Financial Lit Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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WS Assessment

Target 21:

PROBABILITY

**I can:**

* Understand the definition of simple random sample.
* Understand the basic term in probability: even and outcome.
* Calculate Conditioning Probability
* Expected Value

**Unit 10 Math Topics:**

* Probabilities using multiplicative rule
* Combination rule
* Permutation rule

**Basic Concepts**

If you roll a die, pick a card from deck of playing cards, or randomly select a person and observe their hair color, we are executing an **experiment** or procedure. In probability, we look at the likelihood of different outcomes. We begin with some terminology.





We can write the result as a simplified fraction or as a decimal or percent.

Let's say you have a bag with 20 cherries, 14 sweet and 6 sour. If you pick a cherry at random, what is the probability that it will be sweet?

Write the sample space for the sum of two six-side dice and find the following

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | **1** | **2** | **3** | **4** | **5** | **6** | | 1 |  |  |  |  |  |  | | 2 |  |  |  |  |  |  | | 3 |  |  |  |  |  |  | | 4 |  |  |  |  |  |  | | 5 |  |  |  |  |  |  | | 6 |  |  |  |  |  |  | | rolling a 6  rolling sum of 6  rolling sum of 6 at least 4.  rolling an even number  rolling sum of even number  rolling a 5 or a 3.  rolling sum of 5 or 3 |

A probability is always a value between 0 and 1, or from 0% to 100%. If the probability of an event is 0 there are no outcomes that correspond with that event and we say it is **impossible**. If the probability of an event is 1 then every outcome corresponds to that event and we say it is **certain**.



In the experiment of two dice, find the probability of

rolling a sum larger than 50 rolling a sum less than 20

rolling NOT a pair rolling NOT a 6

**Independent and Dependent Events**

Two events A and B are independent if the probability of B occurring is the same whether or not A occurs. If the probability of B is affected by the occurrence of A, then we say that the events are dependent.



The probability of B given A is called a conditional probability since it depends, or is conditional, on A occurring.

Suppose you have a bag containing 6 red Legos, 4 green Legos, and 3 black Legos. What is the probability of selecting

a. two red Legos in a row if we put the first red Lego back in the bag?

b. two red Legos in a row if we don’t put the first Lego back in the bag?

c. a red Lego and then a green Lego if we do not put the red Lego back in the bag?

In your drawer you have 10 pairs of socks, 6 of which are white, and 7 tee shirts, 3 of which are white. If you randomly reach in and pull out a pair of socks and a tee shirt, what is the probability both are white?

Suppose there is a 6% chance you will receive a citation if you ride the MAX train without a ticket. What is the probability that you get away without a single citation if you ride without purchasing a ticket for 20 days this month?



In the experiment of two dice, find the probability of rolling two dice and getting a pair or a sum of 6?

P(pair or sum of 6) = P(pair) + P (sum of 6) – P (pair and a sum of 6)

Suppose we draw one card from a standard deck. What is the probability that we get a Queen or a King?

Suppose we draw one card from a standard deck. What is the probability that we get a red card or a King?

The table shows the number of survey subjects who have received and not received a speeding ticket in the last year, and the color of their car. Find the probability that a randomly chosen person:

a) Has a red car *and* got a speeding ticket

b) Has a red car *or* got a speeding ticket.

**Conditional Probability**

Often it is required to compute the probability of an event given that another event has occurred.

What is the probability that two cards drawn at random from a deck of playing cards will both be aces?

The table shows the number of survey subjects who have received and not received a speeding ticket in the last year, and the color of their car. Find the probability that a randomly chosen person:

a) Has a speeding ticket *given* they have a red car

b) Has a red car *given* they have a speeding ticket

If you draw two cards from a deck, what is the probability that you will get the Ace of Diamonds and a black card?

**Expected Value**

Expected value is one of the useful probability concepts we will discuss. It has many applications, from insurance policies to making financial decisions, and it's one thing that the casinos and government agencies that run gambling operations and lotteries may hope most people never learn about.

You are commissioned to design a game for a local carnival. Your proposed game will have players roll a six-sided die. If it comes up 6, they win $10. If not, they get to roll again. If they get a 6 on the second roll, then they win $3. If they do not get a 6 on the second roll, they lose. With the game design complete, you now need to decide how much the carnival game owner should charge players in order to make a profit over the long run.

|  |  |  |
| --- | --- | --- |
| Outcome | Rolling Event | Probability |
| $10 | Roll a 6 on the first roll | P(6) = |
| $3 | Roll NOT a 6 on the first roll and a 6 on second roll | P(not 6 then 6) |
| $0 | Roll NOT a 6 on the first roll and NOT a 6 on second roll | P (not 6 then not 6) |



Expected Winnings:

If the carnival owner charges exactly $2.08 to play, the game is considered **a fair game** since the expected winnings would be $0. In a fair game, the player isn’t expected to win anything, nor is the owner expected to earn anything over the long run. However, if the carnival owner charges the player more than $2.08 to play, they will earn money over the long run.

Suppose you suggest charging $5 to play. We can determine the net winnings by subtracting the $5 the player has to pay from their expected winnings. This gives us

Net player winnings $2.08 –b $5.00 = - $2.92

This means that over the long run, players can expect to lose an average of $2.92 each game they play, and the carnival owner can expect to earn an average of $2.92 per game over the long run.

Pick4 is a game by the Oregon Lottery that costs $1 to play. In this game you pick 4 numbers in a specific pattern. If you get the exact sequence, you can in theory earn a lot of money. Suppose that the payouts are as follows. Determine the player’s expected net winnings.

For 3 months, a coffee shop tracked their morning sales of coffee, between 6am and 10am. The results were recorded

How many cups of coffee should they expect to sell each morning?

A 40-year-old man in the U.S. has a 0.242% risk of dying during the next year2. An insurance company charges $275 for a life-insurance policy that pays a $100,000 death benefit. What is the expected value for the person buying the insurance?

**Assessment Target 21**

**I can…** use factorial to do permutation and combination counting

Show work

At some random moment, you look at your clock and note the minutes reading.

a. What is probability the minutes reading is 15?

b. What is the probability the minutes reading is 15 or less?

A card is pulled a deck of cards and noted. The card is then replaced, the deck is shuffled, and a second card is removed and noted. What is the probability that both cards are Aces?

In your drawer you have 10 pairs of socks, 6 of which are white, and 7 tee shirts, 3 of which are white. If you reach in and randomly grab a pair of socks and a tee shirt, what the probability at least one is white?

In your drawer you have 10 pairs of socks, 6 of which are white. If you reach in and randomly grab two pairs of socks, what is the probability that both are white?

A friend offers to play a game, in which you roll 3 standard 6-sided dice. If all the dice roll different values, you give him $1. If any two dice match values, you get $2. What is the expected value of this game? Would you play?

An insurance company estimates the probability of an earthquake in the next year to be 0.0013. The average damage done by an earthquake it estimates to be $60,000. If the company offers earthquake insurance for $100, what is their expected value of the policy?