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Examples

Cancer:
- Lung Cancer
- Cancer of pharynx
- Cancer of larynx
- Cancer of esophagus
- Cancer of stomach
- Cancer of pancreas
- Cancer of uterine cervix
- Cancer of kidney
- Cancer of ureter
- Cancer of bladder
- Cancer of colon
- Leukemia

Cardiovascular Disease:
- Stroke
- Sudden death
- Heart attack
- Peripheral vascular disease
- Aortic aneurysm
- Atherosclerosis

Pulmonary Illness:
- Pneumonia
- Emphysema
- Bronchitis
- Influenza
- Chronic airway obstruction

Reproductive Risks:
- Reduction of fertility
- Spontaneous abortion & stillbirth
- Lower birth weight in infants
- Cervical cancer

Other:
- Cataracts
- Delayed healing of broken bones
- Periodontal maladies
- Ulcers
- Hypertension
- Brain hemorrhage
- Wrinkles

Classroom Discussion

Some smokers will get one of these diseases, some will get more than one of these diseases, and some smokers will get none. Some of the students will have heard about the 104-year-old woman who has smoked, drank, and "had a good time" all her life and is still healthy and happy. She is an example of an individual who engaged in behaviors that have a high probability of leading to disease, but who "beat the odds." In addition, it is rare to hear of an adolescent with lung cancer. The result is that most adolescents think they, too, will beat the odds. "Adolescents have a sense of invulnerability — an attitude of 'it won't happen to me'" (Dusenbury, Khuri, & Millman, 1992, p. 833). An adolescent who is currently healthy tends to think long-term health consequences are too far off in the future to be real or threatening. As Paulos (1995) puts it, "suffering ordained for twenty years from now is, like a million-dollar debt due in twenty years, considerably easier to bear than is suffering scheduled for tomorrow."

Directions

The teacher should display the data in a summary format on the board. The following chart is one possible summary method, filled with example data for 5 groups of 4 students each.

Sample Summary Chart

Disease	Totals from each group 1 2 3 4 5	Total # with Disease/ Total in Class	Percentage "With Disease"
No disease – healthy	1 + 0 + 1 + 0 + 0	2/20	10%
Cancer of the Lips	1 + 0 + 0 + 1 + 1	3/20	15%
Cancer of the Mouth	0 + 0 + 1 + 0 + 0	1/20	5%
Stroke	1 + 0 + 0 + 0 + 1	2/20	10%
Emphysema	0 + 1 + 0 + 1 + 0	2/20	10%
Lung Cancer	1 + 1 + 2 + 0 + 1	5/20	25%
Bronchitis	0 + 1 + 0 + 1 + 0	2/20	10%
Heart Disease	0 + 0 + 0 + 1 + 0	1/20	5%
Ulcers	0 + 1 + 0 + 0 + 0	1/20	5%
Wrinkles	0 + 0 + 0 + 0 + 1	1/20	5%
Cancer of the Tongue	0 + 1 + 0 + 0 + 0	1/20	5%

This model assumes that each student will get, at most, one disease, which is a simplified and conservative estimate of risk for smokers. However, the objective of this exercise is for students to understand that there are varying probabilities for contracting different diseases. Why did lung cancer have the greatest percentage among the diseases those students "contracted?" If the summary table fails to match the theoretical distribution, you can increase the number of throws. The following table demonstrates the probabilities of rolling the eleven possible totals of 2 dice. Because there are more possible ways to roll a 7, for example, the outcome probability is highest for a roll of 7. There is only 1 way to roll a 2 or an 12, so the probability for both of these outcomes is 1/36, or .027.

probability of matching each of the three numbers. The probability of matching the first number is 1/4, since there are four possible outcomes for the first number (1, 2, 3, or 4). After the first number is selected by the lottery, there are three remaining numbers in the pool. Thus, since there are three possible outcomes for the second number, the probability of matching the second number is 1/3. After the second number has been drawn, two of the four numbers have been removed from the pool, so there are two possible outcomes for the third number.

Thus, the probability of matching the third number is 1/2. Since matching the first number, matching the second number, and matching the third number are all separate events, you have to multiply them to determine the probability of all of them occurring. Thus, the probability of matching all three numbers is 1/4 x 1/3 x 1/2, or 1/24. In other words, there are 24 possible outcomes for this drawing, so your chances of picking the same one as the lottery is 1/24. These 24 combinations are depicted in Figure 1 below.

The following explanation describes how to determine the number of possible combinations mathematically. For the first number drawn, there are four possibilities; for each of these four first-number options, there are three second-number options, resulting in 12 first- and second-number combinations; and for each of these 12 first- and second-number options, there are two third-number options. In other words, there are 4 x 3 x 2 = 24 different combinations.

Figure 1: Possible Three-Number Combinations Using 1, 2, 3, and 4

Possibilities of the 1st number		1			2			3			4	
Possibilities for combinations of 1st and 2nd number	1,2	1,3	1,4	2,1	2,3	2,4	3,1	3,2	3,4	4,1	4,2	4,3
Possibilities for combinations of 1st, 2nd, and 3rd number	1,2,3 1,2,4	1,3,2 1,3,4	1,4,2 1,4,3	2,1,3 2,1,4	2,3,1 2,3,4	2,4,1 2,4,3	3,1,2 3,1,4	3,2,1 3,2,4	3,4,1 3,4,2	4,1,2 4,1,3	4,2,1 4,2,3	4,3,1 4,3,2

However, the way lotteries are run, you do not have to match the three numbers in the exact order they are drawn: if the lottery draws 421, that combination is the same as 241, 412, and all of the other possible combinations of 1, 2, and 4. As a result, for the purposes of a lottery, there are not 24 different combinations in this example, since many of these combinations would be considered the same in a lottery drawing (e.g., 124 and 214). In other words, for each three-number combination, there will be a certain number of equivalent forms created by changing the order of the numbers. Thus, to find the number of different combinations *in the* *case of a lottery*, we have to determine how many different ways each three-number combination can be arranged. This procedure is similar to the process described above. The following steps show the number of different ways any three-number combination can be arranged: for the first number, any of the three numbers can be selected, so there are three different options for the first number. For each of these three first-number options, there are two different second-number options, resulting in six first- and second-number combinations. For each of these six first- and second-number options, there is one third-number option. Thus, there are 3 x 2 x 1 = 6 different ways to arrange a three-number combination. These steps are graphically represented in Figure 2 below.

Figure 2: Possible Three-Number Combinations Using 1, 2, and 4

Possibilities of the 1st number	1	2	4
Possibilities for combinations of 1st and 2nd number	1,2 1,4	2,1 2,4	4,1 4,2
Possibilities for combinations of 1st, 2nd, and 3rd number	1,2,4 1,4,2	2,1,4 2,4,1	4,1,2 4,2,1

This process reveals that for each collection of three numbers, there are actually six combinations that are considered identical by the lottery. This means that of the 24 original combinations from Figure 1, there are 24 ÷ 6 = 4 different combinations for the purposes of a lottery. Thus, your chances of matching the number drawn in this hypothetical lottery is 1/4.

Thus, your chances of matching the number drawn in this hypothetical lottery is 1/4.

This procedure can be applied to a real lottery as well. While this discussion at first may seem too complicated for students, it uses the same principles and steps as the discussion above. With a pool of 48 numbers, we can calculate the probability of six randomly selected numbers matching your six numbers using the formula for combined probability [probability of A and B = (probability of A) x (probability of B)]. The probability of matching the first number is 1/48. Once you have matched the first number, the probability that you will match the next number is 1/47 (you have already removed one number from the pool, so there are 47 left to choose from). Similarly, the probability of matching the third, fourth, fifth, and sixth numbers are 1/46, 1/45, 1/44, and 1/43 respectively. Since these are all different events, you must multiply them to determine the probability of all of them happening. The result of this operation is 1 in 8,835,488,640. However, this operation does not take into account the possibility

Section 4 Worksheet B Answers

1. The first question is a matter of opinion, though almost all jackpots are paid to the winner over a 20-year period. Some states have a "cash option," which allows the winner to take the winnings in one lump sum but cuts the winnings by 55 to 60%. The following table describes the advantages and disadvantages of each choice.

	Advantages	**Disadvantages**
Parceled out in small payments	Enforced self-discipline. Consistent payout each year for 20 or 25 years.	Cannot invest total winnings. Seems much smaller than what you expected from winning the jackpot.
One lump sum	Could invest money and make even more.	Winner may impulsively spend all of winnings, leaving nothing for future years.

2. $1,000,000 ÷ 20 = $50,000

This $50,000 will decrease in value every year. In 10 years, for example, at an inflation rate of 4%, the $50,000 will have the purchasing power of $34,627. In 20 years, at the same rate, the $50,000 will have the purchasing power of $23,021.

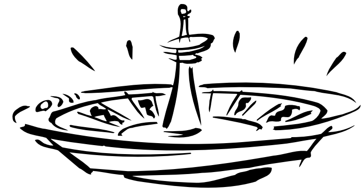
3. $35,000,000 ÷ 20 = $1,750,000

- Assume her mother has collected 2 of the 20 payments. **2 x $1,750,000** = $3,500,000
- $35,000,000 - $3,500,000 = $31,500,000
- At a tax rate of 26% she would owe **$31,500,000 x .26** = $8,190,000

4. Selling the annuity to a company for one lump sum would provide the lottery winner with more money in the present but a smaller amount in the long run. This option would be advisable only if the lottery winner needed money immediately to pay off debts.

- **$5,000,000 ÷ 20** = $250,000
- You've collected 5 payments: **5 x $250,000** = $1,250,000
- 15 payments remain: **15 x $250,000** = $3,750,000
- If Stone Street Capital buys this remaining amount at 40 cents on the dollar, you will receive **.40 x $3,750,000** = $1,500,000
- It becomes a choice of $1,500,000 now or $250,000 a year for the next 15 years.

Facing the Odds:



The Mathematics of Gambling and Other Risks

♠ Section 5 Worksheet D

Gambling in the United States: Thoughts, Feelings, and Opinions

Please read the following statements and circle your reactions to them. Use the table to the right to reference the value you assign to the statement.

SA = Strongly Agree
A = Agree
U = Undecided
D = Disagree
SD = Strongly Disagree

1.	Gambling activity is on the increase in the United States	SA	A	U	D	SD
2.	A higher percentage of adults than teenagers are pathological gamblers.	SA	A	U	D	SD
3.	The majority of adults who are pathological gamblers began gambling when they were teenagers.	SA	A	U	D	SD
4.	Children of pathological gamblers are more likely to have alcohol, drug, gambling, or eating disorder problems than children of non-pathological gamblers.	SA	A	U	D	SD
5.	Adolescent students are equally as likely as adults to become problem gamblers.	SA	A	U	D	SD
6.	Historically, people started gambling about 200 years ago.	SA	A	U	D	SD
7.	Among adolescents, males gamble more than females.	SA	A	U	D	SD
8.	Among problem gamblers, casino games are the most popular form of gambling.	SA	A	U	D	SD
9.	Two-thirds of compulsive gamblers commit illegal acts to support their gambling habits.	SA	A	U	D	SD

Section 5 Worksheet E Answers

The following data represents population figures and lottery expenditures for the six New England states.

STATE	1997 Population	1997 Expenditures on Lottery Products	1997 Expenditures on All Types of Gambling	1997 Per Capita Lottery Expenditure	1997 Per Capita Expenditure on Gambling
Maine	1,242,000	185,000,000	260,000,000	148.95	209.34
New Hampshire	1,173,000	176,655,620	550,000,000	150.60	468.88
Vermont	589,000	77,323,314	68,000,000	131.28	115.45
Massachusetts	6,118,000	3,100,000,000	3,800,000,000	506.70	621.12
Rhode Island	987,000	548,715,864	600,000,000	555.94	607.90
Connecticut	3,270,000	500,000,000	7,500,000,000	152.91	2,293.58
NEW ENGLAND TOTALS	13,379,000	4,587,694,798	12,778,000,000	342.90	955.08

Figures represent actual reported amounts or close approximations based on previous reported amounts.

1. To calculate the per capita expenditure on the lottery ifor each of the New England states, divide each state's expenditure on lottery products by the state's population. For example, for Maine's per capita lottery expenditure, $185,000,000 ÷ 1,242,000 = $148.95.

2. To calculate the New England totals, add the six figures in the first three columns.

3. To calculate the per capita expenditure on the lottery in New England in 1997, divide the total expenditures on lottery product by the total population. Thus, $4,587,694,798 ÷ 13,379,000 people = $342.90 per person. If students add the six state per capita figures and divide by six, they will come up with a figure which is an incorrect answer (see Answers to Worksheet 5A, #5 for a discussion of averaging averages).