LESSON 1

Name: _____ School: _____

# HOW SMALL IS SMALL?

***Explore the Scale of Microscopic Life***

*Includes excerpts from: www.exploratorium.edu/*

Viruses are much smaller than human cells; they are even smaller than the bacteria in our bodies. Their tiny size makes them too small to see under a light microscope and detectable only by other means. It also means they are small enough to ride on a tiny sneeze droplet.

**Materials:** Scissors, table to work on

**Procedure:** Cut out each of these labels. Can you guess the relative size of each object? Put them in order from smallest to largest. ***OPTIONAL: Take a picture and send it in with your lesson!***

| | |
|---|---|
| **sneeze droplet** | **DNA** |
| **wavelength of blue light** | **virus** |
| **ribosome** | **this dot --> .** |
| **antibody** | **N95 mask pore size** |
| **antibody** | **protein** |
| **human cell** | **bacteria** |

***Cut out the whole box first**, then cut out each individual* square. If your lesson is printed two-sided, you can still cut out the box and preserve the rest of what's on the back side.

When you try to arrange these items according to size, you get a feel for the point at which things become difficult to visually imagine. You can easily see ants and 24-point periods, for example, but what about a bacterium or the droplet from a sneeze? Humans only directly interact with things that are of a size within a few orders of magnitude of our length scale, around 1 meter**. It's difficult to grasp the relative sizes of things at length scales much smaller than we can see with our eyes. They just seem "small" or "microscopic."**

*OPTIONAL EXPERIENCE FOR STUDENTS WITH INTERNET: Check out this awesome demo of the "Scale of the Universe"*
*www.scaleofuniverse.com*
Did you ever realize that a DUST MITE is so huge?!?

LESSON 1

QUESTIONS:

1. What is the smallest thing you've ever seen with your eyes (without magnification)? Have you seen something even smaller under a microscope?

2. What do you think is the reason that a coronavirus can grow and thrive inside a human, but not on a table?

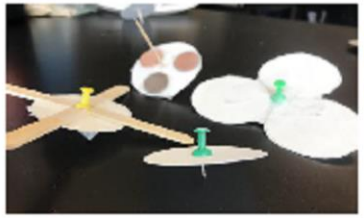
# ANSWERS

1. *DNA (diameter of a single strand): 2 nanometers*
2. *protein: 5 to 50 nanometers*
3. *antibody (large protein): 15 nanometers*
4. *ribosome: 25 nanometers*
5. *virus: 20 to 100 nanometers*
6. *N95 (professional-grade) mask pore size: 300 nanometers*
7. *wavelength of blue light: 400 nanometers*
8. *sneeze droplet: 0.5 to 12 micrometers*
9. *bacteria: 1 to 5 micrometers*
10. *human cell: 10 to 100 micrometers*
11. *period in 24-point font: 1 millimeter*
12. *ant: 5 millimeters*

*Without complete cellular machinery, coronaviruses cannot reproduce on their own. Unlike bacteria, which can multiply inside or outside your body, a virus has to infect a living cell to make more viruses. This means any coronaviruses that happen to get on a surface will inactivate over time and that the most likely way to get infected is through direct contact with an infected person.*

LESSON 2

# Spinning Top



1. **Trace and cut** a circle out of construction paper or a paper plate.
2. **Poke** a hole through the center of your circle with a pushpin.
3. **Glue** or tape a pushpin or toothpick to the center of the circle.
4. **Test it!** Add various materials to extend your top or increase the weight.
5. **Spin!** See how long your top spins. What could you change to make it spin faster and longer?

## Angular Momentum

**Momentum** ($p$) is the quantity of motion of a moving body ($p = mv$). **Angular momentum** ($L$) is the product of an object's rotational speed ($\omega$) and its **moment of inertia** ($I$), a body's tendency to resist angular acceleration (speeding up or slowing down). As you increase either speed or the moment of inertia, angular momentum increases ($L = I\omega$).

## Moment of Inertia

The amount of force required to move a chair depends on the mass of the chair. Similarly, the amount of twisting force, or **torque**, required to rotate an object depends on the **moment of inertia**, also known as angular mass. This is found by multiplying the mass of an object by the distance from the center of rotation. Increasing mass or length increases the moment and spin time.

## NAVY NOTES

The Naval Ocean Surveillance System is composed of a series of satellites. Satellites rotate about an axis continuously while they orbit the earth. This rotation gives the satellite more stability and keeps its orientation constant.

Learn more: www.teachengineering.org, search "Super Spinners"

www.usna.edu/stem

LESSON 3

# MATH MAGIC!
## *How does it Work?*

## 1. THE CALENDAR TRICK

**January**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 1 | | | | 1 | 2 | 3 | 4 |
| 2 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 3 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 4 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 5 | 26 | 27 | 28 | 29 | 30 | 31 | |

**February**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 5 | | | | | | | 1 |
| 6 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 7 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 8 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 9 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |

**March**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 10 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 11 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 12 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 13 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 14 | 29 | 30 | 31 | | | | |

**April**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 14 | | | | 1 | 2 | 3 | 4 |
| 15 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 16 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 17 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 18 | 26 | 27 | 28 | 29 | 30 | | |

**May**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 18 | | | | | | 1 | 2 |
| 19 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 20 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 21 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 22 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 23 | 31 | | | | | | |

**June**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 23 | | 1 | 2 | 3 | 4 | 5 | 6 |
| 24 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 25 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 26 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 27 | 28 | 29 | 30 | | | | |

**July**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 27 | | | | 1 | 2 | 3 | 4 |
| 28 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 29 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 30 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 31 | 26 | 27 | 28 | 29 | 30 | 31 | |

**August**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 31 | | | | | | | 1 |
| 32 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 33 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 34 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 35 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 36 | 30 | 31 | | | | | |

**September**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 36 | | | 1 | 2 | 3 | 4 | 5 |
| 37 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 38 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 39 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 40 | 27 | 28 | 29 | 30 | | | |

**October**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 40 | | | | | 1 | 2 | 3 |
| 41 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 42 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 43 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 44 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |

**November**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 45 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 46 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 47 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 48 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 49 | 29 | 30 | | | | | |

**December**

| Wk | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| 49 | | | 1 | 2 | 3 | 4 | 5 |
| 50 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 51 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 52 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 53 | 27 | 28 | 29 | 30 | 31 | | |

- Ask a family member to draw a 3x3 box around ANY nine numbers on a calendar.
- You can instantly tell them what the numbers add up to!

SECRET: Just look at the number in the middle and multiply it by 9.

- **17 x 9 = 153**

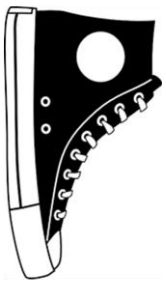
*OR…THE SLOW WAY:*

- 9+10+11+16+17+18+23+24+25 = 153

**QUESTION TO ANSWER:** How does this work? What is the pattern? _____

_____

## 2. SHOE MATH MAGIC



- Multiply your shoe size by 5 (must be a whole number, round up if you have to)
- Add 50
- Multiply by 20
- Add 1020 (the number ten, followed by the last two digits of the current year)
- Subtract the year you were born (four digit year)
- First digit = shoe size
  Last 2 digits = age (or the age you'll be after your birthday this year)

**QUESTION TO ANSWER:** How does this work? What is the pattern? _____

_____

LESSON 3

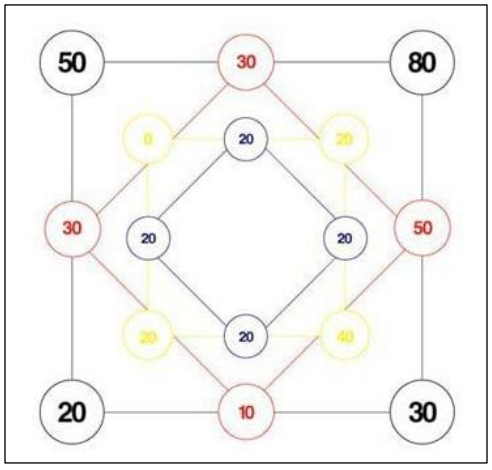
**MORE MATH MAGIC (JUST FOR FUN)…**

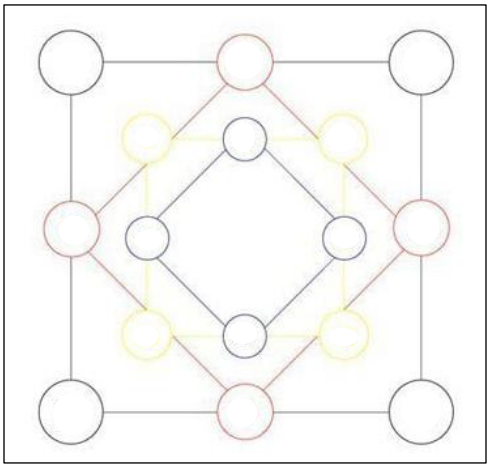
Think of a whole number 1 through 10
2. Double it!
3. Add 4
4. Divide by 2
5. Subtract the original number
Is the numeral 2?!

Choose a number, any number!
2. Multiply the number by 100.
3. Subtract the original number from the answer.
4. Add the digits in your answer.
Is your number 18?!

- Choose any 4 numbers to write on the corners of the larger square.
- Subtract (corner to corner).
- Write the differences on the next largest square's corners (where it meets in between on the line) and so on…
- FINAL SQUARE: Like magic, all of the corners are the exact same numeral!

EXAMPLE



DO YOUR OWN

LESSON 4

# CREATE ART WITH MULTIPLICATION

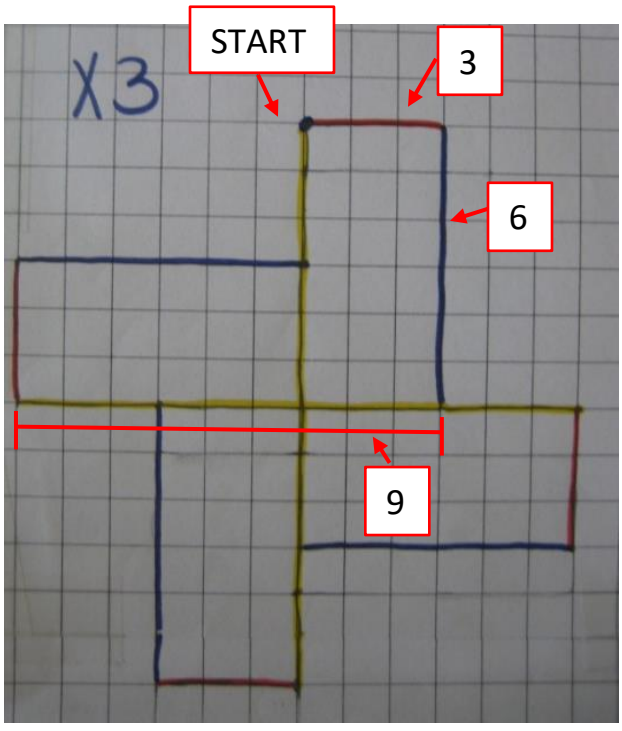
PROCEDURE:

1. Choose your favorite multiplier (For example, three = 3, 6, 9, 12, 15, etc.)
2. We are looking for single digit numbers, so any two-digit numbers that appear, you need to add their digits together until you get a single digit. Do you see a repeated pattern?

   3
   6
   9
   12 = 1+2= 3
   15 = 1+5=6
   18 =1+8=9
   21 =2+1=3

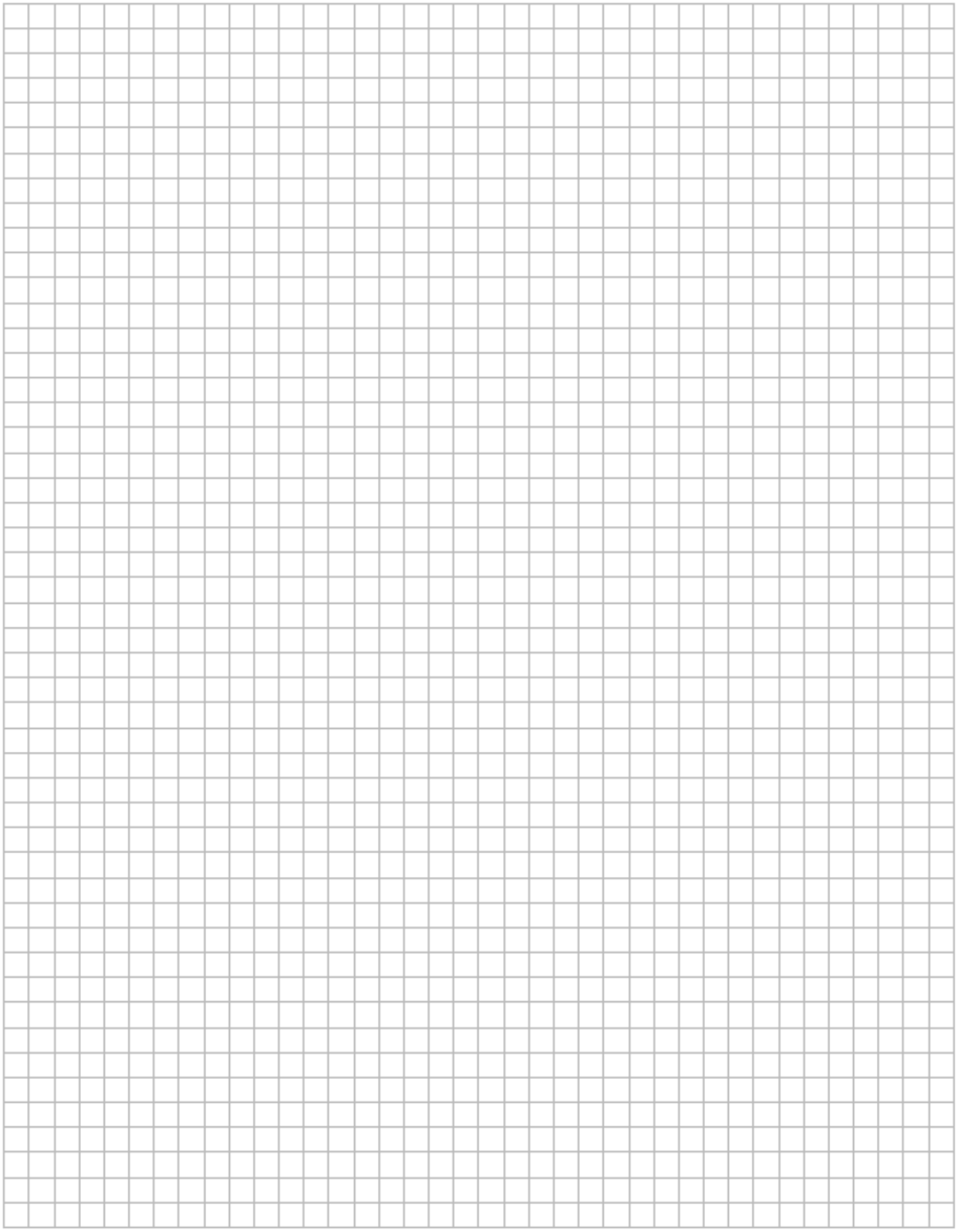
3. Take your number pattern to the graph paper on the next page.
   Pick your starting spot and then draw a line 3 units right
   Then 6 units down. *(OPTIONAL: Use a different color for each number)*
   Then 9 units left.
   Then 3 units up.
   Then 6 units right
   Then 9 units down
   And so on and so on, until you get back to your original starting point.

EXAMPLE



LESSON 4

Try a bunch on your own. Try x1, x2, x3. What does x9 look like? How about x15?



LESSON 5

# DOMINO MATH

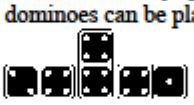
*(MORE PAPER CUTTING!)*

1. Cut out the dominoes on the next page. You should have a total of 28 dominoes.
2. Read the instructions below (FYI, "pips" means "dots" on the domino).
3. Have fun playing this **CLASSIC GAME** with someone in your house!

**Object of the game**
The first player to score 100 or more points wins the game. If you want a shorter game, play to a total of 50 points.

**Game preparations**
All dominoes are shuffled face down. If there are 2 players, each player draws 7 dominoes, and if there are 3 or 4 players each player draws 5 dominoes. The remaining dominoes are left in the middle of the table as the stock (usually called the boneyard). The players keep their domino hands secret and place the dominoes on their long edges in such a way that only they themselves can see the spots (usually called pips) on them.

**How to play**
To start the game the player with the highest double domino sets it on the table. The turn then passes clockwise to the next player. To find out who has the highest double domino one player asks everyone: Does anyone have double 6? If someone has it, they must set it on the table. If no-one has it, the player continues asking all the way down to double 0. If no-one still has a double domino, players shuffle all the dominoes and draw again.

The dominoes are played as a chain on the table. On his/her turn the player plays one domino from his/her hand to either end of the domino chain, so that the connected domino ends match.
For example:  matches  .
Double dominoes are always placed crosswise. Since on the table there are always two open ends where the dominoes can be played, the two open ends of a double domino are at its long sides.
Example: 

If a player is unable to play a domino, he/she must draw dominoes from the boneyard until he/she finds a suitable domino and plays it on the table. He/she must add the drawn dominoes to his/her hand and not return them to the boneyard. If there are no dominoes left in the boneyard, he/she must pass a turn.

**The end**
The game ends when a player plays his/her last domino. He/she scores points equal to the number of pips on the unplayed dominoes of all other players.
The game also ends when all players have consecutively passed their turn. In this case the player whose dominoes have the least number of pips scores points equal to the number of pips on the unplayed dominoes of all other players.
Play again until someone reaches 100 points.

**Variation**
The game can also be played so that if a player is unable to play a domino, he/she must draw one domino from the boneyard. If it is suitable, the player plays it on the table, after which the turn passes to the next player. If it is not suitable, the player adds it to his/her hand and the turn passes to the next player.

LESSON 5