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CSI ALGEBRA

The Real Number System

IDEAL UNIT: The Real Number System	**TIME RANGE:** 45-60 Minutes	**SUPPLIES:** Pencil & Paper

TOPICS OF FOCUS:

- The Real Number System
- Properties of Real Numbers
- Irrational Numbers
- Square Root Approximation
- Perfect Squares

COMMON CORE ALIGNMENT:

This particular unit was mapped to the curriculum of most algebra textbooks. CSI activities are ideal as a small group unit review or an enrichment activity.

7.NS.2	Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.
7.NS.3	Solve real-world and mathematical problems involving the four operations with rational numbers.
8.NS.1	Understand informally that every number has a decimal expansion; the rational numbers are those with decimal expansions that terminate in 0s or eventually repeat. Know that other numbers are called irrational.
8.NS.2	Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., $\pi 2$).
8.EE.2	Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.

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CSI

General Procedures

*A.) As an optional hook, you can provide or read students the letter from Chief Harris. These are relatively the same for each CSI activity and introduce the criminal, world region the crimes take place and the math topic.

B.) Provide groups (ideally 2-3), the possible suspects, 6 crime scene puzzles and worksheet. You may choose to laminate the criminals or crime scenes for easier reuse. They also work well printed as a packet.

C.) Students will work to solve the crime. Generally, it takes between 45-60 minutes to complete. You can drop hints or provide assistance to help groups that are behind the pace. There are some problems that push advanced critical thinking in applications and others that focus on repeated skill practice. Previewing which crime scenes might be the most challenging so you can be prepared to help small groups or the whole class is a good idea.

Answers in this document are provided, but not with much detail because there have been instances of students or their parents purchasing the documents when teachers have opted to use it as a summative assessment.

D.) At the end of each scene, students will receive a clue that will substitute into the "Cryptic Text Message". This provides an element of self-checking because if the Cryptic Text does not lead to a criminal, they know they need to recheck their work. In the end, students will determine which suspect should be arrested. *The gender, race and ethnicity of the guilty "suspect" is intentionally varied across the entire CSI series.*

*E.) There is an emphasis on "evidence" since this is an investigation. This means detailed work and the ability to argue their logic. You may like for students to create a portfolio of evidence proving that they have arrested the right person and will demonstrate their understanding of their mathematical content present in the problem.

*F.) Some teachers enjoy having their students present and defend their evidence to the class in a brief oral presentation.

*Optional Extensions

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THE EVIDENCE

INVESTIGATOR:_____

1.	**CLUE**
2.	**CLUE**
3.	**CLUE**

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4.

CLUE

5.

CLUE

6.

CLUE

CRYPTIC TEXT MESSAGE

SUSPECT

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CSI: The Real Number System

Detectives,

A thief, working under the alias Guapo Arcsin, has caused a ruckus all throughout Central America. It is believed that Guapo is a member of the evil genius group, the Mathemagicians. From what the detectives have gathered thus far from the previous thefts, the Mathemagicians are building a world conquering device.

Fortunately, Guapo has left behind a trail of notes and a cryptic text message that he has told us will calculate toward his favorite number. Thus far there are six suspects that police have questioned. It is hoped that someone with a relatively strong number sense can crack some codes that have puzzled the detectives on the case so far.

Your job is to bring Guapo to justice and save the planet. You need to be prepared to state your case and demonstrate your understanding of the following skills that Guapo is known to use in his notes.

- The Real Number System
- Properties of Real Numbers
- Irrational Numbers
- Square Root Approximation
- Perfect Squares and Cubes

In your investigation, be sure to show all of your work. We need to have clear evidence that supports your calculations and conclusions. This is not a time to be sloppy. The slightest miscalculation or illegible footnote could result in a not guilty verdict.

Oh, did I mention that use of a calculator might prematurely set off his world conquering device? Good luck to you, gumshoe.

Chief Harris

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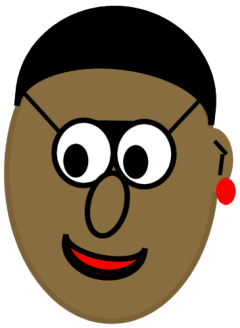
THE SUSPECTS

Who is Guapo Arcsin?

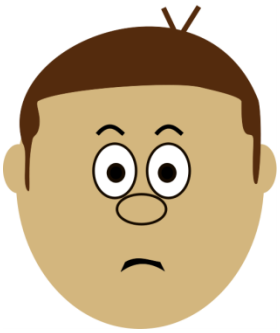
Name	Stillman
Occupation	College Student
Favorite Number	-7

Name	Charmelle
Occupation	Mechanical Engineer
Favorite Number	π



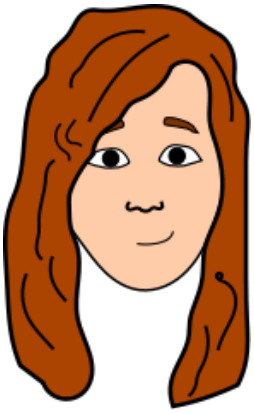
Name	Hiram
Occupation	Doctor
Favorite Number	61

Name	Logan
Occupation	Politician
Favorite Number	13



Name	Pedro
Occupation	Firefighter
Favorite Number	1/5

Name	Eden
Occupation	Organic Farmer
Favorite Number	0



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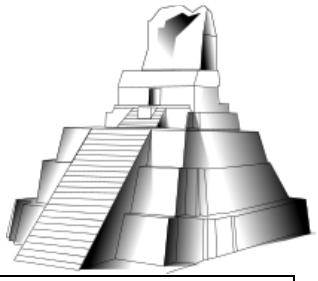
Scene #1 Machu Picchu - Peru

At about 12:24, Guapo Arcsin broke into the famous Incan ruins and stole an Intihuatana stone. The Intihuatana is a ritual South American stone used to tell time.

Hello Peru Peeps and Police,



To let you know upfront, I plan on conquering the world. Okay, now that I have your attention, I figure I'll give you a fighting chance to stop me. MuHahahahahaha. I found this puzzle carved into an Incan temple.

Determine which properties of real numbers are illustrated in these examples.

1.	$3 + 7 = 7 + 3$	2.	$4 + (-4) = 0$
3.	$9 \cdot 1 = 9$	4.	$8 \cdot (6 \cdot 5) = (8 \cdot 6) \cdot 5$

Figure out which property is left out.

Transitive Property	*Commutative Property of Addition*	*Associative Property of Multiplication*	*Multiplicative Identity*	*Additive Inverse Property*
⬇	⬇	⬇	⬇	⬇
E = 81	**C = 64**	**A = 81**	**M = 81**	**L = 81**

Sincerely Yours,
Guapo Arcsin

P.S. Please be aware I will later send you a CRYPTIC PUZZLE SOLVER TEXT MESSAGE.

Scene #2 Mayan Ruins -- Mexico

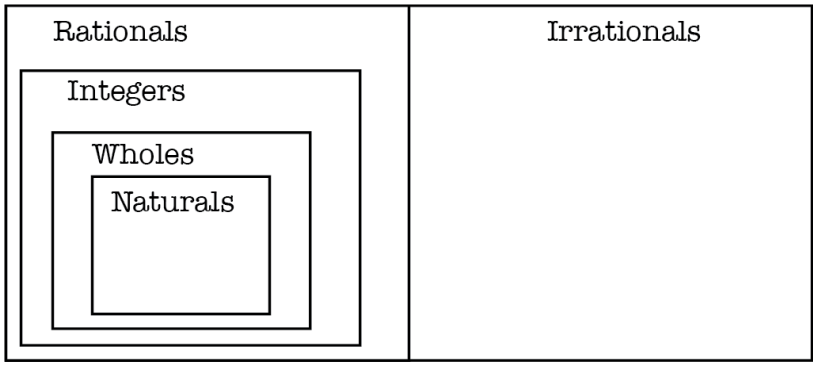
Four rare limestone cornerstones were extracted from the ruins of a Mayan ceremonial platform. These stones could perhaps lay the foundation for a devastating world conquering device.

My Dearest,

Since I haven't been captured yet, I've been thinking about developing my own number system like the Mayans. I need to review the Real Number System first. *Write the numbers in the correct categories.*

7	π	$\sqrt{2}$
$^1/_4$	$.\overline{333}$	0
-3	$-^5/_6$	0.94183 ...

The Real Number System



Are there more integers or irrationals?

More Integers	*More Irrationals*	*The Same*
⬇	⬇	⬇
L = -6	**m = -6**	**r = -6**

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Scene #3 Andes Mountains -- Colombia

Thursday night, Guapo Arcsin traversed the mountains and shaved two dozen alpacas. While it's unclear what he plans to do with the wool, there are now many cold and confused alpacas. He carved this note into the mountain.

Greetings Police Officer,

I see that my puzzles have befuddled even the best of you. I've made the next one even harder. Remember my World Conquering Device will go off at the touch of a calculator.

1.)	A is a Rational Number
2.)	A's numerator is the smallest Natural Number
3.)	A's denominator is a Prime, positive Integer. How many classifications of Real Numbers are there?

A = _____

Give up yet? Your Friend,

Guapo Arcsin

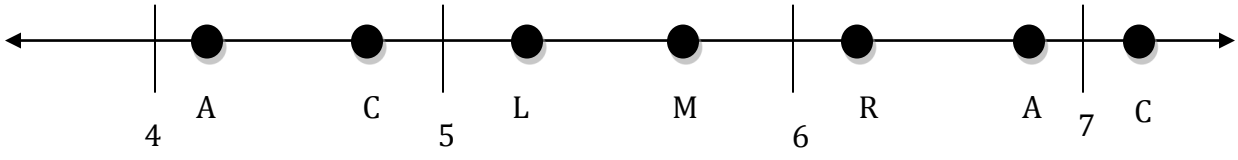
Scene #4 Panama Canal -- Panama

An oiler tanker ship was reported missing from the canal. Apparently the captain decided to go ashore to eat a sandwich and was shocked to find this note in place of his boat.

To Whom It May Concern,

I'm sure you are thoroughly confused by now. Hopefully you don't arrest the wrong person!

1.)	X = the next smallest Integer that is a perfect cube less than -1.
2.)	Y = a Whole Number with the smallest perfect square greater than 1.
3.)	$\sqrt{-XY}$ which is an Irrational Number.
4.)	Mystery Letter = Approximation of $\sqrt{-XY}$ on the number line.



Mystery Letter = 32

_____ = 32

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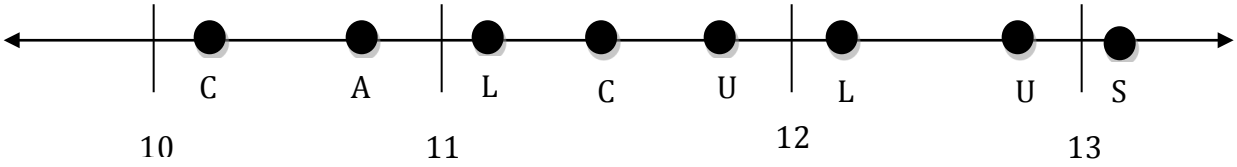
Scene #5 St. Cecilia Acatitlan - Mexico

An unknown amount of rubble and multiple Aztec jade masks depicting various gods were stolen. Guapo has successfully robbed the Aztecs, Incans, and Mayans. It's unknown what he's capable of...he must be stopped quickly.

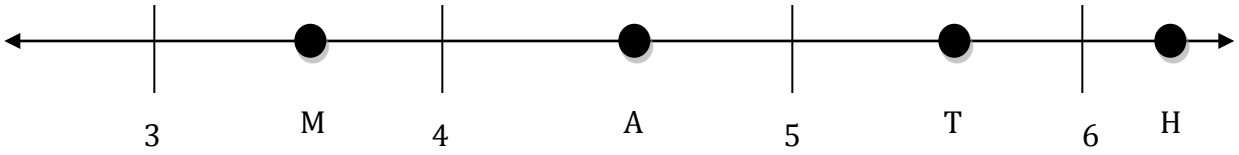
What's Good?

I am inspired by the native abstract art to approximate some irrational numbers. Just like you trying to catch me, these go on, and on, forever.

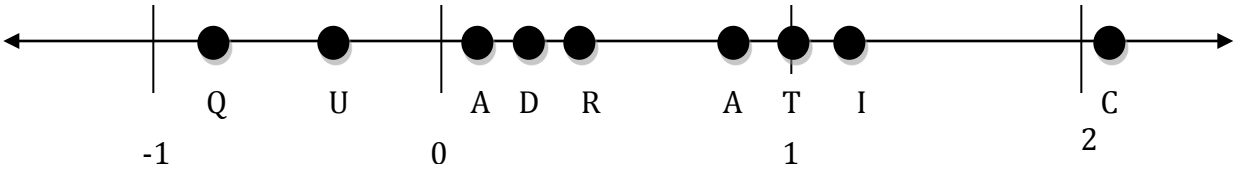
Which point most accurately represents $\sqrt{168}$?



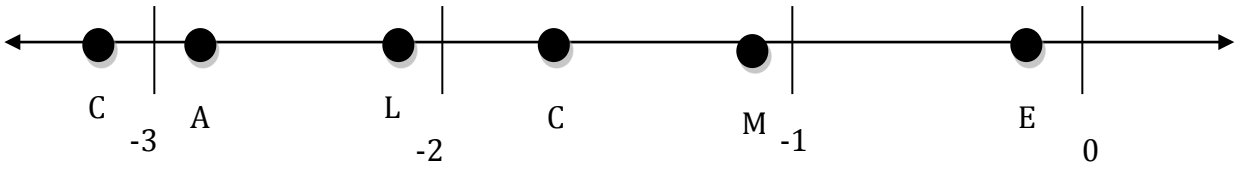
Which point most accurately represents $\sqrt{number_of_letter_in_the_alphabet}$?
Use your previous answer. (HINT: C=3, A=1, L=12 etc.)



Which point most accurately represents $\sqrt{|number_of_letter_in_the_alphabet - 6|}$?



Which point most accurately represents $\sqrt{(number_of_letter_in_the_alphabet)} - 5$?



Round your last answer to the nearest integer and you might have figured out me out.

Final Letter = Rounded Answer _____ =_____

We will be deploying our device soon. Good luck.

Happy Holidays,

Guapo Arcsin

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Scene #6 Museo Nacional de Antropologia - Mexico City

Three rare, blind naked mole rats were stolen from the National Museum of Anthropology. We suspect Guapo Arcsin will be using their abnormal DNA as part of his World Conquering Device.

I thought I'd go out with a bang since I had some extra time for this puzzle. I'm sure you won't figure it out. ***What is L?***

$$L = 36a(a - c) - 24c(2a - 3c) + 2a\big(-2(3a + c)\big) + 77$$

L = ___

So fine, whatever, you were actually able to distribute and combine like terms. Whoopdidoo. Too bad that doesn't tell you the value of L. Here's the problem. I even did it for you. **UNLESS I'M LYING.**

4 + 3 = 3 + 4 = 7 is an example of the associative property

3 + (1+5) = (3+1) +5 = 9 is an example of the commutative property

So a = 7 and c = 9

HAHAHAHAHA see I just gave you an answer! **Or did I?** MUHAHAHAHA. Better figure it out quickly before you plug them in to find L. I'd surely hate if you did it wrong.

CRYPTIC PUZZLE SOLVER TEXT MESSAGE

omg u arent gonna figure this out.
my num is perfect!

L A – M + E – R + 1 – C + A · 5

rofl Guapo 'Too Slick' Arcsin

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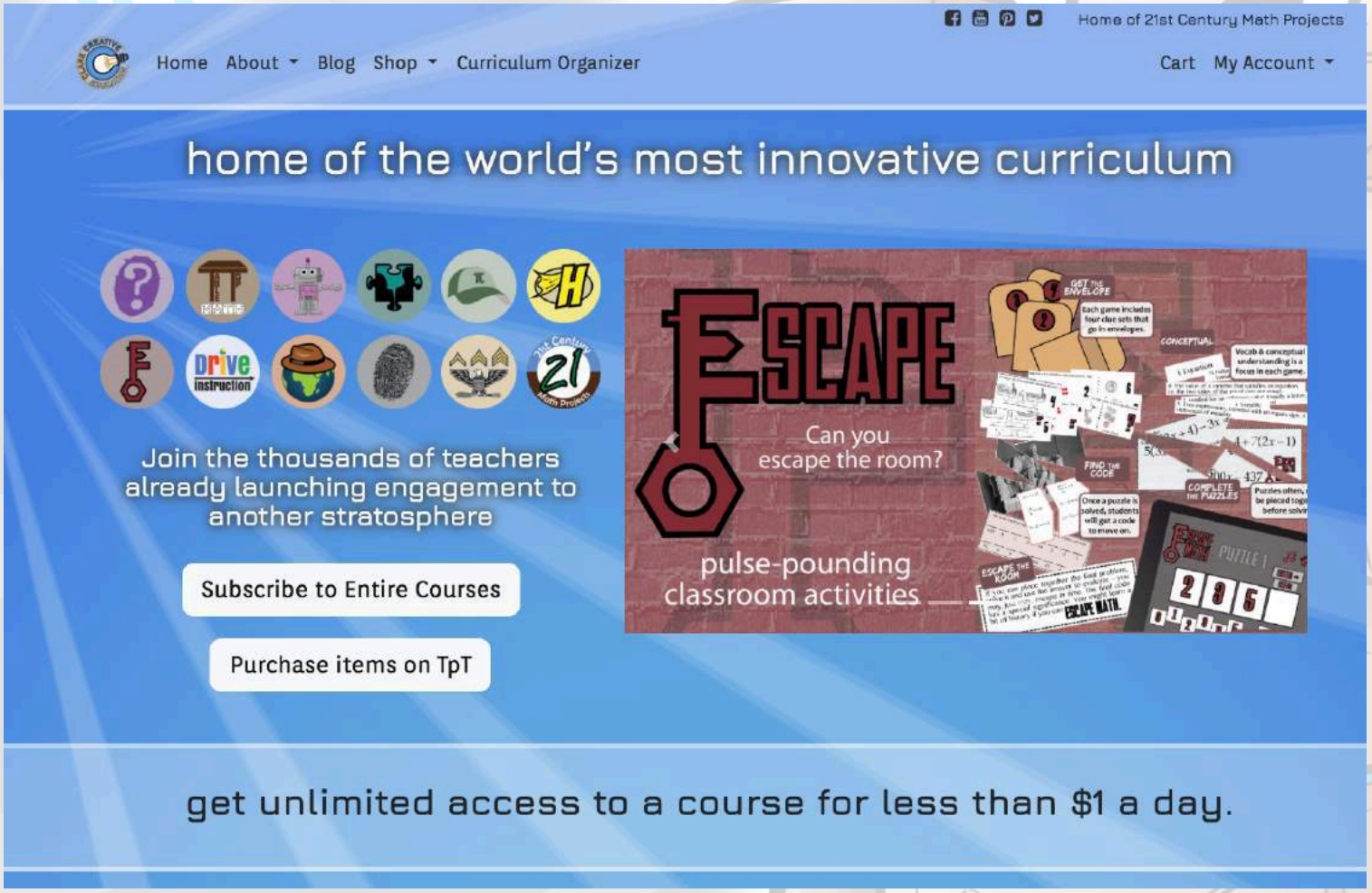

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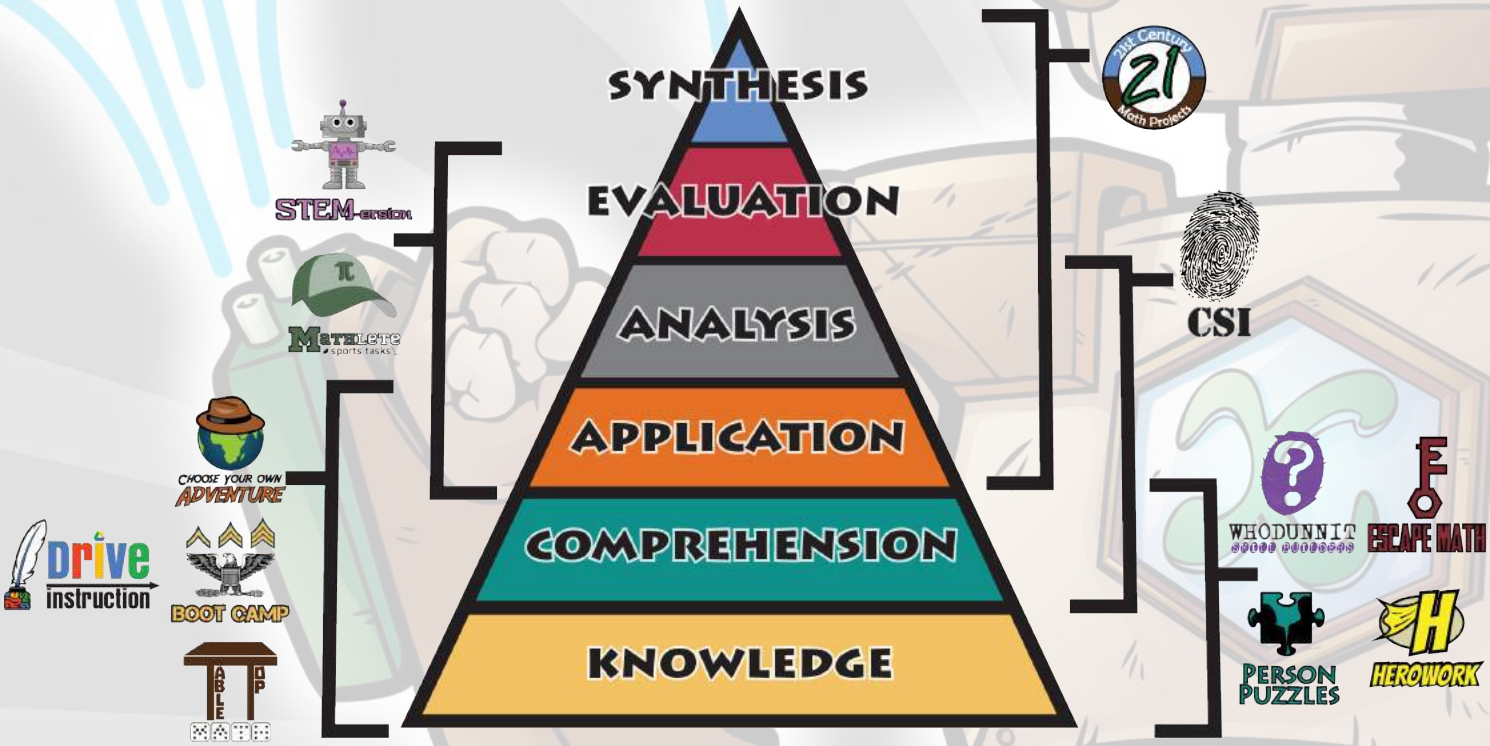

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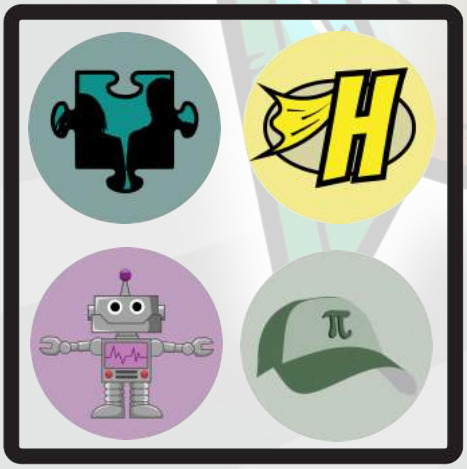
How much time?

Quick
~15-20 minutes



"A Class Period"
~45-60 minutes

Extended
3+ Days (can be modified)

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CSI - Algebra - Unit 2 - The Real Number System

Scene #1 Machu Picchu - Peru

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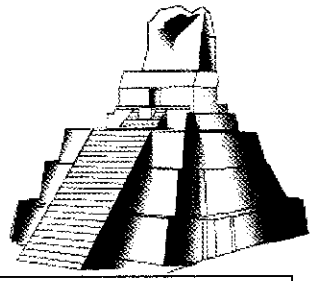

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Determine which properties of real numbers are illustrated in these examples.

1. Commutative $3 + 7 = 7 + 3$ Property of Addition	2. Additive Inverse $4 + (-4) = 0$ Property
3. Multiplicative Identity $9 \cdot 1 = 9$	4. Associative Property $8 \cdot (6 \cdot 5) = (8 \cdot 6) \cdot 5$ of multiplication

Figure out which property is left out.

Transitive Property	*Commutative Property of Addition*	*Associative Property of Multiplication*	*Multiplicative Identity*	*Additive Inverse Property*
⬇	⬇	⬇	⬇	⬇
E = 81	**C = 64**	**A = 81**	**M = 81**	**L = 81**

Sincerely Yours,
Guapo Arcsin

P.S. Please be aware I will later send you a CRYPTIC PUZZLE SOLVER TEXT MESSAGE.

Scene #2 Mayan Ruins -- Mexico

Four rare limestone cornerstones were extracted from the ruins of a Mayan ceremonial platform. These stones could perhaps lay the foundation for a devastating world conquering device.

My Dearest,

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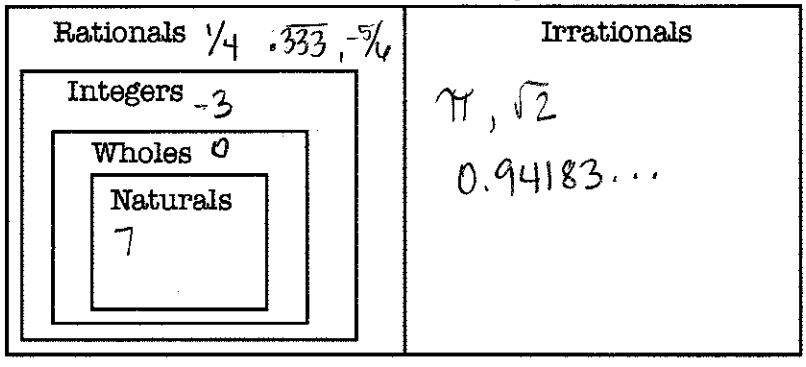
The Real Number System



Are there more integers or irrationals?

More Integers	*More Irrationals*	*The Same*
⬇	⬇	⬇
L = -6	**m = -6**	**r = -6**

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Scene #3 Andes Mountains -- Colombia

Thursday night, Guapo Arcsin traversed the mountains and shaved two dozen alpacas. While it's unclear what he plans to do with the wool, there are now many cold and confused alpacas. He carved this note into the mountain.

Greetings Police Officer,

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1.)	A is a Rational Number
2.)	A's numerator is the smallest Natural Number
3.)	A's denominator is a Prime, positive Integer. How many classifications of Real Numbers are there?

A = $\frac{1}{5}$

Give up yet? Your Friend,

Guapo Arcsin

Scene #4 Panama Canal -- Panama

An oiler tanker ship was reported missing from the canal. Apparently the captain decided to go ashore to eat a sandwich and was shocked to find this note in place of his boat.

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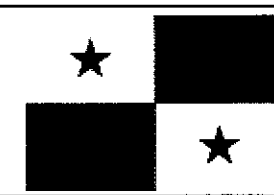
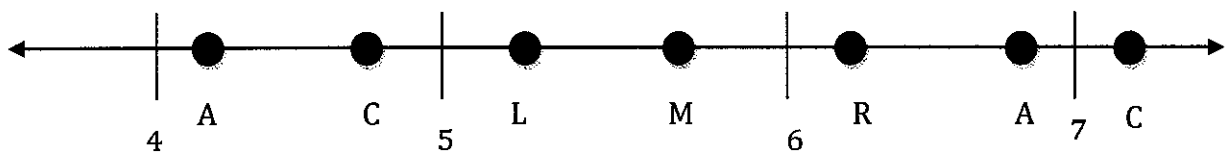


1.)	X = the next smallest Integer that is a perfect cube less than -1. -8
2.)	Y = a Whole Number with the smallest perfect square greater than 1. 4
3.)	$\sqrt{-XY}$ which is an Irrational Number.
4.)	Mystery Letter = Approximation of $\sqrt{-XY}$ on the number line.



Mystery Letter = 32

M = **32**

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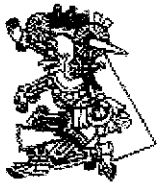
Scene #5 St. Cecilia Acatitlan - Mexico

An unknown amount of rubble and multiple Aztec jade masks depicting various gods were stolen. Guapo has successfully robbed the Aztecs, Incans, and Mayans. It's unknown what he's capable of...he must be stopped quickly.



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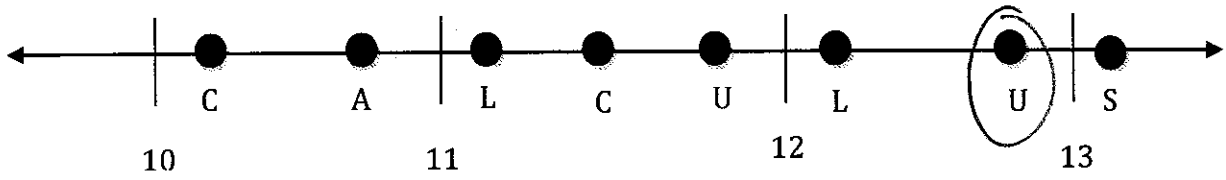
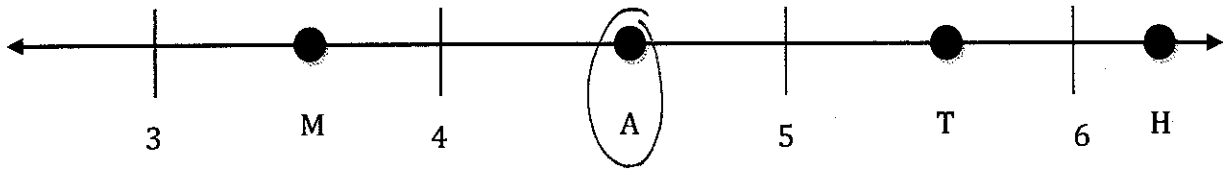
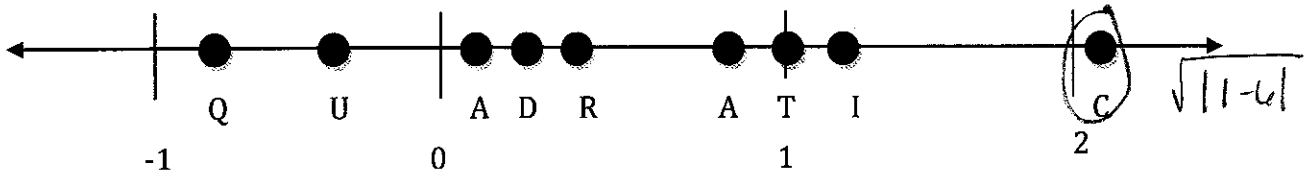
Which point most accurately represents $\sqrt{168}$? $\sqrt{169}=13$



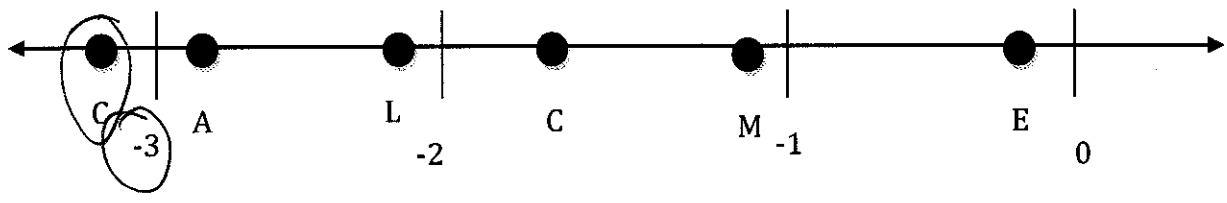
Which point most accurately represents $\sqrt{number_of_letter_in_the_alphabet}$? Use your previous answer. (HINT: C=3, A=1, L=12 etc.) $U=21$ $\sqrt{21}$



Which point most accurately represents $\sqrt{|number_of_letter_in_the_alphabet - 6|}$?



Which point most accurately represents $\sqrt{(number_of_letter_in_the_alphabet)} - 5$?



Round your last answer to the nearest integer and you might have figured out me out.

Final Letter = Rounded Answer C = -3

We will be deploying our device soon. Good luck.

Happy Holidays,

Guapo Arcsin

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Scene #6 Museo Nacional de Antropologia - Mexico City

Three rare, blind naked mole rats were stolen from the National Museum of Anthropology. We suspect Guapo Arcsin will be using their abnormal DNA as part of his World Conquering Device.

I thought I'd go out with a bang since I had some extra time for this puzzle. I'm sure you won't figure it out. ***What is L?***

$$L = 36a(a-c) - 24c(2a-3c) + 2a(-2(3a+c)) + 77$$

$L = 36(9)(9-7) - 24(7)(2(9)-3(7)) + 2(9)(-2(3(9)+7)) + 77$

$L = 324(2) - 168(-3) + 18(-68) + 77$

$L = 648 + 504 - 1224 + 77$

$L = 5$

L = 5

So fine, whatever, you were actually able to distribute and combine like terms. Whoopdidoo. Too bad that doesn't tell you the value of L. Here's the problem. I even did it for you. **UNLESS I'M LYING.**

$4 + 3 = 3 + 4 =$ 7 is an example of the **a**ssociative property ← backwards

$3 + (1+5) = (3+1) + 5 =$ 9 is an example of the **C**ommutative property

So a = 7 and c = 9 a=9 and c=7

HAHAHAHAHA see I just gave you an answer! **Or did I?** MUHAHAHAHA. Better figure it out quickly before you plug them in to find L. I'd surely hate if you did it wrong.

CRYPTIC PUZZLE SOLVER TEXT MESSAGE

omg u arent gonna figure this out.
my num is perfect!

E=81
r=-6
A=1/2
m=32
C=3
L=5

$$L\,A - M + E - R + 1 - C + A \cdot 5$$

rofl Guapo 'Too Slick' Arcsin

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CS1- Algebra - Unit 2 - The Real Number System

THE EVIDENCE

INVESTIGATOR: Key

1.

1. Communicative Property of Addition
2. Additive Inverse Property
3. Multiplicative Identity
4. Associative Property of Multiplication

CLUE

E = 81

2.

Integers => 7, 0, -3

Irrationals => π, $\sqrt{2}$, 0.94183...

CLUE

r = -6

3.

$\frac{1}{5}$

CLUE

A = $\frac{1}{5}$

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4.

$x = -8$

$y = 4$

$\sqrt{-xy} = \sqrt{-(-8)(4)} = \sqrt{32} \approx 5.66$

CLUE

M = 32

5.

$\sqrt{168} \approx 12.96$

$\sqrt{21} \approx 4.58$

$\sqrt{|1-6|} = \sqrt{|-5|} = \sqrt{5} \approx 2.24$

$\sqrt{3} - 5 \approx 1.73 - 5 \approx -3.27$

CLUE

C = -3

6. $a = 9 \quad c = 7$

$L = 36a(a-c) - 24c(2a-3c) + 2a(-2(3a+c)) + 77$

$L = 5$

CLUE

L = 5

CRYPTIC TEXT MESSAGE

$LA - M + E - R + 1 - C + A \cdot 5$

$5\left(\frac{1}{5}\right) - 32 + 81 - (-6) + 1 - (-3) + \frac{1}{5}(5)$

$1 - 32 + 81 + 6 + 1 + 3 + 1 = 61$

SUSPECT

61

Hiram

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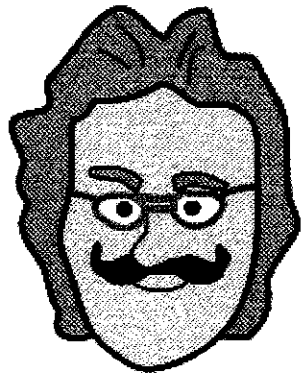
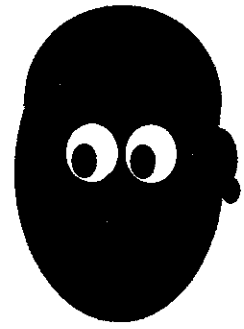
THE SUSPECTS

Who is Guapo Arcsine?

Name	Stillman
Occupation	College Student
Favorite Number	-7

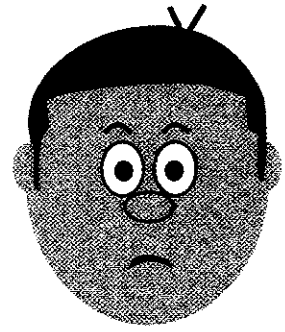


Name	Charmelle
Occupation	Mechanical Engineer
Favorite Number	π

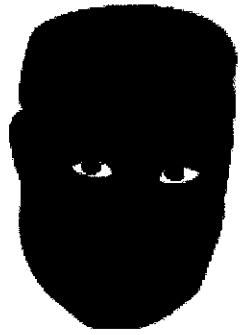


Name	Hiram
Occupation	Doctor
Favorite Number	61

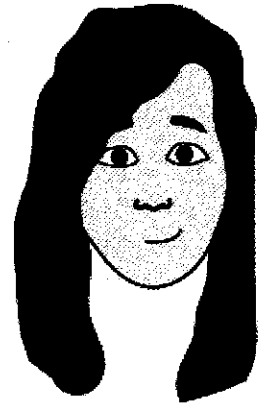
Name	Logan
Occupation	Politician
Favorite Number	13



Name	Pedro
Occupation	Firefighter
Favorite Number	1/5



Name	Eden
Occupation	Organic Farmer
Favorite Number	0



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CSI

The Real Number System

Rubric

Skills & Understandings		Exemplary	Proficient	Developing
I can organize numbers within the classifications of real numbers.				
I can understand and identify properties of real numbers.				
I can approximate the value of square roots of irrational numbers.				
I can identify perfect squares and cubes.				
Math Processes		**Exemplary**	**Proficient**	**Developing**
Skills & Mechanics	*accurately performs calculations*			
	demonstrates fluency with mathematical skills and processes			
Applications	*accurately interprets word problems and addresses them with appropriate math skills*			
	can articulate the meaning of calculations in the context of the problems.			
Use of Evidence & Analysis	*can determine what evidence is appropriate to answer a question*			
	utilizes mathematical outcomes to support their conclusions			

COMMENTS:

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