Chapter 5

Present Worth Analysis

Systematic Economic Analysis Technique

1. **Identify the investment alternatives**
2. **Define the planning horizon**
3. **Specify the discount rate**
4. **Estimate the cash flows**
5. **Compare the alternatives**
6. **Perform supplementary analyses**
7. **Select the preferred investment**

Measures of Economic Worth

- Present Worth (≥ $0)
- Future Worth (≥ $0)
- Annual Worth (≥ $0)
- Capitalized Worth (≥ $0)
- Discounted Payback Period (≤ Value, e.g. 2 yrs)
- Payback Period (≤ Value)
- Internal Rate of Return (≥ MARR)
- External Rate of Return (≥ MARR)
- Modified Internal Rate of Return (≥ MARR)
- Benefit/Cost Ratio (≥ 1.0)

Measures of Economic Worth

- **Ranking Methods or Incremental Methods**
  - **Present Worth**
  - **Future Worth**
  - **Annual Worth**
  - **Capitalized Worth**
  - **Discounted Payback Period**
  - **Payback Period**
- **Incremental Methods**
  - **Internal Rate of Return**
  - **External Rate of Return**
  - **Modified Internal Rate of Return**
  - **Benefit/Cost Ratio**

Measures of Economic Worth

- **The following are consistent measures of economic worth, i.e., yield the same recommendation (*if performed correctly*)**
  - **Present Worth**
  - **Future Worth**
  - **Annual Worth**
  - **Internal Rate of Return**
  - **External Rate of Return**
  - **Benefit/Cost Ratio**
- **Capitalized worth yields the same recommendation if the planning horizon is infinitely long or equal to a least common multiple of lives of the investment alternatives**

Present Worth Analysis

- Ranking versus incremental analysis
- Before-tax versus after-tax analysis
- Equal versus unequal lives
- Single versus multiple alternatives
- Finite versus infinite planning horizon
- Discounted payback period and payback period analyses

Present Worth Analysis

Single Alternative

Present Worth Method

- converts all cash flows to a single sum equivalent at time zero using ***i* = *MARR*** over the planning horizon
- the most popular DCF method

$$PW\ (i\%) = \sum_{i=0}^{n} A_t (1+i)^{-t}$$

(bring all cash flows back to "time zero" and add them up!)

Example 5.2

A $500,000 investment in a surface mount placement machine is being considered. Over a 10-year planning horizon, it is estimated the SMP machine will produce net annual savings of $92,500. At the end of 10 years, it is estimated the SMP machine will have a $50,000 salvage value. Based on a 10% MARR and a present worth analysis, should the investment be made?

PW = -$500K + $92.5K(P|A 10%,10) + $50K(P|F 10%,10)

= $87,650.50

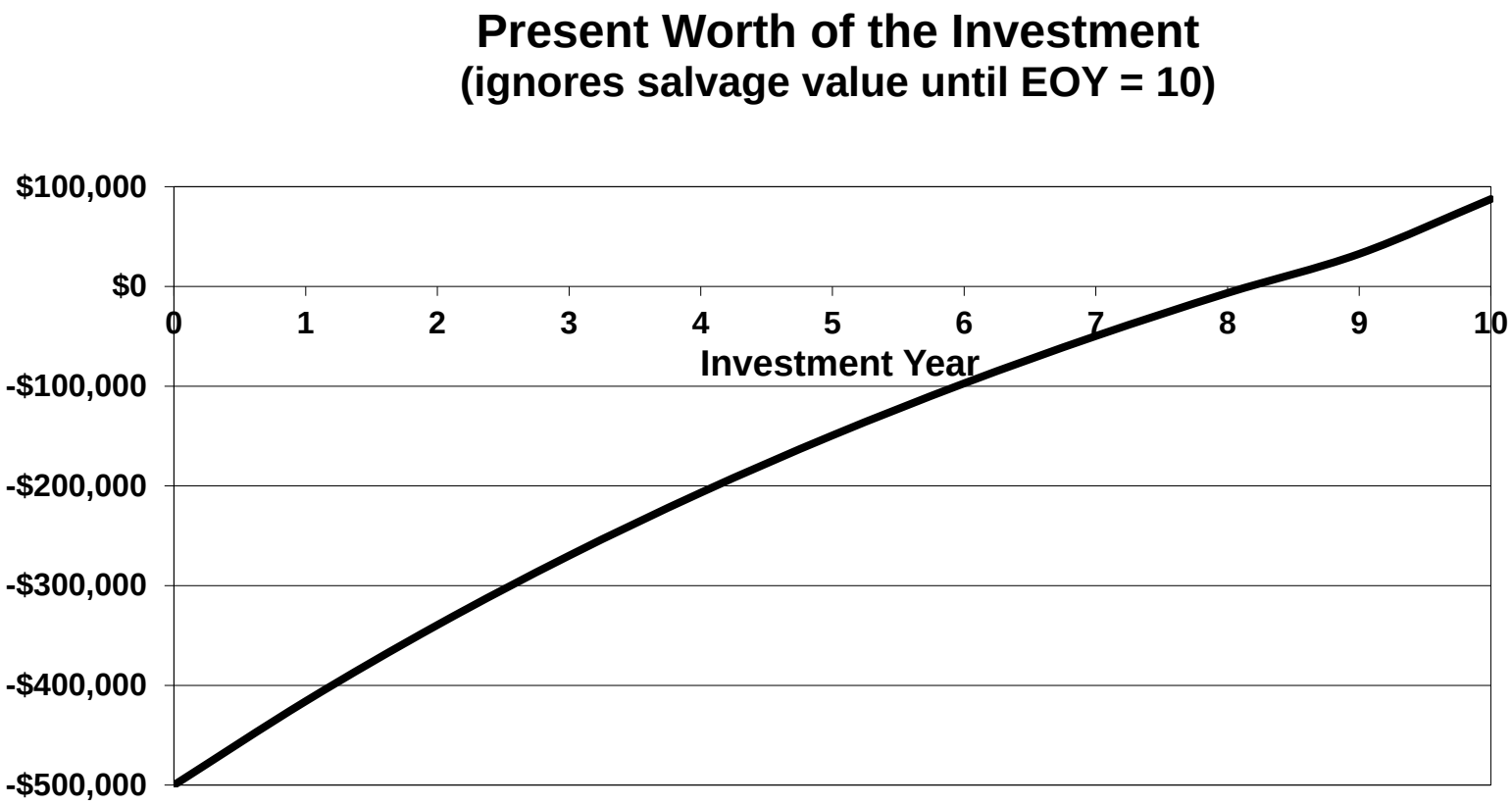
=PV(10%,10,-92500,-50000)-500000

= $87,649.62

Solving with Excel®,

MARR =	10%	(ignores salvage value until EOY = 10)	
EOY	CF	Cum(PW)	
0	-$500,000	-$500,000.00	=B3
1	$92,500	-$415,909.09	=NPV($B$1,$B$4:B4)+$B$3
2	$92,500	-$339,462.81	=NPV($B$1,$B$4:B5)+$B$3
3	$92,500	-$269,966.19	=NPV($B$1,$B$4:B6)+$B$3
4	$92,500	-$206,787.45	=NPV($B$1,$B$4:B7)+$B$3
5	$92,500	-$149,352.22	=NPV($B$1,$B$4:B8)+$B$3
6	$92,500	-$97,138.39	=NPV($B$1,$B$4:B9)+$B$3
7	$92,500	-$49,671.26	=NPV($B$1,$B$4:B10)+$B$3
8	$92,500	-$6,519.33	=NPV($B$1,$B$4:B11)+$B$3
9	$92,500	$32,709.70	=NPV($B$1,$B$4:B12)+$B$3
10	$142,500	$87,649.62	=NPV($B$1,$B$4:B13)+$B$3
PW =	$87,649.62	=NPV(B1,B4:B13)+B3	

Plotting Cumulative Present Worth,



Present Worth Analysis

Multiple Alternatives

$$\underset{\forall j}{Maximize} \; PW_j(i\%) = \sum_{i=0}^{n} A_{jt}(1+i)^{-t}$$

Choose the alternative with the greatest present worth

Example 5.3

Two design alternatives (A & B) are being considered for a new ride (The Scream Machine) at a theme park in Florida. Alternative A requires a $300,000 investment and will produce net annual revenue of $55,000/yr. Alternative B requires a $450,000 investment and will produce net annual revenue of $80,000/yr. At the end of the 10-yr planning horizon, both designs will have negligible salvage values. Based on a 10% *MARR*, which should be chosen? (The "do nothing" alternative is feasible and assumed to have a PW of $0.)

$PW_A(10\%) = -\$300{,}000 + \$55{,}000(P/A\ 10\%,10) = \$37{,}951.35$

$=PV(10\%,10,-55000)-300000 = \$37{,}951.19 > \$0$

(A is better than doing nothing)

$PW_B(10\%) = -\$450{,}000 + \$80{,}000(P/A\ 10\%,10) = \$41{,}565.60$

$=PV(10\%,10,-80000)-450000 = \$41{,}565.37 > PW_A$

(B is better than A)

Example 5.3

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How does PW change with changing *MARR*?

$PW_A(10\%) = -\$300{,}000 + \$55{,}000(P/A\ 10\%,10) = \$37{,}951.35$

=PV(10%,10,-55000)-300000 = $37,951.19 > $0

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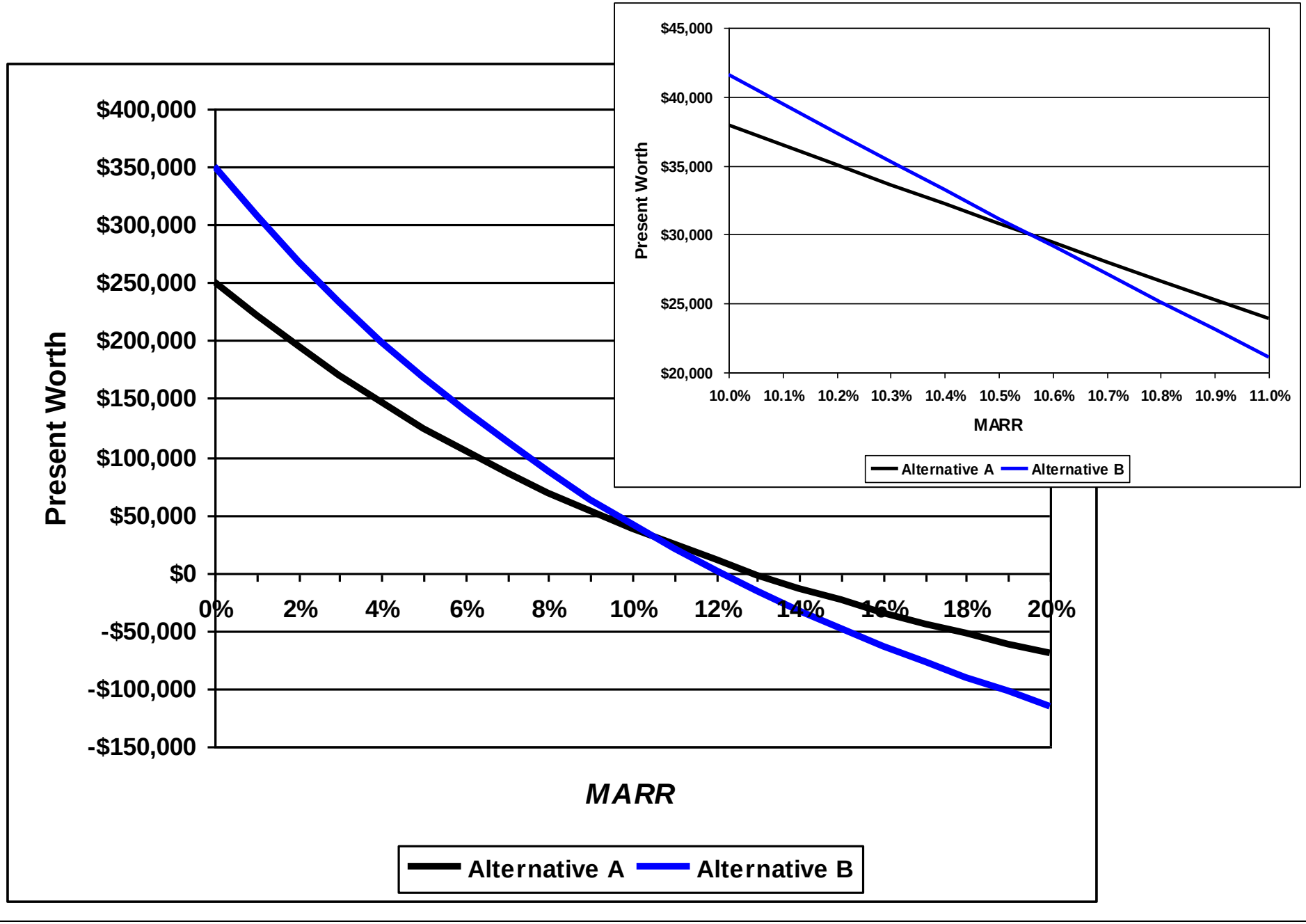
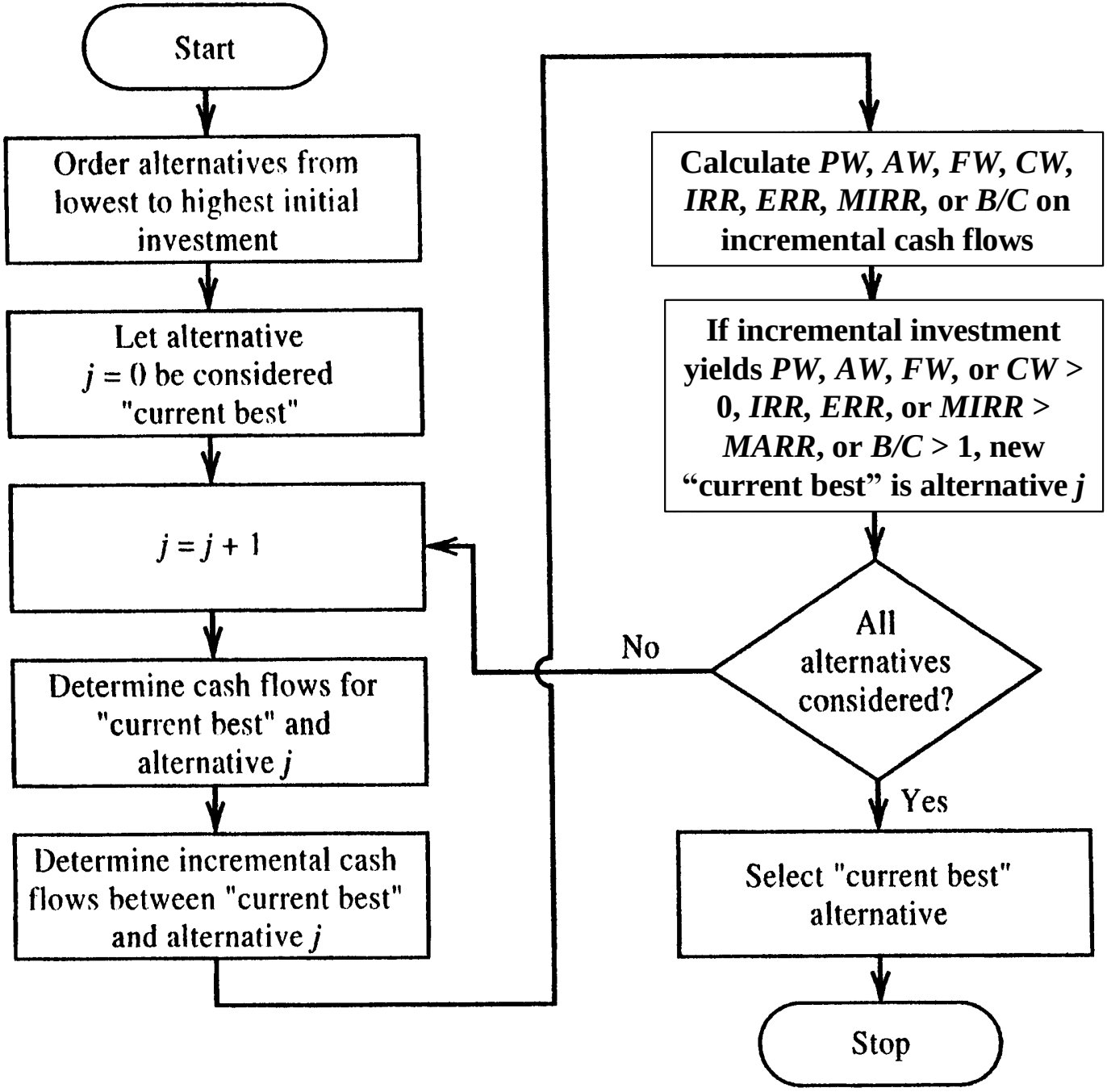

$400,000
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
-$50,000
-$100,000
-$150,000
Present Worth
0%
2%
4%
6%
8%
10%
12%
14%
16%
18%
20%
MARR
Alternative A
Alternative B
$45,000
$40,000
$35,000
$30,000
$25,000
$20,000
Present Worth
10.0%
10.1%
10.2%
10.3%
10.4%
10.5%
10.6%
10.7%
10.8%
10.9%
11.0%
MARR
Alternative A
Alternative B



Flow Chart for the Incremental Comparison of Investment Alternatives

Example 5.4

Let's use an incremental approach to evaluate the two design alternatives for a new ride at a theme park. Recall, Alternative A required a $300,000 investment and produced annual revenue of $55,000; Alternative B required a $450,000 investment and produced annual revenue of $80,000. At the end of the 10-yr planning horizon, both had negligible salvage values. Based on a 10% *MARR*, which should be chosen?

$PW_A(10\%) = -\$300{,}000 + \$55{,}000(P/A\ 10\%,10) = \$37{,}951.35$

=PV(10%,10,-55000)-300000 = $37,951.19 > $0

(A is better than doing nothing)

$PW_{B-A}(10\%) = -\$150{,}000 + \$25{,}000(P/A\ 10\%,10) = \$3{,}614.25$

=PV(10%,10,-25000)-150000 = $3,614.18 > $0

(B is better than A)

Present Worth Analysis

"One Shot" Investments

Example 5.5

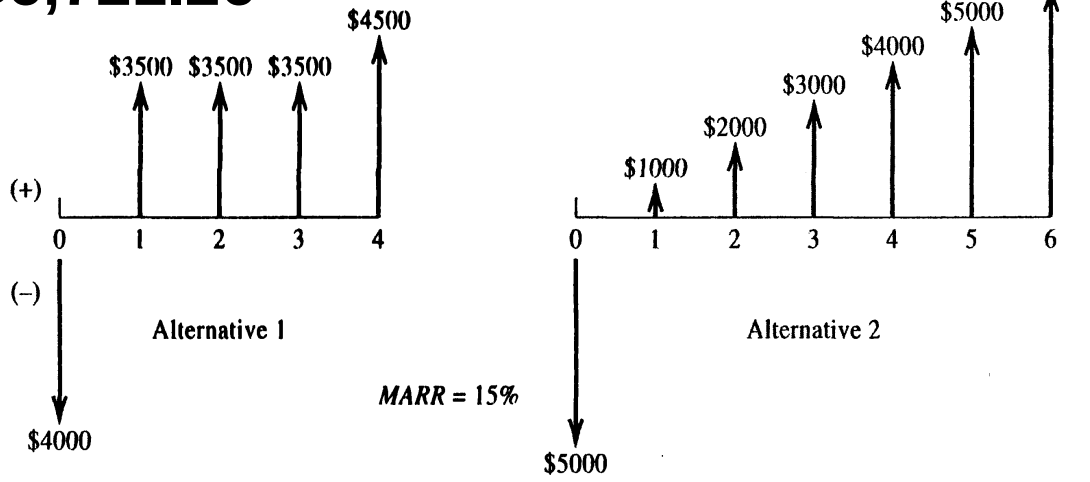
Two investment alternatives (1 & 2) are available, with the CFDs shown below. They are "one shot" investments. Using a 15% MARR, which should be chosen?

$PW_1(15\%) = -\$4{,}000 + \$3{,}500(P|A\ 15\%,4) + \$1{,}000(P|F\ 15\%,4)$

$PW_1(15\%) = \$6{,}564.18$

$PW_2(15\%) = -\$5{,}000 + \$1{,}000(P|A\ 15\%,6) + \$1{,}000(P|G\ 15\%,6)$

$PW_2(15\%) = \$6{,}721.26$



Example 5.5

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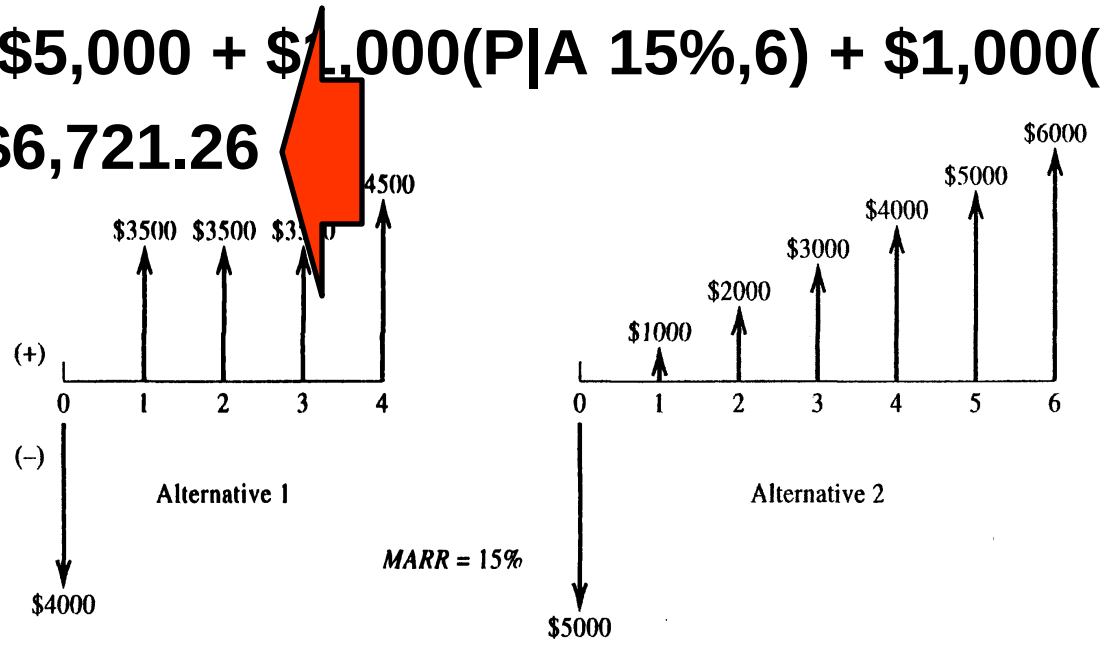
$PW_1(15\%) = -\$4{,}000 + \$3{,}500(P|A\ 15\%,4) + \$1{,}000(P|F\ 15\%,4)$

$PW_1(15\%) = \$6{,}564.18$

$PW_2(15\%) = -\$5{,}000 + \$1{,}000(P|A\ 15\%,6) + \$1{,}000(P|G\ 15\%,6)$

$PW_2(15\%) = \$6{,}721.26$



Discounted Payback Period Analysis

Single Alternative

Discounted Payback Period Method

- determines how long it takes to fully recover an investment while considering the time value of money
- increasing in popularity
- determine the smallest value of m such that

$$\sum_{t=0}^{m} A_t (1+i)^{-t} \geq 0$$

(determine the point in time when cumulative discounted cash flow ≥ $0)

Discounted Payback Period

- **EASTMAN calls this the *net present value payback year***
- **Let's use Excel's® SOLVER and/or GOAL SEEK to determine the DPBP for the SMP investment with salvage value decreasing as geometric and gradient series.**

Example 5.6

Based on a 10% MARR, how long does it take for the $500,000 investment in a surface mount placement machine to be recovered, based on an annual savings of $92,500 and a negligible salvage value, regardless of how long the machine is used?

 # years =NPER(10%,92500,-500000)

= 8.16 years

Example 5.6 (Continued)

How is the PW of the investment in the SMP machine affected when salvage value decreases from $500,000 to $50,000 over the 10-year planning horizon? Consider both geometric and gradient decreases.

Example 5.6 (Continued)

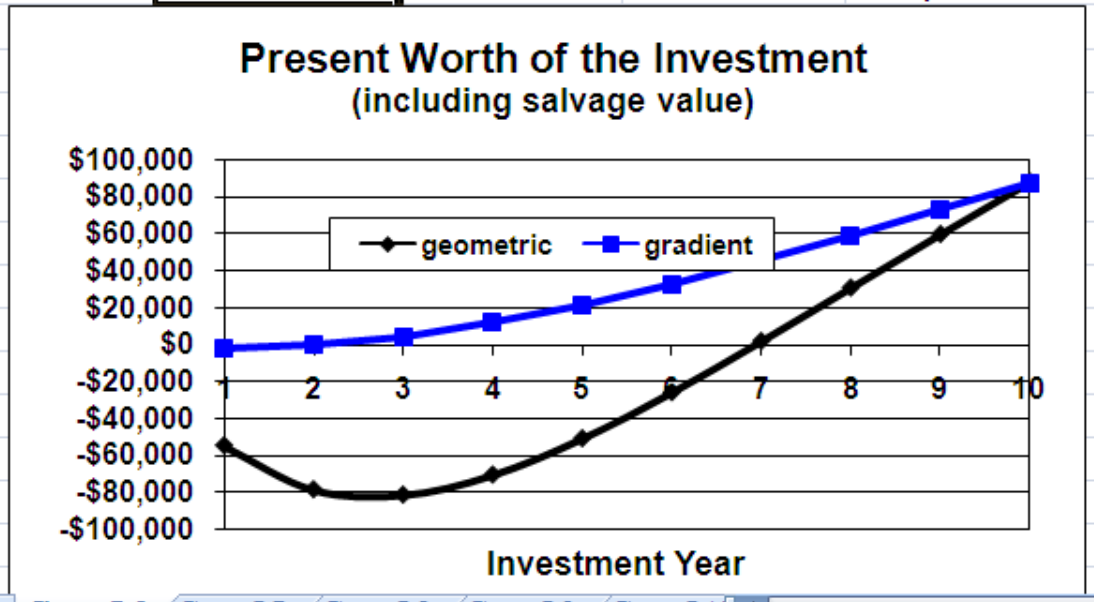
How is the PW of the investment in the SMP machine affected when salvage value decreases from $500,000 to $50,000 over the 10-year planning horizon? Consider both geometric and gradient decreases.

G = ($500,000 - $50,000)/10 = $45,000/yr

j =RATE(10,,-500000,50000) = -20.6%/yr

D13 =PV($B$1,A13,-B13,-C13)+$B$3

	A	B	C	D	E	F	G
1	MARR =	10%					
2	EOY	CF	$SV_{geometric}$	$Cum(PW_{geom})$	$SV_{gradient}$	$Cum(PW_{grad})$	
3	0	-$500,000	$500,000	n/a	$500,000	n/a	
4	1	$92,500	$397,500	-$54,545.45	$455,000	-$2,272.73	=PV($B$1,A4,-B4,-E4)+$B$3
5	2	$92,500	$316,013	-$78,295.45	$410,000	-$619.83	=PV($B$1,A5,-B5,-E5)+$B$3
6	3	$92,500	$251,230	-$81,213.42	$365,000	$4,263.71	=PV($B$1,A6,-B6,-E6)+$B$3
7	4	$92,500	$199,728	-$70,370.67	$320,000	$11,776.86	=PV($B$1,A7,-B7,-E7)+$B$3
8	5	$92,500	$158,784	-$50,760.10	$275,000	$21,401.14	=PV($B$1,A8,-B8,-E8)+$B$3
9	6	$92,500	$126,233	-$25,883.17	$230,000	$32,690.62	=PV($B$1,A9,-B9,-E9)+$B$3
10	7	$92,500	$100,355	$1,826.83	$185,000	$45,262.99	=PV($B$1,A10,-B10,-E10)+$B$3
11	8	$92,500	$79,782	$30,699.75	$140,000	$58,791.71	=PV($B$1,A11,-B11,-E11)+$B$3
12	9	$92,500	$63,427	$59,608.94	$95,000	$72,998.98	=PV($B$1,A12,-B12,-E12)+$B$3
13	10	$92,500	$50,424	$87,813.27	$50,000	$87,649.62	=PV($B$1,A13,-B13,-E13)+$B$3



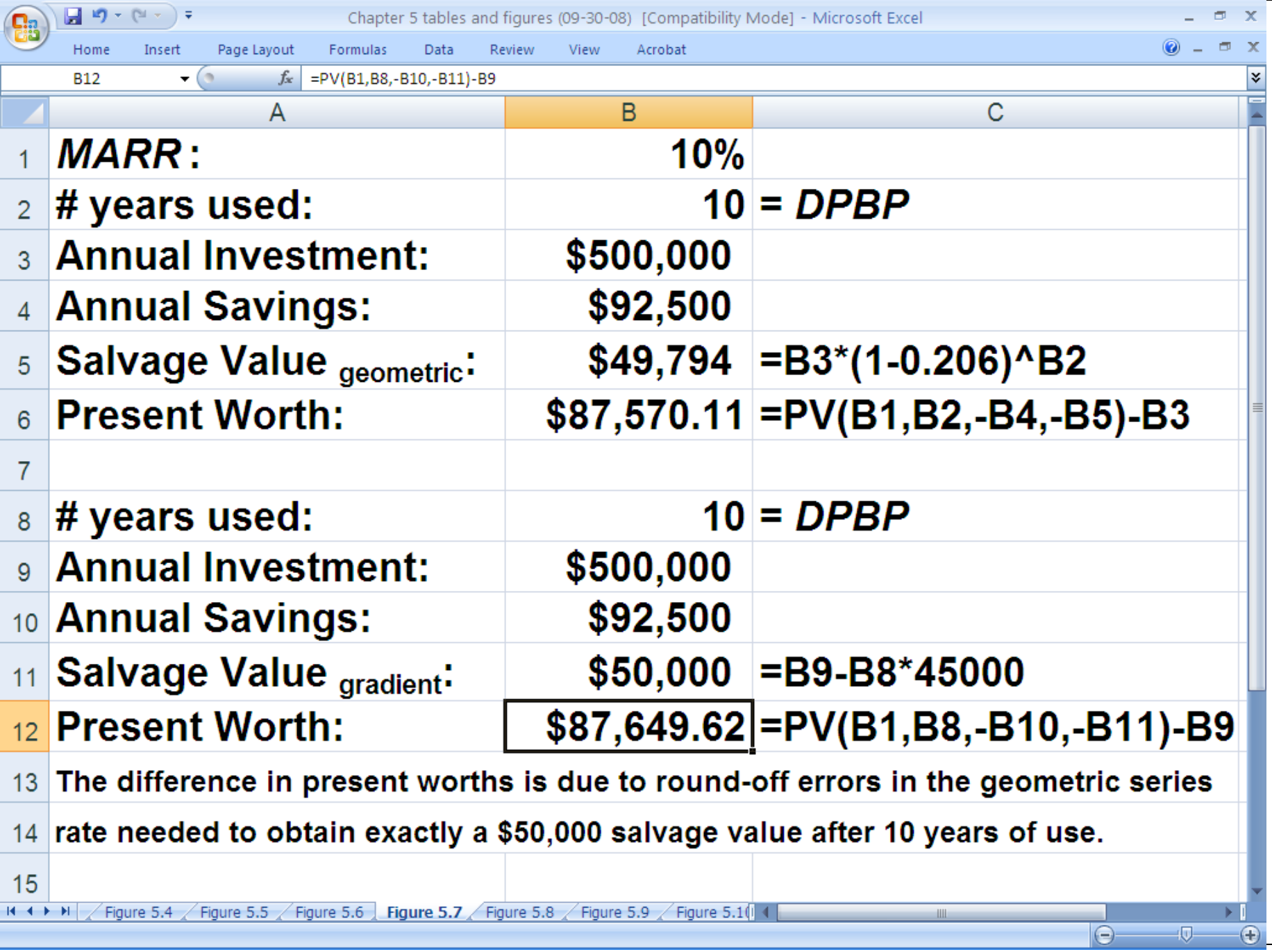
Example 5.7

Based on a 10% MARR, how long does it take for the $500,000 investment in a surface mount placement machine to be recovered, based on an annual savings of $92,500 and a salvage value at the end of n years equal to

a) $500,000(1 – 0.206)^n and

b) $500,000 - $45,000n?

The Excel® SOLVER tool is used to solve the example.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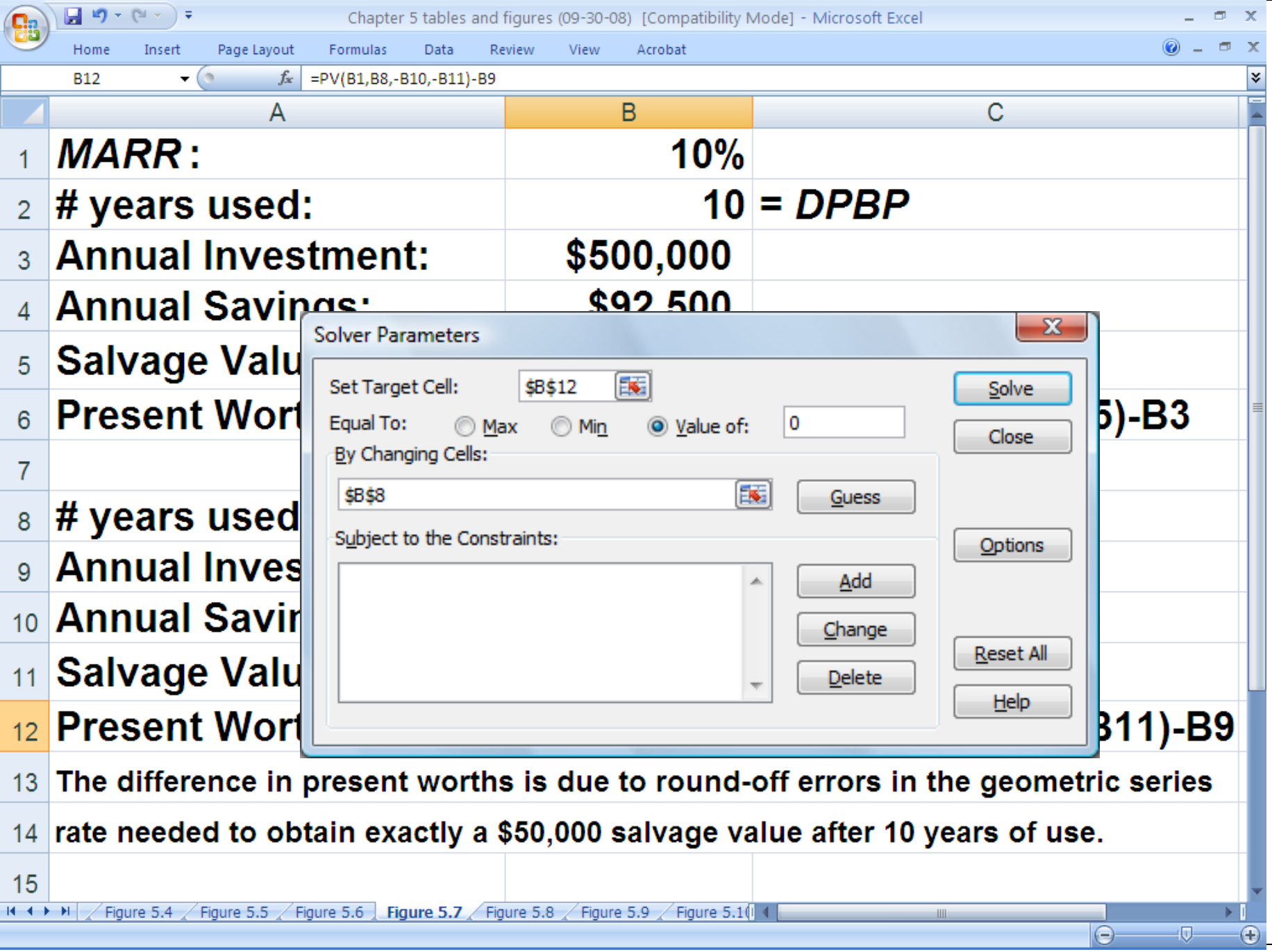
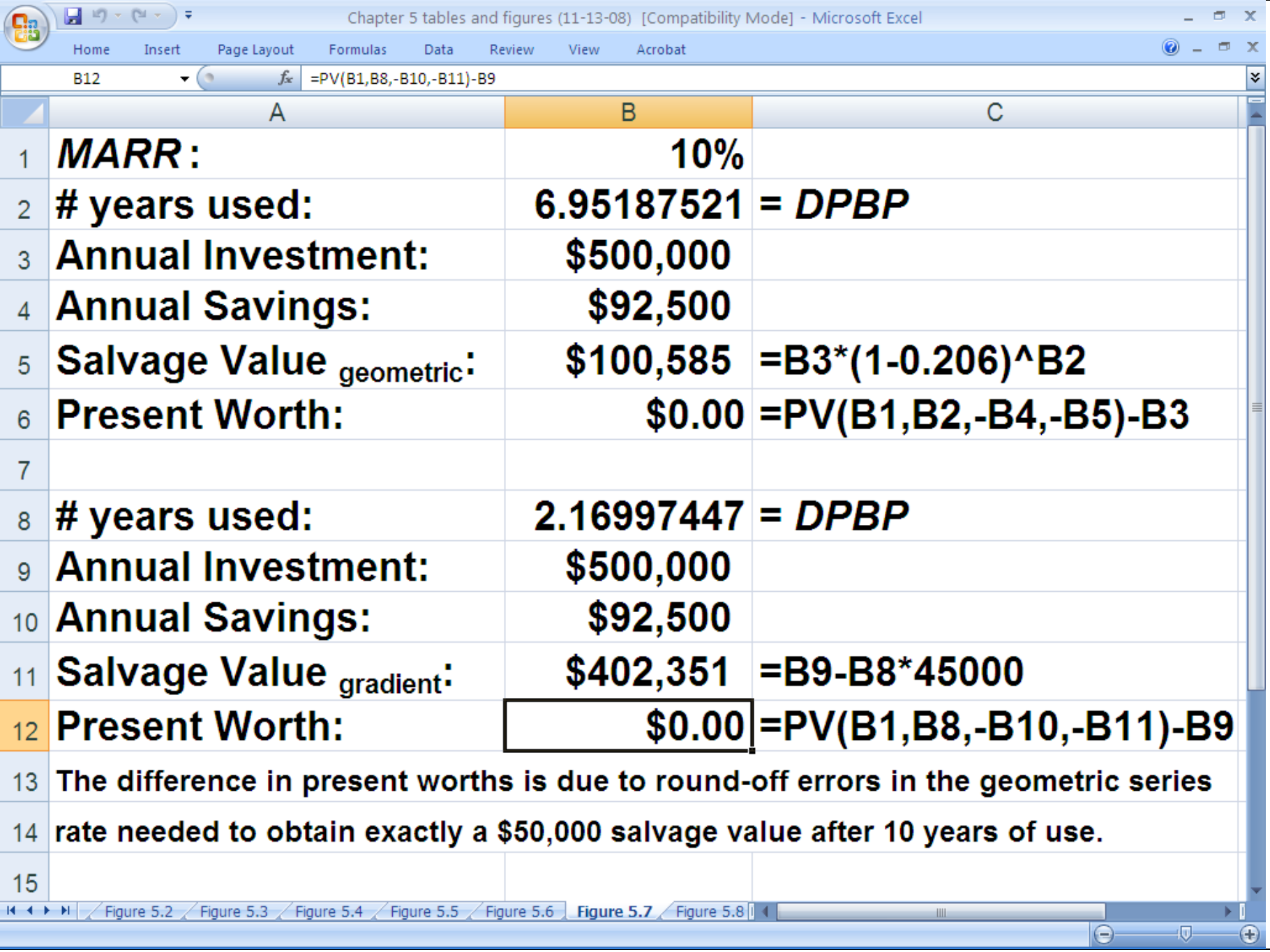
Home Insert Page Layout Formulas Data Review View Acrobat
B12
=PV(B1,B8,-B10,-B11)-B9
A B C
1 MARR: 10%
2 # years used: 10 = DPBP
3 Annual Investment: $500,000
4 Annual Savings: $92,500
5 Salvage Value geometric: $49,794 =B3*(1-0.206)^B2
6 Present Worth: $87,570.11 =PV(B1,B2,-B4,-B5)-B3
7
8 # years used: 10 = DPBP
9 Annual Investment: $500,000
10 Annual Savings: $92,500
11 Salvage Value gradient: $50,000 =B9-B8*45000
12 Present Worth: $87,649.62 =PV(B1,B8,-B10,-B11)-B9
13 The difference in present worths is due to round-off errors in the geometric series
14 rate needed to obtain exactly a $50,000 salvage value after 10 years of use.
15
Figure 5.4 Figure 5.5 Figure 5.6 Figure 5.7 Figure 5.8 Figure 5.9 Figure 5.1


Chapter 5 tables and figures (09-30-08) [Compatibility Mode] - Microsoft Excel
Home Insert Page Layout Formulas Data Review View Acrobat
B12
=PV(B1,B8,-B10,-B11)-B9
A
B
C
1 MARR: 10%
2 # years used: 10 = DPBP
3 Annual Investment: $500,000
4 Annual Savings: $92,500
5 Salvage Valu
6 Present Wort
7
8 # years used
9 Annual Inves
10 Annual Savir
11 Salvage Valu
12 Present Wort
13 The difference in present worths is due to round-off errors in the geometric series
14 rate needed to obtain exactly a $50,000 salvage value after 10 years of use.
15
Solver Parameters
Set Target Cell: $B$12
Equal To: Max Min Value of: 0
By Changing Cells:
$B$8
Guess
Subject to the Constraints:
Add
Change
Delete
Solve
Close
Options
Reset All
Help
Figure 5.4 Figure 5.5 Figure 5.6 Figure 5.7 Figure 5.8 Figure 5.9 Figure 5.1


Chapter 5 tables and figures (11-13-08) [Compatibility Mode] - Microsoft Excel
Home Insert Page Layout Formulas Data Review View Acrobat
B12
=PV(B1,B8,-B10,-B11)-B9
A B C
1 MARR: 10%
2 # years used: 6.95187521 = DPBP
3 Annual Investment: $500,000
4 Annual Savings: $92,500
5 Salvage Value geometric: $100,585 =B3*(1-0.206)^B2
6 Present Worth: $0.00 =PV(B1,B2,-B4,-B5)-B3
7
8 # years used: 2.16997447 = DPBP
9 Annual Investment: $500,000
10 Annual Savings: $92,500
11 Salvage Value gradient: $402,351 =B9-B8*45000
12 Present Worth: $0.00 =PV(B1,B8,-B10,-B11)-B9
13 The difference in present worths is due to round-off errors in the geometric series
14 rate needed to obtain exactly a $50,000 salvage value after 10 years of use.
15
Figure 5.2 Figure 5.3 Figure 5.4 Figure 5.5 Figure 5.6 Figure 5.7 Figure 5.8

Payback Period Method

- EASTMAN calls it the *cash payback year*
- determines the length of time required to recover the initial investment without considering the time value of money
- not equivalent to those already considered
- a popular method of valuing investments
- determine the smallest value of m such that

$$\sum_{t=0}^{m} A_t \geq 0$$

(ignores cash flows that occur after the payback period)

Why Use the Payback Period Method?

- does not require interest rate calculations
- does not require a decision concerning the MARR
- easily explained and understood
- reflects a manager's attitudes when capital is limited
- hedge against uncertainty of future cash flows
- provides a rough measure of the liquidity of an investment

Example 5.8

What is the payback period for the $500,000 SMP investment, given an annual savings of $92,500?

PBP = $500,000/$92,500

= 5.4054 years

=NPER(0%,92500,-500000)

= 5.4054

Discounted Payback Period Analysis

Multiple Alternatives

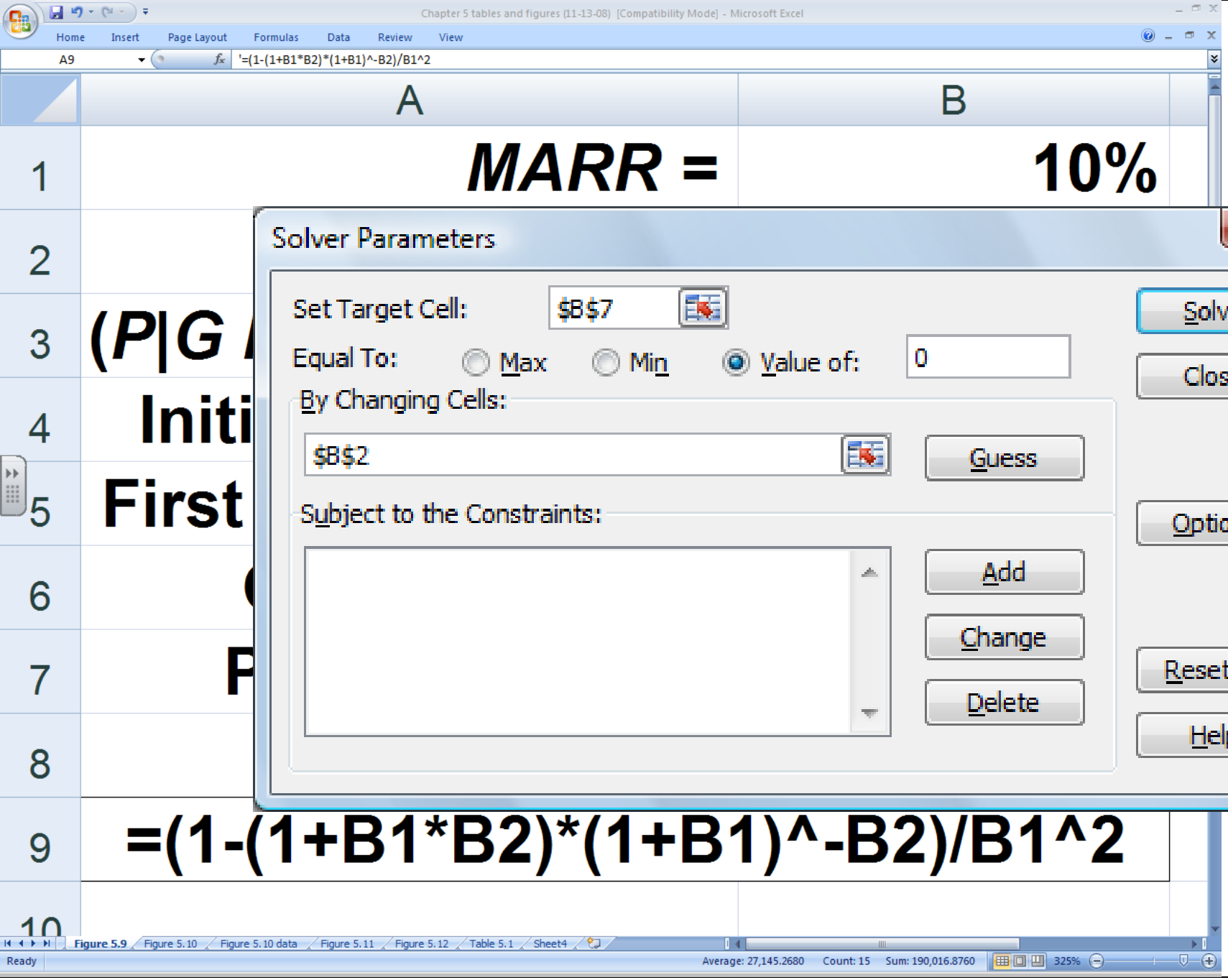
Example 5.9

Now, suppose a third design (alternative C) is developed for The Scream Machine. As before, A requires a $300,000 investment and produces revenue of $55,000/yr; and B requires a $450,000 investment and produces revenue of $80,000/yr. The new design (C) requires a $150,000 investment and produces 1st year revenue of $45,000; thereafter, revenue decreases by $5000/yr. Based on a 10% *MARR*, which design has the smallest DPBP?

$DPBP_A(10\%)$ =NPER(10%,-55000,300000) = 8.273 years

$DPBP_B(10\%)$ =NPER(10%,-80000,450000) = 8.674 years

$DPBP_C(10\%)$ = 6.273 years (using the Excel® SOLVER tool)


Chapter 5 tables and figures (11-13-08) [Compatibility Mode] - Microsoft Excel
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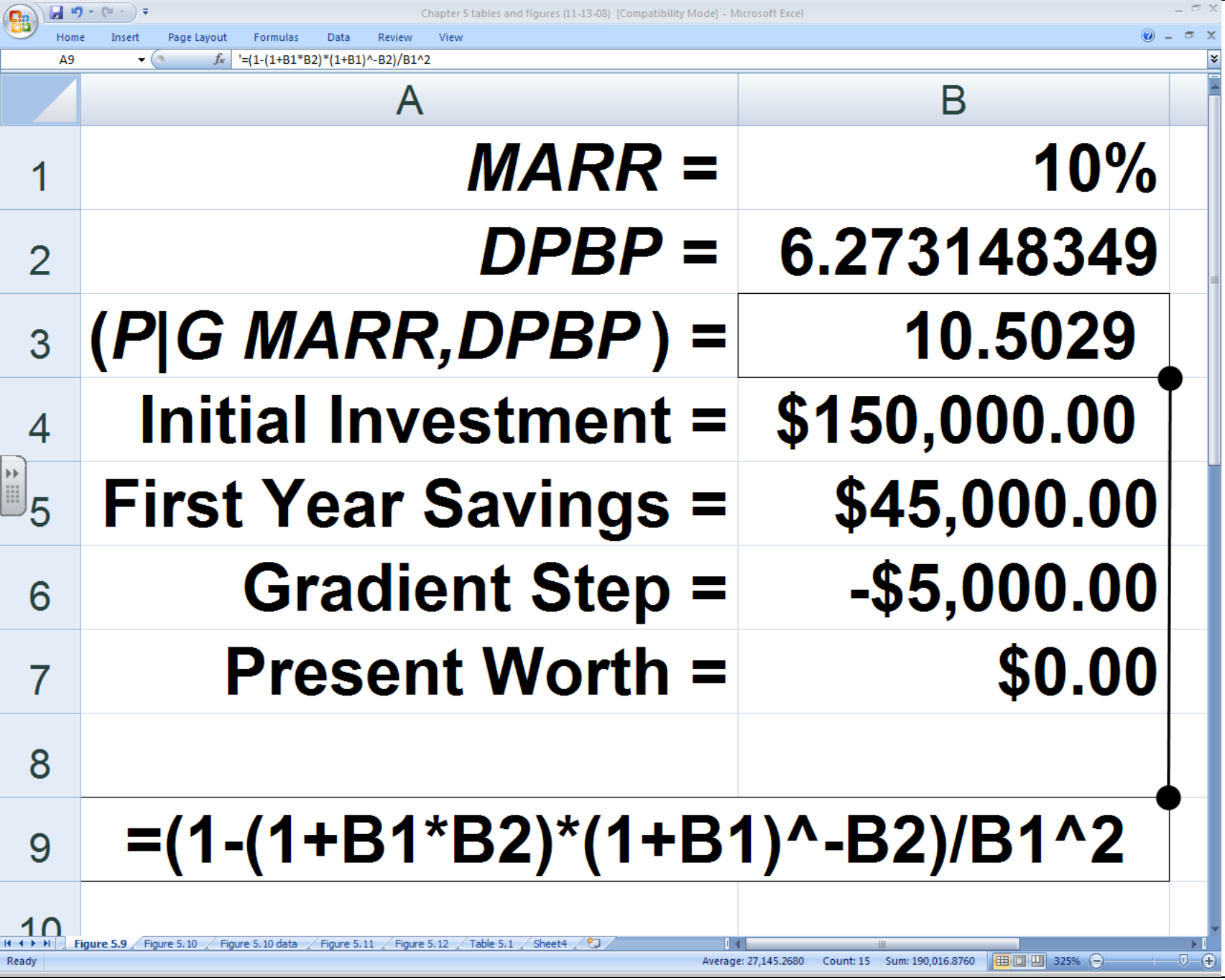
A9
'=(1-(1+B1*B2)*(1+B1)^-B2)/B1^2
A
B
1
MARR =
10%
2
3
(P|G
4
Initi
5
First
6
7
P
8
9
=(1-(1+B1*B2)*(1+B1)^-B2)/B1^2
10
Solver Parameters
Set Target Cell:
$B$7
Equal To:
Max
Min
Value of:
0
By Changing Cells:
$B$2
Subject to the Constraints:
Solve
Close
Guess
Options
Add
Change
Reset All
Delete
Help
Figure 5.9
Figure 5.10
Figure 5.10 data
Figure 5.11
Figure 5.12
Table 5.1
Sheet4
Ready
Average: 27,145.2680
Count: 15
Sum: 190,016.8760
325%


Chapter 5 tables and figures (11-13-08) [Compatibility Mode] - Microsoft Excel
Home
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Data
Review
View
A9
'=(1-(1+B1*B2)*(1+B1)^-B2)/B1^2
A
B
1 MARR = 10%
2 DPBP = 6.273148349
3 (P|G MARR,DPBP) = 10.5029
4 Initial Investment = $150,000.00
5 First Year Savings = $45,000.00
6 Gradient Step = -$5,000.00
7 Present Worth = $0.00
8
9 =(1-(1+B1*B2)*(1+B1)^-B2)/B1^2
10
Figure 5.9
Figure 5.10
Figure 5.10 data
Figure 5.11
Figure 5.12
Table 5.1
Sheet4
Ready
Average: 27,145.2680
Count: 15
Sum: 190,016.8760
325%

Example 5.9

Now, suppose a third design (alternative C) is developed for The Scream Machine. As before, A requires a $300,000 investment and produces revenue of $55,000/yr; and B requires a $450,000 investment and produces revenue of $80,000/yr. The new design (C) requires a $150,000 investment and produces 1st year revenue of $45,000; thereafter, revenue decreases by $5000/yr. Based on a 10% *MARR*, which design has the smallest DPBP?

$DPBP_A(10\%)$ =NPER(10%,-55000,300000) = 8.273 years

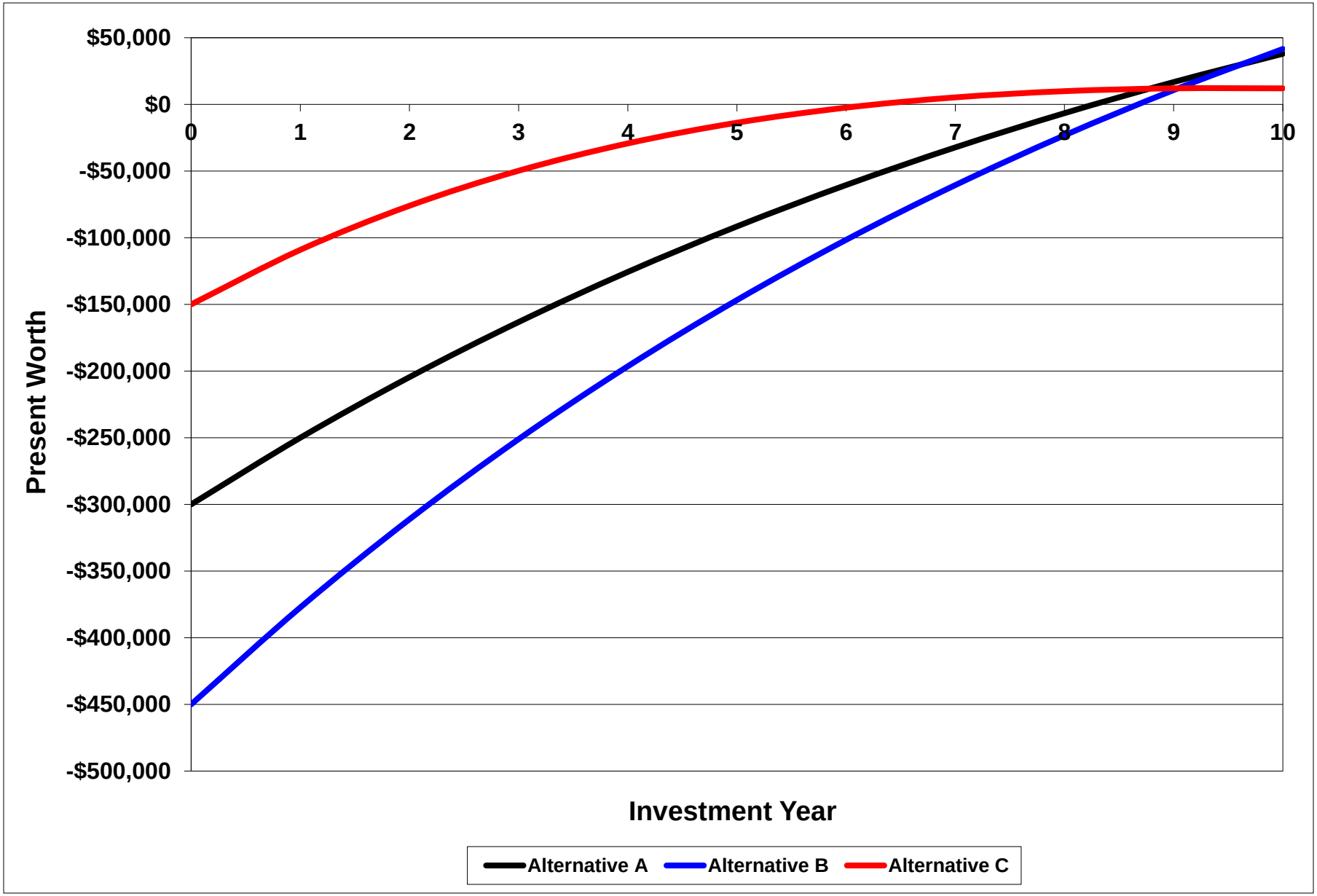
$DPBP_B(10\%)$ =NPER(10%,-80000,450000) = 8.674 years

$DPBP_C(10\%)$ = 6.273 years (using SOLVER)

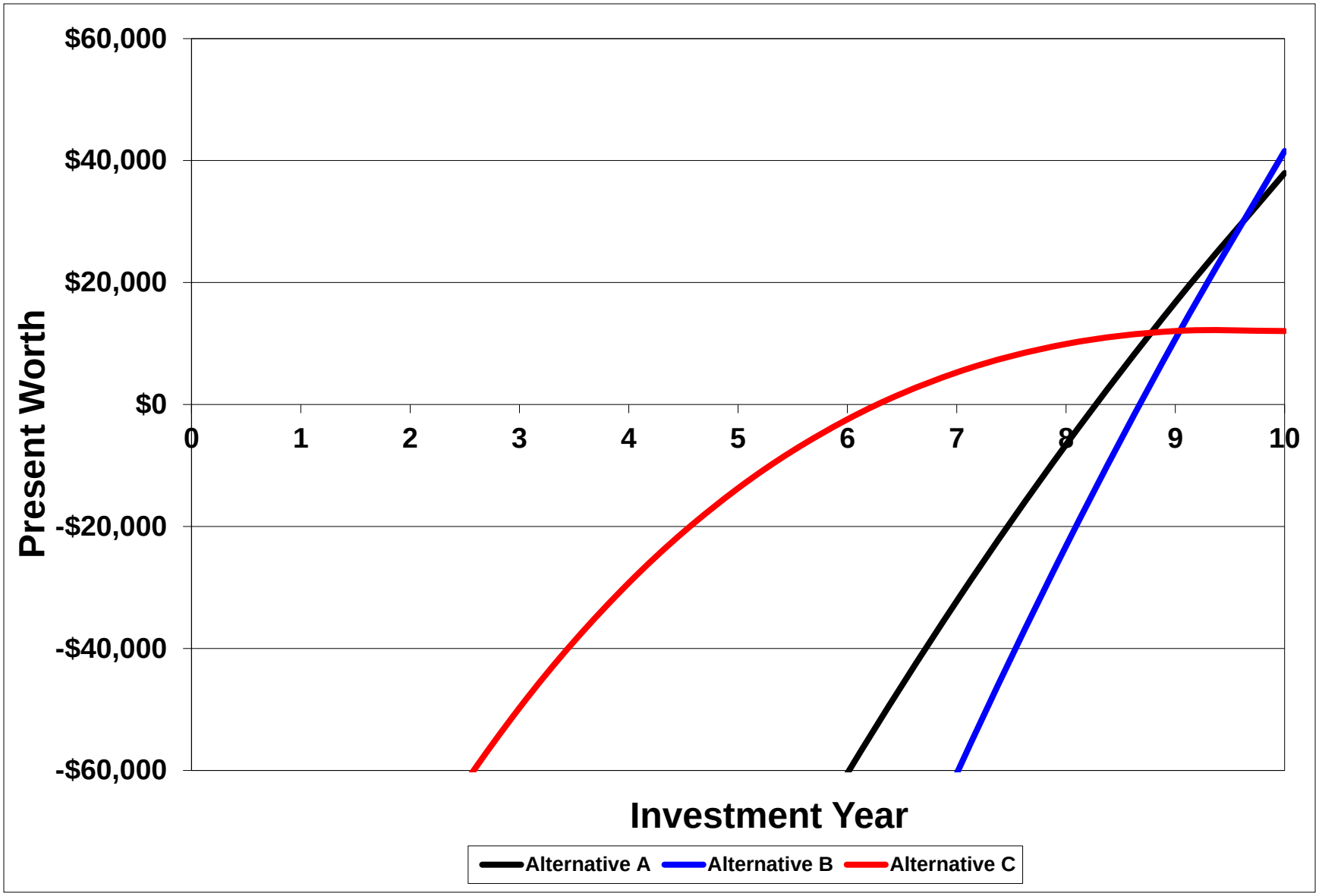
Note: $PW_C(10\%) = -\$150{,}000 + \$45{,}000(P|A\ 10\%,10) - \$5{,}000(P|G\ 10\%,10)$

$PW_C(10\%) = \$12{,}048.81 < PW_A(10\%) < PW_B(10\%)$ B is best, not C!!

Present Worth as a Function of Investment Duration



Close-Up of Critical Region



Example 5.10

Three investments are available, but only one can be pursued: invest $10,000 and obtain $5,000/yr for 2 yrs, plus $1,000 after 5 yrs; invest $10,000 and receive $5,000, $4,000, $3,000, $2,000, and $1,000 over the next 5 yrs; invest $10,000 and receive $2,500/yr for 5 yrs, plus $10,000 after 5 yrs. Which is best using PBP? using PW and a MARR of 10%?

EOY	CF(1)	CumCF(1)	CF(2)	CumCF(2)	CF(3)	CumCF(3)
0	-$10,000	-$10,000	-$10,000	-$10,000	-$10,000	-$10,000
1	$5,000	-$5,000	$5,000	-$5,000	$2,500	-$7,500
2	$5,000	$0	$4,000	-$1,000	$2,500	-$5,000
3	$0	$0	$3,000	$2,000	$2,500	-$2,500
4	$0	$0	$2,000	$4,000	$2,500	$0
5	$1,000	$1,000	$1,000	$5,000	$12,500	$12,500
PBP =		2 yrs		2.33 yrs		4 yrs
PW (10%) =	-$701.39		$2,092.13		$5,686.18	

PBP ranking: 1, 2, 3

PW ranking: 3, 2, 1

Capitalized Worth Analysis

Single Alternative

Capitalized Worth Method

- a perpetuity is an investment that has an infinite life
- the capitalized worth is the present worth of a perpetuity
- the capitalized worth indicates the amount of money needed "up front" such that the interest earned will cover the cash flow requirements forever for the investment
- used mostly by government

$$CW\ (i) = AW\ (i) / i$$

Example 5.11

Every 10 years the dome of the state capital building has to be cleaned, sand blasted, and re-touched. It costs $750,000 to complete the work. Using a 5% MARR, what is the capitalized cost for the refurbishment of the capital dome?

$CC = \$750{,}000 + \$750{,}000(P|F\ 5\%,10) + \$750{,}000(P|F\ 5\%,10) + \ldots$

or

$CC = \$750{,}000(A|P\ 5\%,10)/0.05 = \$750{,}000(0.1295)/0.05 = \$1{,}942{,}500$

CC =PMT(5%,10,-750000)/0.05 = $1,942,569

or

$CC = \$750{,}000 + \$750{,}000(A|F\ 5\%,10)/0.05$

$= \$750{,}000 + \$750{,}000(0.0795)/0.05 = \$1{,}942{,}500$

CC =750000+PMT(5%,10,,-750000)/0.05 = $1,942,569

Recall, $(A/P\ i\%,n) = (A/F\ i\%,n) + i$

Example 5.12

A new highway is to be constructed. Asphalt paving will be used. The asphalt will cost $150/ft, including the material and paving operation. Due to heavy usage, the asphalt is expected to last 5 yrs before requiring resurfacing. The cost of resurfacing will be the same/ft. Paved ditches must be installed on each side of the highway and will cost $7.75/ft to install; ditches will have to be re-paved in 15 yrs at a cost equal to the initial cost. Four pipe culverts are required/mile; each costs $8,000 and will last 10 yrs; replacements will cost $10,000, each, forever. Annual maintenance of the highway will cost $9,000/mi. Cleaning each culvert will cost $1,250/yr. Cleaning and maintaining each ditch will cost $3.75/ft every year. Using a 5% MARR, what is the capitalized cost (*CC*) per mile for the highway?

Example 5.12 (Solution)

Paving Highway and Ditches/mile

CC = 5,280 ft/mi[$150/ft(A|P 5%,5) + $7.75/ft(A|P 5%,15)]/0.05

= $3,737,409

=5280*(PMT(5%,5,-150)+PMT(5%,15,-7.75))/0.05 = $3,737,487

Highway Maintenance/mile

CC = $9,000/0.05 = $180,000

Ditch Maintenance/mile

CC = 2(5,280 ft/mi)($3.75/ft)/0.05 = $792,000

Culverts/mile

CC = 4[($8,000 + $1,250/0.05 + $10,000(A|F 5%,10)/0.05]

= $195,600

=4*(8000+1250/0.05+PMT(5%,10,,-10000)/0.05)

= $195,604

Highway/mile

CC = $3,737,487 + $180,000 + $792,000 + $195,604

= $4,905,091

Example 5.13

How much will it cost to endow a $12,500 scholarship if the endowment earns 4.5% interest?

CW = $12,500/0.045 = $277,777.78

Example 5.14

Suppose, instead of endowing a scholarship, you wish to establish a fund that will pay for the cost of a scholarship for 100 years. How much must you contribute to a fund that earns interest at an annual rate of 9%, if the size of the scholarship grows at an annual rate of 4.5%?

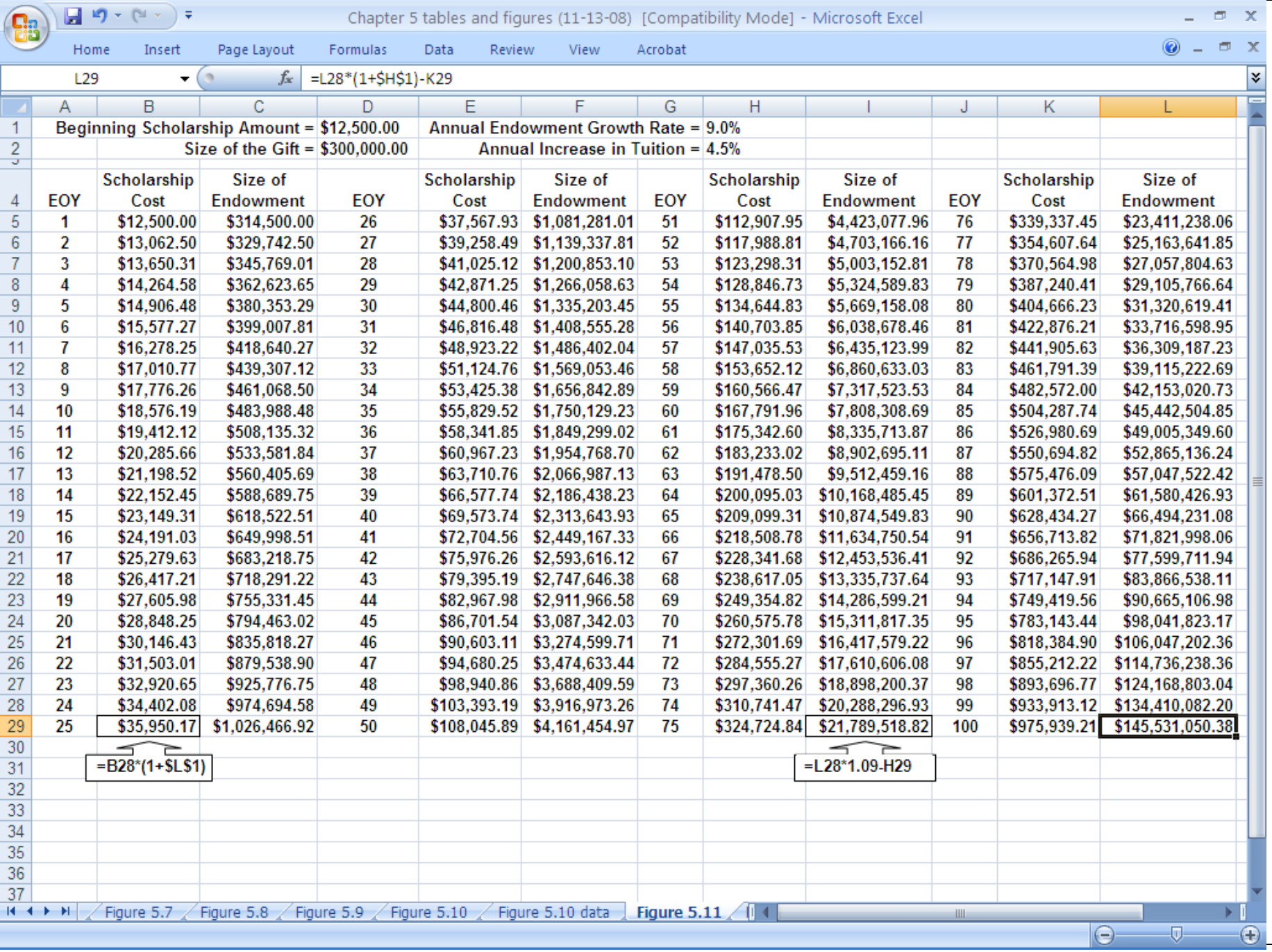

Chapter 5 tables and figures (11-13-08) [Compatibility Mode] - Microsoft Excel
Home Insert Page Layout Formulas Data Review View Acrobat
L29
=L28*(1+$H$1)-K29
Beginning Scholarship Amount = $12,500.00
Size of the Gift = $300,000.00
Annual Endowment Growth Rate = 9.0%
Annual Increase in Tuition = 4.5%
EOY Scholarship Cost Size of Endowment EOY Scholarship Cost Size of Endowment EOY Scholarship Cost Size of Endowment EOY Scholarship Cost Size of Endowment
1 $12,500.00 $314,500.00 26 $37,567.93 $1,081,281.01 51 $112,907.95 $4,423,077.96 76 $339,337.45 $23,411,238.06
2 $13,062.50 $329,742.50 27 $39,258.49 $1,139,337.81 52 $117,988.81 $4,703,166.16 77 $354,607.64 $25,163,641.85
3 $13,650.31 $345,769.01 28 $41,025.12 $1,200,853.10 53 $123,298.31 $5,003,152.81 78 $370,564.98 $27,057,804.63
4 $14,264.58 $362,623.65 29 $42,871.25 $1,266,058.63 54 $128,846.73 $5,324,589.83 79 $387,240.41 $29,105,766.64
5 $14,906.48 $380,353.29 30 $44,800.46 $1,335,203.45 55 $134,644.83 $5,669,158.08 80 $404,666.23 $31,320,619.41
6 $15,577.27 $399,007.81 31 $46,816.48 $1,408,555.28 56 $140,703.85 $6,038,678.46 81 $422,876.21 $33,716,598.95
7 $16,278.25 $418,640.27 32 $48,923.22 $1,486,402.04 57 $147,035.53 $6,435,123.99 82 $441,905.63 $36,309,187.23
8 $17,010.77 $439,307.12 33 $51,124.76 $1,569,053.46 58 $153,652.12 $6,860,633.03 83 $461,791.39 $39,115,222.69
9 $17,776.26 $461,068.50 34 $53,425.38 $1,656,842.89 59 $160,566.47 $7,317,523.53 84 $482,572.00 $42,153,020.73
10 $18,576.19 $483,988.48 35 $55,829.52 $1,750,129.23 60 $167,791.96 $7,808,308.69 85 $504,287.74 $45,442,504.85
11 $19,412.12 $508,135.32 36 $58,341.85 $1,849,299.02 61 $175,342.60 $8,335,713.87 86 $526,980.69 $49,005,349.60
12 $20,285.66 $533,581.84 37 $60,967.23 $1,954,768.70 62 $183,233.02 $8,902,695.11 87 $550,694.82 $52,865,136.24
13 $21,198.52 $560,405.69 38 $63,710.76 $2,066,987.13 63 $191,478.50 $9,512,459.16 88 $575,476.09 $57,047,522.42
14 $22,152.45 $588,689.75 39 $66,577.74 $2,186,438.23 64 $200,095.03 $10,168,485.45 89 $601,372.51 $61,580,426.93
15 $23,149.31 $618,522.51 40 $69,573.74 $2,313,643.93 65 $209,099.31 $10,874,549.83 90 $628,434.27 $66,494,231.08
16 $24,191.03 $649,998.51 41 $72,704.56 $2,449,167.33 66 $218,508.78 $11,634,750.54 91 $656,713.82 $71,821,998.06
17 $25,279.63 $683,218.75 42 $75,976.26 $2,593,616.12 67 $228,341.68 $12,453,536.41 92 $686,265.94 $77,599,711.94
18 $26,417.21 $718,291.22 43 $79,395.19 $2,747,646.38 68 $238,617.05 $13,335,737.64 93 $717,147.91 $83,866,538.11
19 $27,605.98 $755,331.45 44 $82,967.98 $2,911,966.58 69 $249,354.82 $14,286,599.21 94 $749,419.56 $90,665,106.98
20 $28,848.25 $794,463.02 45 $86,701.54 $3,087,342.03 70 $260,575.78 $15,311,817.35 95 $783,143.44 $98,041,823.17
21 $30,146.43 $835,818.27 46 $90,603.11 $3,274,599.71 71 $272,301.69 $16,417,579.22 96 $818,384.90 $106,047,202.36
22 $31,503.01 $879,538.90 47 $94,680.25 $3,474,633.44 72 $284,555.27 $17,610,606.08 97 $855,212.22 $114,736,238.36
23 $32,920.65 $925,776.75 48 $98,940.86 $3,688,409.59 73 $297,360.26 $18,898,200.37 98 $893,696.77 $124,168,803.04
24 $34,402.08 $974,694.58 49 $103,393.19 $3,916,973.26 74 $310,741.47 $20,288,296.93 99 $933,913.12 $134,410,082.20
25 $35,950.17 $1,026,466.92 50 $108,045.89 $4,161,454.97 75 $324,724.84 $21,789,518.82 100 $975,939.21 $145,531,050.38
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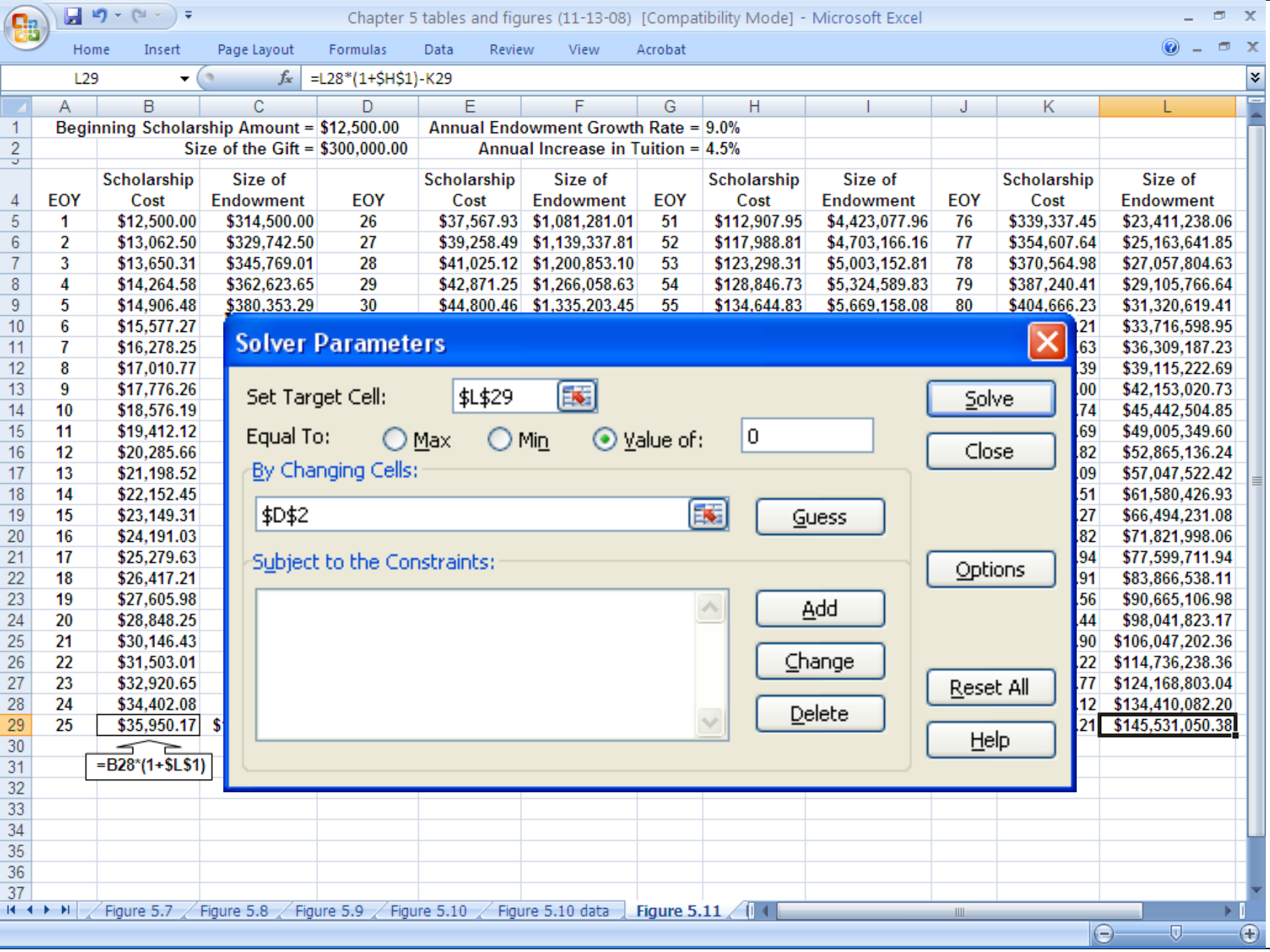
Figure 5.7 Figure 5.8 Figure 5.9 Figure 5.10 Figure 5.10 data Figure 5.11


Chapter 5 tables and figures (11-13-08) [Compatibility Mode] - Microsoft Excel
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Size of the Gift = $300,000.00
Annual Endowment Growth Rate = 9.0%
Annual Increase in Tuition = 4.5%
EOY Scholarship Cost Size of Endowment
1 $12,500.00 $314,500.00
2 $13,062.50 $329,742.50
3 $13,650.31 $345,769.01
4 $14,264.58 $362,623.65
5 $14,906.48 $380,353.29
6 $15,577.27
7 $16,278.25
8 $17,010.77
9 $17,776.26
10 $18,576.19
11 $19,412.12
12 $20,285.66
13 $21,198.52
14 $22,152.45
15 $23,149.31
16 $24,191.03
17 $25,279.63
18 $26,417.21
19 $27,605.98
20 $28,848.25
21 $30,146.43
22 $31,503.01
23 $32,920.65
24 $34,402.08
25 $35,950.17
=B28*(1+$L$1)
EOY Scholarship Cost Size of Endowment
26 $37,567.93 $1,081,281.01
27 $39,258.49 $1,139,337.81
28 $41,025.12 $1,200,853.10
29 $42,871.25 $1,266,058.63
30 $44,800.46 $1,335,203.45
EOY Scholarship Cost Size of Endowment
51 $112,907.95 $4,423,077.96
52 $117,988.81 $4,703,166.16
53 $123,298.31 $5,003,152.81
54 $128,846.73 $5,324,589.83
55 $134,644.83 $5,669,158.08
EOY Scholarship Cost Size of Endowment
76 $339,337.45 $23,411,238.06
77 $354,607.64 $25,163,641.85
78 $370,564.98 $27,057,804.63
79 $387,240.41 $29,105,766.64
80 $404,666.23 $31,320,619.41
$33,716,598.95
$36,309,187.23
$39,115,222.69
$42,153,020.73
$45,442,504.85
$49,005,349.60
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By Changing Cells:
$D$2
Subject to the Constraints:
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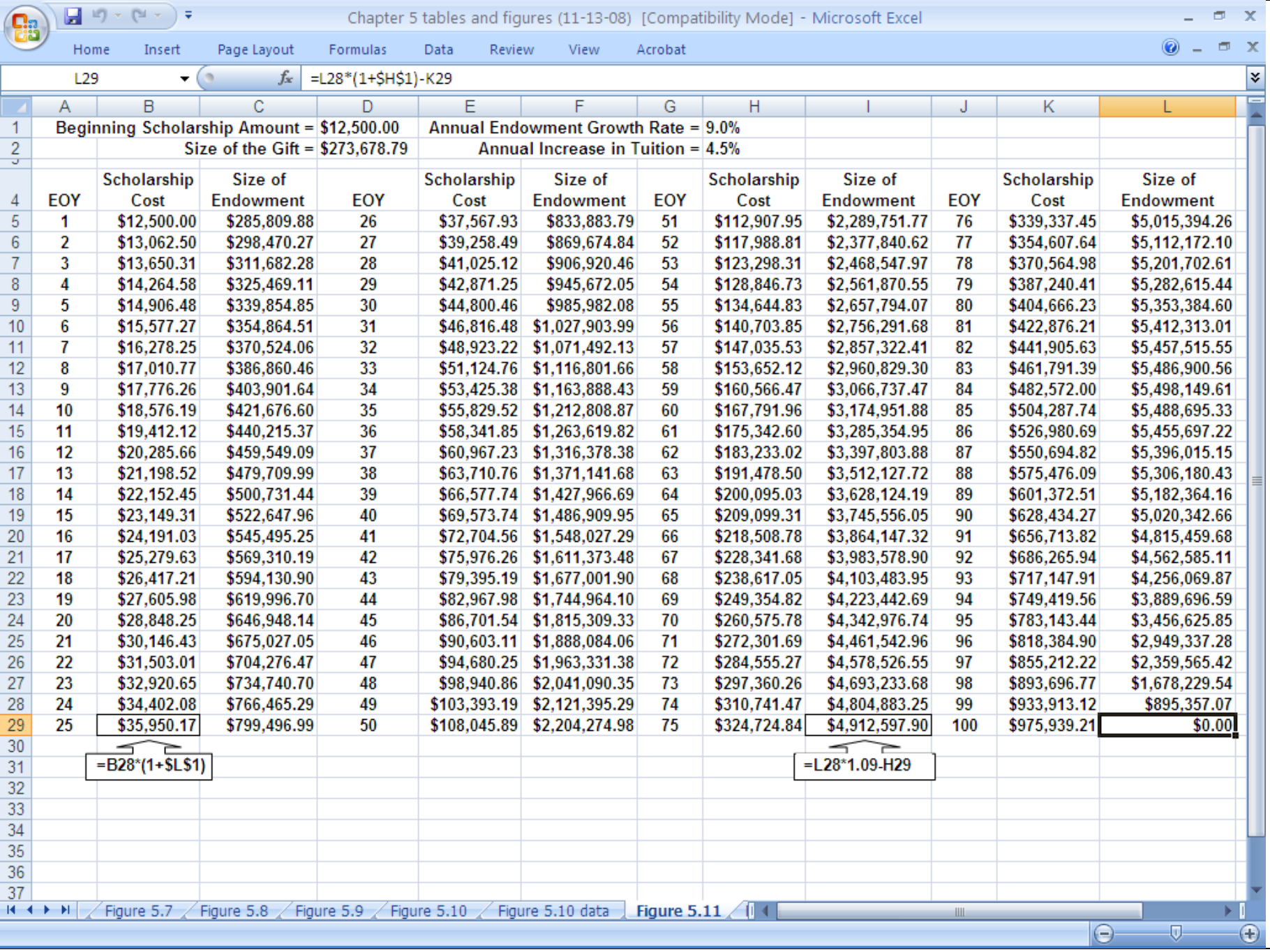
Help
Figure 5.7 Figure 5.8 Figure 5.9 Figure 5.10 Figure 5.10 data Figure 5.11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Size of the Gift = $273,678.79
Annual Endowment Growth Rate = 9.0%
Annual Increase in Tuition = 4.5%
EOY Scholarship Cost Size of Endowment EOY Scholarship Cost Size of Endowment EOY Scholarship Cost Size of Endowment EOY Scholarship Cost Size of Endowment
1 $12,500.00 $285,809.88 26 $37,567.93 $833,883.79 51 $112,907.95 $2,289,751.77 76 $339,337.45 $5,015,394.26
2 $13,062.50 $298,470.27 27 $39,258.49 $869,674.84 52 $117,988.81 $2,377,840.62 77 $354,607.64 $5,112,172.10
3 $13,650.31 $311,682.28 28 $41,025.12 $906,920.46 53 $123,298.31 $2,468,547.97 78 $370,564.98 $5,201,702.61
4 $14,264.58 $325,469.11 29 $42,871.25 $945,672.05 54 $128,846.73 $2,561,870.55 79 $387,240.41 $5,282,615.44
5 $14,906.48 $339,854.85 30 $44,800.46 $985,982.08 55 $134,644.83 $2,657,794.07 80 $404,666.23 $5,353,384.60
6 $15,577.27 $354,864.51 31 $46,816.48 $1,027,903.99 56 $140,703.85 $2,756,291.68 81 $422,876.21 $5,412,313.01
7 $16,278.25 $370,524.06 32 $48,923.22 $1,071,492.13 57 $147,035.53 $2,857,322.41 82 $441,905.63 $5,457,515.55
8 $17,010.77 $386,860.46 33 $51,124.76 $1,116,801.66 58 $153,652.12 $2,960,829.30 83 $461,791.39 $5,486,900.56
9 $17,776.26 $403,901.64 34 $53,425.38 $1,163,888.43 59 $160,566.47 $3,066,737.47 84 $482,572.00 $5,498,149.61
10 $18,576.19 $421,676.60 35 $55,829.52 $1,212,808.87 60 $167,791.96 $3,174,951.88 85 $504,287.74 $5,488,695.33
11 $19,412.12 $440,215.37 36 $58,341.85 $1,263,619.82 61 $175,342.60 $3,285,354.95 86 $526,980.69 $5,455,697.22
12 $20,285.66 $459,549.09 37 $60,967.23 $1,316,378.38 62 $183,233.02 $3,397,803.88 87 $550,694.82 $5,396,015.15
13 $21,198.52 $479,709.99 38 $63,710.76 $1,371,141.68 63 $191,478.50 $3,512,127.72 88 $575,476.09 $5,306,180.43
14 $22,152.45 $500,731.44 39 $66,577.74 $1,427,966.69 64 $200,095.03 $3,628,124.19 89 $601,372.51 $5,182,364.16
15 $23,149.31 $522,647.96 40 $69,573.74 $1,486,909.95 65 $209,099.31 $3,745,556.05 90 $628,434.27 $5,020,342.66
16 $24,191.03 $545,495.25 41 $72,704.56 $1,548,027.29 66 $218,508.78 $3,864,147.32 91 $656,713.82 $4,815,459.68
17 $25,279.63 $569,310.19 42 $75,976.26 $1,611,373.48 67 $228,341.68 $3,983,578.90 92 $686,265.94 $4,562,585.11
18 $26,417.21 $594,130.90 43 $79,395.19 $1,677,001.90 68 $238,617.05 $4,103,483.95 93 $717,147.91 $4,256,069.87
19 $27,605.98 $619,996.70 44 $82,967.98 $1,744,964.10 69 $249,354.82 $4,223,442.69 94 $749,419.56 $3,889,696.59
20 $28,848.25 $646,948.14 45 $86,701.54 $1,815,309.33 70 $260,575.78 $4,342,976.74 95 $783,143.44 $3,456,625.85
21 $30,146.43 $675,027.05 46 $90,603.11 $1,888,084.06 71 $272,301.69 $4,461,542.96 96 $818,384.90 $2,949,337.28
22 $31,503.01 $704,276.47 47 $94,680.25 $1,963,331.38 72 $284,555.27 $4,578,526.55 97 $855,212.22 $2,359,565.42
23 $32,920.65 $734,740.70 48 $98,940.86 $2,041,090.35 73 $297,360.26 $4,693,233.68 98 $893,696.77 $1,678,229.54
24 $34,402.08 $766,465.29 49 $103,393.19 $2,121,395.29 74 $310,741.47 $4,804,883.25 99 $933,913.12 $895,357.07
25 $35,950.17 $799,496.99 50 $108,045.89 $2,204,274.98 75 $324,724.84 $4,912,597.90 100 $975,939.21 $0.00
=B28*(1+$L$1)
=L28*1.09-H29
Figure 5.7 Figure 5.8 Figure 5.9 Figure 5.10 Figure 5.10 data Figure 5.11

Capitalized Worth Analysis

Multiple Alternatives

Example 5.15

In a developing country, two alternatives are being considered for delivering water from a mountainous area to an arid area. A pipeline can be installed at a cost of $125 million; major replacements every 15 years will cost $10 million. Annual O&M costs are estimated to be $5 million. Alternately, a canal can be constructed at a cost of $200 million; annual O&M costs are estimated to be $1 million; upgrades of the canal will be required every 10 years at a cost of $5 million. Using a 5% MARR and a capitalized cost analysis, which alternative should be chosen?

Example 5.15 (Solution)

Pipeline

CC = \$125,000,000 + [\$10,000,000(A|F 5%,15)
+ \$5,000,000]/0.05 = \$234,268,000.00

=125000000+(PMT(5%,15,,-10000000)+5000000)/0.05

= \$234,268,457.52

Canal

CC = \$200,000,000 + [\$5,000,000(A|F 5%,10)
+ \$1,000,000]/0.05 = \$227,950,000.00

= 200000000+(PMT(5%,10,,-5000000)+1000000)/.05

CC = \$227,950,457.50

Pit Stop #5— Open Road Ahead!

1. True or False: Present worth analysis is the most popular *DCF* measure of economic worth.
2. True or False: Unless non-monetary considerations dictate otherwise, choose the mutually exclusive investment alternative that has the greatest present worth, regardless of the lives of the alternatives.
3. True or False: When using present worth analysis to evaluate the economic viability of mutually exclusive alternatives, use a common period of time in the comparison.
4. True or False: If $PW > 0$ and $MARR = 20\%$, then $DPBP < 5$ years.
5. True or False: $DPBP \geq PBP$.
6. True or False: If $CW > 0$, then $PW > 0$.
7. True or False: If $PW(A) > PW(B)$, then $CW(A) > CW(B)$, $DPBP(A) < DPBP(B)$, and $PBP(A) < PBP(B)$.
8. True or False: *PW*, *FW, AW, CW,* and *B/C* are ranking methods; therefore, the alternative having the greatest *PW*, *FW, AW, CW,* or *B/C* should be recommended.
9. True or False: Either ranking or incremental analysis can be used with all four "worth" methods (*PW*, *FW, AW,* and *CW*).
10. True or False: The "do nothing" alternative always has negligible incremental costs and revenues.

Pit Stop #5— Open Road Ahead!

1. True or False: Present worth analysis is the most popular *DCF* measure of economic worth. TRUE
2. True or False: Unless non-monetary considerations dictate otherwise, choose the mutually exclusive investment alternative that has the greatest present worth, regardless of the lives of the alternatives. FALSE
3. True or False: When using present worth analysis to evaluate the economic viability of mutually exclusive alternatives, use a common period of time in the comparison. TRUE
4. True or False: If $PW > 0$ and $MARR = 20\%$, then $DPBP < 5$ years. FALSE
5. True or False: $DPBP \geq PBP$. TRUE
6. True or False: If $CW > 0$, then $PW > 0$. TRUE
7. True or False: If $PW(A) > PW(B)$, then $CW(A) > CW(B)$, $DPBP(A) < DPBP(B)$, and $PBP(A) < PBP(B)$. FALSE
8. True or False: *PW*, *FW, AW, CW,* and *B/C* are ranking methods; therefore, the alternative having the greatest *PW*, *FW, AW, CW,* or *B/C* should be recommended. FALSE
9. True or False: Either ranking or incremental analysis can be used with all four "worth" methods (*PW*, *FW, AW,* and *CW*). TRUE
10. True or False: The "do nothing" alternative always has negligible incremental costs and revenues. FALSE