WHAT ARE MY CHANCES?

Student/Class Goal
Some people play the lottery everyday and wonder when they might win.

Outcome (*lesson objective*)
Students will gain an understanding of probability terminology; evaluate situations and calculate probabilities of events in order to make informed decisions in their lives.

Time Frame
Up to 6 classes

Standard *Use Math to Solve Problems and Communicate*

NRS EFL 2-6

Number Sense	Benchmarks	Geometry & Measurement	Benchmarks	Processes	Benchmarks
Words to numbers connection		Geometric figures		Word problems	
Calculation	2.2, 3.2, 4.2, 5.1, 6.1	Coordinate system		Problem solving strategies	4.26, 5.26, 6.27
Order of operations		Perimeter/area/volume formulas		Solutions analysis	
Compare/order numbers		Graphing two-dimensional figures		Calculator	2.19, 3.22, 4.28, 5.28, 6.29
Estimation		Measurement relationships		Mathematical terminology/symbols	2.20, 3.23, 4.29, 5.29, 6.30
Exponents/radical expressions		Pythagorean theorem		Logical progression	
Algebra & Patterns	**Benchmarks**	Measurement applications		Contextual situations	4.31, 5.31, 6.32
Patterns/sequences		Measurement conversions		Mathematical material	
Equations/expressions		Rounding		Logical terms	
Linear/nonlinear representations		**Data Analysis & Probability**	**Benchmarks**	Accuracy/precision	
Graphing		Data interpretation		Real-life applications	2.22, 3.27, 4.34, 5.35, 6.36
Linear equations		Data displays construction		Independence/range/fluency	2.23, 3.28, 4.35, 5.36, 6.37
Quadratic equations		Central tendency			
		Probabilities	2.17, 3.19, 4.23, 5.23, 6.24		
		Contextual probability	3.2, 4.24, 5.24, 6.25		

Materials
Dice, number or color spinners, coins, decks of cards, colored cubes or square tiles
Small brown lunch bags
Variety of items to raffle off
Tickets (can be bought at Wal-Mart or Office Max) or small squares of paper
Container to hold collected tickets
Probability Definitions and Terms Teacher Resource
7-11-Doubles Handout
What's my Risk? Handout
Test Guessing Handout
Probability Workplace Applications

Learner Prior Knowledge
Probability is all around us. The weather forecaster predicts a 60% chance of snow; medical researchers predict people with certain diets have a high chance of heart disease; airlines calculate the chance of a person dying in an airplane crash is 1 in 10,000,000. Many students have participated in or heard about games of chance such as casino gambling, horse racing or lotteries. Students should have had experiences with fractions, ratio and proportion.

Teacher Prior Planning
When completing the activities with the coins, dice, cards and lottery, you might choose to do one of those activities each day of class or set up stations (write up directions prior to class) and use vocabulary to debrief about each activity.

Instructional Activities
Step 1 - Discuss with the class if they have ever purchased a raffle or lottery ticket. Did they win? Why did they purchase the ticket? Explain to the class that over the next few classes they will learn the math of raffles and games of chance: **probability** or the study of uncertainty.

TEACHER NOTE Pass out tickets to students as they contribute to the discussion. If students ask why one student got 3 tickets and they received none, explain that by answering questions and participating in discussions, they are increasing their probability of passing the GED. Ask students to put their names on the back of tickets and collect them at the end of the first lesson. Continue this procedure throughout this lesson.

Step 2 **-** Distribute a coin to each person. Ask the students what is the chance of tossing “heads”? “tails”? Students will recognize that there is a 50-50 chance of tossing either heads or tails. Discuss ways we use tossing coins in our lives (to determine which team starts a sporting event, etc.). Chance has no “memory” - the **outcomes** of prior **trials** have no impact on the next. The chance occurrence of six heads in a row has no effect on getting heads on the next toss of a coin. That chance remains 50-50.

TEACHER NOTE A detailed explanation of the terminology of probability can be found on the Teacher Resource *Probability Definitions and Terms*. Bolded words are found on this resource and can be used to clarify during discussion. Ask students to write definitions for these words in their journals or learning logs.

Write the following equation on the board: Probability of an event happening = Number of favorable outcomes/total number of outcomes. Have the students go back to the coin question and substitute values to find the probability of tossing “heads” (1/2). Logically, we could argue that if it is a fair coin, obtaining a head is just as likely as obtaining a tail. Since there are two possible outcomes that are equally likely, each has a probability of ½. The **theoretical probability** of obtaining a head is ½.

Now, ask students to determine the probability of obtaining a head through data collection. Take a fair coin and toss it 10 times, recording the result of the toss in a frequency table (number of heads and number of tails). In 10 tosses, you might have had 3 tails and 7 heads (7/10 for heads) or 8 tails and 2 heads (2/8 for heads). These ratios are called **relative frequencies.**

Ask students what they think **experimental probability** is. (Probability based on the results of an experiment.) Fill small brown bags (identified as bags A-?) with 10 colored cubes or tiles. Be sure each bag has 2-4 colors including red. Working in small groups, ask the students to draw one item out of the bag, record the color and then return the item to the bag. Repeat this procedure 10 times. Ask each group to calculate their experimental probability of drawing a red item. Ask students to swap bags with another group, and try the activity again. Is the experimental probability the same or different? Why? Ask the students if they can think of situations where experimental probability is used.

Since it is impossible to conduct an infinite number of trials, we can only consider the relative frequency or experimental probability for a very large number of trials as an approximation of the theoretical probability. The probability of some events can be determined only through data collections (experimental probability), conducting a sufficiently large number of trials to become confident that the resulting relative frequency is an approximation of the theoretical probability.

Step 3 **–** (possibly day 2) Probability applies to situations in which all possible outcomes of an experiment are known. This explains why the study of probability began with the study of gambling. In all games of chance, the possibilities are completely known: a deck has 52 cards, a die has 6 sides, a roulette wheel has 38 numbers. In such situations, the probability of an event can be found by counting the number of ways something can happen as well as the total number of things that can happen. Most games of chance involve very large numbers and play unfolds very fast, so people play hunches rather than calculate odds. Some familiarity with the **principles of counting** could help in these situations. An efficient way of counting is necessary to handle large masses of statistical data (e.g. the level of inventory at the end of a given month, or the number of production runs on a given machine in a 24 hour period, etc.) and for an understanding of probability.

Distribute dice, and have the students calculate the probability of rolling a 6 (1/6). Quiz the group on the probability of rolling other number situations (an even number, an odd number, a number less than 3, a number greater than 4, etc.) Be sure to include a situation where the probability is zero (rolling a number greater than 6) and 1 (rolling a number less than 7). Ask students to reduce the theoretical probability to lowest terms. After completing these calculations, ask the students if they think the probability of any of those outcomes occurring will always be correct. Let the students roll their dice to see what happens. Were their results as they expected? Discuss with the students what they know about probability so far. Help students understand that probabilities can range from 1 (a sure thing) to 0 (an impossible outcome).

Ask the students if the probabilities of rolling a six changes each time you roll a die? (No) The handout, *7-11-Doubles*, can be distributed as an extension activity with two dice. Pass out two dice to each pair of students. Ask the students if it would be easy or hard to roll snake eyes? Ask, what is the probability of rolling a one? (1/6) Now what is the probability of rolling a one again? (1/6) To find the probability of rolling two 1's in a row or two at the same time, we multiply 1/6 times 1/6 and get 1/36. The chart on the handout proves that there are 36 possible combinations of rolling two dice, and there is only one time out of 36 when two 1's will turn up.

Step 4 **-** (possibly day 3) Review the lesson in Step 2. (Be sure to pass out tickets.) Show the class a deck of 52 cards. If you draw a card from the deck, how many possible outcomes are there? (52) What would be the probability of drawing an ace (4/52)? Ask a student to draw a card from the deck. Chances are an ace will not be drawn. If that is the case, do not replace the card. What is the probability of drawing an ace? (4/51) If an ace was drawn on the first draw, what would be the probability of drawing a second ace? (3/51). Explain to the class that the example with the cards is an example of **dependent probability.**

Ask each student to count the number of tickets they have for today. Pass out tickets when they arrive to class, if they arrive on time, get back from the break on time, etc. They need lots of tickets for this activity. You can use the tickets you have collected in previous lessons (pass out and count) or save them until the end. Collect data on the number of tickets each student has. Add the totals as you collect the tickets, so you have a total for the entire class. Ask each student to calculate the probability of one of their tickets being drawn. Share this information with the group and determine who has the greatest probability of having one of their tickets drawn. Draw the first ticket, read the name, and ask the person whose ticket is drawn to pick a prize (small candy bars, pens, pencils, folders, etc.). Continue by asking the current winner to draw the next ticket. After each draw, change the probability for the next draw, looking at who should win according to "experimental probability" and who does. Discuss with the class their experiences with raffles.

TEACHER NOTE This lesson is fun to do during the winter holiday season. Wrap up the small items you want to raffle and indicate on the paper who might like the item.

Step 5 - (possibly day 4) Review with the probability lessons previously taught. Ask the students if anyone has ever played a Pick 3 lottery game. How does it work? Did they think they had a good chance of winning this game? Ask students to explain the betting to you or go to the Ohio Lottery web site for information (http://www.ohiolottery.com/index.stm). Discuss with the class how to determine the **probability of consecutive events**. In the Pick 3 game there are 10 numbers that can be drawn each time. A straight bet would be 1/10 times 1/10 times 1/10 = 1/1000 chance of winning. In a six-way boxed bet, where the numbers can occur in any order, the probability would be 3/10 times 2/10 times 1/10 = 6/1000 or 3/500 or 1/167. Ask the class to figure out how they could calculate the probability of winning in some of the other lottery games. (They can check probabilities at the Ohio Lottery site.) Be sure to use a calculator for the math and round to the nearest whole number.

Step 6 **-** Review the lessons on probability covered so far using the Star Review diagram. Ask students how they can use the information they've learned so far. To construct a star, use large chart paper and begin drawing the first leg of a star (bottom left to upper right corner). As you cover the material, write vocabulary words on the leg or at the end of each point. Continue constructing legs as each activity and vocabulary are discussed until a star is created.

Ask students to describe their experiences with car insurance. Make sure that you bring out the following ideas:

- Young drivers are more costly to insure than middle age drivers.
- Male teens are more expensive to insure than female teens.
- If you have had an accident, your rate will be more.
- The further you drive to work each week, the higher your insurance rate, etc.

Ask why they think this happens. Hopefully the class will bring up the idea that these drivers are more likely to be in accidents. Insurance rates are based on driving statistics, which result in statistical probability.

TEACHER NOTE *The Book of Risks: Fascinating Facts about the Chances We take Every Day*, by Larry Laudan (1994), has great information about everyday risks. The *What's my Risk?* handout provides the statistical probability of various everyday events occurring.

Another everyday example for students getting ready to take the GED test could be an activity on test guessing. Ask students if they have every guessed on a true-or-false test. Most will probably admit to having guessed on some questions, ask them how they guessed (looked for a pattern, tossed a coin, whatever came to their heads, etc.). Create a "test" of three true-or-false questions that students will **not** know the answers. Ask the students to answer the three questions and explain how they decided which answers to choose. Then compile the students' answers. Divide the students into pairs or triples and distribute the *Test Guessing* handout.

Begin the discussion by asking the students to give their answers to question 3. Be sure that they understand that there are eight equally likely outcomes. (C means correct; W means wrong): CCC, CCW, CWC, CWW, WCC, WCW, WWC, WWW. These eight values form the sample space of this situation. Of these outcomes, only one (CCC) gives a score of 70% or greater, so the probability of passing is 1/8. One way to think about computing the probabilities is to assume that the guesses are independent; for example, the probability of CCW is the product of the probabilities of C, C and W for individual questions. Since the probability of C (or W) on each question is ½, the probability of CCW is ½ x ½ x ½ = 1/8. Extend the discussion by asking students to determine the possible values for the random variable and associated probabilities. Advanced students might like to try question 5 (sample space has 32 or 2^5 elements) and 6 P(C) = 1/3 and P(W) = 2/3 for each question).

Step 7**-** Hold "Probability Day" with the class. Each student will write an essay describing what they have learned about probability and how the study of that concept has influenced their life. Provide several GED format exercises for the students to complete or give students the Probability Workplace Applications. Finally, hold a final raffle using the tickets the students have earned throughout the lesson.

Assessment/Evidence (*based on outcome)*
Students discuss in writing how this lesson relates to their life and discuss what they have learned.

Teacher Reflection/Lesson Evaluation
Not yet completed.

Next Steps
Students can use what they learned to make choices (lottery, gambling, risks). Additional lessons on average, mean, median and mode can be found at *Global Statistics.*

Technology Integration
The Insurance Information Institute http://www.iii.org/
Auto Crashes http://www.iii.org/issues_updates/auto-crashes.html
Insurance Institute for Highway Safety http://www.iihs.org/research/default.html

Purposeful/Transparent
Lesson relates to the student's goal of learning about probability by focusing on authentic, purposeful examples.

Contextual
Activities are connected to life situations (insurance costs, raffles, life risks, gambling, etc)

Building Expertise
The lessons link familiar situations to new skills. Lesson structure increases in difficulty as it progresses

Probability Definitions and Terms
Teacher Resource

Probability and statistics constitute the area of mathematics that is most commonly used (and misused) in everyday life. Together they determine how insurance companies set their rates, how brokers make investment decisions, how casinos reap their profits and how laboratories test experimental drugs. When a baseball manager sends in a left-handed pinch hitter, he is playing the **law of averages** – using statistics to give the team the best chance of coming out ahead.

Law of Large Numbers	(law of averages) law that tells you there is a fifty-fifty chance of winning a coin toss.

Both **probability** and **statistics** employ some technical language, and it is crucial to examine such language closely. When properly used, statistics can clearly summarize complex information; when improperly used it can bolster a weak argument or create a false impression. As Mark Twain wrote in his diary, "There are three kinds of lies: lies, damned lies and statistics."

Statistics	the branch of mathematics that deals with collecting, analyzing, organizing, interpreting and presenting numerical data. Part of its purpose is to summarize what *has* happened in order to predict what *will* or *might* happen. In this way statistics is closely connected with probability.
Probability	the study of chance and the mathematical measure of the likelihood of an event happening. It is useful in predicting outcomes of a future event. Numbers between 0 and 1 measure the likelihood of an event. A probability of 0 indicates that the event will not happen and a probability of 1 indicates that the event is certain to happen.

COIN EXAMPLE Carlos has been collecting coins in a jar. One evening he counts his coins and finds: 10 quarters, 15 dimes and 25 nickels. Removing a coin from the jar is an example of an **event.** There would be 50 ways for an event (removal of a coin) to occur. Each occurrence is referred to as an **outcome**. For example, removing any one of the fifty coins is an outcome. Suppose Carlos reaches into the jar and removes a coin without looking. The outcome of removing a quarter is called a **favorable outcome**. Since there are 10 quarters in the jar of 50 coins, the chance of the favorable outcome occurring is 10 out of 50 or 20%. When Carlos reaches into the jar and removes a coin without looking, he is *randomly* selecting a coin. A random selection means that all coins are *equally likely* to be selected. Whenever all the outcomes are equally likely, the probability is called **theoretical probability**.

Outcome	one of the possible results
Event	some combination of possible outcomes in one experiment trial
Favorable outcome	a particular outcome
Probability of a Favorable Outcome	"First Principle of Probability" or odds of an event. To find a basic probability with all outcomes equally likely, we use a fraction. Number of Favorable Outcomes / Total Number of Possible Outcomes
Notation	P(event) = the probability of the event occurring
Theoretical Probability	The probability of an event occurring based on logical analysis of the situation or the *laws of probability (*flipping a coin, rolling dice). $P(\text{E}) = \dfrac{\text{Number of favorable outcomes}}{\text{Number of possible outcomes}}$
Frequency	number of times a result happens
Relative frequency	ratio of frequency of the outcome to the number of trials $\dfrac{\text{Number of observed occurrences of the event}}{\text{Total number of trials}}$

COIN EXAMPLE Conduct an **experiment** with a penny using 20 **trials.** Toss the penny 20 times, record on a chart how the coin comes up each time – heads or tails. Continue tossing. Can you guess your results? This shows how to find the **experimental probability** of an event by collecting data and evaluating the data to predict the outcome of a specific event. Usually, a large number of trials are observed and counted.

A researcher studies fish in a stream. He studies 100 fish and finds 30 of them have high mercury levels in their blood. He concludes that if he pulls another fish there is a 3/10 experimental probability that the fish will have high mercury levels.

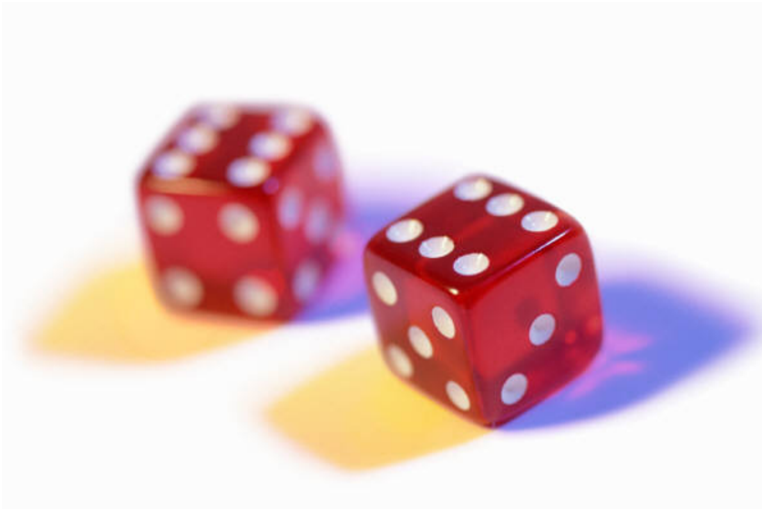
Experiment	controlled study whose outcome is uncertain but not entirely unknown
Trial	every time the observer records the result of an experiment
Experimental Probability	The probability of an event occurring based on experiments and research generated through data collection. Sample data or observations are used to estimate the probability of a specific event occurring. $P(E) = \frac{\text{Number of times the event happens}}{\text{Total number of tries}}$

DICE EXAMPLE Let's say that you want to flip a coin and roll a die. There are 2 ways that you can flip a coin and 6 ways that you can roll a die. There are then 2 x 6 = 12 ways that you can flip a coin *and* roll a die. If you want to hit one note on a piano and play one string on a banjo, then there are 88 x 5 = 440 ways to do both. If you want to draw 2 cards from a standard deck of 52 cards without replacing them, then there are 52 ways to draw the first and 51 ways to draw the second, so there are a total of 52 x 51 = 2652 ways to draw the two cards.

Fundamental Counting Principle	to find the number of ways to make successive choices in a series of different categories, multiply together the number of choices in each category; the guiding rule for finding the number of ways to accomplish two tasks. If there are *m* ways to do one thing, and *n* ways to do another, then there are *m x n* ways of doing both.

MARBLE EXAMPLE Margo has a bag that contains two red marbles, a blue marble and a green marble. She draws one marble at random from the bag. She replaces the marble and draws another marble from the bag. The probability that Margo removes a red marble on her first draw is ½. Since she replace the marble, the probability of removing a red marble on the second draw is still ½. This is an example of events that are **independent**. The two events are independent -- the outcome of the first event does not affect the second event. Suppose Margo does not replace the first marble before she draws a second marble. If Margo removed a red marble on the first draw there are 3 marbles left and only one of them is red. On the second draw, the probability that Margo will draw a red marble is 1/3. This is an example of events that are **dependent**. Two events A and B are dependent when the first event A affects the probability of the second event B. If B follows A, then the probability of B occurring is written $P(B|A)$ and is read, "the probability of B given that A has occurred."

Independent Events	When an experiment is made of several trials, the outcome of one trial has no effect on the outcome of any other. To calculate the probability that two or more independent events will occur, <u>multiply</u> their probabilities. The probability of three heads in a row is ½ x ½ x ½ = 1/8. Probability of Independent Events $P(A \text{ and } B) = P(A) \times P(B)$
Dependent Events	The probability of drawing consecutively 2 kings out of a deck of cards. The probability of the second event is dependent on what happened in the first event. For example, if a king is drawn from a deck of cards (4/52), the probability of drawing a second king will be dependent on drawing the first king (3/51). Probability of Dependent Events P(A and B) = P(A) x P(B|A)
Mutually exclusive	In two or more events, if no two of them can possibly happen in the same trial. When picking one card from a deck, it is impossible to pick a card that is both a spade and a club.
Probability of Consecutive Events	To find the probability of two events happening in succession, (one after another), multiply the probabilities of each.



7 -- 11 -- Doubles

Dice games are often played when gambling. But what is the probability of getting a 7, 11 or doubles? What is the chance or rolling snake eyes?

Complete the chart below to determine the sum you will get when you roll 2 dice together. To make the chart easier to understand, the dice will be identified as black and red numbers. For example, if you roll a 2-black and 3-red, your sum will be 5.

	1	**2**	**3**	**4**	**5**	**6**
1						
2						
3						
4						
5						
6						

Now look at the data on your chart.

How many “Doubles” were there? __________

How many times did you get snake eyes (two 1’s rolled)? _________________

To determine how many times you will get a particular sum; use the grid below to complete a frequency chart of your data. Every time a particular sum occurs, put an x in the box above the number.

Two Dice Toss
Data

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**

What number occurred most frequently? _______________

What number occurred least frequently? __________________

Were there any numbers that did not occur at all? If so which ones? Why?

____

____

If you were betting on a dice game, what numbers would you bet on? Why?

____

____

How can you use this information in you life?

____

____

What’s My Risk?

We all participate in risky activities at one time or another, but what is a safe risk? Is driving a race car too risky? What about rock climbing? Study the following activities and decide which ones are too risky for you!

Annual Risk Odds – In the next year, chances are:

Up to 1 in 100

- You will be injured: 1 in 3
- If you give birth, your baby will have a defect: 1 in 6
- You will have an auto accident: 1 in 12
- You will have a heart attack (if over 35):1 in 77
- You will be injured at home: 1 in 80
- You will fracture your skull: 1 in 100

Above 1 in 100

- You will die: 1 in 115
- You will be attacked with a deadly weapon: 1 in 260
- You will die of heart disease: 1 in 340
- You will injure yourself on a chair or bed: 1 in 400
- You will die of cancer: 1 in 500
- Someone in your household will die in an accident: 1 in 700
- Your will get breast cancer (females): 1 in 1000
- You will die of a stroke: 1 in 1700
- You will be raped (females): 1 in 2500

Above 1 in 2,500

- You will die in an accident: 1 in 2,900
- You will die in an auto accident: 1 in 5,000
- You will die of breast cancer: 1 in 5,000
- You will have AIDS: 1 in 5,700

Above 1 in 10,000

- You will be murdered: 1 in 11,000
- If pregnant, you will die in pregnancy or childbirth: 1 in 14,000
- You will deliberately kill yourself: 1 in 20,000 (females) 1 in 5,000 (males)
- You will die from a fall: 1 in 20,000
- You will die in an accident at work: 1 in 26,000
- You will be killed by a car while walking: 1 in 40,000
- You will die in a fire: 1 in 50,000
- You will drown: 1 in 50,000

Above 1 in 50,000

- If you are a nonsmoker married to a smoker, you will die of lung cancer from your spouse’s smoking: 1 in 60,000
- You will be stabbed to death: 1 in 60,000
- You will die from complications of surgery: 1 in 80,000

Test Guessing

Suppose that you have to take a true-or-false test with three questions and you have forgotten to study. You take the test, but you have to guess on each question.

1. Since there are only two choices for each question (true or false), what is the probability that you will guess the correct answer for the first question? ____________________
   For the second question? ____________________ For the third question? ____________________

2. Using C for a correct guess and W for a wrong guess, list all the possible outcomes of answering the three questions on the test. For example, you would record CCC to indicate the possibility of getting all three questions correct. Hint: Eight outcomes are possible.

3. If you are truly guessing, what is the probability associated with each of the eight outcomes? ____________________

   Describe two ways to explain your answer.

4. If 70 percent is the lowest passing grade, what is the probability that you will pass the test by guessing? ____________________

   Challenge Questions…

5. Repeat the analysis (questions 1-4) for a true-or-false test of five questions.

6. Repeat the analysis (questions 1-4) for a three-question multiple-choice test with three options for each answer.

Probability Workplace Applications

United States telephone numbers consist of a 3-digit area code, a 3-digit exchange and a 4-digit station number.

In how many ways can you arrange the 3-digit exchange and the 4-digit station number to forma a telephone number?

Suppose that someone randomly dials the area code in a long distance call (in the US). The exchange and station numbers match yours. What is the probability that the number dialed is your phone number? Note: Even though some area codes are not valid, such as 000, it is still possible to dial these numbers.

During times of national crisis, the US government can draft young men into the armed services. This has been done in the past by randomly assigning numbers from 1 to 366 to the calendar days. Traditionally, two drums of capsules are used. One drum contains number capsules identified 1 to 366. The second drum contains birth-date capsules, one for each of the 366 days of the year (assuming a leap year). One capsule is randomly drawn from each drum so that a number capsule is matched with a date capsule. For example, a number capsule of 128 and a date capsule of April 4 mean that those 18 year-olds born on April 4the would be the 128th group to be drafted.

What is the theoretical probability that your birth date will be the first date capsule to be drawn?

What is the theoretical probability that the number 1 will be the first date capsule drawn from the other drum?

What is the probability that your birth date will be drawn first and assigned the draft number 1? Express this number as a percent.

Consider all the possible draft numbers that can be assigned to your date of birth. What is the probability that your date of birth is assigned the number 1?

You inspect the trees in your orchard for a certain parasite that has appeared in some of your trees. You collect samples from 30 randomly selected trees. Your analysis shows that 12 of the samples are infested ant rest of the samples are clean.

What are the two possible events that can occur in your orchard trees with respect to the parasitic infestation?

Are these events mutually exclusive? Are they equally likely?

What is the experimental probability that a randomly selected tree from your orchard is infested with this parasite?

You read in the newspaper that a man purchased 12 eggs and found every one to be double-yolked. One source stated that the random chance of getting an egg that is double-yolked is 1 in 531.

What is the probability of getting a double-yolked egg?

If the number of yolks in each of the twelve eggs is independent of one another, what is the probability of getting 12 double-yolked eggs?

Suppose your family purchases 12 eggs every week. Approximately how many dozen eggs would your family have to purchase at this rate to expect to find one double-yolked egg inside a carton?

What other factors might affect the probability of getting even one double-yolked egg?

A person's blood is one of four possible types – A, B, AB or O – depending on the person's gene pair. The gene pair is the result of the combination of the gene pairs from the person's parents. Type A, for example results from a combination yielding gene pairs of AA. Type B results from a combination yielding gene pairs of BB. And type AB results from a combination yielding the mixed gene pair of AB. You can chart the combinations of gene pairs for blood type.

Probability Workplace Applications

Suppose one parent has gene pair of AA and other parent has AB. Make a chart of the possible outcomes of gene pairs for their offspring.

List the probabilities for each of the possible blood types.

Out of a population of 100 children whose parents have the gene pairs about, approximately how many would you expect to have blood type A? How many would you expect to have blood type AB? How many would have blood type B?

A simple test to determine left-handedness involves spread apart the ring and middle fingers of each hand to form a "v." A right-handed person can stretch the fingers of his or her left hand farther than the right hand. A left-handed person will have a larger spread on his or her right hand. If there is no difference in the spread, the person tends to be right-handed and has good coordination in both hands. A quick test of this theory found that it was correct 22 out of 25 cases.

A test outcome is correct or incorrect. How many outcomes are possible with the 25 test cases? Are they all equally likely? Does the test of the theory above yield a theoretical probability or experimental probability?

What is the probability of correctly predicting right- or left-handedness when this test is performed on an individual?

What is the probability that it is incorrect?

You can perform the test with yourself and classmates. Do your results agree with the results given above?

While overhauling an eight-cylinder engine, you forgot to number the eight rod caps. When you reassemble the rods, you do not know which cap to match with each rod.

How many combinations of rods and caps are possible?

What is the probability of "accidentally" matching all eight caps with the correct rods on the first try?

A certain product is assembled in stages using three machines: Machine A, Machine B and Machine C. During the previous six months, each of the machines has broken down, causing a slowdown in production while it was being repaired. You have kept a record of the last six months' history.

Machine	**Days Operating**	**Days Down for Repair**
A	**116**	**16**
B	**106**	**26**
C	**122**	**10**

For each machine, determine the experimental probability of the machine being down on any given day.

If all machines are down at the same time, production must cease. Assuming that each machine's status is independent of the others, determine the probability that all three machines will be down at the same time.

A company produces a certain type of candy. Each bag contains small candies that can have one of five different color coatings: read, orange, brown, green and yellow. Each bag, on the average, contains about 45 candies. The bags are filled from a bin that has a uniform mixture of each of these five colors.

What is the probability that the first piece of candy into a bag is red?

What is the probability that the first piece of candy into a bag is not red?

What is the probability that the second piece of candy into a bag is not red?

What is the probability that both the first and second candies into the bag are not read?

What is the probability that a bag gets filled with 45 pieces of candy from the bin and not one of the pieces is read?