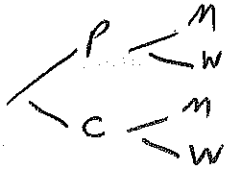
Geometry
Combinatorics Worksheet –
Simple Cases, Pascal's Triangle Day 1

Name Key
Period ____

1. For dinner, you must choose pizza (P) or chicken (C), and either milk (M) or water (W). Use a tree diagram, and list the outcome set (set of all possible dinners).

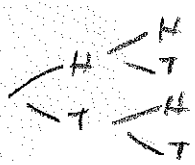


PM, PW, CM, CW
(4 outcomes)

2. In a certain state the license plates are 3 numerical digits followed by one letter. How many license plates are possible?

$\frac{10}{\text{num}} \quad \frac{10}{\text{num}} \quad \frac{10}{\text{num}} \quad \frac{26}{\text{letter}} = \boxed{26{,}000}$

3. Suppose you toss a coin twice. What are the possible outcomes? Draw a tree diagram to determine the outcome set.



HH, HT, TH, TT
4 outcomes

4. You roll two dice. What are all the possible outcomes?

$\frac{6}{\text{1st roll}} \times \frac{6}{\text{2nd roll}} = \boxed{36}$

5. If you roll two dice and add the numbers together, how many different sums are possible?

1+1=2
6+6=12

2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

11 possible sums

6. Alex has 6 pairs of pants, 10 shirts and 3 pairs of shoes that he wears for work. How many different combinations of a pair of pants, a shirt and a pair of shoes can Alex wear to work?

$\frac{6}{\text{pants}} \times \frac{10}{\text{shirts}} \times \frac{3}{\text{shoes}} = \boxed{180 \text{ outfits}}$

7. In how many ways can Jordan, Shelby, Sean, Nathan, and Steven stand in line?

$\frac{5}{} \quad \frac{4}{} \quad \frac{3}{} \quad \frac{2}{} \quad \frac{1}{}$

20 6

$\frac{20}{\times 6}$
120

120

8. Danielle, Connor, and Isaac ran in a race. In how many different orders can they finish the race?

$\frac{3}{1^{st}} \times \frac{2}{2^{nd}} \times \frac{1}{3^{rd}} = 6$

9. From 6 students (4 boys and 2 girls) a teacher wishes to pick a boy and a girl. Find the number of possible outcomes.

$\frac{4}{boys} \times \frac{2}{girl} = 8$

10. If a store has three kinds of sweaters each in eight different colors, how many different sweaters can you buy?

$\frac{3}{kinds} \times \frac{8}{colors} = 24$

11. Write the first ten rows of Pascal's Triangle:

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1
1 8 28 56 70 56 28 8 1
1 9 36 84 126 126 84 36 9 1

Geometry
Counting Worksheet Day 2

Name Key

1. How many four-person committees can be chosen from a group of seven people?

$$_7C_4 = \frac{7!}{(7-4)!\,4!} = \frac{7!}{3!4!} = \frac{7\cdot6\cdot5\cdot4\cdot3\cdot2\cdot1}{3\cdot2\cdot1\cdot4\cdot3\cdot2\cdot1} = 35$$

2. Find the number of possible choices when you choose one item from each category: 3 cars, 5 colors

$3 \cdot 5 = 15$

3. How many four-digit numbers can you make by arranging the numbers 1, 3, 7, and 9?

$4 \cdot 3 \cdot 2 \cdot 1 = 24$

D1 4. In how many ways can Jordan, Shelby, Sean, Nathan, and Steven stand in line?

$5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 120$

5. There are ten players on the basketball team. How many ways can a starting lineup of five players be chosen?

$$_{10}C_5 = \frac{10!}{5!5!} = \frac{10\cdot9\cdot8\cdot7\cdot6}{5\cdot4\cdot3\cdot2\cdot1} = 252$$

6. How many ways can a president and vice-president be selected in a class of seventeen students? order matter

$$_{17}P_2 = \frac{17!}{15!} = 17\cdot16 = 272$$

P1 7. Danielle, Connor, and Isaac ran in a race. In how many different orders can they finish the race?

$3 \cdot 2 \cdot 1 = 6$

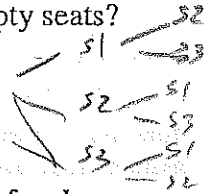
D C I
D I C
C D I
C I D
I D C
I C D

8. Find the number of possible choices when you choose one item from each category: 3 drinks, 4 vegetables, 2 desserts.

$3 \cdot 4 \cdot 2 = 24$

9. If there are three seats available on the bus and two people who want to sit down, how many different ways can those two people arrange themselves in the empty seats?

$3 \cdot 2 = 6$



10. Ms. Crump always includes a few bonus questions on her tests. Since if you get them wrong they don't count against your score, you might as well try them. However, on the last test she said you were only allowed to answer two of the five bonus questions offered. How many ways could this happen?

$$_5C_2 = \frac{5!}{3!2!} = \frac{5\cdot4}{2} = 10$$

AB BC CD DE
AC BD CE
AE BE

11. Andrew has six different kinds of cars to use on his model railroad. In how many different orders can he arrange the cars to be pulled by the engine?

$6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 720$

30 · 24
120
60
720

12. It is student council election time again! Your principle has asked you to vote for two representatives from your math class. Since your class is small (8 students) it should not be too hard to figure out how many ways two students could be selected in this process. Can you figure it out?

$$_8C_2 = \frac{8!}{6!2!} = \frac{8\cdot7\cdot6\cdot5\cdot4\cdot3\cdot2\cdot1}{6\cdot5\cdot4\cdot3\cdot2\cdot1\cdot2\cdot1} = 28$$

13. How many different ways is there to arrange 5 students in a row?

a) 5 b) 15 c) 25 d) 50 e) 120

5 4 3 2 1 = 120

14. How many ways are there to arrange 6 chairs in a row?

a) 36 b) 216 c) 512 d) 720 e) 46,656

6 5 4 3 2 1 = 720

15. How many different two-digit numbers can be formed using each of the digits 3, 5, and 7 only once?

a) 3 b) 6 c) 8 d) 9 e) 12

3 2 = 6

16. A box contains four slips of paper, each with one of the letters m, a, t, or h written on it. What is the number of three-letter outcomes that may be selected?

a) 12 b) 24 c) 36 d) 48 e) 60

4 3 2 = 24

17. How many different four-digit numbers can be formed from using the digits 2, 5, 6, and 8, if each digit is used only once in each arrangement?

a) 4 b) 12 c) 20 d) 24 e) 28

4 3 2 1 = 24

18. How many 4-digit numbers are possible using the digits 1, 2, 3, 4, 5, and 6, no digit used twice? (or > 2)

a) 256 b) 360 c) 512 d) 720 e) 1024

6 5 4 3 = 360

19. How many combinations of 4 CD's can be chosen from 14 CD's offered by a CD club?

a) 124 b) 321 c) 518 d) 742 e) 1001

$_{14}C_4 = \frac{14!}{10!\,4!} = \frac{14\cdot13\cdot12\cdot11}{4\cdot3\cdot2\cdot1} = 1001$

20. A book club offers your choice of 3 bestsellers for \$10. How many combinations of 3 bestsellers can you choose from among the 15 offered by the club?

a) 90 b) 365 c) 256 d) 455 e) 1025

$_{15}C_3 = \frac{15!}{12!\,3!} = \frac{15\cdot14\cdot13}{3\cdot2\cdot1} = 455$

21. From 6 students, 4 boys and 2 girls, a teacher wishes to pick a boy and a girl. Find the number of possible outcomes.

a) 4 b) 7 c) 8 d) 9 e) 15

4 2 = 8

22. Seth is to select a center and guard for his basketball team from a group of 7 people. Find the number of possible outcomes.

a) 14 b) 42 c) 49 d) 56 e) 72

7 · 6

23. New license plates for passenger cars in Massachusetts display three digits followed by three letters. What is the number of different plates possible?

a) 16,986,000 b) 17,576,000 c) 18,824,000 d) 20,124,000 e) 22,980,000

10 10 10 26 26 26

24. Authorization codes used by company consist four digits followed by two letters. How many different authorization codes are possible?

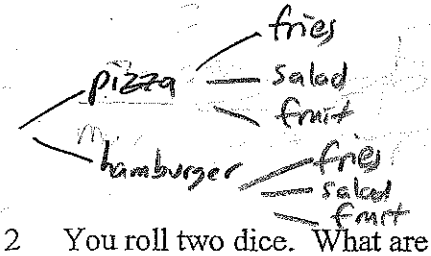
a) 920,000 b) 5,560,000 c) 5,600,000 d) 6,084,000 e) 6,760,000

10 10 10 10 26 26

Geometry
Counting/Combinations/Permutations
Worksheet Day 3

Name Key
Date _____ Period _____

1 Suppose you're at a restaurant and you can choose between pizza and a hamburger as a main meal, fries, salad, and fruit as a side dish. What are the possible meal combinations you could make?



pizza & fries
pizza & salad
pizza & fruit
hamburger & fries
hamburger & salad
hamburger & fruit

2 You roll two dice. What are all the possible outcomes?

11	21	31	41	51	61
12	22	32	42	52	62
13	23	33	43	53	63
14	24	34	44	54	64
15	25	35	45	55	65
16	26	30	46	56	66

3 In how many ways can three letters be chosen from the letters A, B, C, D, and E? (ABC is different from ACB, etc.) ← order matters = permutation

using boxes: $\boxed{5} \times \boxed{4} \times \boxed{3} = \boxed{35}$
1st letter, 2nd letter, 3rd letter

using formula: ${}_5P_3 = \frac{n!}{(n-r)!} = \frac{5!}{2!}$

$= \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{2 \cdot 1} = 5 \cdot 4 \cdot 3 = \boxed{35}$

4 Use Pascal's Triangle to evaluate

a ${}_3C_2 = \boxed{3}$ b ${}_5C_3 = \boxed{10}$ c ${}_6C_4 = \boxed{15}$ d ${}_6C_2 = \boxed{15}$

1
1 1
1 2 1
1 3 (3) 1
1 4 6 4 1
1 5 10 (10) 5 1
1 6 (15) 20 (15) 6 1

5 A pizza shop offers seven toppings. How many different "four item" pizzas can be made?

${}_7C_4 = \frac{7!}{3!4!} = \frac{7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{3 \cdot 2 \cdot 1 \cdot 4 \cdot 3 \cdot 2 \cdot 1} = \frac{7 \cdot 6 \cdot 5}{3 \cdot 2} = \boxed{35}$

(order doesn't matter)

6 Six of your favorite songs are not among the 17 chosen by a radio station. If you want to play three of your favorite songs, in how many ways can you choose three songs from the six?

assuming order doesn't matter: ${}_6C_3 = \boxed{20}$ (by Pascal's Δ)

Geometry

Name _____

Combinations/Permutations

Per/Sec. _____ Date _____

1. Each of two dice is marked with a different integer from 1 to 6 inclusive. The two dice are rolled and the numbers on the top face of each die are added. How many different sums are possible?

a) 11 b) 12 c) 24 d) 34 e) 36

lowest = 1+1 highest 6+6

2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

2. Two dice are tossed. What is the number of ways 8 can appear from the throw of the dice?

a) 0 b) 2 c) 4 d) 5 e) 6

6+2
5+3
4+4
3+5
2+6

6+2
5+3
4+4

3. How many possible outcomes are there if you roll 2 dice?

a) 12 b) 36 c) 48 d) 60 e) 72

assuming order matters: $\frac{6}{1^{st}\text{ die}} \cdot \frac{6}{2^{nd}\text{ die}} = 36$

4. Two coins are tossed, a penny and a dime. What is the number of possible outcomes?

a) 1 b) 2 c) 3 d) 4 e) 5

H H
H T
T H
T T

5. Eight boys and twelve girls attend a party. How many different dancing pairs of one girl and one boy can be formed?

a) 4 b) 20 c) 40 d) 80 e) 96

$\frac{8}{}\cdot\frac{12}{}$

6. Emily has 5 blouses and 3 pair of slacks. Find the number of possible outfits consisting of one blouse and one pair of slacks.

a) 2 b) 4 c) 8 d) 15 e) $\frac{3}{5}$

$\frac{5}{\text{blouses}} \cdot \frac{3}{\text{slacks}} = 15$

7. A student has a choice of 4 math classes and 5 history classes. In how many ways can she choose one math and one history class?

a) 9 b) 10 c) 20 d) 24 e) 54

$\frac{4}{\text{math}} \cdot \frac{5}{\text{history}} = 20$

8. There are 5 candidates for governor and 6 candidates for controller. In how many ways can these offices be filled?

a) 4 b) 11 c) 18 d) 24 e) 30

$\frac{5}{\text{gov}} \cdot \frac{6}{\text{cont.}} = 30$

9. Patrick picks a marble from a bag containing 8 differently colored marbles, then replaces the marble, and picks another. What is the number of possible outcomes?

a) 56 b) 64 c) 128 d) 256 e) 512

$\frac{8}{1^{st}\text{ pick}} \cdot \frac{8}{2^{nd}\text{ pick}} = 64$

10. A room has 5 doors. In how many ways can Miguel enter the room and leave by any door?

a) 5 b) 10 c) 15 d) 20 e) 25

$\frac{5}{\text{enter door}} \cdot \frac{5}{\text{leave door}} = 25$

11. There are 5 candidates for senior class president, 3 candidates for vice president, and 4 candidates for secretary. How many different ways can the offices be filled?

a) 12 b) 30 c) 35 d) 60 e) 75

order matters, Permutation:

$\frac{5}{P} \cdot \frac{3}{VP} \cdot \frac{4}{sec} = 60$

12. Alex has 6 pairs of pants, 10 shirts, and 3 pairs of shoes that he wears for work. How many different combinations of a pair of pants, a shirt, and a pair of shoes can Alex wear to work?

a) 140 b) 155 c) 180 d) 200 e) 225

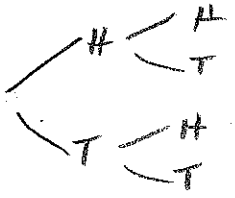
$\frac{6}{\text{pants}} \cdot \frac{10}{\text{shirts}} \cdot \frac{3}{\text{shoes}} = 180$

Geometry
Counting/Combinations/Permutations
Day 3

Key

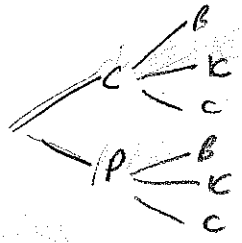
I. Trees

1 Suppose you toss a coin twice. What are the possible outcomes? Draw a tree diagram to determine the outcome set.



HH
HT
TH
TT

2 Suppose you are on an airplane, and you have a choice of chicken or pasta for the main meal and a choice of a brownie, ice cream, or cookies for dessert. What are all the possible meals you could select? Draw a tree diagram to determine the answer.



chicken & brownie
chicken & ice cream
chicken & cookies
pasta & brownie
pasta & ice cream
pasta & cookies

II Permutations (No repetition, order matters)

1 Five horses are running a race. In how many different ways can these horses come in first, second, or third place?

Formula: $_5P_3 = \frac{5!}{(5-3)!} = \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{2 \cdot 1} = 5 \cdot 4 \cdot 3 = 60$

boxes: $\frac{5}{1^{st}\text{ place}} \cdot \frac{4}{2^{nd}\text{ place}} \cdot \frac{3}{3^{rd}\text{ place}} = 60$

2 Find the number of different ways to arrange four people in a line.

$4 \cdot 3 \cdot 2 \cdot 1 = 24$ ways

III Combinations

1 At Coldstone Creamery you can choose between nuts, Oreos, and sprinkles as your toppings. How many different ways can you choose two of the toppings? Draw a tree diagram to determine the answer. nuts & oreos, nuts & sprinkles, ~~oreos & nuts~~, oreos & sprinkles, ~~sprinkles & nuts~~, ~~sprinkles & oreos~~ ← crossed out duplicates (if order doesn't matter)

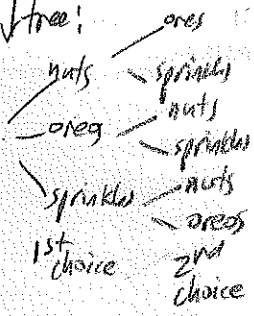
3 ways

We call choosing r items from a possible n items <u>combinations</u>, and the notation is ${}_nC_r$ --"n choose r." In our last example we had to choose 2 topping from a total of 3 toppings. We would say "${}_3C_2$" or "3 choose 2."

We can always make a tree diagram for combinations, but sometimes it gets a little confusing, especially if we have many items to choose from. There is no repetition and order does <u>not</u> matter.

It can be easier to evaluate ${}_nC_r$ by using Pascal's Triangle:

tree!



Pascal's Triangle

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1

Let's refer back to our Coldstone Creamery example where we needed to evaluate ${}_3C_2$.

Count down to row 3.
Go over to column 2. (Don't forget to start counting with 0.)

The answer for ${}_3C_2$ is 3

Now try the following examples:

${}_4C_3 =$ 4 ${}_2C_1 =$ 2

${}_5C_2 =$ 10 ${}_6C_4 =$ 15

2 Suppose that there is a club that has six members. How many ways can a committee of 3 members be formed? ${}_6C_3 = 20$

Geometry
Combinatorics Worksheet –
Simple Cases, Pascal's Triangle

Name_____

Period _____

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11. Write the first ten rows of Pascal's Triangle:

Geometry
Counting Worksheet

Name_____

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2. Find the number of possible choices when you choose one item from each category: 3 cars, 5 colors

3. How many four-digit numbers can you make by arranging the numbers 1, 3, 7, and 9?

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5. There are ten players on the basketball team. How many ways can a starting lineup of five players be chosen?

6. How many ways can a president and vice-president be selected in a class of seventeen students?

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13. How many different ways is there to arrange 5 students in a row?

a) 5 b) 15 c) 25 d) 50 e) 120

14. How many ways are there to arrange 6 chairs in a row?

a) 36 b) 216 c) 512
d) 720 e) 46,656

15. How many different two-digit numbers can be formed using each of the digits 3, 5, and 7 only once?

a) 3 b) 6 c) 8 d) 9 e) 12

16. A box contains four slips of paper, each with one of the letters m, a, t, or h written on it. What is the number of three-letter outcomes that may be selected?

a) 12 b) 24 c) 36 d) 48 e) 60

17. How many different four-digit numbers can be formed from using the digits 2, 5, 6, and 8, if each digit is used only once in each arrangement?

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18. How many 4-digit numbers are possible using the digits 1, 2, 3, 4, 5, and 6, no digit used twice?

a) 256 b) 360 c) 512 d) 720 e) 1024

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Geometry
Counting/Combinations/Permutations
Worksheet

Name_____
Date_____Period_____

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2 You roll two dice. What are all the possible outcomes?

3 In how many ways can three letters be chosen from the letters A, B, C, D, and E? (ABC is different from ACB, etc.)

4 Use Pascal's Triangle to evaluate

a $_3C_2$ b $_5C_3$ c $_6C_4$ d $_6C_2$

5 A pizza shop offers seven toppings. How many different "four item" pizzas can be made?

6 Six of your favorite songs are not among the 17 chosen by a radio station. If you want to play three of your favorite songs, in how many ways can you choose three songs from the six?

Geometry

Name _____

Combinations/Permutations

Per/Sec. _____ Date _____

1. Each of two dice is marked with a different integer from 1 to 6 inclusive. The two dice are rolled and the numbers on the top face of each die are added. How many different sums are possible?

   a) 11 b) 12 c) 24 d) 34 e) 36

2. Two dice are tossed. What is the number of ways 8 can appear from the throw of the dice?

   a) 0 b) 2 c) 4 d) 5 e) 6

3. How many possible outcomes are there if you roll 2 dice?

   a) 12 b) 36 c) 48 d) 60 e) 72

4. Two coins are tossed, a penny and a dime. What is the number of possible outcomes?

   a) 1 b) 2 c) 3 d) 4 e) 5

5. Eight boys and twelve girls attend a party. How many different dancing pairs of one girl and one boy can be formed?

   a) 4 b) 20 c) 40 d) 80 e) 96

6. Emily has 5 blouses and 3 pair of slacks. Find the number of possible outfits consisting of one blouse and one pair of slacks.

   a) 2 b) 4 c) 8 d) 15 e) $\frac{3}{5}$

7. A student has a choice of 4 math classes and 5 history classes. In how many ways can she choose one math and one history class?

   a) 9 b) 10 c) 20 d) 24 e) 54

8. There are 5 candidates for governor and 6 candidates for controller. In how many ways can these offices be filled?

   a) 4 b) 11 c) 18 d) 24 e) 30

9. Patrick picks a marble from a bag containing 8 differently colored marbles, then replaces the marble, and picks another. What is the number of possible outcomes?

   a) 56 b) 64 c) 128 d) 256 e) 512

10. A room has 5 doors. In how many ways can Miguel enter the room and leave by any door?

    a) 5 b) 10 c) 15 d) 20 e) 25

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    a) 12 b) 30 c) 35 d) 60 e) 75

12. Alex has 6 pairs of pants, 10 shirts, and 3 pairs of shoes that he wears for work. How many different combinations of a pair of pants, a shirt, and a pair of shoes can Alex wear to work?

    a) 140 b) 155 c) 180 d) 200 e) 225

Geometry
Counting/Combinations/Permutations

I. Trees

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III Combinations

1 At Coldstone Creamery you can choose between nuts, Oreos, and sprinkles as your toppings. How many different ways can you choose two of the toppings? Draw a tree diagram to determine the answer.

We call choosing r items from a possible n items *combinations*, and the notation is ${}_nC_r$ --"n choose r." In our last example we had to choose 2 topping from a total of 3 toppings. We would say "${}_3C_2$" or "3 choose 2."

We can always make a tree diagram for combinations, but sometimes it gets a little confusing, especially if we have many items to choose from. There is no repetition and order does *not* matter.

It can be easier to evaluate ${}_nC_r$ by using Pascal's Triangle:

Pascal's Triangle

Let's refer back to our Coldstone Creamery example where we needed to evaluate ${}_3C_2$.

Count down to row 3.
Go over to column 2. (Don't forget to start counting with 0.)

The answer for ${}_3C_2$ is _____

Now try the following examples:

${}_4C_3 =$ _____ ${}_2C_1 =$ _____

${}_5C_2 =$ _____ ${}_6C_4 =$ _____

2 Suppose that there is a club that has six members. How many ways can a committee of 3 members be formed?