Solutions to end-of-chapter problems

Engineering Economy, 8th edition

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Chapter 2
Factors: How Time and Interest Affect Money

Determination of F, P and A

2.1 (1) (F/P, 10%, 7) = 1.9487
(2) (A/P, 12%,10) = 0.17698
(3) (P/G,15%,20) = 33.5822
(4) (F/A,2%,50) = 84.5794
(5) (A/G,35%,15) = 2.6889

2.2 F = 1,200,000(F/P,7%,4)
= 1,200,000(1.3108)
= $1,572,960

2.3 F = 200,000(F/P,10%,3)
= 200,000(1.3310)
= $266,200

2.4 P = 7(120,000)(P/F,10%,2)
= 840,000(0.8264)
= $694,176

2.5 F = 100,000,000/30(F/A,10%,30)
= 3,333,333(164.4940)
= $548,313,333

2.6 P = 25,000(P/F,10%,8)
= 25,000(0.4665)
= $11,662.50

2.7 P = 8000(P/A,10%,10)
= 8000(6.1446)
= $49,156.80

2.8 P = 100,000((P/A,12%,2)
= 100,000(1.6901)
= $169,010

2.9 F = 12,000(F/A,10%,30)
= 12,000(164.4940)
= $1,973,928

2.10 A = 50,000,000(A/F,20%,3)
= 50,000,000(0.27473)
= $13,736,500

2.11 F = 150,000(F/P,18%,5)
= 150,000(2.2878)
= $343,170

2.12 P = 75(P/F,18%,2)
= 75(0.7182)
= $53.865 million

2.13 A = 450,000(A/P,10%,3)
= 450,000(0.40211)
= $180,950

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

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

2.16 F = (200 – 90)(F/A,10%,8)
= 110(11.4359)
= $1,257,949

2.17 F = 125,000(F/A,10%,4)
= 125,000(4.6410)
= $580,125

2.18 F = 600,000(0.04)(F/A,10%,3)
= 24,000(3.3100)
= $79,440

2.19 P = 90,000(P/A,20%,3)
= 90,000(2.1065)
= $189,585

2.20 A = 250,000(A/F,9%,5)
= 250,000(0.16709)
= $41,772.50

2.21 A = 1,150,000(A/P,5%,20)
= 1,150,000(0.08024)
= $92,276

2.22 P = (110,000* 0.3)(P/A,12%,4)
= (33,000)(3.0373)
= $100,231

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

2.24 A = 50,000(A/F,20%,3)
= 50,000(0.27473)
= $13,736

Factor Values

2.25 (a) 1. Interpolate between i = 8% and i = 9% at n = 15:

$0.4/1 = x/(0.3152 - 0.2745)$

$x = 0.0163$

$(P/F,8.4\%,15) = 0.3152 - 0.0163$

$= 0.2989$

2. Interpolate between i = 16% and i = 18% at n = 10:

$1/2 = x/(0.04690 - 0.04251)$

$x = 0.00220$

$(A/F,17\%,10) = 0.04690 - 0.00220$

$= 0.04470$

(b) 1. $(P/F,8.4\%,15) = 1/(1 + 0.084)^{15}$

$= 0.2982$

2. $(A/F,17\%,10) = 0.17/[(1 + 0.17)^{10} - 1]$

$= 0.04466$

(c) 1. = -PV(8.4%,15,,1) displays 0.29824

2. = -PMT(17%,10,,1) displays 0.04466

2.26 (a) 1. Interpolate between i = 18% and i = 20% at n = 20:

$1/2 = x/40.06$

$x = 20.03$

$(F/A,19\%,20) = 146.6280 + 20.03$

$=166.658$

2. Interpolate between i = 25% and i = 30% at n = 15:

$1/5 = x/0.5911$

$x = 0.11822$

$(P/A,26\%,15) = 3.8593 - 0.11822$

$= 3.7411$

(b) 1. $(F/A,19\%,20) = [(1+ 0.19)^{20} - 1]/0.19$

$= 165.418$

2. $(P/A,26\%,15) = [(1 + 0.26)^{15} - 1]/[0.26(1 + 0.26)^{15}]$

$= 3.7261$

(c) 1. = -FV(19%,20,1) displays 165.41802

2. = -PV(26%,15,1) displays 3.72607

2.27 (a) 1. Interpolate between n = 32 and n = 34:

1/2 = x/78.3345

x = 39.1673

(F/P,18%,33) = 199.6293 + 39.1673

= 238.7966

2. Interpolate between n = 50 and n = 55:

4/5 = x/0.0654

x = 0.05232

(A/G,12%,54) = 8.1597 + 0.05232

= 8.2120

(b) 1. (F/P,18%,33) = $(1+0.18)^{33}$

= 235.5625

2. (A/G,12%,54) = $\{(1/0.12) – 54/(1+0.12)^{54} –1\}$

= 8.2143

2.28 Interpolated value: Interpolate between n = 40 and n = 45:

3/5 = x/(72.8905 – 45.2593)

x = 16.5787

(F/P,10%,43) = 45.2593 + 16.5787

= 61.8380

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

= 60.2401

% difference = [(61.8380 - 60.2401)/ 60.2401]*100

= 2.65%

Arithmetic Gradient

2.29 (a) G = $-300 (b) CF_5 = $2800 (c) n = 9

2.30 $P_0 = 500(P/A,10\%,9) + 100(P/G,10\%,9)$
$= 500(5.7590) + 100(19.4215)$
$= 2879.50 + 1942.15$
$= \$4821.65$

2.31 (a) Revenue = 390,000 + 2(15,000)
= \$420,000

(b) A = 390,000 + 15,000(A/G,10%,5)
= 390,000 + 15,000(1.8101)
= \$417,151.50

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

2.33 500 = 200 + G(A/G,10%.7)
500 = 200 + G(2.6216)
G = \$114.43

2.34 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

2.35 3500 = A + 40(A/G,10%,9)
3500 = A + 40(3.3724)
A = \$3365.10

2.36 In \$ billion units,
P = 2.1(P/F,18%,5)
= 2.1(0.4371)
= 0.91791 = \$917,910,000

917,910,000 = 100,000,000(P/A,18%,5) + G(P/G,18%,5)
917,910,000 = 100,000,000(3.1272) + G(5.2312)
G = \$115,688,561

2.37 95,000 = 55,000 + G(A/G,10%,5)
95,000 = 55,000 + G(1.8101)
G = \$22,098

2.38 P in year 0 = 500,000(P/F,10%,10)
= 500,000(0.3855)
= \$192,750

192,750 = A + 3000(P/G,10%,10)
192,750 = A + 3000(22.8913)
A = \$124,076

Geometric Gradient

2.39 Find (P/A,g,i,n) using Equation [2.32] and $A_1 = 1$
For n = 1: $P_g = 1*\{1 – [(1 + 0.05)/(1 + 0.10)]^1\}/(0.10 – 0.05)$
$= 0.90909$

For n = 2: $P_g = 1*\{1 – [(1 + 0.05)/(1 + 0.10)]^2\}/(0.10 – 0.05)$
$= 1.77686$

2.40 Decrease deposit in year 4 by 7% per year for three years to get back to year 1.
First deposit = $5550/(1 + 0.07)^3$
= \$4530.45

2.41 $P_g = 35{,}000\{1 – [(1 + 0.05)/(1 + 0.10)]^6\}/(0.10 – 0.05)$
= \$170,486

2.42 $P_g = 200{,}000\{1 – [(1 + 0.03)/(1 + 0.10)]^5\}/(0.10 – 0.03)$
= \$800,520

2.43 First find P_g and then convert to F in year 15

$P_g = (0.10)(160{,}000)\{1 - [(1 + 0.03)/(1 + 0.07)]^{15}/(0.07 - 0.03)\}$

$= 16{,}000(10.883) = \$174{,}128.36$

$F = 174{,}128.36(F/P,7\%,15)$

$= 174{,}128.36\ (2.7590)$

$= \$480{,}420.15$

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

$= 260(15.8399)$

$= \$4119.37$

(b) $P_{Total} = (4119.37)(51{,}000)$

$=\$210{,}087{,}870$

2.45 Solve for P_g in geometric gradient equation and then convert to A

$A_1 = 5{,}000{,}000(0.01) = 50{,}000$

$P_g = 50{,}000[1 - (1.10/1.08)^5]/(0.08 - 0.10)$

$= \$240{,}215$

$A = 240{,}215(A/P,8\%,5)$

$= 240{,}215(0.25046)$

$= \$60{,}164$

2.46 First find P_g and then convert to F

$P_g = 5000[1 - (0.95/1.08)^5]/(0.08 + 0.05)$

$= \$18{,}207$

$F = 18{,}207(F/P,8\%,5)$

$= 18{,}207(1.4693)$

$= \$26{,}751$

Interest Rate and Rate of Return

2.47 1,000,000 = 290,000(P/A,i,5)

(P/A,i,5) = 3.44828

Interpolate between 12% and 14% interest tables or use Excel's RATE function

By RATE, i = 13.8%

2.48 50,000 = 10,000(F/P,i,17)

5.0000 = (F/P,i,17)

$5.0000 = (1 + i)^{17}$

i = 9.93%

2.49 F = A(F/A,i%,5)

451,000 = 40,000(F/A,i%,5)

(F/A,i%,5) = 11.2750

Interpolate between 40% and 50% interest tables or use Excel's RATE function

By RATE, i = 41.6%

2.50 Bonus/year = 6(3000)/0.05 = $360,000

1,200,000 = 360,000(P/A,i,10)

(P/A,i,10) = 3.3333

i = 27.3%

2.51 Set future values equal to each other

Simple: F = P + Pni

= P(1 + 5*0.15)

= 1.75P

Compound: $F = P(1 + i)^n$

$= P(1 + i)^5$

$1.75P = P(1 + i)^5$

i = 11.84%

2.52 100,000 = 190,325(P/F,i,30)

(P/F,i,30) = 0.52542

Find i by interpolation between 2% and 3%, or by solving P/F equation, or by Excel

By RATE function, i = 2.17%

2.53 400,000 = 320,000 + 50,000(A/G,i,5)

(A/G,i,5) = 1.6000

Interpolate between i = 22% and i = 24%

i = 22.6%

Number of Years

2.54 160,000 = 30,000(P/A,15%,n)

(P/A,15%,n) = 5.3333

From 15% table, n is between 11 and 12 years; therefore, n = 12 years

By NPER, n = 11.5 years

2.55 (a) 2,000,000 = 100,000(P/A,5%,n)

(P/A,5%,n) = 20.000

From 5% table, n is > 100 years. In fact, at 5% per year, her account earns $100,000 per year. Therefore, she will be able to withdraw $100,000 forever; actually, n is ∞.

(b) 2,000,000 = 150,000(P/A,5%,n)

(P/A,5%,n) = 13.333

By NPER, n = 22.5 years

(c) The reduction is impressive from forever (n is infinity) to n = 22.5 years for a 50% increase in annual withdrawal. It is important to know how much can be withdrawn annually when a fixed amount and a specific rate of return are involved.

2.56 10A = A(F/A,10%,n)

(F/A,10%,n) = 10.000

From 10% factor table, n is between 7 and 8 years; therefore, n = 8 years

2.57 (a) 500,000 = 85,000(P/A,10%,n)

(P/A,10%,n) = 5.8824

From 10% table, n is between 9 and 10 years.

(b) Using the function = NPER(10%,-85000,500000), the displayed n = 9.3 years.

2.58 1,500,000 = 6,000,000(P/F,25%,n)
(P/F,25%,n) = 0.2500

From 25% table, n is between 6 and 7 years; therefore, n = 7 years

2.59 15,000 = 3000 + 2000(A/G,10%,n)
(A/G,10%,n) = 6.0000

From 10% table, n is between 17 and 18 years; therefore, n = 18 years. She is not correct; it takes longer.

2.60 First set up equation to find present worth of $2,000,000 and set that equal to P in the geometric gradient equation. Then, solve for n.

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

$2{,}000{,}000(P/F,7\%,n) = 10{,}000\{1 – [(1+0.10)/(1+0.07)]^n\}/(0.07 – 0.10)$

Solve for n using Goal Seek or trial and error.
By trial and error, n = is between 25 and 26; therefore, n = 26 years

Exercises for Spreadsheets

2.61

Part	Function	Answer
a	= -FV(10%,30,100000000/30)	**$548,313,409**
b	= -FV(10%,33,100000000/30)	**$740,838,481**
c	= -FV(10%,33,100000000/30) + FV(10%,3,(100000000/30)*2)	**$718,771,814**

2.62

	A	B	C	D	E
1	Part		Function	Result	Conclusion
2	(a) $12,000 for 30 years		= - FV(10%,30,12000)	$1,973,928.27	Not quite reached
3					
4	(a) $8000 for 15; $15,000 for 15 years		= - FV(10%,30,8000) - FV(10%,15,7000)	$ 1,538,359.55	Not reached
5					
6	(b) $12,000 for n years		= NPER(10%,-12000,,2000000)	30.13	Years
7					
8	(c) $8000 for 15; $15000 for 15 years				
9	One solution: Continue the deposits beyond year 30 and determine the future worth year by year.	Year	Function	Accumulated	Conclusion
10		31	= -FV(10%,$B10,8000) - FV(10%,$B10-15,7000)	$ 1,707,195.51	
11		32	= -FV(10%,$B11,8000) - FV(10%,$B11-15,7000)	$ 1,892,915.06	
12		33	= -FV(10%,$B12,8000) - FV(10%,$B12-15,7000)	$ 2,097,206.57	33 years
13		34	= -FV(10%,$B13,8000) - FV(10%,$B13-15,7000)	$ 2,321,927.22	
14		35	= -FV(10%,$B14,8000) - FV(10%,$B14-15,7000)	$ 2,569,119.94	

2.63 Goal Seek template before and result after with solution for G = $115.69 million

	A	B	C	D
1	Gradient amount is ($1000)			$ 50.00
2				
3	Year	Deposit	PV in year 0	FV in year 5
4	0			
5	1	100.00	$84.75	
6	2	150.00	$192.47	
7	3	200.00	$314.20	
8	4	250.00	$443.15	
9	5	300.00	$574.28	$1,313.81
10				

Goal Seek

Set cell: $D$9

To value: 2100

By changing cell: $D$1

OK Cancel

	A	B	C	D	E
1	Gradient amount is ($1000)			$ 115.69	
2					
3	Year	Deposit	PV in year 0	FV in year 5	
4	0				
5	1	100.00	$84.75		
6	2	215.69	$239.65		
7	3	331.38	$441.34		
8	4	447.08	$671.94		
9	5	562.77	$917.93	$2,100.00	

2.64 Here is one approach to the solution using NPV and FV functions with results (left) and formulas (right).

Year, n	Deposit	Present worth in year 0	Future worth in year n
0			
1	10,000	9,346	10,000
2	11,000	18,954	21,700
3	12,100	28,831	35,319
4	13,310	38,985	51,101
5	14,641	49,424	69,319
6	16,105	60,155	90,277
7	17,716	71,188	114,312
8	19,487	82,529	141,801
9	21,436	94,189	173,163
10	23,579	106,176	208,864
11	25,937	118,498	249,422
12	28,531	131,167	295,412
13	31,384	144,190	347,475
14	34,523	157,578	406,321
15	37,975	171,342	472,739
16	41,772	185,492	547,603
17	45,950	200,039	631,885
18	50,545	214,993	726,662
19	55,599	230,367	833,127
20	61,159	246,171	952,605
21	67,275	262,419	1,086,563
22	74,002	279,122	1,236,624
23	81,403	296,294	1,404,591
24	89,543	313,947	1,592,455
25	98,497	332,095	1,802,424
26	108,347	350,752	2,036,941
27	119,182	369,932	2,298,709
28	131,100	389,650	2,590,718
29	144,210	409,920	2,916,279
30	158,631	430,759	3,279,049

Year, n	Deposit	Present worth in year 0	Future worth in year n
0			
= $A3+1	10000	=NPV(7%,$B$4:$B4)	= -FV(7%,$A4,,$C4)
= $A4+1	= $B4*1.1	=NPV(7%,$B$4:$B5)	= -FV(7%,$A5,,$C5)
= $A5+1	= $B5*1.1	=NPV(7%,$B$4:$B6)	= -FV(7%,$A6,,$C6)
= $A6+1	= $B6*1.1	=NPV(7%,$B$4:$B7)	= -FV(7%,$A7,,$C7)
= $A7+1	= $B7*1.1	=NPV(7%,$B$4:$B8)	= -FV(7%,$A8,,$C8)
= $A8+1	= $B8*1.1	=NPV(7%,$B$4:$B9)	= -FV(7%,$A9,,$C9)
= $A9+1	= $B9*1.1	=NPV(7%,$B$4:$B10)	= -FV(7%,$A10,,$C10)
= $A10+1	= $B10*1.1	=NPV(7%,$B$4:$B11)	= -FV(7%,$A11,,$C11)
= $A11+1	= $B11*1.1	=NPV(7%,$B$4:$B12)	= -FV(7%,$A12,,$C12)
= $A12+1	= $B12*1.1	=NPV(7%,$B$4:$B13)	= -FV(7%,$A13,,$C13)
= $A13+1	= $B13*1.1	=NPV(7%,$B$4:$B14)	= -FV(7%,$A14,,$C14)
= $A14+1	= $B14*1.1	=NPV(7%,$B$4:$B15)	= -FV(7%,$A15,,$C15)
= $A15+1	= $B15*1.1	=NPV(7%,$B$4:$B16)	= -FV(7%,$A16,,$C16)
= $A16+1	= $B16*1.1	=NPV(7%,$B$4:$B17)	= -FV(7%,$A17,,$C17)
= $A17+1	= $B17*1.1	=NPV(7%,$B$4:$B18)	= -FV(7%,$A18,,$C18)
= $A18+1	= $B18*1.1	=NPV(7%,$B$4:$B19)	= -FV(7%,$A19,,$C19)
= $A19+1	= $B19*1.1	=NPV(7%,$B$4:$B20)	= -FV(7%,$A20,,$C20)
= $A20+1	= $B20*1.1	=NPV(7%,$B$4:$B21)	= -FV(7%,$A21,,$C21)
= $A21+1	= $B21*1.1	=NPV(7%,$B$4:$B22)	= -FV(7%,$A22,,$C22)
= $A22+1	= $B22*1.1	=NPV(7%,$B$4:$B23)	= -FV(7%,$A23,,$C23)
= $A23+1	= $B23*1.1	=NPV(7%,$B$4:$B24)	= -FV(7%,$A24,,$C24)
= $A24+1	= $B24*1.1	=NPV(7%,$B$4:$B25)	= -FV(7%,$A25,,$C25)
= $A25+1	= $B25*1.1	=NPV(7%,$B$4:$B26)	= -FV(7%,$A26,,$C26)
= $A26+1	= $B26*1.1	=NPV(7%,$B$4:$B27)	= -FV(7%,$A27,,$C27)
= $A27+1	= $B27*1.1	=NPV(7%,$B$4:$B28)	= -FV(7%,$A28,,$C28)
= $A28+1	= $B28*1.1	=NPV(7%,$B$4:$B29)	= -FV(7%,$A29,,$C29)
= $A29+1	= $B29*1.1	=NPV(7%,$B$4:$B30)	= -FV(7%,$A30,,$C30)
= $A30+1	= $B30*1.1	=NPV(7%,$B$4:$B31)	= -FV(7%,$A31,,$C31)
= $A31+1	= $B31*1.1	=NPV(7%,$B$4:$B32)	= -FV(7%,$A32,,$C32)
= $A32+1	= $B32*1.1	=NPV(7%,$B$4:$B33)	= -FV(7%,$A33,,$C33)

Answers: (a) 26 years; (b) 30 years, only 4 years more than the $2 million milestone.

2.65 (a) Present worth is the value of the savings for each bid

Bid 1: Savings = $10,000

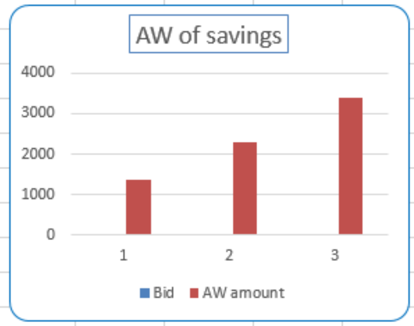
Bid 2: Savings = $17,000

Bid 3: Savings = $25,000

(b) and (c) Spreadsheet for A values and column chart

		Part (b)	
Bid	Savings	AW formula	AW amount
1	10,000	= - PMT(6%,10,$B3)	$1,358.68
2	17,000	= - PMT(6%,10,$B4)	$2,309.76
3	25,000	= - PMT(6%,10,$B5)	$3,396.70

Part (c)



ADDITIONAL PROBLEMS AND FE REVIEW QUESTIONS

2.66 Answer is (a)

2.67 P = 840,000(P/F,10%,2)
= 840,000(0.8264)
= $694,176
Answer is (a)

2.68 P = 81,000(P/F,6%,4)
= 81,000(0.7921)
= $64,160
Answer is (d)

2.69 F = 25,000(F/P,10%,25)
= 25,000(10.8347)
= $270,868
Answer is (c)

2.70 A = 10,000,000(A/F,10%,5)
= 10,000,000(0.16380)
= $1,638,000
Answer is (a)

2.71 A = 2,000,000(A/F,8%,30)
= 2,000,000(0.00883)
= $17,660
Answer is (a)

2.72 390 = 585(P/F,i,5)
(P/F,i,5) = 0.6667
From tables, i is between 8% and 9%
Answer is (c)

2.73 AW = 26,000 + 1500(A/G,8%,5)
= $28,770
Answer is (b)

2.74 30,000 = 4202(P/A,8%,n)
(P/A,8%,5) = 7.1395
n = 11 years
Answer is (d)

2.75 $23{,}632 = 3000\{1- [(1+0.04)^n/(1+0.06)^n]\}/(0.06-0.04)$
$[(23{,}632*0.02)/3000]-1 = (0.98113)^n$
log 0.84245 = nlog 0.98113
n = 9
Answer is (b)

2.76 A = 800 – 100(A/G,8%,6)
= 800 – 100(2.2763)
= $572.37
Answer is (c)

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

2.78 109.355 = 7(P/A,i,25)
(P/A,i,25) = 15.6221

From tables, i = 4%

Answer is (a)

2.79 28,800 = 7000(P/A,10%,5) + G(P/G,10%,5)

28,800 = 7000(3.7908) + G(6.8618)

G = $330

Answer is (d)

2.80 40,000 = 11,096(P/A,i,5)

(P/A,i,5) = 3.6049

i = 12 %

Answer is (c)

Solution to Case Study, Chapter 2

The Amazing Impact of Compound Interest

1. Ford Model T and a New Car

(a) Inflation rate is substituted for i = 3.10% per year

(b) Model T: Beginning cost in 1909: P = \$825
Ending cost: n = 1909 to 2015 + 50 years = 156 years; F = \$96,562

$F = P(1+i)^n = 825(1.031)^{156}$
$= 825(117.0447)$
$= \$96,562$

New car: Beginning cost: P = \$28,000
Ending cost: n = 50 years; F = \$128,853

$F = P(1+i)^n = 28{,}000(1.031)^{50}$
$= 28{,}000(4.6019)$
$= \$128{,}853$

2. Manhattan Island

(a) i = 6.0% per year

(b) Beginning amount in 1626: P = \$24
Ending value: n = 391; F = \$188.3 billion

$F = 24(1.06)^{391}$
$= 24(7{,}845{,}006.7)$
$= \$188{,}280{,}161$ (\$188.3 billion)

3. Pawn Shop Loan

(a) i per week = (30/200)*100 = 15% per week i per year = $[(1.15)^{52} - 1]*100$ = 143,214% per year

Subtraction of 1 considers repayment of the original loan of $200 when the interest rate is calculated (see Chapter 4 for details.)

(b) Beginning amount: P = $200
Ending owed:1 year later, F = $286,627

F = P(F/P, 15%,52)
= $200(1.15)^{52}$
= 200(1433.1370)
= $286,627

4. Capital Investment

(a) i = 15^{+}% per year

1,000,000 = 150,000(P/A,i%,60)
(P/A,i%,60) = 6.6667
i = 15^{+}%

(b) Beginning amount: P = $1,000,000 invested
Ending total amount over 60 years: 150,000(60) = $9 million

Value: F_{60} = 150,000(F/A,15%,60)
= 150,000(29220.0)
= $4,383,000,000 ($4.38 billon)

5. Diamond Ring

(a) i = 4% per year

(b) Beginning price: P = $50
Ending value after 179 years: F = $55,968

n = great grandmother + grandmother + mother + girl
= 65 + 60 + 30 + 24

$= 179$ years

$$F = 50(F/P,4\%,179)$$
$$= 50(1119.35)$$
$$= \$55,968$$