Chapter 5

Present Worth Analysis

Solutions to Problems

5.1 A service alternative is one that has only costs (no revenues).

5.2 (a) For independent projects, select all that have PW $\geq$ 0; (b) For mutually exclusive projects, select the one that has the highest numerical value.

5.3 (a) Service; (b) Revenue; (c) Revenue; (d) Service; (e) Revenue; (f) Service

5.4 (a) Total possible = $2^5 = 32$

(b) Because of restrictions, cannot have any combinations of 3,4, or 5. Only 12 are acceptable: DN, 1, 2, 3, 4, 5, 1&3, 1&4, 1&5, 2&3, 2&4, and 2&5.

5.5 Equal service means that the alternatives end at the same time.

5.6 Equal service can be satisfied by using a *specified planning period* or by using the *least common multiple of the lives* of the alternatives.

5.7 Capitalized cost represents the present worth of service for an infinite time. Real world examples that might be analyzed using CC would be Yellowstone National Park, Golden Gate Bridge, Hoover Dam, etc.

5.8 PW_{old} = -1200(3.50)(P/A,15%,5)
= -4200(3.3522)
= $-14,079

PW_{new} = -14,000 – 1200(1.20)(P/A,15%,5)
= -14,000 – 1440(3.3522)
= $-18,827

Keep old brackets

5.9 PW_A = -80,000 – 30,000(P/A,12%,3) + 15,000(P/F,12%,3)
= -80,000 – 30,000(2.4018) + 15,000(0.7118)
= $-141,377

PW_B = -120,000 – 8,000(P/A,12%,3) + 40,000(P/F,12%,3)
= -120,000 – 8,000(2.4018) + 40,000(0.7118)
= $-110,742
Select Method B

5.10 Bottled water: Cost/mo = -(2)(0.40)(30) = $24.00
PW = -24.00(P/A,0.5%,12)
= -24.00(11.6189)
= $-278.85

Municipal water: Cost/mo = -5(30)(2.10)/1000 = $0.315
PW = -0.315(P/A,0.5%,12)
= -0.315(11.6189)
= $-3.66

5.11 PW_{single} = -4000 - 4000(P/A,12%,4)
= -4000 - 4000(3.0373)
= $-16,149

PW_{site} = $-15,000

Buy the site license

5.12 $PW_{variable}$ = -250,000 – 231,000(P/A,15%,6) – 140,000(P/F,15%,4)
+ 50,000(P/F,15%,6)
= -250,000 – 231,000(3.7845) – 140,000(0.5718) + 50,000(0.4323)
= $-1,182,656

PW_{dual} = -224,000 –235,000(P/A,15%,6) –26,000(P/F,15%,3)
+ 10,000(P/F,15%,6)
= -224,000 –235,000(3.7845) –26,000(0.6575) + 10,000(0.4323)
= $-1,126,130

Select dual speed machine

5.13 PW_{JX} = -205,000 – 29,000(P/A,10%,4) – 203,000(P/F,10%,2)
+ 2000(P/F,10%,4)
= -205,000 – 29,000(3.1699) – 203,000(0.8264) + 2000(0.6830)
= $-463,320

PW_{KZ} = -235,000 – 27,000(P/A,10%,4) + 20,000(P/F,10%,4)
= -235,000 – 27,000(3.1699) + 20,000(0.6830)
= $-306,927

Select material KZ

5.14 $PW_K = -160,000 – 7000(P/A,2\%,16) –120,000(P/F,2\%,8) + 40,000(P/F,2\%,16)$
$= -160,000 – 7000(13.5777) –120,000(0.8535) + 40,000(0.7284)$
$= \$-328,328$

$PW_L = -210,000 – 5000(P/A,2\%,16) + 26,000(P/F,2\%,16)$
$= -210,000 – 5000(13.5777) + 26,000(0.7284)$
$= \$-258,950$
Select process L

5.15 $PW_{plastic} = -75,000 - 27,000(P/A,10\%,6) - 75,000(P/F,10\%,2)$
$- 75,000(P/F,10\%,4)$
$= -75,000 - 27,000(4.3553) - 75,000(0.8264) - 75,000(0.6830)$
$= \$-305,798$

$PW_{aluminum} = -125,000 – 12,000(P/A,10\%,6) – 95,000(P/F,10\%,3)$
$+ 30,000(P/F,10\%,6)$
$= -125,000 – 12,000(4.3553) – 95,000(0.7513) + 30,000(0.5645)$
$= \$-231,702$

Use aluminum case

5.16 $i/year = (1 + 0.03)^2 – 1 = 6.09\%$
$PW_A = -1,000,000 - 1,000,000(P/A,6.09\%,5)$
$= -1,000,000 - 1,000,000(4.2021)$ (by equation)
$= \$-5,202,100$

$PW_B = -600,000 – 600,000(P/A,3\%,11)$
$= -600,000 – 600,000(9.2526)$
$= \$-6,151,560$

$PW_C = -1,500,000 – 500,000(P/F,3\%,4) – 1,500,000(P/F,3\%,6)$
$- 500,000(P/F,3\%,10)$
$= -1,500,000 – 500,000(0.8885) – 1,500,000(0.8375) – 500,000(0.7441)$
$= \$-3,572,550$

Select plan C

5.17 $FW_{solar} = -12,600(F/P,10\%,4) – 1400(F/A,10\%,4)$
$= -12,600(1.4641) – 1400(4.6410)$
$= \$-24,945$

$FW_{line} = -11,000(F/P,10\%,4) – 800(F/P,10\%,4)$
$= -11,000(1.4641) – 800(4.6410)$
$= \$-19,818$
Install power line

5.18 $FW_{20\%} = -100(F/P,10\%,15) – 80(F/A,10\%,15)$
$= -100(4.1772) – 80(31.7725)$
$= \$-2959.52$

$FW_{35\%} = -240(F/P,10\%,15) – 65(F/A,10\%,15)$
$= -240(4.1772) – 65(31.7725)$
$= \$-3067.74$

20% standard is slightly more economical

5.19 $FW_{purchase} = -150,000(F/P,15\%,6) + 12,000(F/A,15\%,6) + 65,000$
$= -150,000(2.3131) + 12,000(8.7537) + 65,000$
$= \$-176,921$

$FW_{lease} = -30,000(F/A,15\%,6)(F/P,15\%,1)$
$= - 30,000(8.7537)(1.15)$
$= \$-302,003$

Purchase the clamshell

5.20 $FW_{HSS} = -3500(F/P,1\%,6) –2000(F/A,1\%,6) – 3500(F/P,1\%,3)$
$= -3500(1.0615) –2000(6.1520) – 3500(1.0303)$
$= \$-19,625$

$FW_{gold} = -6500(F/P,1\%,6) –1500(F/A,1\%,6)$
$= -6500(1.0615) –1500(6.1520)$
$= \$-16,128$

$FW_{titanium} = -7000(F/P,1\%,6) –1200(F/A,1\%,6)$
$= -7000(1.0615) –1200(6.1520)$
$= \$-14,813$

Use titanium nitride bits

5.21 $FW_A = -300,000(F/P,12\%,10) – 900,000(F/A,12\%,10)$
$= -300,000(3.1058) – 900,000(17.5487)$
$= \$-16,725,570$

$FW_B = -1,200,000(F/P,12\%,10) – 200,000(F/A,12\%,10)$
$– 150,000(F/A,12\%,10)$
$= -1,200,000(3.1058) – 200,000(17.5487) – 150,000(17.5487)$
$= \$-9,869,005$

Select Plan B

5.22 CC = -400,000 – 400,000(A/F,6%,2)/0.06
= -400,000 – 400,000(0.48544)/0.06
=$-3,636,267

5.23 CC = -1,700,000 – 350,000(A/F,6%,3)/0.06
= - 1,700,000 – 350,000(0.31411)/0.06
= $-3,532,308

5.24 CC = -200,000 – 25,000(P/A,12%,4)(P/F,12%,1) – [40,000/0.12])P/F,12%,5)
= -200,000 – 25,000(3.0373)(0.8929) – [40,000/0.12])(0.5674)
= $-456,933

5.25 CC = -250,000,000 – 800,000/0.08 – [950,000(A/F,8%,10)]/0.08
- 75,000(A/F,8%,5)/0.08
= -250,000,000 – 800,000/0.08 – [950,000(0.06903)]/0.08
-75,000(0.17046)/0.08
= $-251,979,538

5.26 Find AW and then divide by i.

AW = [-82,000(A/P,12%,4) – 9000 +15,000(A/F,12%,4)]
= [-82,000(0.32923) – 9000 +15,000(0.20923)]/0.12
= $-32,858.41

CC = -32,858.41/0.12
= $-273,820

5.27 (a) P_{29} = 80,000/0.08
= $1,000,000

(b) P_0 = 1,000,000(P/F,8%,29)
= 1,000,000(0.1073)
= $107,300

5.28 Find AW of each plan, then take difference, and divide by i.
AW_A = -50,000(A/F,10%,5)
= -50,000(0.16380)
= $-8190

AW_B = -100,000(A/F,10%,10)
= -100,000(0.06275)
= $-6275

CC of difference = (8190 - 6275)/0.10
= $19,150

5.29 $CC = -3,000,000 – 50,000(P/A,1\%,12) – 100,000(P/A,1\%,13)(P/F,1\%,12) - [50,000/0.01](P/F,1\%,25)$

$= -3,000,000 – 50,000(11.2551) – 100,000(12.1337)(0.8874) - [50,000/0.01](0.7798)$

$= \$-8,538,500$

5.30 $CC_{petroleum} = [-250,000(A/P,10\%,6) –130,000 + 400,000 + 50,000(A/F,10\%,6)]/0.10$

$= [-250,000(0.22961) –130,000 + 400,000 + 50,000(0.12961)]/0.10$

$= \$2,190,780$

$CC_{inorganic} = [-110,000(A/P,10\%,4) – 65,000 + 270,000 + 20,000(A/F,10\%,4)]/0.10$

$= [-110,000(0.31547) – 65,000 + 270,000 + 20,000(0.21547)]/0.10$

$= \$1,746,077$

Petroleum-based alternative has a larger profit.

5.31 $CC = 100,000 + 100,000/0.08$

$= \$1,350,000$

5.32 $CC_{pipe} = -225,000,000 – 10,000,000/0.10 – [50,000,000(A/F,10\%,40)]/0.10$

$= -225,000,000 – 10,000,000/0.10 – [50,000,000(0.00226)]/0.10$

$= \$-326,130,000$

$CC_{canal} = -350,000,000 – 500,000/0.10$

$= \$-355,000,000$

Build the pipeline

5.33 $CC_E = [-200,000(A/P,3\%,8) + 30,000 + 50,000(A/F,3\%,8)]/0.03$

$= [-200,000(0.14246) + 30,000 + 50,000(0.11246)]/0.03$

$= \$237,700$

$CC_F = [-300,000(A/P,3\%,16) + 10,000 + 70,000(A/F,3\%,16)]/0.03$

$= [-300,000(0.07961) + 10,000 + 70,000(0.04961)]/0.03$

$= \$-347,010$

$CC_G = -900,000 + 40,000/0.03$

$= \$433,333$

Select alternative G.

5.34 No-return payback refers to the time required to recover an investment at i = 0%.

5.35 The alternatives that have large cash flows beyond the date where other alternatives recover their investment might actually be more attractive *over the entire lives* of the alternatives (based on PW, AW, or other evaluation methods).

5.36 $0 = -40{,}000 + 6000(P/A,8\%,n) + 8000(P/F,8\%,n)$

Try n = 9: $0 \neq +1483$

Try n = 8: $0 \neq -1198$

n is between 8 and 9 years

5.37 $0 = -22{,}000 + (3500 - 2000)(P/A,4\%,n)$

$(P/A,4\%,n) = 14.6667$

n is between 22 and 23 *quarters* or 5.75 years

5.38 $0 = -70{,}000 + (14{,}000 - 1850)(P/A,10\%,n)$

$(P/A,10\%,n) = 5.76132$

n is between 9 and 10; therefore, it would take 10 years.

5.39 (a) $n = 35{,}000/(22{,}000 - 17{,}000) = 7$ years

(b) $0 = -35{,}000 + (22{,}000 - 17{,}000)(P/A,10\%,n)$

$(P/A,10\%,n) = 7.0000$

n is between 12 and 13; therefore, n = 13 years.

5.40 $-250{,}000 - 500n + 250{,}000(1 + 0.02)^n = 100{,}000$

Try n = 18: 98,062 < 100,000

Try n = 19: 104,703 > 100,000

n is 18.3 months or 1.6 years.

5.41 Payback: Alt A: $0 = -300{,}000 + 60{,}000(P/A,8\%,n)$

$(P/A,8\%,n) = 5.0000$

n is between 6 and 7 years

Alt B: $0 = -300{,}000 + 10{,}000(P/A,8\%,n) + 15{,}000(P/G,8\%,n)$

Try n = 7: $0 > -37{,}573$

Try n = 8: $0 < +24{,}558$

n is between 7 and 8 years

Select A

PW for 10 yrs: Alt A: PW = -300,000 + 60,000(P/A,8%,10)
= - 300,000 + 60,000(6.7101)
= $102,606

Alt B: PW = -300,000 + 10,000(P/A,8%,10) + 15,000(P/G,8%,10)
= -300,000 + 10,000(6.7101) + 15,000(25.9768)
= $156,753

Select B

Income for Alt B increases rapidly in later years, which is not accounted for in payback analysis.

5.42 LCC = -6.6 – 3.5(P/F,7%,1) – 2.5(P/F,7%,2) – 9.1(P/F,7%,3) – 18.6(P/F,7%,4)
- 21.6(P/F,7%,5) - 17(P/A,7%,5)(P/F,7%,5) – 14.2(P/A,7%,10)(P/F,7%,10)
- 2.7(P/A,7%,3)(P/F,7%,17)
= -6.6 – 3.5(0.9346) – 2.5(0.8734) – 9.1(0.8163) – 18.6(0.7629) - 21.6(0.7130)
- 17(4.1002)(0.7130) – 14.2(7.0236)(0.5083) - 2.7(2.6243)(0.3166)
= $-151,710,860

5.43 LCC = – 2.6(P/F,6%,1) – 2.0(P/F,6%,2) – 7.5(P/F,6%,3) – 10.0(P/F,6%,4)
-6.3(P/F,6%,5) – 1.36(P/A,6%,15)(P/F,6%,5) -3.0(P/F,6%,10)
- 3.7(P/F,6%,18)
= – 2.6(0.9434) – 2.0(0.8900) – 7.5(0.8396) – 10.0(0.7921) -6.3(0.7473)
– 1.36(9.7122)(0.7473) -3.0(0.5584) - 3.7(0.3503)
= $-36,000,921

5.44 LCC_A = -750,000 – (6000 + 2000)(P/A,0.5%,240) – 150,000[(P/F,0.5%,60)
+ (P/F,0.5%,120) + (P/F,0.5%,180)]
= -750,000 – (8000)(139.5808) – 150,000[(0.7414) + (0.5496) + (0.4075)]
= $-2,121,421

LCC_B = -1.1 – (3000 + 1000)(P/A,0.5%,240)
= -1.1 – (4000)(139.5808)
= $-1,658,323

Select proposal B.

5.45 LCC_A = -250,000 – 150,000(P/A,8%,4) – 45,000 – 35,000(P/A,8%,2)
-50,000(P/A,8%,10) – 30,000(P/A,8%,5)
= -250,000 – 150,000(3.3121) – 45,000 – 35,000(1.7833)
-50,000(6.7101) – 30,000(3.9927)
= $-1,309,517

LCC_B = -10,000 – 45,000 - 30,000(P/A,8%,3) – 80,000(P/A,8%,10)
- 40,000(P/A,8%,10)
= -10,000 – 45,000 - 30,000(2.5771) – 80,000(6.7101) - 40,000(6.7101)
= $-937,525

LCC_C = -175,000(P/A,8%,10)
= -175,000(6.7101)
= $-1,174,268

Select alternative B.

5.46 I = 10,000(0.06)/4 = $150 every 3 months

5.47 800 = (V)(0.04)/2
V = $40,000

5.48 1500 = (20,000)(b)/2
b = 15%

5.49 Bond interest rate and market interest rate are the same.
Therefore, PW = face value = $50,000.

5.50 I = (50,000)(0.04)/4
= $500 every 3 months

PW = 500(P/A,2%,60) + 50,000(P/F,2%,60)
= 500(34.7609) + 50,000(0.3048)
= $32,620

5.51 There are 17 years or 34 semiannual periods remaining in the life of the bond.

I = 5000(0.08)/2
= $200 every 6 months

PW = 200(P/A,5%,34) + 5000(P/F,5%,34)
= 200(16.1929) + 5000(0.1904)
= $4190.58

5.52 I = (V)(0.07)/2
201,000,000 = I(P/A,4%,60) + V(P/F,4%,60)

Try V = 226,000,000: 201,000,000 > 200,444,485
Try V = 227,000,000: 201,000,000 < 201,331,408

By interpolation, V = $226,626,340

5.53 (a) I = (50,000)(0.12)/4
= $1500

Five years from now there will be 15(4) = 60 payments left. PW_5 then is:

PW_5 = 1500(P/A,2%,60) + 50,000(P/F,2%,60)
= 1500(34.7609) + 50,000(0.3048)
= $67,381

(b) Total = 1500(F/A,3%,20) + 67,381 [PW in year 5 from (a)]
= 1500(26.8704) + 67,381
= $107,687

FE Review Solutions

5.54 Answer is (b)

5.55 PW = 50,000 + 10,000(P/A,10%,15) + [20,000/0.10](P/F,10%,15)
= $173,941
Answer is (c)

5.56 CC = [40,000/0.10](P/F,10%,4)
= $273,200
Answer is (c)

5.57 CC = [50,000/0.10](P/F,10%,20)(A/F,10%,10)
= $4662.33
Answer is (b)

5.58 PW_X = -66,000 –10,000(P/A,10%,6) + 10,000(P/F,10%,6)
= -66,000 –10,000(4.3553) + 10,000(0.5645)
= $-103,908
Answer is (c)

5.59 PW_Y = -46,000 –15,000(P/A,10%,6) - 22,000(P/F,10%,3) + 24,000(P/F,10%,6)
= -46,000 –15,000(4.3553) - 22,000(0.7513) + 24,000(0.5645)
= $-114,310
Answer is (d)

5.60 CC_X = [-66,000(A/P,10%,6) – 10,000 + 10,000(A/F,10%,6)]/0.10
= [-66,000(0.22961) – 10,000 + 10,000(0.12961)]/0.10
= $-238,582
Answer is (d)

5.61 CC = -10,000(A/P,10%,5)/0.10
= -10,000(0.26380)/0.10
= $-26,380
Answer is (b)

5.62 Answer is (c)

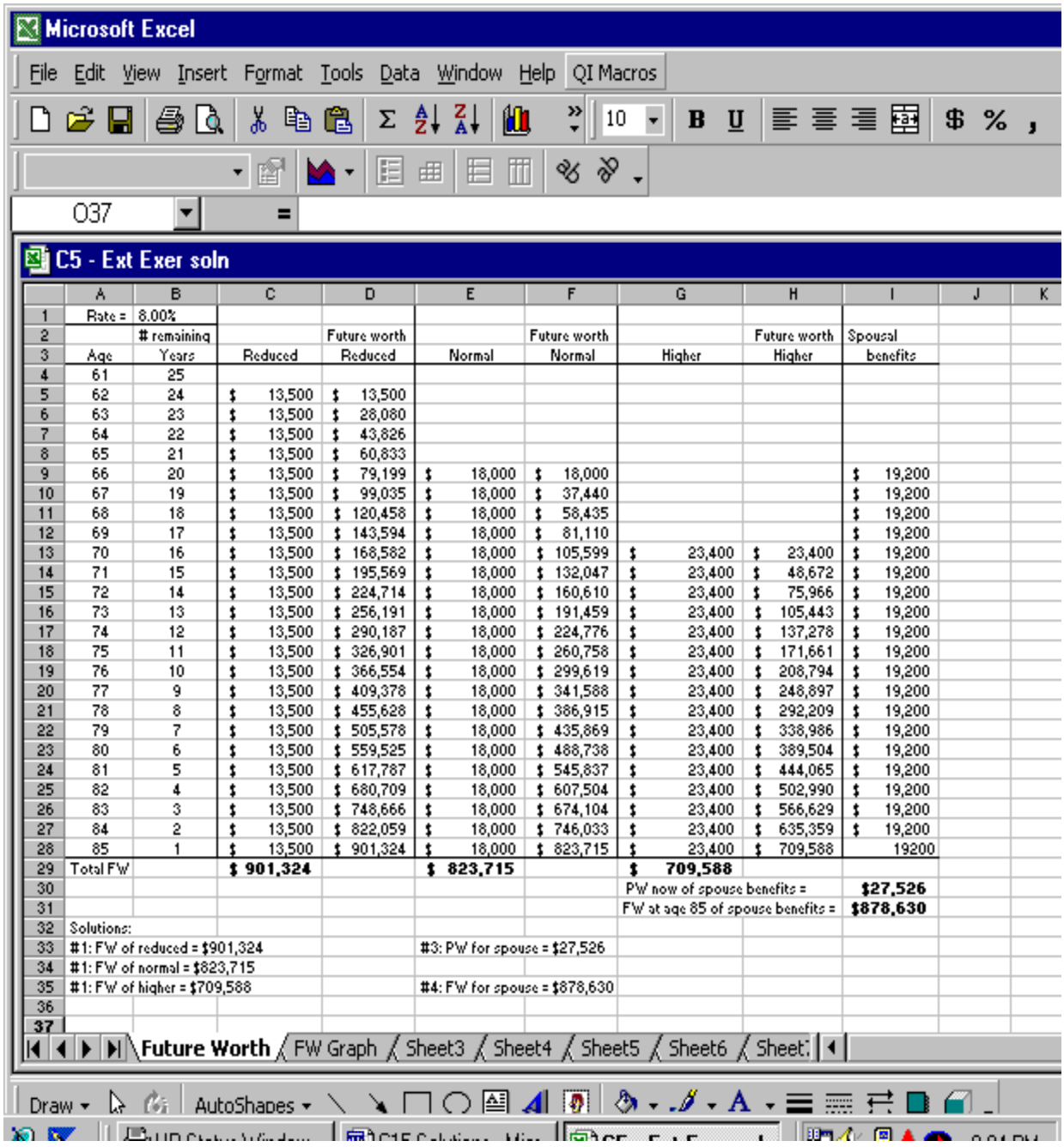
5.63 Answer is (b)

5.64 Answer is (a)

5.65 Answer is (b)

Extended Exercise Solution

Questions 1, 3 and 4:



Microsoft Excel

File Edit View Insert Format Tools Data Window Help QI Macros

O37 =

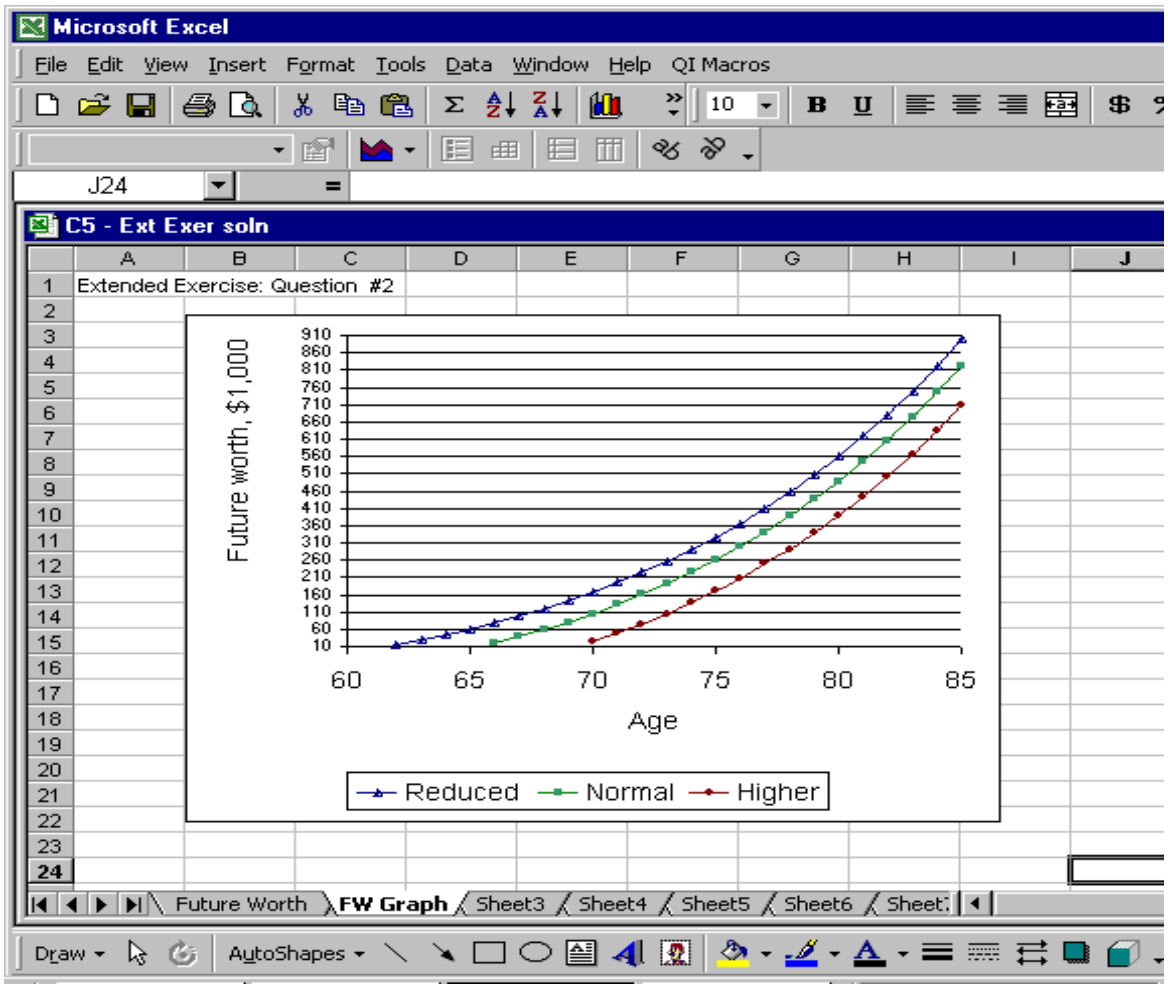
C5 - Ext Exer soln

	A	B	C	D	E	F	G	H	I	J	K
1	Rate =	8.00%									
2		# remaining		Future worth		Future worth		Future worth	Spousal		
3	Age	Years	Reduced	Reduced	Normal	Normal	Higher	Higher	benefits		
4	61	25									
5	62	24	$ 13,500	$ 13,500							
6	63	23	$ 13,500	$ 28,080							
7	64	22	$ 13,500	$ 43,826							
8	65	21	$ 13,500	$ 60,833							
9	66	20	$ 13,500	$ 79,199	$ 18,000	$ 18,000			$ 19,200		
10	67	19	$ 13,500	$ 99,035	$ 18,000	$ 37,440			$ 19,200		
11	68	18	$ 13,500	$ 120,458	$ 18,000	$ 58,435			$ 19,200		
12	69	17	$ 13,500	$ 143,594	$ 18,000	$ 81,110			$ 19,200		
13	70	16	$ 13,500	$ 168,582	$ 18,000	$ 105,599	$ 23,400	$ 23,400	$ 19,200		
14	71	15	$ 13,500	$ 195,569	$ 18,000	$ 132,047	$ 23,400	$ 48,672	$ 19,200		
15	72	14	$ 13,500	$ 224,714	$ 18,000	$ 160,610	$ 23,400	$ 75,966	$ 19,200		
16	73	13	$ 13,500	$ 256,191	$ 18,000	$ 191,459	$ 23,400	$ 105,443	$ 19,200		
17	74	12	$ 13,500	$ 290,187	$ 18,000	$ 224,776	$ 23,400	$ 137,278	$ 19,200		
18	75	11	$ 13,500	$ 326,901	$ 18,000	$ 260,758	$ 23,400	$ 171,661	$ 19,200		
19	76	10	$ 13,500	$ 366,554	$ 18,000	$ 299,619	$ 23,400	$ 208,794	$ 19,200		
20	77	9	$ 13,500	$ 409,378	$ 18,000	$ 341,588	$ 23,400	$ 248,897	$ 19,200		
21	78	8	$ 13,500	$ 455,628	$ 18,000	$ 386,915	$ 23,400	$ 292,209	$ 19,200		
22	79	7	$ 13,500	$ 505,578	$ 18,000	$ 435,869	$ 23,400	$ 338,986	$ 19,200		
23	80	6	$ 13,500	$ 559,525	$ 18,000	$ 488,738	$ 23,400	$ 389,504	$ 19,200		
24	81	5	$ 13,500	$ 617,787	$ 18,000	$ 545,837	$ 23,400	$ 444,065	$ 19,200		
25	82	4	$ 13,500	$ 680,709	$ 18,000	$ 607,504	$ 23,400	$ 502,990	$ 19,200		
26	83	3	$ 13,500	$ 748,666	$ 18,000	$ 674,104	$ 23,400	$ 566,629	$ 19,200		
27	84	2	$ 13,500	$ 822,059	$ 18,000	$ 746,033	$ 23,400	$ 635,359	$ 19,200		
28	85	1	$ 13,500	$ 901,324	$ 18,000	$ 823,715	$ 23,400	$ 709,588	19200		
29	Total FW		**$ 901,324**		**$ 823,715**		**$ 709,588**				
30							PW now of spouse benefits =		**$27,526**		
31							FW at age 85 of spouse benefits =		**$878,630**		
32	Solutions:										
33	#1: FW of reduced = $901,324				#3: PW for spouse = $27,526						
34	#1: FW of normal = $823,715										
35	#1: FW of higher = $709,588				#4: FW for spouse = $878,630						
36											
37											

Future Worth | FW Graph | Sheet3 | Sheet4 | Sheet5 | Sheet6 | Sheet7

Draw AutoShapes

Question 2:



Case Study Solution

1. Set first cost of toilet equal to monthly savings and solve for n:

$$[(115.83 - 76.12) + 50](A/P,0.75\%,n) = 2.1(0.76 + 0.62)$$
$$89.71(A/P,0.75\%,n) = 2.898$$
$$(A/P,0.75\%,n) = 0.03230$$

From 0.75% interest table, n is between 30 and 36 months

By interpolation, n = 35 months or 2.9 years

2. If the toilet life were to decrease by 50% to 2.5 years, then the homeowner would not breakeven at any interest rate (2.6 years is required at 0% and longer times would be required for i > 0%). If the interest rate were to increase by more than 50% (say from 9% to 15%), the payback period would increase from 2.9 years (per above solution) to a little less than 3.3 years (from 1.25% interest table). Therefore, the payback period is much more sensitive to the toilet life than to the interest rate.

3. cost/month = 76.12 (A/P,0.5%,60)
= 76.12 (0.01933)
= $1.47

CCF/month = 2.1 + 2.1
= 4.2

cost/CCF = 1.47/4.2
= $0.35/CCF or $0.47/1000 gallons (vs $0.40/1000 gallons at 0% interest)

4. (a) If 100% of the $115.83 cost of the toilet is rebated, the cost to the city at 0% interest is

$$c = \frac{115.83}{(2.1 + 2.1)(12)(5)}$$

= $0.46/CCF or $0.61/1000 gal (vs $0.40/1000 gal at 75% rebate)

This is still far below the city's cost of $1.10/1000 gallons. Therefore, the success of the program is not sensitive to the percentage of cost rebated.

(b) Use the same relation for cost/month as in question 3 above, except with varying interest rates, the values shown in the table below are obtained for n = 5 years.

Interest Rate, %	4	6	8	10	12	15
$ / CCF	0.33	0.35	0.37	0.39	0.40	0.43
$/1000 gal	0.45	0.47	0.49	0.51	0.54	0.58

The results indicate that even at an interest rate of 15% per year, the cost at $0.58/1000 gallons is significantly below the city's cost of $1.10/1000 gallons. Therefore, the program's success is not sensitive to interest rates.

(c) Use the same equation as in question 3 above with i = 0.5% per month and varying life values.

Life, years	2	3	4	5	6	8	10	15	20
$ / CCF	0.80	0.55	0.43	0.35	0.30	0.24	0.20	0.15	0.13
$/1000 gal	1.07	0.74	0.57	0.47	0.40	0.32	0.27	0.20	0.17

For a 2-year life and an interest rate of a nominal 6% per year, compounded monthly, the cost of the program is $1.07/1000 gallons, which is very close to the savings of $1.10/1000 gallons. But the cost decreases rapidly as life increases.

If further sensitivity analysis is performed, the following results are obtained. At an interest rate of 8% per year, the costs and savings are equal. Above 8% per year, the program would not be cost effective for a 2-year toilet life at the 75% rebate level. When the rebate is increased to 100%, the cost of the program exceeds the savings at all interest rates above 4.5% per year for a toilet life of 3 years.

These calculations reveal that at very short toilet lives (2-3 years), there are some conditions under which the program will not be financially successful. Therefore, it can be concluded that the program's success is mildly sensitive to toilet life.