

**Solutions to end-of-chapter problems**  
**Engineering Economy, 7<sup>th</sup> edition**

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**Chapter 2**  
**Factors: How Time and Interest Affect Money**

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**2.1** (1)  $(P/F, 6\%, 8) = 0.6274$   
(2)  $(A/P, 10\%, 10) = 0.16275$   
(3)  $(A/G, 15\%, 20) = 5.3651$   
(4)  $(A/F, 2\%, 30) = 0.02465$   
(5)  $(P/G, 35\%, 15) = 7.5974$

**2.2**  $P = 21,300(P/A, 10\%, 5)$   
 $= 21,300(3.7908)$   
 $= \$80,744$

**2.3** Cost now =  $142(0.60)$   
 $= \$85.20$   
Present worth at regular cost =  $142(P/F, 10\%, 2)$   
 $= 142(0.8264)$   
 $= \$117.35$   
  
Present worth of savings =  $117.35 - 85.20$   
 $= \$32.15$

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

**2.5**  $F = 50,000(F/P, 6\%, 14)$   
 $= 50,000(2.2609)$   
 $= \$113,045$

**2.6**  $F = 1,900,000(F/P, 15\%, 3)$   
 $F = 1,900,000(1.5209)$   
 $= \$2,889,710$

**2.7**  $A = 220,000(A/P, 10\%, 3)$   
 $= 220,000(0.40211)$   
 $= \$88,464$

**2.8**  $P = 75,000(P/F, 12\%, 4)$   
 $= 75,000(0.6355)$   
 $= \$47,663$

$$\begin{aligned}
2.9 \quad F &= 1.3(F/P, 18\%, 10) \\
&= 1.3(5.2338) \\
&= 6.80394 \quad (\$6,803,940)
\end{aligned}$$

$$\begin{aligned}
2.10 \quad P &= 200,000(P/F, 15\%, 1) + 300,000(P/F, 15\%, 3) \\
&= 200,000(0.8696) + 300,000(0.6575) \\
&= \$371,170
\end{aligned}$$

$$2.11 \quad \text{Gain in worth of building after repairs} = (600,000/0.75 - 600,000) - 25,000 = 175,000$$

$$\begin{aligned}
F &= 175,000(F/P, 8\%, 5) \\
&= 175,000(1.4693) \\
&= \$257,128
\end{aligned}$$

$$\begin{aligned}
2.12 \quad F &= 100,000(F/P, 8\%, 4) + 150,000(F/P, 8\%, 3) \\
&= 100,000(1.3605) + 150,000(1.2597) \\
&= \$325,005
\end{aligned}$$

$$\begin{aligned}
2.13 \quad P &= (110,000 * 0.3)(P/A, 12\%, 4) \\
&= (33,000)(3.0373) \\
&= \$100,231
\end{aligned}$$

$$\begin{aligned}
2.14 \quad P &= 600,000(0.04)(P/A, 10\%, 3) \\
&= 24,000(2.4869) \\
&= \$59,686
\end{aligned}$$

$$\begin{aligned}
2.15 \quad A &= 950,000(A/P, 6\%, 20) \\
&= 950,000(0.08718) \\
&= \$82,821
\end{aligned}$$

$$\begin{aligned}
2.16 \quad A &= 434(A/P, 8\%, 5) \\
&= 434(0.25046) \\
&= \$108.70
\end{aligned}$$

$$\begin{aligned}
2.17 \quad F &= (0.18 - 0.04)(100)(F/A, 6\%, 8) \\
&= 14(9.8975) \\
&= \$138.57
\end{aligned}$$

$$\begin{aligned}
2.18 \quad F_{\text{difference}} &= 10,500(F/P, 7\%, 18) - 10,500(F/P, 4\%, 18) \\
&= 10,500(3.3799) - 10,500(2.2058) \\
&= \$12,328
\end{aligned}$$

$$\begin{aligned}
2.19 \quad F &= (200 - 90)(F/A, 10\%, 8) \\
&= 110(11.4359) \\
&= \$1,257,949
\end{aligned}$$

$$\begin{aligned}
2.20 \quad A &= 350,000(A/F, 10\%, 3) \\
&= 350,000(0.30211) \\
&= \$105,739
\end{aligned}$$

2.21 (a) 1. Interpolate between  $i = 12\%$  and  $i = 14\%$  at  $n = 15$ .

$$\begin{aligned}
1/2 &= x/(0.17102 - 0.14682) \\
x &= 0.0121
\end{aligned}$$

$$\begin{aligned}
(A/P, 13\%, 15) &= 0.14682 + 0.0121 \\
&= 0.15892
\end{aligned}$$

2. Interpolate between  $i = 25\%$  and  $i = 30\%$  at  $n = 10$ .

$$\begin{aligned}
2/5 &= x/(9.9870 - 7.7872) \\
x &= 0.8799
\end{aligned}$$

$$\begin{aligned}
(P/G, 27\%, 10) &= 9.9870 - 0.8799 \\
&= 9.1071
\end{aligned}$$

$$\begin{aligned}
(b) \quad 1. \quad (A/P, 13\%, 15) &= [0.13(1 + 0.13)^{15}] / [(1 + 0.13)^{15} - 1] \\
&= 0.15474
\end{aligned}$$

$$\begin{aligned}
2. \quad (P/G, 27\%, 10) &= [(1 + 0.27)^{10} - (0.27)(10) - 1] / [0.27^2(1 + 0.27)^{10}] \\
&= 9.0676
\end{aligned}$$

2.22 (a) 1. Interpolate between  $n = 60$  and  $n = 65$ :

$$\begin{aligned}
2/5 &= x/(4998.22 - 2595.92) \\
x &= 960.92
\end{aligned}$$

$$\begin{aligned}
(F/P, 14\%, 62) &= 4998.22 - 960.92 \\
&= 4037.30
\end{aligned}$$

2. Interpolate between  $n = 40$  and  $n = 48$ :

$$\begin{aligned}
5/8 &= x/(0.02046 - 0.01633) \\
x &= 0.00258
\end{aligned}$$

$$\begin{aligned}
(A/F, 1\%, 45) &= 0.02046 - 0.00258 \\
&= 0.01788
\end{aligned}$$

$$\begin{aligned}
(b) \quad 1. \quad (F/P, 14\%, 62) &= (1 + 0.14)^{62} - 1 \\
&= 3373.66
\end{aligned}$$

$$\begin{aligned}
2. \quad (A/F, 1\%, 45) &= 0.01 / [(1 + 0.01)^{45} - 1] \\
&= 0.01771
\end{aligned}$$

(c) 1. = -FV(14%,62,,1) displays 3373.66

3. = PMT(1%,45,,1) displays 0.01771

**2.23** Interpolated value: Interpolate between n = 40 and n = 45:

$$\begin{aligned} 3/5 &= x/(72.8905 - 45.2593) \\ x &= 16.5787 \end{aligned}$$

$$\begin{aligned} (F/P,10\%,43) &= 45.2593 + 16.5787 \\ &= 61.8380 \end{aligned}$$

Formula value:  $(F/P,10\%,43) = (1 + 0.10)^{43} - 1 = 59.2401$

% difference =  $[(61.8380 - 59.2401) / 59.2401] * 100 = 4.4\%$

**2.24** Interpolated value: Interpolate between n = 50 and n = 55:

$$\begin{aligned} 2/5 &= x/(14524 - 7217.72) \\ x &= 2922.51 \end{aligned}$$

$$\begin{aligned} (F/A,15\%,52) &= 7217.72 + 2922.51 \\ &= 10,140 \end{aligned}$$

Formula value:  $(F/A,15\%,52) = [(1 + 0.15)^{52} - 1] / 0.15 = 9547.58$

% difference =  $[(10,140 - 9547.58) / 9547.58] (100) = 6.2\%$

**2.25** (a) Profit in year 5 =  $6000 + 1100(4) = \$10,400$

$$\begin{aligned} \text{(b) } P &= 6000(P/A,8\%,5) + 1100(P/G,8\%,5) \\ &= 6000(3.9927) + 1100(7.3724) \\ &= \$32,066 \end{aligned}$$

**2.26** (a)  $G = (241 - 7) / 9 = \$26$  billion per year

(b) Loss in year 5 =  $7 + 4(26) = \$111$  billion

$$\begin{aligned} \text{(c) } A &= 7 + 26(A/G,8\%,10) \\ &= 7 + 26(3.8713) \\ &= \$107.7 \text{ billion} \end{aligned}$$

**2.27**  $A = 200 - 5(A/G,8\%,8)$   
 $= 200 - 5(3.0985)$   
 $= \$184.51$

$$\begin{aligned}
2.28 \quad P &= 60,000(P/A, 10\%, 5) + 10,000(P/G, 10\%, 5) \\
&= 60,000(3.7908) + 10,000(6.8618) \\
&= \$296,066
\end{aligned}$$

$$2.29 \quad (a) \quad CF_3 = 70 + 3(4) = \$82 \quad (\$82,000)$$

$$\begin{aligned}
(b) \quad P &= 74(P/A, 10\%, 10) + 4(P/G, 10\%, 10) \\
&= 74(6.1446) + 4(22.8913) \\
&= \$546.266 \quad (\$546,266)
\end{aligned}$$

$$\begin{aligned}
F &= 546.266(F/P, 10\%, 10) \\
&= 521.687(2.5937) \\
&= \$1416.850 \quad (\$1,416,850)
\end{aligned}$$

$$\begin{aligned}
2.30 \quad 601.17 &= A + 30(A/G, 10\%, 9) \\
601.17 &= A + 30(3.3724) \\
A &= \$500
\end{aligned}$$

$$\begin{aligned}
2.31 \quad P &= 2.1B (P/F, 18\%, 5) \\
&= 2.1B (0.4371) \\
&= \$917,910,000
\end{aligned}$$

$$\begin{aligned}
917,910,000 &= 50,000,000(P/A, 18\%, 5) + G(P/G, 18\%, 5) \\
917,910,000 &= 50,000,000(3.1272) + G(5.2312) \\
G &= \$14,557,845
\end{aligned}$$

$$\begin{aligned}
2.32 \quad 75,000 &= 15,000 + G(A/G, 10\%, 5) \\
75,000 &= 15,000 + G(1.8101) \\
G &= \$33,147
\end{aligned}$$

2.33 First find  $P_g$  (using equation) and then convert to A

$$\begin{aligned}
\text{For } n = 1: P_g &= \{1 - [(1 + 0.04)/(1 + 0.10)]^1\} / (0.10 - 0.04) \\
&= 0.90909
\end{aligned}$$

$$\begin{aligned}
A &= 0.90909(A/P, 10\%, 1) \\
&= 0.90909(1.1000) \\
&= 1.0000
\end{aligned}$$

$$\begin{aligned}
\text{For } n = 2: P_g &= \{1 - [(1 + 0.04)/(1 + 0.10)]^2\} / (0.10 - 0.04) \\
&= 1.7686
\end{aligned}$$

$$\begin{aligned}
A &= 1.7686(A/P, 10\%, 2) \\
&= 1.7686(0.57619) \\
&= 1.0190
\end{aligned}$$

$$2.34 P_g = 50,000\{1 - [(1 + 0.06)/(1 + 0.10)]^8\}/(0.10 - 0.06)$$

$$= \$320,573$$

$$2.35 P_{g1} = 10,000\{1 - [(1 + 0.04)/(1 + 0.08)]^{10}\}/(0.08 - 0.04)$$

$$= \$78,590$$

$$P_{g2} = 10,000\{1 - [(1 + 0.06)/(1 + 0.08)]^{11}\}/(0.08 - 0.06)$$

$$= \$92,926$$

Difference = \$14,336

$$2.36 P_g = 260\{1 - [(1 + 0.04)/(1 + 0.06)]^{20}\}/(0.06 - 0.04)$$

$$= 260(15.8399)$$

$$= \$4118.37 \text{ per acre-ft}$$

$$2.37 P = 30,000[10/(1 + 0.06)] = \$283,019$$

$$2.38 18,000,000 = 3,576,420(P/A, i, 7)$$

$$(P/A, i, 7) = 5.0330$$

From interest tables in P/A column and  $n = 7$ ,  $i = 9\%$  per year.

Can be solved using the RATE function = RATE(7,3576420,18000000).

$$2.39 813,000 = 170,000(F/P, i, 15)$$

$$813,000 = 170,000(1 + i)^{15}$$

$$\log 4.78235 = (15)\log (1 + i)$$

$$0.6796/15 = \log (1 + i)$$

$$\log (1 + i) = 0.04531$$

$$1 + i = 1.11$$

$$i = 11 \% \text{ per year}$$

Can be solved using the RATE function = RATE(15,,-170000,813000).

$$2.40 100,000 = 210,325(P/F, i, 30)$$

$$(P/F, i, 30) = 0.47545$$

Find  $i$  by interpolation between 2% and 3%, by solving the P/F equation for  $i$ , or by spreadsheet. By spreadsheet function = RATE(30,,100000,-210325),  $i = 2.51\%$ .

$$2.41 \quad (1,000,000 - 1,900,000) = 200,000(F/P, i, 4)$$

$$(F/P, i, 4) = 4.5$$

Find  $i$  by interpolation between 40% and 50%, by solving F/P equation, or by spreadsheet. By spreadsheet function = RATE(4,,-200000,900000),  $i = 45.7\%$  per year.

$$2.42 \quad 800,000 = 250,000(P/A, i, 5)$$

$$(P/A, i, 5) = 3.20$$

Interpolate between 16% and 18% interest tables or use a spreadsheet. By spreadsheet function,  $i = 16.99\% \approx 17\%$  per year.

$$2.43 \quad 87,360 = 24,000(F/A, i, 3)$$

$$(F/A, i, 3) = 3.6400$$

For  $n = 3$  in F/A column, 3.6400 is in 20% interest table. Therefore,  $i = 20\%$  per year.

$$2.44 \quad 48,436 = 42,000 + 4000(A/G, i, 5)$$

$$6436 = 4000(A/G, i, 5)$$

$$(A/G, i, 5) = 1.6090$$

For  $n = 5$  in A/G column, value of 1.6090 is in 22% interest table.

$$2.45 \quad 600,000 = 80,000(F/A, 15\%, n)$$

$$(F/A, 15\%, n) = 7.50$$

Interpolate in the 15% interest table or use a spreadsheet function. By spreadsheet,  $n = 5.4$  years.

$$2.46 \quad \text{Starting amount} = 1,600,000(0.55) = \$880,000$$

$$1,600,000 = 880,000(F/P, 9\%, n)$$

$$(F/P, 9\%, n) = 1.8182$$

Interpolate in 9% interest table or use the spreadsheet function = NPER(9%,,-880000,1600000) to determine that  $n = 6.94 \approx 7$  years.

$$2.47 \quad 200,000 = 29,000(P/A, 10\%, n)$$

$$(P/A, 10\%, n) = 6.8966$$

Interpolate in 10% interest table or use a spreadsheet function to display  $n = 12.3$  years.

$$2.48 \quad 1,500,000 = 18,000(F/A, 12\%, n)$$

$$(F/A, 12\%, n) = 83.3333$$

Interpolate in 12% interest table or use the spreadsheet function

= NPV(12%, -18000, 1500000) to display  $n = 21.2$  years. Time from now is

$$21.2 - 15 = 6.2 \text{ years.}$$

**2.49**  $350,000 = 15,000(P/A, 4\%, n) + 21,700(P/G, 4\%, n)$

Solve by trial and error in 4% interest table between 5 and 6 years to determine  $n \approx 6$  years

**2.50**  $16,000 = 13,000 + 400(A/G, 8\%, n)$   
 $(A/G, 8\%, n) = 7.5000$

Interpolate in 8% interest table or use a spreadsheet to determine that  $n = 21.8$  years.

**2.51**  $140(0.06 - 0.03) = 12\{1 - [(0.97170)]^x\}$   
 $4.2/12 = 1 - [0.97170]^x$   
 $0.35 - 1 = - [0.97170]^x$   
 $0.65 = [0.97170]^x$

$$\log 0.65 = (x)(\log 0.97170)$$
$$x = 15 \text{ years}$$

**2.52**  $135,300 = 35,000 + 19,000(A/G, 10\%, n)$   
 $100,300 = 19,000(A/G, 10\%, n)$   
 $(A/G, 10\%, n) = 5.2789$

From A/G column in 10% interest table,  $n = 15$  years.

**2.53**  $88,146 = 25,000\{1 - [(1 + 0.18)/(1 + 0.10)]^n\}/(0.10 - 0.18)$   
 $3.52584 = \{1 - [(1.18)/(1.10)]^n\}/(-.08)$   
 $-0.28207 = \{1 - [(1.18)/(1.10)]^n\}$   
 $-1.28207 = - [(1.18)/(1.10)]^n$   
 $1.28207 = [(1.07273)]^n$

$$\log 1.28207 = n \log 1.07273$$
$$0.10791 = n(0.03049)$$
$$n = 3.54 \text{ years}$$

**2.54**  $P = 30,000(P/F, 12\%, 3)$   
 $= 30,000(0.7118)$   
 $= \$21,354$

Answer is (d)



**2.55**  $30,000 = 4200(P/A, 8\%, n)$   
 $(P/A, 8\%, n) = 7.14286$

n is between 11 and 12 years

Answer is (c)

**2.56**  $A = 22,000 + 1000(A/G, 8\%, 5) = \$23,847$

Answer is (a)

**2.57** Answer is (d)

**2.58**  $A = 800 - 100(A/G, 4\%, 6) = \$561.43$

Answer is (b)

**2.59** Answer is (b)

**2.60**  $F = 61,000(F/P, 4\%, 4)$   
 $= 61,000(1.1699)$   
 $= \$71,364$

Answer is (c)

**2.61**  $P = 90,000(P/A, 10\%, 10)$   
 $= 90,000(6.1446)$   
 $= \$553,014$

Answer is (d)

**2.62**  $A = 100,000(A/P, 10\%, 7)$   
 $= 100,000(0.20541)$   
 $= \$20,541$

Answer is (b)

**2.63**  $A = 1,500,000(A/F, 10\%, 20)$   
 $= 1,500,000(0.01746)$   
 $= \$26,190$

Answer is (a)

**2.64** In \$1 million units

$$\begin{aligned} A &= 3(10)(A/P,10\%,10) \\ &= 30(0.16275) \\ &= \$4.8825 \quad (\approx \$4.9 \text{ million}) \end{aligned}$$

Answer is (c)

**2.65**  $75,000 = 20,000(P/A,10\%,n)$   
 $(P/A,10\%,n) = 3.75$

By interpolation or NPER function,  $n = 4.9$  years

Answer is (b)

**2.66**  $50,000(F/A,6\%,n) = 650,000$   
 $(F/A,6\%,n) = 13.0000$

By interpolation or NPER function,  $n = 9.9$  years

Answer is (d)

**2.67**  $40,000 = 13,400(P/A,i,5)$   
 $(P/A,i,5) = 2.9851$

By interpolation or RATE function,  $i = 20.0$  % per year

Answer is (a)

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

Answer is (b)

**2.69**  $F = [5000(P/A,10\%,20) + 1000(P/G,10\%,20)](F/P,10\%,20)$   
 $= [5000(8.5136) + 1000(55.4069)](6.7275)$   
 $= \$659,126$

Answer is (d)

**2.70**  $A = 300,000 - 30,000(A/G,10\%,4)$   
 $= 300,000 - 30,000(1.3812)$   
 $= \$258,564$

Answer is (b)

$$\begin{aligned} \mathbf{2.71} \quad F &= \{5000[1 - (1.03/1.10)^{20}]/(0.10 - 0.03)\}(F/P, 10\%, 20) \\ &= \{5000[1 - (1.03/1.10)^{20}]/(0.10 - 0.03)\}(6.7275) \\ &= \$351,528 \end{aligned}$$

Answer is (c)

## Solution to Case Study, Chapter 2

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There is no definitive answer to case study exercises. The following are examples only.

### Time Marches On; So Does the Interest Rate

1. Situation	A	B	C	D
Interest rate	6% per year	6% per year	15% per year	Simple: 780% per year Comp'd: 143,213% per year

$$\begin{aligned}
 \text{C: } 2 \text{ million} &= 300,000(P/A, i\%, 65) \\
 (P/A, i\%, 64) &= 6.666667 \\
 i &= 15\%
 \end{aligned}$$

$$\text{D: } 30/200 = 15\% \text{ per week}$$

$$\text{Simple: } 15\% (52 \text{ weeks}) = 780\% \text{ per year}$$

$$\text{Compound: } (1.15)^{52} - 1 = 143,213\% \text{ per year}$$

2. A: Start -- \$24

$$\text{End -- } F = 24(1.06)^{385} = \$132 \text{ billion}$$

B: Start -- \$2000 per year or \$20,000 total over 10 years

$$\text{End -- } F_{32} = A(F/A, 6\%, 10) = \$26,361.60$$

$$F_{70} = F_{32}(F/P, 6\%, 38) = \$241,320$$

C: Start -- \$2 million

$$\text{End -- } 300,000(65) = \$19.5 \text{ million over 65 years}$$

$$F_{65} = 300,000(F/A, 15\%, 65) = \$17.6 \text{ billion (equivalent)}$$

D: Simple interest

$$\text{Start -- } \$200$$

$$\text{End -- } (0.15)(12)(200) + 200 = \$1760$$

Compound interest

$$\text{Start -- } \$200$$

$$\text{End -- } 200(1.15)^{52} = \$286,627$$