# Chapter 5

# Present Worth Analysis

**5-1**
Sarah and her husband decide they will buy $1,000 worth of utility stocks beginning one year from now. Since they expect their salaries to increase, they will increase their purchases by $200 per year for the next nine years. What would the present worth of all the stocks be if they yield a uniform dividend rate of 10% throughout the investment period and the price/share remains constant?

**5-2**
Using an interest rate of 8%, what is the capitalized cost of a tunnel to transport water through the Lubbock mountain range if the first cost is $1,000,000 and the maintenance costs are expected to occur in a 6-year cycle as shown below?

| End of Year: | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Maintenance: | $35,000 | $35,000 | $35,000 | $45,000 | $45,000 | $60,000 |

**5-3**
The investment in a crane is expected to produce profit from its rental as shown below, over the next six years. Assume the salvage value is zero. What is the present worth of the investment, assuming 12% interest?

| Year | Profit |
|---|---|
| 1 | $15,000 |
| 2 | 12,500 |
| 3 | 10,000 |
| 4 | 7,500 |
| 5 | 5,000 |
| 6 | 2,500 |

**5-4**
A tax refund expected one year from now has a present worth of $3,000 if i = 6 %. What is its present worth if i = 10 %?

**5-5**
It takes $10,000 to put on a Festival of Laughingly Absurd Works each year. Immediately before this year's FLAW, the sponsoring committee finds that it has $60,000 left in an account paying 8% interest. After this year, how many more FLAWs can be sponsored without raising more money? Think Carefully!

**5-6**

An engineer is considering buying a life insurance policy for his family. He currently owes about $77,500 in different loans, and would like his family to have an annual available income of $35,000 indefinitely (that is, the annual interest should amount to $35,000 so that the original capital does not decrease).

(a) He feels he can safely assume that the family will be able to get a 4% interest rate on that capital. How much life insurance should he buy?

(b) If he now assumes the family can get a 7% interest rate, calculate again how much life insurance should he buy?

**5-7**

The winner of a sweepstakes prize is given the choice of one million dollars or the guaranteed amount of $80,000 a year for 20 years. If the value of money is taken at a 5% interest rate, which choice is better for the winner?

**5-8**

The annual income from an apartment house is $20,000. The annual expense is estimated to be $2,000. If the apartment house could be sold for $100,000 at the end of 10 years, how much could you afford to pay for it now, with 10% considered a suitable interest rate?

**5-9**

A scholarship is to be established that will pay $200 per quarter at the beginning of Fall, Winter, and Spring quarters. It is estimated that a fund for this purpose will earn 10% interest, compounded quarterly. What lump sum at the beginning of Summer quarter, when deposited, will assure that the scholarship may be continued into perpetuity?

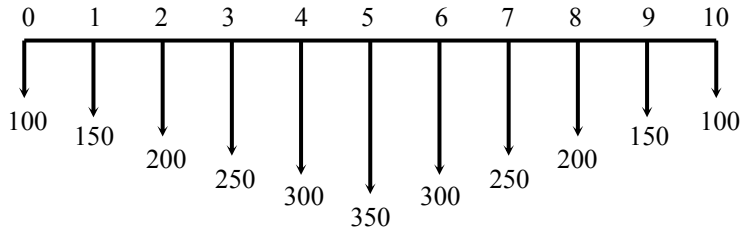
**5-10**

Your company has been presented with an opportunity to invest in a project. The facts on the project are presented below:

| | |
|---|---|
| Investment required | $60,000,000 |
| Salvage value after 10 years | 0 |
| Gross income expected from the project | 20,000,000/yr |
| Operating costs: | |
| Labor | 2,500,000/yr |
| Materials, licenses, insurance, etc | 1,000,000/yr |
| Fuel and other costs | 1,500,000/yr |
| Maintenance costs | 500,000/yr |

The project is expected to operate as shown for ten years. If your management expects to make 25% on its investments before taxes, would you recommend this project?

**5-11**
Find the Present Equivalent of the following cash flow diagram if i = 18 %.




**5-12**
A couple wants to begin saving money for their child's education. They estimate that $10,000 will be needed on the child's 18th birthday, $12,000 on the 19th birthday, $14,000 on the 20th birthday, and $16,000 on the 21st birthday. Assume an 8% interest rate with only annual compounding. The couple is considering two methods of setting aside the needed money.

(a) How much money would have to be deposited into the account on the child's first birthday (note: a child's "first birthday" is celebrated one year after the child is born) to accumulate enough money to cover the estimated college expenses?

(b) What uniform annual amount would the couple have to deposit each year on the child's first through seventeenth birthdays to accumulate enough money to cover the estimated college expenses?

**5-13**
Assume you borrowed $50,000 at an interest rate of 1 percent per month, to be repaid in uniform monthly payments for 30 years. In the 163rd payment, how much of it would be interest, and how much of it would be principal?

**5-14**
A municipality is seeking a new tourist attraction, and the town council has voted to allocate $500,000 for the project. A survey shows that an interesting cave can be enlarged and developed for a contract price of $400,000. It would have an infinite life.

The estimated annual expenses of operation are:

| | |
|---|---|
| Direct Labour | $30,000 |
| Maintenance | 15,000 |
| Electricity | 5,000 |

The price per ticket is to be based upon an average of 1,000 visitors per month. If money is worth 8%, what should be the price of each ticket?

**5-15**
A middle-aged couple has made an agreement with Landscapes Forever Company, a gravesite landscaping and maintenance firm. The agreement states that Landscapes Forever will provide "deluxe landscaping and maintenance" for the couple's selected gravesite forever for an annual fee of $1,000. To arrange payment, the couple has set us a variable rate perpetual trust fund with their bank. The bank guarantees that the trust fund will

earn a minimum of 5% per year. Assume that the services of Landscapes Forever will not be needed until after the wife has died, and that she lives to the ripe old age of 100.

(a) What is the smallest amount of money that the couple would have to deposit into the trust fund?

(b) Suppose that the couple made this minimum deposit on the wife's 50th birthday, and suppose that the interest rate paid by the trust fund fluctuated as follows:

| Wife's Age | Interest Rate |
|---|---|
| 50 - 54 | 5 % |
| 55 - 64 | 10% |
| 65 - 74 | 15% |
| 75 - 84 | 20% |

What is the largest sum of money that could be withdrawn from the trust fund on the wife's 85th birthday, and still have the perpetual payments to Landscapes Forever made?

**5-16**

A local car wash charges $3.00 per wash or the option of paying $12.98 for 5 washes, payable in advance with the first wash. If you normally washed your car once a month, would the option be worthwhile if your minimum attractive rate of return (MARR) is 12% compounded annually?

**5-17**

A project has a first cost of $14,000, uniform annual benefits of $2,400, and a salvage value of $3,000 at the end of its 10 year useful life. What is its net present worth at an interest rate of 12%?

**5-18**

A person borrows $5,000 at an interest rate of 18%, compounded monthly. Monthly payments of $180.76 are agreed upon.

(a) What is the length of the loan?
(Hint: it is an integral number of years.)
(b) What is the total amount that would be required at the end of the sixth month to payoff the entire loan balance?

**5-19**

A $50,000 30-year loan with a nominal interest rate of 6% is to be repaid in payments of $299.77 per month (for 360 months). The borrower wants to know how many payments, N*, he will have to make until he owes only half of the amount he borrowed initially. His minimum attractive rate of return (MARR) is a nominal 10% compounded monthly.

**5-20**

A project has a first cost of $10,000, net annual benefits of $2,000, and a salvage value of $3,000 at the end of its 10 year useful life. The project will be replaced identically at the end of 10 years, and again at the end of 20 years. What is the present worth of the entire 30 years of service if the interest rate is 10%?

**5-21**
The present worth of costs for a $5,000 investment with a complex cash flow diagram is $5,265. What is the capitalized cost if the project has a useful life of 12 years, and the MARR is 18%?

**5-22**
A used car dealer tells you that if you put $1,500 down on a particular car your payments will be $190.93 per month for 4 years at a nominal interest rate of 18%. Assuming monthly compounding, what is the present price you are paying for the car?

**5-23**
What is the price of a 3-year Savings Certificate worth $5,000 three years hence, at 12 % interest, compounded continuously, with loss of interest if taken out before three years?

**5-24**
If the current interest rate on bonds of a certain type is 10% nominal, compounded semi-annually, what should the market price of a $1,000 face value, 14 percent bond be? The bond will mature (pay face value) 6½ years from today and the next interest payment to the bondholder will be due in 6 months.

**5-25**
What is the Present Worth of a series that decreases uniformly, by $20 per year, from $400 in Year 11 to $220 in Year 20, if i equals 10 %?

**5-26**
Many years ago BigBank loaned $12,000 to a local homeowner at a nominal interest rate of 4.5%, compounded monthly. The terms of the mortgage called for payments of $60.80 at the end of each month for 30 years. BigBank has just received the $300^{th}$ payment, thus the loan has five more years to maturity. The outstanding balance is now $3,261.27.

Because BigBank currently charges a nominal 13% compounded monthly on home mortgages, it could earn a better return on its money if the homeowner would pay off the loan now; however, the bank realizes the homeowner has little economic incentive to do that with such a low interest rate on the loan. Therefore, BigBank plans to offer the homeowner a discount.

If the homeowner will pay today an amount of $3,261.27 - D, where D is the dollar amount of the discount, BigBank will consider the loan paid in full. If for BigBank the minimum attractive rate of return (MARR) is 10% (effective annual rate), what is the maximum discount, D, it should offer the homeowner?

**5-27**
A resident will give money to his town to purchase a Vietnam veteran memorial statue and to maintain it at a cost of $500 per year forever. If an interest rate of 10% is used, and the resident gives a total of $15,000; how much can be paid for the statue?

**5-28**
A rich widow decides on her 70th birthday to give most of her wealth to her family and worthy causes, retaining an amount in a trust fund sufficient to provide her with an annual end of year payment of $60,000. If she is earning a steady 10% rate of return on her investment, how much should she retain to provide these payments until she is 95 (the last payment the day before she is 96)? If she dies on her 85th birthday, how much will remain in the trust fund?

**5-29**
J.D. Homeowner has just bought a house with a 20-year, 9%, $70,000 mortgage on which he is paying $629.81 per month.

(a) If J.D. sells the house after ten years, how much must he give the bank to completely pay off the mortgage at the time of the 120th payment?
(b) How much of the first $379.33 payment on the loan is interest?

**5-30**
Dolphin Inc. trains mine seeking dolphins in a 5-mine tank. They are considering purchasing a new tank. The U.S. Navy will pay $105,000 for each dolphin trained and a new tank costs $750,000 and realistic dummy mines cost $250,000. The new tank will allow the company to train 3 dolphins per year and will last 10 years costing $50,000 per year to maintain. Determine the net present value if the MARR equals 5%?

**5-31**
Using an 8-year analysis and a 10% interest rate, determine which alternative should be selected, based on net present worth.

| Alternative | A | B |
|---|---|---|
| First Cost | $5,300 | $10,700 |
| Uniform Annual Benefit | 1,800 | 2,100 |
| Useful life | 4 years | 8 years |

**5-32**
Three purchase plans are available for a new car.

Plan A: $5,000 cash immediately
Plan B: $1,500 down and 36 monthly payments of $116.25
Plan C: $1,000 down and 48 monthly payments of $120.50

If a customer expects to keep the car five years and her minimum attractive rate of return (MARR) is 18% compounded monthly, which payment plan should she choose?

**5-33**
Given the following three mutually exclusive alternatives.

| | Alternative | | |
|---|---|---|---|
| | A | B | C |
| Initial Cost | $50 | $30 | $40 |
| Annual Benefits | 15 | 10 | 12 |
| Useful Life(years) | 5 | 5 | 5 |

What alternative is preferable if i = 10%?

**5-34**
Consider two investments:

(1) Invest $1,000 and receive $110 at the end of each month for the next 10 months.
(2) Invest $1,200 and receive $130 at the end of each month for the next 10 months.

If this were your money, and you want to earn at least 12% interest on your money, which investment would you make, if any? What nominal interest rate do you earn on the investment you choose? Solve by present worth analysis.

**5-35**
A farmer has just purchased a tractor for which he had to borrow $20,000. The bank has offered the following choice of payment plans determined using an interest rate of 8%. If the farmer's minimum attractive rate of return (MARR) is 15%, which plan should he choose?

Plan A: $5,010 per year for 5 years
Plan B: $2,956 per year for 4 years plus $15,000 at end of 5 years
Plan C: Nothing for 2 years, then $9,048 per year for 3 years

**5-36**
Projects A and B have first costs of $5,000 and $9,000, respectively. Project A has net annual benefits of $2,500 during each year of its 5 year useful life, after which it can be replaced identically.

Project B has net annual benefits of $3,300 during each year of its 10 year life. Use present worth analysis, an interest rate of 30% per year, and a 10 year analysis period to determine which project to select.

**5-37**
The lining of a chemical tank in a certain manufacturing operation is replaced every 5 years at a cost of $5,000. A new type lining is now available which would last 10 years, but costs $13,000. The tank needs a new lining now and you intend to use the tank for 40 years, replacing linings when necessary. Compute the present worth of costs of 40 years of service for the 5-year and 10-year linings if i = 10%.

**5-38**
A manufacturing firm has a before-tax minimum attractive rate of return (MARR) of 12% on new investments. What uniform annual benefit would Investment B have to generate to make it preferable to Investment A?

| Year | Investment A | Investment B |
|---|---|---|
| 0 | - $60,000 | - $45,000 |
| 1 - 6 | +15,000 | ? |

**5-39**
The city council wants the municipal engineer to evaluate three alternatives for supplementing the city water supply. The first alternative is to continue deep well pumping at an annual cost of $10,500. The second alternative is to install an 18" (45.7)pipeline from a surface reservoir. First cost is $25,000 and annual pumping cost is $7,000.

The third alternative is to install a 24" (61 cm) pipeline from the reservoir at a first cost of $34,000 and annual pumping cost of $5,000. Life of all alternatives is 20 years. For the second and third alternatives, salvage value is 10% of first cost. With interest at 8%, which alternative should the engineer recommend? Use present worth analysis.

**5-40**
A magazine subscription is $12 annually, or $28 for a 3-year subscription. If the value of money is 12%, which choice is best?

**5-41**
Two alternatives are being considered for recovering aluminium from garbage. The first has a capital cost of $100,000, a first year maintenance cost of $5000, with maintenance increasing by $1500 per year for each year after the first.

The second has a capital cost of $120,000, a first year maintenance cost of $3,000, with maintenance increasing by $1,000 per year after the first.

Revenues from the sale of aluminums are $20,000 in the first year, increasing $2,000 per year for each year after the first. Life of both alternatives is 10 years. There is no salvage value. The before-tax Minimum Attractive Rate of Return is 10%. Using Present Worth Analysis determine which alternative is preferred.

**5-42**
A brewing company is deciding between two used filling machines as a temporary measure, before a plant expansion is approved and completed. The two machines are:

(a) The Kram Filler. Its initial cost is $85,000, and the estimated annual maintenance is $8,000.

(b) The Zanni Filler. The purchase price is $42,000, with annual maintenance costs of $8,000.

The Kram filler has a higher efficiency, compared with the Zanni, and it is expected that the savings will amount to $4,000 per year if the Kram filler is installed. It is anticipated that the filler machine will not be needed after 5 years, and at that time, the salvage value for the Kram filler would be $25,000, while the Zanni would have little or no value.

Assuming a minimum attractive rate of return (MARR) of 10%, which filling machine should be purchased?

**5-43**

Two technologies are currently available for the manufacture of an important and expensive food and drug additive. The two can be described as follows:

Laboratory A.

Is willing to release the exclusive right to manufacture the additive in this country for $50,000 payable immediately, and a $40,000 payment each year for the next 10 years.
The production costs are $1.23 per unit of product.

Laboratory B.

This laboratory is also willing to release similar manufacturing rights. They are asking for the following schedule of payments:

On the closing of the contract, $10,000.
From years 1 to 5, at the end of each year, a payment of $25,000 each.
From years 6 to 10, also at the end of each year, a payment of $20,000.

The production costs are $1.37 per unit of product.

Neither lab is to receive any money after 10 years for this contract. It is anticipated there will be an annual production of 100,000 items for the next 10 years. On the basis of analyses and trials, the products of A and B are practically identical in quality. Assuming a MARR of 12%, which lab should be chosen?

**5-44**

An engineering analysis by net present worth (NPW) is to be made for the purchase of two devices A and B. If an 8% interest rate is used, recommend the device to be purchased.

| | Cost | Uniform Annual Benefit | Salvage | Useful Life |
|---|---|---|---|---|
| Device A | $600 | $100 | $250 | 5 years |
| Device B | 700 | 100 | 180 | 10 years |

**5-45**

A company decides it must provide repair service for the equipment it sells. Based on the following, which alternative for providing repair service should be selected?

| Alternative | Net Present Worth |
|---|---|
| A | -$15,725 |
| B | -6,657 |
| C | -8,945 |

**5-46**

A firm is considering the purchase of a new machine to increase the output of an existing production process. Of all the machines considered, the management has narrowed the field to the machines represented by the cash flows shown as follows:

| Machine | Initial Investment | Annual Operating Cost |
|---|---|---|
| 5 | $50,000 | $22,500 |
| 2 | 60,000 | 20,540 |
| 4 | 75,000 | 17,082 |
| 1 | 80,000 | 15,425 |
| 3 | 100,000 | 11,374 |

If each of these machines provides the same service for 3 years and the minimum attractive rate of return is 12%, which machine should be selected?

### *5-1 Solution*

PW of the base amount ($1,000) is: 1,000(P/A, 10%, 10) = $6,144.57

PW of the gradient is: 200(P/G, 10%, 10) = $4,578.27

Total PW = 6,144.57 + 4,578.27 = $10,722.84

### *5-2 Solution*

Capitalized Cost = PW of Cost for an infinite time period. As the initial step, compute the Equivalent Annual Maintenance Cost.

EAC = 35,000 + [10,000(F/A, 8%, 3) + 15,000](A/F, 8%, 6) = $41,468.80

For n = ∞, P = A/I

Capitalized Cost = 1,000,000 + (41,468.80/0.08) = $1,518,360.

### *5-3 Solution*

P = 15,000(P/A, 12%, 6) - 2,500(P/G, 12%, 6) = $39,340

### *5-4 Solution*

Let x = refund value when received at the end of year 1 = 3,000(F/P, 6%, 1);
$PW_x$ = x(P/F, 10%, 1)
Therefore the PW if i = 10% = 3,000(F/P, 6%, 1)(P/F, 10%, 1) = $2,890.94

### *5-5 Solution*

60,000 - 10,000 = 10,000(P/A, 8%, n)
(P/A, 8%, n) = 50,000/10,000
= 5

Therefore n = 6 which is the number of FLAWs after this year's. There will be some money left over but not enough to pay for a $7^{th}$ year.

### *5-6 Solution*

(a) If they get 4% interest rate:
n = ∞
A = Pi or P = A/i = 35,000/0.04 = 875,000

Total life insurance = 77,500 + 875,000 = $952,500

(b) If they can get 7% interest rate:

again, $n = \infty$

$P = A/i = 35{,}000/0.07 = 500{,}000$

Total life insurance = 77,500 + 500,000 = $577,500

### *5-7 Solution*

Alternative 1: P = $1,000,000

Alternative 2: P = 80,000K(P/A, 5%, 20) = 81K(7.469) = $996,960

Choose alternative 1: take $1,000,000 now

### *5-8 Solution*

$P = (A_{INCOME} - A_{EXPENSES})(P/A, i\ \%, n) + F_{RE\text{-}SALE}(P/F, i\ \%, n)$
$= (20{,}000 - 2{,}000)(P/A, 10\%, 10) + 100{,}000(P/F, 10\%, 10)$
$= \$149{,}160$

### *5-9 Solution*

P = 200(P/A, 2 1/2 %, 3) = 571.20

A' = 571.20(A/P, 2 1/2 %, 4) = 151.82

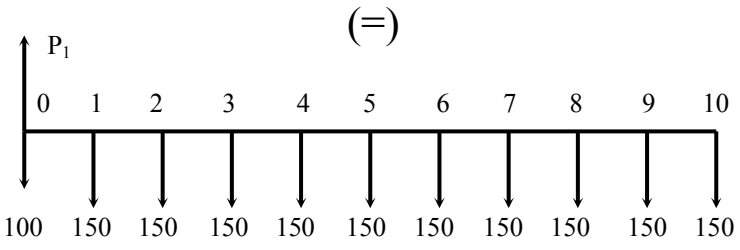
For $n = \infty$, P' = A' / i = 151.82 / 0.025 = $6,073 deposit

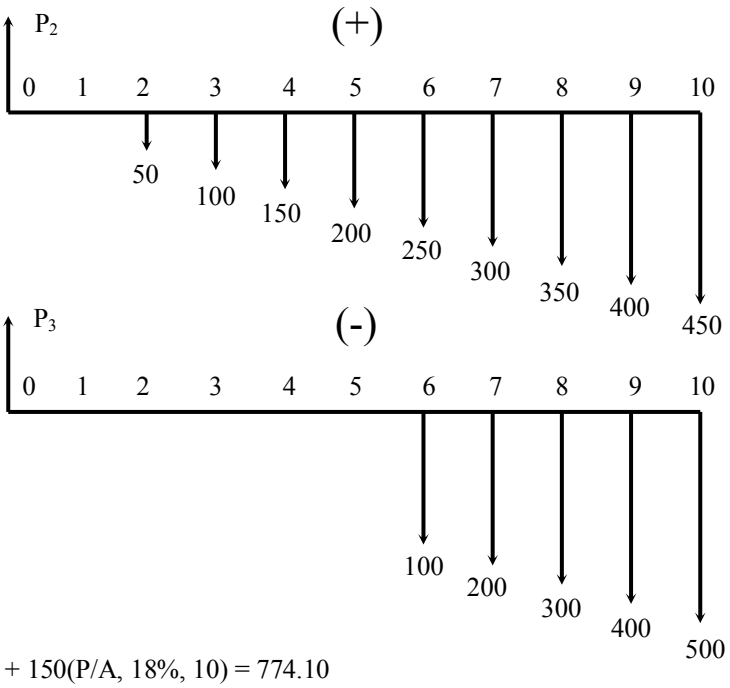
### *5-10 Solution*

PW = -60,000,000 + 14,500,000(P/A, 25%, 10) = -$8,220,500

Reject due to negative NPW

### *5-11 Solution*



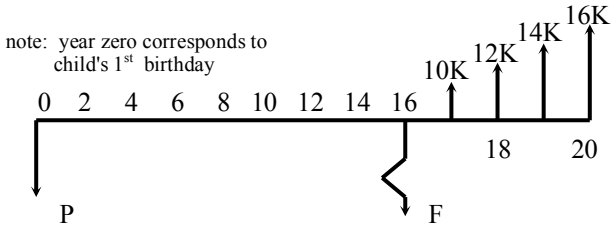



$P_1 = 100 + 150(P/A, 18\%, 10) = 774.10$
$P_2 = 50(P/G, 18\%, 10) = 717.60$
$P_3 = 100(P/G, 18\%, 6)(P/F, 18\%, 4) = 365.34$

$P = P_1 + P_2 + P_3 = \$1{,}126.36$

***5-12 Solution***

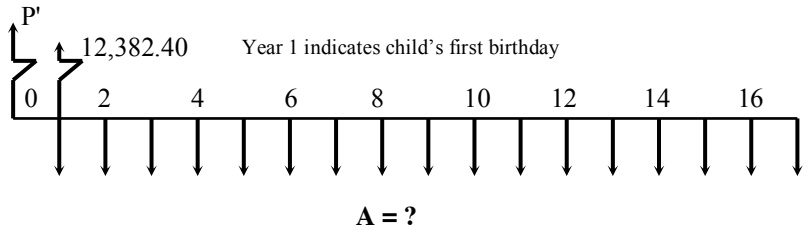
(a)




Let F = the $'s needed at the beginning of year 16
= 10,000(P/A, 8%, 4) + 2,000(P/G, 8%, 4)
= 42,420

The amount needed today P = 42,420(P/F, 8%, 16) = $12,382.40

(b)



P' = 12,382.40(P/F, 8%, 1) = 11,464.86

A = 11,464.86(A/P, 8%, 17) = $1,256.55

### *5-13 Solution*

In general, the interest paid on a loan at time t is determined by multiplying the effective interest rate times the outstanding principal just after the preceding payment at time t - 1.

To find the interest paid at time t = 163 (call it $I_{163}$), first find the outstanding principal at time t = 162 (call it $P_{162}$).

This can be done by computing the future worth at time t = 162 of the amount borrowed, minus the future worth of 162 payments. Alternately, compute the present worth, at time 162, of the 198 payments remaining.

The uniform payments are 50,000(A/P, 1%, 360) = $514.31, thus

$P_{162}$ = 50,000(F/P, 0.01, 162) - 514.31(F/A, 1%, 162) = 514.31(P/A, 1%, 198) = $44,259.78

The interest is $I_{163}$ = 0.01(44,259.78) = $442.59
and the principal in the payment is $514.31 - 442.59 = $71.72

### *5-14 Solution*

If the $100,000 cash, left over after developing the cave, is invested at 8%, it will yield a perpetual annual income of $8,000. This $8,000 can be used toward the $50,000 a year of expenses. The balance of the expenses can be raised through ticket sales, making the price per ticket

$42,000/12,000 tickets = $3.50/ticket

Alternate solution:

$$PW_{COST} = PW_{BENEFIT}$$
$$400{,}000 + (30{,}000 + 15{,}000 + 5{,}000)/.08 = 500{,}000 + T/.08$$
$$400{,}000 + 625{,}000 = 500{,}000 + T/.08$$
$$T = 525{,}000(0.08)$$
$$= 42{,}000$$

Ticket Price = 42,000/ 12(1,000) = $3.50

### *5-15 Solution*

(a) P = A/i = 1,000/0.05 = $20,000

(b)

| Age | i | Trust Fund Balance | |
|---|---|---|---|
| 50-54 | 5% | 20,000.00(F/P, 5%, 5) = | 25,520.00 |
| 55-64 | 10% | 25,520.00(F/P, 10%, 10) = | 66,198.88 |

| | | | |
|---|---|---|---|
| 65-74 | 15% | 66,198.88(F/P, 15%, 10) = | 267,840.00 |
| 75-84 | 20% | 267,840.00(F/P, 20%, 10) = | 1,658,469.43 |

Therefore the largest sum which could be withdrawn from the trust fund is 1,658,469.43 - 20,000 = $1,632,469.43

### *5-16 Solution*

First, convert the effective annual MARR to its equivalent effective monthly rate:

$(1.12)^{1/12} - 1 = 0.9489\%$

Any measure of worth could now be used, but net present value is probably the easiest.

NPV = (-12.98 + 3.00) + 3.00(P/A, 0.9489%, 4) = $1.74 > 0

Therefore, the option is economical.

### *5-17 Solution*

PW = -14,000 + 2,400(P/A, 20%, 10) + 3,000(P/F, 20%, 10) = $526.00

### *5-18 Solution*

(a) $P = A(P/A, i\%, n)$

$5{,}000 = 180.76(P/A, 1\frac{1}{2}\%, n)$

$(P/A, \frac{1}{2}\%, n) = 5{,}000/180.76$

$= 27.66$

From the 1½% interest table n = 36 months = 6 years.

(b) 180.762 + 180.762(P/A, 1½%, 30) = $4,521.91

### *5-19 Solution*

The MARR is irrelevant in this problem. The outstanding principal is always equal to the present worth of the remaining payments when the payments are discounted at the loan's effective interest rate.

Therefore, let N' be the remaining payments.

$\frac{1}{2}(50{,}000) = 299.77(P/A, \frac{1}{2}\%, N)$

$(P/A, \frac{1}{2}\%, N) = 83.397$

$N = 108.30 \approx 108$

So, $N^* = 360 - N$

$= 252$ payments

### *5-20 Solution*

PW of 10 years = - 10,000 + 2,000(P/A, 10%, 10) + 3,000(P/F, 10%, 10) = $3,445.76

PW of 30 years = 3,445.76[1 - (P/F, 10%, 30)] / [1 - (P/F, 10%, 10)] = $5,286.45

Alternate Solution:

PW of 30 years = [1 + (P/F, 10%, 10) + (P/F, 10%, 20)](-10,000) + 2,000(P/A, 10%, 30)
+ 3000 [(P/F, 10%, 10) + (P/F, 10%, 20) +(P/F, 10%, 30)]
= $5,286.45

### *5-21 Solution*

Capitalized Cost = 5,265(A/P, 18%, 12)(P/A, 18%, ∞) = 5,265(0.2086)(1/.18) = $6,102

### *5-22 Solution*

A = 190.93 per period, i = 0.18/12 = 0.015, n = 4 × 12 = 48

P = 1,500 + 190.93(P/A, i%, 48)
= $8,000

### *5-23 Solution*

$P = Fe^{-rn} = \$5{,}000e^{-(0.12)3} = 5{,}000e^{-0.36} = \$3{,}488.50$

### *5-24 Solution*

Bi-yearly interest payment = 0.07(1,000) = $70

PV = $70(P/A, 5%, 13) + $1,000(P/F, 5%, 13) = $1,187.90

### *5-25 Solution*

PW = [400(P/A, 10%, 10) - 20(P/G, 10%, 10)](P/F, 10%, 10)
= $770.91

### *5-26 Solution*

The cash flows prior to now are irrelevant. The relevant cash flows are the following:

| t | loan continues | paid off early | loan continues minus paid off early |
|---|---|---|---|
| 0 | 0 | +(3,261.27 - D) | -(3,261.27 - D) |
| 1-6 | +60.80 | | +60.80 |

Any measure of worth could be used.

The appropriate discount rate is the effective monthly MARR: $(1.1)^{1/12} - 1 = 0.00797$

Therefore, using NPV = 0 = -3261.27 + D + 60.80(P/A, 0.797%, 60)

D=$370.60

### *5-27 Solution*

Capitalized Cost = 15,000 = P + 500(P/A, 10%, ∞)
P = 15,000 - 500(1/0.1) = $10,000

### *5-28 Solution*

P = 60K(P/A, 10%, 26) = 60K(9.161) = $549,660

P' = 60K(P/A, 10%, 11) = 60K(6.495) = $389,700

### *5-29 Solution*

(a) P = 629.81 + 629.81(P/A, ¾%, 120) = $49,718.46

(b) $70,000 × 0.0075 = $525

### *5-30 Solution*

NPV = -Cost - Cost of Mines - Annual Maintenance (P/A, 5%, 10) + Income(P/A, 5%, 10)
= -750,000 - 250,000(5) - 50,000(P/A, 5%, 10) + 105,000(3)(P/A, 5%, 10)
= $46,330

### *5-31 Solution*

NPW = PW(benefits) - PW(costs)

Alternative A:

NPW = 1,800(P/A, 10%, 8) - 5,300 - 5,300(P/F, 10%, 4)
= $683.10

Alternative B:

NPW = 2,100(P/A, 10%, 8) - 10,700 = $503.50

Select alternative A

### *5-32 Solution*

Note that in all cases the car is kept 5 years that is the common analysis period.

i = 18%/12 = 1½%

$PWC_A$ = $5,000

$PWC_B$ = 1,500 + 116.25(P/A, 1½%, 36) = $4,715,59

$PWC_C$ = 1,000 + 120.50(P/A, 1½%, 48) = $5,102.18

Therefore Plan B is best

### *5-33 Solution*

| | A | B | C |
|---|---|---|---|
| Initial Cost | 50.00 | 30.00 | 40.00 |
| Annual Benefits | 15.00 | 10.00 | 12.00 |
| Useful Life(years) | 5 | 5 | 5 |
| Present Worth Benefits | 56.87 | 37.91 | 45.49 |
| Present Worth Costs | 50.00 | 30.00 | 40.00 |
| Net Present Worth = PWB - PWC | 6.87 | 7.91 | 5.49 |

Choose C

### *5-34 Solution*

i = 12%/12 = 1% per month

Alternative 1: NPW = 110(P/A, 1%, 10) - 1,000 = $41.81
Alternative 2: NPW = 130(P/A, 1%, 10) - 1,200 = $31.23

Choose Alternative 1 $\rightarrow$ Maximum NPW

Nominal Interest: NPW = 0 = -1,000 + 110(P/A, i%, 10)
(P/A, i%, 10) = 9.1

From tables: i $\cong$ 1.75%

Nominal interest = 1.75% $\times$ 12 mo. = 21%

### *5-35 Solution*

$PWC_A = 5{,}010(P/A, 15\%, 5) = \$16{,}794$

$PWC_B = 2{,}956(P/A, 15\%, 4) + 15{,}000(P/F, 15\%, 5) = \$15{,}897.$

$PWC_C = 9{,}048(P/A, 15\%, 3)(P/F, 15\%, 2) = \$15{,}618$

Plan C is lowest cost plan

### *5-36 Solution*

$PW_A = -5{,}000[1 + (P/F, 30\%, 5)] + 2{,}500(P/A, 30\%, 10) = \$1{,}382.20$

$PW_B = -9{,}000 + 3{,}300(P/A, 30\%, 10) = \$\ 1{,}202.08$

Select A because of higher present worth of benefits.

### *5-37 Solution*

PW 5 yr Lining:

$PW = [5{,}000(A/P, 10\%, 5)](P/A, 10\%, 40) = \$12{,}898.50$

PW 10 yr Lining:

$PW = [13{,}000(A/P, 10\%, 10)](P/A, 10\%, 40) = \$20{,}683.50$

### *5-38 Solution*

NPW of $A = -60 + 15(P/A, 12\%, 6) = 1.665$

NPW of $B \geq 1.665 = -45 + B(P/A, 12\%, 6)$

$\therefore\ B = 11{,}351$

$B > \$11{,}351$ per year

### *5-39 Solution*

Fixed output, therefore minimize cost.

| Year | DEEPWELL | 18" PIPELINE | 24" PIPELINE |
|---|---|---|---|
| 0 | | -25,000 | -34,000 |
| 1-20 | -10,500 | -7,000 | -5,000 |
| 20 | | +2,500 | +3,400 |

Deepwell: PWC = - 10,500(P/A, 8%, 20) -$103,089

18" Pipeline: PW of Cost = -25,000 - 7,000(P/A, 8%, 20) + 2,500(P/F, 8%, 20) = -$493,190

24" Pipeline: PW of Cost = -34,000 - 5,000(P/A, 8%, 20) + 3,400(P/F, 8%, 20) = -$82,361

Choose 24" Pipeline

### *5-40 Solution*

28 <?=?> 12 + 12(P/A, 12%, 2) = 12 + 12(1.69) = 32.28

Choose 3 yr subscription because 28 < 32.28

### *5-41 Solution*

Alternative 1: NPW = -100,000 + (20,000 - 5,000)(P/A, 10%, 10) = $3,620.50

Alternative 2: NPW = -120,000 + (20,000 - 3,000)(P/A, 10%, 10) = $7,356.00

Choose Alternative 2 → Maximum. NPW

### *5-42 Solution*

Fixed output, therefore minimize costs

Kram:
NPW = 25,000(P/F, 10%, 5) - 85,000 - 4,000(P/A, 10%, 5)
= -$84,641.5 (or a PWC $84,641.50)

Zani:
NPW = -42,000 - 8,000(P/A, 10%, 5)
= -$72,328 (or a PWC of $72,328)

Therefore choose the Zani filler.

### *5-43 Solution*

Laboratory A: The annual production cost = 1.23 × 100K = $123K

PWC = 50,000 + [40,000 + 123,000](P/A, 12%, 10) = $970,950

Laboratory B: The annual production cost = 1.37 × 100K = $137K

PWC = 10,000 + [25,000 + 137,000](P/A, 12%, 5)
+ [20,000 + 137,000](P/A, 12%, 5)(P/F, 12%, 5) = $915,150

Therefore choose Laboratory B.

### *5-44 Solution*

Device A:

NPW = 100(P/A, 8%, 10) + 250(P/F, 8%, 10) - 600 - [600 - 250](P/F, 8%, 5) = -$51.41

Device B:

NPW = 100(P/A, 8%, 10) + 180(P/F, 8%, 10) - 700 = $54.38

Select device B

### *5-45 Solution*

None of the alternatives look desirable, but since one of the alternatives must be chosen (the do nothing alternative is not available), choose the one that maximizes NPW. Thus the best of the three alternatives is B.

### *5-46 Solution*

Minimize the PW of Cost:

| Machine | Initial Investment | Operating Costs × (P/A, 12%, 3) | PW of Costs |
|---|---|---|---|
| 5 | -50,000 | + 22,500 (2.402) | = 104,045 |
| 2 | -60,000 | + 20,540(2.402) | = 109,337 |
| 4 | -75,000 | + 17,082(2.402) | = 116,031 |
| 1 | -80,000 | + 15,425(2.402) | = 117,051 |
| 3 | -100,000 | + 11,374(2.402) | = 127,320 |

Select machine 5