CHAPTER 3

3.1 The M-file can be written as

```
function Vol = tankvolume(R, d)
if d < R
  Vol = pi * R ^ 2 * d / 3;
elseif d <= 3 * R
  V1 = pi * R ^ 3 / 3;
  V2 = pi * R ^ 2 * (d - R);
  Vol = V1 + V2;
else
  Vol = 'overtop';
end
```

This function can be used to evaluate the test cases with the following script:

```
clear, clc, format compact
tankvolume(0.9,1)
tankvolume(1.5,1.25)
tankvolume(1.3,3.8)
tankvolume(1.3,4)
```

Results:

```
ans =
    1.0179
ans =
    2.9452
ans =
   15.5739
ans =
overtop
```

3.2 The M-file can be written as

```
function futureworth(P, i, n)
nn=0:n;
F=P*(1+i).^nn;
y=[nn;F];
fprintf('\n  year   future worth\n');
fprintf('%5d %14.2f\n',y);
```

This function can be used to evaluate the test case.

```
>> futureworth(100000,0.05,10)

  year   future worth
    0      100000.00
    1      105000.00
    2      110250.00
```

```
    3      115762.50
    4      121550.63
    5      127628.16
    6      134009.56
    7      140710.04
    8      147745.54
    9      155132.82
   10      162889.46
```

3.3 The M-file can be written as

```
function annualpayment(P, i, n)
nn = 1:n;
A = P*i*(1+i).^nn./((1+i).^nn-1);
y = [nn;A];
fprintf('\n  year   annual payment\n');
fprintf('%5d %14.2f\n',y);
```

This function can be used to evaluate the test case.

```
>> annualpayment(100000,.033,5)

  year   annual payment
    1      103300.00
    2       52488.39
    3       35557.14
    4       27095.97
    5       22022.84
```

3.4 The M-file can be written as

```
function Ta = avgtemp(Tm, Tp, ts, te)
w = 2*pi/365;
t = ts:te;
T = Tm + (Tp-Tm)*cos(w*(t-205));
Ta = mean(T);
```

This function can be used to evaluate the test cases

```
>> avgtemp(23.1,33.6,0,59)
ans =
   13.1332
>> avgtemp(10.6,17.6,180,242)
ans =
   17.2265
```

3.5 The M-file can be written as

```
function sincomp(x,n)
i = 1;
tru = sin(x);
```

```
ser = 0;
fprintf('\n');
fprintf('order  true value     approximation     error\n');
while (1)
  if i > n, break, end
  ser = ser + (-1)^(i - 1) * x^(2*i-1) / factorial(2*i-1);
  er = (tru - ser) / tru * 100;
  fprintf('%3d  %14.10f  %14.10f  %12.7f\n',i,tru,ser,er);
  i = i + 1;
end
```

This function can be used to evaluate the test case.

```
>> sincomp(0.9,8)

order  true value     approximation     error
  1   0.7833269096   0.9000000000  -14.8945592
  2   0.7833269096   0.7785000000    0.6162063
  3   0.7833269096   0.7834207500   -0.0119797
  4   0.7833269096   0.7833258498    0.0001353
  5   0.7833269096   0.7833269174   -0.0000010
  6   0.7833269096   0.7833269096    0.0000000
  7   0.7833269096   0.7833269096   -0.0000000
  8   0.7833269096   0.7833269096    0.0000000
```

3.6 The M-file can be written as

```
function [r, th] = polar(x, y)
r = sqrt(x .^ 2 + y .^ 2);
if x > 0
  th = atan(y/x);
elseif x < 0
  if y > 0
    th = atan(y / x) + pi;
  elseif y < 0
    th = atan(y / x) - pi;
  else
    th = pi;
  end
else
  if y > 0
    th = pi / 2;
  elseif y < 0
    th = -pi / 2;
  else
    th = 0;
  end
end
th = th * 180 / pi;
```

This function can be used to evaluate the test cases. For example, for the first case

```
>> [r,th]=polar(2,0)
r =
     2
th =
     0
```

All the cases are summarized as shown:

x	y	r	θ
2	0	2	0
2	1	2.236068	26.56505
0	3	3	90
−3	1	3.162278	161.5651
−2	0	2	180
−1	−2	2.236068	−116.565
0	0	0	0
0	−2	2	−90
2	2	2.828427	45

3.7 The M-file can be written as given below:

```
function polar2(x, y)
r = sqrt(x .^ 2 + y .^ 2);
n = length(x);
for i = 1:n
  if x(i) > 0
    th(i) = atan(y(i) / x(i));
  elseif x(i) < 0
    if y(i) > 0
      th(i) = atan(y(i) / x(i)) + pi;
    elseif y(i) < 0
      th(i) = atan(y(i) / x(i)) - pi;
    else
      th(i) = pi;
    end
  else
    if y(i) > 0
      th(i) = pi / 2;
    elseif y(i) < 0
      th(i) = -pi / 2;
    else
      th(i) = 0;
    end
  end
  th(i) = th(i) * 180 / pi;
end
ou=[x;y;r;th];
fprintf('\n     x         y       radius     angle\n');
fprintf('%8.2f %8.2f %10.4f %10.4f\n',ou);
```

This function can be used to evaluate the test cases and display the results in tabular form.

```
>> x=[2 2 0 -3 -2 -1 0 0 2];
>> y=[0 1 3 1 0 -2 0 -2 -2];
>> polar2(x,y)

     x         y        radius      angle
    2.00      0.00      2.0000      0.0000
    2.00      1.00      2.2361     26.5651
    0.00      3.00      3.0000     90.0000
   -3.00      1.00      3.1623    161.5651
   -2.00      0.00      2.0000    180.0000
   -1.00     -2.00      2.2361   -116.5651
    0.00      0.00      0.0000      0.0000
    0.00     -2.00      2.0000    -90.0000
    2.00     -2.00      2.8284    -45.0000
```

3.8 The M-file can be written as given below:

```
function grade = lettergrade(score)
if score <0 || score >100
  error('Value must be >= 0 and <= 100')
elseif score >= 90
  grade = 'A';
elseif score >= 80
  grade = 'B';
elseif score >= 70
  grade = 'C';
elseif score >= 60
  grade = 'D';
else
  grade = 'F';
end
```

This function can be tested with a few cases as with the following script:

```
clear, clc, format compact
grade = lettergrade(89.9999)
grade = lettergrade(90)
grade = lettergrade(45)
grade = lettergrade(120)
```

Results:

```
grade =
B
grade =
A
grade =
F
Error using lettergrade (line 3)
Value must be >= 0 and <= 100
```

3.9 The M-file can be written as given below:

```
function Manning(A)
A(:,5)=sqrt(A(:,2))./A(:,1).*(A(:,3).*A(:,4)./(A(:,3)+2*A(:,4))).
^(2/3);
fprintf('\n    n          S          B          H          U\n');
fprintf('%8.3f %8.4f %10.2f %10.2f %10.4f\n',A');
```

This function can be run to create the table.

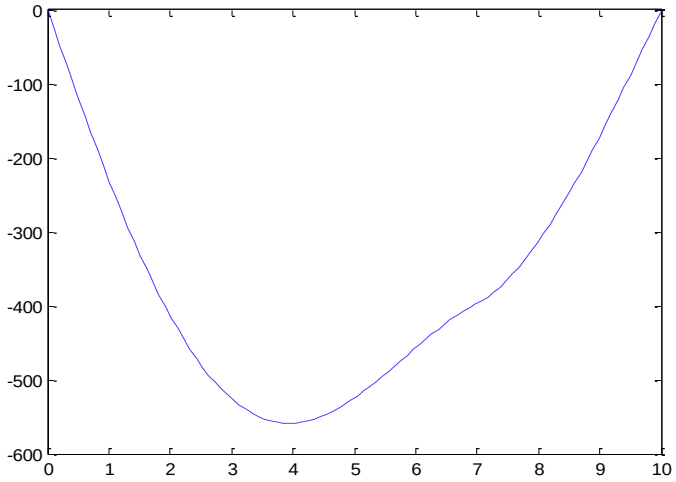
```
>> A=[.036 .0001 10 2
.020 .0002 8 1
.015 .0012 20 1.5
.03 .0007 25 3
.022 .0003 15 2.6];
>> Manning(A)

    n          S          B          H          U
   0.036   0.0001      10.00       2.00     0.3523
   0.020   0.0002       8.00       1.00     0.6094
   0.015   0.0012      20.00       1.50     2.7569
   0.030   0.0007      25.00       3.00     1.5894
   0.022   0.0003      15.00       2.60     1.2207
```

3.10 The M-file can be written as

```
function beam(x)
xx = linspace(0,x);
n=length(xx);
for i=1:n
  uy(i) = -5/6.*(sing(xx(i),0,4)-sing(xx(i),5,4));
  uy(i) = uy(i) + 15/6.*sing(xx(i),8,3) + 75*sing(xx(i),7,2);
  uy(i) = uy(i) + 57/6.*xx(i)^3 - 238.25.*xx(i);
end
plot(xx,uy,'--')

function s = sing(xxx,a,n)
if xxx > a
  s = (xxx - a).^n;
else
  s=0;
end
```

This function can be run to create the plot:

```
>> beam(10)
```

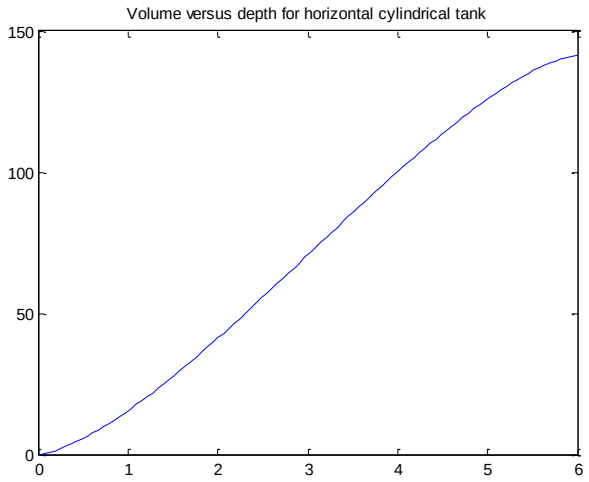


3.11 The M-file can be written as

```
function cylinder(r, L, plot_title)
% volume of horizontal cylinder
% inputs:
% r = radius
% L = length
% plot_title = string holding plot title

h = linspace(0,2*r);
V = (r^2*acos((r-h)./r)-(r-h).*sqrt(2*r*h-h.^2))*L;
plot(h, V)
title(plot_title)
```

This function can be run to generate the following plot:

```
>> cylinder(3,5,...
'Volume versus depth for horizontal cylindrical tank')
```



3.12 The unvectorized version generates the following values for t and y:

```
t =
  0 2.5000 5.0000 7.5000 10.0000 12.5000 15.0000 17.5000 20.0000
y =
 18.0000 16.2426 12.0000 7.7574 6.0000 7.7574 12.0000 16.2426
   18.0000
```

A vectorized version that generates the same results can be written as

```
tt=tstart:(tend-tstart)/ni:tend
yy=12+6*cos(2*pi*tt/(tend-tstart))
```

3.13

```
function s=SquareRoot(a,eps)
ind=1;
if a ~= 0
  if a < 0
    a=-a;ind=j;
  end
  x = a / 2;
  while(1)
    y = (x + a / x) / 2;
    e = abs((y - x) / y);
    x = y;
    if e < eps, break, end
  end
  s = x;
else
  s = 0;
end
s=s*ind;
```

The function can be tested:

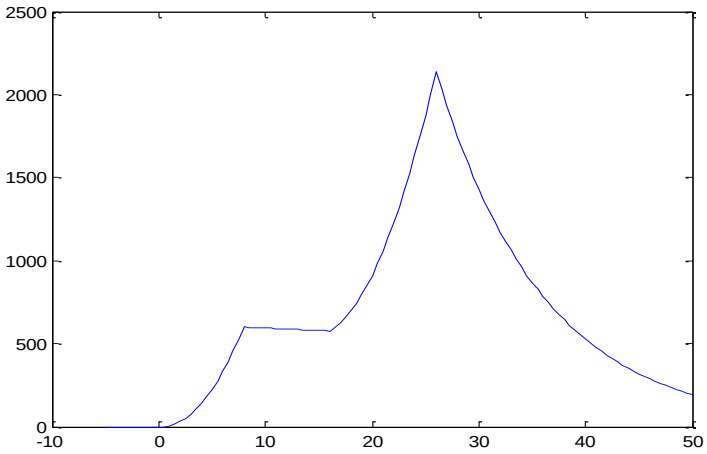
```
>> SquareRoot(0,1e-4)
ans =
     0
>> SquareRoot(2,1e-4)
ans =
    1.4142
>> SquareRoot(10,1e-4)
ans =
    3.1623
>> SquareRoot(-4,1e-4)
ans =
        0 + 2.0000i
```

3.14 The following function implements the piecewise function:

```
function v = vpiece(t)
if t<0
  v = 0;
elseif t<8
  v = 10*t^2 - 5*t;
elseif t<16
  v = 624 - 3*t;
elseif t<26
  v = 36*t + 12*(t - 16)^2;
else
  v = 2136*exp(-0.1*(t-26));
end
```

Here is a script that uses `vpiece` to generate the plot

```
k=0;
for i = -5:.5:50
  k=k+1;
  t(k)=i;
  v(k)=vpiece(t(k));
end
plot(t,v)
```



3.15 This following function employs the round to larger method. For this approach, if the number is exactly halfway between two possible rounded values, it is always rounded to the larger number.

```
function xr=rounder(x, n)
if n < 0,error('negative number of integers illegal'),end
xr=round(x*10^n)/10^n;
```

Here are the test cases:

```
>> rounder(477.9587,2)
ans =
  477.9600
>> rounder(-477.9587,2)
ans =
 -477.9600
>> rounder(0.125,2)
ans =
    0.1300
>> rounder(0.135,2)
ans =
    0.1400
>> rounder(-0.125,2)
ans =
   -0.1300
>> rounder(-0.135,2)
ans =
   -0.1400
```

A preferable approach is called *banker's rounding* or *round to even*. In this method, a number exactly midway between two possible rounded values returns the value whose rightmost significant digit is even. Here is as function that implements banker's rounding along with the test cases that illustrate how it differs from `rounder`:

```
function xr=rounderbank(x, n)
if n < 0,error('negative number of integers illegal'),end
x=x*10^n;
if mod(floor(abs(x)),2)==0 & abs(x-floor(x))==0.5
  xr=round(x/2)*2;
else
  xr=round(x);
end
xr=xr/10^n;
```

```
>> rounder(477.9587,2)
ans =
  477.9600
>> rounder(-477.9587,2)
ans =
 -477.9600
>> rounderbank(0.125,2)
ans =
    0.1200
```

```
>> rounderbank(0.135,2)
ans =
    0.1400
>> rounderbank(-0.125,2)
ans =
   -0.1200
>> rounderbank(-0.135,2)
ans =
   -0.1400
```

3.16

```
function nd = days(mo, da, leap)
nd = 0;
for m=1:mo-1
  switch m
    case {1, 3, 5, 7, 8, 10, 12}
      nday = 31;
    case {4, 6, 9, 11}
      nday = 30;
    case 2
      nday = 28+leap;
  end
  nd=nd+nday;
end
nd = nd + da;
```

```
>> days(1,1,0)
ans =
     1
>> days(2,29,1)
ans =
    60
>> days(3,1,0)
ans =
    60
>> days(6,21,1)
ans =
   173
>> days(12,31,1)
ans =
   366
```

3.17

```
function nd = days(mo, da, year)
leap = 0;
if year / 4 - fix(year / 4) == 0, leap = 1; end
nd = 0;
for m=1:mo-1
  switch m
    case {1, 3, 5, 7, 8, 10, 12}
      nday = 31;
    case {4, 6, 9, 11}
      nday = 30;
    case 2
      nday = 28+leap;
```

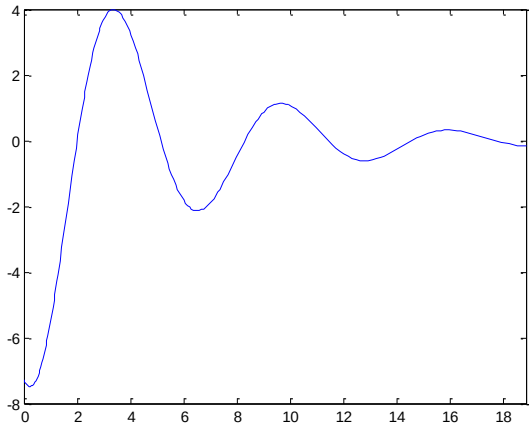
```
  end
  nd=nd+nday;
end
nd = nd + da;

>> days(1,1,1997)
ans =
     1
>> days(2,29,2004)
ans =
    60
>> days(3,1,2001)
ans =
    60
>> days(6,21,2004)
ans =
   173
>> days(12,31,2008)
ans =
   366
```

3.18

```
function fr = funcrange(f,a,b,n,varargin)
% funcrange: function range and plot
%   fr=funcrange(f,a,b,n,varargin): computes difference
%      between maximum and minimum value of function over
%      a range. In addition, generates a plot of the function.
% input:
%   f = function to be evaluated
%   a = lower bound of range
%   b = upper bound of range
%   n = number of intervals
% output:
%   fr = maximum - minimum
x = linspace(a,b,n);
y = f(x,varargin{:});
fr = max(y)-min(y);
fplot(f,[a b],varargin{:})
end
```

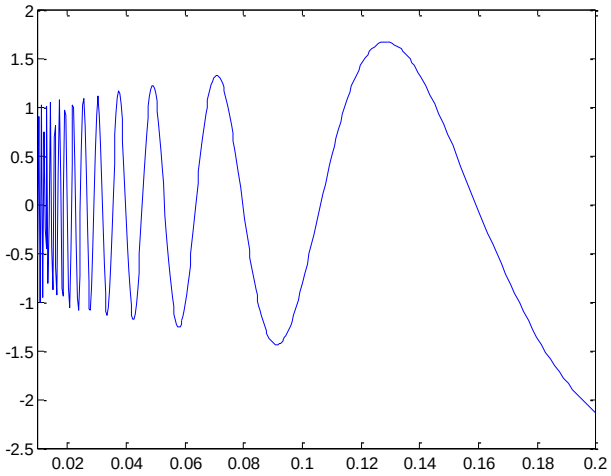
(a)

```
>> f=@(t) 8*exp(-0.25*t).*sin(t-2);
>> funcrange(f,0,6*pi,1000)


ans =
       10.791
```



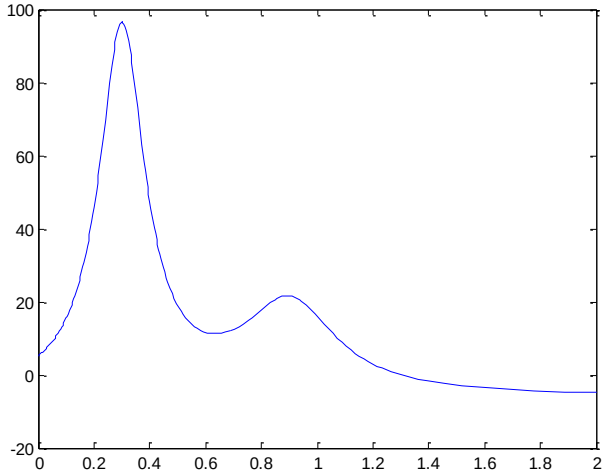
(b)

```
>> f=@(x) exp(4*x).*sin(1./x);
>> funcrange(f,0.01,0.2,1000)
ans =
    3.8018
```



(c)

```
>> funcrange(@humps,0,2,1000)
ans =
  101.3565
```



3.19

```
function yend = odesimp(dydt, dt, ti, tf, yi, varargin)
% odesimp: Euler ode solver
% yend = odesimp(dydt, dt, ti, tf, yi, varargin):
%   Euler's method solution of a single ode
% input:
%   dydt = function defining ode
%   dt = time step
%   ti = initial time
%   tf = final time
%   yi = initial value of dependent variable
% output:
%   yend = dependent variable at final time
t = ti; y = yi; h = dt;
while (1)
  if t + dt > tf, h = tf - t; end
  y = y + dydt(y,varargin{:}) * h;
  t = t + h;
  if t >= tf, break, end
end
yend = y;
```

test run:

```
>> dvdt=@(v,m,cd) 9.81-(cd/m)*v*abs(v);
>> odesimp(dvdt,0.5,0,12,-10,70,0.23)

ns =
   53.0427
```

3.20 Here is a function to solve this problem:

```
function [theta,c,mag]=vector(a,b)
amag=norm(a);
bmag=norm(b);
adotb=dot(a,b);
```

```
theta=acos(adotb/amag/bmag)*180/pi;
c=cross(a,b);
mag=norm(c);
x1=[0 a(1)];y1=[0 a(2)];z1=[0 a(3)];
x2=[0 b(1)];y2=[0 b(2)];z2=[0 b(3)];
x3=[0 c(1)];y3=[0 c(2)];z3=[0 c(3)];
x4=[0 0];y4=[0 0];z4=[0 0];
plot3(x1,y1,z1,'--b',x2,y2,z2,'--r',x3,y3,z3,'-k',x4,y4,z4,'o')
xlabel('x');ylabel('y');zlabel('z');
```

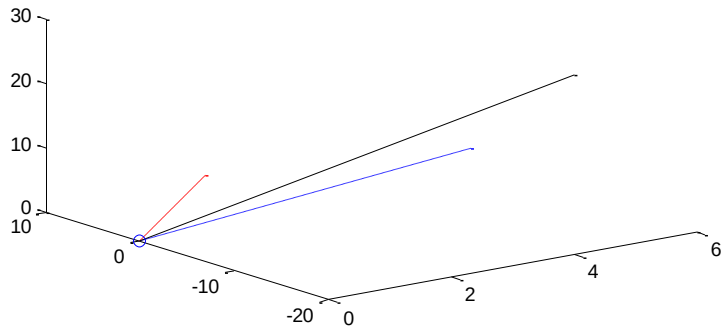
Here is a script to run the three cases:

```
b = [2 6 4]; a = [6 4 2];
[th,c,m]=vector(a,b)
pause
a = [3 2 -6]; b = [4 -3 1];
[th,c,m]=vector(a,b)
pause
a = [2 -2 1]; b = [4 2 -4];
[th,c,m]=vector(a,b)
pause
a = [-1 0 0]; b = [0 -1 0];
[th,c,m]=vector(a,b)
```

When this is run, the following output is generated:

(a)

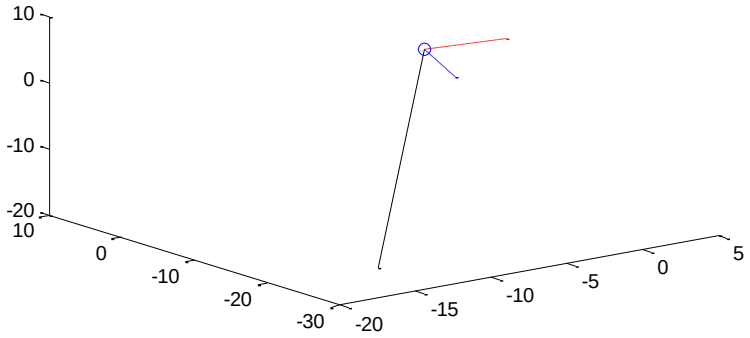
```
th =
   38.2132
c =
     4   -20    28
m =
   34.6410
```



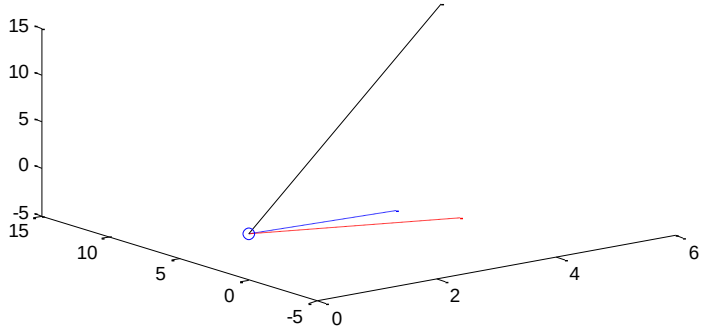
(b)

```
th =
    90
c =
```

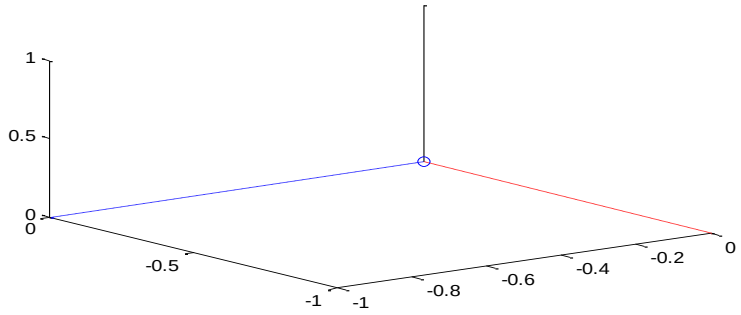
```
    -16    -27    -17
m =
    35.6931
```




```
(c)
th =
     90
c =
      6     12     12
m =
     18
```



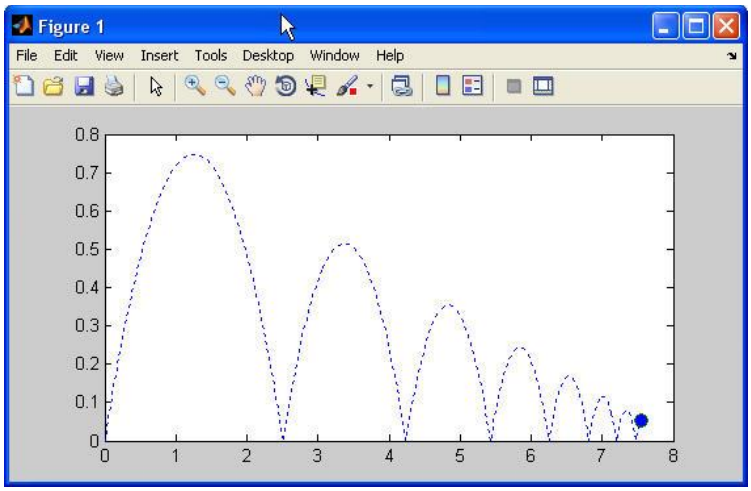

```
(d)
th =
     90
c =
      0      0      1
m =
      1
```



3.21 The script for this problem can be written as shown below:

```
clc,clf,clear
maxit=1000;
g=9.81; theta0=50*pi/180; v0=5; CR=0.83;
j=1;t(j)=0;x=0;y=0;
xx=x;yy=y;
plot(x,y,'o','MarkerFaceColor','b','MarkerSize',8)
xmax=8; axis([0 xmax 0 0.8])
M(1)=getframe;
dt=1/128;
j=1; xxx=0; iter=0;
while(1)
  tt=0;
  timpact=2*v0*sin(theta0)/g;
  ximpact=v0*cos(theta0)*timpact;
  while(1)
    j=j+1;
    h=dt;
    if tt+h>timpact,h=timpact-tt;end
    t(j)=t(j-1)+h;
    tt=tt+h;
    x=xxx+v0*cos(theta0)*tt;
    y=v0*sin(theta0)*tt-0.5*g*tt^2;
    xx=[xx x];yy=[yy y];
    plot(xx,yy,':',x,y,'o','MarkerFaceColor','b','MarkerSize',8)
    axis([0 xmax 0 0.8])
    M(j)=getframe;
    iter=iter+1;
    if tt>=timpact, break, end
  end
  v0=CR*v0;
  xxx=x;
  if x>=xmax|iter>=maxit,break,end
end
pause
clf
axis([0 xmax 0 0.8])
movie(M,1,36)
```

Here's the plot that will be generated:

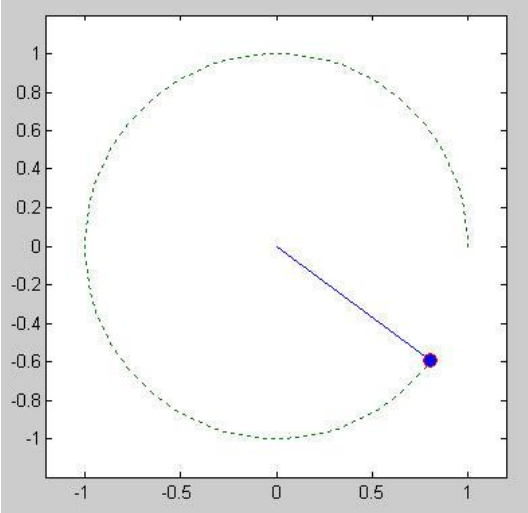


3.22 The function for this problem can be written as shown:

```
function phasor(r, nt, nm)
% function to show the orbit of a phasor
% r = radius
% nt = number of increments for theta
% nm = number of movies
clc;clf
dtheta=2*pi/nt;
th=0;
fac=1.2;
xx=r;yy=0;
for i=1:nt+1
  x=r*cos(th);y=r*sin(th);
  xx=[xx x];yy=[yy y];
  plot([0 x],[0 y],xx,yy,':',...
       x,y,'o','MarkerFaceColor','b','MarkerSize',8)
  axis([-fac*r fac*r -fac*r fac*r]);
  axis square
  M(i)=getframe;
  th=th+dtheta;
end
pause
clf
axis([-fac*r fac*r -fac*r fac*r]);
axis square
movie(M,1,36)
```

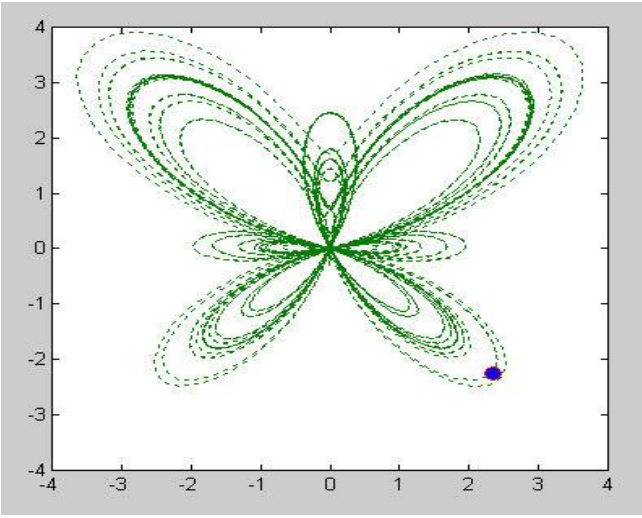
When it is run, the result is as follows:

```
>> phasor(1, 256, 10)
```



3.23 A script to solve this problem based on the parametric equations described in Prob. 2.22:

```
clc;clf
t=[0:1/16:128];
x(1)=sin(t(1)).*(exp(cos(t(1)))-2*cos(4*t(1))-sin(t(1)/12).^5);
y(1)=cos(t(1)).*(exp(cos(t(1)))-2*cos(4*t(1))-sin(t(1)/12).^5);
xx=x;yy=y;
plot(x,y,xx,yy,':',x,y,'o','MarkerFaceColor','b','MarkerSize',8)
axis([-4 4 -4 4]); axis square
M(1)=getframe;
for i = 2:length(t)
  x=sin(t(i)).*(exp(cos(t(i)))-2*cos(4*t(i))-sin(t(i)/12).^5);
  y=cos(t(i)).*(exp(cos(t(i)))-2*cos(4*t(i))-sin(t(i)/12).^5);
  xx=[xx x];yy=[yy y];

plot(x,y,xx,yy,':',x,y,'o','MarkerFaceColor','b','MarkerSize',8)
  axis([-4 4 -4 4]); axis square
  M(i)=getframe;
End
```



3.24

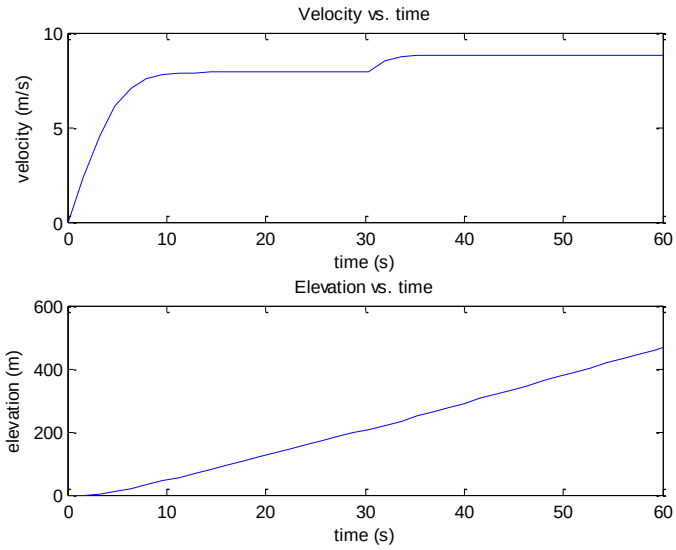
```
% YourFullName
% Hot Air Balloon Script
clear,clc,clf
global g
% set parameters
g=9.81;
r=8.65; % balloon radius
CD=0.47; % dimensionless drag coefficient
mP=265; % mass of payload
P=101300; % atmospheric pressure
Rgas=287; % Universal gas constant for dry air
TC=100; % air temperature
rhoa=1.2; % air density
zd=200; % elevation at which mass is jettisoned
md=100; % mass jettisoned
ti=0; % initial time (s)
tf=60; % final time (s)
vi=0; % initial velocity
zi=0; % initial elevation
dt=1.6; % integration time step

% precomputations
d = 2 * r; Ta = TC + 273.15; Ab = pi / 4 * d ^ 2;
Vb = pi / 6 * d ^ 3; rhog = P / Rgas / Ta; mG = Vb * rhog;
FB = Vb * rhoa * g; FG = mG * g; cdp = rhoa * Ab * CD / 2;

% compute times, velocities and elevations
[t,y] = Balloon(ti,vi,zi,tf,dt,FB,FG,mG,cdp,mP,md,zd);

% Display results
fprintf('      t(s)     v(m/s)     z(m/s)\n');
xx=[t y];
fprintf('%10.3f %10.3f %10.3f\n',xx');

% Plot results
subplot(2,1,1)
plot(t,y(:,1))
title('Velocity vs. time')
xlabel('time (s)'),ylabel('velocity (m/s)')
subplot(2,1,2)
plot(t,y(:,2))
title('Elevation vs. time')
xlabel('time (s)'),ylabel('elevation (m)')

function [tout,yout]=Balloon(ti,vi,zi,tf,dt,varargin)
% balloon
% function
[tout,yout]=Balloon(ti,vi,zi,tf,dt,FB,FG,mG,cdp,mP,md,zd)
% Function to generate solutions of vertical velocity and
elevation
% versus time with Euler's method for a hot air balloon
% Input:
```

```
% FB = buoyancy force (N)
% FG = gravity force (N)
% mG = mass (kg)
% cdp=dimensional drag coefficient
% mP= mass of payload (kg)
% md=mass jettisoned (kg)
% zd=elevation at which mass is jettisoned (m)
% ti = initial time (s)
% vi=initial velocity (m/s)
% zi=initial elevation (m)
% tf = final time (s)
% dt=integration time step (s)
% Output:
% tout = vector of times (s)
% yout[:,1] = velocities (m/s)
% yout[:,2] = elevations (m)

% Code to implement Euler's method to compute output
t = ti; y = [vi zi];
tout = t; yout = y;
while(1)
  if t + dt > tf, dt = tf - t; end
  dy=dydt(y,varargin{:});
  y = y + dy' * dt;
  t = t + dt;
  tout = [tout; t]; yout = [yout; y];
  if t >= tf, break, end
end
end

function [dy]=dydt(y,FB,FG,mG,cdp,mP,md,zd)
global g
if y(2) < zd
    mP1 = mP;
  else
    mP1 = mP - md;
  end
  dy = [(FB - FG) / (mP1 + mG) - mP1 * g / (mP1 + mG) - ...
                  cdp / (mP1 + mG) * y(1) ^ 2; y(1)];
end
```

Output:

```
      t(s)     v(m/s)     z(m/s)
     0.000      0.000      0.000
     1.600      2.352      0.000
     3.200      4.496      3.762
     4.800      6.090     10.956
     6.400      7.051     20.699
     8.000      7.539     31.981
     9.600      7.760     44.043
    11.200      7.854     56.459
    12.800      7.893     69.025
    14.400      7.909     81.655
    16.000      7.916     94.309
```

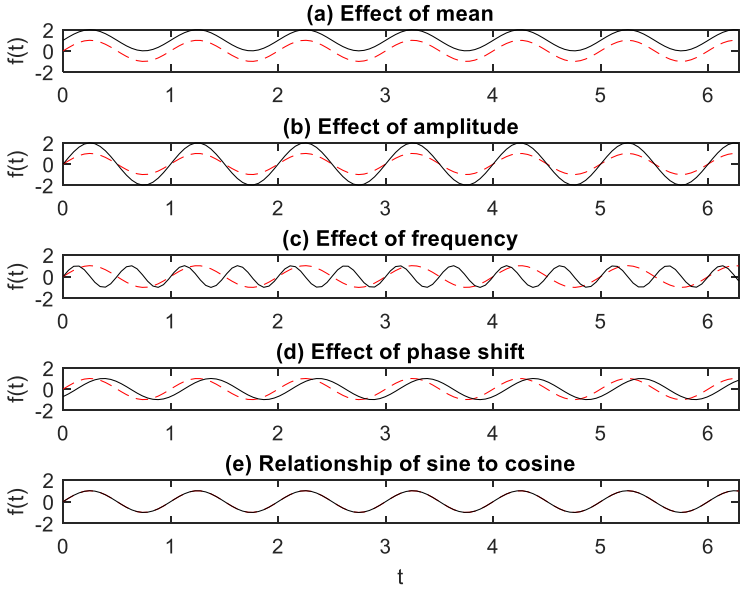
```
17.600        7.918     106.975
19.200        7.920     119.644
20.800        7.920     132.316
22.400        7.920     144.988
24.000        7.920     157.660
25.600        7.920     170.332
27.200        7.920     183.005
28.800        7.920     195.677
30.400        7.920     208.350
32.000        8.495     221.022
33.600        8.704     234.615
35.200        8.773     248.541
36.800        8.795     262.577
38.400        8.802     276.649
40.000        8.804     290.732
41.600        8.805     304.818
43.200        8.805     318.906
44.800        8.805     332.994
46.400        8.805     347.082
48.000        8.805     361.171
49.600        8.805     375.259
51.200        8.805     389.347
52.800        8.805     403.435
54.400        8.805     417.523
56.000        8.805     431.612
57.600        8.805     445.700
59.200        8.805     459.788
60.000        8.805     466.832
```



3.25

```
clc,clf
t=[0:pi/64:2*pi]; f=1;
y1=sin(2*pi*f*t); y2=1+sin(2*pi*f*t);
subplot(5,1,1)
plot(t,y1,'r--',t,y2,'k');
```

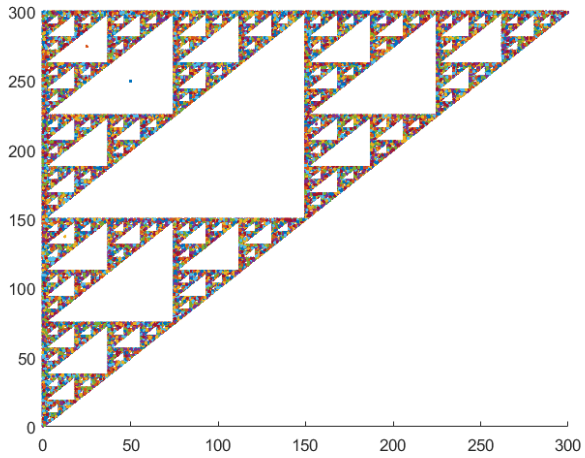
```
xlim([min(t) max(t)]),ylim([-2 2]),ylabel('f(t)')
title('(a) Effect of mean')
y3=2*sin(2*pi*f*t);
subplot(5,1,2)
plot(t,y1,'r--',t,y3,'k')
xlim([min(t) max(t)]),ylim([-2 2]),ylabel('f(t)')
title('(b) Effect of amplitude')
y4=sin(4*pi*t);
subplot(5,1,3)
plot(t,y1,'r--',t,y4,'k')
xlim([min(t) max(t)]),ylim([-2 2]),ylabel('f(t)')
title('(c) Effect of frequency')
y5=sin(2*pi*f*t-pi/4);
subplot(5,1,4)
plot(t,y1,'r--',t,y5,'k')
xlim([min(t) max(t)]),ylim([-2 2]),ylabel('f(t)')
title('(d) Effect of phase shift')
y6=cos(2*pi*f*t-pi/2);
subplot(5,1,5)
plot(t,y1,'r--',t,y6,'k')
xlim([min(t) max(t)]),ylim([-2 2]),xlabel('t'),ylabel('f(t)')
title('(e) Relationship of sine to cosine')
```



3.26

```
clear, clc
m=100;n=200;hold on
for ii=1:100000
  q=3*rand(1);
  if q<1
    m=m/2;n=n/2;
  elseif q<2
    m=m/2;n=(300+n)/2;
  else
    m=(300+m)/2;n=(300+n)/2;
```

```
  end
  if ii >= 100000, break, end
  plot(m,n,'.')
end
hold off
```



3.27

```
clc
format compact
A = [5 7 9; 1 8 4; 7 6 2];
Fn = Fnorm(A)
Fn=norm(A,'fro')
```

(a)

```
function Norm = Fnorm(x)
[m,n]=size(x);
s=0;
for i = 1:m
  for j = 1:n
    s = s + x(i,j)^2;
  end
end
Norm=sqrt(s);
```

Result:

```
Fn =
   18.0278
Fn =
   18.0278
```

(b)

```
function Norm = Fnorm(x)
Norm=sqrt(sum(sum(x.^2)));
```

Result:

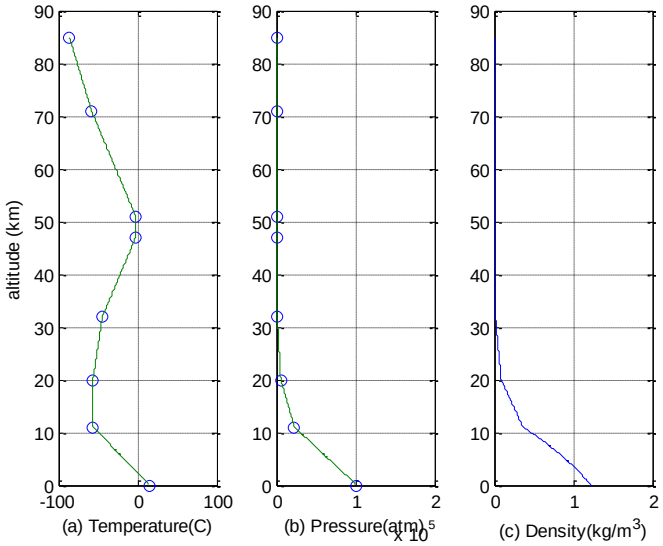
```
Fn =
   18.0278
Fn =
   18.0278
```

3.28

```
% Script to generate a plot of temperature, pressure and density
% for the International Standard Atmosphere
clc,clf
h=[0 11 20 32 47 51 71 84.852];
gamma=[-6.5 0 1 2.8 0 -2.8 -2];
T=[15 -56.5 -56.5 -44.5 -2.5 -2.5 -58.5 -86.28];
p=[101325 22632 5474.9 868.02 110.91 66.939 3.9564 0.3734];
hint=[0:0.1:84.852];
for i=1:length(hint)
  [Tint(i),pint(i),rint(i)]=StdAtm(h,T,p,gamma,hint(i));
end
subplot(1,3,1)
plot(T,h,'o',Tint,hint),grid,xlabel('(a) Temperature(C)')
ylabel('altitude (km)')
subplot(1,3,2)
plot(p,h,'o',pint,hint)
grid,xlabel('(b) Pressure(atm)')
subplot(1,3,3)
plot(rint,hint),grid,xlabel('(c) Density(kg/m^3)')
[Tint(i),pint(i),rint(i)]=StdAtm(h,T,p,gamma,85);

function [Tint,pint,rint] = StdAtm(h,T,p,gamma,hi)
R=8.3144621; M=0.0289644;
n=length(h);
if hi<h(1) || hi>h(n)
  error('Outside range')
else
  for i=1:n-1
    if hi<=h(i+1)
      Tint=T(i)+gamma(i)*(hi-h(i));
      pint=p(i)+(p(i+1)-p(i))/(h(i+1)-h(i))*(hi-h(i));
      rint=pint*M/(R*(Tint+273.15));
      break
    end
  end
end
end
```

Results:

```
Error using StdAtm (line 5)
Outside range

Error in Prob0328StdAtmScript (line 20)
[Tint(i),pint(i),rint(i)]=StdAtm(h,T,p,gamma,85);
```



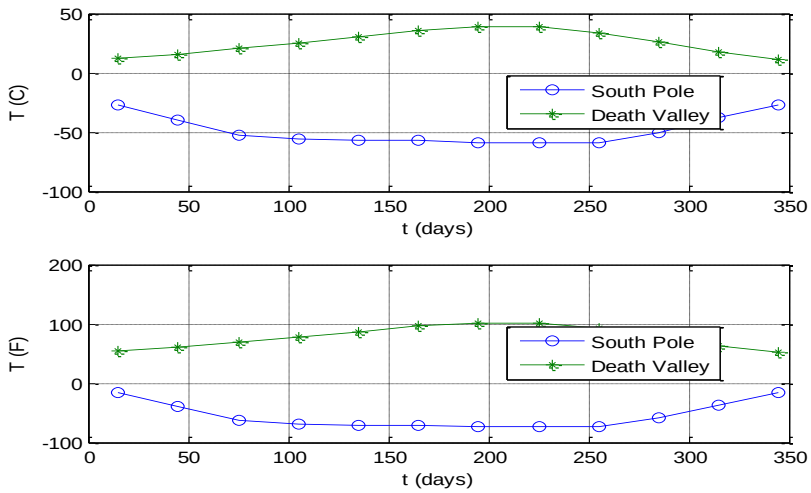
3.29

```
% Script to generate stacked plots of temperatures versus time
% for Death Valley and the South Pole with Celsius time series
% on the top plot and Fahrenheit on the bottom.

clc,clf
t=[15 45 75 105 135 165 195 225 255 285 315 345];
TFDV=[54 60 69 77 87 96 102 101 92 78 63 52];
TCSP=[-27 -40 -53 -56 -57 -57 -59 -59 -59 -50 -38 -27];
TCDV=TempConv(TFDV,'C');
TFSP=TempConv(TCSP,'F');

% Create plot
subplot(2,1,1)
plot(t,TCSP,'o-',t,TCDV,'*-'),grid,xlabel('t (days)')
ylabel('T (C)'), legend('South Pole','Death
Valley','location','best')
subplot(2,1,2)
plot(t,TFSP,'o-',t,TFDV,'*-'),grid,xlabel('t (days)')
ylabel('T (F)'), legend('South Pole','Death
Valley','location','best')

% Test of error trap
TKSP=TempConv(TCSP,'K');

function [Teout] = TempConv(Tein,Unit)

% temperature conversion Celsius Fahrenheit
% Teout = TempConv(Tein,Unit)
% Input:
%   Tein = vector of input temperature
%   Unit = desired unit of output temperature
%         ('C' for Celsius & 'F' for Fahreheit.
```

```
% Output:
%   Teout = vector of output temperatures

if Unit == 'C'
  Teout=5/9*(Tein-32);
elseif Unit == 'F'
  Teout=9/5*Tein+32;
else
  error('Unit must be either ''C'' or ''F'' ')
end

end
```

Results:

```
Error using TempConv (line 17)
Unit must be either 'C' or 'F'

Error in Prob0329TempConvScript (line 21)
TKSP=TempConv(TCSP,'K');
```



3.30

```
clc
U=['psi' 'atm' 'inHg' 'kg/cm2' 'inH2O' 'Pa' 'bar' 'dyne/cm2' 'ftH2O'
...
   'mmHg' 'torr' 'ksi']';
C=[6894.76 101325 3376.85 98066.5 248.843 1 100000 0.1 2988.98 ...
   133.322 133.322 6894760]';
while(1)
  while(1)
    disp(sprintf('\nPressure units available
are:\n\n1)psi\t2)atm\t3)inHg\t4)
kg/cm2\n5)inH2O\t6)Pa\t7)bar\t8)dyne/cm2\n9)ftH2O\t10)mmHg\t11)torr\t
12)ksi\n'))
    i=input('Input unit:');
    if i >= 1 && i <= 12, break, end
```

```
    disp(sprintf('\nEntry must be from 1 to 12 -- please re-enter
value\n'))
  end
  Pg=input('\nInput pressure:');
  while(1)
    while(1)
      disp(sprintf('\nPressure units available
are:\n\n1)psi\t2)atm\t3)inHg\t4)
kg/cm2\n5)inH2O\t6)Pa\t7)bar\t8)dyne/cm2\n9)ftH2O\t10)mmHg\t11)torr\t
12)ksi\n'))
      j=input('Desired unit:');
      if j >= 1 && j <= 12, break, end
      disp(sprintf('\nEntry must be from 1 to 12 -- please re-enter
value\n'))
    end
    Pd = C(j) / C(i) * Pg
    q=input('\nAnother choice of output units (y or n)?','s');
    if q == 'n', break, end
  end
  q=input('\nConvert another pressure (y or n)?','s');
  if q == 'n', break, end
end
```

(a) Duplicate the hand calculation example to ensure that you get about 420.304 atm for an input of 28.6 psi.

Results:

(a)

```
Pressure units available are:
1)psi      2)atm      3)inHg          4)kg/cm2
5)inH2O    6)Pa       7)bar      8)dyne/cm2
9)ftH2O    10)mmHg    11)torr    12)ksi
Input unit:1
Input pressure:28.6
Pressure units available are:
1)psi      2)atm      3)inHg          4)kg/cm2
5)inH2O    6)Pa       7)bar      8)dyne/cm2
9)ftH2O    10)mmHg    11)torr    12)ksi
Desired unit:2
Pd =
  420.3040
```

(b)

```
Desired unit:13
Entry must be from 1 to 12 -- please re-enter value
Pressure units available are:
1)psi      2)atm      3)inHg          4)kg/cm2
5)inH2O    6)Pa       7)bar      8)dyne/cm2
9)ftH2O    10)mmHg    11)torr    12)ksi
```

```
Desired unit:Q
Error using input
Undefined function or variable 'Q'.
Error in Prob033OPressConvScript (line 27)
      j=input('Desired unit:');
Desired unit:
```