

Solutions to end-of-chapter problems  
Basics of Engineering Economy, 2<sup>nd</sup> edition  
Leland Blank and Anthony Tarquin

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Chapter 2  
Factors: How Time and Interest Affect Money

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- 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

$$\begin{aligned}
 2.7 \quad (a) \quad F &= 3000(F/P, 10\%, 12) + 5000(F/P, 10\%, 8) \\
 &= 3000(3.1384) + 5000(2.1436) \\
 &= \$20,133.20
 \end{aligned}$$

(b) Sum two calculator functions

$$\begin{aligned}
 &FV(10, 12, -, -3000) + FV(10, 8, -, -5000) \\
 &9,415.29 + 10,717.94 = \$20,133.23
 \end{aligned}$$

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

$$\begin{aligned}
 2.8 \quad (a) \quad P &= 30,000,000(P/F, 10\%, 5) - 15,000,000 \\
 &= 30,000,000(0.6209) - 15,000,000 \\
 &= \$3,627,000
 \end{aligned}$$

(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.

$$\begin{aligned}
 2.9 \quad F &= 280,000(F/P, 12\%, 2) \\
 &= 280,000(1.2544) \\
 &= \$351,232
 \end{aligned}$$

$$\begin{aligned}
 2.10 \quad A &= 12,700,000(A/P, 20\%, 8) \\
 &= 12,700,000(0.26061) \\
 &= \$3,309,747
 \end{aligned}$$

$$\begin{aligned}
 2.11 \quad P &= 6000(P/A, 10\%, 10) \\
 &= 6000(6.1446) \\
 &= \$36,867.60
 \end{aligned}$$

$$\begin{aligned}
 2.12 \quad (a) \quad A &= 60,000(A/P, 8\%, 5) \\
 &= 60,000(0.25406) \\
 &= \$15,027.60
 \end{aligned}$$

(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

$$\begin{aligned}
 2.13 \quad A &= 20,000,000(A/P, 10\%, 6) \\
 &= 20,000,000(0.22961) \\
 &= \$4,592,200
 \end{aligned}$$

$$\begin{aligned}
 2.14 \quad A &= 50,000(A/F, 20\%, 3) \\
 &= 50,000(0.27473) \\
 &= \$13,736.50
 \end{aligned}$$

$$\begin{aligned}
 2.15 \quad (a) \quad 17,000,000(A/P, i, 8) &= 2,737,680 \\
 (A/P, i, 8) &= 0.16104 \\
 \text{From interest tables at } n = 8, i &= 6\% \text{ per year}
 \end{aligned}$$

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

(c) If the spreadsheet function is  $= \text{RATE}(8, -2737680, 17000000)$ , display is 6.00%

$$\begin{aligned}
 2.16 \quad (a) \quad A &= 3,000,000(10)(A/P, 8\%, 10) \\
 &= 30,000,000(0.14903) \\
 &= \$4,470,900
 \end{aligned}$$

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

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

$$\begin{aligned}
 2.17 \quad P &= 1,400,000(F/P, 7\%, 4) \\
 &= 1,400,000(1.3108) \\
 &= \$1,835,120
 \end{aligned}$$

$$\begin{aligned}
 2.18 \quad P &= 600,000(P/F, 12\%, 4) \\
 &= 600,000(0.6355) \\
 &= \$381,300
 \end{aligned}$$

$$\begin{aligned}
 2.19 \quad (a) \quad A &= 225,000(A/P, 15\%, 4) \\
 &= 225,000(0.35027) \\
 &= \$78,811
 \end{aligned}$$

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

$$\begin{aligned}
 2.20 \quad P &= 100,000((P/F, 12\%, 2) \\
 &= 100,000(0.7972) \\
 &= \$79,720
 \end{aligned}$$

$$\begin{aligned}
 2.21 \quad F &= 65,000(F/P, 4\%, 5) \\
 &= 65,000(1.2167) \\
 &= \$79,086
 \end{aligned}$$

$$\begin{aligned}
 2.22 \quad P &= (280,000 - 90,000)(P/A, 10\%, 5) \\
 &= 190,000(3.7908) \\
 &= \$720,252
 \end{aligned}$$

$$\begin{aligned}
 2.23 \quad F &= 649(F/P, 8\%, 2) \\
 &= 649(1.1664) \\
 &= \$757
 \end{aligned}$$

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

$$\begin{aligned}
 F &= 20,000,000(F/P, 8\%, 2) \\
 &= 20,000,000(1.1664) \\
 &= \$23,328,000
 \end{aligned}$$

$$\begin{aligned}
 \text{Interest} &= 23,328,000 - 20,000,000 \\
 &= \$3,328,000
 \end{aligned}$$

$$\begin{aligned}
 2.25 \quad P &= 2,100,000(P/F, 10\%, 2) \\
 &= 2,100,000(0.8264) \\
 &= \$1,735,440
 \end{aligned}$$

$$\begin{aligned}
 2.26 \quad P &= 40,000(P/F, 12\%, 4) \\
 &= 40,000(0.6355) \\
 &= \$25,420
 \end{aligned}$$

$$\begin{aligned}
 2.27 \quad (a) \quad A &= 850,000(A/F, 18\%, 5) \\
 &= 850,000(0.13978) \\
 &= \$118,813
 \end{aligned}$$

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

$$\begin{aligned}
 2.28 \quad P &= 95,000,000(P/F, 12\%, 3) \\
 &= 95,000,000(0.7118) \\
 &= \$67,621,000
 \end{aligned}$$

$$\begin{aligned}
 2.29 \quad F &= 375,000(F/P, 10\%, 6) \\
 &= 375,000(1.7716) \\
 &= \$664,350
 \end{aligned}$$

$$\begin{aligned}
 2.30 \quad F &= 150,000(F/P, 8\%, 8) \\
 &= 150,000(1.8509) \\
 &= \$277,635
 \end{aligned}$$

$$\begin{aligned}
 2.31 \quad (a) \quad P &= 7000(P/F, 10\%, 2) + 9000(P/F, 10\%, 4) + 15,000(P/F, 10\%, 5) \\
 &= 7000(0.8264) + 9000(0.6830) + 15,000(0.6209) \\
 &= \$21,245.30
 \end{aligned}$$

(b) Three calculator functions are added.

$$\begin{aligned} & -PV(10,2,0,7000) - PV(10,4,0,9000) - PV(10,5,0,15000) \\ & \text{Total is } 5785.12 + 6147.12 + 9313.82 = \$21,246.06 \end{aligned}$$

$$\begin{aligned} 2.32 \quad P &= 600,000(0.10)(P/F,10\%,2) + 1,350,000(0.10)(P/F,10\%,5) \\ &= 60,000(0.8264) + 135,000(0.6209) \\ &= \$133,406 \end{aligned}$$

$$\begin{aligned} 2.33 \quad P &= 8,000,000(P/A,10\%,5) \\ &= 8,000,000(3.7908) \\ &= \$30,326,400 \end{aligned}$$

$$\begin{aligned} 2.34 \quad A &= 10,000,000(A/P,10\%,10) \\ &= 10,000,000(0.16275) \\ &= \$1,627,500 \end{aligned}$$

$$\begin{aligned} 2.35 \quad A &= 140,000(4000)(A/P,10\%,4) \\ &= 560,000,000(0.31547) \\ &= \$176,663,200 \end{aligned}$$

$$\begin{aligned} 2.36 \quad P &= 1,500,000(P/A,8\%,4) \\ &= 1,500,000(3.3121) \\ &= \$4,968,150 \end{aligned}$$

$$\begin{aligned} 2.37 \quad A &= 3,250,000(A/P,15\%,6) \\ &= 3,250,000(0.26424) \\ &= \$858,780 \end{aligned}$$

$$\begin{aligned} 2.38 \quad P &= 280,000(P/A,18\%,8) \\ &= 280,000(4.0776) \\ &= \$1,141,728 \end{aligned}$$

$$\begin{aligned} 2.39 \quad A &= 3,500,000(A/P,25\%,5) \\ &= 3,500,000(0.37185) \\ &= \$1,301,475 \end{aligned}$$

$$\begin{aligned} 2.40 \quad A &= 5000(7)(A/P,10\%,10) \\ &= 35,000(0.16275) \\ &= \$5696.25 \end{aligned}$$

$$\begin{aligned} 2.41 \quad (a) \quad F &= 70,000(F/P,12\%,6) + 90,000(F/P,12\%,4) \\ &= 70,000(1.9738) + 90,000(1.5735) \\ &= \$279,781 \end{aligned}$$

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

$$\begin{aligned} 2.42 \quad F &= (458-360)(0.90)(20,000)(P/A,10\%,5) \\ &= 1,764,000(3.7908) \\ &= \$6,686,971 \end{aligned}$$

$$\begin{aligned} 2.43 \quad (a) \text{ Let } CF_4 \text{ be the amount in year 4} \\ 100,000(F/P,9\%,3) + 75,000(F/P,9\%,2) + CF_4(F/P,9\%,1) &= 290,000 \\ 100,000(1.2950) + 75,000(1.1881) + CF_4(1.0900) &= 290,000 \\ (1.09)CF_4 &= 71,392.50 \\ CF_4 &= \$65,497.71 \end{aligned}$$

$$\begin{aligned} (b) \text{ F in year 5 for 2 known amounts} \\ &= -FV(9\%,3,0,100000) - FV(9\%,2,0,75000) \end{aligned}$$

$$\begin{aligned} \text{P in year 4 of \$290,000 minus amount above (assume it's in cell H9)} \\ &= -PV(9\%,1,0,290000-H9) \end{aligned}$$

Answer is \$65,495.05

$$\begin{aligned} 2.44 \quad P &= 225,000(P/A,15\%,3) \\ &= 225,000(2.2832) \\ &= \$513,720 \end{aligned}$$

$$\begin{aligned} 2.45 \quad 400,000 &= 50,000(F/A,12\%,n) \\ (F/A,12\%,n) &= 8.0000 \end{aligned}$$

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

$$\begin{aligned} 2.46 \quad F &= P(F/P,10\%,n) \\ 3P &= P(F/P,10\%,n) \\ (F/P,10\%,n) &= 3.000 \end{aligned}$$

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

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

Solve for n by trial and error:

$$\begin{aligned} \text{Try } n = 5: & 400,000(F/P,10\%,5) + 50,000(F/A,10\%,5) \\ & 400,000(1.6105) + 50,000(6.1051) \\ & 949,455 < 1,200,000 \quad n \text{ too low} \end{aligned}$$

$$\begin{aligned} \text{Try } n = 8: & 400,000(2.1436) + 50,000(11.4359) \\ & 1,429,235 > 1,200,000 \quad n \text{ too high} \end{aligned}$$

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  $A = 9000 - 560(A/G, 10\%, 5)$   
 $= 9000 - 560(1.8101)$   
 $= \$7986$

$$\begin{aligned}
2.53 \quad & 14,000 = 8000(P/A, 10\%, 4) - G(P/G, 10\%, 4) \\
& 14,000 = 8000(3.1699) - G(4.3781) \\
& G = \$2594.55
\end{aligned}$$

$$\begin{aligned}
2.54 \quad & P = 20,000(P/A, 10\%, 10) + 2000(P/G, 10\%, 10) \\
& = 20,000(6.1446) + 2000(22.8913) \\
& = \$168,675
\end{aligned}$$

$$\begin{aligned}
2.55 \quad & A = 100,000 + 10,000(A/G, 10\%, 5) \\
& = 100,000 + 10,000(1.8101) \\
& = \$118,101
\end{aligned}$$

$$\begin{aligned}
& F = 118,101(F/A, 10\%, 5) \\
& = 118,101(6.1051) \\
& = \$721,018
\end{aligned}$$

$$\begin{aligned}
2.56 \quad & P = 0.50(P/A, 10\%, 5) + 0.10(P/G, 10\%, 5) \\
& = 0.50(3.7908) + 0.10(6.8618) \\
& = \$2.58
\end{aligned}$$

$$\begin{aligned}
2.57 \quad (a) \quad & \text{Income} = 390,000 - 2(15,000) \\
& = \$360,000
\end{aligned}$$

$$\begin{aligned}
(b) \quad & A = 390,000 - 15,000(A/G, 10\%, 5) \\
& = 390,000 - 15,000(1.8101) \\
& = \$362,848.50
\end{aligned}$$

$$\begin{aligned}
2.58 \quad & 475,000 = 25,000(P/A, 10\%, 6) + G(P/G, 10\%, 6) \\
& 475,000 = 25,000(4.3553) + G(9.6842) \\
& 9.6842G = 366,117.50 \\
& G = \$37,805.65
\end{aligned}$$

$$\begin{aligned}
2.59 \quad & \text{Factors: First find } P \text{ and then convert to } F \\
& P = 1,000,000(P/A, 10\%, 5) + 200,000(P/G, 10\%, 5) \\
& = 1,000,000(3.7908) + 200,000(6.8618) \\
& = \$5,163,160 \\
& F = 5,163,160(F/P, 10\%, 5) \\
& = 5,163,160(1.6105) \\
& = \$8,315,269
\end{aligned}$$

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:

$$\begin{aligned}A &= 500,000(A/F, 10\%, 10) \\&= 500,000(0.06275) \\&= \$31,375\end{aligned}$$

$$\begin{aligned}31,375 &= 20,000 + G(A/G, 10\%, 10) \\31,375 &= 20,000 + G(3.7255) \\G &= \$3053.28\end{aligned}$$

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

$$\begin{aligned}F &= 965,695(F/P, 10\%, 5) \\&= 965,695(1.6105) \\&= \$1,555,252\end{aligned}$$

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

$$\begin{aligned}F &= 3,663,253,200 (F/P, 10\%, 5) \\&= 3,663,253,200 (1.6105) \\&= \$5,899,669,279\end{aligned}$$

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

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

$$\begin{aligned}F &= 104,105.31(F/P, 7\%, 20) \\&= 104,105.31(3.8697) \\&= \$402,856\end{aligned}$$

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

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)

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

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

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

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

$$\begin{aligned}
 F &= 70,475.50(F/P, 10\%, 12) \\
 &= 70,475.50(3.1384) \\
 &= \$221,180
 \end{aligned}$$

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

$$\begin{aligned}
 400,000 &= A_1[1 - (1.04/1.10)^5]/(0.10 - 0.04) \\
 4.0759 A_1 &= 400,000 \\
 A_1 &= \$98,138
 \end{aligned}$$

$$\begin{aligned}
 \text{Cost in year 3} &= 98,138(1.04)^2 \\
 &= \$106,146
 \end{aligned}$$

2.74 Solve for  $A_1$  in geometric gradient equation

$$\begin{aligned}
 900,000 &= A_1[1 - (1.05/1.15)^5]/(0.15 - 0.05) \\
 3.65462 A_1 &= 900,000 \\
 A_1 &= \$246,263
 \end{aligned}$$

2.75 First find P and then convert to F

$$\begin{aligned}
 P &= 5000[1 - (0.95/1.08)^5]/(0.08 + 0.05) \\
 &= \$18,207
 \end{aligned}$$

$$\begin{aligned}
 F &= 18,207(F/P, 8\%, 5) \\
 &= 18,207(1.4693) \\
 &= \$26,751
 \end{aligned}$$

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

$$\begin{aligned}
 A_1 &= 1250/(0.95)^3 \\
 &= \$1457.94
 \end{aligned}$$

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

$$\begin{aligned}
 2.78 \quad F &= 8000(F/A, 10\%, 5) \\
 &= 8000(6.1051) \\
 &= \$48,841
 \end{aligned}$$

$$\begin{aligned}
 2.79 \quad F &= 200,000(F/A, 10\%, 6) \\
 &= 200,000(7.7156) \\
 &= \$1,543,120
 \end{aligned}$$

$$\begin{aligned}
 2.80 \quad P &= 97,000(P/A, 10\%, 4)(P/F, 10\%, 1) \\
 &= 97,000(3.1699)(0.9091) \\
 &= \$279,530
 \end{aligned}$$

$$\begin{aligned}
 2.81 \quad F \text{ in year 17} &= 5000(F/A, 8\%, 18) \\
 &= 5000(37.4502) \\
 &= \$187,251
 \end{aligned}$$

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

$$\begin{aligned}
 A &= 187,251(A/P, 8\%, 5) \\
 &= 187,251(0.25046) \\
 &= \$46,899
 \end{aligned}$$

$$\begin{aligned}
 2.82 \quad F \text{ in year 8} &= 100(F/A, 10\%, 3)(F/P, 10\%, 6) + 200(F/A, 10\%, 4)(F/P, 10\%, 2) \\
 &= 100(3.3100)(1.7716) + 200(4.6410)(1.21) \\
 &= \$1709.52
 \end{aligned}$$

$$\begin{aligned}
 2.83 \quad (a) \quad F &= (62,000,000/10)(F/A, 8\%, 10)(F/P, 8\%, 2) + (9,000,000/2)(F/A, 8\%, 2) \\
 &= 6,200,000(14.4866)(1.1664) + 4,500,000(2.08) \\
 &= \$114,122,456
 \end{aligned}$$

(b) Calculator functions are  $FV(8, 2, 0, FV(8, 10, 62000000) + FV(8, 2, 4500000))$

$$\begin{aligned}
 2.84 \quad (a) \quad 1. \text{ For } \$5000 \text{ in year 0, find } A \text{ in years 1-9} \\
 A_1 &= 5000(A/P, 10\%, 9) \\
 &= 5000(0.17364) \\
 &= \$868.20
 \end{aligned}$$

$$\begin{aligned}
 2. \text{ For } \$4000 \text{ in years 1-9, the } A \text{ is} \\
 A_2 &= \$4000
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ For the extra } \$1000 \text{ in years 5-9, convert to } A \text{ in years 1-9} \\
 A_3 &= 1000(F/A, 10\%, 5)(A/F, 10\%, 9) \\
 &= 1000(6.1051)(0.07364) \\
 &= \$449.58
 \end{aligned}$$

$$\begin{aligned}
 \text{Total A} &= A_1 + A_2 + A_3 \\
 &= 868.20 + 4000 + 449.58 \\
 &= \$5318
 \end{aligned}$$

(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 =	<b>\$5,317.79</b>
13	Function	<b>-PMT(10%,9,NPV(10%,B3:B11) + B2)</b>

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

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

Find total amount owed  $F_{\text{owed}}$  after 4 years

$$\begin{aligned}
 F_{\text{owed}} &= 10,000,000(F/P, 8\%, 4) \\
 &= 10,000,000(1.3605) \\
 &= \$13,606,000
 \end{aligned}$$

$$\begin{aligned}
 \text{Due in year 4} &= 13,606,000 - 7,012,224 \\
 &= \$6,593,776
 \end{aligned}$$

2.86 (a) First find present worth of  $A = \$200$  in years 1 through 7

$$\begin{aligned}
 P &= 200(P/A, 10\%, 7) \\
 &= 200(4.8684) \\
 &= \$973.68
 \end{aligned}$$

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

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

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

$$\begin{aligned} P_7 &= 50,000(P/A, 8\%, 3) \\ &= 50,000(2.5771) \\ &= \$128,855 \end{aligned}$$

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

$$\begin{aligned} A &= 514,905(A/P, 8\%, 35) \\ &= 514,905(0.08580) \\ &= \$44,179 \end{aligned}$$

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

$$\begin{aligned} P_0 &= 450 - 40(P/F, 10\%, 1) + 200(P/A, 10\%, 6)(P/F, 10\%, 1) \\ &= 450 - 40(0.9091) + 200(4.3553)(0.9091) \\ &= \$1205.52 \end{aligned}$$

$$\begin{aligned} F_7 &= 1205.52(F/P, 10\%, 7) \\ &= 1205.52(1.9487) \\ &= \$2349.20 \end{aligned}$$

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

$$\begin{aligned} A &= 2337.50(A/P, 10\%, 5) \\ &= 2337.50(0.26380) \\ &= \$616.63 \end{aligned}$$

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

$$\begin{aligned} \text{(a) } P &= 90,000(P/A, 10\%, 3)(P/F, 10\%, 1) \\ &= 90,000(2.4869)(0.9091) \\ &= \$203,476 \end{aligned}$$

$$\begin{aligned} \text{(b) } F &= 90,000(F/A, 10\%, 3) \\ &= 90,000(3.3100) \\ &= \$297,900 \end{aligned}$$

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	<b>P =</b>	<b>\$143,281</b>	<b>= NPV(8%,B3:B10)+B2</b>
12	<b>A =</b>	<b>\$24,933</b>	<b>=PMT(8%,8,B11)</b>

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 =  $6.2(0.701) = \$4.3462$

$$\begin{aligned} F &= 4.0658(F/A, 14\%, 2)(F/P, 14\%, 2) + 4.3462(F/A, 14\%, 2) \\ &= 4.0658(2.1400)(1.2996) + 4.3462(2.1400) \\ &= \$20.6084 \text{ billion} \end{aligned}$$

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

$$\begin{aligned} A &= -20,000,000(A/P, 10\%, 8) + 7,000,000 \\ &= -20,000,000(0.18744) + 7,000,000 \\ &= \$3,251,200 \end{aligned}$$

$$\begin{aligned} \text{(b) } F &= 3,251,200(F/A, 10\%, 8) \\ &= 3,251,200(11.4359) \\ &= \$37,180,398 \end{aligned}$$

$$\begin{aligned} 2.96 \quad \text{(a)} \quad 1,500,000(F/P, 10\%, 5) + A(F/A, 10\%, 5) &= 15,000,000 \\ 1,500,000(1.6105) + A(6.1051) &= 15,000,000 \\ 6.1051A &= 12,584,250 \\ A &= \$2,061,268 \end{aligned}$$

(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

$$\begin{aligned} F_8 &= 15,000(F/A, 8\%, 7) + 10,000(F/A, 8\%, 4) \\ &= 15,000(8.9228) + 10,000(4.5061) \\ &= \$178,903 \end{aligned}$$

$$\begin{aligned} A &= 178,903(A/F, 8\%, 8) \\ &= 178,903(0.09401) \\ &= \$16,819 \end{aligned}$$

2.98 In \$ million units

$$\begin{aligned} P &= 1.4(P/A, 6\%, 2) + [1.4(P/A, 6\%, 13) + 0.03(P/G, 6\%, 13)](P/F, 6\%, 2) \\ &= 1.4(1.8334) + [1.4(8.8527) + 0.03(45.9629)](0.8900) \\ &= \$14.824 \quad (\$14,824,434) \end{aligned}$$

$$\begin{aligned}
 2.99 \quad P \text{ in year } -1 &= 10,000(P/A, 12\%, 21) + 1500(P/G, 12\%, 21) \\
 &= 10,000(7.562) + 1500(46.8188) \\
 &= \$145,848.20
 \end{aligned}$$

$$\begin{aligned}
 F \text{ in year } 20 &= 145,848.20(F/P, 12\%, 21) \\
 &= 145,848.20(10.8038) \\
 &= \$1,575,715
 \end{aligned}$$

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

$$\begin{aligned}
 P_{-1} &= (30,000) \frac{1 - (1.05/1.10)^8}{(0.10 - 0.05)} \\
 &= \$186,454
 \end{aligned}$$

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

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

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

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

(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

$$\begin{aligned}
 2.102 \quad A &= 550,000(A/P, 10\%, 12) + 550,000 + 40,000(A/G, 10\%, 12) \\
 &= 550,000(0.14676) + 550,000 + 40,000(4.3884) \\
 &= \$806,254
 \end{aligned}$$

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

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

$$\begin{aligned}
 F &= 50,044.20(F/P, 12\%, 6) \\
 &= 122,439(1.9738) \\
 &= \$98,777
 \end{aligned}$$

$$\begin{aligned}
2.104 \text{ Development cost, year 0} &= 600,000(F/A, 15\%, 3) \\
&= 600,000(3.4725) \\
&= \$2,083,500
\end{aligned}$$

$$\begin{aligned}
\text{Present worth of income, year } -1 &= 250,000(P/A, 15\%, 6) + G(P/G, 15\%, 6) \\
&= 250,000(3.7845) + G(7.9368)
\end{aligned}$$

Move development cost to year  $-1$  and set equal to income

$$\begin{aligned}
2,083,500(P/F, 15\%, 1) &= 250,000(3.7845) + G(7.9368) \\
2,083,500(0.8696) &= 250,000(3.7845) + G(7.9368) \\
G &= \$109,072
\end{aligned}$$

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

$$\begin{aligned}
20,000(P/F, 10\%, 8) &= 1000(P/A, 10\%, 8) + 200(P/G, 10\%, 8) - 1600(P/F, 10\%, 4) \\
&\quad + x(P/F, 10\%, 4)
\end{aligned}$$

$$\begin{aligned}
20,000(0.4665) &= 1000(5.3349) + 200(16.0287) - 1600(0.6830) + x(0.6830) \\
9330 &= 5334.90 + 3205.74 - 1092.80 + 0.683x \\
x &= \$2755.72
\end{aligned}$$

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

$$\begin{aligned}
30,000 &= 2000 + 200(A/G, 10\%, 8) - 2400(P/F, 10\%, 3)(A/P, 10\%, 8) \\
&\quad - 2600(P/F, 10\%, 4)(A/P, 10\%, 8) + x(P/F, 10\%, 3)(A/P, 10\%, 8) \\
&\quad + 2x(P/F, 10\%, 4)(A/P, 10\%, 8)
\end{aligned}$$

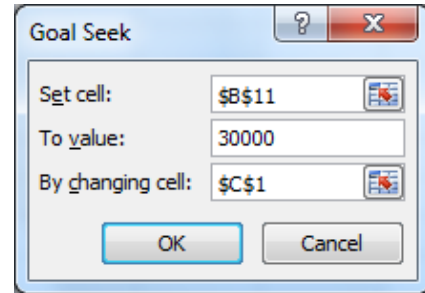
$$\begin{aligned}
30,000 &= 2000 + 200(3.0045) - 2400(0.7513)(0.18744) \\
&\quad - 2600(0.6830)(0.18744) + x(0.7513)(0.18744) \\
&\quad + 2x(0.6830)(0.18744)
\end{aligned}$$

$$\begin{aligned}
30,000 &= 2000 + 600.90 - 337.98 - 332.86 + 0.14082x + 0.25604x \\
&\hspace{15em} 0.39686x = 28,069.94
\end{aligned}$$

$$x = \$70,730$$

(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

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

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

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

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

(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)

$$= \$24,037,964$$

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

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

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

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

2.112 Answer is (a)

$$\begin{aligned} 2.113 \quad F &= 1000(F/P, 8\%, 10) \\ &= 1000(2.1589) \\ &= \$2159 \end{aligned}$$

Answer is (a)

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

Answer is (d)

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

Answer is (a)

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

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

Answer is (d)

$$\begin{aligned}
2.117 \quad A &= 50,000,000(P/F, 4\%, 1)(A/P, 4\%, 21) \\
&= 50,000,000(0.9615)(0.07128) \\
&= \$3,426,786
\end{aligned}$$

Answer is (b)

$$\begin{aligned}
2.118 \quad F &= 50,000(F/P, 18\%, 7) \\
&= 50,000(3.1855) \\
&= \$159,275
\end{aligned}$$

Answer is (b)

$$\begin{aligned}
2.119 \quad F &= 100,000(F/A, 18\%, 5) \\
&= 100,000(7.1542) \\
&= \$715,420
\end{aligned}$$

Answer is (c)

$$\begin{aligned}
2.120 \quad P &= 100,000(P/F, 10\%, 2) \\
&= \$100,000(0.8264) \\
&= \$82,640
\end{aligned}$$

Answer is (b)

$$\begin{aligned}
2.121 \quad 10,000 &= 2x(P/F, 10\%, 2) + x(P/F, 10\%, 4) \\
10,000 &= 2x(0.8264) + x(0.6830) \\
2.3358x &= 10,000 \\
x &= \$4281
\end{aligned}$$

Answer is (a)

$$\begin{aligned}
2.122 \quad P &= 100,000(P/A, 10\%, 5) - 5000(P/G, 10\%, 5) \\
&= 100,000(3.7908) - 5000(6.8618) \\
&= \$344,771
\end{aligned}$$

Answer is (a)

$$\begin{aligned}
2.123 \quad 24,000 &= 3000(P/A, 8\%, n) \\
(P/A, 8\%, n) &= 8.000 \\
\text{From 8\% tables, } n &\text{ is between 13 and 14}
\end{aligned}$$

Answer is (c)

$$\begin{aligned}
2.124 \quad 1000(F/P, 10\%, 20) + 1000(F/P, 10\%, n) &= 8870 \\
1000(6.7275) + 1000(F/P, 10\%, n) &= 8870 \\
1000(F/P, 10\%, n) &= 2142.5 \\
(F/P, 10\%, n) &= 2.1425 \\
n &= 8
\end{aligned}$$

Deposit year = 20 - 8 = 12

Answer is (d)

$$\begin{aligned}
2.125 \quad P &= 8,000(P/A, 10\%, 5) + 900(P/G, 10\%, 5) \\
&= 8,000(3.7908) + 900(6.8618) \\
&= \$36,502
\end{aligned}$$

Answer is (d)

$$\begin{aligned}
2.126 \quad P_{-1} &= A_1(n/1+i) \\
&= 9000[8/(1.08)] \\
&= \$66,667
\end{aligned}$$

$$\begin{aligned}
P_0 &= P_{-1}(F/P, 8\%, 1) \\
&= 66,667(1.0800) \\
&= \$72,000
\end{aligned}$$

Answer is (c)