Solutions to end-of-chapter problems

***Basics of Engineering Economy*, 2nd edition**

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Chapter 2
Factors: How Time and Interest Affect Money

2.1 (a) (F/P,10%,20) = 6.7275
(b) (A/F,4%,8) = 0.10853
(c) (P/A,8%,20) = 9.8181
(d) (A/P,20%,28) = 0.20122
(e) (F/A,30%,15) = 167.2863

2.2 P = 30,000(P/F,10%,8)
= 30,000(0.4665)
= $13,995

2.3 F = 15,000(F/P,6%,25)
= 15,000(4.2919)
= 64,378.50

2.4 (a) F = 885,000 + 100,000(F/P,10%,3)
= 885,000 + 100,000(1.3310)
= $1,018,000

(b) Spreadsheet function is = -FV(10%,3,,100000) + 885000
Display is $1,018,000

2.5 (a) P = 19,000(P/F,10%,7)
= 19,000(0.5132)
= $9750.80

(b) If the calculator function is PV(10,7,0,19000), display is P = $-9750.00

(c) If the spreadsheet function is = -PV(10%,7,,19000), display is $9750.00

2.6 (a) Total for 7 lots is 7(120,000) = $840,000
P = 840,000(P/F,10%,2)
= 840,000(0.8264)
= $694,176

(b) If the calculator function is PV(10,2,0,840000), display is P = $-694,214.88

(c) If the spreadsheet function is = -PV(10%,2,,840000), display is $694,214.88

2.7 (a) F = 3000(F/P,10%,12) + 5000(F/P,10%,8)
= 3000(3.1384) + 5000(2.1436)
= $20,133.20

(b) Sum two calculator functions
FV(10,12,,-3000) + FV(10,8,-5000)
9,415.29 + 10,717.94 = $20,133.23

(c) If the spreadsheet function is = – FV(10%,12,,3000) – FV(10%,8,,5000), the display is $20,133.23

2.8 (a) P = 30,000,000(P/F,10%,5) – 15,000,000
= 30,000,000(0.6209) – 15,000,000
= $3,627,000

(b) If the spreadsheet function is = -PV(10%,5,,30000000) – 15,000000, the display is $3,627,640

The increased decimal accuracy of a spreadsheet function indicates an increased the required amount of $640.

2.9 F = 280,000(F/P,12%,2)
= 280,000(1.2544)
= $351,232

2.10 A = 12,700,000(A/P,20%,8)
= 12,700,000(0.26061)
= $3,309,747

2.11 P = 6000(P/A,10%,10)
= 6000(6.1446)
= $36,867.60

2.12 (a) A = 60,000(A/P,8%,5)
= 60,000(0.25406)
= $15,027.60

(b) If calculator function is PMT(8,5,-60000,0), the answer is $15,027.39

(c) A spreadsheet function of = -PMT(8%,5,60000) displays $15,027.39

2.13 A = 20,000,000(A/P,10%,6)
= 20,000,000(0.22961)
= $4,592,200

2.14 A = 50,000(A/F,20%,3)
= 50,000(0.27473)
= $13,736.50

2.15 (a) 17,000,000(A/P,i,8) = 2,737,680
(A/P,i,8) = 0.16104
From interest tables at n = 8, i = 6% per year

(b) Calculator function is i(8,-2737680,17000000,0) to obtain i = 6.00%

(c) If the spreadsheet function is = RATE(8,-2737680,17000000), display is 6.00%

2.16 (a) A = 3,000,000(10)(A/P,8%,10)
= 30,000,000(0.14903)
= $4,470,900

(b) If calculator function is PMT(8,10,-30000000,0), the answer is $4,470,884.66

(c) If the spreadsheet function is = -PMT(8%,10,30000000), display is A = $4,470,884.66

2.17 P = 1,400,000(F/P,7%,4)
=1,400,000(1.3108)
= $1,835,120

2.18 P = 600,000(P/F,12%,4)
= 600,000(0.6355)
= $381,300

2.19 (a) A = 225,000(A/P,15%,4)
= 225,000(0.35027)
= $78,811

(b) Recall amount = 78,811/0.10
= $788,110 per year

2.20 P = 100,000((P/F,12%,2)
= 100,000(0.7972)
= $79,720

2.21 F = 65,000(F/P,4%,5)
= 65,000(1.2167)
= $79,086

2.22 P = (280,000-90,000)(P/A,10%,5)
= 190,000(3.7908)
= $720,252

2.23 F = 649(F/P,8%,2)
= 649(1.1664)
= $757

2.24 The value of the system is the interest saved on $20 million for 2 years.

F = 20,000,000(F/P,8%,2)
= 20,000,000(1.1664)
= $23,328,000

Interest = 23,328,000 - 20,000,000
= $3,328,000

2.25 P = 2,100,000(P/F,10%,2)
= 2,100,000(0.8264)
= $1,735,440

2.26 P = 40,000(P/F,12%,4)
= 40,000(0.6355)
= $25,420

2.27 (a) A = 850,000(A/F,18%,5)
= 850,000(0.13978)
= $118,813

(b) Spreadsheet function = PMT(18%,5,,850000) results in a minus sign.

2.28 P = 95,000,000(P/F,12%,3)
= 95,000,000(0.7118)
= $67,621,000

2.29 F = 375,000(F/P,10%,6)
= 375,000(1.7716)
= $664,350

2.30 F = 150,000(F/P,8%,8)
= 150,000(1.8509)

= $277,635

2.31 (a) P = 7000(P/F,10%,2) + 9000(P/F,10%,4) + 15,000(P/F,10%,5)
= 7000(0.8264) + 9000(0.6830) + 15,000(0.6209)
= $21,245.30

(b) Three calculator functions are added.

-PV(10,2,0,7000) – PV(10,4,0,9000) – PV(10,5,0,15000)
Total is 5785.12 + 6147.12 + 9313,82 = $21,246.06

2.32 P = 600,000(0.10)(P/F,10%,2) + 1,350,000(0.10)(P/F,10%,5)
= 60,000(0.8264) + 135,000(0.6209)
= $133,406

2.33 P = 8,000,000(P/A,10%,5)
= 8,000,000(3.7908)
= $30,326,400

2.34 A = 10,000,000(A/P,10%,10)
= 10,000,000(0.16275)
= $1,627,500

2.35 A = 140,000(4000)(A/P,10%,4)
= 560,000,000(0.31547)
= $176,663,200

2.36 P = 1,500,000(P/A,8%,4)
= 1,500,000(3.3121)
= $4,968,150

2.37 A = 3,250,000(A/P,15%,6)
= 3,250,000(0.26424)
= $858,780

2.38 P = 280,000(P/A,18%,8)
= 280,000(4.0776)
= $1,141,728

2.39 A = 3,500,000(A/P,25%,5)
= 3,500,000(0.37185)
= $1,301,475

2.40 A = 5000(7)(A/P,10%,10)
= 35,000(0.16275)
= $5696.25

2.41 (a) F = 70,000(F/P,12%,6) + 90,000(F/P,12%,4)
= 70,000(1.9738) + 90,000(1.5735)
= $279,781

(b) Spreadsheet function is = - FV(12%,6,0,70000) – FV(12%,4,0,90000) to obtain $279,784.33

2.42 F = (458-360)(0.90)(20,000)(P/A,10%,5)
= 1,764,000(3.7908)
= $6,686,971

2.43 (a) Let CF_4 be the amount in year 4
100,000(F/P,9%,3) + 75,000(F/P,9%,2) + CF_4(F/P,9%,1) = 290,000
100,000(1.2950) + 75,000(1.1881) + CF_4(1.0900) = 290,000
(1.09)CF_4 = 71.392.50
CF_4 = $65,497.71

(b) F in year 5 for 2 known amounts
= -FV(9%,3,0,100000) - FV(9%,2,0,75000)

P in year 4 of $290,000 minus amount above (assume it's in cell H9)
= -PV(9%,1,0,290000-H9)

Answer is $65,495.05

2.44 P = 225,000(P/A,15%,3)
= 225,000(2.2832)
= $513,720

2.45 400,000 = 50,000(F/A,12%,n)
(F/A,12%,n) = 8.0000

From 12% interest table, n is between 5 and 6 years. Therefore, n = 6

2.46 F = P(F/P,10%,n)
3P = P(F/P,10%,n)
(F/P,10%,n) = 3.000

From 10% interest tables, n is between 11 and 12 years. Therefore, n = 12 years

2.47 (a) 1,200,000 = 400,000(F/P,10%,n) + 50,000(F/A,10%,n)

Solve for n by trial and error:

Try n = 5: 400,000(F/P,10%,5) + 50,000(F/A,10%,5)

400,000(1.6105) + 50,000(6.1051)
949,455 < 1,200,000 n too low

Try n = 8: 400,000(2.1436) + 50,000(11.4359)
1,429,235 > 1,200,000 n too high
By continued interpolation, n is between 6 and 7. Therefore, n = 7 years

(b) Spreadsheet function = NPER(10%,-50000,-400000,1200000) displays 6.67

2.48 2,000,000(F/P,7%,n) = 158,000(F/A,7%,n)

Solve for n by trial and error (in $ thousands):

Try n = 30: 2,000,000(F/P,7%,30) = 158,000(F/A,7%,30)
2,000,000(7.6123) = 158,000(94.4608)
15,224,600 > 14,924,806 n too low

Try n = 32: 2,000,000(8.7153) = 158,000(110.2182)
17,430,600 > 17,414,476 n too low

Try n = 33: 2,000,000(9.3253) = 158,000(118.9334)
18,650,600 < 18,791,447 n too high

By interpolation, n is between 32 and 33, and close to 32 years.

Spreadsheet function is = NPER(7%,-158000,2000000) to display 32.1 years

2.49 (a) P = 26,000(P/A,10%,5) + 2000(P/G,10%,5)
= 26,000(3.7908) + 2000(6.8618)
= $112,284

(b) Spreadsheet: enter each annual cost in adjacent cells and use the NPV function to display P = $112,284

Calculators have no function for gradients; use the PV function on each cash flow and add the five P values to get $112,284.55

2.50 A = 72,000 + 1000(A/G,8%,5)
= 72,000 + 1000(1.8465)
= $73,846

2.51 (a) 84,000 = 15,000 + G(A/G,10%,5)
84,000 = 15,000 + G(1.8101)
G = $38,119

(b) The annual increase of over $38,000 is substantially larger than the first-year

cost of $15,000

2.52 A = 9000 – 560(A/G,10%,5)
= 9000 – 560(1.8101)
= $7986

2.53 14,000 = 8000(P/A,10%,4) – G(P/G,10%,4)
14,000 = 8000(3.1699) – G(4.3781)
G = $2594.55

2.54 P = 20,000(P/A,10%,10) + 2000(P/G,10%,10)
= 20,000(6.1446) + 2000(22.8913)
= $168,675

2.55 A = 100,000 + 10,000(A/G,10%,5)
= 100,000 + 10,000(1.8101)
= $118,101

F = 118,101(F/A,10%,5)
= 118,101(6.1051)
= $721,018

2.56 P = 0.50(P/A,10%,5) + 0.10(P/G,10%,5)
= 0.50(3.7908) + 0.10(6.8618)
= $2.58

2.57 (a) Income = 390,000 – 2(15,000)
= $360,000

(b) A = 390,000 - 15,000(A/G,10%,5)
= 390,000 - 15,000(1.8101)
= $362,848.50

2.58 475,000 = 25,000(P/A,10%,6) + G(P/G,10%,6)
475,000 = 25,000(4.3553) + G(9.6842)
9.6842G = 366,117.50
G = $37,805.65

2.59 Factors: First find P and then convert to F
P = 1,000,000(P/A,10%,5) + 200,000(P/G,10%,5)
= 1,000,000(3.7908) + 200,000(6.8618)
= $5,163,160

F = 5,163,160(F/P,10%,5)
= 5,613,160(1.6105)
= $8,315,269

Spreadsheet: Enter gradient series in cells, e.g., B2 through B6; use FV function with embedded NPV function = -FV(10%,5,,NPV(10%,B2:B6)) to display $8,315,300

2.60 Convert F to A or P and then plug values into A/G or P/G equation. Using A:

$$A = 500,000(A/F,10\%,10)$$
$$= 500,000(0.06275)$$
$$= \$31,375$$

$$31,375 = 20,000 + G(A/G,10\%,10)$$
$$31,375 = 20,000 + G(3.7255)$$
$$G = \$3053.28$$

2.61 $$A = 7,000,000 - 500,000(A/G,10\%,5)$$
$$= 7,000,000 - 500,000(1.8101)$$
$$= \$6,094,950$$

2.62 First find P and then convert to F

$$P = 300,000(P/A,10\%,5) - 25,000(P/G,10\%,5)$$
$$= 300,000(3.7908) - 25,000(6.8618)$$
$$= \$965,695$$

$$F = 965,695(F/P,10\%,5)$$
$$= 965,695(1.6105)$$
$$= \$1,555,252$$

2.63 $$P = 950,000(800)(P/A,10\%,5) + 950,000(800)(0.15)(P/G,10\%,5)$$
$$= 760,000,000(3.7908) + 142,500(800)(6.8618)$$
$$= \$3,663,253,200$$

$$F = 3,663,253,200\ (F/P,10\%,5)$$
$$= 3,663,253,200\ (1.6105)$$
$$= \$5,899,669,279$$

2.64 $$P = (23,000)\ \frac{1 - (1.02/1.10)^5}{(0.10 - 0.02)}$$
$$= \$90,405$$

2.65 Find present worth of geometric gradient, then F after 20 years

$$P = (0.12)(60,000)\ \frac{1 - (1.04/1.07)^{20}}{(0.07 - 0.04)}$$
$$= \$104,105.31$$

F = 104,105.31(F/P,7%,20)
= 104,105.31(3.8697)
= $402,856

2.66 $P = 900[1 - (1.10/1.08)^{10}]/(0.08 - 0.10)$
= $9063.21

In present worth terms, the $11,000 extra cost is not fully recovered by the savings.

2.67 First find P and then convert to A. (in million-people units)

$P = 15,000(10)[1 - (1.15/1.08)^5]/(0.08 - 0.15)$
= $790,491,225,000

A = 790,491,225,000(A/P,8%,5)
= 790,491,225,000(0.25046)
= $197.986 billion (spreadsheet answer is $197,983,629,604)

2.68 First find P and then convert to A

P = 8000[10/(1 + 0.10)]
= $72,727

A = 72,727(A/P,10%,10)
= 72,727(0.16275)
= $11,836

2.69 Solve for A_1 in geometric gradient equation

$65,000 = A_1[1 - (1.08/1.10)^3]/(0.10 - 0.08)$
$2.67799A_1 = 65,000$
$A_1 = \$24,272$

2.70 Solve for P in geometric gradient equation and then convert to A
$A_1 = 5,000,000(0.01) = 50,000$

$P = 50,000[1 - (1.10/1.08)^5]/(0.08 - 0.10)$
= $240,215

A = 240,215(A/P,8%,5)
= 240,215(0.25046)
= $60,164

2.71 First find P and then convert to F

$P = 5000[1 - (1.15/1.10)^{12}]/(0.10 - 0.15)$
$= \$70,475.50$

$F = 70,475.50(F/P,10\%,12)$
$= 70,475.50(3.1384)$
$= \$221,180$

2.72 (a) $80,000 = A_1[1 - (0.92/1.10)^{10}]/(0.10 + 0.08)$
$4.6251\ A_1 = 80,000$
$A_1 = \$17,297$

(b) Read Section A.4 first. Enter series into cells with any starting value for year 1. Use the NPV function to determine P. In Goal Seek, set the NPV cell equal to 80,000; designate the changing cell at the cell with the starting value in year 1. When OK is entered, the display is $17,297

2.73 Solve for A_1 in geometric gradient equation and then find cost in year 3

$400,000 = A_1[1 - (1.04/1.10)^5]/(0.10 - 0.04)$
$4.0759\ A_1 = 400,000$
$A_1 = \$98,138$

Cost in year $3 = 98,138(1.04)^2$
$= \$106,146$

2.74 Solve for A_1 in geometric gradient equation

$900,000 = A_1[1 - (1.05/1.15)^5]/(0.15 - 0.05)$
$3.65462A_1 = 900,000$
$A_1 = \$246,263$

2.75 First find P and then convert to F

$P = 5000[1 - (0.95/1.08)^5]/(0.08 + 0.05)$
$= \$18,207$

$F = 18,207(F/P,8\%,5)$
$= 18,207(1.4693)$
$= \$26,751$

2.76 Since 4th deposit is known to be $1250, increase it by 5% each year to year one

$A_1 = 1250/(0.95)^3$
$= \$1457.94$

2.77 P = 60,000 + 40,000(P/A,10%,3)
= 60,000 + 40,000(2.4869)
= $159,476

2.78 F = 8000(F/A,10%,5)
= 8000(6.1051)
= $48,841

2.79 F = 200,000(F/A,10%,6)
= 200,000(7.7156)
= $1,543,120

2.80 P = 97,000(P/A,10%,4)(P/F,10%,1)
= 97,000(3.1699)(0.9091)
= $279,530

2.81 F in year 17 = 5000(F/A,8%,18)
= 5000(37.4502)
= $187,251

Use this F value as a present worth to calculate A for the next 5 years

A = 187,251(A/P,8%,5)
= 187,251(0.25046)
= $46,899

2.82 F in year 8 = 100(F/A,10%,3)(F/P,10%,6) + 200(F/A,10%,4)(F/P,10%,2)
= 100(3.3100)(1.7716) + 200(4.6410)(1.21)
= $1709.52

2.83 (a) F = (62,000,000/10)(F/A,8%,10)(F/P,8%,2) + (9,000,000/2)(F/A,8%,2)
= 6,200,000(14.4866)(1.1664) + 4,500,000(2.08)
= $114,122,456

(b) Calculator functions are FV(8,2,0,FV(8,10,6200000) + FV(8,2,4500000)

2.84 (a) 1. For $5000 in year 0, find A in years 1-9
A_1 = 5000(A/P,10%,9)
= 5000(0.17364)
= $868.20

2. For $4000 in years 1-9, the A is
A_2 = $4000

3. For the extra $1000 in years 5-9, convert to A in years 1-9

$A_3 = 1000(F/A,10\%,5)(A/F,10\%,9)$
$= 1000(6.1051)(0.07364)$
$= \$449.58$

Total $A = A_1 + A_2 + A_3$
$= 868.20 + 4000 + 449.58$
$= \$5318$

(b)

	A	B
1	Year	Cash flow, $
2	0	5000
3	1	4000
4	2	4000
5	3	4000
6	4	4000
7	5	5000
8	6	5000
9	7	5000
10	8	5000
11	9	5000
12	A =	$5,317.79
13	Function	-PMT(10%,9,NPV(10%,B3:B11) + B2)

2.85 Find the future worth F_{paid} of 3 payments in year 4

$F_{paid} = 2{,}000{,}000(F/A,8\%,3)(F/P,8\%,1)$
$= 2{,}000{,}000(3.2464)(1.08)$
$= \$7{,}012{,}224$

Find total amount owed F_{owed} after 4 years
$F_{owed} = 10{,}000{,}000(F/P,8\%,4)$
$= 10{,}000{,}000(1.3605)$
$= \$13{,}606{,}000$

Due in year 4 = 13,606,000 - 7,012,224
= $6,593,776

2.86 (a) First find present worth of A = $200 in years 1 through 7
$P = 200(P/A,10\%,7)$
$= 200(4.8684)$
$= \$973.68$

Set present worth of given cash flows equal to $973.68 and solve for CF_3

$973.68 = 200 + 200(P/A,10\%,2) + CF_3(P/F,10\%,3) + 200(P/A,10\%,4)(P/F,10\%,3)$
$973.68 = 200 + 200(1.7355) + CF_3(0.7513) + 200(3.1699)(0.7513)$
$973.68 = \$1023.41 + 0.7513CF_3$
$CF_3 = \$-66.19$

A negative cash flow of \$66.19 makes A = \$200 per year

(b) Use PMT with an embedded NPV function to calculate annual equivalent. Goal Seek tool sets PMT value at 200 and the year 3 cash flow is the changing cell. Answer is CF_3= \$-66.19.

2.87 Find P in year 7, move to year 25, and then solve for A

P_7 = 50,000(P/A,8%,3)
= 50,000(2.5771)
= \$128,855

F_{25} = 128,855(F/P,8%,18)
= 128,855(3.9960)
= \$514,905

A = 514,905(A/P,8%,35)
= 514,905(0.08580)
= \$44,179

2.88 Find P in year 0 then convert to F. In \$ million units,

P_0 = 450 – 40(P/F,10%,1) + 200(P/A,10%,6)(P/F,10%,1)
= 450 – 40(0.9091) + 200(4.3553)(0.9091)
= \$1205.52

F_7 = 1205.52(F/P,10%,7)
= 1205.52(1.9487)
= \$2349.20

2.89 P = 850 + 400(P/A,10%,5) –100(P/F,10%,1) + 100(P/F,10%,5)
= 850 + 400(3.7908) –100(0.9091) + 100(0.6209)
= \$2337.50

A = 2337.50(A/P,10%,5)
= 2337.50(0.26380)
= \$616.63

2.90 Power savings = 1,000,000(0.15) = \$150,000
Payments to engineer = 150,000(0.60) = \$90,000 per year

(a) P = 90,000(P/A,10%,3)(P/F,10%,1)
= 90,000(2.4869)(0.9091)
= \$203,476

(b) F = 90,000(F/A,10%,3)
= 90,000(3.3100)
= $297,900

2.91 Factors: (a) P = 31,000(P/A,8%,3) + 20,000(P/A,8%,5)(P/F,8%,3)
= 31,000(2.5771) + 20,000(3.9927)(0.7938)
= $143,278

(b) A = 143,278(A/P,8%,8)
= 143,278(0.17401)
= $24,932

Spreadsheet:

	A	B	C
1	**Year**	**Cash flow, $**	**Functions**
2	0		
3	1	31000	
4	2	31000	
5	3	31000	
6	4	20000	
7	5	20000	
8	6	20000	
9	7	20000	
10	8	20000	
11	**P =**	**$143,281**	**`= NPV(8%,B3:B10)+B2**
12	**A =**	**$24,933**	**`=-PMT(8%,8,B11)**

2.92 P = 13,500 + 67,500(P/F,12%,1)
= 13,500 + 67,500(0.8929)
= $73,770.75

A = 73,770.75(A/P,12%,5)
= 73,770.75(0.27741)
= $20,465

2.93 Find F in year 7 and convert to A

F_7 = 4,000,000(F/A,10%,8) + 1,000,000(F/A,10%,4)
= 4,000,000(11.4359) + 1,000,000(4.6410)
= $50,384,600

A = 50,384,600(A/F,10%,7)
= 50,384,600(0.10541)
= $5,311,041

2.94 In $ billion units,

Gross revenue first 2 years = 5.8(0.701) = $4.0658
Gross revenue last 2 years = 6.2(0.701) = $4.3462

F = 4.0658(F/A,14%,2)(F/P,14%,2) + 4.3462(F/A,14%,2)
= 4.0658(2.1400)(1.2996) + 4.3462(2.1400)
= $20.6084 billion

2.95 (a) Net income, years 1-8 = $7,000,000

A = -20,000,000(A/P,10%,8) + 7,000,000
= -20,000,000(0.18744) + 7,000,000
= $3,251,200

(b) F = 3,251,200(F/A,10%,8)
= 3,251,200(11.4359)
= $37,180,398

2.96 (a) 1,500,000(F/P,10%,5) + A(F/A,10%,5) = 15,000,000
1,500,000(1.6105) + A(6.1051) = 15,000,000
6.1051A = 12,584,250
A = $2,061,268

(b) If entries are in cells B2 through B7, the payment is found using = -FV(10%,5,,NPV(10%,B3:B7)+B2). Goal Seek value for this cell is $15 million and the changing cell is the year 1 cash flow. Answer is $2,061,266.

2.97 First find F in year 8 and then solve for A

F_8 = 15,000(F/A,8%,7) + 10,000(F/A,8%,4)
= 15,000(8.9228) + 10,000(4.5061)
= $178,903

A = 178,903(A/F,8%,8)
= 178,903(0.09401)
= $16,819

2.98 In $ million units

P = 1.4(P/A,6%,2) + [1.4(P/A,6%,13) + 0.03(P/G,6%,13)](P/F,6%,2)
= 1.4(1.8334) + [1.4(8.8527) + 0.03(45.9629)](0.8900)
= $14.824 ($14,824,434)

2.99 P in year -1 = 10,000(P/A,12%,21) + 1500(P/G,12%,21)
= 10,000(7.562) + 1500(46.8188)
= $145,848.20

F in year 20 = 145,848.20(F/P,12%,21)
= 145,848.20(10.8038)
= $1,575,715

2.100 Find P in year -1for geometric gradient, than move to year 0 to find P

$$P_{-1} = (30{,}000)\frac{1 - (1.05/1.10)^8}{(0.10 - 0.05)}$$

= $186,454

$F = P_0 = 186{,}454(F/P,10\%,1)$
= 186,454(1.10)
= $205,099

2.101 (a) Factors: Find P in year –1 using gradient factor and then move forward 1 year

$P_{-1} = 2{,}500{,}000(P/A,10\%,11) + 200{,}000(P/G,10\%,11)$
= 2,500,000(6.4951) + 200,000(26.3963)
= $21,517,010

$F = P_0 = 21{,}517{,}010(F/P,10\%,1)$
= 22,836,825(1.1000)
= $23,668,711

(b) Spreadsheet: If entries are in cells B2 through B12, the function
= NPV(10%,B3:B12)+B2 displays $23,668,600, which is the future worth F of the P in year -1

2.102 A = 550,000(A/P,10%,12) + 550,000 + 40,000(A/G,10%,12)
= 550,000(0.14676) + 550,000 + 40,000(4.3884)
= $806,254

2.103 Find P in year –6 using arithmetic gradient factor and then find F today

$P_{-6} = 10{,}000(P/A,12\%,6) + 1000(P/G,12\%,6)$
= 10,000(4.1114) + 1000(8.9302)
= 41,114 + 8930.20
= $50,044.20

$F = 50{,}044.20(F/P,12\%,6)$

= 122,439(1.9738)
= $98,777

2.104 Development cost, year 0 = 600,000(F/A,15%,3)
= 600,000(3.4725)
= $2,083,500

Present worth of income, year –1 = 250,000(P/A,15%,6) + G(P/G,15%,6)
= 250,000(3.7845) + G(7.9368)

Move development cost to year –1 and set equal to income

2,083,500(P/F,15%,1) = 250,000(3.7845) + G(7.9368)
2,083,500(0.8696) = 250,000(3.7845) + G(7.9368)
G = $109,072

2.105 Move $20,000 to year 0, add and subtract $1600 in year 4 to use gradient, and solve for x

20,000(P/F,10%,8) = 1000(P/A,10%,8) + 200(P/G,10%,8) – 1600(P/F,10%,4)
+ x(P/F,10%,4)

20,000(0.4665) = 1000(5.3349) + 200(16.0287) – 1600(0.6830) + x(0.6830)
9330 = 5334.90 + 3205.74 – 1092.80 + 0.683x
x = $2755.72

2.106 (a) Add and subtract $2400 and $2600 in periods 3 and 4, respectively, to use gradient

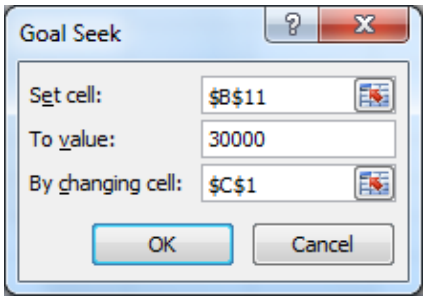
30,000 = 2000 + 200(A/G,10%,8) – 2400(P/F,10%,3)(A/P,10%,8)
-2600(P/F,10%,4)(A/P,10%,8) + x(P/F,10%,3)(A/P,10%,8)
+ 2x(P/F,10%,4)(A/P,10%,8)

30,000 = 2000 + 200(3.0045) – 2400(0.7513)(0.18744)
-2600(0.6830)(0.18744) + x(0.7513)(0.18744)
+ 2x(0.6830)(0.18744)

30,000 = 2000 + 600.90 – 337.98 – 332.86 + 0.14082x + 0.25604x
0.39686x = 28,069.94
x = $70,730

(b) Spreadsheet uses Goal Seek to find x = $70,726

	A	B	C
1	**Year**	**Cash Flow, $**	**70726.04**
2	0		**Functions**
3	1	2,000	`2000
4	2	2,200	`=B3+200
5	3	70,726	`=C$1
6	4	141,452	`=2*B$5
7	5	2,800	`=B4+600
8	6	3,000	`=B7+200
9	7	3,200	`=B8+200
10	8	3,400	`=B9+200
11		30,000	`=-PMT(10%,8,NPV(10%,B3:B10)+B2)



2.107 Find P in year 1 for geometric gradient; move back to year 0

$P_1 = 22{,}000[1 - (1.08/1.10)^9]/(0.10 - 0.08)$
$= \$167{,}450$

$P_0 = 22{,}000(P/F,10\%,1) + P_1(P/F,10\%,1)$
$= 22{,}000(0.9091) + 167{,}450(0.9091)$
$= \$172{,}229$

2.108 Find P in year 2, then move back to year 0

$P_2 = 11{,}500[1 - (1.10/1.15)^8]/(0.15 - 0.10)$
$= \$68{,}829$

$P_0 = 11{,}500(P/A,15\%,2) + P_2(P/F,15\%,2)$
$= 11{,}500(1.6257) + 68{,}829(0.7561)$
$= \$70{,}737$

2.109 (a) Find P in year 4 for the geometric gradient, then move all cash flows to future

$P_4 = 500{,}000[1 - (1.15/1.12)^{16}]/(0.12 - 0.15)$
$= \$8{,}773{,}844$

$F = 500{,}000(F/A,12\%,4)(F/P,12\%,16) + P_4(F/P,12\%,16)$
$= 500{,}000(4.7793)(6.1304) + 8{,}773{,}844(6.1304)$
$= \$68{,}436{,}684$

(b) Spreadsheet

	A	B
1	**Year**	**Cash Flow, $**
2	0	
3	1	500,000
4	2	500,000
5	3	500,000
6	4	500,000
7	5	500,000
8	6	575,000
9	7	661,250
10	8	760,438
11	9	874,503
12	10	1,005,679
13	11	1,156,530
14	12	1,330,010
15	13	1,529,511
16	14	1,758,938
17	15	2,022,779
18	16	2,326,196
19	17	2,675,125
20	18	3,076,394
21	19	3,537,853
22	20	4,068,531
23		$68,436,701.40
24	`=-FV(12%,20,,NPV(12%,B3:B22)+B2)	

2.110 Find P in year 3, then find present worth of all cash flows

$P_3 = 4{,}100{,}000[1 - (0.90/1.06)^{17}]/(0.06 + 0.10)$
$= \$24{,}037{,}964$

$P_0 = 4{,}100{,}000(P/A,6\%,3) + P_3(P/F,6\%,3)$
$= 4{,}100{,}000(2.6730) + 24{,}037{,}964(0.8396)$
$= \$31{,}141{,}574$

2.111 Find P in year 5, then find future worth of all cash flow:

$P_5 = 4000[1 - (0.85/1.10)^{9}]/(0.10 + 0.15)$
$= \$14{,}428$

$F = [4000(F/A,10\%,5) + P_5] (F/P,10\%,9)$
$= [4000(6.1051) +14{,}428] (2.3579)$
$= [24{,}420 + 14{,}428] (2.3579)$
$= \$91{,}601$

2.112 Answer is (a)

2.113 $F = 1000(F/P,8\%,10)$
$= 1000(2.1589)$
$= \$2159$

Answer is (a)

2.114 $A = 2{,}800{,}000(A/F,6\%,10)$
$= \$212{,}436$

Answer is (d)

2.115 $A = 10{,}000{,}000((A/P,15\%,7)$
$= \$2{,}403{,}600$

Answer is (a)

2.116 $P_{29} = 100{,}000(P/A,8\%,20)$
$= 100{,}000(9.8181)$
$= \$981{,}810$

$F_{29} = P_{29}$
$A = F_{29}(A/F,8\%,29)$
$= \$981{,}810(A/F,8\%,29)$
$= \$981{,}810(0.00962)$
$= \$9445$

Answer is (d)

2.117 A = 50,000,000(P/F,4%,1)(A/P,4%,21)
= 50,000,000(0.9615)(0.07128)
= $3,426,786

Answer is (b)

2.118 F = 50,000(F/P,18%,7)
= 50,000(3.1855)
= $159,275

Answer is (b)

2.119 F = 100,000(F/A,18%,5)
= 100,000(7.1542)
= $715,420

Answer is (c)

2.120 P = 100,000(P/F,10%,2)
= $100,000(0.8264)
= $82,640

Answer is (b)

2.121 10,000 = 2x(P/F,10%,2) + x(P/F,10%,4)
10,000 = 2x(0.8264) + x(0.6830)
2.3358x = 10,000
x = $4281

Answer is (a)

2.122 P = 100,000(P/A,10%,5) - 5000(P/G,10%,5)
= 100,000(3.7908) - 5000(6.8618)
= $344,771

Answer is (a)

2.123 24,000 = 3000(P/A,8%,n)
(P/A,8%,n) = 8.000
From 8% tables, n is between 13 and 14

Answer is (c)

2.124 $1000(F/P,10\%,20) + 1000(F/P,10\%,n) = 8870$

$1000(6.7275) + 1000(F/P,10\%,n) = 8870$

$1000(F/P,10\%,n) = 2142.5$

$(F/P,10\%,n) = 2.1425$

$n = 8$

Deposit year = 20 - 8 = 12

Answer is (d)

2.125 $P = 8{,}000(P/A,10\%,5) + 900(P/G,10\%,5)$

$= 8{,}000(3.7908) + 900(6.8618)$

$= \$36{,}502$

Answer is (d)

2.126 $P_{-1} = A_1(n/1+i)$

$= 9000[8/(1.08)]$

$= \$66{,}667$

$P_0 = P_{-1}(F/P,8\%,1)$

$= 66{,}667(1.0800)$

$= \$72{,}000$

Answer is (c)