Sample Solutions for

A Concise Introduction to MATLAB

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From Chapter 1

Problem 1.11 The ideal gas law gives

$$\frac{T}{V} = \frac{P}{nR} = \text{ constant}$$

Thus $T_1/V_1 = T_2/V_2$, or $V_2 = V_1 T_2/T_1$. The session is:

```
>>V1 = 28500;T1 = 273.2 - 15;T2 = 273.2 + 31;
>>V2 = V1*T2/T1
V2 =
   3.3577e+4
```

The volume is 3.3577×10^4 ft^3.

Problem 1.24 The session is

```
≫r = 10;
≫phi = [0:0.01:4*pi];
≫x = r*(phi-sin(phi));
≫y = r*(1-cos(phi));
≫plot(x,y),xlabel('x'),ylabel('y')
```

The plot is shown in the figure.

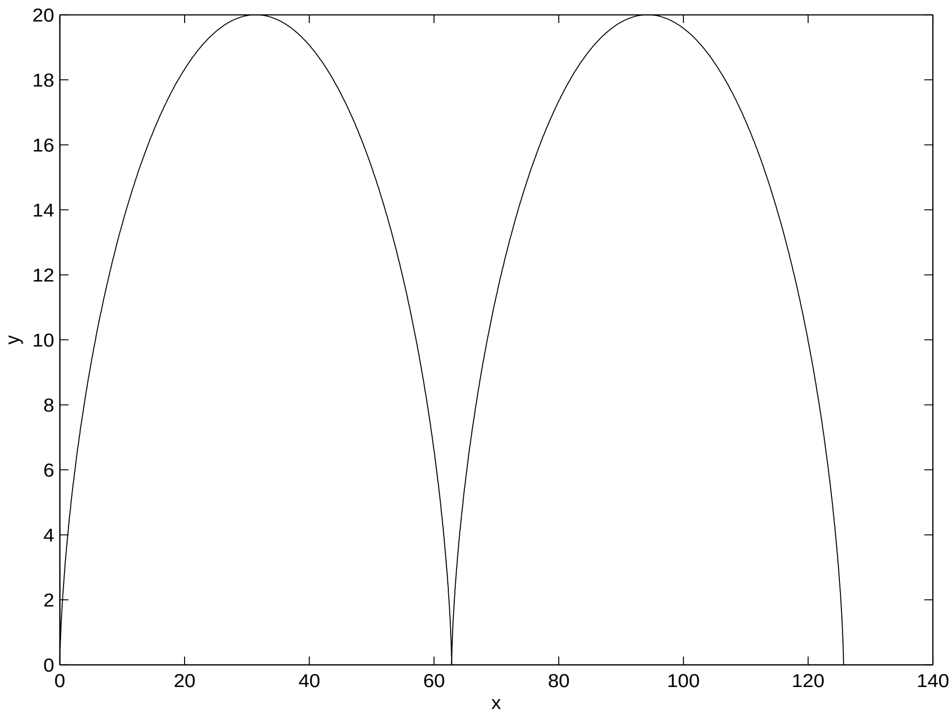

Figure : for Problem 1.24

From Chapter 2

Problem 2.14 The session is

```
≫F = [400,550,700,500,600]; D = [2,0.5,0.75,1.5,3];
≫W = F.*D
W =
   800 275 525 750 1800
≫Total_Work = sum(W)
Total_Work =
   4150
```

The work done on each segment is 800, 275, 750, and 1800 joules, respectively. (1 joule = 1 N·m.) The total work done is 4150 joules.

Problem 2.16 The session is

```
≫wage = [5,5.5,6.5,6,6.25]; hours = [40,43,37,50,45];
≫output = [1000,1100,1000,1200,1100];
≫earnings = wage.*hours
earnings =
  200.0000   236.5000   240.5000   300.0000   281.2500
≫total_salary = sum(earnings)
total_salary =
  1.2582e+003
≫total_widgets = sum(output)
total_widgets =
  5400
≫average_cost = total_salary/total_widgets
average_cost =
  0.2330
≫average_hours = sum(hours)/total_widgets
average_hours =
  0.0398
≫[maximum,most_efficient] = max(output./earnings)
maximum =
  5
most_efficient =
  1
≫[minimum,least_efficient] = min(output./earnings)
minimum =
  3.9111
least_efficient =
  5
```

The workers earned \$200, \$236.50, \$240.50, \$300, and \$281.25 respectively. The total salary paid out was \$1258.20, and 5400 widgets were made. The average cost to produce one widget was 23.3 cents, and it took an average of 0.0398 hr to produce one widget. The first worker, who produced 5 widgets per dollar of earnings, was the most efficient. The fifth worker, who produced 3.911 widgets per dollar of earnings, was the least efficient.

From Chapter 3

Problem 3.10 The function file is

```
function t = time(h,v0,g)
% Computes time t to reach a specified height h, with initial speed v0.
t = roots([0.5*g,-v0,h])
```

A test session follows.

```
≫time(100,50,9.81)
t =
  7.4612
  2.7324
```

The smaller value is the time to reach the height while ascending; the larger value is the time to reach the height while descending.

From Chapter 4

Problem 4.10 The script file is

```
price = [19,18,22,21,25,19,17,21,27,29];
cost_new_shares = 100*sum(price.*(price<20))
income_selling = 100*sum(price.*(price>25))
shares_change = 100*(sum(price<20)-sum(price>25));
total_shares = 1000 + shares_change
net_increase = price(10)*total_shares - price(1)*1000
```

The results are: `cost_new_shares = 7300`, `income_selling = 5600`, `total_shares = 1200`, and `net_increase = 15800`. Thus you spent $7300 in buying shares. You received $5600 from the sale of shares. After the tenth day you own 1200 shares. The net increase in the worth of your portfolio is $15,800.

Problem 4.31 The script file is

```
amount = 10000;
k = 0;
while amount < 1e+6
  k = k+1;
  amount = amount*1.06 +10000;
end
amount
k
```

The result is `amount = 1.0418e+006` and `k = 33`. Thus, after 33 years, the amount will be $1,041,800.

From Chapter 5

Problem 5.8(a) The y component of the vessel is $y = 0.5t^2 + 10$. A thousand points is enough to generate an accurate plot, so we choose a time increment of 0.01. The script file is

```
t = [0:0.01:10];
x = t; y = 0.5*t.^2 + 10;
yb = 2*x+6;
plot(x,y,x,yb),xlabel('x (mi)'),ylabel('y (mi)'), ...
   gtext('Boundary'),gtext('Vessel')
```

The plot is shown in the figure.

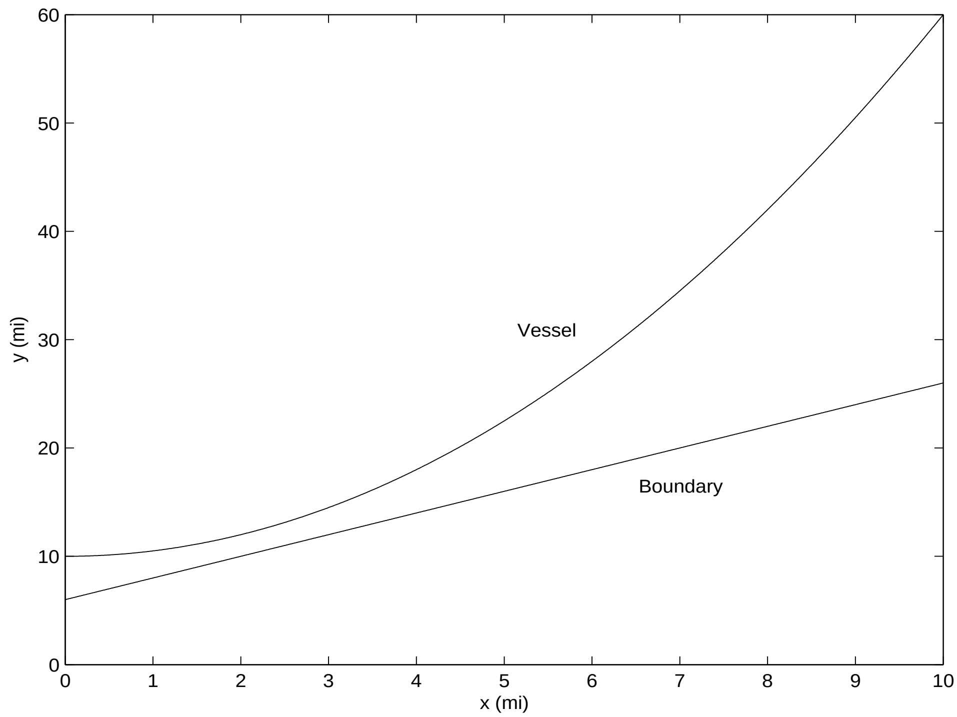

Figure : for Problem 5.8a.

From Chapter 6

Problem 6.11 The mean and standard deviation of the part weight are $\mu = 1$ and $\sigma = 0.2$.

(a) Because the pallet weight is the sum of the part weights, the mean and variance of the pallet weight are given by $\mu_p = 10(300)\mu = 3000$ lb, and $\sigma_p^2 = 10(300)\sigma^2 = 120$. Thus $\sigma_p = \sqrt{120} = 10.95$ lb.

(b) From equation (6.2-2), the probability that the pallet weight W exceeds 3015 lb is given by

$$P(W > 3015) = 1 - P(W \leq 3015) = 1 - \frac{1}{2}\left[1 + \text{erf}\left(\frac{3015 - 3000}{\sqrt{120}\sqrt{2}}\right)\right]$$

The MATLAB session to evaluate this is

```
≫P = 1-(1+erf(15/(sqrt(240))))/2
P =
   0.0855
```

The probability is 0.0855. Thus the pallet weight will exceed 3015 lb 8.55% of the time.

From Chapter 7

Problem 7.10 Note that $m(t) = 2200(1 - 0.8t/40)$ and that

$$\frac{dv}{dt} = \frac{T}{m(t)} - g$$

Integrate both sides of this equation to obtain

$$v(40) = \int_0^{40} \frac{T}{m(t)}\,dt - 40g = \int_0^{40} \frac{48000}{2200(1-0.8t/40)}\,dt - 40g$$

or

$$v(40) = \int_0^{40} \frac{240}{11(1-0.02t)}\,dt - 40(9.81)$$

The MATLAB session is

```
>>quad('240./(11*(1-0.02*t))',0,40)-40*9.81
ans =
   1.3634e+003
```

The velocity at burnout is 1363.4 m/s.

Problem 7.33 The state variable form, with $x_1 = y$ and $x_2 = \dot{y}$, is

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -x_1 + \mu(1 - x_1^2)x_2 = -x_1 + (1 - x_1^2)x_2$$

since $\mu = 1$. First create the following function file:

```
function xdot = vanderp(t,x)
xdot(1) = x(2);
xdot(2) = (1-x(1)^2)*x(2) - x(1);
xdot = [xdot(1);xdot(2)];
```

Then use the following script file to solve the equation and plot x_1, which is the same as y.

```
[t, x] = ode45('vanderp', [0, 20], [2, 0]);
plot(t,x(:,1)),xlabel('t'),ylabel('y(t)')
```

The plot is shown in the figure.

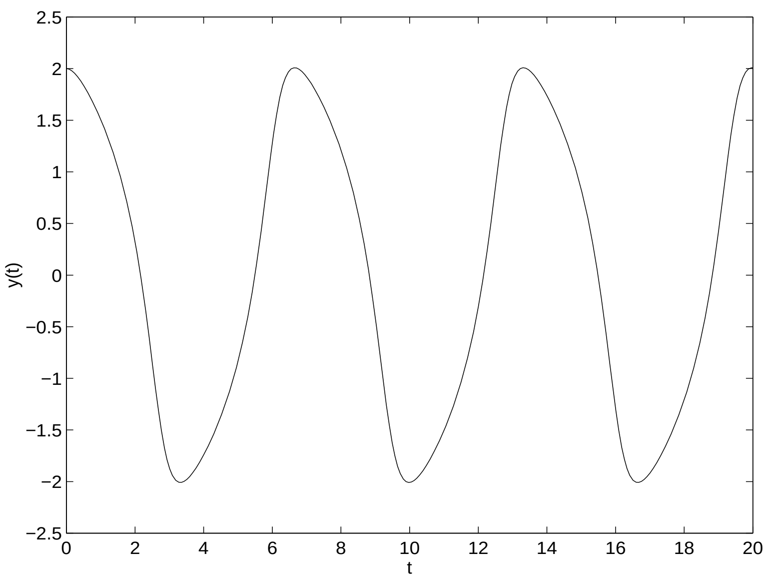

Figure : for Problem 7.33

From Chapter 8

Problem 8.17 The distance d is given by

$$d = \sqrt{h^2 + 30^2}$$

Note also that $\sin\theta = h/d$. Substitute these expressions into the equation for B to obtain

$$B = \frac{c}{h^2 + 30^2} \frac{h}{\sqrt{h^2 + 30^2}} = \frac{ch}{(h^2 + 30^2)^{3/2}}$$

To maximize B, solve the equation $dB/dh = 0$. The session is:

```
≫syms c h
≫B = c*h/((h^2+30^2)^(3/2));
≫dBdh = diff(B,h);
≫hsoln = solve(dBdh,h)
hsoln =
[ 15*2^(1/2) ]
[-15*2^(1/2) ]
```

Because the height h cannot be negative, we choose the positive solution: $h = 15\sqrt{2} = 21.2$ ft. The session to check the second derivative is:

```
≫d2Bdh2 = diff(dBdh,h);
≫second_der = subs(d2Bdh2,h,hsoln(1))
second_der =
-1/41006250*c*1350^(1/2)*2^(1/2)
```

Because the second derivative is negative, the solution $h = 15\sqrt{2}$ gives a relative maximum.

The angle θ is given by

$$\theta = \sin^{-1}\left(\frac{h}{\sqrt{h^2 + 30^2}}\right)$$

Continue the session as follows to compute θ.

```
≫h = hsoln(1)
≫theta = double(asin(h/sqrt(h^2+30^2)))
theta =
   0.6155
```

Thus $\theta = 0.6155$ rad ($35.26°$).

Problem 8.18 The equation of motion becomes

$$100\frac{dv}{dt} = 500(2 - e^{-t}\sin 5\pi t)$$

or

$$\frac{dv}{dt} = 10 - 5e^{-t}\sin 5\pi t$$

The solution is given by

$$v(5) = \int_0^5 \left(10 - 5e^{-t}\sin 5\pi t\right)\, dt = 50 - 5\int_0^5 e^{-t}\sin 5\pi t\, dt$$

The session to evaluate this equation is:

```
>>syms t
>>f = exp(-t)*sin(5*pi*t);
>>v = double(50-5*int(f,0,5))
v =
   49.6808
```

Thus the velocity at $t = 5$ s is 49.6808 m/s.