



# **NCTM Session: Mathematics and Integrative STEM — Solar Batteries and Solar Houses Fuel Student Application of Mathematics**

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## STEM<sup>4</sup>: The power of collaboration for change

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International Technology and Engineering Educators Association

### Background

As a nation we are falling short in preparing students for college majors or careers in the areas of science, technology, engineering, and mathematics (STEM). Too few high school graduates have the knowledge, skills, and experiences to be prepared for STEM fields. For instance, according to the National Science Board, 25% of twelfth graders achieved a level of proficient or higher in mathematics and 22% of twelfth graders achieved

- Math
- Science
- Technology
- Engineering
  
- Integrative STEM
- [www.iteea.org/STEM4.aspx](http://www.iteea.org/STEM4.aspx)





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# Connecting Math and STEM

## Three Main Principles to Drive STEM Education

### Principle 1

STEM education should advance the learning of each individual STEM discipline.

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### Principle 2

STEM education should provide logical and authentic connections between and across the individual STEM disciplines.

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### Principle 3

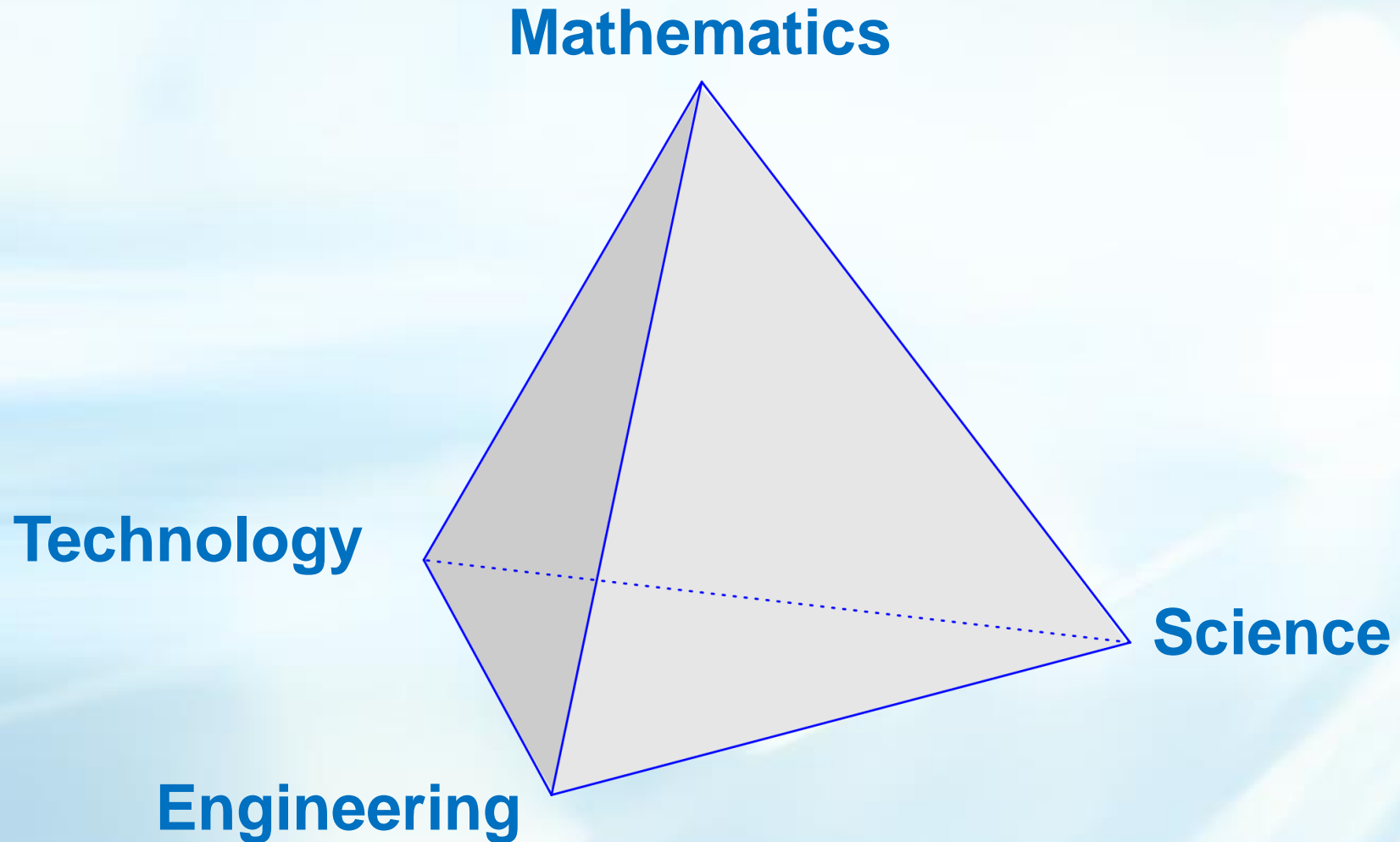
STEM education should serve as a bridge to STEM careers.

## Why Learn Math?

- Experience Joy, Wonder and Beauty – Positive Identity.
- Make Sense of Our World
- Increase Opportunities



# STEM – May not Lead, needs to be Connect





# Lead with Engineering Design

- Where do you use math?
  - Measure
  - Graph
  - Count
  - Histogram or Bar chart
  - Equation



# Lead with Engineering Design

- Where do you apply/learn/do math?
  - Explore Possibilities
  - Test and Evaluate
- What does it look like?





# Challenge

## Create a Passive Solar House with Thermal Energy Battery

- Use supplies
- Greater than 20cm tall
- Window
- Roof
- Footprint no greater than  $460 \text{ cm}^2$
- Where is the math?



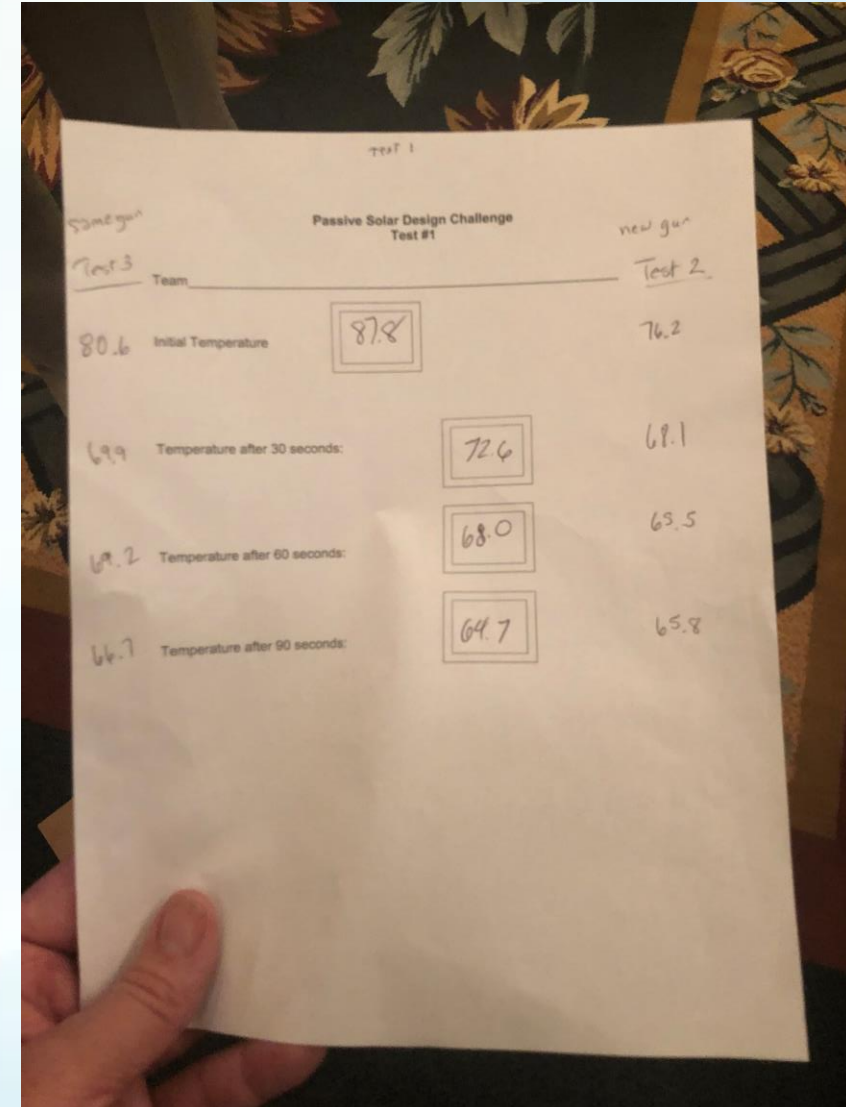
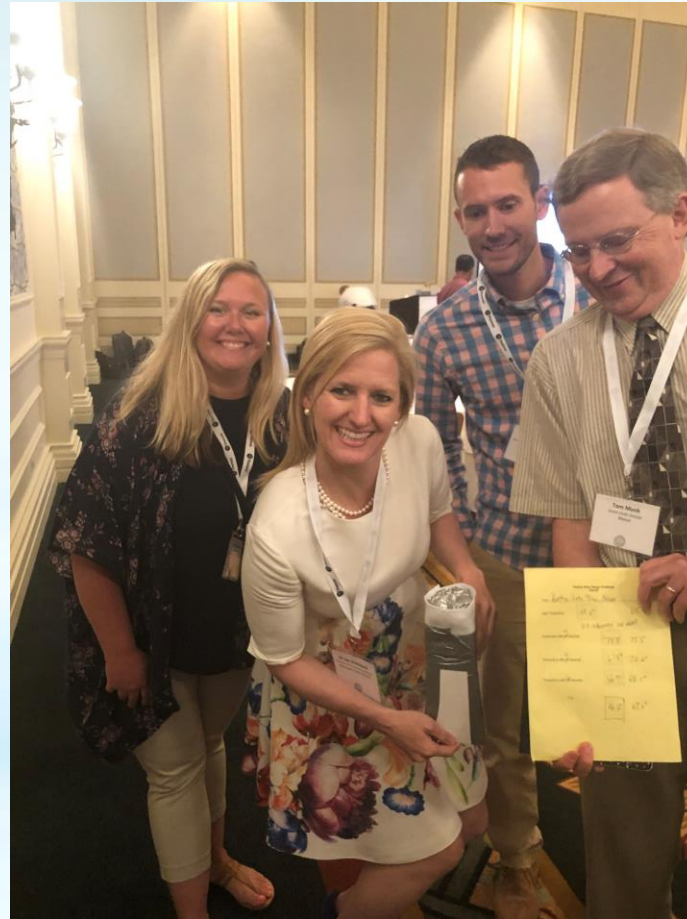






# Challenge – Math Component

Where is the math?

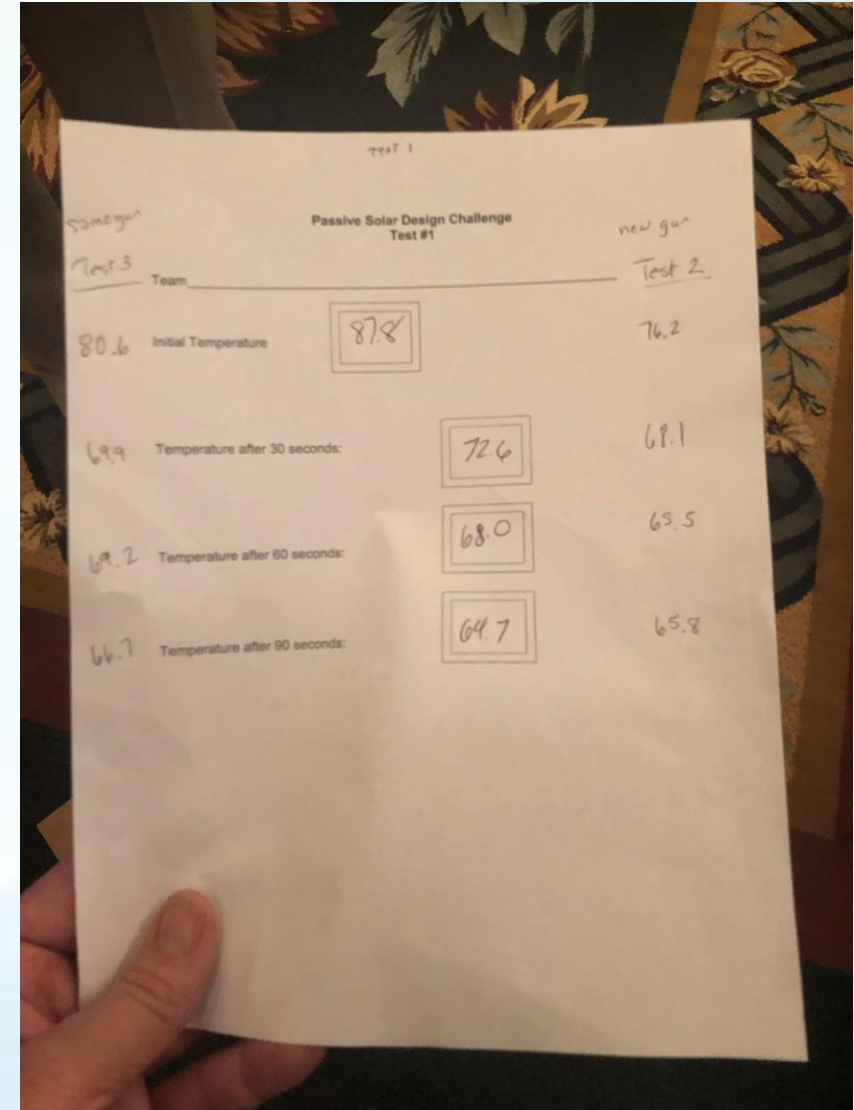


# Doing Math in STEM

Use the data to create a mathematical rule to describe the change in temperature at 30 second intervals.

This rule will be used to project additional readings beyond the last data point as well as consider how the rule would function over an extended time,

Systematically vary the qualities of your battery and use math to describe the impacts.







## Join Us In the Live Room!

- To see how those variations look.
- How we can use mathematics to describe the changes.
- Connections to STEM.



# A Mathematical Dive into the Solar Battery





# What do you Notice? What do you Wonder?

- That is not a lot of battery.
- The rocks are different colors.
- Many go for height.
- Some cover the battery some don't.





# What do you Notice? What do you Wonder?

- How much of the efficiency is on account of the battery?
- And how much is on account of the structure?
- Does the amount of battery matter?
- Does the battery color or materials matter?
- Does the shape of the battery matter?

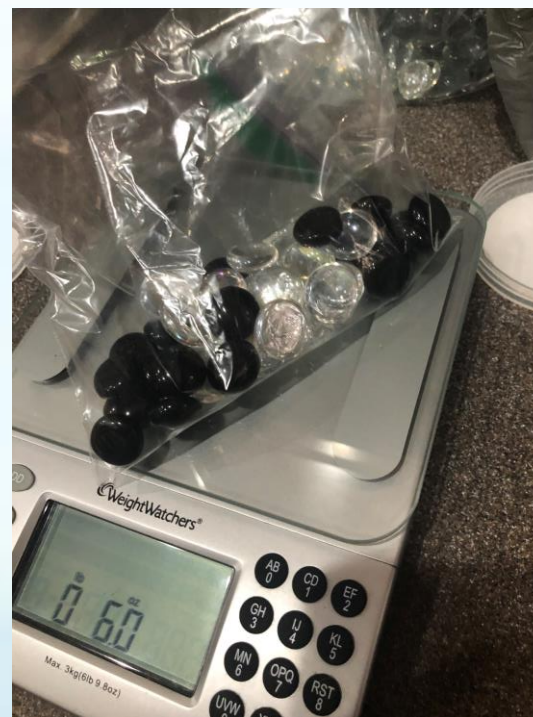
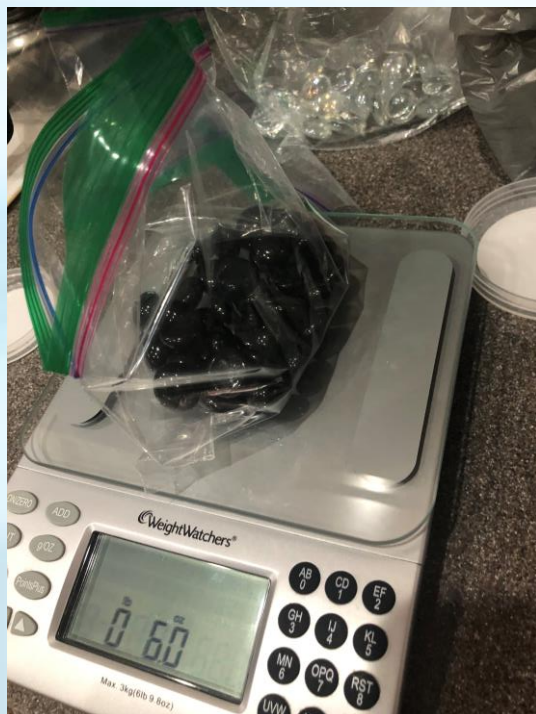
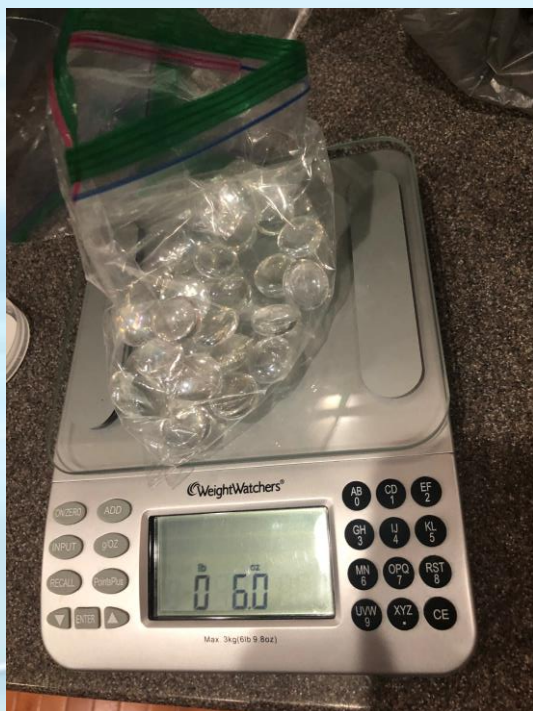


# What do you Wonder?

- Does the battery color or materials matter?
- Does the shape of the battery matter?

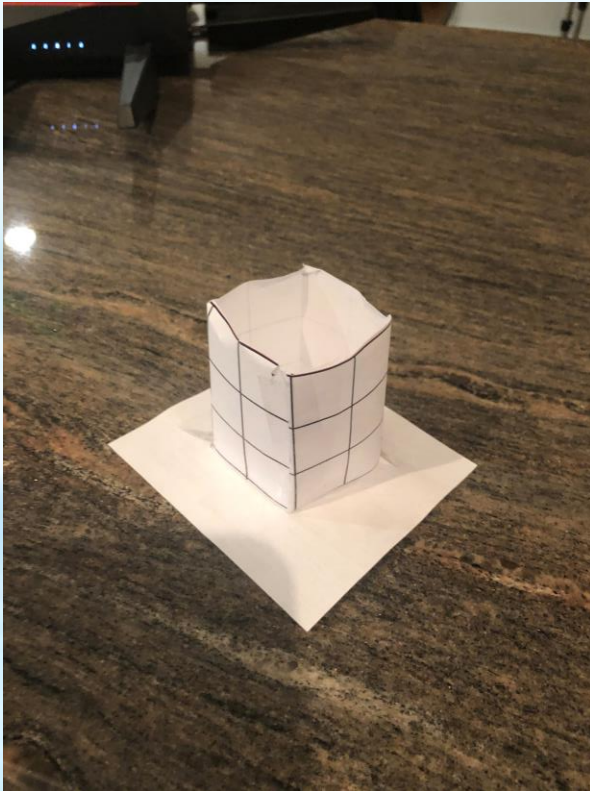
# Test and look at data

- Different types of materials Glass vs Stones
- Different colors or shades of materials.

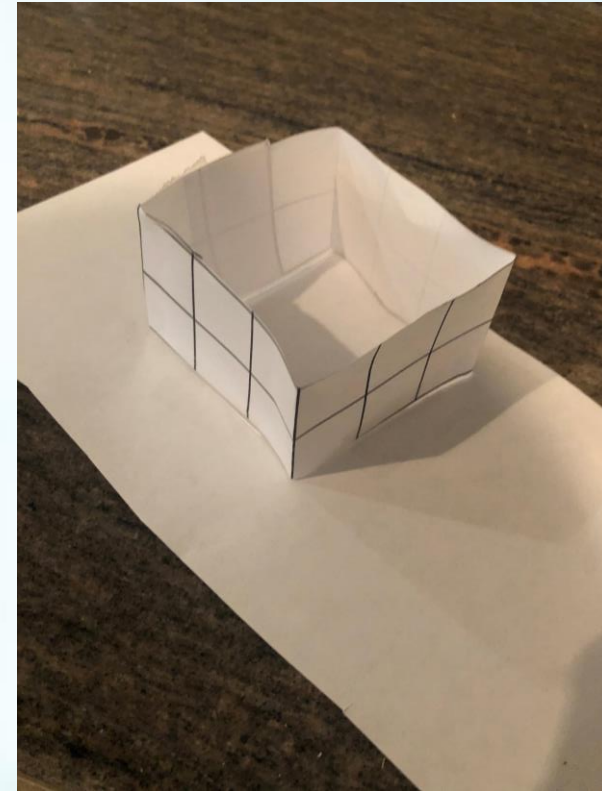




# Considered different sizes (of the base)



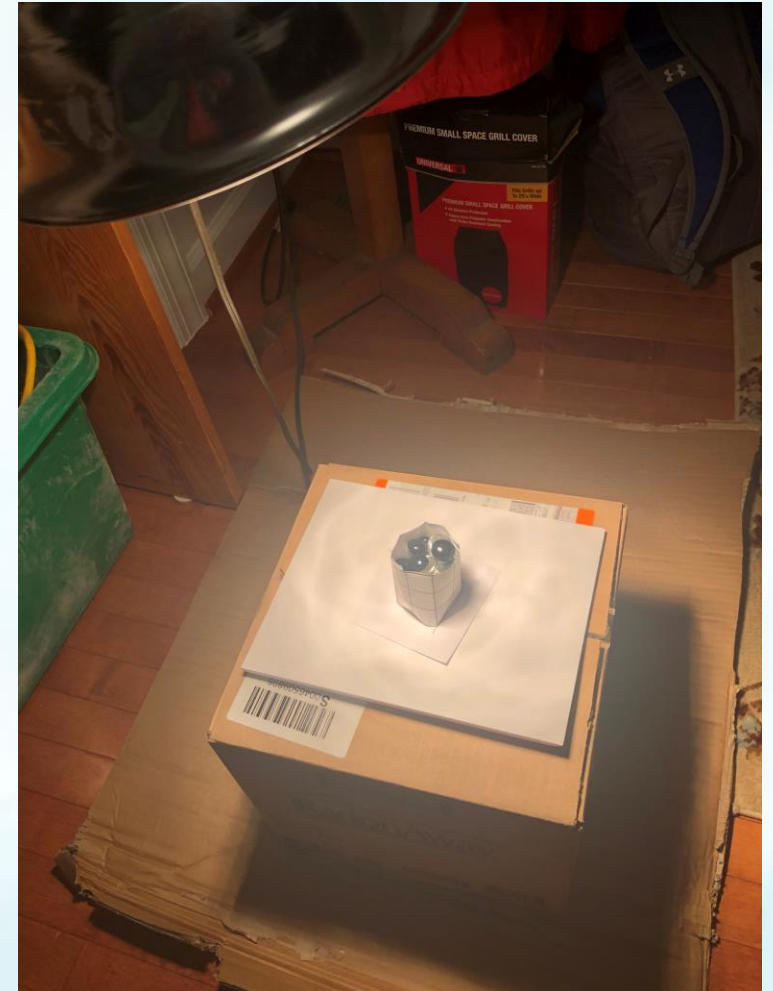
**2x2 base**



**3x3 base**

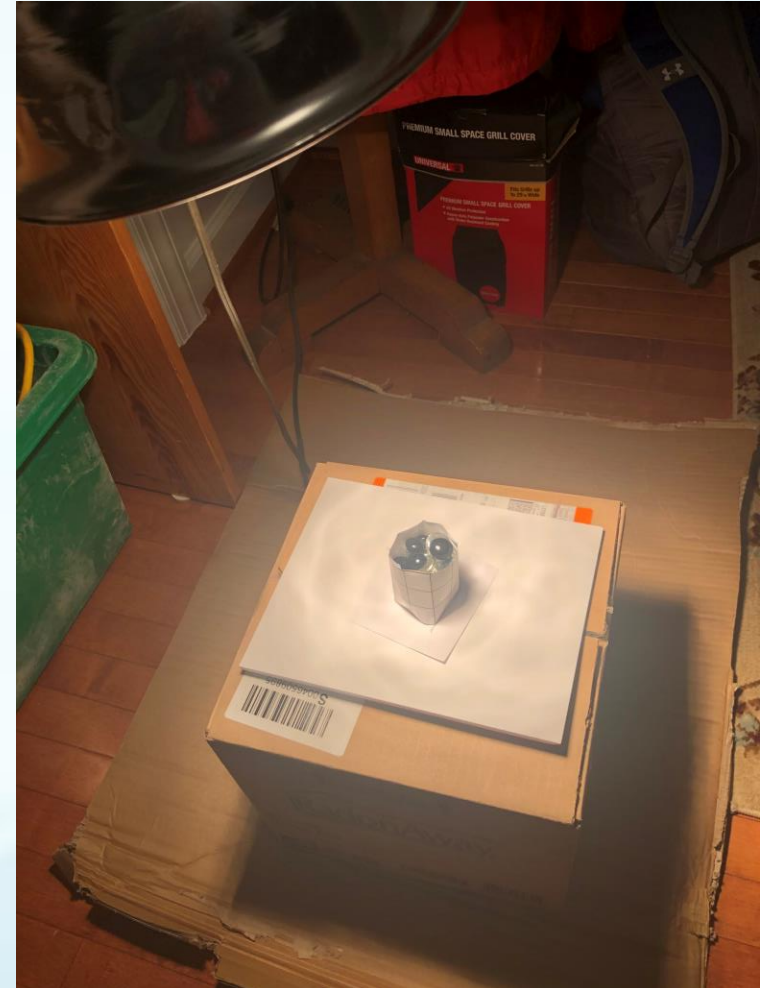
# Protocol

- Take temperature
- Heat for 60 seconds.
- Take temperature then every 30 second for 2 additional minutes.



# What we learned starting out

- Distance to heat source matters in this simulation.
- Floor was too far away so we set on top of box for a standard distance from heat.
- Need to think about this in terms of a house?







# Does the shape matter? Why?

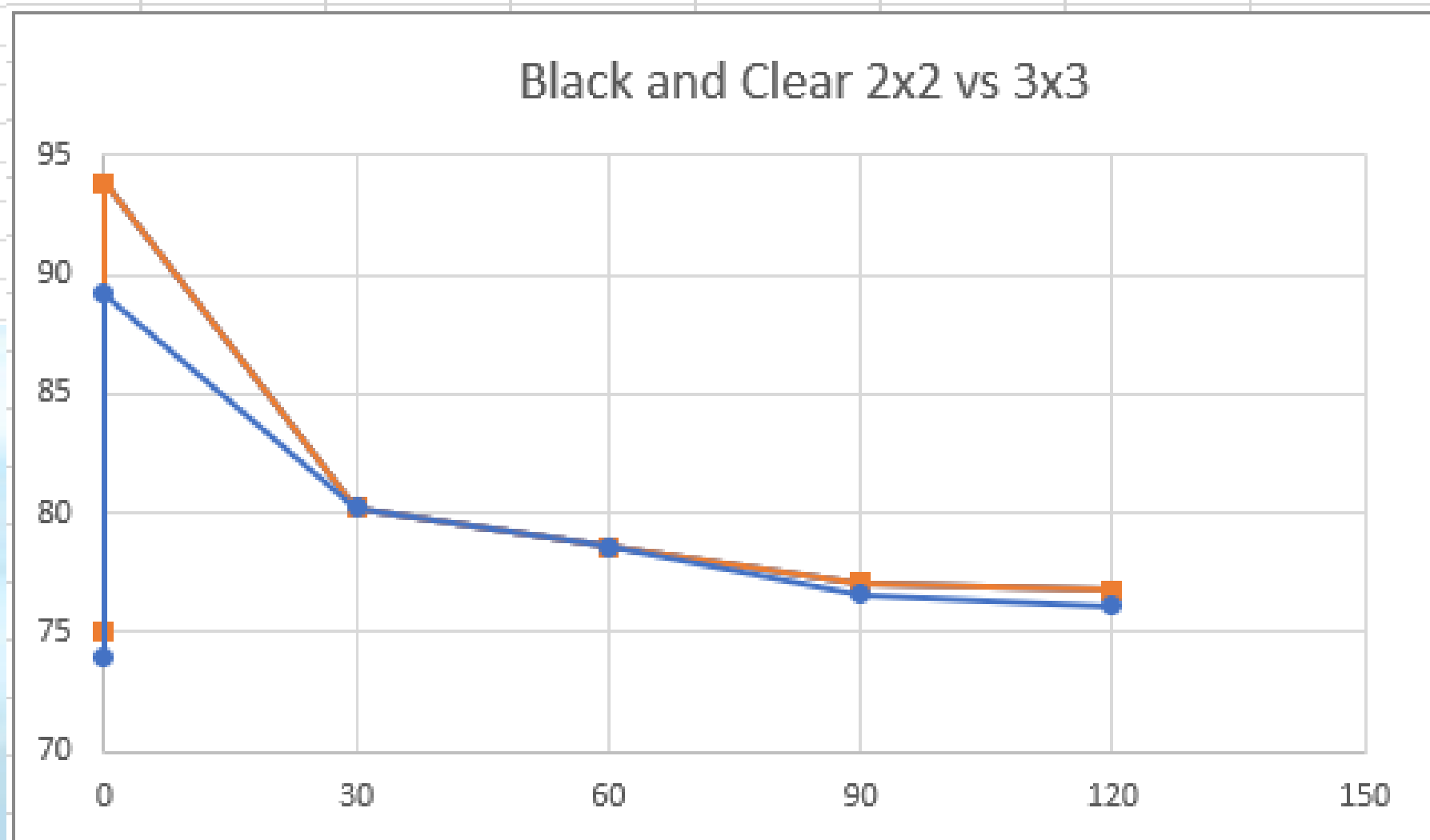
Black & Clear		
	2x2	3X3
0	75	73.9
0	93.9	89.2
30	80.2	80.2
60	78.6	78.6
90	77.1	76.6
120	76.8	76.1

Black Glass		
	2x2	3X3
0	74.4	71.4
0	93	88.1
30	82	78.4
60	79.7	76.6
90	78.2	75.9
120	77.1	75.3



# Does the shape matter? Why?

Black & Clear		
	2x2	3X3
0	75	73.9
0	93.9	89.2
30	80.2	80.2
60	78.6	78.6
90	77.1	76.6
120	76.8	76.1





# Look across data. Notice and Wonder

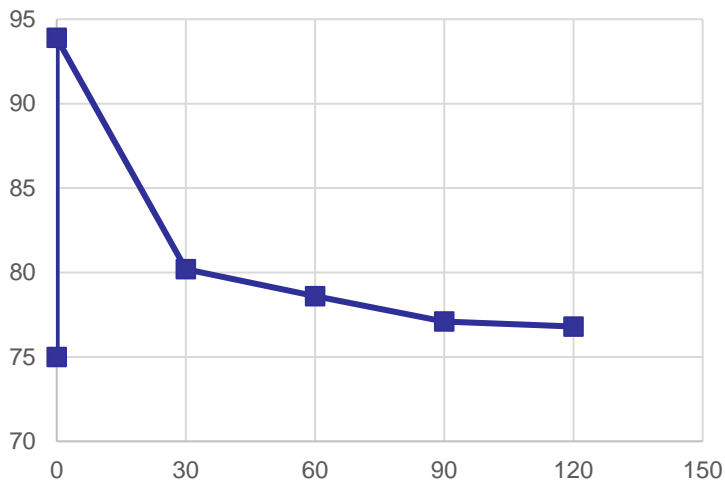
Black & Clear		Black Glass		Dark Stones		Clear Glass		White Stones	
	2x2		2x2		2x2		2x2		2x2
0	75	0	74.4	0	72.8	0	71.4	0	73.4
0	93.9	0	93	0	95	0	88	0	92.4
30	80.2	30	82	30	82.2	30	79.5	30	80.6
60	78.6	60	79.7	60	79.1	60	77.3	60	77
90	77.1	90	78.2	90	77.9	90	76.2	90	75.3
120	76.8	120	77.1	120	77	120	75.3	120	74.6



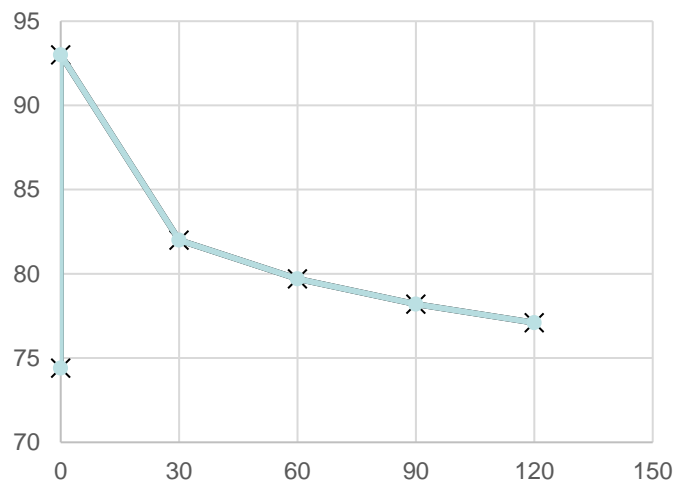


# Look across data. Notice and Wonder

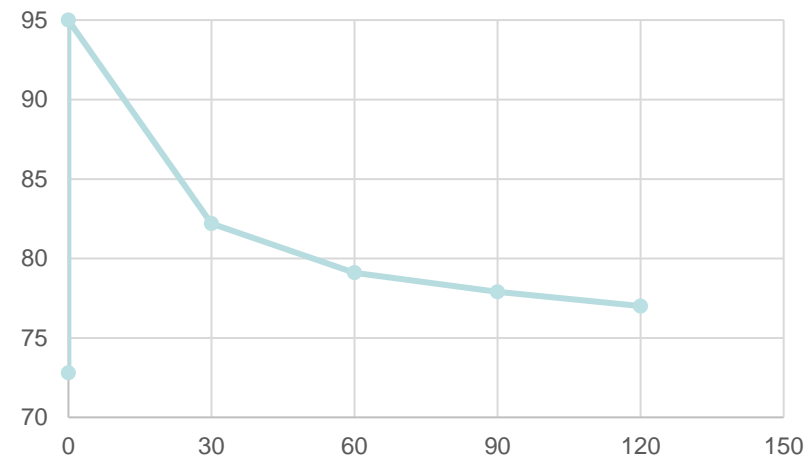
Black and Clear 2x2



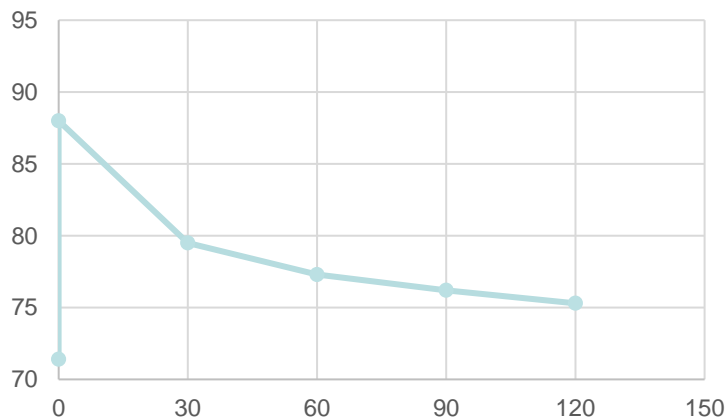
Black Glass 2x2



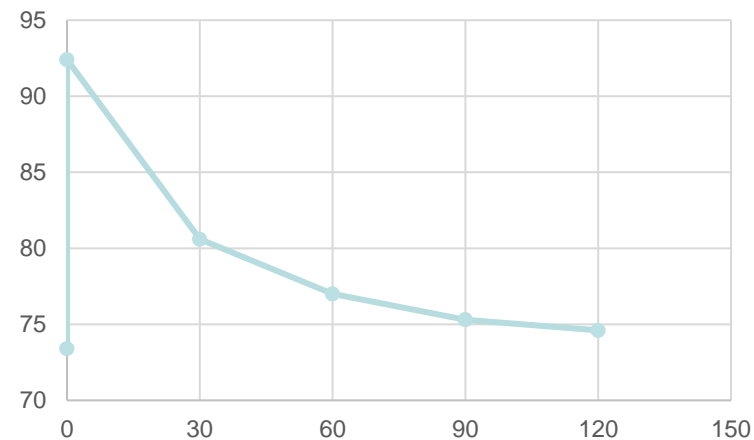
Dark Stones 2x2



Clear Glass 2x2



Light Rocks 2x2



# Can we create a rule?

- Some consistency. Some Not so much.
- Adjust process. Light off, count to 5 them start clock.
- See amount of heat lost roughly same fraction.
- Where will it stop?

Black			
	2x2		
0	74.4		
0	93		
30	82	11	0.59140
60	79.7	2.3	0.30263
90	78.2	1.5	0.28302
120	77.1	1.1	0.28947



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CELEBRATING 100 YEARS







# Thank you!

- Thanks to our Integrative STEM Colleagues.
- Thanks to Katelyn for doing this with me!
- Thanks to you for your interest in Math, Science and STEM!