1. An asset with a first cost of $20,000 has an annual operating cost of $12,000 and a $4000 salvage value after its 4-year life. If the project will be needed for 6 years, what would the market (salvage) value of the 2-year-old asset have to be for the annual worth to be the same as it is for one life cycle of the asset? Use an interest rate of 10% per year.

$$AW_4 = -20{,}000(A/P,10\%,4) - 12{,}000 + 4000(A/F,10\%,4)$$
$$= -20{,}000(0.31547) - 12{,}000 + 4000(0.21547)$$
$$= \$\text{-}17{,}448$$

$$-17{,}448 = -20{,}000(A/P,10\%,6) - 12{,}000 - (20{,}000 - 4000)(P/F,10\%,4)(A/P,10\%,6)$$
$$+ S(A/F,10\%,6)$$

$$= -20{,}000(0.22961) - 12{,}000 - (20{,}000 - 4000)(0.6830)(0.22961)$$
$$+ S(0.12961)$$

$$(0.12961)S = 1{,}653.38$$

$$S = \$12{,}756$$

2. A sports mortgage is an innovative way to finance cash-strapped sports programs by allowing fans to sign up to pay a "mortgage" for the right to buy good seats at football games for several decades with season tickets locked in at current prices. At Notre Dame, the locked-in price period is 50 years. If a fan pays a $130,000 "mortgage" fee now (i.e., in year 0) when season tickets are selling for $290 each, what is the equivalent annual cost of the football tickets over the 50-year period at an interest rate of 8% per year?

$$AW = -130{,}000(A/P,8\%,50) - 290$$
$$= -130{,}000(0.08174) - 290$$
$$= \$\text{-}10{,}916 \text{ per year}$$

3. If a fan buys a sports mortgage to USC football games by paying $130,000 in 10 equal payments starting now , and then pays a fixed price of $290 per year for 50 years (starting 1 year from now) for season tickets, what is the AW in years 1 through 50 of the season tickets at 8% per year interest?

Find PW and convert to AW

$$PW = -13{,}000 - 13{,}000(P/A,8\%,9) - 290(P/A,8\%,50)$$
$$= -13{,}000 - 13{,}000(6.2469) - 290(12.2335)$$
$$= \$\text{-}97{,}757$$

$$AW = 97{,}757(A/P,8\%,50)$$
$$= 97{,}757(0.08174)$$
$$= \$\text{-}7{,}991 \text{ per year}$$

4. Eight years ago, Ohio Valley Trucking purchased a large-capacity dump truck for $115,000 to provide short-haul earthmoving services. The company sold it today for $45,000. Operating and maintenance costs averaged $10,500 per year. A complete overhaul at the end of year 4 cost an extra $3600. Calculate the annual cost of the truck at 8% per year interest.

$$AW = -115{,}000(A/P,8\%,8) - 10{,}500 - 3600(P/F,8\%,4)(A/P,8\%,8) + 45{,}000(A/F,8\%,8)$$
$$= -115{,}000(0.17401) - 10{,}500 - 3600(0.7350)(0.17401) + 45{,}000(0.09401)$$
$$= \$\text{-}26{,}741 \text{per year}$$

5. James developed the two cash flow diagrams shown. The cash flows for alternative B represent two life cycles of A. Calculate the annual worth value of each over the respective life cycles to demonstrate that they are the same. Use an interest rate of 10% per year.
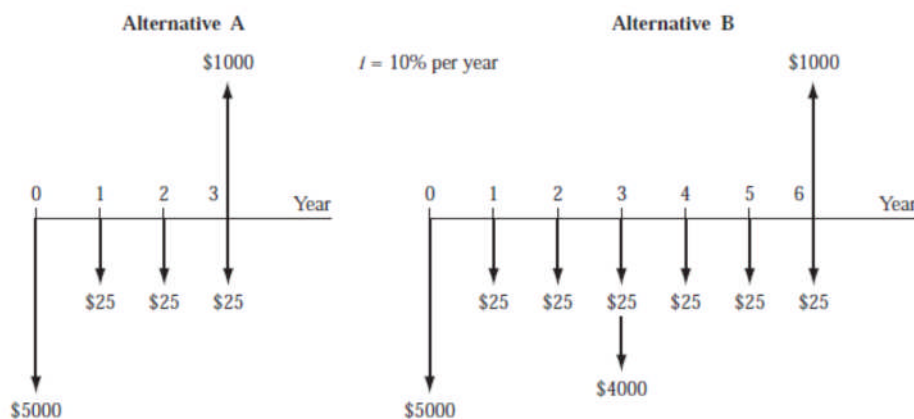
$$AW_A = -5000(A/P,10\%,3) - 25 + 1000(A/F,10\%,3)$$
$$= -5000(0.40211) - 25 + 1000(0.30211)$$
$$= \$\text{-}1733.44$$

$$AW_B = -5000(A/P,10\%,6) - 25 - 4000(P/F,10\%,3)(A/P,10\%,6) + 1000(A/F,10\%,6)$$
$$= -5000(0.22961) - 25 - 4000(0.7513)(0.22961) + 1000(0.12961)$$
$$= \$\text{-}1733.46$$

AW values are the same; slight difference due to round-off

6. Sylvia has received a $500,000 inheritance from her favorite, recently deceased aunt in Hawaii. Sylvia is planning to purchase a condo in Hawaii in the same area where her aunt lived all her life and to rent it to vacationers. She hopes to make 8% per year on this purchase over an ownership period of 20 years. The condo's total first cost is $500,000, and she conservatively expects to sell it for 90% of the purchase price. No annual M&O costs are considered in the analysis. (a) What is the capital recovery amount? (b) If there is a real boom in rental real estate 10 years in the future, what sales price (as a percentage of original purchase price) is necessary at that time (year 10) to realize the same amount as the 8% return expected over the 20-year ownership period?

(a) $CR = -500,000(A/P,8\%,20) + (0.9)500,000(A/F,8\%,20)$
$= -500,000(0.10185) + 450,000(0.02185)$
$= \$-41,093 \text{ per year}$

(b) $41,093 = 500,000(A/P,8\%,10) - S(A/F,8\%,10)$
$= 500,000(0.14903) - S(0.06903)$

$S = (74,515 - 41,093)/0.06903)$
$= \$484,166$

Sales price must be at least 96.8% of purchase price 10 years earlier.

7. Humana Hospital Corporation installed a new MRI machine at a cost of $750,000 this year in its medical professional clinic in Cedar Park. This state-of the- art system is expected to be used for 5 years and then sold for $75,000. Humana uses a return requirement of 24% per year for all of its medical diagnostic equipment. As a bioengineering student currently serving a coop semester on the management staff of Humana Corporation in Louisville, Kentucky, you are asked to determine the minimum revenue required each year to realize the expected recovery and return. Also, you are asked to draw two cash flow diagrams, one showing the MRI purchase and sale cash flow and a second depicting the required capital recovery each year.

$CR = -750,000(A/P,24\%,5) + 75,000(A/F,24\%,5)$
$= -750,000(0.36425) + 75,000(0.12425)$
$= \$-263,869 \text{ per year}$

Cash flow diagrams are shown here.

CR = $263,869 per year

Capital recovery

MRI purchase and sale
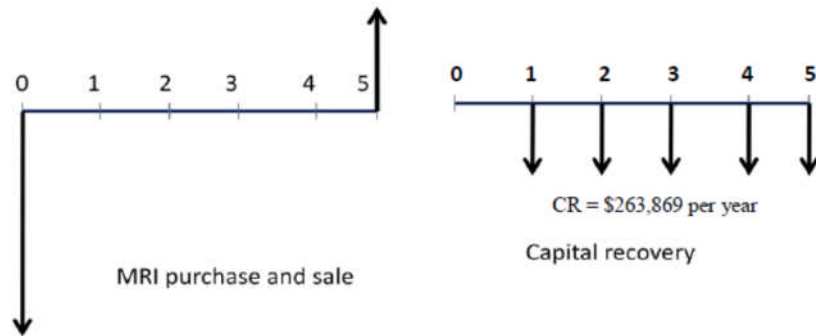
8. Polypropylene wall caps, used for covering exterior vents for kitchen cooktops, bathroom fans, dryers, and other building air exhausts, can be made by two different methods. Method X will have a first cost of $75,000, an operating cost of $32,000 per year, and a $9000 salvage value after 4 years. Method Y will have a first cost of $140,000, an operating cost of $24,000 per year, and a $19,000 salvage value after its 4-year life. At an interest rate of 10% per year, which method should be used on the basis of an annual worth analysis?

$AW_X = -75,000(A/P,10\%,4) - 32,000 + 9000(A/F,10\%,4)$
$= -75,000(0.31547) - 32,000 + 9000(0.21547)$
$= \$-53,721$

$AW_Y = -140,000(A/P,10\%,4) - 24,000 + 19,000(A/F,10\%,4)$
$= -140,000(0.31547) - 24,000 + 19,000(0.21547)$
$= \$-64,072$

Use Method X

9. Nissan's all-electric car, the Leaf, has a base price of $32,780 in the United States, but it is eligible for a $7500 federal tax credit. A consulting engineering company wants to evaluate the purchase or lease of one of the vehicles for use by its employees traveling to job sites in the local area. The cost for leasing the vehicle will be $4200 per year (payable at the end of each year) after an initialization charge of $2500 paid now. If the company purchases the vehicle, it will also purchase a home charging station for $2200 that will be partially offset by a 50% tax credit. If the company expects to be able to sell the car and charging station for 40% of the base price of the car alone at the end of 3 years, should the company purchase or lease the car? Use an interest rate of 10% per year and annual worth analysis.

4

$$AW_{Buy} = [-32{,}780 - 2200 + 7500 + 0.5(2200)](A/P,10\%,3) + 0.40(32{,}780)(A/F,10\%,3)$$
$$= (-26{,}380)(0.40211) + 13{,}112(0.30211)$$
$$= \${-}6{,}646$$

$$AW_{Lease} = -2500(A/P,10\%,3) - 4200$$
$$= -2500(0.40211) - 4200$$
$$= \${-}5{,}205$$

The company should lease the car

10. A new structural design software package is available for analyzing and designing three-sided guyed towers and three- and four-sided self-supporting towers. A single-user license will cost \$6000 per year. A site license has a one-time cost of \$22,000. A structural engineering consulting company is trying to decide between two alternatives: buy a single-user license now and one each year for the next 3 years (which will provide 4 years of service), or buy a site license now. Determine which strategy should be adopted at an interest rate of 10% per year for a 4-year planning period using the annual worth method of evaluation.

$$AW_{Single} = -6000(A/P,10\%,4) - 6000(P/A,10\%,3)(A/P,10\%,4)$$
$$= -6000(0.31547) - 6000(2.4869)(0.31547)$$
$$= \${-}6{,}600$$

$$AW_{Site} = -22{,}000(A/P,10\%,4)$$
$$= -22{,}000(0.31547)$$
$$= \${-}6{,}940$$

Buy the single-user license

11. The city council in a certain southwestern city is considering whether to construct permanent restrooms in 22 of its smaller parks (i.e., parks of less than 12 acres) or pay for portable toilets on a year round basis. The cost of constructing the 22 permanent restrooms will be \$3.8 million. The 22 portable restrooms can be rented for \$7500 each for 1 year. The service life of a permanent restroom is 20 years. Using an interest rate of 6% per year and an annual worth analysis, determine if the city should build the permanent restrooms or lease the portable ones.

$$AW_{permanent} = -3,800,000(A/P,6\%,20)$$
$$= -3,800,000(0.08718)$$
$$= \$-331,284$$

$$AW_{portable} = -22(7500)$$
$$= \$-165,000$$

The city should lease the restrooms

12. The cash flows for two small raw water treatment systems are shown. Determine which should be selected on the basis of an annual worth analysis at 10% per year interest.

	MF	UF
First cost, $	–33,000	–51,000
Annual cost, $ per year	–8,000	–3,500
Salvage value, $	4,000	11,000
Life, years	3	6

$$AW_{MF} = -33,000(A/P,10\%,3) - 8000 + 4000(A/F,10\%,3)$$
$$= -33,000(0.40211) - 8000 + 4000(0.30211)$$
$$= \$-20,061$$

$$AW_{UF} = -51,000(A/P,10\%,6) - 3500 + 11,000(A/F,10\%,6)$$
$$= -51,000(0.22961) - 3500 + 11,000(0.12961)$$
$$= \$-13,784$$

Select the UF system

13. PGM Consulting is under contract to Montgomery County for evaluating alternatives that use a robotic, liquid-propelled "pig" to periodically inspect the interior of buried potable water pipes for leakage, corrosion, weld strength, movement over time, and a variety of other parameters. Two equivalent robot instruments are available. Robot Joeboy will have a first cost of $85,000, annual M&O costs of $30,000, and a $40,000 salvage value after 3 years. Robot Watcheye will have a first cost of $125,000, annual M&O costs of $27,000, and a $33,000 salvage value after its 5-year life. Assume an interest rate of 8% per year.

(a) Which robot is the better economic option?

(b) Using the spreadsheet Goal Seek tool, determine the first cost of the robot not selected in (a) so that it will be the economic selection.

(a) $AW_{Joe} = -85{,}000(A/P{,}8\%{,}3) - 30{,}000 + 40{,}000(A/F{,}8\%{,}3)$
$= -85{,}000(0.38803) - 30{,}000 + 40{,}000(0.30803)$
$= \$-50{,}661$

$AW_{Watch} = -125{,}000(A/P{,}8\%{,}5) - 27{,}000 + 33{,}000(A/F{,}8\%{,}5)$
$= -125{,}000(0.25046) - 27{,}000 + 33{,}000(0.17046)$
$= \$-52{,}682$

Select robot Joeboy

14. You work for Midstates Solar Power. A manager asked you to determine which of the following two machines will have the lower (a) capital recovery and (b) equivalent annual total cost. Machine Semi2 has a first cost of $80,000 and an operating cost of $21,000 in year 1, increasing by $500 per year through year 5, after which time it will have a salvage value of $13,000. Machine Auto1 has a first cost of $62,000 and an operating cost of $21,000 in year 1, increasing by 8% per year through year 5, after which time it will have a scavenge value of $2000. Utilize an interest rate of 10% per year to determine both estimates.

(a) $CR_{Semi2} = -80{,}000(A/P{,}10\%{,}5) + 13{,}000(A/F{,}10\%{,}5)$
$= -80{,}000(0.26380) + 13{,}000(0.16380)$
$= \$-18{,}975$ per year

$CR_{Auto1} = -62{,}000(A/P{,}10\%{,}5) + 2000(A/F{,}10\%{,}5)$
$= -62{,}000(0.26380) + 2000(0.16380)$
$= \$-16{,}028$ per year

Capital recovery for Auto1 is lower by $2947 per year