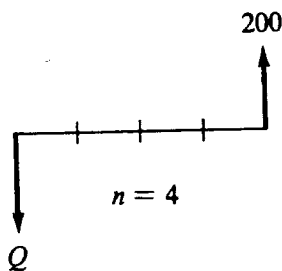


Problems

3-1 A woman borrowed \$2000 and agreed to repay it at the end of three years, together with 10% simple interest per year. How much will she pay three years hence?

3-2 A \$5000 loan was to be repaid with 8% simple annual interest. A total of \$5350 was paid. How long was the loan outstanding?

3-3 Solve the diagram below for the unknown Q assuming a 10% interest rate.



(Answer: $Q = \$136.60$)

3-4 The following series of payments will repay a present sum of \$5000 at an 8% interest rate. Using single payment factors, what present sum is equivalent to this series of payments at a 10% interest rate?

<i>Year</i>	<i>End-of-year payment</i>
1	\$1400
2	1320
3	1240
4	1160
5	1080

3-5 A man went to his bank and borrowed \$750. He agreed to repay the sum at the end of three years, together with the interest at 8% per year, compounded annually. How much will he owe the bank at the end of three years? (Answer: \$945)

3-6 What sum of money now is equivalent to \$8250 two years hence, if interest is 8% per annum, compounded semi-annually? (Answer: \$7052)

3-7 The local bank offers to pay 5% interest, compounded annually, on savings deposits. In a nearby town, the bank pays 5% interest, compounded quarterly. A man who has \$3000 to put in a savings account wonders if the increased interest paid in the nearby town justifies driving his car there

to make the deposit. Assuming he will leave all money in the account for two years, how much additional interest would he obtain from the out-of-town bank over the local bank?

3-8 A sum of money invested at 4% interest, compounded semi-annually, will double in amount in approximately how many years? (*Answer: 17½ years*)

3-9 The Apex Company sold a water softener to Marty Smith. The price of the unit was \$350. Marty asked for a deferred payment plan, and a contract was written. Under the contract, the buyer could delay paying for the water softener provided that he purchased the coarse salt for re-charging the softener from Apex. At the end of two years, the buyer was to pay for the unit in a lump sum, including 6% interest, compounded quarterly. The contract provided that, if the customer ceased buying salt from Apex at any time prior to two years, the full payment due at the end of two years would automatically become due.

Six months later, Marty decided to buy salt elsewhere and stopped buying from Apex, who thereupon asked for the full payment that was to have been due 18 months hence. Marty was unhappy about this, so Apex offered as an alternative to accept the \$350 with interest at 20% per annum compounded semiannually for the six months that Marty had the water softener. Which of these alternatives should Marty accept? Explain.

3-10 Linda Dunlop will deposit \$1500 in a bank savings account that pays 10% interest per year, compounded daily. How much will Linda have in her account at the end of two and one-half years?

3-11 For the following cash flow, compute the interest rate at which the \$100 cost is equivalent to the subsequent benefits.

<i>Year</i>	<i>Cash Flow</i>
0	-\$100
1	+25
2	+45
3	+45
4	+30

3-12 The United States recently purchased \$1 billion of 30-year zero-coupon bonds from a struggling foreign nation. The bonds yield 4½% per year interest. The zero coupon bonds pay no interest during their 30-year life. Instead, at the end of 30 years, the U. S. Government is to receive back its \$1 billion together with interest at 4½% per year. A U. S. Senator objected to the purchase, claiming that the correct interest rate for bonds like this is 5¼%. The result, he said, was a multimillion dollar gift to the foreign country without the approval of the U. S. Congress. Assuming the Senator's 5¼% interest rate is correct, how much will the foreign country have saved in interest when they repay the bonds at the end of 30 years?

3-13 One thousand dollars is borrowed for one year at an interest rate of 1% per month compounded monthly. If this same sum of money could be borrowed for the same period at an interest rate of 12% per year compounded annually, how much could be saved in interest charges?

3-14 Given a sum of money Q that will be received six years from now. At 5% annual interest the present worth now of Q is \$60. At this same interest rate, what would be the value of Q ten years from now?

3-15 In 1995 an anonymous private collector purchased a painting by Picasso entitled *Angel Fernandez de Soto* for \$29,152,000. The picture depicts Picasso's friend deSoto seated in a Barcelona cafe drinking absinthe. The painting was done in 1903 and valued then at \$600. If the painting was owned by the same family until its sale in 1995, what rate of return did they receive on the \$600 investment?

- 3-16** a. If \$100 at time "0" will be worth \$110 a year hence and was \$90 a year ago, compute the interest rate for the past year and the interest rate next year.
b. Assume \$90 invested a year ago will return \$110 a year from now. What is the annual interest rate in this situation?

3-17 How much must you invest now at 7.9% interest to accumulate \$175,000 in 63 years?

3-18 We know that a certain piece of equipment will cost \$150,000 in five years. How much will it cost today using 10% interest?

3-19 The local garbage company charges \$6.00 a month for garbage collection. It had been their practice to send out bills to their 100,000 customers at the end of each two-month period. Thus, they would send a bill to each customer for \$12 at the end of February for garbage collection during January and February.

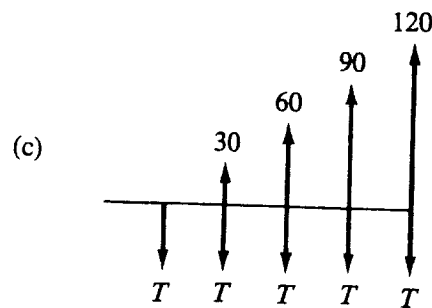
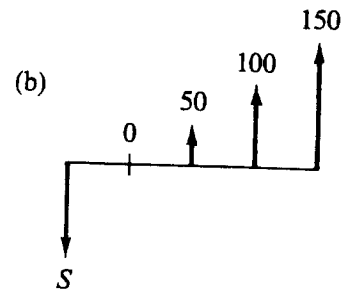
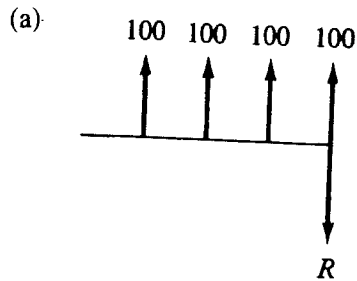
Recently the firm changed its billing date so now they send out the two-month bills after one month's service has been performed. Bills for January–February, for example, are sent out at the end of January. The local newspaper claims the firm is receiving half their money before they do the garbage collection. This unearned money, the newspaper says, could be temporarily invested for one month at 1% per month interest by the garbage company to earn extra income.

Compute how much extra income the garbage company could earn each year if it invests the money as described by the newspaper. (Answer: \$36,000)

3-20 Sally Stanford is buying an automobile that costs \$12,000. She will pay \$2000 immediately and the remaining \$10,000 in four annual end-of-year principal payments of \$2500 each. In addition to the \$2500, she must pay 15% interest on the unpaid balance of the loan each year. Prepare a cash flow table to represent this situation.

Problems

4-1 Solve Diagrams (a)–(c) below for the unknowns R , S , and T , assuming a 10% interest rate.



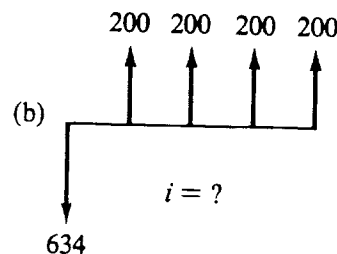
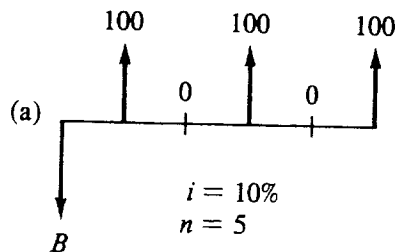
(Answers: $R = \$464.10$; $S = \$218.90$; $T = \$54.30$)

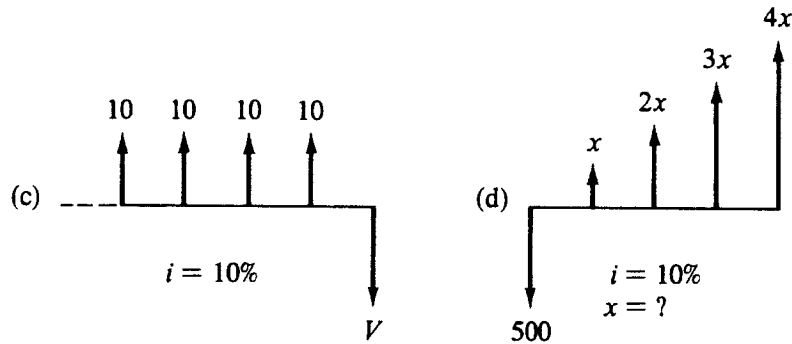
4-2 A man borrowed \$500 from a bank on October 15th. He must repay the loan in 16 equal monthly payments, due on the 15th of each month, beginning November 15th. If interest is computed at 1% per month, how much must he pay each month?

(Answer: \$33.95)

4-3 A local finance company will loan \$10,000 to a homeowner. It is to be repaid in 24 monthly payments of \$499.00 each. The first payment is due thirty days after the \$10,000 is received. What interest rate per month are they charging? (Answer: $1\frac{1}{2}\%$)

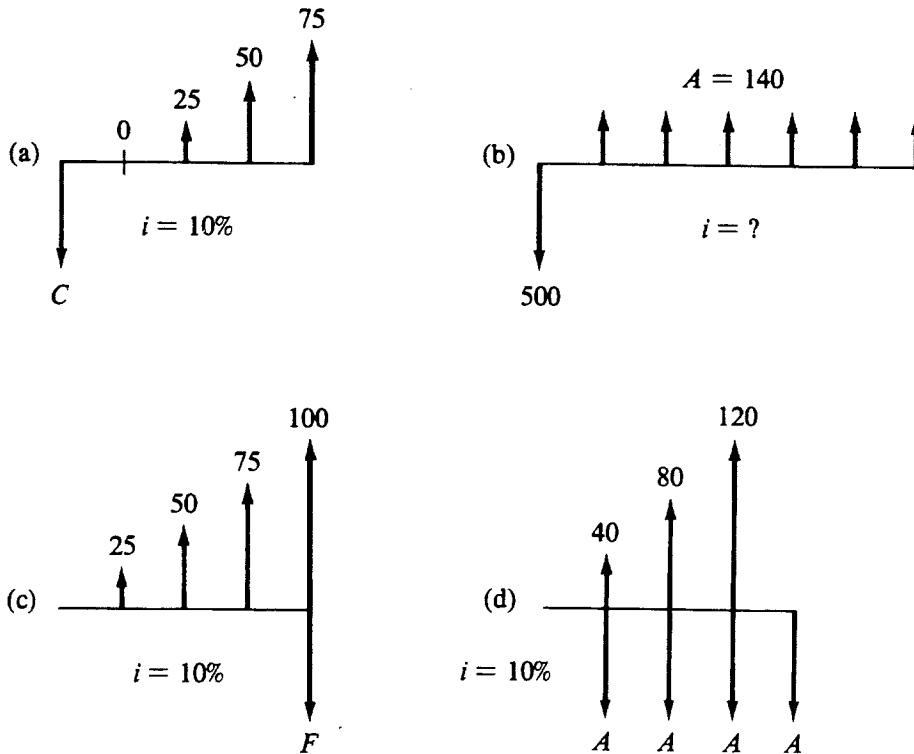
4-4 For Diagrams (a)–(d) below, compute the unknown values: B , i , V , x , respectively, using the minimum number of compound interest factors.





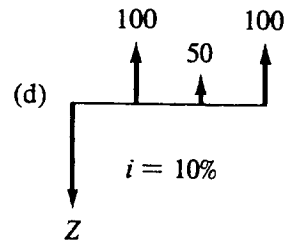
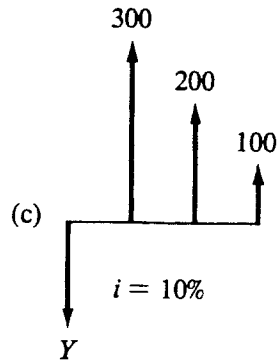
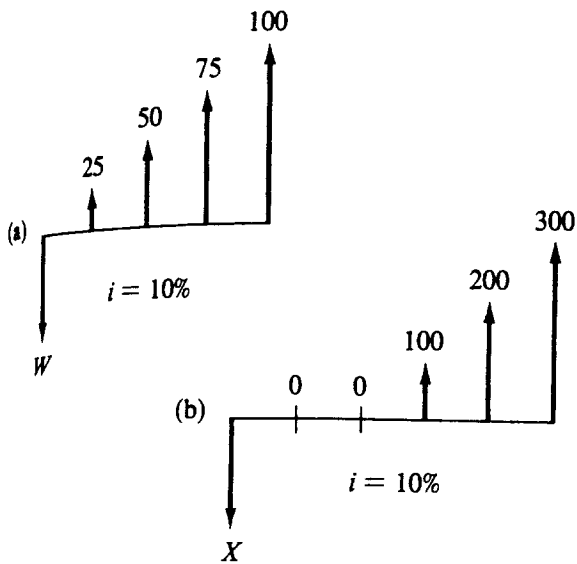
(Answers: $B = \$228.13$; $i = 10\%$; $V = \$51.05$; $x = \$66.24$)

4-5 For Diagrams (a)–(d) below, compute the unknown values: C , i , F , A , respectively.



(Answers: $C = \$109.45$; $i = 17.24\%$; $F = \$276.37$; $A = \$60.78$)

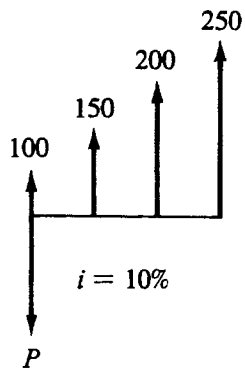
4-6 For Diagrams (a) through (d) compute the unknown values: W , X , Y , Z , respectively.



4-7 Using linear interpolation, determine the value of $(P/A, 6\frac{1}{2}\%, 10)$ from the Compound Interest Tables. Compute this same value using the equation. Why do the values differ?

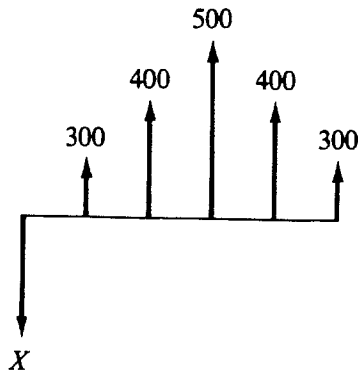
4-8 Four plans have been presented for the repayment of \$5000 in five years with interest at 8%. Still another way to repay the \$5000 would be to make four annual end-of-year payments of \$1000 each, followed by a final payment at the end of the fifth year. How much would the final payment be?

4-9 Compute the value of P in the diagram below:

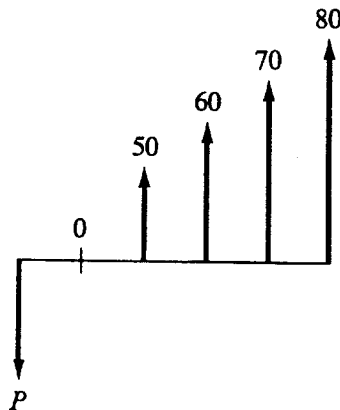


(Answer: \$589.50)

4-10 Compute the value of X in the diagram below using a 10% interest rate.



4-11 Compute the value of P in the diagram below using a 15% interest rate.



4-12 A local bank will lend a customer \$1000 on a two-year car loan as follows:

Money to pay for car	\$1000
Two years' interest at 7%: $2 \times 0.07 \times 1000$	<u>140</u>
	\$1140

$$24 \text{ monthly payments} = \frac{1140}{24} = \$47.50$$

The first payment must be made in thirty days. What is the nominal annual interest rate the bank is receiving?

4-13 A local lending institution advertises the "51-50 Club." A person may borrow \$2000 and repay \$51 for the next fifty months, beginning thirty days after receiving the money. Compute the nominal annual interest rate for this loan. What is the effective interest rate?

4-14 A loan company has been advertising on television a plan where one may borrow \$1000 and make a payment of \$10.87 per month. This payment is for interest only and includes no payment on the principal. What is the nominal annual interest rate that they are charging?

4-15 What effective interest rate per annum corresponds to a nominal rate of 12% compounded monthly? (*Answer: 12.7%*)

4-16 Mr. Sansome withdrew \$1000 from a savings account and invested it in common stock. At the end of five years, he sold the stock and received a check for \$1307. If Mr. Sansome had left his \$1000 in the savings account, he would have received an interest rate of 5%, compounded quarterly. Mr. Sansome would like to compute a comparable interest rate on his common stock investment. Based on quarterly compounding, what nominal annual interest rate did Mr. Sansome receive on his investment in stock? What effective annual interest rate did he receive?

4-17 A woman opened an account in a local store. In the charge account agreement, the store indicated it charges $1\frac{1}{2}\%$ each month on the unpaid balance. What nominal annual interest rate is being charged? What is the effective interest rate?

4-18 A man buys a car for \$3000 with no money down. He pays for the car in thirty equal monthly payments with interest at 12% per annum, compounded monthly. What is his monthly loan payment? (*Answer: \$116.10*)

4-19 What amount will be required to purchase, on a man's 40th birthday, an annuity to provide him with thirty equal semi-annual payments of \$1000 each, the first to be received on his 50th birthday, if nominal interest is 4% compounded semi-annually?

4-20 Upon the birth of his first child, Dick Jones decided to establish a savings account to partly pay for his son's education. He plans to deposit \$20 per month in the account, beginning when the boy is 13 months old. The savings and loan association has a current interest policy of 6% per annum, compounded monthly, paid quarterly. Assuming no change in the interest rate, how much will be in the savings account when Dick's son becomes sixteen years old?

4-21 An engineer borrowed \$3000 from the bank, payable in six equal end-of-year payments at 8%. The bank agreed to reduce the interest on the loan if interest rates declined in the United States before the loan was fully repaid. At the end of three years, at the time of the third payment, the bank agreed to reduce the interest rate from 8% to 7% on the remaining debt. What was the amount of the equal annual end-of-year payments for each of the first three years? What was the amount of the equal annual end-of-year payments for each of the last three years?

4-22 On a new car, it is estimated that the maintenance cost will be \$40 the first year. Each subsequent year, it is expected to be \$10 more than the previous one. How much would you need to set aside when you bought a new car to pay all future maintenance costs if you planned to keep it seven years? Assume interest is 5% per annum. (*Answer: \$393.76*)

4-23 A man decides to deposit \$50 in the bank today and make ten additional deposits every six months beginning six months from now, the first of which will be \$50 and increasing \$10 per deposit after that. A few minutes after he makes the last deposit, he decides to withdraw all the money deposited. If the bank pays 6% nominal interest compounded semi-annually, how much money will he receive?

4-24 A young engineer wishes to become a millionaire by the time he is sixty years old. He believes that by careful investment he can obtain a 15% rate of return. He plans to add a uniform sum of money to his investment program each year, beginning on his 20th birthday and continuing through

his 59th birthday. How much money must the engineer set aside in this project each year?

4-25 The council members of a small town have decided that the earth levee that protects the town from a nearby river should be rebuilt and strengthened. The town engineer estimates that the cost of the work at the end of the first year will be \$85,000. He estimates that in subsequent years the annual repair costs will decline by \$10,000, making the second-year cost \$75,000; the third-year \$65,000, and so forth. The council members want to know what the equivalent present cost is for the first five years of repair work if interest is 4%.
(Answer: \$292,870)

4-26 A \$150 bicycle was purchased on December 1st with a \$15 down payment. The balance is to be paid at the rate of \$10 at the end of each month, with the first payment due on December 31st. The last payment may be some amount less than \$10. If interest on the unpaid balance is computed at $1\frac{1}{2}\%$ per month, how many payments will there be, and what is the amount of the final payment?
(Answers: 16 payments; final payment: \$1.99)

4-27 A company buys a machine for \$12,000, which it agrees to pay for in five equal annual payments, beginning one year after the date of purchase, at an interest rate of 4% per annum. Immediately after the second payment, the terms of the agreement are changed to allow the balance due to be paid off in a single payment the next year. What is the final single payment?
(Answer: \$7778)

4-28 An engineering student bought a car at a local used car lot. Including tax and insurance, the total price was \$3000. He is to pay for the car in twelve equal monthly payments, beginning with the first payment immediately (in other words, the first payment was the down payment). Nominal interest on the loan is 12%, compounded monthly. After he makes six payments (the down payment plus five additional payments), he decides to sell the car. A buyer agrees to pay a cash amount to pay off the loan in full at the time the next payment is due and also to pay the engineering student \$1000. If there are no penalty charges for this early payment of the loan, how much will the car cost the new buyer?

4-29 A bank recently announced an "instant cash" plan for holders of its bank credit cards. A cardholder may receive cash from the bank up to a pre-set limit (about \$500). There is a special charge of 4% made at the time the "instant cash" is sent the cardholders. The debt may be repaid in monthly installments. Each month the bank charges $1\frac{1}{2}\%$ on the unpaid balance. The monthly payment, including interest, may be as little as \$10. Thus, for \$150 of "instant cash," an initial charge of \$6 is made and added to the balance due. Assume the cardholder makes a monthly payment of \$10 (this includes both principal and interest). How many months are required to repay the debt? If your answer includes a fraction of a month, round up to the next month.

4-30 The treasurer of a firm noted that many invoices were received by his firm with the following terms of payment: "2%—10 days, net 30 days". Thus, if he were to pay the bill within ten days of its date, he could deduct 2%. On the other hand, if he did not promptly pay the bill, the full amount would be due thirty days from the date of the invoice. Assuming a 20-day compounding period, the 2% deduction for prompt payment is equivalent to what effective interest rate per year?

4-31 In 1555, King Henry borrowed money from his bankers on the condition that he pay 5% of the loan at each fair (there were four fairs per year) until he had made forty payments. At that time the loan would be considered repaid. What effective annual interest did King Henry pay?

4-32 A man wants to help provide a college education for his young daughter. He can afford to invest \$600/yr for the next four years, beginning on the girl's fourth birthday. He wishes to give his daughter \$4000 on her 18th, 19th, 20th, and 21st birthdays, for a total of \$16,000. Assuming 5% interest, what uniform annual investment will he have to make on the girl's 8th through 17th birthdays? (Answer: \$792.73)

4-33 A man has \$5000 on deposit in a bank that pays 5% interest compounded annually. He wonders how much more advantageous it would be to transfer his funds to another bank whose dividend policy is 5% interest, compounded continuously. Compute how much he would have in his savings account at the end of three years under each of these situations.

4-34 A friend was left \$50,000 by his uncle. He has decided to put it into a savings account for the next year or so. He finds there are varying interest rates at savings institutions: $4\frac{3}{8}\%$ compounded annually, $4\frac{1}{4}\%$ compounded quarterly, and $4\frac{1}{8}\%$ compounded continuously. He wishes to select the savings institution that will give him the highest return on his money. What interest rate should he select?

4-35 One of the local banks indicates that it computes the interest it pays on savings accounts by the continuous compounding method. Suppose you deposited \$100 in the bank and they pay 4% per annum, compounded continuously. After five years, how much money will there be in the account?

4-36 A company expects to install smog control equipment on the exhaust of a gasoline engine. The local smog control district has agreed to pay to the firm a lump sum of money to provide for the first cost of the equipment and maintenance during its ten-year useful life. At the end of ten years the equipment, which initially cost \$ 10,000, is valueless. The company and smog control district have agreed that the following are reasonable estimates of the end-of-year maintenance costs:

Year 1	\$500	Year 6	\$200
2	100	7	225
3	125	8	250
4	150	9	275
5	175	10	300

Assuming interest at 6% per year, how much should the smog control district pay to the company now to provide for the first cost of the equipment and its maintenance for ten years? (Answer: \$11,693)

4-37 One of the largest automobile dealers in the city advertises a three-year-old car for sale as follows:

Cash price \$3575, or a down payment of \$375 with 45 monthly payments of \$93.41.

Susan DeVaux bought the car and made a down payment of \$800. The dealer charged her the same interest rate used in his advertised offer. How much will Susan pay each month for 45 months? What effective interest rate is being charged? (Answers: \$81.03; 16.1%)

4-38 At the Central Furniture Company, customers who purchase on credit pay an effective annual interest rate of 16.1 %, based on monthly compounding. What is the nominal annual interest rate that they pay?

4-39 Mary Lavor plans to save money at her bank for use in December. She will deposit \$30 a month, beginning on March 1st and continuing through November 1st. She will withdraw all the money on December 1st. If the bank pays $\frac{1}{2}\%$ interest each month, how much money will she receive on December 1st?

4-40 A man makes an investment every three months at a nominal annual interest rate of 28%, compounded quarterly. His first investment was \$100, followed by investments *increasing* \$20 each three months. Thus, the second investment was \$120, the third investment \$140, and so on. If he continues to make this series of investments for a total of twenty years, what will be the value of the investments at the end of that time?

4-41 A debt of \$5000 can be repaid, with interest at 8%, by the following payments.

<i>Year</i>	<i>Payment</i>
1	\$500
2	1000
3	1500
4	2000
5	X

The payment at the end of the fifth year is shown as X . How much is X ?

4-42 Consider the cash flow:

<i>Year</i>	<i>Cash Flow</i>
0	-\$100
1	+50
2	+60
3	+70
4	+80
5	+140

Which one of the following is correct for this cash flow?

a. $100 = 50 + 10(A/G, i, 5) + 50(P/F, i, 5)$

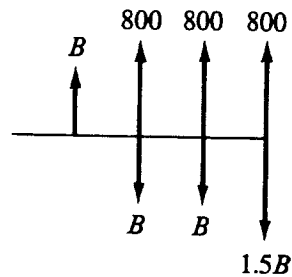
b.

$$\frac{50(P/A, i, 5) + 10(P/G, i, 5) + 50(P/F, i, 5)}{100} = 1$$

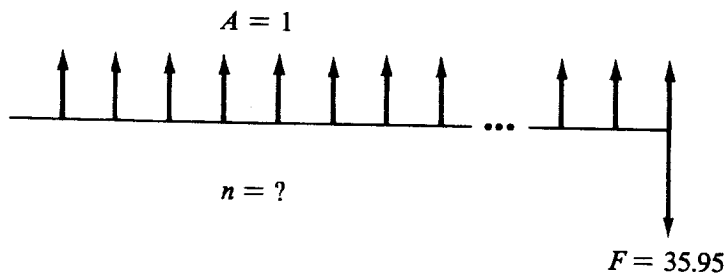
c. $100(A/P, i, 5) = 50 + 10(A/G, i, 5)$

d. None of the equations are correct.

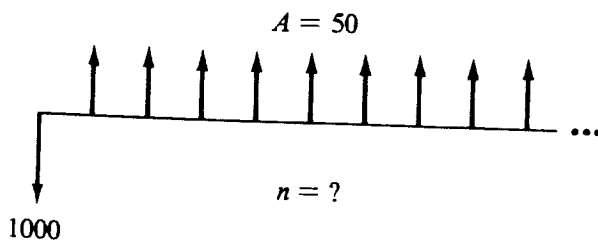
4-43 If $i = 12\%$, what is the value of B in the diagram below?



4-44 For a 10% interest rate, compute the value of n for the figure below.



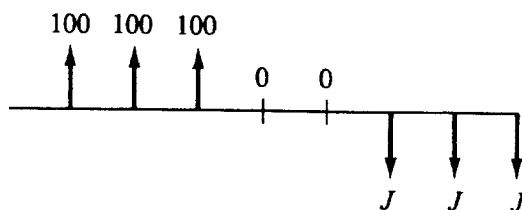
4-45 For the figure below, what is the value of n , based on a $3\frac{1}{2}\%$ interest rate?



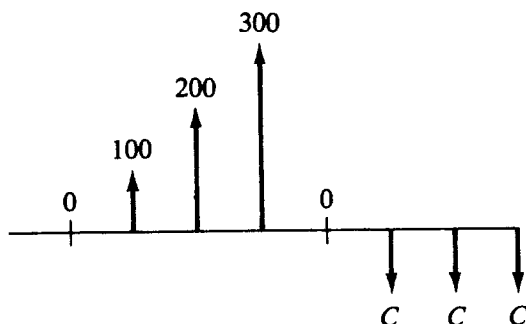
4-46 How many months will it take to pay off a \$525 debt, with monthly payments of \$15 at the end of each month if the interest rate is 18%, compounded monthly?

(Answer: 50 months)

4-47 For the diagram below and a 10% interest rate, compute the value of J .



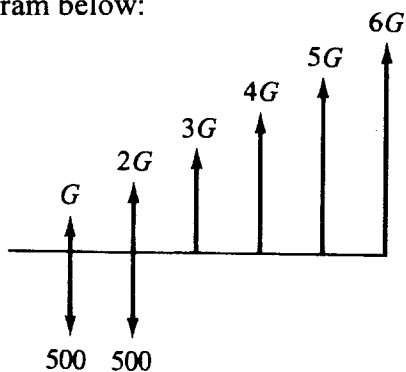
4-48 For the diagram below and a 10% interest rate, compute the value of C .



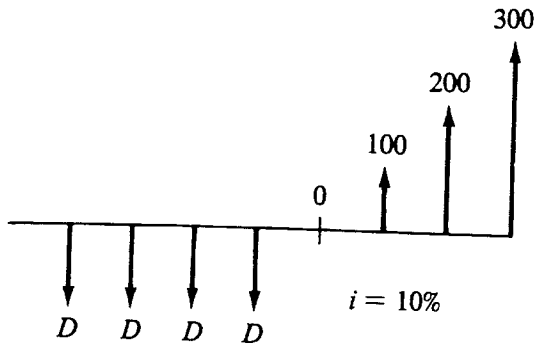
4-49 On January 1st, Frank Jenson bought a used car for \$4200 and agreed to pay for it as follows: $\frac{1}{3}$ down payment; the balance to be paid in 36 equal monthly payments; the first payment due February 1st; an annual interest rate of 9%, compounded monthly.

- a. What is the amount of Frank's monthly payment?
- b. During the summer, Frank made enough money that he decided to pay off the entire balance due on the car as of October 1st. How much did Frank owe on October 1st?

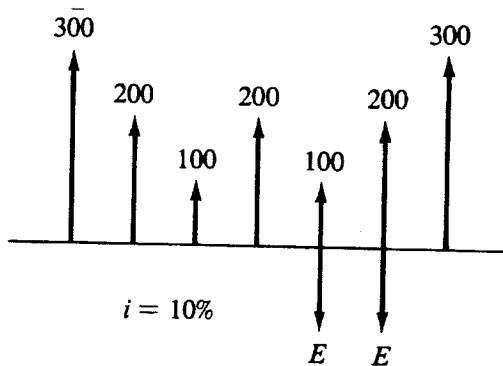
4-50 If $i = 12\%$, compute G in the diagram below:



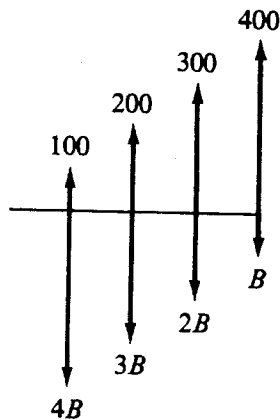
4-51 Compute the value of D in the diagram below:



4-52 Compute E for the figure below:



4-53 Compute B in the figure below, using a 10% interest rate.



4-54 On January 1st, Laura Brown borrowed \$1000 from the Friendly Finance Company. The loan is to be repaid by four equal payments which are due at the end of March, June, September, and December. If the finance company charges 18% interest, compounded quarterly, what is the amount of each payment? What is the effective annual interest rate? (Answers: \$278.70; 19.3%)

4-55 If you want a 12% rate of return, continuously compounded, on a project that will yield \$6000 at the end of 2½ years, how much must you be willing to invest now? (Answer: \$4444.80)

- 4-56** What monthly interest rate is equivalent to an effective annual interest rate of 18%?
- 4-57** A department store charges $1\frac{3}{4}\%$ interest per month, compounded continuously, on its customer's charge accounts. What is the nominal annual interest rate? What is the effective interest rate? (Answers: 21%; 23.4%)
- 4-58** A bank is offering to sell six-month certificates of deposit for \$9500. At the end of six months, the bank will pay \$10,000 to the certificate owner. Based on a six-month interest period, compute the nominal annual interest rate and the effective annual interest rate.
- 4-59** Two savings banks are located across the street from each other. The West Bank put a sign in the window saying, "We pay 6.50%, compounded daily." The East Bank decided that they would do better, so they put a sign in their window saying, "We pay 6.50%, compounded continuously." Jean Silva has \$10,000 which she will put in the bank for one year. How much additional interest will Jean receive by placing her money in the East Bank rather than the West Bank?
- 4-60** A bank advertises it pays 7% annual interest, compounded daily, on savings accounts, provided the money is left in the account for four years. What effective annual interest rate do they pay?
- 4-61** To repay a \$1000 loan, a man paid \$91.70 at the end of each month for twelve months. Compute the nominal interest rate he paid.
- 4-62** Sally Struthers wants to have \$10,000 in a savings account at the end of six months. The bank pays 8%, compounded continuously. How much should Sally deposit now? (Answer: \$9608)
- 4-63** A student bought a \$75 used guitar and agreed to pay for it with a single \$85 payment at the end of six months. Assuming semi-annual (every six months) compounding, what is the nominal annual interest rate? What is the effective interest rate?
- 4-64** A firm charges its credit customers $1\frac{3}{4}\%$ interest per month. What is the effective interest rate?
- 4-65** One thousand dollars is invested for seven months at an interest rate of one percent per month. What is the nominal interest rate? What is the effective interest rate? (Answers: 12%; 12.7%)
- 4-66** The *Rule of 78's* is a commonly used method of computing the amount of interest, when the balance of a loan is repaid in advance.

If one adds the numbers representing twelve months,

$$1 + 2 + 3 + 4 + 5 + \dots + 11 + 12 = 78$$

If a twelve-month loan is repaid at the end of one month, for example, the interest the borrower would be charged is $\frac{12}{78}$ of the year's interest. If the loan is repaid at the end of two months, the total interest charged would be $(12 + 11)/78$, or $\frac{23}{78}$ of the year's interest. After eleven months the interest charge would therefore be $\frac{77}{78}$ of the total year's interest.

Helen Reddy borrowed \$10,000 on January 1st at 9% annual interest, compounded monthly. The loan was to be repaid in twelve equal end-of-period payments. Helen made the first two payments and then

decided to repay the balance of the loan when she pays the third payment. Thus she will pay the third payment plus an additional sum.

You are to calculate the amount of this additional sum

- a. Based on the Rule of 78's;
- b. Based on exact economic analysis methods.

4-67 Consider the following cash flow:

<i>Year</i>	<i>Cash flow</i>
0	-\$P
1	+1000
2	+850
3	+700
4	+550
5	+400
6	+400
7	+400
8	+400

Alice was asked to compute the value of P for the cash flow at 8% interest. She wrote the following three equations:

- a. $P = 1000(P/A, 8\%, 8) - 150(P/G, 8\%, 8) + 150(P/G, 8\%, 4)(P/F, 8\%, 4)$
- b. $P = 400(P/A, 8\%, 8) + 600(P/A, 8\%, 5) - 150(P/G, 8\%, 4)$
- c. $P = 150(P/G, 8\%, 4) + 850(P/A, 8\%, 4) + 400(P/A, 8\%, 4)(P/F, 8\%, 4)$

Which of the equations is correct?

4-68 Ann Landers deposits \$100 at the end of each month into her bank savings account. The bank pays 6% nominal interest, compounded and paid quarterly. No interest is paid on money not in the account for the full three-month period. How much will be in Ann's account at the end of three years? (Answer: \$3912.30)

4-69 A college professor just won \$85,000 in the state lottery. After paying income taxes, about half the money will be left. She and her husband plan to spend her sabbatical year on leave from the university on an around-the-world trip, but she must continue to teach three more years first. She estimates the trip will cost \$40,000 and they will spend the money as a continuous flow of funds during their year of travel. She will put enough of her lottery winnings in a bank account now to pay for the trip. The bank pays 7% nominal interest, compounded continuously. She asks you to compute how much she should set aside in the account for their trip.

4-70 Mark Johnson saves a fixed percentage of his salary at the end of each year. This year he saved \$1500. For the next five years, he expects his salary to increase at an 8% annual rate, and he plans to increase his savings at the same 8% annual rate. He invests his money in the stock market. Thus there will be six end-of-year investments (\$1500 plus five more). Solve the problem using the geometric gradient factor.

- a. How much will his investments be worth at the end of six years if they increase in the stock market at a 10% annual rate?
- b. How much will Mark have at the end of six years if his stock market investments only increase at an 8% annual rate?

4-71 The *Bawl Street Journal* costs \$206, payable now, for a two-year subscription. The newspaper is published 252 days per year (five days per week, except holidays). If a 10% nominal annual interest rate, compounded quarterly, is used:

- a. What is the effective annual interest rate in this problem?
- b. Compute the equivalent interest rate per $\frac{1}{252}$ of a year.
- c. What is a subscriber's cost per copy of the newspaper, taking interest into account?

4-72 Michael Jackson deposited \$500,000 into a bank for six months. At the end of that time, he withdrew the money and received \$520,000. If the bank paid interest based on continuous compounding:

- a. What was the effective annual interest rate?
- b. What was the nominal annual interest rate?

4-73 The I've Been Moved Corporation receives a constant flow of funds from its worldwide operations. This money (in the form of checks) is continuously deposited in many banks with the goal of earning as much interest as possible for "IBM." One billion dollars is deposited each month, and the money earns an average of $\frac{1}{2}\%$ interest per month, compounded continuously. Assume all the money remains in the accounts until the end of the month.

- a. How much interest does IBM earn each month?
- b. How much interest would IBM earn each month if it held the checks and made deposits to its bank accounts just four times a month?

4-74 A married couple is opening an Individual Retirement Account (IRA) at a bank. Their goal is to accumulate \$1,000,000 in the account by the time they retire from work in forty years. The bank manager estimates they may expect to receive 8% nominal annual interest, compounded quarterly, throughout the forty years. The couple believe their income will increase at a 7% annual rate during their working careers. They wish to start with as low a deposit as possible to their IRA now and increase it at a 7% rate each year. Assuming end-of-year deposits, how much should they deposit the first year?

4-75 The Macintosh Co. has an employee savings plan in which an employee may invest up to 5% of his or her annual salary. The money is invested in company common stock with the company guaranteeing the annual return will never be less than 8%. Jill was hired at an annual salary of \$52,000. She immediately joined the savings plan investing the full 5% of her salary each year. If Jill's salary increases at an 8% uniform rate, and she continues to invest 5% of it each year. what amount of money is she guaranteed to have at the end of 20 years?

- 4-76** The football coach at a midwest university was given a five-year employment contract which paid \$225,000 the first year, and increased at an 8% uniform rate in each subsequent year. At the end of the first year's football season, the alumni demanded that he be fired. The alumni agreed to buy the coach's remaining four years on the contract by paying him the equivalent present sum, computed using a 12% interest rate. How much will the coach receive?
- 4-77** A group of ten public-spirited citizens has agreed that they will support the local school hot lunch program. Each year one of the group is to pay the \$15,000 years' cost that occurs continuously and uniformly during the year. Each member of the group is to underwrite the cost for one year. Slips of paper numbered Year 1 through Year 10 are put in a hat. As one of the group you draw the slip marked Year 6. Assuming an 8% nominal interest rate per year, how much do you need to set aside now to meet your obligation in Year 6?
- 4-78** In 1990 Mrs. John Hay Whitney sold her painting by Renoir, *Au Moulin de la Galette*, depicting an open-air Parisian dance hall, for \$71 million. The buyer also had to pay the auction house commission of 10%, or a total of \$78.1 million. Mrs. Whitney purchased the painting in 1929 for \$165,000.
- What rate of return did she receive on her investment?
 - Was the rate of return really as high as you computed in *a*? Explain.
- 4-79** Derive an equation to find the end of year future sum F that is equivalent to a series of n beginning-of-year payments B at interest rate i . Then use the equation to determine the future sum F equivalent to six B payments of \$100 at 8% interest. (Answer: $F = \$792.28$)
- 4-80** A woman made ten annual end-of-year purchases of \$1000 worth of common stock. The stock paid no dividends. Then for four years she held the stock. At the end of the four years she sold all the stock for \$28,000. What interest rate did she obtain on her investment?
- 4-81** For some interest rate i and some number of interest periods n , the uniform series capital recovery factor is 0.1728 and the sinking fund factor is 0.0378. What is the interest rate?
- 4-82** What interest rate, compounded quarterly, is equivalent to a 9.31% effective interest rate?
- 4-83** A contractor wishes to set up a special fund by making uniform semiannual end-of-period deposits for 20 years. The fund is to provide \$10,000 at the end of each of the last five years of the 20-year period. If interest is 8%, compounded semiannually, what is the required semiannual deposit?
- 4-84** How long will it take for \$10,000, invested at 5% per year, compounded continuously, to triple in value?
- 4-85** If \$200 is deposited in a savings account at the beginning of each of 15 years, and the account draws interest at 7% per year, how much will be in the account at the end of 15 years?
- 4-86** An automobile may be purchased with a \$3000 downpayment now and 60 monthly payments of \$280. If the interest rate is 12% compounded monthly, what is the price of the automobile?
- 4-87** If the nominal annual interest rate is 12% compounded quarterly, what is the effective annual interest rate?

4-88 A man is purchasing a small garden tractor. There will be no maintenance cost the first two years as the tractor is sold with two years free maintenance. The third year the maintenance is estimated at \$20. In subsequent years the maintenance cost will increase by \$20 per year (that is, fourth year maintenance will be \$40; fifth year \$60, and so on). How much would need to be set aside now at 8% interest to pay the maintenance costs on the tractor for the first six years of ownership?

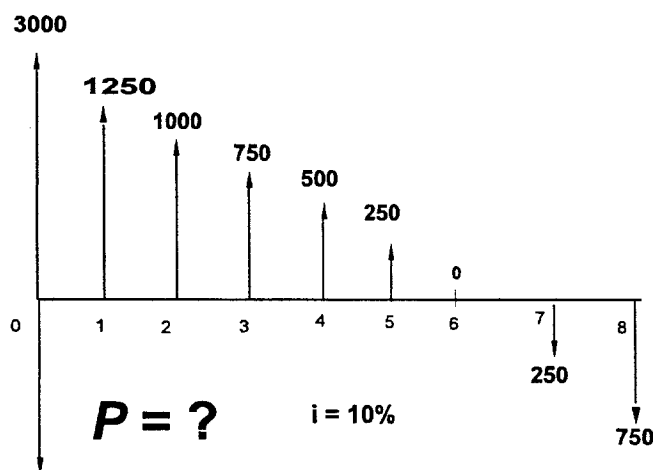
4-89 How many months, at an interest rate of one percent per month, does money have to be invested before it will double in value?

4-90 A company deposits \$2000 at the end of every year for ten years in a bank. The company makes no deposits during the subsequent five years. If the bank pays 8% interest, how much would be in the account at end of 15 years?

4-91 A bank pays 10% nominal annual interest on special three-year certificates. What is the effective annual interest rate if interest is compounded:

- every three months?
- daily?
- continuously?

4-92 Find the value of P for the cash flow diagram shown below.



4-93 A bank is offering a loan of \$25,000 with a nominal interest rate of 18% compounded monthly, payable in 60 months.

- What is the monthly payment?
- If a loan origination fee of 2% is charged at the time of the loan, compute the effective interest rate?

Hint -- The loan origination fee of 2% will be taken out from the loan amount.

4-94 Select the best alternative among the following five alternatives. Assume the investment is for a period of 4 years. $P = \$10,000$

- a. 11.98% interest rate compounded continuously
- b. 12.00% interest rate compounded daily
- c. 12.01% interest rate compounded monthly
- d. 12.02% interest rate compounded quarterly
- e. 12.03% interest rate compounded yearly

4-95 Pete Samprass borrows \$10,000 to purchase a car. He must repay the loan in 48 equal end-of-period monthly payments. Interest is calculated at 1.25% per month. Determine the following:

- a. The nominal annual interest rate.
- b. The effective annual interest rate.
- c. The amount of the monthly payment.

4-96 Picabo Street borrows \$1,000. To repay the amount she makes twelve equal monthly payments of \$90.30. Determine the following:

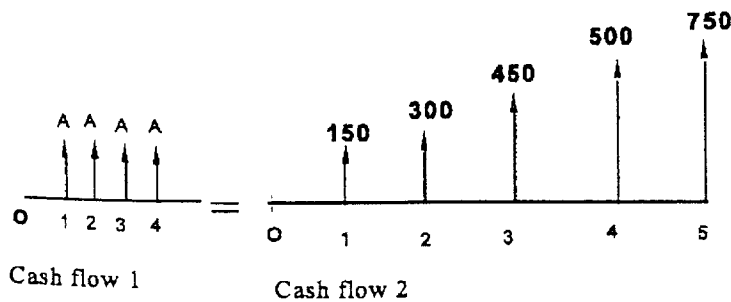
- a. The effective monthly interest rate.
- b. The nominal annual interest rate.
- c. The effective annual interest rate.

4-97 Bart Simpson wishes to tour the country with his friends. To do this, he is saving money in order to buy a bus.

- a. How much money must Bart deposit in a savings account paying 8% nominal annual interest, compounded continuously, in order to have \$8000 in 4-1/2 years?
- b. A friend offers to repay Bart \$8000 in 4-1/2 years if Bart gives him \$5000 now. Assuming continuous compounding, what is the nominal annual interest rate of this offer?

4-98 How much must be deposited now at 5.25% interest to produce \$300 at the end of every year for 10 years?

4-99 The following two cash flow transactions are said to be equivalent in terms of economic desirability at an interest rate of 12% compounded annually. Determine the unknown value *A*.



4-100 A realtor sold a house on August 31, 1997 for \$150,000 to a buyer in which a 20% down payment was made. The buyer took a 15-year mortgage on the property with an effective interest rate of 8% per annum. The buyer intends to pay off the mortgage owed in yearly payments starting on August 31, 1998.

a. How much of the mortgage will still be owed after the August 31, 2004 payment will have been paid?

b. Solve the same problem by separating the interest and the principal amounts.

4-101 To provide for a college education for his daughter, a man opened an escrow account in 1981 in which equal deposits were made. The first deposit was made on January 1, 1981 and the last deposit was made on January 1, 1998. The yearly college expenses including tuition were estimated to be \$8000, for each of the 4 years. Assuming the interest rate to be 5.75%, what was the size of the yearly deposit in the escrow account in order for the daughter to draw \$8000 per year for four years beginning January 1, 1998?

4-102 What is the present worth of a series of equal quarterly payments of \$3000 that extends over a period of 8 years if the interest rate is 10% compounded monthly?

4-103 You are taking a \$2000 loan. You will pay it back in four equal amounts, paid every six months starting three years from now. The interest rate is 6% compounded semiannually. Calculate:

a. The effective interest rate, based on both semiannual and continuous compounding.

b. The amount of each semiannual payment.

c. The total interest paid.

4-104 Develop a complete amortization table for a loan of \$4500, to be paid back in 24 uniform monthly installments, based on an interest rate of 6%. The amortization table must include the following column headings:

payment number, principal owed (beginning of period), interest owed in each period, total owed (end of each period), principal paid in each payment, uniform monthly payment amount.

You must also show the equations used to calculate each column of the table. You are encouraged to use spreadsheets. *The entire table must be shown.*

4-105 Using the loan and payment plan developed in problem 4-104, determine the month that the final payment is due, and the amount of the final payment, if \$500 is paid for payment 8 and \$280 is paid for payment 10. This problem requires a separate amortization table.

4-106 The following beginning of month (BOM) and end of month (EOM) amounts are to be deposited in a savings account that pays interest at 9%, compounded monthly:

Today (BOM 1)	\$400
EOM 2	270
EOM 6	100
EOM 7	180
BOM 10	200

Set up a spreadsheet to calculate the account balance at the end of the first year (EOM12). The spreadsheet must include the following column headings: month number; deposit BOM; account balance at BOM; interest earned in each month; deposit EOM; account balance at EOM. Also, draw a cash flow diagram of this problem and solve for the account balance at the EOM 12 using the compound interest tables.

4-107 Eighty thousand dollars are borrowed at 7% to purchase a house. The loan is to be repaid in equal monthly payments over a 30 year period. The first payment is paid exactly at the end of the first month. Calculate the interest and principal in the second payment, if the second payment is made 33 days after the first payment.

4-108 A student wants to have \$30,000 at graduation four years from now to buy a new car. His grandfather gave him \$10,000 as a high school graduation present. How much must the student save each year if he deposits the \$10,000 today and can earn 12% on both the \$10,000 and his earnings in a mutual fund his grandfather recommends?

4-109 A city engineer knows that she will need \$25,000,000 in three years to replace toll booths on a toll road in the city. Traffic on the road is estimated to be 20,000,000 vehicles per year. How much per vehicle should the toll price be to cover the cost of the toll booth replacement project? Interest is 10%. (Simplify your analysis by assuming that the toll receipts are received at the end of each year in a lump sum)

4-110 Traffic at a certain intersection is currently 2000 cars per day. A consultant has told the city that traffic is expected to grow at a continuous rate of 5% per year for the next 4 years. How much traffic will be expected at the end of two years?

4-111 What single amount on April 1, 1998 is equivalent to a series of equal, semiannual cash flows of \$1000 that starts with a cash flow on January 1, 1996, and ends with a cash flow on January 1, 2005? The interest rate is 14% and compounding is quarterly.

4-112 A forklift truck costs \$29,000. A company agrees to purchase the forklift truck with the understanding that it will make a single payment for the balance due in 3 years. The vendor agrees to the deal and offers two different interest schedules. The first schedule uses an annual effective interest rate of 13%. The second schedule uses 12.75% compounded continuously. *a.* Which schedule should the company accept? *b.* What would be size of the single payment?

4-113 PARC Co. has money to invest in an employee benefit plan and you have been chosen as the plan's trustee. As an employee yourself you want to maximize the interest earned on this investment and have found an account that pays 14% compounded continuously. PARC Co. is providing you \$1200 per month to put into your account for seven years. What is the balance in this account after the seven year period?

4-114 Paco's saving account earns 13% compounded weekly and receives quarterly deposits of \$38,000. His first deposit occurs on October 1, 1996, and the last deposit occurs on April 1, 2012. Tisha's account earns 13% compounded weekly. Semiannual deposits of \$18,000 are made into her account with the first one occurring on July 1, 2006, and the last one occurring on January 1, 2015. What single amount on January 1, 2007, is equivalent to both cash flow series?

4-115 The first of a series of equal semiannual cash flows occurs on July 1, 1997, and the last occurs on January 1, 2010. Each cash flow is equal to \$128,000. The nominal interest rate is 12% compounded semiannually. What single amount on July 1, 2001 is equivalent to this cash flow system?

4-116 The first of a series of equal, monthly cash flows of \$2000 occurs on April 1, 1998, and the last of the monthly cash flows occurs on February 1, 2000. This series of monthly cash flows is equivalent to a series of semiannual cash flows. The first semiannual cash flow occurs on July 1, 2001, and the last semiannual cash flow occurs on January 1, 2010. What is the amount of each semiannual cash flow? Use a nominal interest rate of 12% with monthly compounding on all accounts.

4-117 What single amount on October 1, 1997, is equal to a series of \$1000 quarterly deposits made into an account? The first deposit occurs on October 1, 1997 and the last deposit occurs on January 1, 2011. The account earns 13% compounded continuously.

4-118 Barry, a recent Texas Tech graduate, never took Engineering Economics. When he graduated, he was employed by a prominent architectural firm. The earnings from this job allowed him to deposit \$750 each quarter into a savings account. There were two banks offering a savings account in his town (a small town!). The first bank was offering 4.5% interest compounded continuously. The second bank offered 4.6% compounded monthly. Barry decided to deposit in the first bank since it offered continuous compounding. Based on this information, did he make the right decision?

4-119 A series of monthly cash flows is deposited into an account which earns 12% nominal interest compounded monthly. Each monthly deposit is equal to \$2100. The first monthly deposit occurs on June 1, 1998 and the last monthly deposit occurs on January 1, 2005. The above account (the series of monthly deposits, 12% nominal interest, and monthly compounding) also has equivalent quarterly withdrawals from it. The first quarterly withdrawal is equal to \$5000 and occurs on October 1, 1998. The last \$5000 withdrawal occurs on January 1, 2005. How much remains in the account after the last withdrawal?

4-120 Our cat, Fred, wants to purchase a new litter box. The cost is \$100 and he'll finance it over 2 years at an annual rate of 18% compounded monthly and to be repaid in 24 monthly payments.

a. What is his monthly payment?

b. At the time of the 13th payment, Fred decides to pay off the remainder of the loan.

Using regular compound interest factors, determine the amount of this last payment.

4-121 Our cat, Fred, has convinced me that I should set up an account such that he will be assured of his "Meow Mix" for the next four years. I will deposit an amount " P " today such that he can make end of the month withdrawals of \$10 for the next 48 months. Consider an interest rate of 6%

compounded monthly and that the account will be emptied with the last withdrawal.

- a. What is the value of “ P ” that I must deposit today?
- b. What is the account balance immediately after the 24th withdrawal has been made?

4-122 When Jerry Garcia was alive he bought a house for \$500,000 and made a \$100,000 down payment. He obtained a 30 year loan for the remaining amount. Payments were made monthly. The nominal annual interest rate was 9%. After ten years (120 payments) he decided to pay the remaining balance on the loan.

- a. What was his monthly loan payment?
- b. What must he have paid (in addition to his regular 120th monthly payment) to pay the remaining balance of his loan?
- c. Recompute part (a) using 6% compounded continuously.

4-123 Jim Duggan made an investment of \$10,000 in a savings account 10 years ago. This account paid interest of 5-1/2% for the first 4 years and 6-1/2% interest for the remaining 6 years. The interest charges were compounded quarterly.

- a. How much is this investment worth now?
- b. What is the equivalent effective interest rate per year on this investment?

▣ **4-124** Net revenues at an older manufacturing plant will be \$2M for this year. The net revenue will decrease 15% per year for five years, when the assembly plant will be closed (at the end of year 6). If the firm's interest rate is 10%, calculate the PW of the revenue stream.

▣ **4-125** What is the present worth of cash flows that begin at \$10,000 and increase at 8% per year for 4 years? The interest rate is 6%.

▣ **4-126** What is the present worth of cash flows that begin at \$30,000 and decrease at 15% per year for 6 years? The interest rate is 10%.

▣ **4-127** Calculate and print out an amortization schedule for a used car loan. The nominal interest is 12% per year, compounded monthly. Payments are made monthly for 3 years. The original loan is for \$11,000.

▣ **4-128** Calculate and print out an amortization schedule for a new car loan. The nominal interest is 9% per year, compounded monthly. Payments are made monthly for 5 years. The original loan is for \$17,000.

▣ **4-129** For the used car loan of Problem 4.127, graph the monthly payment.

- a. As a function of the interest rate (5% to 15%).
- b. As a function of the number of payments (24 to 48).

▣ **4-130** For the new car loan of Problem 4.128, graph the monthly payment.

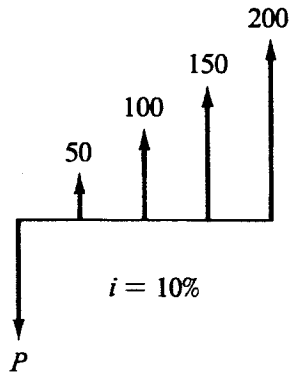
- a. As a function of the interest rate (4% to 14%).
- b. As a function of the number of payments (36 to 84).

- ☞ **4-131** Your beginning salary is \$50,000. You deposit 10% at the end of each year in a savings account that earns 6% interest. Your salary increases by 5% per year. What value does your savings book show after 40 years?
- ☞ **4-132** The market volume for widgets is increasing by 15% per year from current profits of \$200,000. Investing in a design change will allow the profit per widget to stay steady, otherwise they will drop 3% per year. What is the present worth of the savings over the next 5 years? Ten years? The interest rate is 10%.
- ☞ **4-133** A 30-year mortgage for \$120,000 has been issued. The interest rate is 10% and payments are made monthly. Print an amortization schedule.
- ☞ **4-134** A homeowner may upgrade a fuel oil based furnace to a natural gas unit. The investment will be \$2500 installed. The cost of the natural gas will average \$60 per month over the year, instead of the \$145 per month that the fuel oil costs. If the interest rate is 9% per year, how long will it take to recover the initial investment?
- ☞ **4-135** Develop a general purpose spreadsheet to calculate an amortization schedule for a loan. The user inputs to the spreadsheet will be the loan amount, the number of payments per year, the number of years payments are made, and the nominal interest rate. Submit printouts of your analysis of a loan in the amount of \$15,000 @ 8.9% nominal rate for 36 months and for 60 months of payments.
- ☞ **4-136** Use the spreadsheet developed for Problem 4-135 to analyze 180-month and 360-month house loan payments. Analyze a \$100,000 mortgage loan at a nominal interest rate of 7.5% and submit a graph of the interest and principal paid over time. You need not submit the printout of the 360 payments because it will not fit on one page.

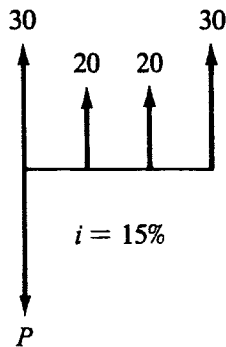
5. For now, stable prices are assumed. The problem of inflation-deflation is deferred to Chapter 13. Similarly, income taxes are deferred to Chapter 11.

Problems

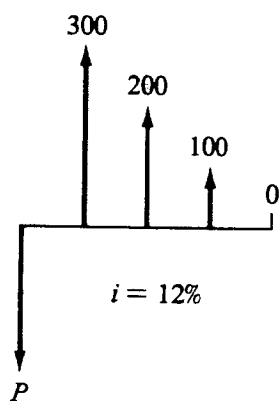
- 5-1 Compute P for the following diagram.



- 5-2 Compute the value of P that is equivalent to the four cash flows in the diagram below.

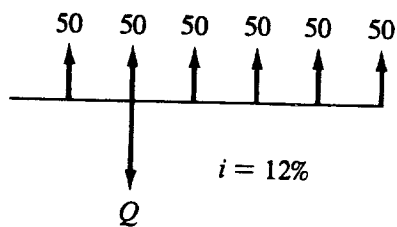


- 5-3 What is the value of P for the situation shown below?

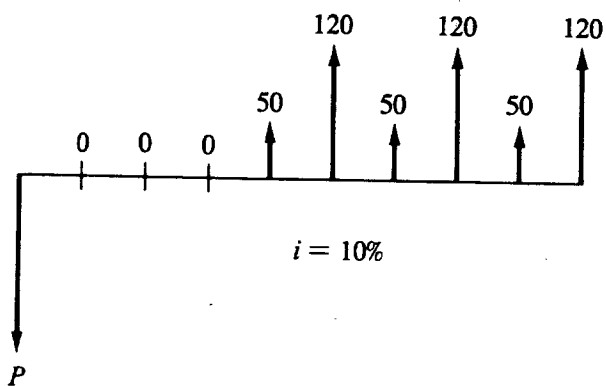


(Answer: $P = \$498.50$)

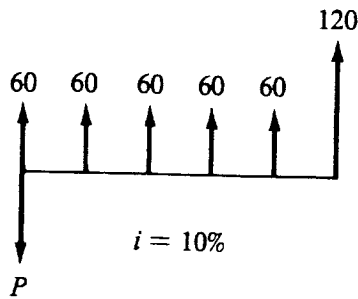
5-4 Compute the value of Q in the figure below.



5-5 For the diagram, compute P .



5-6 Compute P for the following diagram.



(Answer: $P = \$324.71$)

5-7 The annual income from a rented house is \$12,000. The annual expenses are \$3000. If the house can be sold for \$145,000 at the end of ten years, how much could you afford to pay for it now, if you considered 18% to be a suitable interest rate? (Answer: \$68,155)

5-8 Consider the following cash flow. At a 6% interest rate, what is the value of P , at the end of Year 1, that is equivalent to the benefits at the end of Years 2 through 7?

Year	Cash flow
1	$-P$
2	+100
3	+200
4	+300
5	+400
6	+500
7	+600

5-9 A rather wealthy man decided he would like to arrange for his descendants to be well educated. He would like each child to have \$60,000 for his or her education. He plans to set up a perpetual trust fund so that six children will receive this assistance each generation. He estimates that there will be four generations per century, spaced 25 years apart. He expects the trust to be able to obtain a 4% rate of return, and the first recipients to receive the money ten years hence. How much money should he now set aside in the trust? (Answer: \$389,150)

5-10 How much would the owner of a building be justified in paying for a sprinkler system that will save \$750 a year in insurance premiums if the system has to be replaced every twenty years and has a salvage value equal to 10% of its initial cost? Assume money is worth 7%. (Answer: \$8156)

5-11 A man had to have the muffler replaced on his two-year-old car. The repairman offered two alternatives. For \$50 he would install a muffler guaranteed for two years. But for \$65 he would install a muffler guaranteed "for as long as you own the car." Assuming the present owner expects to keep the car for about three more years, which muffler would you advise him to have installed

if you thought 20% were a suitable interest rate and the less expensive muffler would only last two years?

5-12 A consulting engineer has been engaged to advise a town how best to proceed with the construction of a 200,000 m³ water supply reservoir. Since only 120,000 m³ of storage will be required for the next 25 years, an alternative to building the full capacity now is to build the reservoir in two stages. Initially, the reservoir could be built with 120,000 m³ of capacity and then, 25 years hence, the additional 80,000 m³ of capacity could be added by increasing the height of the reservoir. Estimated costs are as follows:

	<i>Construction cost</i>	<i>Annual maintenance cost</i>
Build in two stages.		
<i>First stage:</i> 120,000 m ³ reservoir	\$14,200,000	\$75,000
<i>Second stage:</i> Add 80,000 m ³ of capacity, additional construction and maintenance costs	12,600,000	25,000
Build full capacity now. 200,000 m ³ reservoir	\$22,400,000	\$100,000

If interest is computed at 4%, which construction plan is preferred?

5-13 An engineer has received two bids for an elevator to be installed in a new building. The bids, plus his evaluation of the elevators, are as follows:

<i>Alternatives</i>	<i>Bids</i>	<i>Engineer's estimates</i>		
	<i>Installed cost</i>	<i>Service life, in years</i>	<i>Annual operating cost, including repairs</i>	<i>Salvage value at end of service life</i>
Westinghome	\$45,000	10	\$2700/yr	\$3000
Itis	54,000	15	2850/yr	4500

The engineer will make a present worth analysis using a 10% interest rate. Prepare the analysis and determine which bid should be accepted.

5-14 A railroad branch line is to be constructed to a missile site. It is expected the railroad line will be used for 15 years, after which the missile site will be removed and the land turned back to agricultural use. The railroad track and ties will be removed at that time.

In building the railroad line, either treated or untreated wood ties may be used. Treated

ties have an installed cost of \$6 and a ten-year life; untreated ties are \$4.50 with a six-year life. If at the end of fifteen years the ties then in place have a remaining useful life of four years or more, they will be used by the railroad elsewhere and have an estimated salvage value of \$3 each. Anytime ties are removed that are at the end of their service life, or are too close to the end of their service life to be used elsewhere, they are sold for \$0.50 each.

Determine the most economical plan for the initial railroad ties and their replacement for the fifteen-year period. Make a present worth analysis assuming 8% interest.

5-15 A weekly business magazine offers a one-year subscription for \$58 and a three-year subscription for \$116. If you thought you would read the magazine for at least the next three years, and consider 20% as a minimum rate of return, which way would you purchase the magazine, with three one-year subscriptions or a single three-year subscription. (*Answer:* Choose the three-year subscription.)

5-16 A manufacturer is considering purchasing equipment which will have the following financial effects:

<i>Year</i>	<i>Disbursements</i>	<i>Receipts</i>
0	\$4400	\$0
1	660	880
2	660	1980
3	440	2420
4	220	1760

If money is worth 6%, should he invest in the equipment?

5-17 Jerry Stans, a young industrial engineer, prepared an economic analysis for some equipment to replace one production worker. The analysis showed that the present worth of benefits (of employing one less production worker) just equaled the present worth of the equipment costs, based on a ten-year useful life for the equipment. It was decided not to purchase the equipment.

A short time later, the production workers won a new three-year union contract that granted them an immediate 40¢-per-hour wage increase, plus an additional 25¢-per-hour wage increase in each of the two subsequent years. Assume that in each and every future year, a 25¢-per-hour wage increase will be granted.

Jerry Stans has been asked to revise his earlier economic analysis. The present worth of benefits of replacing one production employee will now increase. Assuming an interest rate of 8%, the justifiable cost of the automation equipment (with a ten-year useful life) will increase by how much? Assume the plant operates a single eight-hour shift, 250 days per year.

5-18 The management of an electronics manufacturing firm believes it is desirable to install some automation equipment in their production facility. They believe the equipment would have a ten-year life with no salvage value at the end of ten years. The plant engineering department has surveyed the plant and suggested there are eight mutually exclusive alternatives available.

<i>Plan</i>	<i>Initial cost, in thousands</i>	<i>Net annual benefit, in thousands</i>
1	\$265	\$51
2	220	39
3	180	26
4	100	15
5	305	57
6	130	23
7	245	47
8	165	33

If the firm expects a 10% rate of return, which alternative, if any, should they adopt?
(Answer: Plan 1)

5-19 The president of the E. L. Echo Corporation thought it would be appropriate for his firm to "endow a chair" in the Industrial Engineering Department of the local university; that is, he was considering making a gift to the university of sufficient money to pay the salary of one professor forever. One professor in the department would be designated the E. L. Echo Professor of Industrial Engineering, and his salary would come from the fund established by the Echo Corporation. If the professor will receive \$67,000 per year, and the interest received on the endowment fund is expected to remain at 8%, what lump sum of money will the Echo Corporation need to provide to establish the endowment fund? (Answer: \$837,500)

5-20 A man who likes cherry blossoms very much would like to have an urn full of them put on his grave once each year forever after he dies. In his will, he intends to leave a certain sum of money in the trust of a local bank to pay the florist's annual bill. How much money should be left for this purpose? Make whatever assumptions you feel are justified by the facts presented. State your assumptions, and compute a solution.

5-21 A local symphony association offers memberships as follows:

Continuing membership, per year	\$ 15
Patron lifetime membership	375

The patron membership has been based on the symphony association's belief that it can obtain a 4% rate of return on its investment. If you believed 4% to be an appropriate rate of return, would you be willing to purchase the patron membership? Explain why or why not.

5-22 A battery manufacturing plant has been ordered to cease discharging acidic waste liquids containing mercury into the city sewer system. As a result, the firm must now adjust the pH and remove the mercury from its waste liquids. Three firms have provided quotations on the necessary equipment. An analysis of the quotations provided the following table of costs.

<i>Bidder</i>	<i>Installed cost</i>	<i>Annual operating cost</i>	<i>Annual income from mercury recovery</i>	<i>Salvage value</i>
Foxhill Instrument	\$35,000	\$8000	\$2000	\$20,000
Quicksilver	40,000	7000	2200	0
Almaden	100,000	2000	3500	0

If the installation can be expected to last twenty years and money is worth 7%, which equipment should be purchased? (*Answer: Almaden*)

5-23 A firm is considering three mutually exclusive alternatives as part of a production improvement program. The alternatives are:

	<i>A</i>	<i>B</i>	<i>C</i>
Installed cost	\$10,000	\$15,000	\$20,000
Uniform annual benefit	1,625	1,530	1,890
Useful life, in years	10	20	20

For each alternative, the salvage value at the end of its useful life is zero. At the end of ten years, *A* could be replaced with another *A* with identical cost and benefits. The minimum attractive rate of return is 6%. Which alternative should be selected?

5-24 A steam boiler is needed as part of the design of a new plant. The boiler can be fired either by natural gas, fuel oil, or coal. A decision must be made on which fuel to use. An analysis of the costs shows that the installed cost, with all controls, would be least for natural gas at \$30,000; for fuel oil it would be \$55,000; and for coal it would be \$180,000. If natural gas is used rather than fuel oil, the annual fuel cost will increase by \$7500. If coal is used rather than fuel oil, the annual fuel cost will be \$15,000 per year less. Assuming 8% interest, a twenty-year analysis period, and no salvage value, which is the most economical installation?

5-25 An investor has carefully studied a number of companies and their common stock. From his analysis, he has decided that the stocks of six firms are the best of the many he has examined. They represent about the same amount of risk and so he would like to determine the one in which to invest. He plans to keep the stock for four years and requires a 10% minimum attractive rate of return.

<i>Common stock</i>	<i>Price per share</i>	<i>Annual end-of-year dividend per share</i>	<i>Estimated price at end of 4 years</i>
Western House	\$23 ³ / ₄	\$1.25	\$32
Fine Foods	45	4.50	45
Mobile Motors	30 ⁵ / ₈	0	42
Trojan Products	12	0	20
U.S. Tire	33 ³ / ₈	2.00	40
Wine Products	52 ¹ / ₂	3.00	60

Which stock, if any, should the investor consider purchasing? (*Answer: Trojan Products*)

5-26 A home builder must construct a sewage treatment plant and deposit sufficient money in a perpetual trust fund to pay the \$5000 per year operating cost and to replace the treatment plant every forty years. The plant will cost \$150,000, and future replacement plants will also cost \$150,000 each. If the trust fund earns 8% interest, what is the builder's capitalized cost to construct the plant and future replacements, and to pay the operating costs?

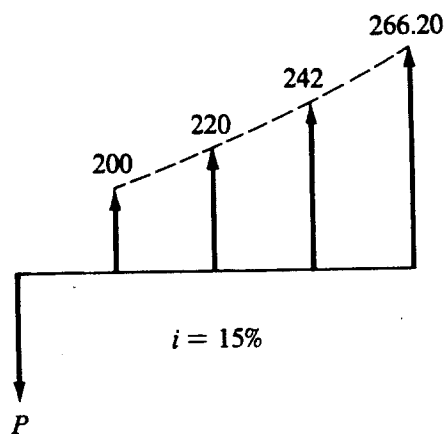
5-27 Using an eight-year analysis period and a 10% interest rate, determine which alternative should be selected:

	<i>A</i>	<i>B</i>
First cost	\$5300	\$10,700
Uniform annual benefit	1800	2,100
Useful life, in years	4	8

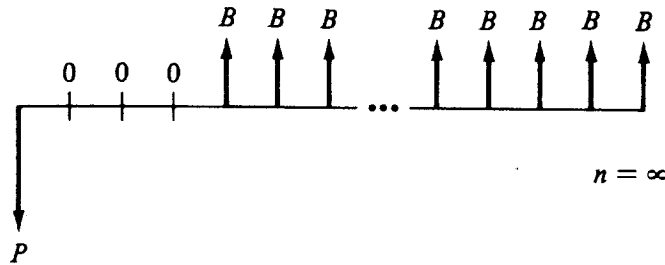
5-28 The local botanical society wants to ensure that the gardens in a local park are properly cared for. They just recently spent \$100,000 to plant the gardens. They would like to set up a perpetual fund to provide \$100,000 for future replantings of the gardens every ten years. If interest is 5%, how much money would be needed to forever pay the cost of replanting?

5-29 An elderly lady decided to distribute most of her considerable wealth to charity and to retain for herself only enough money to provide for her living. She feels that \$1000 a month will amply provide for her needs. She will establish a trust fund at a bank which pays 6% interest, compounded monthly. At the end of each month she will withdraw \$1000. She has arranged that, upon her death, the balance in the account is to be paid to her niece, Susan. If she opens the trust fund and deposits enough money to pay her \$1000 a month forever, how much will Susan receive when her Aunt dies?

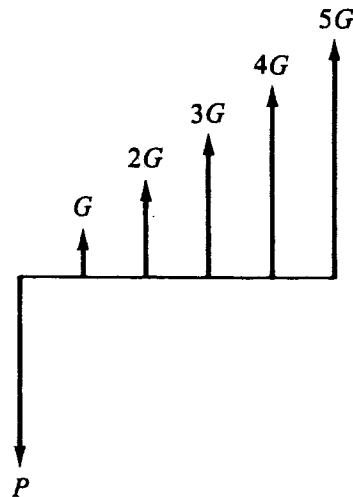
5-30 Solve the diagram below for P using a geometric gradient factor.



5-31 If $i = 10\%$, what is the value of P ?



5-32 A stonecutter was carving the headstone for a well-known engineering economist.



He carved the figure above and then started the equation as follows:

$$P = G(P/G, i, 6)$$

He realized he had made a mistake. The equation should have been

$$P = G(P/G, i, 5) + G(P/A, i, 5)$$

The stonecutter does not want to discard the stone and start over. He asks you to help him with his problem. The right side of Eq. 1 can be multiplied by one compound interest factor and then the equation will be correct for the carved figure. Equation 1 will be of the form:

$$P = G(P/G, i, 6) (\quad , i, \quad)$$

Write the complete equation.

5-33 In a present worth analysis, one alternative has a Net Present Worth of +420, based on a six-year analysis period that equals the useful life of the alternative. A 10% interest rate was used in the computations.

The alternative is to be replaced at the end of the six years by an identical piece of equipment with the same cost, benefits, and useful life. Based on a 10% interest rate, compute the Net Present Worth of the equipment for the twelve-year analysis period. (Answer: NPW = +657.09)

5-34 A project has a Net Present Worth (NPW) of -140 as of Jan. 1, 2000. If a 10% interest rate is used, what is the project NPW as of Dec. 31, 1997?

5-35 Consider the following four alternatives. Three are "do something" and one is "do nothing."

	Alternative			
	A	B	C	D
Cost	\$0	\$50	\$30	\$40
Net annual benefit	0	12	4.5	6
Useful life, in years		5	10	10

At the end of the five-year useful life of *B*, a replacement is not made. If a ten-year analysis period and a 10% interest rate are selected, which is the preferred alternative?

5-36 Six mutually exclusive alternatives are being examined. For an 8% interest rate, which alternative should be selected? Each alternative has a six-year useful life.

	Alternatives					
	A	B	C	D	E	F
Initial cost	\$20.00	\$35.00	\$55.00	\$60.00	\$80.00	\$100.00
Uniform annual benefit	6.00	9.25	13.38	13.78	24.32	24.32

5-37 A building contractor obtained bids for some asphalt paving, based on a specification. Three paving subcontractors quoted the following prices and terms of payment:

	Price	Payment schedule
1. <i>Quick Paving Co.</i>	\$85,000	50% payable immediately; 25% payable in six months; 25% payable at the end of one year.
2. <i>Tartan Paving Co.</i>	\$82,000	Payable immediately.
3. <i>Faultless Paving Co.</i>	\$84,000	25% payable immediately; 75% payable in six months.

The building contractor uses a 12% nominal interest rate, compounded monthly, in this type of bid analysis. Which paving subcontractor should be awarded the paving job?

5-38 A cost analysis is to be made to determine what, if anything, should be done in a situation where there are three "do something" and one "do nothing" alternatives. Estimates of the cost and benefits are as follows:

<i>Alternatives</i>	<i>Cost</i>	<i>Uniform annual benefit</i>	<i>End-of-useful-life salvage value</i>	<i>Useful life, in years</i>
1	\$500	\$135	\$ 0	5
2	600	100	250	5
3	700	100	180	10
4	0	0	0	0

Use a ten-year analysis period for the four mutually exclusive alternatives. At the end of five years, Alternatives 1 and 2 may be replaced with identical alternatives (with the same cost, benefits, salvage value, and useful life).

- a. If an 8% interest rate is used, which alternative should be selected?
- b. If a 12% interest rate is used, which alternative should be selected?

5-39 Consider five mutually exclusive alternatives:

	<i>Alternatives</i>				
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
Initial cost	\$600	\$600	\$600	\$600	\$600
Uniform annual benefits for first five years	100	100	100	150	150
Uniform annual benefits for last five years	50	100	110	0	50

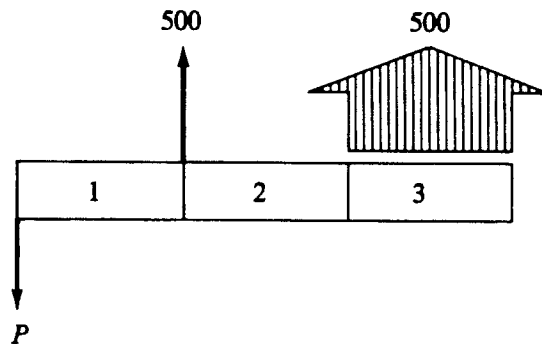
The interest rate is 10%. If all the alternatives have a ten-year useful life, and no salvage value, which alternative should be selected?

5-40 On February 1, the Miro Company needs to purchase some office equipment. The company is presently short of cash and expects to be short for several months. The company treasurer has indicated that he could pay for the equipment as follows:

<i>Date</i>	<i>Payment</i>
April 1	\$150
June 1	300
Aug. 1	450
Oct. 1	600
Dec. 1	750

A local office supply firm has been contacted, and they will agree to sell the equipment to the firm now and to be paid according to the treasurer's payment schedule. If interest will be charged at 3% every two months, with compounding once every two months, how much office equipment can the Miro Company buy now? (Answer: \$2020)

5-41 Using 5% nominal interest, compounded continuously, solve for P .



5-42 By installing some elaborate inspection equipment on its assembly line, the Robot Corp. can avoid hiring an extra worker. The worker would have earned \$26,000 a year in wages, and Robot would have paid an additional \$7500 a year in employee benefits. The inspection equipment has a six-year useful life and no salvage value. Use a nominal 18% interest rate in your calculations. How much can Robot afford to pay for the equipment if the wages and worker benefits are paid:

- a. at the end of each year?
- b. monthly?
- c. continuously?
- d. Explain why the answers in *b* and *c* are larger than in *a*.

Assume the compounding matches the way the wages and benefits are paid, that is, annually, monthly, and continuously, respectively.

5-43 Using capitalized cost, determine which type of road surface is preferred on a particular section of highway. Use 12% interest rate.

	<i>A</i>	<i>B</i>
Initial cost	\$500,000	\$700,000
Annual maintenance	35,000	25,000
Periodic resurfacing	350,000	450,000
	every 10 years	every 15 years

5-44 What amount of money deposited 50 years ago at 8% interest would provide a perpetual payment of \$10,000 a year beginning this year?

5-45 Annual maintenance costs for a particular section of highway pavement are \$2000. The placement of a new surface would reduce the annual maintenance cost to \$500 per year for the first five years and to \$1000 per year for the next five years. After ten years the annual maintenance would again be \$2000. If maintenance costs are the only saving, what investment can be justified for the new surface. Assume interest at 4%.

5-46 A small dam was constructed for \$2 million. The annual maintenance cost is \$15,000. If interest is 5%, compute the capitalized cost of the dam, including maintenance.

5-47 Twenty-five thousand dollars is deposited in a savings account that pays 5% interest, compounded semi-annually. Equal annual withdrawals are to be made from the account, beginning one year from now and continuing forever. What is the maximum equal annual withdrawal?

5-48 Two alternative courses of action have the following schedules of disbursements:

Year	A	B
0	-\$1300	
1	0	-\$100
2	0	-200
3	0	-300
4	0	-400
5	0	-500
	<u>-\$1300</u>	<u>-\$1500</u>

Based on a 6% interest rate, which alternative should be selected?

5-49 An investor is considering buying a 20-year corporate bond. The bond has a face value of \$ 1000 and pays 6% interest per year in two semi-annual payments. Thus the purchaser of the bond will receive \$30 every six months and, in addition, he/she will receive \$1000 at the end of 20 years, along with the last \$30 interest payment. If the investor thinks he/she should receive 8% interest, compounded semi-annually, how much would the investor be willing to pay for the bond?

5-50 A trust fund is to be established for three purposes: (1) provide \$750,000 for the construction and \$250,000 for the initial equipment of a small engineering laboratory; (2) pay the \$150,000 per year laboratory operating cost; and (3) pay for \$100,000 of replacement equipment every four years, beginning four years from now.

At 6% interest, how much money is required in the trust fund to provide for the laboratory and equipment and its perpetual operation and equipment replacement?

5-51 A city has developed a plan which will provide for future municipal water needs. The plan proposes an aqueduct which passes through 500 feet of tunnel in a nearby mountain. Two alternatives are being considered. The first proposes to build a full-capacity tunnel now for \$556,000. The second proposes to build a half-capacity tunnel now (cost = \$402,000) which should be adequate for 20 years, and then to build a second parallel half-capacity tunnel. The maintenance cost of the tunnel lining for the full-capacity tunnel is \$40,000 every 10 years, and for each half-capacity tunnel it is \$32,000 every 10 years.

The friction losses in the half-capacity tunnel will be greater than if the full-capacity tunnel were built. The estimated additional pumping costs in the single half-capacity tunnel will be \$2000 per year, and for the two half-capacity tunnels it will be \$4000 per year. Based on capitalized cost and a 7% interest rate, which alternative should be selected?

5-52 A road building contractor has received a major highway construction contract that will require $50,000 \text{ m}^3$ of crushed stone each year for five years. The needed stone can be obtained from a quarry for $\$5.80/\text{m}^3$. As an alternative the contractor has decided to try and purchase the quarry. He believes if he owned the quarry the stone would only cost him $\$4.30/\text{m}^3$. He thinks he could resell the quarry at the end of five years for $\$40,000$. If the contractor uses a 10% interest rate, how much would he be willing to pay for the quarry?

5-53 A new office building was constructed five years ago by a consulting engineering firm. At that time the firm obtained a bank loan for $\$100,000$ with a 12% annual interest rate, compounded quarterly. The terms of the loan call for equal quarterly payments to repay the loan in 10 years. The loan also allows for its prepayment at any time without penalty.

Due to internal changes in the firm, it is now proposed to refinance the loan through an insurance company. The new loan would be for a 20-year term with an interest rate of 8% per year, compounded quarterly. The new equal quarterly payments would repay the loan in the 20-year period. The insurance company requires the payment of a 5% loan initiation charge (often described as a "five-point loan fee") which will be added to the new loan.

- a. What is the balance due on the original mortgage if 20 payments have been made in the last five years?
- b. What is the difference between the equal quarterly payments on the present bank loan and the proposed insurance company loan?

5-54 Given the following data, using present worth analysis find the best alternative.

	<i>Alt. A</i>	<i>Alt. B</i>	<i>Alt. C</i>
Initial Cost	\$10,000	15,000	\$12,000
Annual Benefit	6,000	10,000	5,000
Salvage Value	1,000	-2,000	3,000
Useful Life	2 years	3 years	4 years
MARR	10%	10%	10%

Analysis Period = 12 years $i = 10\%$

5-55 The local Audubon Society has just put a new bird feeder in the park at a cost of $\$500$. The feeder has a useful life of 5 years and an annual maintenance cost of $\$50$. Our cat, Fred, was very impressed with the project. He wants to establish a fund that will maintain the feeder in perpetuity (that's forever!). Replacement feeders cost $\$500$ every 5 years. If the fund will earn 5% interest, what amount must he raise for its establishment? Note that it will cover both maintenance and replacement costs following the initial investment.

5-56 We want to donate a marble birdbath to the city park as a memorial to our cat, Fred, while he can still enjoy it. We also want to set up a perpetual care fund to cover future expenses "forever". The initial cost of the bath is $\$5000$. Routine annual operating costs are $\$200$ per year but every fifth

year the cost will be \$500 to cover major cleaning and maintenance as well as operation.

- a. What is the capitalized cost of this project if the interest rate is 8 percent?
- b. How much is the present worth of this project if it is to be demolished after 75 years?

The final \$500 payment in the 75th year will cover the year's operating cost and the site reclamation.

5-57 A corporate bond has a face value of \$1000 with maturity date 20 years from today. The bond pays interest semi-annually at a rate of 8% per year based on the face value. The interest rate paid on similar corporate bonds has decreased to a current rate of 6%. Determine the market value of the bond.

5-58 IBP Inc. is considering establishing a new machine to automate a meat packing process. The machine will save \$50,000 in labor annually. The machine can be purchased for \$200,000 today and will be used for a period of 10 years. It has a salvage value of \$10,000 at the end of its useful life. The new machine will require an annual maintenance cost of \$9000. The corporation has a minimum rate of return of 10%. Do you recommend automating the process?

5-59 Argentina is considering constructing a bridge across the Rio de La Plata to connect its Northern coast to the Southern coast of Uruguay. If this bridge is constructed, it will reduce the travel time from Buenos Aires, Argentina to Sao Paulo, Brazil by over 10 hours, and has the potential to significantly improve the flow of manufactured goods between the two countries. The cost of the new bridge, which will be the longest bridge in the world and span over 50 miles, will be \$700 million. The bridge will require an annual maintenance of \$10 million for repairs and upgrades, and is estimated to last 80 years. It is estimated that 550,000 vehicles will use the bridge during the first year of operation, and an additional 50,000 vehicles per year until the 10th year. These data are based on a toll charge of \$90 per vehicle. The annual traffic for the remainder of the life of the bridge will be 1,000,000 vehicles per year. The government requires a minimum rate of return of 9% in order to proceed with the project.

- a. Does this project provide sufficient revenues to offset its costs?
- b. What other considerations are there besides economics in deciding whether or not to construct the bridge?

5-60 Telefono Mexico is expanding its facilities to serve a new manufacturing plant. The new plant will require 2000 telephone lines this year, and another 2000 lines after expansion in 10 years. The plant will be in operation for 30 years. The telephone company is evaluating two options to serve the demand.

- Option 1:** Provide one cable now with capacity to serve 4000 lines. The cable cost will be \$200,000, and will require \$15,000 in annual maintenance.
- Option 2:** Provide a cable with capacity to serve 2000 lines now, and a second cable to serve the other 2000 lines in 10 years. The cost of each cable will be \$150,000 and each cable will have an annual maintenance of \$10,000.

The telephone cables will last at least 30 years, and the cost to remove the cables are offset by the salvage value.

- a. Which alternative should be selected based on a 10% interest rate?
- b. Will your answer to part (a) change if the demand for additional lines is in 5 years instead of 10 years?

5-61 Dr. Fog E. Professor is retiring and wants to endow a chair of engineering economics at his university. It is expected that he will need to cover an annual cost of \$100,000 forever. What lump sum must he donate to the university today if the endowment will earn 10% interest?

5-62 Dick Dickerson Construction Inc. has asked to you help them select a new backhoe. You have a choice between a wheel-mounted version which costs \$50,000, has an expected life of 5 years and a salvage value of \$2000 and a track-mounted one which costs \$80,000, has a 5 year life, and an expected salvage value of \$10,000. Both machines will achieve the same productivity. Interest is 8%. Which one will you recommend? Use a Present Worth analysis.

5-63 A student has a job which leaves her with \$250 per month in disposable income. She decides that she will use the money to buy a car. Before looking for a car, she arranges a 100% loan whose terms are \$250 per month for 36 months at 18% annual interest. What is the maximum car purchase price that she can afford with her loan?

5-64 The student in problem 5-63 finds a car she likes and the dealer offers to arrange financing. His terms are 12% interest for 60 months and no down payment. The car's sticker price is \$12,000. Can she afford to purchase this car with her \$250 monthly disposable income?

5-65 The student in problem 5-64 really wants this particular car. She decides to try and negotiate a different interest rate. What is the highest interest rate that she can accept, given a 60 month term and \$250 per month payments?

5-66 Walt Wallace Construction Enterprises is investigating purchasing a new dump truck. Interest is 9%. They have found two models that they like. Their cash flows are shown below:

<i>Model</i>	<i>First Cost</i>	<i>Annual Operating Cost</i>	<i>Annual Income</i>	<i>Salvage Value</i>	<i>Life</i>
<i>A</i>	\$50,000	\$2000	\$9,000	\$10,000	10yrs
<i>B</i>	\$80,000	\$1000	\$12,000	\$30,000	10yrs

- a. Using Present Worth analysis, which truck should they buy and why?
- b. Before they can close the deal, the dealer sells out of Model B and cannot get anymore. What should they do now and why?

5-67 We know a car costs 60 monthly payments of \$199. The car dealer has set us a nominal interest rate of 4.5% compounded daily. What is the purchase price of the car?

5-68 A machine costs \$980,000 to purchase and will provide \$200,000 a year in benefits. The company plans to use the machine for 13 years and then will sell the machine for scrap, receiving \$20,000. The company interest rate is 12%. Should the machine be purchased?

5-69 Two different companies are offering a punch press for sale. Company A charges \$250,000 to deliver and install the device. Company A has estimated that the machine will have maintenance and operating costs of \$4000 a year and will provide an annual benefit of \$89,000. Company B charges \$205,000 to deliver and install the device. Company B has estimated that their press will have maintenance and operating costs of \$4300 a year and will provide an annual benefit of \$86,000. Both machines will last 5 years and can be sold for \$15,000 for the scrap metal. Use an interest rate of 12%. Which machine should your company purchase, based on the above data?

5-70 Austin General Hospital is evaluating new office equipment offered by three companies. The equipment have the following characteristics:

	<i>Company A</i>	<i>Company B</i>	<i>Company C</i>
First cost	\$15,000	\$25,000	\$20,000
Maintenance & operating costs	1,600	400	900
Annual benefit	8,000	13,000	11,000
Salvage value	3,000	6,000	4,500
Useful life, in years	4	4	4

MARR = 15 % Using NPW analysis, from which company should you purchase the equipment?

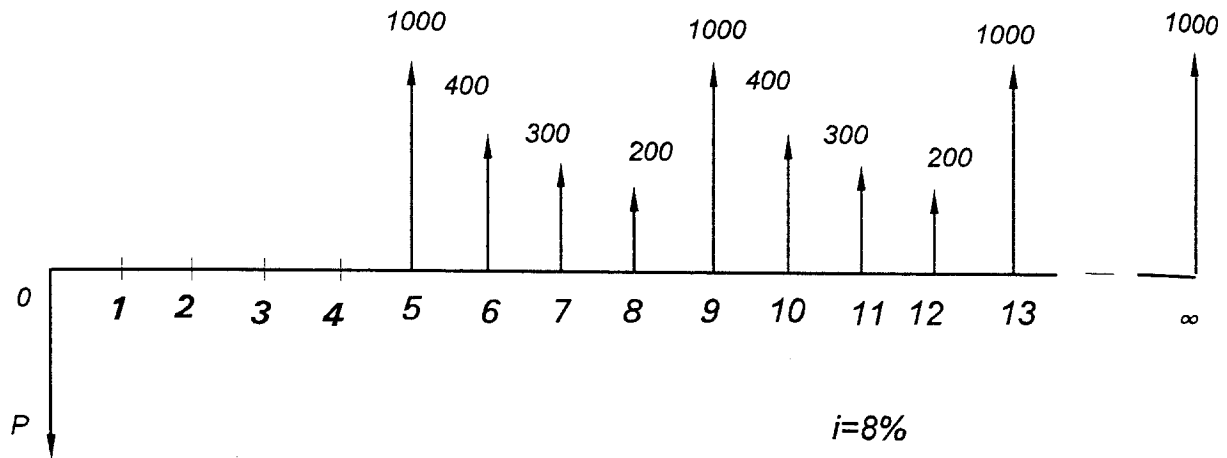
5-71 Calculate the present worth of a 4.5% \$5000 bond with interest paid semiannually. The bond matures in 10 years, and the investor desires to make 8% per year compounded quarterly on the investment.

5-72 The following costs are associated with three tomato-peeling machines being considered for use in a food canning plant.

	<i>Machine A</i>	<i>Machine B</i>	<i>Machine C</i>
First Cost	\$52,000	\$63,000	\$67,000
Maintenance & operating costs	15,000	9,000	12,000
Annual benefit	38,000	31,000	37,000
Salvage value	13,000	19,000	22,000
Useful life, in years	4	6	12

If the canning company uses a MARR of 12%, which is the best alternative? Use NPW to make your decision. Note: Consider the least common multiple as the study period.

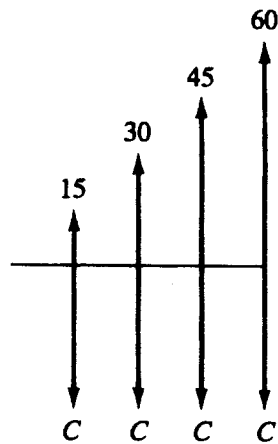
5-73 Find P for the cash flow diagram given below



Problems

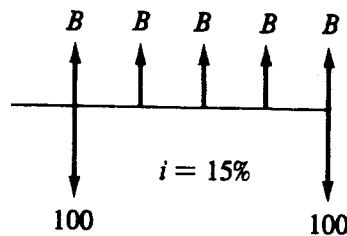
6-1 On April 1st, \$100 is loaned to a man. The loan is to be repaid in three equal semi-annual (every six months) payments. If the annual interest rate is 7% compounded semiannually, how much is each payment? (*Answer: \$35.69*)

6-2 Compute the value of C for the following diagram, based on a 10% interest rate.

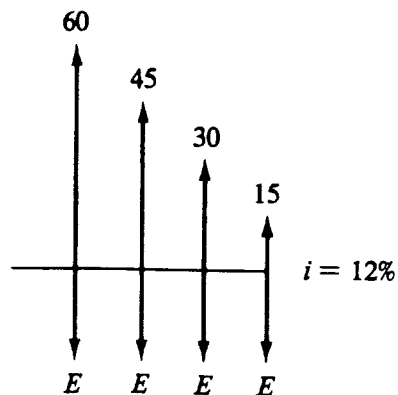


(*Answer: $C = \$35.72$*)

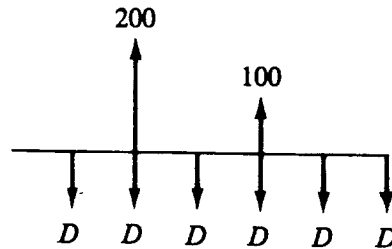
6-3 Compute the value of B for the following diagram:



6-4 Compute the value of E :

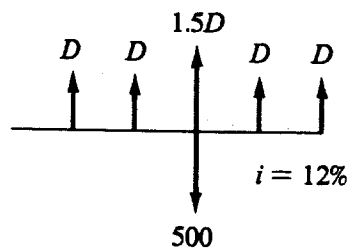


6-5 If $i = 6\%$, compute the value of D that is equivalent to the two disbursements shown.

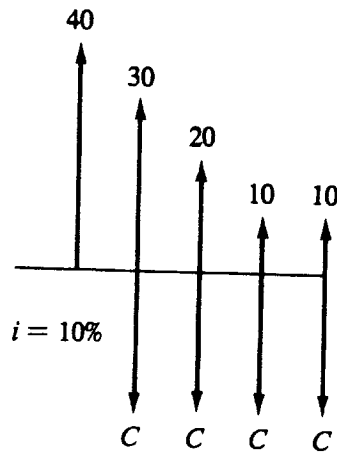


(Answer: $D = \$52.31$)

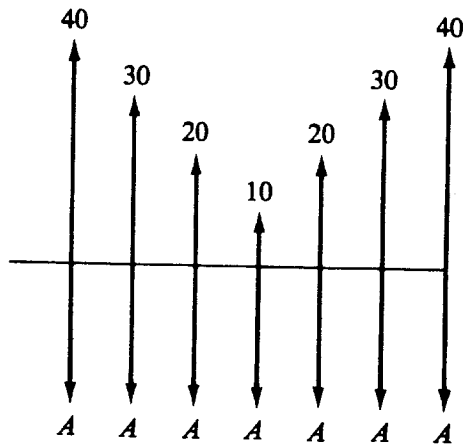
6-6 For the diagram, compute the value of D :



6-7 What is C in the figure below?



6-8 If interest is 10%, what is A ?



6-9 A certain industrial firm desires an economic analysis to determine which of two different machines should be purchased. Each machine is capable of performing the same task in a given amount of time. Assume the minimum attractive return is 8%. The following data are to be used in this analysis:

	<i>Machine X</i>	<i>Machine Y</i>
First cost	\$5000	\$8000
Estimated life, in years	5	12
Salvage value	0	\$2000
Annual maintenance cost	0	150

Which machine would you choose? Base your answer on annual cost.
(Answers: $X = \$1252$; $Y = \$1106$)

6-10 An electronics firm invested \$60,000 in a precision inspection device. It cost \$4000 to operate and maintain in the first year, and \$3000 in each of the subsequent years. At the end of four years, the firm changed their inspection procedure, eliminating the need for the device. The purchasing agent was very fortunate in being able to sell the inspection device for the \$60,000 that had originally been paid for it. The plant manager asks you to compute the equivalent uniform annual cost of the device during the four years it was used. Assume interest at 10% per year.
(Answer: \$9287)

6-11 A firm is about to begin pilot plant operation on a process it has developed. One item of optional equipment that could be obtained is a heat exchanger unit. The company finds that one can be obtained now for \$30,000, and that this unit can be used in other company operations. It is estimated that the heat exchanger unit will be worth \$35,000 at the end of eight years. This seemingly high salvage value is due primarily to the fact that the \$30,000 purchase price is really

a rare bargain. If the firm believes 15% is an appropriate rate of return, what annual benefit is needed to justify the purchase of the heat exchanger unit? (Answer: \$4135)

6-12 The maintenance foreman of a plant in reviewing his records found that a large press had the following maintenance cost record for the last five years:

5 years ago:	\$ 600
4 years ago:	700
3 years ago:	800
2 years ago:	900
Last year:	1000

After consulting with a lubrication specialist, he changed the preventive maintenance schedule. He believes that this year maintenance will be \$900 and will decrease \$100 a year in each of the following four years. If his estimate of the future is correct, what will be the equivalent uniform annual maintenance cost for the ten-year period? Assume interest at 8%. (Answer: \$756)

6-13 A firm purchased some equipment at a very favorable price of \$30,000. The equipment resulted in an annual net saving of \$1000 per year during the eight years it was used. At the end of eight years, the equipment was sold for \$40,000. Assuming interest at 8%, did the equipment purchase prove to be desirable?

6-14 A manufacturer is considering replacing a production machine tool. The new machine would cost \$3700, have a life of four years, have no salvage value, and save the firm \$500 per year in direct labor costs and \$200 per year indirect labor costs. The existing machine tool was purchased four years ago at a cost of \$4000. It will last four more years and have no salvage value at the end of that time. It could be sold now for \$1000 cash. Assume money is worth 8%, and that the difference in taxes, insurance, and so forth, for the two alternatives is negligible. Determine whether or not the new machine should be purchased.

6-15 Two possible routes for a power line are under study. Data on the routes are as follows:

	<i>Around the lake</i>	<i>Under the lake</i>
Length	15 km	5 km
First cost	\$5000/km	\$25,000/km
Maintenance	\$200/km/yr	\$400/km/yr
Useful life, in years	15	15
Salvage value	\$3000/km	\$5000/km
Yearly power loss	\$500/km	\$500/km
Annual property taxes	2% of first cost	2% of first cost

If 7% interest is used, should the power line be routed around the lake or under the lake?
(Answer: Around the lake.)

6-16 Steve Lowe must pay his property taxes in two equal installments on December 1 and April 1. The two payments are for taxes for the fiscal year that begins on July 1 and ends the following

June 30. Steve purchased a home on September 1. He estimates the annual property taxes will be \$850 per year. Assuming the annual property taxes remain at \$850 per year for the next several years, Steve plans to open a savings account and to make uniform monthly deposits the first of each month. The account is to be used to pay the taxes when they are due.

To begin the account, Steve deposits a lump sum equivalent to the monthly-payments-that-will-not-have-been-made for the first year's taxes. The savings account pays 9% interest, compounded monthly and payable quarterly (March 31, June 30, September 30, and December 31). How much money should Steve put into the account when he opens it on September 1? What uniform monthly deposit should he make from that time on? (A careful *exact* solution is expected.)
(Answers: Initial deposit \$350.28; Monthly deposit \$69.02)

6-17 An oil refinery finds that it is now necessary to process its waste liquids in a costly treating process before discharging them into a nearby stream. The engineering department estimates that the waste liquid processing will cost \$30,000 at the end of the first year. By making process and plant alterations, it is estimated that the waste treatment cost will decline \$3000 each year. As an alternate, a specialized firm, Hydro-Clean, has offered a contract to process the waste liquids for the ten years for a fixed price of \$15,000 per year, payable at the end of each year. Either way, there should be no need for waste treatment after ten years. If the refinery manager considers 8% a suitable interest rate, should he accept the Hydro-Clean offer or not?

6-18 Bill Anderson buys an automobile every two years as follows: initially he pays a downpayment of \$6000 on a \$15,000 car. The balance is paid in 24 equal monthly payments with annual interest at 12%. When he has made the last payment on the loan, he trades in the two-year old car for \$6000 on a new \$15,000 car, and the cycle begins over again.

Doug Jones decided on a different purchase plan. He thought he would be better off if he paid \$15,000 cash for a new car. Then he would make a monthly deposit in a savings account so that, at the end of two years, he would have \$9000 in the account. The \$9000 plus the \$6000 trade-in value of the car will allow Doug to replace his two-year-old car by paying \$9000 for a new one. The bank pays 6% interest, compounded quarterly.

- a. What is Bill Anderson's monthly payment to pay off the loan on the car?
- b. After he purchased the new car for cash, how much per month should Doug Jones deposit in his savings account to have sufficient money for the next car two years hence?
- c. Why is Doug's monthly savings account deposit smaller than Bill's payment?

6-19 Claude James, a salesman, needs a new car for use in his business. He expects to be promoted to a supervisory job at the end of three years, and so his concern now is to have a car for the three years he expects to be "on the road." The company will reimburse their salesmen each month at the rate of 25¢ per mile driven. Claude has decided to drive a low-priced automobile. He finds, however, that there are three different ways of obtaining the automobile:

- a. Purchase for cash; the price is \$13,000.
- b. Lease the car; the monthly charge is \$350 on a 36-month lease, payable at the end of

each month; at the end of the three-year period, the car is returned to the leasing company.

- c. Lease the car with an option to purchase it at the end of the lease; pay \$360 a month for 36 months; at the end of that time, Claude could purchase the car, if he chooses, for \$3500.

Claude believes he should use a 12% interest rate in determining which alternative to select. If the car could be sold for \$4000 at the end of three years, which method should he use to obtain it?

6-20 A college student has been looking for a new tire for his car and has located the following alternatives:

<i>Tire warranty</i>	<i>Price per tire</i>
12 mo.	\$39.95
24 mo.	59.95
36 mo.	69.95
48 mo.	90.00

If the student feels that the warranty period is a good estimate of the tire life and that a 10% interest rate is appropriate, which tire should he buy?

6-21 A suburban taxi company is considering buying taxis with diesel engines instead of gasoline engines. The cars average 50,000 kilometers a year, with a useful life of three years for the taxi with the gas engine, and four years for the diesel taxi. Other comparative information is as follows:

	<i>Diesel</i>	<i>Gasoline</i>
Vehicle cost	\$13,000	\$12,000
Fuel cost per liter	48¢	51¢
Mileage, in km/liter	35	28
Annual repairs	300	200
Annual insurance premium	500	500
End-of-useful-life resale value	2,000	3,000

Determine the more economical choice if interest is 6%.

6-22 When he started work on his 22nd birthday, D. B. Cooper decided to invest money each month with the objective of becoming a millionaire by the time he reaches his 65th birthday. If he expects his investments to yield 18% per annum, compounded monthly, how much should he invest each month? (*Answer:* \$6.92 a month.)

6-23 Linda O'Shay deposited \$30,000 in a savings account as a perpetual trust. She believes the account will earn 7% annual interest during the first ten years and 5% interest thereafter. The trust is to provide a uniform end-of-year scholarship at the University. What uniform amount could be used for the student scholarship each year, beginning at the end of the first year and continuing forever?

6-24 A motorcycle is for sale for \$2600. The motorcycle dealer is willing to sell it on the following terms:

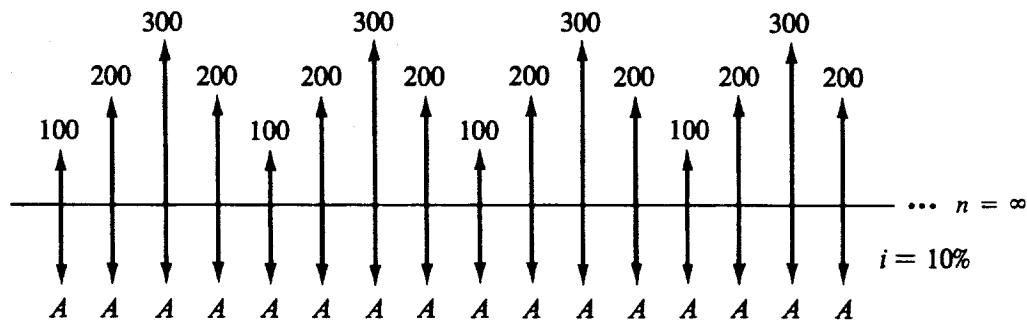
No downpayment; pay \$44 at the end of each of the first four months; pay \$84 at the end of each month after that, until the motorcycle is paid in full.

Based on these terms and a 12% annual interest rate compounded monthly, how many \$84 payments will be required?

6-25 A machine costs \$20,000 and has a five-year useful life. At the end of the five years, it can be sold for \$4000. If annual interest is 8%, compounded semi-annually, what is the equivalent uniform annual cost of the machine? (An *exact* solution is expected.)

6-26 The average age of engineering students when they graduate is a little over 23 years. This means the working career of most engineers is almost exactly 500 months. How much would an engineer need to save each month to become a millionaire by the end of his working career? Assume a 15% interest rate, compounded monthly.

6-27 As shown in the cash flow diagram, there is an annual disbursement of money that varies from year to year from \$100 to \$300 in a fixed pattern that repeats forever. If interest is 10%, compute the value of A , also continuing forever, that is equivalent to the fluctuating disbursements.



6-28 Alice White has arranged to buy some home recording equipment. She estimates that it will have a five-year useful life and no salvage value. The dealer, who is a friend, has offered Alice two alternative ways to pay for the equipment:

- Pay \$2000 immediately and \$500 at the end of one year.
- Pay nothing until the end of four years when a single payment of \$3000 must be made.

If Alice believes 12% is a suitable interest rate, which method of payment should she select? (Answer: Select *b*)

6-29 A company must decide whether to buy Machine *A* or Machine *B*:

	<i>Machine A</i>	<i>Machine B</i>
Initial cost	\$10,000	\$20,000
Useful life, in years	4	10
End-of-useful-life salvage value	\$10,000	\$10,000
Annual maintenance	1,000	0

At a 10% interest rate, which machine should be installed? (*Answer: Machine A*)

6-30 The Johnson Company pays \$200 a month to a trucker to haul wastepaper and cardboard to the city dump. The material could be recycled if the company would buy a \$6000 hydraulic press bailer and spend \$3000 a year for labor to operate the bailer. The bailer has an estimated useful life of thirty years and no salvage value. Strapping material would cost \$200 per year for the estimated 500 bales a year that would be produced. A wastepaper company will pick up the bales at the plant and pay the Johnson Co. \$2.30 per bale for them.

- a. If interest is 8%, is it economical to install and operate the bailer?
- b. Would you recommend that the bailer be installed?

6-31 Consider the following:

	<i>Alternative</i>	
	<i>A</i>	<i>B</i>
Cost	\$50	\$180
Uniform annual benefit	15	60
Useful life, in years	10	5

The analysis period is ten years, but there will be no replacement for Alternative *B* at the end of five years. Based on a 15% interest rate, determine which alternative should be selected.

6-32 Consider the following two mutually exclusive alternatives:

	Alternative	
	A	B
Cost	\$100	\$150
Uniform annual benefit	16	24
Useful life, in years	∞	20

Alternative B may be replaced with an identical item every twenty years at the same \$150 cost and will have the same \$24 uniform annual benefit. Using a 10% interest rate, determine which alternative should be selected.

6-33 Some equipment will be installed in a warehouse that a firm has leased for seven years. There are two alternatives:

	Alternative	
	A	B
Cost	\$100	\$150
Uniform annual benefit	55	61
Useful life, in years	3	4

At any time after the equipment is installed, it has no salvage value. Assume that Alternatives A and B will be replaced at the end of their useful lives by identical equipment with the same costs and benefits. For a seven-year analysis period and a 10% interest rate, determine which alternative should be selected.

6-34 When he purchased his home, Al Silva borrowed \$80,000 at 10% interest to be repaid in 25 equal annual end-of-year payments. Ten years later, after making ten payments, Al found he could refinance the balance due on his loan at 9% interest for the remaining 15 years.

To refinance the loan, Al must pay the original lender the balance due on the loan, plus a penalty charge of 2% of the balance due; to the new lender he also must pay a \$1000 service charge to obtain the loan. The new loan would be made equal to the balance due on the old loan, plus the 2% penalty charge, and the \$1000 service charge. Should Al refinance the loan, assuming that he will keep the house for the next 15 years?

6-35 Consider the following three mutually exclusive alternatives:

	A	B	C
Cost	\$100	\$150.00	\$200.00
Uniform annual benefit	10	17.62	55.48
Useful life, in years	∞	20	5

Assuming that Alternatives B and C are replaced with identical replacements at the end of their useful lives, and an 8% interest rate, which alternative should be selected? (Answer: Select C)

6-36 When Sandra began working, she resolved to save \$ 1000 a year from her income. After working a couple of months, she realized that it is easier to set a goal than to follow it. Her overall goal is to have saved a "reasonable sum of money" after ten years of work; she decides she can accomplish the same goal in a less painful way by changing her savings pattern: instead of saving \$ 1000 a year in a bank account that pays 6% annual interest, she will save an annual sum based on the geometric gradient. She believes her salary will increase 7% each year. Thus, she can save a fixed percentage of her salary each year, and still achieve her goal of saving \$ 1000/year, by making a smaller deposit at the end of the first year and increasing the amount of the deposit each year by the same 7% rate her salary increases.

- a. What amount does she want to have in the bank at the end of ten years?
- b. Following her revised savings plan, how much should she deposit in her savings account at the end of the first year?

6-37 An engineer has a fluctuating future budget for the maintenance of a particular machine. During each of the first five years, \$1000 per year will be budgeted. During the second five years, the annual budget will be \$1500 per year. In addition, \$3500 will be budgeted for an overhaul of the machine at the end of the fourth year, and another \$3500 for an overhaul at the end of the eighth year.

The engineer asks you to compute what uniform annual expenditure would be equivalent to these fluctuating amounts, assuming interest at 6% per year.

6-38 An engineer wishes to have five million dollars by the time he retires in 40 years. Assuming 15% nominal interest, compounded continuously, what annual sum must he set aside? (*Answer:* \$2011)

6-39 Two mutually exclusive alternatives are being considered.

Year	A	B
0	-\$3000	-\$5000
1	+845	+1400
2	+845	+1400
3	+845	+1400
4	+845	+1400
5	+845	+1400

One of the alternatives must be selected. Using a 15% nominal interest rate, compounded continuously, determine which one. Solve by annual cash flow analysis.

6-40 A company must decide whether to provide their salesmen with company-owned automobiles, or to pay the salesmen a mileage allowance and have them drive their own automobiles. New automobiles would cost about \$18,000 each and could be resold four years later for about \$7000 each. Annual operating costs would be \$600 per year plus 12¢ per mile. If the salesmen drive their own automobiles, the company probably would pay them 30¢ per mile. Calculate the number of miles each salesman would have to drive each year for it to be economically practical for the company to provide the automobiles. Assume a 10% annual interest rate.

6-41 A pump is required for ten years at a remote location. The pump can be driven by an electric motor if a powerline is extended to the site. Otherwise, a gasoline engine will be used. Based on the following data and a 10% interest rate, how should the pump be powered?

	<i>Gasoline</i>	<i>Electric</i>
First cost	\$2400	\$6000
Annual operating cost	1200	750
Annual maintenance	300	50
Salvage value	300	600
Life in years	5 yrs	10 yrs

6-42 The town of Dry Gulch needs an additional supply of water from Pine Creek. The town engineer has selected two plans for comparison. *Gravity plan*: Divert water at a point ten miles up Pine Creek and carry it through a pipeline by gravity to the town. *Pumping plan*: Divert water at a point closer to the town and pump it to the town. The pumping plant would be built in two stages, with one-half capacity installed initially and the other half installed ten years later.

An analysis will assume a 40-year life, 10% interest and no salvage value. Costs are as follows:

	<i>Gravity</i>	<i>Pumping</i>
Initial investment	\$2,800,000	\$1,400,000
Additional investment in 10th year	None	200,000
Operation and maintenance Power cost	10,000/year	25,000/year
Average first 10 years	None	50,000/year
Average next 30 years	None	100,000/year

Determine the more economical plan.

6-43 Uncle Elmo needs to replace the family privy. The local sanitary engineering firm has submitted two alternative structural proposals with respective cost estimates as shown below. Which construction should Uncle Elmo choose if his minimum attractive rate of return is 6%. Use both a Present Worth and Annual Cost approach to compare.

	<i>Masonite</i>	<i>Brick</i>
First Cost	\$250	\$1000
Annual Maintenance	20	10
Service Life	4 yr	20 yr
Salvage Value	\$10	\$100

6-44 Art Arfons, a K-State educated engineer, has made a considerable fortune. He wishes to start a perpetual scholarship for engineering students at K-State. The scholarship will provide a student with

an annual stipend of \$2500 for each of four years (freshmen through senior), plus an additional \$5000 during the senior year to cover entertainment expenses. Assume that students graduate in four years, a new award is given every four years, and the money is provided at the beginning of each year with the first award at the beginning of year one. The interest rate is 8%.

- a. Determine the equivalent uniform annual cost (EUAC) of providing the scholarship.
- b. How much money must Art donate to K-State?

6-45 Jenny McCarthy is an engineer for a municipal power plant. The plant uses natural gas which is currently provided from an existing pipeline at an annual cost of \$10,000 per year. Jenny is considering a project to construct a new pipeline. The initial cost of the new pipeline would be \$35,000 but it would reduce the annual cost to \$5000 per year. Assume an analysis period of 20 years and no salvage value for either the existing or new pipeline. The interest rate is 6%.

- a. Determine the equivalent uniform annual cost (EUAC) for the new pipeline?
- b. Should the new pipeline be constructed?

6-46 Your company must make a \$500,000 balloon payment on a lease 2 years and 9 months from today. You have been directed to deposit an amount of money quarterly, beginning today to provide for the \$500,000 payments. The account pays 4% per year, compounded quarterly. What is the required quarterly deposit? Note: Lease payments are beginning of the quarter.

6-47 A machine has a first cost of \$150,000, an annual Operation and Maintenance cost of \$2500, a life of 10 years, and a salvage value of \$30,000. At the end of years 4 and 8, it requires a major service which costs \$20,000 and \$10,000 respectively. At the end of year 5, it will need to be overhauled at a cost of \$45,000. What is the Equivalent Uniform Annual Cost of owning and operating this particular machine?

6-48 Mr. Wiggley wants to buy a new house. It will cost \$178,000. The bank will loan us 90% of the purchase price at a nominal interest rate of 10.75% compounded weekly and we will make monthly payments. What is the amount of the monthly payments if Mr. Wiggley intends to pay the house off in 25 years?

6-49 The manager in a canned food processing plant is trying to decide between two labeling machines. Their respective costs and benefits are as follows:

	<i>Machine A</i>	<i>Machine B</i>
First cost	\$15,000	\$25,000
Maintenance and operating costs	1,600	400
Annual benefit	8,000	13,000
Salvage value	3,000	6,000
Useful life, in years	7	10

Assume an interest rate of 12%. Use annual cash flow analysis to determine which machine should be selected.

6-50 Carp, Inc. wants to evaluate two methods of shipping their products. The following cash flows are associated with the alternatives:

	<i>Alternative</i>	
	<i>A</i>	<i>B</i>
First cost	\$700,000	\$1,700,000
Maintenance & operating costs	18,000	29,000
+ Cost gradient (begin yr-1)	+900/yr	+750/yr
Annual benefit	154,000	303,000
Salvage value	142,000	210,000
Useful life, in years	10	20

Using a MARR of 15% and annual cash flow analysis, decide which is the most desirable alternative.

- ☐ **6-51** A new car is purchased for \$12,000 with a 0% down, 9% loan. The loan's length is 4 years. After making 30 payments the owner desires to pay off the loan's remaining balance. How much is owed?
- ☐ **6-52** A year after buying her car, Anita has been offered a job in Europe. Her car loan is for \$15,000 at a 9% nominal interest rate for 60 months. If she can sell the car for \$12,000, how much does she get to keep after paying off the loan?
- ☐ **6-53** A \$78,000 mortgage has a 30 year term and a 9% nominal interest rate.
- What is the monthly payment?
 - After the first year of payments, what is the outstanding balance?
 - How much interest is paid in month 13? How much principal?
- ☐ **6-54** A \$92,000 mortgage has a 30 year term and a 9% nominal interest rate.
- What is the monthly payment?
 - After the first year of payments, what fraction of the loan has been repaid?
 - After the first ten years of payments, what is the outstanding balance?
 - How much interest is paid in month 25? How much principal?

- **6-55** A 30 year mortgage for \$95,000 is issued at a 9% nominal interest rate.
- What is the monthly payment?
 - How long does it take to pay off the mortgage, if \$1000 per month is paid?
 - How long does it take to pay off the mortgage, if double payments are made?
- **6-56** A 30 year mortgage for \$145,000 is issued at a 6% nominal interest rate.
- What is the monthly payment?
 - How long does it take to pay off the mortgage, if \$1000 per month is paid?
 - How long does it take to pay off the mortgage, if 20% extra is paid each month?
- **6-57** Solve Problem 6-15 for the breakeven first cost/km of going under the lake.
- **6-58** Redo Problem 6-21 to calculate the EUAW of the alternatives as a function of miles driven per year to see if there is a crossover point in the decision process. Graph your results.
- **6-59** Set up Problem 6-30 on a spreadsheet to make all the input data variable and determine various scenarios which would make the bailer economical.
- **6-60** Develop a spreadsheet to solve Problem 6-42. What is the breakeven cost of the additional pumping investment in the 10th year?