Warm Up

1. There are 12 toppings available and I get to pick 3 for my pizza. How many different pizzas could I theoretically make? (Order doesn't matter)

   This is a combination question. 12C3 (or nCr(12,3) on Desmos) = 220 different pizzas.

2. There are 28 people in class, and I am going to pick 5 students to share their answers. In how many different ways could this happen? (Order matters)

   This is a permutation question. 28P5 (or nPr(28,5)) = 11,793,600 different outcomes.

3. The Pick 4 Game from Oregon's Lottery asks you to pick 4 numbers (0-9). There are several ways to win.
   a. Option A: All four game play numbers must match the Lottery's numbers in the exact order. How many possible outcomes are there?

   This is a permutation question. 10P4 (or nPr(10,4) on Desmos) = 5040 different outcomes. Permutations mean without replacement, but order matters.

   b. Option B: All four game play numbers can match the Lottery's numbers in any order. How many possible outcomes are there?

   This is a combination question. 10C4 (or nCr(10,4) on Desmos) = 210 different outcomes Combinations mean without replacement, and order doesn't matter.

4. A website asks me to create a PIN that has 2 letters first, and then 2 numbers. How many different ways could I choose a pin? Repetition is allowed, and order matters (of course).

   This is a counting principle problem. 26*26*10*10 = 67600 different pins.

5. My Bank has me create a PIN that is just a 4 digit number. How many different ways could I pick a 4 digit pin? Repetition is allowed, and order matters.

   This is a counting principle problem. 10*10*10*10 = 10,000 different pins.

6. Of the options in 4 & 5, which would be more secure?

   The option in question 4 is more secure, since there are more possible PINs. It would be harder to hack/guess the pin.

Notes Probability Day 5

Expected Value

Expected value is the average gain or loss of an event in the long run (over many trials). We can compute the expected value by multiplying each outcome by the probability of that outcome, and then adding up the products.

Expected value is a useful decision making tool.

Example 1: Gambling
I decided to take up gambling, but I'm no good at poker, so I just use a single 6-sided die (singular of dice). I pay $1 to play. Then I pick a number, and if the die roll matches, I win $10. If the die roll doesn't match, I pay $10. Is this a good game for me to play?

	probability of event	amount won or lost	product
win	⅙ ≈ 0.17	-1+10 = $9	$1.53 ($1.50 if you use a fraction for ⅙)
lose	⅚ ≈ 0.83	-1-10 = $-11	-$9.13 ($9.17 if you use a fraction for ⅚)
			-$7.60 (-$7.67 if you use fractions, which are more accurate)

The expected value is that you lose $7.60 per game you play (in the long run). Because this game is so bad, nobody wants to play.

2. We decide to change the rules. Now if you lose, you only have to pay $2. Would you be inclined to play now? Fill in the table to find the expected value or outcome.

	probability of event	amount won or lost	product
win	⅙ ≈ 0.17	-1+10 = $9	$1.53
lose	⅚ ≈ 0.83	-1-2 = $-3	-$2.49
			-$0.96

This is still not worth playing. If you play for a long time, you will lose about $1 per game (actually $0.96) on average.

I'm looking at whether or not to purchase a fire insurance policy for my house. I'm referencing this article, but it's quite complicated so I simplified the numbers. Use the following information:

- the likelihood of a house burning is 1%
- the house would cost 350,000 to replace
- the policy costs me $1000 per year
- in the event of a claim for a fire, I have to first pay a $2000 deductible. The rest of the value of the house will be reimbursed.

I will complete two tables, one for "no insurance" and another for "with insurance".

Table 1: No Insurance

	probability of event	amount won or lost	product
house burns	1%=0.01	-350,000	-$3500
house doesn't burn	99%=0.99	0	$0
	100% = 1.00		-$3500

Table 2: With Insurance

	probability of event	amount won or lost	product
house burns	1%=0.01	-1000-2000=-3000*	-$30
house doesn't burn	99%=0.99	-1000	-$990
	100% = 1.00		-$1020

* If the house burns, the insurance policy will pay to replace the house, so I only lose the amount of the deductible and the amount of the insurance that I paid.

Without insurance, my expected loss this year is $3500.
With insurance, my expected loss is only $1020
Write your decision: I will buy insurance.