***CHAPTER 7***

**RISK ANALYSIS, REAL OPTIONS, AND CAPITAL BUDGETING**

**Answers to Concepts Review and Critical Thinking Questions**

**1.** Forecasting risk is the risk that a poor decision is made because of errors in projected cash flows. The danger is greatest with a new product because the cash flows are probably harder to predict.

**2.** With a sensitivity analysis, one variable is examined over a broad range of values. With a scenario analysis, all variables are examined for a limited range of values.

**3.** It is true that if average revenue is less than average cost, the firm is losing money. This much of the statement is correct. At the margin, however, accepting a project with marginal revenue in excess of its marginal cost clearly acts to increase operating cash flow.

**4.** From the shareholder perspective, the financial break-even point is the most important. A project can exceed the accounting and cash break-even points but still be below the financial break-even point. This causes a reduction in shareholder (your) wealth.

**5.** The project will reach the cash break-even first, the accounting break-even next, and finally the financial break-even. For a project with an initial investment and sales afterwards, this ordering will always apply. The cash break-even is achieved first since it excludes depreciation. The accounting break-even is next since it includes depreciation. Finally, the financial break-even, which includes the time value of money, is achieved.

**6.** Traditional NPV analysis is often too conservative because it ignores profitable options such as the ability to expand the project if it is profitable, or abandon the project if it is unprofitable. The option to alter a project when it has already been accepted has a value, which increases the NPV of the project.

**7.** The type of option most likely to affect the decision is the option to expand. If the country just liberalized its markets, there is likely the potential for growth. First entry into a market, whether an entirely new market, or with a new product, can give a company name recognition and market share. This may make it more difficult for competitors entering the market.

**8.** Sensitivity analysis can determine how the financial break-even point changes when some factors (such as fixed costs, variable costs, or revenue) change.

**9.** There are two sources of value with this decision to wait. The price of the timber can potentially increase, and the amount of timber will almost definitely increase, barring a natural catastrophe or forest fire. The option to wait for a logging company is quite valuable, and companies in the industry have models to estimate the future growth of a forest depending on its age.

**10.** Option analysis should stop when the additional analysis has a negative NPV. Since the additional analysis is likely to occur almost immediately, then it would have a negative NPV when the benefits of the additional analysis outweigh the costs. The benefits of the additional analysis are the reduction in the possibility of making a bad decision. Of course, the additional benefits are often difficult, if not impossible, to measure, so much of this decision is based on experience.

**Solutions to Questions and Problems**

*NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.*

 *Basic*

**1.** *a*. To calculate the accounting break-even, we first need to find the depreciation for each year. The depreciation is:

 Depreciation = $845,000/8

 Depreciation = $105,625 per year

 And the accounting break-even is:

 *Q*A = ($950,000 + 105,625)/($53 – 27)

 *Q*A = 40,600.96 units

 *b.* We will use the tax shield approach to calculate the OCF. The OCF is:

 OCFbase = [(*P* – *v*)*Q* – FC](1 – *TC*) + *TCD*

 OCFbase = [($53 – 27)(51,000) – $950,000](1 – .22) + .22($105,625)

 OCFbase = $316,518

 Now we can calculate the NPV using our base-case projections. There is no salvage value or NWC, so the NPV is:

 NPVbase = –$845,000 + $316,518(PVIFA10%,8)

 NPVbase = $843,597.50

 To calculate the sensitivity of the NPV to changes in the quantity sold, we will calculate the NPV at a different quantity. We will use sales of 52,000 units. The OCF at this sales level is:

 OCFnew = [($53 – 27)(52,000) – $950,000](1 – .22) + .22($105,625)

 OCFnew = $336,798

 And the NPV is:

 NPVnew = –$845,000 + $336,798(PVIFA10%,8)

 NPVnew = $951,789.81

 So, the change in NPV for every unit change in sales is:

 ΔNPV/Δ*Q* = ($843,597.50 – 951,789.81)/(51,000 – 52,000)

 ΔNPV/Δ*Q* = +$108.19

 If sales were to drop by 500 units, then NPV would drop by:

 NPV drop = $108.19(500)

 NPV drop = $54,096.15

 You may wonder why we chose 52,000 units. Because it doesn’t matter! Whatever new quantity we use, when we calculate the change in NPV per unit sold, the ratio will be the same.

 *c.* To find out how sensitive OCF is to a change in variable costs, we will compute the OCF at a variable cost of $28. Again, the number we choose to use here is irrelevant: We will get the same ratio of OCF to a one dollar change in variable cost no matter what variable cost we use. So, using the tax shield approach, the OCF at a variable cost of $28 is:

 OCFnew = [($53 – 28)(51,000) – $950,000](1 – .22) + .22($105,625)

 OCFnew = $276,738

 So, the change in OCF for a $1 change in variable costs is:

 ΔOCF/Δ*v* = ($316,518 – 276,738)/($27 – 28)

 ΔOCF/Δ*v* = –$39,780

 If variable costs decrease by $1 then OCF would increase by $39,780.

**2.** We will use the tax shield approach to calculate the OCF for the best- and worst-case scenarios. For the best-case scenario, the price and quantity increase by 10 percent, so we will multiply the base-case numbers by 1.1, a 10 percent increase. The variable and fixed costs both decrease by 10 percent, so we will multiply the base-case numbers by .9, a 10 percent decrease. Doing so, we get:

 OCFbest = {[($53)(1.1) – ($27)(.9)](51,000)(1.1) – $950,000(.9)}(1 – .22) + .22($105,625)

 OCFbest = $844,109.50

 The best-case NPV is:

 NPVbest = –$845,000 + $844,109.50(PVIFA10%,8)

 NPVbest = $3,658,261.89

 For the worst-case scenario, the price and quantity decrease by 10 percent, so we will multiply the base-case numbers by .9, a 10 percent decrease. The variable and fixed costs both increase by 10 percent, so we will multiply the base-case numbers by 1.1, a 10 percent increase. Doing so, we get:

 OCFworst = {[($53)(.9) – ($27)(1.1)](51,000)(.9) – $950,000(1.1)}(1 – .22) + .22($105,625)

 OCFworst = –$147,426.50

 The worst-case NPV is:

 NPVworst = –$845,000 – $147,426.50(PVIFA10%,8)

 NPVworst = –$1,631,509.50

**3.** We can use the accounting break-even equation:

 *Q*A = (FC + *D*)/(*P* – *v*)

 to solve for the unknown variable in each case. Doing so, we find:

 (1): *Q*A = 143,286 = ($820,000 + *D*)/($39 – 30)

 *D* = $469,574

 (2): *Q*A = 104,300 = ($2,320,000 + 975,000)/(*P* – $27)

 *P* = $58.59

 (3): *Q*A = 24,640 = ($237,000 + 128,700)/($92 – *v*)

 *v* = $77.16

**4.** When calculating the financial break-even point, we express the initial investment as an equivalent annual cost (EAC). Dividing the initial investment by the 5-year annuity factor, discounted at 12 percent, the EAC of the initial investment is:

 EAC = Initial Investment/PVIFA12%,5

 EAC = $485,000/3.60478

 EAC = $134,543.72

 Note that this calculation solves for the annuity payment with the initial investment as the present value of the annuity. In other words:

 PVA = *C*({1 – [1/(1 + *R*)]*t*}/*R*)

 $485,000 = *C*{[1 – (1/1.12)5]/.12}

 *C* = $134,543.72

 The annual depreciation is the cost of the equipment divided by the economic life, or:

 Annual depreciation = $485,000/5

 Annual depreciation = $97,000

 Now we can calculate the financial break-even point. The financial break-even point for this project is:

 *Q*F = [EAC + FC(1 – *TC*) – *D*(*TC*)]/[(*P* – VC)(1 – *TC*)]

 *Q*F = [$134,543.72 + $310,000(1 – .24) – $97,000(.24)]/[($19 – 6)(1 – .24)]

 *Q*F = 35,107.66, or about 35,108 units

**5.** If we purchase the machine today, the NPV is the cost plus the present value of the increased cash flows, so:

 NPV0 = –$2,950,000 + $485,000(PVIFA8%,10)

 NPV0 = $304,389.48

 We should not necessarily purchase the machine today, but rather we would want to purchase the machine when the NPV is the highest. So, we need to calculate the NPV each year. The NPV each year will be the cost plus the present value of the increased cash savings. However, we must be careful. In order to make the correct decision, the NPV for each year must be taken to a common date. We will discount all of the NPVs to today. Doing so, we get:

 Year 1: NPV1 = [–$2,635,000 + $485,000(PVIFA8%,9)]/1.08

 NPV1 = $365,500.59

 Year 2: NPV2 = [–$2,320,000 + $485,000(PVIFA8%,8)]/1.082

 NPV2 = $400,480.01

 Year 3: NPV3 = [–$2,005,000 + $485,000(PVIFA8%,7)]/1.083

 NPV3 = $412,863.80

 Year 4: NPV4 = [–$1,690,000 + $485,000(PVIFA8%,6)]/1.084

 NPV4 = $405,807.51

 Year 5: NPV5 = [–$1,375,000 + $485,000(PVIFA8%,5)]/1.085

 NPV5 = $382,123.21

 Year 6: NPV6 = [–$1,375,000 + $485,000(PVIFA8%,4)]/1.086

 NPV6 = $145,809.60

 The company should purchase the machine three years from now when the NPV is the highest.

**6.** We need to calculate the NPV of the two options: go directly to market now, or utilize test marketing first. The NPV of going directly to market now is:

 NPV = *C*Success (Prob. of Success) + *C*Failure (Prob. of Failure)

 NPV = $29,000,000(.50) + $9,200,000(.50)

 NPV = $19,100,000

 Now we can calculate the NPV of test marketing first. Test marketing requires a $2.1 million cash outlay. Choosing the test marketing option will also delay the launch of the product by one year. Thus, the expected payoff is delayed by one year and must be discounted back to Year 0.

 NPV= *C*0 + {[*C*Success (Prob. of Success)] + [*C*Failure (Prob. of Failure)]}/(1 + *R*)*t*

 NPV = –$2,100,000 + {[$29,000,000(.80)] + [$9,200,000(.20)]}/1.11

 NPV = $20,458,558.56

 The company should test market first since that option has the highest expected payoff.

**7.** We need to calculate the NPV of each option, and choose the option with the highest NPV. So, the NPV of going directly to market is:

 NPV = *C*Success (Prob. of Success)

 NPV = $2,300,000(.50)

 NPV = $1,150,000

 The NPV of the focus group is:

 NPV = *C*0 + *C*Success (Prob. of Success)

 NPV = –$175,000 + $2,300,000(.65)

 NPV = $1,320,000

 And the NPV of using the consulting firm is:

 NPV = *C*0 + *C*Success (Prob. of Success)

 NPV = –$375,000 + $2,300,000(.80)

 NPV = $1,465,000

 The firm should use the consulting firm since that option has the highest NPV.

**8.** The company should analyze both options, and choose the option with the greatest NPV. So, if the company goes to market immediately, the NPV is:

 NPV = *C*Success (Prob. of Success) + *C*Failure (Prob. of Failure)

 NPV = $17,100,000(.55) + $7,900,000(.45)

 NPV = $12,960,000

Customer segment research requires a $945,000 cash outlay. Choosing the research option will also delay the launch of the product by one year. Thus, the expected payoff is delayed by one year and must be discounted back to Year 0. So, the NPV of the customer segment research is:

 NPV= *C*0 + {[*C*Success (Prob. of Success)] + [*C*Failure (Prob. of Failure)]}/(1 + *R*)*t*

 NPV = –$945,000 + {[$17,100,000(.70)] + [$7,900,000(.30)]}/1.13

 NPV = $11,745,265.49

 The company should go to market now since it has the largest NPV.

**9.** *a.* The accounting break-even is the aftertax sum of the fixed costs and depreciation charge divided by the aftertax contribution margin (selling price minus variable cost). So, the accounting break-even level of sales is:

 *Q*A = [(FC + Depreciation)(1 – *TC*)]/[(*P* – VC)(1 – *TC*)]

 *Q*A = [($475,000 + $945,000/7) (1 – .21)]/[($45 – 10.95)(1 – .21)]

 *Q*A = 17,914.83, or about 17,915 units

 *b.* When calculating the financial break-even point, we express the initial investment as an equivalent annual cost (EAC). Dividing the initial investment by the 7-year annuity factor, discounted at 15 percent, the EAC of the initial investment is:

 EAC = Initial Investment/PVIFA15%,7

 EAC = $945,000/4.1604

 EAC = $227,140.54

 Now we can calculate the financial break-even point. The financial break-even point for this project is:

 *Q*F = [EAC + FC(1 – *TC*) – *D*(*TC*)]/[(*P* – VC)(1 – *TC*)]

 *Q*F = [$227,140.54 + $475,000(.79) – ($945,000/7)(.21)]/[($45 – 10.95)(.79)]

 *Q*F = 21,340.19, or about 21,340 units

**10.** When calculating the financial break-even point, we express the initial investment as an equivalent annual cost (EAC). Dividing the initial investment by the 5-year annuity factor, discounted at 8 percent, the EAC of the initial investment is:

 EAC = Initial Investment/PVIFA8%,5

 EAC = $480,000/3.99271

 EAC = $120,219.10

 The annual depreciation is the cost of the equipment divided by the economic life, or:

 Annual depreciation = $480,000/5

 Annual depreciation = $96,000

 Now we can calculate the financial break-even point. The financial break-even point for this project is:

 *Q*F = [EAC + FC(1 – *TC*) – *D*(*TC*)]/[(*P* – VC)(1 – *TC*)]

 *Q*F = [$120,219.10 + $295,000(1 – .21) – $96,000(.21)]/[($71 – 28)(1 – .21)]

 *Q*F = 9,805.98, or about 9,806 units

 *Intermediate*

**11.** *a*. At the accounting break-even, the IRR is zero percent since the project recovers the initial investment. The payback period is *N* years, which is the length of the project since the initial investment is exactly recovered over the project life. The NPV at the accounting break-even is:

 NPV = *I*[(*I*/*N*)(PVIFA*R*%,*N*) – 1]

 *b*. At the cash break-even level, the IRR is –100 percent, the payback period is negative, and the NPV is negative and equal to the initial cash outlay.

 *c*. The definition of the financial break-even is where the NPV of the project is zero. If this is true, then the IRR of the project is equal to the required return. It is impossible to state the payback period, except to say that the payback period must be less than the length of the project. Since the discounted cash flows are equal to the initial investment, the undiscounted cash flows are greater than the initial investment, so the payback must be less than the project life.

**12.** Using the tax shield approach, the OCF at 61,000 units will be:

 OCF = [(*P* – *v*)*Q* – FC](1 – *TC*) + *TCD*

 OCF = [($28 – 16)(61,000) – 245,000](1 – .21) + .21($655,000/4)

 OCF = $419,117.50

 We will calculate the OCF at 62,000 units. The choice of the second level of quantity sold is arbitrary and irrelevant. No matter what level of units sold we choose, we will still get the same sensitivity. So, the OCF at this level of sales is:

 OCF = [($28 – 16)(62,000) – 245,000](1 – .21) + .21($655,000/4)

 OCF = $428,597.50

 The sensitivity of the OCF to changes in the quantity sold is:

 Sensitivity = ΔOCF/Δ*Q* = ($419,117.50 – 428,597.50)/(61,000 – 62,000)

 ΔOCF/Δ*Q* = +$9.48

 OCF will increase by $9.48 for every additional unit sold.

**13.** *a*. The base-case, best-case, and worst-case values are shown below. Remember that in the best case, sales and price increase, while costs decrease. In the worst case, sales and price decrease, and costs increase.

 Scenario Unit Sales Variable Cost Fixed Costs

 Base 195 $9,400 $550,000

 Best 215 8,460 495,000

 Worst 176 10,340 605,000

 Using the tax shield approach, the OCF and NPV for the base-case estimate are:

 OCFbase = [($16,300 – 9,400)(195) – $550,000](1 – .21) + .21($1,675,000/4)

 OCFbase = $716,383

 NPVbase = –$1,675,000 + $716,383(PVIFA12%,4)

 NPVbase = $500,903.92

 The OCF and NPV for the worst-case estimate are:

 OCFworst = [($16,300 – 10,340)(176) – $605,000](1 – .21) + .21($1,675,000/4)

 OCFworst = $436,312

 NPVworst = –$1,675,000 + $436,312(PVIFA12%,4)

 NPVworst = –$349,768.94

 And the OCF and NPV for the best-case estimate are:

 OCFbest = [($16,300 – 8,460)(215) – $495,000](1 – .21) + .21($1,675,000/4)

 OCFbest = $1,025,415

 NPVbest = –$1,675,000 + $1,025,415(PVIFA12%,4)

 NPVbest = $1,439,542.67

 *b*. To calculate the sensitivity of the NPV to changes in fixed costs we choose another level of fixed costs. We will use fixed costs of $551,000. The OCF using this level of fixed costs and the other base-case values with the tax shield approach, is:

 OCF = [($16,300 – 9,400)(195) – $551,000](1 – .21) + .21($1,675,000/4)

 OCF = $715,593

 And the NPV is:

 NPV = –$1,675,000 + $715,593(PVIFA12%,4)

 NPV = $498,504.41

 The sensitivity of NPV to changes in fixed costs is:

 ΔNPV/ΔFC = ($500,903.92 – 498,504.41)/($550,000 – 551,000)

 ΔNPV/ΔFC = –$2.40

 For every dollar fixed costs increase (decrease), NPV decreases (increases) by $2.40.

 *c*. The accounting break-even level is:

 *Q*A = (FC + *D*)/(*P* – *v*)

 *Q*A = ($550,000 + $1,675,000/4)/($16,300 – 9,400)

 *Q*A = 140.40

**14.** The marketing study and the research and development are both sunk costs and should be ignored. We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

|  |  |  |
| --- | --- | --- |
|  | Sales |  |
|  | New clubs | $815 × 55,000 = $44,825,000 |
|  | Exp. clubs | $1,345 × (–10,000) = –13,450,000 |
|  | Cheap clubs | $445 × 12,000 = 5,340,000 |
|  |  | $36,715,000 |

 For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

|  |  |
| --- | --- |
|  | Variable Costs |
|  | New clubs | –$365 × 55,000 = –$20,075,000 |
|  | Exp. clubs | –$730 × (–10,000) = 7,300,000 |
|  | Cheap clubs | –$210 × 12,000 = –2,520,000 |
|  |  | –$15,295,000 |

 The pro forma income statement will be:

|  |  |  |
| --- | --- | --- |
|  | Sales | $36,715,000 |
|  | Variable costs | 15,295,000 |
|  | Fixed costs | 9,450,000 |
|  | Depreciation |  5,600,000 |
|  | EBIT | $6,370,000 |
|  | Taxes |  1,592,500 |
|  | Net income | $4,777,500 |

 Using the bottom-up OCF calculation, we get:

 OCF = NI + Depreciation

 OCF = $4,777,500 + 5,600,000

 OCF = $10,377,500

 So, the payback period is:

 Payback period = 3 + $9,917,500/$10,377,500

 Payback period = 3.96 years

 The NPV is:

 NPV = –$39,200,000 – 1,850,000 + $10,377,500(PVIFA10%,7) + $1,850,000/1.107

 NPV = $10,421,358.80

 And the IRR is:

 IRR = –$39,200,000 – 1,850,000 + $10,377,500(PVIFAIRR%,7) + $1,850,000/IRR7

 IRR = 17.22%

**15.** The best and worst cases for the variables are:

 Base Case Best Case Worst Case

 Unit sales (new) 55,000 60,500 49,500

 Price (new) $815 $897 $734

 VC (new) $365 $329 $402

 Fixed costs $9,450,000 $8,505,000 $10,395,000

 Sales lost (expensive) 10,000 9,000 11,000

 Sales gained (cheap) 12,000 13,200 10,800

 Best case

 We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

|  |  |  |
| --- | --- | --- |
|  | Sales |  |
|  | New clubs | $897 × 60,500 = $54,238,250 |
|  | Exp. clubs | $1,345 × (–9,000) = –12,105,000 |
|  | Cheap clubs | $445 × 13,200 = 5,874,000 |
|  |  | $48,007,250 |

 For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

|  |  |
| --- | --- |
|  | Variable Costs |
|  | New clubs | –$329 × 60,500 = –$19,874,250 |
|  | Exp. clubs | –$730 × (–9,000) = 6,570,000 |
|  | Cheap clubs | –$210 × 13,200 = –2,772,000 |
|  |  | –$16,076,250 |

 The pro forma income statement will be:

|  |  |  |
| --- | --- | --- |
|  | Sales | $48,007,250 |
|  | Variable costs | 16,076,250 |
|  | Fixed costs | 8,505,000 |
|  | Depreciation |  5,600,000 |
|  | EBT | $17,826,000 |
|  | Taxes |  4,456,500 |
|  | Net income | $13,369,500 |

 Using the bottom-up OCF calculation, we get:

 OCF = Net income + Depreciation

 OCF = $13,369,500 + 5,600,000

 OCF = $18,969,500

 And the best-case NPV is:

 NPV = –$39,200,000 – 1,850,000 + $18,969,500(PVIFA10%,7) + 1,850,000/1.107

 NPV = $52,250,813.28

 Worst Case

 We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

|  |  |  |
| --- | --- | --- |
|  | Sales |  |
|  | New clubs | $734 × 49,500 = $36,308,250 |
|  | Exp. clubs | $1,345 × (–11,000) = –14,795,000 |
|  | Cheap clubs | $445 × 10,800 = 4,806,000 |
|  |  | $26,319,250 |

 For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

|  |  |
| --- | --- |
|  | Variable Costs |
|  | New clubs | –$402 × 49,500 = –$19,874,250 |
|  | Exp. clubs | –$730 × (–11,000) = 8,030,000 |
|  | Cheap clubs |  –$210 × 10,800 = –2,268,000 |
|  |  | –$14,112,250 |

 The pro forma income statement will be:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Sales | $26,319,250 |  |
|  | Variable costs | 14,112,250 |  |
|  | Fixed costs | 10,395,000 |  |
|  | Depreciation |  5,600,000 |  |
|  | EBT | –$3,788,000 |  |
|  | Taxes |  –947,000 |  \*assumes a tax credit |
|  | Net income | –$2,841,000 |  |

 Using the bottom-up OCF calculation, we get:

 OCF = NI + Depreciation

 OCF = –$2,841,000 + 5,600,000

 OCF = $2,759,000

 And the worst-case NPV is:

 NPV = –$39,200,000 – 1,850,000 + $2,759,000(PVIFA10%,7) + 1,850,000/1.107

 NPV = –$26,668,689.96

**16.** To calculate the sensitivity of the NPV to changes in the price of the new club, we need to change the price of the new club. We will choose $825, but the choice is irrelevant as the sensitivity will be the same no matter what price we choose.

 We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

|  |  |  |
| --- | --- | --- |
|  | Sales |  |
|  | New clubs | $825 × 55,000 = $45,375,000 |
|  | Exp. clubs | $1,345 × (–10,000) = –13,450,000 |
|  | Cheap clubs | $445 × 12,000 = 5,340,000 |
|  |  | $37,265,000 |

 For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

|  |  |
| --- | --- |
|  | Variable Costs |
|  | New clubs | –$365 × 55,000 = –$20,075,000 |
|  | Exp. clubs | –$730 × (–10,000) = 7,300,000 |
|  | Cheap clubs | –$210 × 12,000 = –2,520,000 |
|  |  | –$15,295,000 |

 The pro forma income statement will be:

|  |  |  |
| --- | --- | --- |
|  | Sales | $37,265,000 |
|  | Variable costs | 15,295,000 |
|  | Fixed costs | 9,450,000 |
|  | Depreciation |  5,600,000 |
|  | EBT | $ 6,920,000 |
|  | Taxes |  1,730,000 |
|  | Net income | $ 5,190,000 |

 Using the bottom-up OCF calculation, we get:

 OCF = NI + Depreciation

 OCF = $5,190,000 + 5,600,000

 OCF = $10,790,000

 And the NPV is:

 NPV = –$39,200,000 – 1,850,000 + $10,790,000(PVIFA10%,7) + 1,850,000/1.107

 NPV = $12,429,581.56

 So, the sensitivity of the NPV to changes in the price of the new club is:

 ΔNPV/Δ*P* = ($10,421,358.80 – 12,429,581.56)/($815 – 825)

 ΔNPV/Δ*P* = $200,822.28

 For every dollar increase (decrease) in the price of the clubs, the NPV increases (decreases) by $200,822.28.

 To calculate the sensitivity of the NPV to changes in the quantity sold of the new club, we need to change the quantity sold. We will choose 56,000 units, but the choice is irrelevant as the sensitivity will be the same no matter what quantity we choose.

 We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

|  |  |  |
| --- | --- | --- |
|  | Sales |  |
|  | New clubs | $815 × 56,000 = $45,640,000 |
|  | Exp. clubs | $1,345 × (–10,000) = –13,450,000 |
|  | Cheap clubs | $445 × 12,000 = 5,340,000 |
|  |  | $37,530,000 |

 For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

|  |  |
| --- | --- |
|  | Variable costs |
|  | New clubs | –$365 × 56,000 = –$20,440,000 |
|  | Exp. clubs | –$730 × (–10,000) = 7,300,000 |
|  | Cheap clubs | –$210 × 12,000 = –2,520,000 |
|  |  | –$15,660,000 |

 The pro forma income statement will be:

|  |  |  |
| --- | --- | --- |
|  | Sales | $37,530,000 |
|  | Variable costs | 15,660,000 |
|  | Fixed costs | 9,450,000 |
|  | Depreciation |  5,600,000 |
|  | EBT |  $ 6,820,000 |
|  | Taxes |  1,705,000 |
|  | Net income | $ 5,115,000 |

 Using the bottom-up OCF calculation, we get:

 OCF = NI + Depreciation

 OCF = $5,115,000 + 5,600,000

 OCF = $10,715,000

 The NPV at this quantity is:

 NPV = –$39,200,000 – $1,850,000 + $10,715,000(PVIFA10%,7) + $1,850,000/1.107

 NPV = $12,064,450.15

 So, the sensitivity of the NPV to changes in the quantity sold is:

 ΔNPV/Δ*Q* = ($10,421,358.80 – 12,064,450.15)/(55,000 – 56,000)

 ΔNPV/Δ*Q* = $1,643.09

 For an increase (decrease) of one set of clubs sold per year, the NPV increases (decreases) by $1,643.09.

**17.** *a*. The base-case NPV is:

 NPV = –$1,900,000 + $436,600(PVIFA14%,10)

 NPV = $377,356.09

 *b.* We would abandon the project if the cash flow from selling the equipment is greater than the present value of the future cash flows. We need to find the sale quantity where the two are equal, so:

 $1,100,000 = ($59)*Q*(PVIFA14%,9)

 *Q* = $1,100,000/[$59(4.9464)]

 *Q* = 3,769

 Abandon the project if *Q* < 3,769 units, because the NPV of abandoning the project is greater than the NPV of the future cash flows.

 *c.* The $1,100,000 is the market value of the project. If you continue with the project in one year, you forgo the $1,100,000 that could have been used for something else.

**18.** *a.* If the project is a success, the present value of the future cash flows will be:

 PV future CFs = $59(11,400)(PVIFA14%,9)

 PV future CFs = $3,326,929.70

 From the previous question, if the quantity sold is 3,500, we would abandon the project, and the cash flow would be $1,100,000. Since the project has an equal likelihood of success or failure in one year, the expected value of the project in one year is the average of the success and failure cash flows, plus the cash flow in one year, so:

 Expected value of project at Year 1 = [($3,326,929.70 + 1,100,000)/2] + $436,600

 Expected value of project at Year 1 = $2,650,064.85

 The NPV is the present value of the expected value in one year minus the cost of the equipment, so:

 NPV = –$1,900,000 + $2,650,064.85/1.14

 NPV = $424,618.29

 *b*. If we couldn’t abandon the project, the present value of the future cash flows when the quantity is 3,500 will be:

 PV future CFs = $59(3,500)(PVIFA14%,9)

 PV future CFs = $1,021,425.78

 The gain from the option to abandon is the abandonment value minus the present value of the cash flows if we cannot abandon the project, so:

 Gain from option to abandon = $1,100,000 – 1,021,425.78

 Gain from option to abandon = $78,574.22

 We need to find the value of the option to abandon times the likelihood of abandonment. So, the value of the option to abandon today is:

 Option value = (.50)($78,574.22)/1.14

 Option value = $34,462.38

**19.** If the project is a success, the present value of the future cash flows will be:

 PV future CFs = $59(22,800)(PVIFA14%,9)

 PV future CFs = $6,653,859.39

 If the sales are only 3,500 units, from Problem 17, we know we will abandon the project, with a value of $1,100,000. Since the project has an equal likelihood of success or failure in one year, the expected value of the project in one year is the average of the success and failure cash flows, plus the cash flow in one year, so:

 Expected value of project at Year 1 = [($6,653,859.39 + $1,100,000)/2] + $436,600

 Expected value of project at Year 1 = $4,313,529.70

 The NPV is the present value of the expected value in one year minus the cost of the equipment, so:

 NPV = –$1,900,000 + $4,313,529.70/1.14

 NPV = $1,883,797.98

 The gain from the option to expand is the present value of the cash flows from the additional units sold, so:

 Gain from option to expand = $59(11,400)(PVIFA14%,9)

 Gain from option to expand = $3,326,929.70

 We need to find the value of the option to expand times the likelihood of expansion. We also need to find the value of the option to expand today, so:

 Option value = (.50)($3,326,929.70)/1.14

 Option value = $1,459,179.69

**20.** *a.* The accounting break-even is the aftertax sum of the fixed costs and depreciation charge divided by the contribution margin (selling price minus variable cost). In this case, there are no fixed costs, and the depreciation is the entire price of the press in the first year. So, the accounting break-even level of sales is:

 *Q*A = [(FC + *D*)(1 – *TC*)]/[(*P* – VC)(1 – *TC*)]

 *Q*A = [($0 + 8,900)(1 – .21)]/[($16 – 3.75)(1 – .21)]

 *Q*A = 726.53, or about 727 units

 *b.* When calculating the financial break-even point, we express the initial investment as an equivalent annual cost (EAC). The initial investment is the $25,000 in licensing fees. Dividing the initial investment by the three-year annuity factor, discounted at 12 percent, the EAC of the initial investment is:

 EAC = Initial Investment/PVIFA12%,3

 EAC = $25,000/2.4018

 EAC = $10,408.72

 Now we can calculate the financial break-even point. Notice that there are no fixed costs or depreciation. The financial break-even point for this project is:

 *Q*F = [EAC + FC(1 – *TC*) – *D*(*T*C)]/[(*P* – VC)(1 – *TC*)]

 *Q*F = ($10,408.72 + 0 – 0)/[($16 – 3.75)(.79)]

 *Q*F = 1,075.56, or about 1,076 units

**21.** The payoff from taking the lump sum is $30,000, so we need to compare this to the expected payoff from taking 1.25 percent of the profit. The decision tree for the movie project is:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   |   |   |   |   |   |   |   |  | Big audience |
|   |   |   |   |   |   |   | 40% |   |  $55,000,000  |
|   |   |  |   |   |   |   | Movie is good |   |   |
|   |   |   | 10% |   | Make movie |   |   |   |   |
|   |   |   | Script is good |   |   |   |  Movie is bad  |  |   |
|  | Read script |   |   |   |   |   | 60% |   |  Small audience  |
|   |   |   |  Script is bad  |   |   |   |   |   |  No profit  |
|   |   |   | 90% |   | Don't make movie |   |   |   |   |
|   |   |   |   |   |  No profit  |   |   |   |   |

 The value of 1.25 percent of the profits is as follows. There is a 40 percent probability the movie is good, and the audience is big, so the expected value of this outcome is:

 Value = $55,000,000 × .40

 Value = $22,000,000

 The value if the movie is good, and has a big audience, assuming the script is good is:

 Value = $22,000,000 × .10

 Value = $2,200,000

 This is the expected value for the studio, but the screenwriter will receive 1.25 percent of this amount, so the payment to the screenwriter will be:

 Payment to screenwriter = $2,200,000 × .0125

 Payment to screenwriter = $27,500

 The screenwriter should take the upfront offer of $30,000.

**22.** We can calculate the value of the option to wait as the difference between the NPV of opening the mine today and the NPV of waiting one year to open the mine. The remaining life of the mine is:

 34,400 ounces/4,300 ounces per year = 8 years

 This will be true no matter when you open the mine. The aftertax cash flow per year if opened today is:

 CF = 4,300($1,025) = $4,407,500

 So, the NPV of opening the mine today is:

 NPV = –$18,200,000 +$4,407,500(PVIFA12%,8)

 NPV = $3,694,872.27

 If you open the mine in one year, the cash flow will be either:

 CFUp = 4,300($1,350) = $5,805,000 per year

 CFDown = 4,300($940) = $4,042,000 per year

 The PV of these cash flows is:

 Price increase CF = $5,805,000(PVIFA12%,8) = $28,837,148.85

 Price decrease CF = $4,042,000(PVIFA12%,8) = $20,079,199.94

 So, the NPV is one year will be:

 NPV = –$18,200,000 + [.60($28,837,148.85) + .40($20,079,199.94)]

 NPV = $7,133,969.28

 And the NPV today is:

 NPV today = $7,133,969.28/1.12

 NPV today = $6,369,615.43

 So, the value of the option to wait is:

 Option value = $6,369,615.43 – 3,694,872.27

 Option value = $2,674,743.16

**23.** *a.* The NPV of the project is the sum of the present value of the cash flows generated by the project. The cash flows from this project are an annuity, so the NPV is:

 NPV = –$31,000,000 + $6,900,000(PVIFA13%,10)

NPV = $6,441,079.98

 *b.* The company should abandon the project if the PV of the revised cash flows for the next nine years is less than the project’s aftertax salvage value. Since the option to abandon the project occurs in Year 1, discount the revised cash flows to Year 1 as well. To determine the level of expected cash flows below which the company should abandon the project, calculate the equivalent annual cash flows the project must earn to equal the aftertax salvage value. We will solve for *C*2, the revised cash flow beginning in Year 2. So, the revised annual cash flow below which it makes sense to abandon the project is:

 Aftertax salvage value = *C*2(PVIFA13%,9)

 $24,000,000 = *C*2(PVIFA13%,9)

 *C*2 = $24,000,000/PVIFA13%,9

 *C*2 = $4,676,853.65

**24.** *a.* The NPV of the project is sum of the present value of the cash flows generated by the project. The annual cash flow for the project is the number of units sold times the cash flow per unit, which is:

 Annual cash flow = 20($195,000)

 Annual cash flow = $3,900,000

 The cash flows from this project are an annuity, so the NPV is:

 NPV = –$14,500,000 + $3,900,000(PVIFA11%,5)

NPV = –$86,001.63

 *b.* The company will abandon the project if unit sales are not revised upward. If the unit sales are revised upward, the aftertax cash flows for the project over the last four years will be:

 New annual cash flow = 30($195,000)

 New annual cash flow = $5,850,000

 The NPV of the project will be the initial cost, plus the expected cash flow in Year 1 based on the 20 unit sales projection, plus the expected value of abandonment, plus the expected value of expansion. We need to remember that the abandonment value occurs in Year 1, and the present value of the expansion cash flows are in Year 1, so each of these must be discounted back to today. So, the project NPV under the abandonment or expansion scenario is:

 NPV = –$14,500,000 + $3,900,000/1.11 + .50($10,400,000)/1.11

 + [.50($5,850,000)(PVIFA11%,4)]/1.11

 NPV = $1,873,561.84

**25.** To calculate the unit sales for each scenario, we multiply the market sales times the company’s market share. We can then use the quantity sold to find the revenue each year, and the variable costs each year. After doing these calculations, we will construct the pro forma income statement for each scenario. We can then find the operating cash flow using the bottom-up approach, which is net income plus depreciation. Doing so, we find:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   |   |  *Pessimistic*  |  *Expected*  |  *Optimistic*  |
|  | Units per year | 18,000 | 23,000 | 28,000 |
|  |   |  |  |  |
|  | Revenue | $2,682,000.00 | $3,519,000.00 | $4,396,000.00 |
|  | Variable costs | 1,476,000.00 | 1,794,000.00 | 2,100,000.00 |
|  | Fixed costs | 980,000.00 | 925,000.00 | 885,000.00 |
|  | Depreciation | 366,666.67 | 341,666.67 | 325,000.00 |
|  | EBT | –$140,666.67 | $458,333.33 | $1,086,000.00 |
|  | Tax | –29,540.00 | 96,250.00 | 228,060.00 |
|  | Net income | –$111,126.67 | $362,083.33 | $857,940.00 |
|  | OCF | $255,540.00 | $703,750.00 | $1,182,940.00 |

 Note that under the pessimistic scenario, the taxable income is negative. We assumed a tax credit in this case. Now we can calculate the NPV under each scenario, which will be:

 NPVPessimistic = –$2,200,000 + $255,540(PVIFA13%,6)

 NPV = –$1,178,466.13

 NPVExpected = –$2,050,000 + $703,750(PVIFA13%,6)

 NPV = $763,275.66

 NPVOptimistic = –$1,950,000 + $1,182,940(PVIFA13%,6)

 NPV = $2,778,861.55

 The NPV under the pessimistic scenario is negative, but the company should probably accept the project.

 *Challenge*

**26.** *a*. Using the tax shield approach, the OCF is:

 OCF = [($295 – 185)(20,000) – $925,000](1 – .22) + .22($3,100,000/5)

 OCF = $1,130,900

 And the NPV is:

 NPV = –$3,100,000 – 380,000 + $1,130,900(PVIFA13%,5)

 + [$380,000 + $400,000(1 – .22)]/1.135

 NPV = $873,226.71

 *b*. In the worst case, the OCF is:

 OCFworst = {[($295)(.9) – 185](20,000) – $925,000}(1 – .22) + .22[$3,100,000(1.15)/5]

 OCFworst = $691,160

 And the worst-case NPV is:

 NPVworst = –$3,100,000(1.15) – $380,000(1.05) + $691,160(PVIFA13%,5) +

 [$380,000(1.05) + $400,000(.85)(1 – .22)]/1.135

 NPVworst = –$1,172,529.29

 The best-case OCF is:

 OCFbest = {[$295(1.1) – 185](20,000) – $925,000}(1 – .22) + .22[$3,100,000(.85)/5]

 OCFbest = $1,570,640

 And the best-case NPV is:

 NPVbest = –$3,100,000(.85) – $380,000(.95) + $1,570,640(PVIFA13%,5) +

 [$380,000(.95) + $400,000(1.15)(1 – .22)]/1.135

 NPVbest = $2,918,982.71

**27.** To calculate the sensitivity to changes in quantity sold, we will choose a quantity of 21,000 tons. The OCF at this level of sales is:

 OCF = [($295 – 185)(21,000) – $925,000](1 – .22) + .22($3,100,000/5)

 OCF = $1,216,700

 The sensitivity of changes in the OCF to quantity sold is:

 ΔOCF/Δ*Q* = ($1,130,900 – 1,216,700)/(20,000 – 21,000)

 ΔOCF/Δ*Q* = +$85.80

 The NPV at this level of sales is:

 NPV = –$3,100,000 – $380,000 + $1,216,700(PVIFA13%,5) + [$380,000 + $400,000(1 – .22)]/1.135

 NPV = $1,175,005.15

 And the sensitivity of NPV to changes in the quantity sold is:

 ΔNPV/Δ*Q* = ($873,226.71 – 1,175,005.15)/(20,000 – 21,000)

 ΔNPV/Δ*Q* = +$301.78

 You wouldn’t want the quantity to fall below the point where the NPV is zero. We know the NPV changes $301.78 for every ton sold, so we can divide the NPV for 20,000 units by the sensitivity to get a change in quantity. Doing so, we get:

 $873,226.71 = $301.78(Δ*Q*)

 Δ*Q* = 2,894

 For a zero NPV, we need to decrease sales by 2,894 units, so the minimum quantity is:

 *Q*Min = 20,000 – 2,894

 *Q*Min = 17,106

**28.** We will use the bottom-up approach to calculate the operating cash flow. Assuming we operate the project for all four years, the cash flows are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | Year | 0 | 1 | 2 | 3 | 4 |
|  | Sales |  | $9,100,000 | $9,100,000 | $9,100,000 | $9,100,000 |
|  | Operating costs |  | 3,700,000 | 3,700,000 | 3,700,000 | 3,700,000 |
|  | Depreciation |  | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 |
|  | EBT |  | $2,400,000 | $2,400,000 | $2,400,000 | $2,400,000 |
|  | Tax |  | 504,000 | 504,000 | 504,000 | 504,000 |
|  | Net income |  | $1,896,000 | $1,896,000 | $1,896,000 | $1,896,000 |
|  | +Depreciation |  | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 |
|  | Operating CF |  | $4,896,000 | $4,896,000 | $4,896,000 | $4,896,000 |
|  |  |  |  |  |  |  |
|  | Change in NWC | –$900,000 | 0 | 0 | 0 | $900,000 |
|  | Capital spending | –$12,000,000 | 0 | 0 | 0 | - |
|  | Total cash flow | –$12,900,000 | $4,896,000 | $4,896,000 | $4,896,000 | $5,796,000 |

 There is no salvage value for the equipment. The NPV is:

 NPV = –$12,900,000 + $4,896,000(PVIFA13%,3) + $5,796,000/1.134

 NPV = $2,214,998.46

 *b.* The cash flows if we abandon the project after one year are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Year | 0 | 1 |  |  |  |
|  | Sales |  | $9,100,000 |  |  |  |
|  | Operating costs |  | 3,700,000 |  |  |  |
|  | Depreciation |  | 3,000,000 |  |  |  |
|  | EBT |  | $2,400,000 |  |  |  |
|  | Tax |  | 504,000 |  |  |  |
|  | Net income |  | $1,896,000 |  |  |  |
|  | +Depreciation |  | 3,000,000 |  |  |  |
|  | Operating CF |  | $4,896,000 |  |  |  |
|  |  |  |  |  |  |  |
|  | Change in NWC | –$900,000 | $900,000 |  |  |  |
|  | Capital spending | –$12,000,000 | 8,289,000 |  |  |  |
|  | Total cash flow | –$12,900,000 | $14,085,000 |  |  |  |

 The book value of the equipment is:

 Book value = $12,000,000 – (1)($12,000,000/4)

 Book value = $9,000,000

 So, the taxes on the salvage value will be:

 Taxes = ($9,000,000 – 8,100,000)(.21)

 Taxes = $189,000

 This makes the aftertax salvage value:

 Aftertax salvage value = $8,100,000 + 189,000

 Aftertax salvage value = $8,289,000

 The NPV if we abandon the project after one year is:

 NPV = –$12,900,000 + $14,085,000/1.13

 NPV = –$435,398.23

 If we abandon the project after two years, the cash flows are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Year | 0 | 1 | 2 |  |  |
|  | Sales |  | $9,100,000 | $9,100,000 |  |  |
|  | Operating costs |  | 3,700,000 | 3,700,000 |  |  |
|  | Depreciation |  | 3,000,000 | 3,000,000 |  |  |
|  | EBT |  | $2,400,000 | $2,400,000 |  |  |
|  | Tax |  | 504,000 | 504,000 |  |  |
|  | Net income |  | $1,896,000 | $1,896,000 |  |  |
|  | +Depreciation |  | 3,000,000 | 3,000,000 |  |  |
|  | Operating CF |  | $4,896,000 | $4,896,000 |  |  |
|  |  |  |  |  |  |  |
|  | Change in NWC | –$900,000 | 0 | $900,000 |  |  |
|  | Capital spending | –$12,000,000 | 0 | 6,158,000 |  |  |
|  | Total cash flow | –$12,900,000 | $4,896,000 | $11,954,000 |  |  |

 The book value of the equipment is:

 Book value = $12,000,000 – (2)($12,000,000/4)

 Book value = $6,000,000

 So the taxes on the salvage value will be:

 Taxes = ($6,000,000 – 6,200,000)(.21)

 Taxes = –$42,000

 This makes the aftertax salvage value:

 Aftertax salvage value = $6,200,000 – 42,000

 Aftertax salvage value = $6,158,000

 The NPV if we abandon the project after two years is:

 NPV = –$12,900,000 + $4,896,000/1.13 + $11,954,000/1.132

 NPV = $794,478.82

 If we abandon the project after three years, the cash flows are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Year | 0 | 1 | 2 | 3 |  |
|  | Sales |  | $9,100,000 | $9,100,000 | $9,100,000 |  |
|  | Operating costs |  | 3,700,000 | 3,700,000 | 3,700,000 |  |
|  | Depreciation |  | 3,000,000 | 3,000,000 | 3,000,000 |  |
|  | EBT |  | $2,400,000 | $2,400,000 | $2,400,000 |  |
|  | Tax |  | 504,000 | 504,000 | 504,000 |  |
|  | Net income |  | $1,896,000 | $1,896,000 | $1,896,000 |  |
|  | +Depreciation |  | 3,000,000 | 3,000,000 | 3,000,000 |  |
|  | Operating CF |  | $4,896,000 | $4,896,000 | $4,896,000 |  |
|  |  |  |  |  |  |  |
|  | Change in NWC | –$900,000 | 0 | 0 | $900,000 |  |
|  | Capital spending | –$12,000,000 | 0 | 0 | 4,422,000 |  |
|  | Total cash flow | –$12,900,000 | $4,896,000 | $4,896,000 | $10,218,000 |  |

 The book value of the equipment is:

 Book value = $12,000,000 – (3)($12,000,000/4)

 Book value = $3,000,000

 So the taxes on the salvage value will be:

 Taxes = ($3,000,000 – 4,800,000)(.21)

 Taxes = –$378,000

 This makes the aftertax salvage value:

 Aftertax salvage value = $4,800,000 – 378,000

 Aftertax salvage value = $4,422,000

 The NPV if we abandon the project after three years is:

 NPV = –$12,900,000 + $4,896,000(PVIFA13%,2) + $10,218,000/1.133

 NPV = $2,348,616.08

 We should abandon the equipment after three years since the NPV of abandoning the project after three years has the highest NPV.

**29.** *a.* The NPV of the project is the sum of the present value of the cash flows generated by the project. The cash flows from this project are an annuity, so the NPV is:

 NPV = –$8,900,000 + $1,600,000(PVIFA10%,10)

NPV = $931,307.37

 *b.* The company will abandon the project if the value of abandoning the project is greater than the value of the future cash flows. The present value of the future cash flows if the company revises its sales downward will be:

 PV of downward revision = $385,000(PVIFA10%,9)

 PV of downward revision = $2,217,224.17

 Since this is less than the abandonment value, the company should abandon the project if sales are revised downward. So, the revised NPV of the project will be the initial cost, plus the PV of the expected cash flow in Year 1, plus the PV of the expected cash flows based on the upward sales projection, plus the PV of the abandonment value. We need to remember that the abandonment value occurs in Year 1, and the present value of the expansion cash flows are in Year 1, so each of these must be discounted back to today. So, the project NPV under the abandonment or expansion scenario is:

 NPV = –$8,900,000 + $1,600,000/1.10 + .50($2,900,000)/1.10

 + [.50($2,810,000)(PVIFA10%,9)]/1.10

 NPV = $1,228,571.33

**30.** First, determine the cash flow from selling the old harvester. When calculating the salvage value, remember that tax liabilities or credits are generated on the difference between the resale value and the book value of the asset. Using the original purchase price of the old harvester to determine annual depreciation, the annual depreciation for the old harvester is:

 DepreciationOld = $65,000/15

 DepreciationOld = $4,333.33

 Since the machine is five years old, the firm has accumulated five annual depreciation charges, reducing the book value of the machine. The current book value of the machine is equal to the initial purchase price minus the accumulated depreciation, so:

 Book value = Initial Purchase Price – Accumulated Depreciation

 Book value = $65,000 – ($4,333.33 × 5 years)

 Book value = $43,333.33

 Since the firm is able to resell the old harvester for $21,000, which is less than the $43,333.33 book value of the machine, the firm will generate a tax credit on the sale. The aftertax salvage value of the old harvester will be:

 Aftertax salvage value = Market value + *TC*(Book value – Market value)

 Aftertax salvage value = $21,000 + .22($43,333.33 – 21,000)

 Aftertax salvage value = $25,913.33

 Next, we need to calculate the incremental depreciation. We need to calculate the depreciation tax shield generated by the new harvester less the forgone depreciation tax shield from the old harvester. Let *P* be the break-even purchase price of the new harvester. So, we find:

 Depreciation tax shieldNew = (Initial investment/Economic life) × *TC*

 Depreciation tax shieldNew = (*P*/10)(.22)

 And the depreciation tax shield on the old harvester is:

 Depreciation tax shieldOld = ($65,000/15)(.22)

 Depreciation tax shieldOld = ($4,333.33)(.22)

 So, the incremental depreciation tax, which is the depreciation tax shield from the new harvester, minus the depreciation tax shield from the old harvester, is:

 Incremental depreciation tax shield = (*P/*10)(.22) – ($4,333.33)(.22)

 Incremental depreciation tax shield = (*P/*10 – $4,333.33)(.22)

 The present value of the incremental depreciation tax shield will be:

 PVDepreciation tax shield = (*P/*10)(.22)(PVIFA15%,10) – $4,333.33(.22)(PVIFA15%,10)

 The new harvester will generate year-end pretax cash flow savings of $13,000 per year for 10 years. We can find the aftertax present value of the cash flows savings as:

 PVSsavings = *C*1(1 – *TC*)(PVIFA15%,10)

PVSsavings = $13,000(1 – .22)(PVIFA15%,10)

 PVSsavings = $50,890.31

 The break-even purchase price of the new harvester is the price, *P*, which makes the NPV of the machine equal to zero.

 NPV = –*P* + Salvage valueOld + PVDepreciation tax shield + PVSavings

 $0 = –*P* + $25,913.33 + (*P/*10)(.22)(PVIFA15%,10) – $4,333.33(.22)(PVIFA15%,10) + $50,890.31

 *P* – (*P/*10)(.22)(PVIFA15%,10) = $76,803.65 – $4,333.33(.22)(PVIFA15%,10)

 *P*[1 – (1*/*10)(.22)(PVIFA15%,10)] = $72,019.09

 *P* = $80,957.88