 // calculations
11 Eo = mo * c ^2/(1.6*10^ -13) ;
12 mbymo =1+( E / Eo ) ;
13 disp ( mbymo , 'Ratio for electron ') ;
14 Eo = m * c ^2/(1.6*10^ -13) ;
15 mbymo =1+( E / Eo ) ;
16 disp ( mbymo , 'Ratio for proton ')
```

Scilab code Exa 16.5 IN A CERTAIN BETATRON

```
1  clc ; clear ;
2  // Example 16.5
3
4  // given data
5  B =0.5;// magnetic field in Wb/m^2
6  d =1.5;// diameter in m
7  f =59;// frequency in Hz
8  e =1.6*10^ -19;// the charge on electron in C
9  c =3*10^8;// speed of light in m/s
10 pi =3.14;// const
11
12 // calculations
13 R = d /2;
14 N = c /(4*(2* pi *50) * R ) ;
```

```
15  E=B*e*R*c/(1.6*10^-13);
16  disp(E,'final energy in MeV');
17  AE=E/N*10^6;
18  disp(AE,'average energy in eV')
```

Scilab code Exa 16.6 CALCULATE MASS AND VELOCITY OF ELCTRONS

```
1  clc;clear;
2  //Example 16.6
3
4  //given data
5  E=0.51;//kinetic energy in MeV
6  R=0.15;//radius in m
7  e=1.6*10^-19;//the charge on electron in C
8  mo=9.12*10^-31;//mass of electron in kg
9  c=3*10^8;//speed of light in m/s
10
11  //calculation
12  Eo=E;
13  m=mo*(1+(E/Eo));
14  b=sqrt(1-(mo/m)^2);
15  v=b*c;
16  B=mo*v/(e*R);
17  disp(B,'magnetic field intensity')
```

Scilab code Exa 16.7 DETERMINE THE FREQUENCY OF GENERA-TOR

```
1  clc;clear;
2  //Example 16.7
3
4  //given data
5  E=4;//applied voltage in MeV
```

```
6  m=3.334*10^-27;//mass of deuteron in kg
7  R=0.75;//radius in m
8  pi=3.14;//const
9  e=1.6*10^-19;//the charge on electron in C
10
11 //calcualtions
12 E=4*10^6*e;
13 fo=sqrt(E/(2*m))/(pi*R);
14 disp(fo,'frequnecy of generator in Hz')
```

Scilab code Exa 16.8 WHAT WOULD BE THE ENERGY OF ELECTRON

```
1  clc;clear;
2  //Example 16.8
3
4  //given data
5  roi=15;//rate of increase in Wb/s
6  tr=10^6;//total revolutions
7
8  //calcualtion
9  IE=roi*10^-6;//increased energy in MeV
10 FE=IE*tr;
11 disp(FE,'Fianl Energy in MeV')
```

Scilab code Exa 16.9 FIND THE MAX ENERGY AND CORRESPONDING WAVELENGTH

```
1  clc;clear;
2  //Example 16.9
3
4  //given data
5  R=0.1;//radius in m
```

```
 6  pi =3.14; //const
 7  h=6.625*10^-34; //Plank's constant
 8  c=3*10^8; //speed of light in m/s
 9  roi =15; //rate of increase in Wb/s
10  t=4*10^-4; //period of accerleartion in s
11  e=1.6*10^-19; //the charge on electron in C
12
13  //calculations
14  N=c*t/(2*pi*R);
15  IE=roi; //incresed energy in eV
16  ME=N*IE*10^-6;
17  disp (ME,'Maximum energy in MeV');
18  ME=ME*10^6*e; //conversion in V
19  p=ME/c;
20  Y=h/p;
21  disp (Y,'corresponding wavelength of X-rays in m')
```