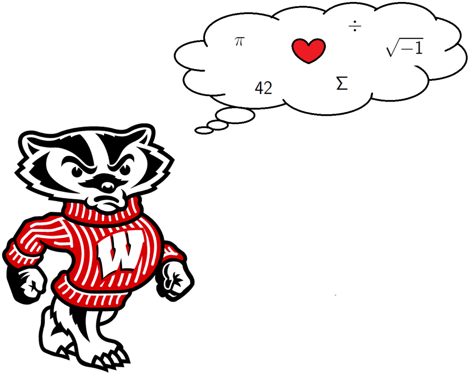
# Mega Math Meet 2019!

UW – Madison



# Welcome!

Please find a seat next to the sign with your team's name.

| Left | Center | Right |
|---|---|---|
| Fall River | Madison | Oregon |
| Fontana | McFarland Blue | Poynette |
| Hartland-Lakeside | McFarland White | Randall |
| Johnson Creek | Merton | Richmond |
| Kettle Moraine | Middleton-Cross Plains | Sauk Prarie |
| Lake Country | Milton | Trevor-Wilmot |
| Lake Mills | Monona Grove | Waunakee |

# Welcome!

*No calculators will be used at the Mega Math Meet*

**Chaperones**: Thank you for coming! We need your help to keep this event on schedule. We need one runner per team...

...who are our runners? Come up to get the first problem.

# Talent Search

Each school year, the Talent Search creates five sets of five problems each and distributes them to high school and middle school students in the state of Wisconsin and throughout the world. These problems are unusual, challenging, and we hope, enjoyable. They are not easy, but their solutions do not require advanced mathematical knowledge, just hard work and creativity. Students can work on the problems at their own pace and send in their solutions to be graded. Top participants are invited to Madison for an Honors Day in the spring and to participate in an exam for the Van Vleck scholarship to UW-Madison.

For more information check out **www.math.wisc.edu/talent/**

# Mental Math

# PENCILS DOWN – Example Problem

Ready!

# PENCILS DOWN – Example Problem

5

# PENCILS DOWN – Example Problem

4

# PENCILS DOWN – Example Problem

3

# PENCILS DOWN – Example Problem

2

# PENCILS DOWN – Example Problem

1

# PENCILS DOWN – Example Problem

$$\frac{4 \times 5 \times 3 \times 16}{60}$$

# PENCILS UP – Example Problem

Write your answer now.

# PENCILS DOWN – Problem # 1

Ready!

# PENCILS DOWN – Problem # 1

5

# PENCILS DOWN – Problem # 1

4

3

# PENCILS DOWN – Problem # 1

2

# PENCILS DOWN – Problem # 1

1

# PENCILS DOWN – Problem # 1

$$\frac{3 \times 3 \times 75 \times 16}{3 \times 25 \times 6 \times 50}$$

# PENCILS UP – Problem # 1

Write your answer now.

# PENCILS DOWN – Problem # 2

Ready!

# PENCILS DOWN – Problem # 2

5

# PENCILS DOWN – Problem # 2

4

# PENCILS DOWN – Problem # 2

3

# PENCILS DOWN – Problem # 2

2

# PENCILS DOWN – Problem # 2

1

# PENCILS DOWN – Problem # 2

$$15000 \times 10^{-3} + 11 \times 10^{3} + 3 \times 10^{2}$$

## PENCILS UP – Problem # 2

Write your answer now.

# PENCILS DOWN – Problem # 3

Ready!

# PENCILS DOWN – Problem # 3

5

# PENCILS DOWN – Problem # 3

4

# PENCILS DOWN – Problem # 3

3

# PENCILS DOWN – Problem # 3

2

## PENCILS DOWN – Problem # 3

$$1$$

# PENCILS DOWN – Problem # 3

$$(3 + 6) + (7 \times 3) - (5 \times 2) + (9 \times 3) - (6 + 4)$$

## PENCILS UP – Problem # 3

Write your answer now.

# PENCILS DOWN – Problem # 4

Ready!

# PENCILS DOWN – Problem # 4

5

# PENCILS DOWN – Problem # 4

4

# PENCILS DOWN – Problem # 4

3

## PENCILS DOWN – Problem # 4

2

# PENCILS DOWN – Problem # 4

1

# PENCILS DOWN – Problem # 4

$$\frac{14 \times 5 - 6 \times 4}{2 + 8}$$

## PENCILS UP – Problem # 4

Write your answer now.

# PENCILS DOWN – Problem # 5

Ready!

# PENCILS DOWN – Problem # 5

5

# PENCILS DOWN – Problem # 5

4

# PENCILS DOWN – Problem # 5

3

# PENCILS DOWN – Problem # 5

2

# PENCILS DOWN – Problem # 5

1

# PENCILS DOWN – Problem # 5

$$\frac{30 \times 12 \times 7 \times 18}{21 \times 15 \times 3}$$

Write your answer now.

# PENCILS DOWN – Problem # 6

Ready!

# PENCILS DOWN – Problem # 6

5

# PENCILS DOWN – Problem # 6

4

# PENCILS DOWN – Problem # 6

3

# PENCILS DOWN – Problem # 6

2

# PENCILS DOWN – Problem # 6

1

# PENCILS DOWN – Problem # 6

$$(5 \times 3) - (2 \times 3) - (3 \times 3) \\ +(1 \times 8) + (4 \times 8)$$

# PENCILS UP – Problem # 6

Write your answer now.

Ready!

# PENCILS DOWN – Problem # 7

5

# PENCILS DOWN – Problem # 7

4

# PENCILS DOWN – Problem # 7

3

# PENCILS DOWN – Problem # 7

2

# PENCILS DOWN – Problem # 7

$$1$$

# PENCILS DOWN – Problem # 7

$$(6-1)+(5-8)+(9-7)+(8-3)$$

# PENCILS UP – Problem # 7

Write your answer now.

# PENCILS DOWN – Problem # 8

Ready!

## PENCILS DOWN – Problem # 8

5

# PENCILS DOWN – Problem # 8

4

# PENCILS DOWN – Problem # 8

3

# PENCILS DOWN – Problem # 8

2

# PENCILS DOWN – Problem # 8

$$1$$

## PENCILS DOWN – Problem # 8

$$(2 \times 5)^3 - (4 + 1)^2$$

# PENCILS UP – Problem # 8

Write your answer now.

# PENCILS DOWN – Problem # 9

Ready!

# PENCILS DOWN – Problem # 9

5

# PENCILS DOWN – Problem # 9

4

# PENCILS DOWN – Problem # 9

3

# PENCILS DOWN – Problem # 9

2

## PENCILS DOWN – Problem # 9

1

# PENCILS DOWN – Problem # 9

$$\frac{15^2 \times 4^4 \times 5}{60^2}$$

# PENCILS UP – Problem # 9

Write your answer now.

# PENCILS DOWN – Problem # 10

Ready!

## PENCILS DOWN – Problem # 10

5

# PENCILS DOWN – Problem # 10

4

# PENCILS DOWN – Problem # 10

3

# PENCILS DOWN – Problem # 10

2

# PENCILS DOWN – Problem # 10

1

# PENCILS DOWN – Problem # 10

$$\frac{24 \times 35}{6 \times 7 \times 2}$$

## PENCILS UP – Problem # 10

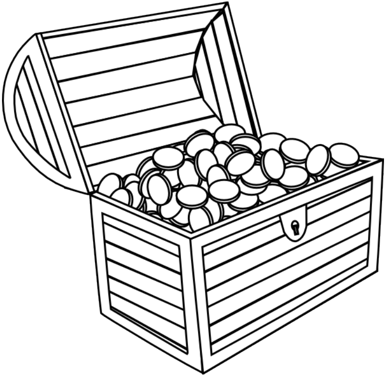
Write your answer now.

# End of the Mental Math Section

Please write your name on the top of your answer page

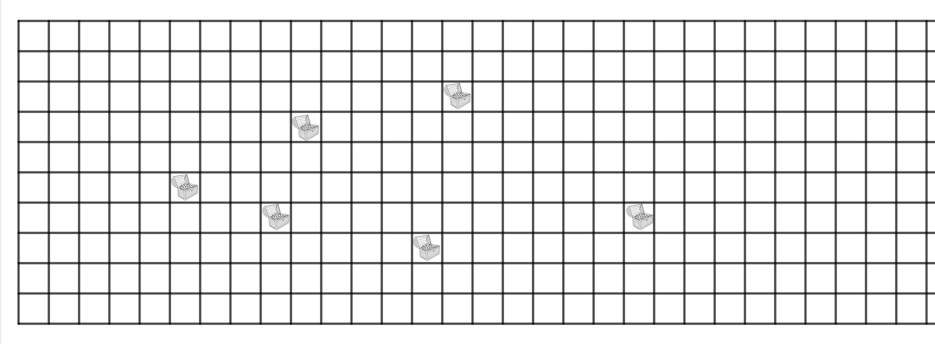
# Problem 2: Mega Math Treasure Hunt

Yarrrrr! On the shores of Lake Mendota is an area called Mathematician's Cove. Legends say that Captain Emmy, the famous pirate, hid her treasure in Mathematician's Cove.



# Problem 2: Mega Math Treasure Hunt

Mathematician's Cove is a rectangle which is made of **1000** squares of side 1 foot. Each square might contain one of the **100** coins hidden by Captain Emmy.



Instead of digging up the whole island, we use a metal detector... Unfortunately, the metal detector does not work so well....

# Problem 2: Mega Math Treasure Hunt

If the metal detector passes over a square with gold, it only beeps 90% of the time!

| | Beeps | Doesn't Beep |
|---|---|---|
| Has gold | 90% | 10% |
| Doesn't have gold | | |

If you try 10 times you *expect* that it will beep 9, but it might beep 10 times, 8 or even 0 if you're extremely unlucky!

# Problem 2: Mega Math Treasure Hunt

To make things worse, the metal detector sometimes beeps without a good reason: If the metal detector goes over a square **without** gold, it will beep 20% of the time!

| | Beeps | Doesn't Beep |
|---|---|---|
| Has gold | 90% | 10% |
| Doesn't have gold | 20% | 80% |

# Problem 2: Mega Math Treasure Hunt

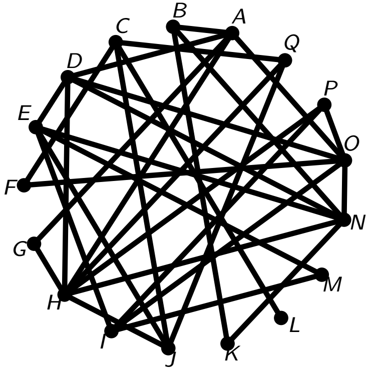
Try to find the gold! (So you can buy a better metal detector.)

**Remember to write your name on the top of your answer sheet!**

*You will have 10 minutes. Calculators are not needed.*

# Problem 3: Road maps

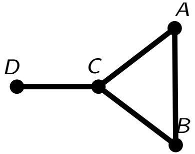
This is an example of a road map of Intricatonia:




It's very complicated! For this reason, Intricationians don't like to use road maps very much.

# Problem 3: Road maps

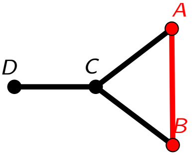
Since road maps are so complicated, Intricationians have invented **Road Tables**, where they record which city is connected to which. Here's an example of a map with its road table.




| | A | B | C | D |
|---|---|---|---|---|
| A | X | 1 | 1 | 0 |
| B | 1 | X | 1 | 0 |
| C | 1 | 1 | X | 1 |
| D | 0 | 0 | 1 | X |

# Problem 3: Road maps

When two cities have a road between them, the corresponding entry in the table is a 1:

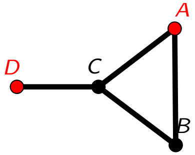



| | A | B | C | D |
|---|---|---|---|---|
| A | X | 1 | 1 | 0 |
| B | 1 | X | 1 | 0 |
| C | 1 | 1 | X | 1 |
| D | 0 | 0 | 1 | X |

Here A and B are connected by a road, so the table has 1's in row A, column B and in column B, row A.

# Problem 3: Road maps

When two cities have no road between them, the corresponding entry in the table is a 0:

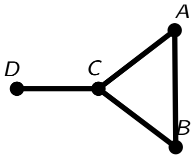



| | A | B | C | D |
|---|---|---|---|---|
| A | X | 1 | 1 | 0 |
| B | 1 | X | 1 | 0 |
| C | 1 | 1 | X | 1 |
| D | 0 | 0 | 1 | X |

Here A and D are not joined by a road, so the table has 0's in row A, column D and in column D, row A.

# Problem 3: Road maps

Finally, there are no roads connecting a city to itself, so we don't worry about the entries in the diagonal.




| | A | B | C | D |
|---|---|---|---|---|
| A | X | 1 | 1 | 0 |
| B | 1 | X | 1 | 0 |
| C | 1 | 1 | X | 1 |
| D | 0 | 0 | 1 | X |

Sometimes, Intricationians draw ellaborate pictures of chickens instead of X's because it doesn't really matter what you put in the diagonal.

# Problem 3: Road maps

Help the Intricatonians by drawing some maps for them!

**Remember to write your name on the top of your answer sheet!**

*You will have 15 minutes. Calculators are not needed.*

# Problem 4: Boxes of Apples

Sun Woo and Brandy worked at Jordan's orchard for 5 days at the end of September last year. Their main job was to pick the apples and store them in boxes. After the harvest was finished and the boxes were collected, they had to sort the boxes of apples by weight.

# Problem 4: Boxes of Apples

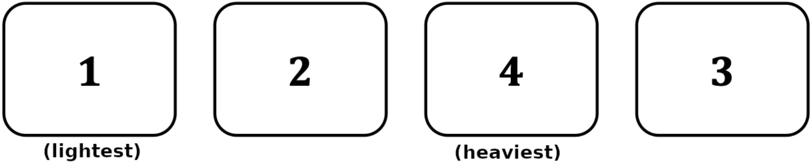
Unfortunately, the only tool provided to Sun Woo and Brandy was a giant two-sided mechanical scale.

# Problem 4: Boxes of Apples

1. Sun Woo and Brandy were able to tie two adjacent boxes to each side of the mechanical scale to compare the weight of these two boxes. They could also use the mechanical scale to swap the chosen adjacent boxes.
2. Both Sun Woo and Brandy did not know the exact weight of all the boxes. They could only determine which of the two adjacent boxes was heavier by using the two-sided mechanical scale.
3. The boxes were too heavy for Sun Woo and Brandy to carry, so they could only use the mechanical scale to swap the adjacent boxes.
4. Sun Woo and Brandy found a method for sorting the boxes. Let's do an example.

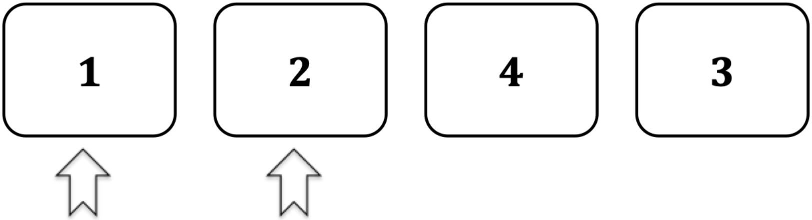
# Problem 4: Boxes of Apples

Say we have four boxes. We've labelled them from lightest (1) to heaviest (4).



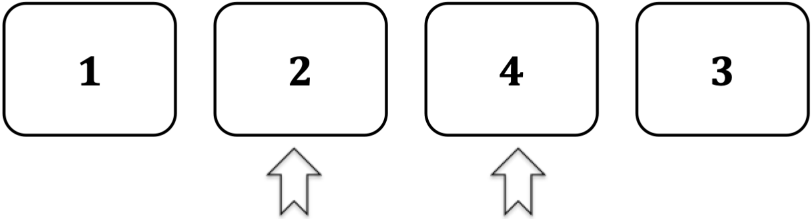
# Problem 4: Boxes of Apples

First, Sun Woo and Brandy use the scale to compare the first two boxes. The box on the left is lighter, so they don't swap the boxes.



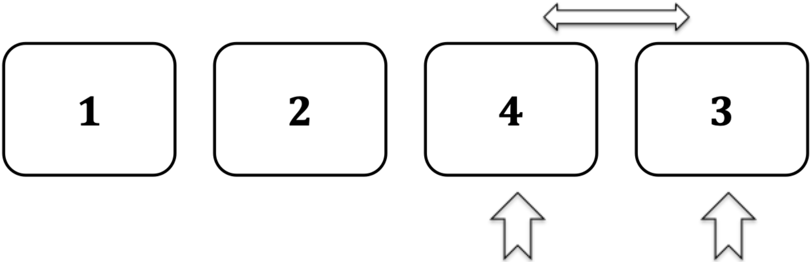
# Problem 4: Boxes of Apples

Sun Woo and Brandy now compare the boxes in the second and third positions. Again, the box on the left is lighter, so they don't swap the boxes.



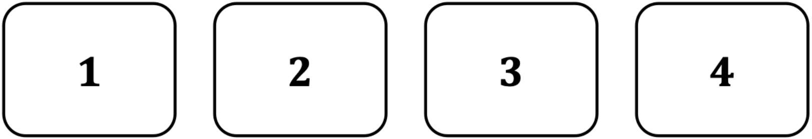
# Problem 4: Boxes of Apples

Finally, they compare the boxes in the third and fourth positions. This time, the box on the right is lighter, so they swap the boxes.



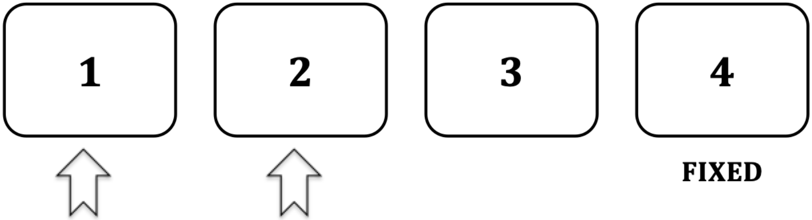
# Problem 4: Boxes of Apples

At this point, Sun Woo and Brandy know for a fact that the rightmost box is the heaviest. However, they did not know for sure whether the remaining 3 boxes were arranged correctly!



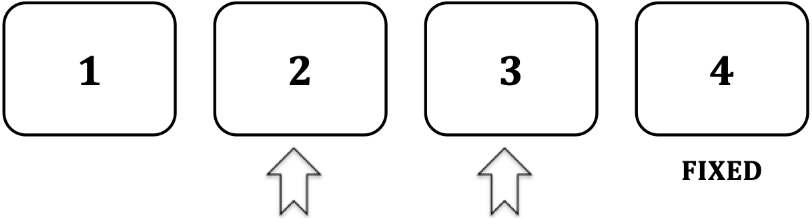
# Problem 4: Boxes of Apples

Now Sun Woo and Brandy need to sort the boxes in the first three positions, so they start over from the beginning. The box on the left is lighter, so they don't swap the boxes.



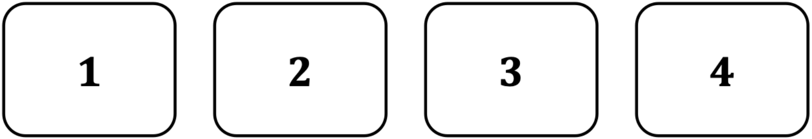
# Problem 4: Boxes of Apples

Now they compare the boxes in the second and third positions. The box on the left is lighter, so they don't swap the boxes.



## Problem 4: Boxes of Apples

Remember that Sun Woo and Brandy already know the last box is the heaviest. Since they went through all the other boxes without swapping any boxes, they must be in the correct order! Overall, they used the scale **5 times**.



# Problem 4: Boxes of Apples

Help Sun Woo and Brandy to sort the apples!

**Remember to write your name on the top of your answer sheet!**

*You will have 15 minutes. Calculators are not needed.*

# Team Problems

Great work so far! Next, your team will work together to solve two team problems:

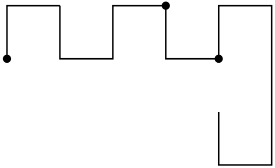
# Team Problems

OK! You will be working on your team problems in the other rooms in this building. Your teacher has been told which room you will be working in. Please stay with your team and your teacher, and we'll head over there together. You can take a snack and restroom break once we get there!

**Chaperones:** Once your students have had their snack, please time the team event. Your team gets 30 minutes total to complete both problems (we recommend splitting into two groups). Please try to start by 11:00.
Once the students are done, please accompany your team back to this room! You only need to turn in one final copy of each problem; be sure your **team name** is on both.

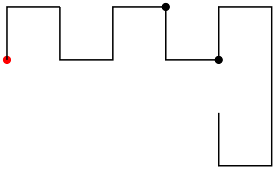
# Team Problem 1: Figure Drawing

In this problem, we're going to turn pictures into words!
**Example:** We are given the following figure:



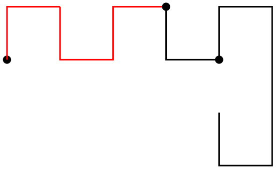
# Team Problem 1: Figure Drawing

The three dots signify that there are three letters. The first letter starts at the red dot.



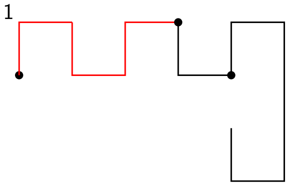
# Team Problem 1: Figure Drawing

Let's look at the first letter!



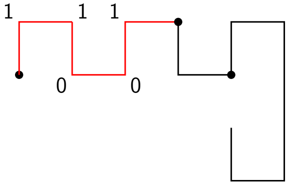
# Team Problem 1: Figure Drawing

Each right turn means 1 and each left turn means 0.
The first turn in the first letter is a right turn, so the first turn gives us a 1.



# Team Problem 1: Figure Drawing

The first letter is 11001.



# Team Problem 1: Figure Drawing

How does 11001 give us a letter?
11001 is a number in binary notation.
We're used to base 10 numbers. For example,

$$324 = 3 \times 100 + 2 \times 10 + 4 \times 1$$

For binary, instead of using $1, 10, 100, \ldots$, we use $1, 2, 4, 8, 16, \ldots$.
So,

$$\begin{array}{ccccccccccc} 1 & & 1 & & 0 & & 0 & & 1 & & \\ 16 & + & 8 & + & 0 & + & 0 & + & 1 & = & 25 \end{array}$$

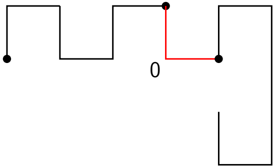
# Team Problem 1: Figure Drawing

Now, we can match up numbers and letters using the following table. The first letter is ‘Z’.

| Letter | Number | Letter | Number |
|---|---|---|---|
| A | 0 | N | 13 |
| B | 1 | O | 14 |
| C | 2 | P | 15 |
| D | 3 | Q | 16 |
| E | 4 | R | 17 |
| F | 5 | S | 18 |
| G | 6 | T | 19 |
| H | 7 | U | 20 |
| I | 8 | V | 21 |
| J | 9 | W | 22 |
| K | 10 | X | 23 |
| L | 11 | Y | 24 |
| M | 12 | Z | 25 |

# Team Problem 1: Figure Drawing

The second letter is 0. This is already in binary!



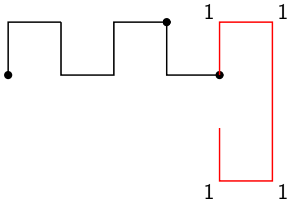
# Team Problem 1: Figure Drawing

So the second letter is ‘A’.

| Letter | Number | Letter | Number |
|---|---|---|---|
| A | 0 | N | 13 |
| B | 1 | O | 14 |
| C | 2 | P | 15 |
| D | 3 | Q | 16 |
| E | 4 | R | 17 |
| F | 5 | S | 18 |
| G | 6 | T | 19 |
| H | 7 | U | 20 |
| I | 8 | V | 21 |
| J | 9 | W | 22 |
| K | 10 | X | 23 |
| L | 11 | Y | 24 |
| M | 12 | Z | 25 |

# Team Problem 1: Figure Drawing

The second letter is 1111.



# Team Problem 1: Figure Drawing

$$\begin{array}{ccccccccc} 1 & & 1 & & 1 & & 1 & & \\ 8 & + & 4 & + & 2 & + & 1 & = & 15 \end{array}$$

# Team Problem 1: Figure Drawing

So the second letter is 'P', and the word is "ZAP".

| Letter | Number | Letter | Number |
|---|---|---|---|
| A | 0 | N | 13 |
| B | 1 | O | 14 |
| C | 2 | P | 15 |
| D | 3 | Q | 16 |
| E | 4 | R | 17 |
| F | 5 | S | 18 |
| G | 6 | T | 19 |
| H | 7 | U | 20 |
| I | 8 | V | 21 |
| J | 9 | W | 22 |
| K | 10 | X | 23 |
| L | 11 | Y | 24 |
| M | 12 | Z | 25 |

# Team Problem 1: Figure Drawing

We need you to crack the codes!

*Your team will have 30 minutes. Calculators are not needed.*

# Team Problem 2: Pigs, Politics, and Ice Cream

- A small group of pigs have formed a political organization, and they want to share a tub of ice cream at each meeting.
- The budget only allows for one tub of ice cream!
- The pigs must vote every day to decide on a flavor.

# Team Problem 2: Pigs, Politics, and Ice Cream

The available flavors are **A**pricot, **B**utter pecan, and **C**offee. If Wilbur prefers coffee to apricot and apricot to butter pecan, he would write C>A >B for his ballot.
After counting the ballots, here are the results:

| Number of Ballots | Preference |
|---|---|
| 3 | A>B>C |
| 2 | B>C>A |
| 2 | C>B>A |
| 2 | C>A>B |

# Team Problem 2: Pigs, Politics, and Ice Cream

One way to determine the most popular flavor is by using overall popularity.

| Number of Ballots | Preference |
|---|---|
| 3 | A>B>C |
| 2 | B>C>A |
| 2 | C>B>A |
| 2 | C>A>B |

# Team Problem 2: Pigs, Politics, and Ice Cream

Overall, C>A, because there are 6 ballots with C>A and only 3 with A>C;

| Number of Ballots | Preference |
|---|---|
| 3 | A>B>C |
| 2 | B>C>A |
| 2 | C>B>A |
| 2 | C>A>B |

# Team Problem 2: Pigs, Politics, and Ice Cream

Overall, B>C, because there are 5 ballots with B>C and only 4 with C>B;

| Number of Ballots | Preference |
|---|---|
| 3 | A>B>C |
| 2 | B>C>A |
| 2 | C>B>A |
| 2 | C>A>B |

# Team Problem 2: Pigs, Politics, and Ice Cream

Overall, A>B, because there are 5 ballots with A>B and only 4 with B>A

| Number of Ballots | Preference |
|---|---|
| 3 | A>B>C |
| 2 | B>C>A |
| 2 | C>B>A |
| 2 | C>A>B |

# Team Problem 2: Pigs, Politics, and Ice Cream

- The overall popularity order is A>B>C>A>B>C>...
- So there is no objectively most popular flavor!
- Each day the pigs will pick an alternative voting method to determine which flavor to get. You will help the pigs determine the winner every day!

*Your team will have 30 minutes. Calculators are not needed.*

# Charades! Rules:

- Each team member will take turns playing the actor.
- The rest of the team will turn and face the audience while a math word or phrase is briefly flashed on the screen.
- It is very important that the team members facing away from the screen do not hear the clue– we ask the audience to NOT call out the answer. If a judge hears an audience member call out the clue, then that schools team will lose a point.
- The actors must pantomime to get their team to guess the clue.
- The actors may use any signals or motions they like, as long as they dont talk, mouth words, or spell out words.
- The first team to correctly guess the clue will receive a point. If no team guesses the clue in two minutes, we'll move on.
- The team with the most points at the end wins!

## Charades!

READY??

Pencil

# Charades!

# Charades!

Square

# Charades!

# Charades!

Radius

# Charades!

# Charades!

Banana

# Charades!

# Charades!

y-axis

# Charades!

# Charades!

multiply

# Charades!

# Charades!

fraction

# Charades!

# Charades!

parallel

# Charades!

## Charades!

teacher

# Charades!

# Charades!

sqhere

# Charades!

## Charades!

calculator

# Charades!

# Charades!

puppy

# Charades!

# Charades!

Pi

# Charades!

# Charades!

Divide

# Charades!

# Charades!

Billion

# Charades!

## Charades!

Football

# Charades!

# Charades!

Pentagon

# Charades!

## Charades!

Area

# Charades!

## Charades!

Perpendicular

# Charades!

## Charades!

Odd number

# Charades!

# Charades!

infinity

# Charades!

Spider Man

# Charades!

# Charades!

probability

# Charades!

# Charades!

test

# Charades!

## Charades!

average

# Charades!

# Charades!

acute angle

# Charades!

Right Angle

# Charades!

## Charades!

I Love Math!