

A *random experiment* is the occurrence of something that has an uncertain result. For example, this is the set of all possible results, or *outcomes* of the random experiment of tossing a die:

$$\{1, 2, 3, 4, 5, 6\}$$

This list of all possible outcomes is the *sample space* of the experiment. An *event* is a subset of a sample space. For example, “rolling an even number” is $\{2, 4, 6\}$ since 2, 4, and 6 are the only outcomes that are even.

List the outcomes of the described events. The sample space is the set of six possible outcomes of rolling a die.

Example Rolling a prime number

Solution $\{2, 3, 5\}$

- | | |
|---------------------------------|--|
| 1. Rolling an odd number | 2. Rolling a perfect square |
| 3. Rolling a number less than 5 | 4. Rolling a number greater than π |

The *probability* of an event is the ratio

$$P = \frac{\text{number of outcomes in the event}}{\text{number of outcomes in the sample space}}$$

Find the probability of obtaining the given outcome on the roll of a die. The sample space is the set of all possible rolls.

Example Rolling a perfect square

Solution

$$\begin{aligned}
 P &= \frac{m}{n} && \frac{\text{number of outcomes in the event}}{\text{number of outcomes in the sample space}} \\
 &= \frac{2}{6} && \frac{2 \text{ perfect squares, 1 and 4}}{6 \text{ die faces}} \\
 &= 0.33333 \dots, && \text{or about } 0.33
 \end{aligned}$$

- | | |
|---------------------------------|----------------------------|
| 5. Rolling an odd number | 6. Rolling an even number |
| 7. Rolling a number less than 5 | 8. Rolling a multiple of 3 |

The following are useful properties of probability.

The probability of an impossible event is 0.

The probability of a certain event is 1.

The probability of any event is a number between 0 and 1, inclusive.

Tell whether the probability of the event is 0, 1, or a number between 0 and 1.

- | | |
|------------------------------|-----------------------------------|
| 9. Rolling a 7 on a die toss | 10. Winning money in a lottery |
| 11. Living to the age of 98 | 12. Tossing a coin heads or tails |

Planning

FOR TEENAGERS THE FUTURE IS NOW. They often consider it a waste of time to think about matters such as life insurance or retirement planning that have nothing to do with today. Indeed, it is true that a young person without family responsibilities rarely needs life insurance. It is also understandable that for someone with more immediate financial concerns, such as how to pay the rent, retirement is something to worry about later—much later. However, this attitude is probably a mistake. Young people should prepare themselves at an early age for the time down the road when such matters will be very important.

A young person who does devote some time to learning about life insurance and retirement faces some difficult decisions. For example, a young person's life insurance premium is much lower than the premium for someone who is much older, but is that enough of a reason to buy the insurance? Some families have purchased cash-value life insurance so that they can borrow on the

policy when it comes time to pay for college. Is that the best way to accomplish this goal?

The earlier retirement is planned for, the more secure and comfortable the retirement years are likely to be. Unfortunately, people from earlier generations have not always learned this lesson. Many older citizens have found themselves trying to get by on fixed-income pensions that do not adequately cover expenses. As a result, they sometimes have had to rely on their grown children for support at a time when those children need to conserve their financial resources to raise and educate their own children.

If the teenagers in this chapter take a closer look at the financial decisions that their parents are making, they may become a bit more understanding when those parents have to turn down a request that would strain the family budget. Who knows? The teenagers might even learn some pointers from the chapter that they can pass on to their parents to assist them in their retirement planning.

7-1 Life Insurance: Who Needs It?

7-2 Spreading the Risk: How Insurance Works

7-3 Value for the Future



Lily never used to care about life insurance. As a topic of conversation she ranked it just below her grandmother's cataract surgery and slightly above her cousin's discussion of his recent vacation illustrated with 243 slides. Her mother tried once to discuss the subject of insurance with her, but Lily didn't really pay close attention.

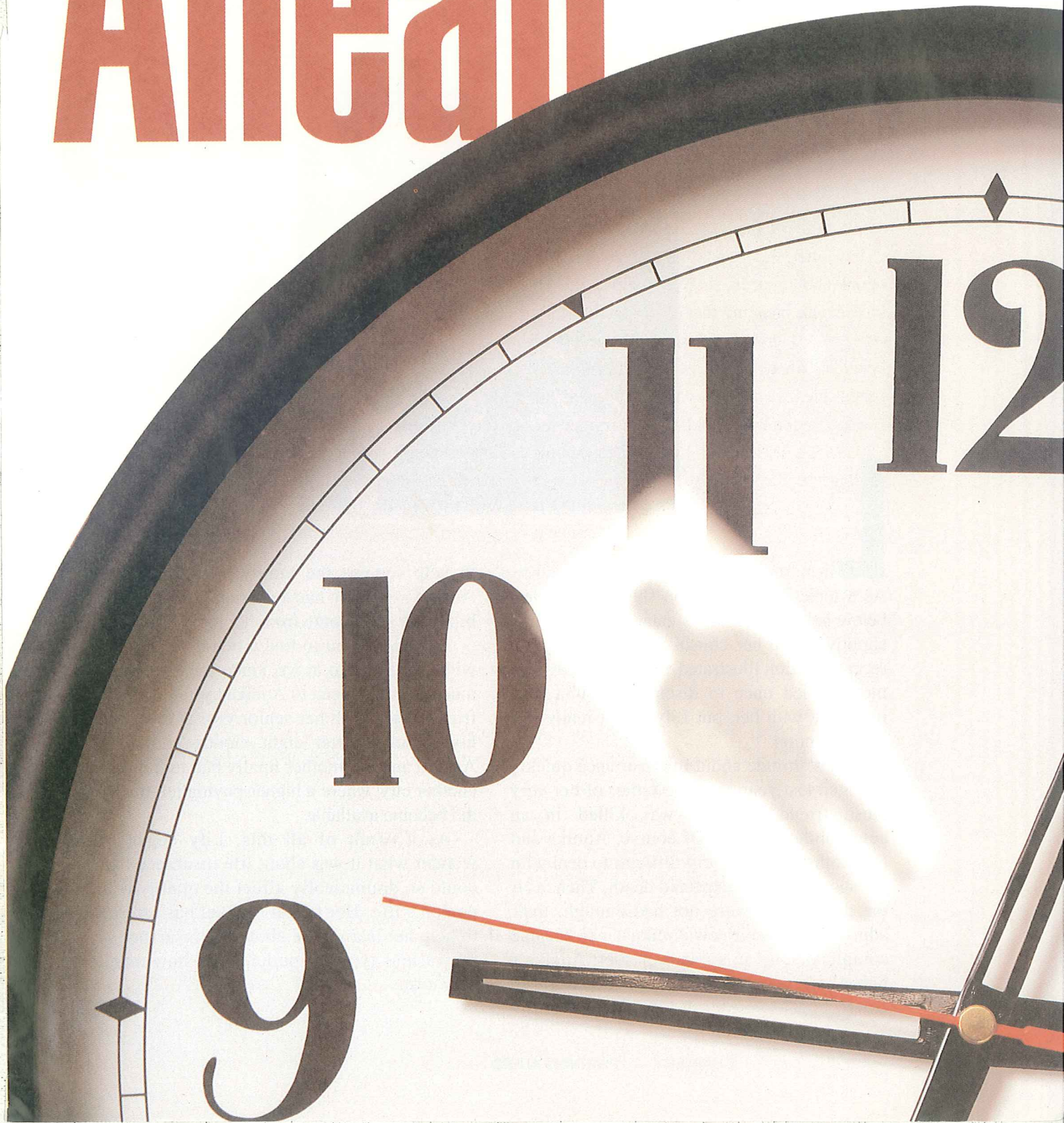
Lily's attitude about life insurance quickly changed last year after the father of her very close friend, Annika, was killed in an automobile accident. Of course, Annika and her mother found it very difficult to deal with the shock of the unexpected death. Then, as if the death itself were not bad enough, their adjustment to their new circumstance became complicated by an unpleasant fact: Annika's father had not purchased enough life insurance

to help support the family after his death. Annika's mother had to struggle to pay the bills with the income from her job.

She had hoped to find a better-paying job without having to move, since she knew how much it would mean to Annika to stay with her friends and finish her senior year at the same high school. After eight months, however, Annika and her mother finally had to move to another city, where a higher-paying job finally did become available.

As a result of all this, Lily began to wonder what it was about life insurance that could so dramatically affect the quality of a person's life. Her friend Manuel has offered to help her learn more about life insurance—the various types of policies and how much they cost.

Ahead



OBJECTIVES: In this lesson, we will help Lily and Manuel to:

- Understand what life insurance is.
- Decide who needs life insurance.
- Determine how much life insurance a family should buy.
- Examine the kinds of life insurance that are available.
- Calculate the cost of various amounts of life insurance.

LIFE INSURANCE

Life insurance is a contract to pay a specified amount of money to a designated person upon the death of the policyowner. If Annika's father had purchased adequate life insurance, his wife would have received enough money to replace the income lost when he died.

How Does Insurance Work? All types of insurance are based on two ideas: risk sharing and statistical probability. Every person faces the possibility of financial disaster caused by an unpredictable event such as an accident, fire, flood, illness, or the death of the principal wage earner. These risks can be lessened if they are shared by a large group of people paying money into a central pool. Then those who have contributed to the pool have the right to call on that reserve when they suffer a loss. Insurance companies manage such pooled money, called **premiums**, that they have collected from their policyowners. In the event of the of the policyowner's death, the company disburses money from the pool to the **beneficiaries**, those people named in the policy as recipients of the benefits.

Who Needs Life Insurance? When a family has only one provider, it is placing its financial security in the hands of that person. If that person should die, then the family may face serious economic difficulty. Although Annika's father was not the sole provider (her mother also worked), his family did depend upon his income. He should have bought a life insurance policy that was large enough to replace all or most of the income that his **dependents** (his wife and children) needed to survive after he died.

In today's families, women are increasingly responsible for providing all or part of the family income. For that reason, women as well as men must decide how much life insurance they need. If a wife and mother were to die, her husband and children might have to not only replace her income but also pay someone to provide child care and housework.



Remember that life insurance is purchased to protect the dependent members of a family. Therefore it is usually a mistake to buy life insurance to cover the life of anyone other than the principal breadwinners. In particular, the money that might be spent on a child's life insurance policy can probably be put to better use, even though the child's premiums are very low. If you are a high school or college student and have no dependents, you probably do not need life insurance.

How Much Insurance Is Needed? An insurance company will generally sell any amount of insurance that a person wants to buy. However, there are some general guidelines that may be helpful in determining how much life insurance a family should purchase.

An ideal goal is to have the insurance provide enough income for the family to continue its current standard of living. According to one major financial services company, this can usually be done without maintaining 100% of current gross pay. Instead, you should attempt to replace your family's usual *net income*, that is, the amount that remains after income and FICA taxes have been deducted. You can probably accomplish this goal by purchasing insurance that provides 75% of the previous gross income. If the premiums for doing this are too high for the family budget, you should at least aim at a replacement income of 60% of the current gross income to avoid a serious lowering of your family's standard of living.

LIFE INSURANCE: TWO TYPES

Manuel's older brother, Martin, is married to Rachel, his childhood sweetheart. The couple has a young child. Manuel's research will be useful to Martin and Rachel as they decide what kind of insurance they need. Manuel has learned that they can choose from two basic types of insurance. The first type, **term insurance**, offers pure protection. The second, called **cash-value insurance**, offers less protection for the same money. However, it also builds up a cash value that the policyowner can draw on in later years.

Term Insurance If Martin and Rachel choose term insurance, they will be protected for a fixed period of time, or *term*. The term is usually five or ten years. If the insured person dies during the term, the beneficiary will receive the **face value of the policy**. If Annika's father had had \$100,000 worth of term insurance, the beneficiary, her mother, would have received \$100,000 on his death. If the insured person does not die during the term, the policy either expires or is renewed for another term. Term insurance generally has the lowest premiums of any insurance available until approximately the age of 50. Because the amount of coverage can be increased or decreased at the end of each term, term insurance is a very flexible option. Manuel discovered three common types of term insurance.

Group life insurance, which people can buy through their place of employment, provides term insurance for a large number of people under a single policy without the need for a medical examination.

A policy of the second type, **renewable convertible term insurance** covers a person for a period of time such as one, five, or ten years and can be renewed without a medical examination. In addition to being renewable, renewable convertible term insurance is convertible into a different form of insurance.

The third alternative is **decreasing term insurance**. Under this option the amount of benefits that an insurance company will award the beneficiaries decreases over time as the children grow up and cease being dependents. After this happens, the parents no longer need as much insurance as they did in earlier years. The appeal of decreasing term insurance is that the premiums are lower than those for renewable term insurance. Often decreasing term insurance is used to provide cash to pay off a mortgage. Policies have been designed so that the face value declines exactly with a person's outstanding mortgage balance.

Cash-Value Insurance If Martin and Rachel choose cash-value insurance, they will be buying protection plus savings. As they pay the premiums, the policy will build up cash value much like a savings account.

Manuel learned about three traditional types of cash-value insurance. The first is **whole life insurance**, also called *straight life* or *ordinary life*. With this kind of insurance policy, you pay premiums for your entire life that are more than enough for the insurance coverage you need. The remaining part of your premium is invested for you by the insurance company, building up the cash value of the policy. You always have the option of cashing in the policy, that is, taking out the money and the interest it has earned. In addition, since the policy has a cash value, you can borrow part of the cash value. If you should die with an outstanding loan, the amount of benefit due to your beneficiaries is reduced. However, the rate of return tends to be low in comparison to the return that you would get investing on your own.

Limited payment life insurance has a fixed number of premium payments that stop after a certain number of years; for example, 20 years. The purchaser pays higher premiums, but the policy is paid up to its cash value in fewer years than is the case for whole life insurance.

If the couple wants a policy in which the cash value buildup is accomplished especially quickly, they might choose an **endowment policy**. An endowment policy, like other cash value insurance, is protection plus savings, but the emphasis is on the savings. Because of this rapid accumulation over a short period of time, the premiums on endowment policies are very high.

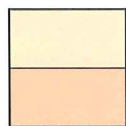
Universal life insurance is a relatively new type of cash value insurance. As with whole life insurance, it gives both protection and savings. Two basic types of universal life differ in the death benefit. In Type A the death benefit remains constant; in Type B the death benefit varies with the cash value so that as the cash value increases, the death benefit also increases. Usually, the insurer guarantees a minimum rate of interest throughout the duration of the policy. As with whole life, you can borrow or withdraw a part of the cash value.

The types of life insurance and their characteristics are summarized in the following chart.

LIFE INSURANCE	
Term Insurance	
Group life	Purchased through an employer; low rates
Renewable convertible term	One-, five-, or ten-year terms; renewable and convertible
Decreasing term	Like renewable convertible term but less expensive and with a gradually decreasing death benefit
Cash-Value Insurance	
Whole life	Combines savings with insurance; can be cashed in for its accumulated cash value
Limited payment	Higher premiums for a fixed number of years, such as 20; builds up cash value more quickly than whole life
Endowment	Emphasis on high cash buildup; very high premiums
Universal life	Combines savings with insurance; can be cashed in for its accumulated cash value

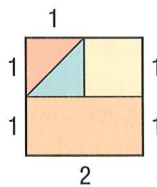
ALGEBRA REVIEW

A thrown dart may land anywhere on its target. So the probability of landing in the top half of the square is, $P = 0.5$.



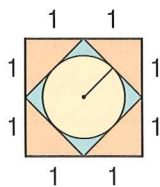
Determine the probability of a dart landing in each region.

1. Lower rectangle
2. Upper-right square
3. Upper-left triangle



Determine the probability of a dart landing in each region.

4. Inner circle
5. Inner diamond
6. Lower-left triangle



What Does it Cost? The cost of life insurance varies widely. The range between the most expensive and the least expensive can be as much as 100%. To find the best price for both term insurance and cash-value life insurance, you should shop around and compare the prices that different insurance companies offer.

How About Taxes? The proceeds paid to a beneficiary from some kinds of life insurance policies are generally free from federal income taxes but may be subject to other taxes, such as an estate tax. Tax laws change from time to time, so you should obtain up-to-date information from a tax adviser.

Ask Yourself

1. What is life insurance?
2. Which member(s) of a family should have life insurance?
3. How much life insurance should a family assume?
4. What are the two basic kinds of life insurance?
5. What is a beneficiary?
6. What advantage does decreasing term insurance have over regular term insurance?

SHARPEN YOUR SKILLS

SKILL 1

To determine how much insurance to buy to replace either 75% or 60% of gross income, you can use the following chart and formula. This chart is also in the Reference Section.

MULTIPLES-OF-SALARY CHART								
Current Age								
Current Gross Earnings	25 Years		35 Years		45 Years		55 Years	
	75%	60%	75%	60%	75%	60%	75%	60%
\$ 7,500	4.0	3.0	5.5	4.0	7.5	5.5	6.5	4.5
9,000	4.0	3.0	5.5	4.0	7.5	5.5	6.5	4.5
15,000	4.5	3.0	6.5	4.5	8.0	6.0	7.0	5.5
23,500	6.5	4.5	8.0	5.5	8.5	6.5	7.5	5.5
30,000	7.5	5.0	8.0	6.0	8.5	6.5	7.0	5.5
40,000	7.5	5.0	8.0	6.0	8.0	6.0	7.0	5.5
65,000	7.5	5.5	7.5	6.0	7.5	6.0	6.5	5.0

Replacement Life Insurance Formula

$$R = mS \quad \text{where } R = \text{required replacement insurance}$$
$$m = \text{multiple from the table}$$
$$S = \text{original gross salary or wage}$$

EXAMPLE 1 Annika's father was earning \$30,000 per year when he was 35 years old.

QUESTION How much insurance should he have bought to replace 75% of his regular gross income?

SOLUTION

Look at the Multiples-of-Salary Chart. Find the income level of \$30,000 in the left-hand column. Then read across to the column for 35 years and 75%. The number 8.0 appears in that space. Use the replacement life insurance formula.

$$R = mS \quad \text{The multiple of salary } m \text{ is } 8.0.$$
$$= 8 \cdot 30,000$$
$$= 240,000$$

Annika's father should have purchased \$240,000 worth of life insurance at age 35 to replace 75% of his gross income.

SKILL 2

The following table shows the comparative premium rates for two of the major types of insurance. This table is also in the Reference Section. *Note:* To use the table to find the cost of \$50,000 worth of life insurance, divide the \$100,000 premium by 2. To find the cost of \$200,000 worth, multiply by 2.

COMPARISON TABLE FOR TERM AND WHOLE LIFE PREMIUMS			
Policy face value is \$100,000			
Age	Five-Year Renewable Term	Whole Life	First-Year Difference
20	\$205	\$ 775	\$ 570
25	207	918	711
30	218	1112	894
35	254	1374	1120
40	363	1729	1366
45	562	2127	1565
50	878	2689	1811

EXAMPLE 2 Ramón is a 30-year-old father who is comparing the premiums for different types of life insurance.

- QUESTIONS**
1. How much would five-year term insurance for \$200,000 cost Ramón per year?
 2. How much would the same amount of whole life insurance cost him?
 3. In one year, how much would he save by buying term insurance instead of whole life?

SOLUTIONS

Use the Comparison Table for Term and Whole Life Premiums.

1. For age 30 the number in the “Five-Year Renewable Term” column is \$218. Ramón’s annual premium would be $2 \cdot 218$, or \$436.
2. For age 30, the number in the “Whole Life” column is \$1112. Ramón’s annual premium would be $2 \cdot 1112$, or \$2224.
3. The difference is $2224 - 436$, or \$1788. Ramón would save \$1788 by buying term insurance.

TRY YOUR SKILLS

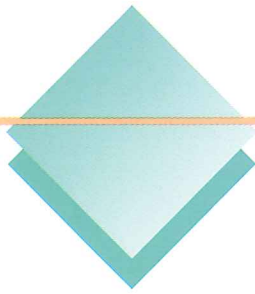
Use the Multiples-of-Salary Chart and the Replacement Life Insurance Formula in Skill 1 to find the amount of life insurance each of these income earners should buy under the conditions described.

	Current Earnings	Age	Income Replacement	Amount of Insurance
1.	\$65,000	35	75%	
2.	65,000	45	60%	
3.	40,000	55	75%	

Use the Comparison Table for Term and Whole Life Premiums in Skill 2 to find the yearly premium for the amounts of insurance listed below at the ages shown.

	Amount of Insurance	Age	Type	Premium
4.	\$100,000	25	Term	
5.	100,000	25	Whole life	
6.	200,000	35	Term	
7.	200,000	35	Whole life	
8.	300,000	45	Term	
9.	300,000	45	Whole life	



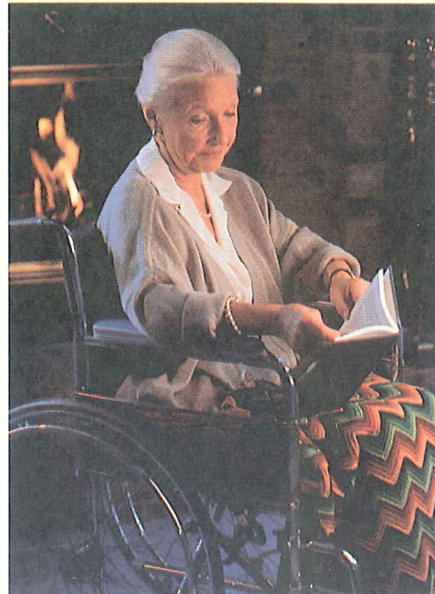


EXERCISE YOUR SKILLS

KEY TERMS

beneficiaries
 cash-value insurance
 decreasing term insurance
 dependents
 endowment policy
 face value of the policy
 group life insurance
 life insurance
 limited payment life insurance
 premiums
 renewable convertible term insurance
 term insurance
 universal life insurance
 whole life insurance

1. Why do people need life insurance?
2. When would it be a good idea for both a husband and a wife to have a life insurance policy?
3. If an aged grandmother were living with a family, would it be a good idea to insure that grandmother's life? Why or why not?



4. Why would "death insurance" be a more accurate term than "life insurance" to describe the kind of policy that has been discussed in this lesson?
5. Why is group life insurance cheaper than life insurance bought as an individual policy?
6. What is the advantage of limited payment life insurance?

Use the Multiples-of-Salary Chart to find the amount of life insurance each of these income earners should buy under the conditions described.

	Current Earnings	Age	Income Replacement	Amount of Insurance
7.	\$40,000	25	60%	
8.	30,000	35	75%	
9.	30,000	45	60%	
10.	23,500	55	75%	
11.	23,500	25	60%	
12.	15,000	35	75%	
13.	15,000	45	60%	

Use the Comparison Table for Term and Whole Life Insurance to find the yearly premium for the amounts of insurance listed below at the ages shown.

	Amount of Insurance	Age	Type	Premium
14.	\$ 50,000	30	Term	
15.	50,000	30	Whole life	
16.	150,000	40	Term	
17.	150,000	40	Whole life	
18.	250,000	50	Term	
19.	250,000	50	Whole life	

20.–22. For each of the three pairs of policies (term and whole life) in Exercises 14–19, which is the less expensive? How much cheaper is the less expensive choice?

MIXED REVIEW

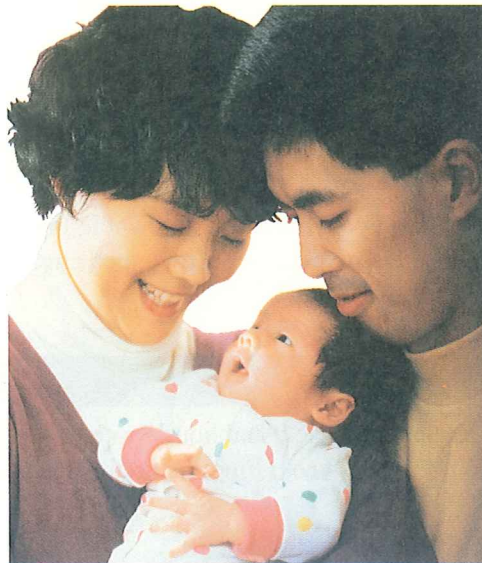
Assume that a person receives $1\frac{1}{2}$ times the usual hourly rate for each hour or part of an hour beyond 40 hours per week. Find the total wages earned in one week in each case.

- Hourly wage rate: \$8.25; total hours worked: 50
- Hourly wage rate: \$11.00; total hours worked: $47\frac{1}{2}$
- Suppose that you can pay off a \$12,500 loan either by paying \$395 per month for 3 years or by paying \$260 per month for 5 years. How much will you save if you pay the loan off in 3 years?

Complete the chart below to determine how much the interest cost will be if you pay 10% of the amount due to the nearest dollar each month and your credit card carries an APR of 9%.

	Month	Balance	Interest	Amount Owed	Payment
4.	1	\$880.00			
5.	2				

- What is the total interest for the two months?
- Tom's weekly gross pay is \$115. The amount withheld for taxes is \$2 and 7.65% of the gross pay is withheld for FICA taxes. Find Tom's take-home pay for the week.
- Write an inequality for each of the following 3 constraints: you want to work no more than 15 hours per week, you want to earn at least \$100 a week, and you won't get a job paying more than \$9 an hour. Let x represent the number of hours you work in 1 week and y represent your weekly salary.



Martin and Rachel finally decided to purchase term insurance on Martin's life rather than the other types of life insurance that were available. Since Martin is still in his twenties, he was able to get a policy with a relatively low premium. The oldest brother, Benjamin, has also started a family recently. Because he is in his thirties, the term insurance that Benjamin purchased is almost \$50 more per year than Martin has to pay for the same \$100,000 policy. Manuel knew that insurance premiums increase as the age of the insured person increases, but he wondered why the amount of the increase was \$50. Why not a \$5 increase—or \$500?

Lily has recently had a similar experience. Her father told her that he had rejected an

insurance salesman's argument that Lily's life should be insured "because her premiums would be so low." She and her father both know that she doesn't need life insurance because no one depends on her for support. Nevertheless, like Martin, she wants to know why her premiums would be so low.

Manuel decided to talk with his cousin Roberto, who works for a major insurance company. One of Roberto's duties is to help prepare new tables that show the premiums that people have to pay for insurance. Manuel hoped that Roberto could explain to him and Lily how the numbers in the tables are computed.

OBJECTIVES: *In this lesson, we will help Lily and Manuel to:*

- *Understand how life-expectation tables are used to estimate the probability that an individual will die within one year.*
- *Learn how an insurance company determines its premium schedule to make a reasonable profit.*