

CSI Algebra 2 & Pre-Calc: Exponential Functions & Logarithms



Detectives,

What's another month without a series of high profile robberies at the hands of the Mathemagicians? The evil genius terrorist group has pulled off another elaborate crime spree across East Asia. As the Mathemagicians work to build their world conquering device, our investigators are trying to piece together the thefts by an anonymous associate, "The Natural One".

Cocky as always, the Mathemagicians have left behind a trail of mathematical puzzles and a cryptic text message that must be solved. After solving the puzzles, you can decode the message which will lead to The Natural One's favorite number. So 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 the Natural One to justice and save the planet. You need to be prepared to state your case and demonstrate your understanding of the following skills that the Natural One is known to use in the notes.

- Evaluating Exponential and Logarithmic Functions
- Switching between Exponentials to Logarithms
- Growth & Decay
- Log Laws
- Compound Interest

Be sure to include:

- Other examples of the concepts
- Definitions
- Any other relevant information.

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

Who is the Natural One?

Name: Jai

Occupation:
Photographer

Favorite Number: 18.4



Name: Donnie

Occupation: Warehouse
Supervisor

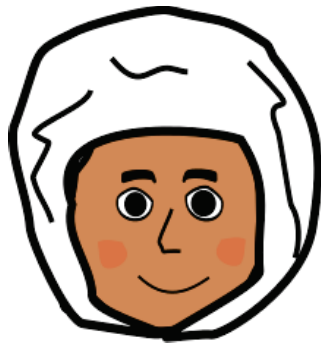
Favorite Number: 4/5



Name: Batulo

Occupation: Blogger

Favorite Number:
32/55



Name: Jeff

Occupation:
Blogger

Favorite
Number: 11



Name: Trish

Occupation: Fashion
Designer

Favorite Number:

-1.6×10^9



Name: Nikki

Occupation: Veterinarian

Favorite Number: 680



Scene #1 Forbidden City -- Beijing, China



The Natural One is suspected to have broken into the famed Chinese palace in the middle of the night. Curators discovered their entire collection of blue and white porcelain was taken and in its place they found this note.

Peace, I'm the Natural One and I'm ready to make your job exponentially harder. While robbing East Asia, I've come across some interesting puzzle inspiration. Like this one, I pulled of a secretary's desk.



Two functions are used to model the population of China (where x equals the number of years after 1900 and y is the population in millions of people) One is using data before the 1978 law was enacted, the other was using data thereafter. What is the population projection of each function for the year 2020? Has the One Child Policy been effective?

Pre-One Child Policy Projection	Post-One Child Policy Projection
$y = 200.28e^{0.0203x}$	$y = 433.09e^{0.0106x}$
2020 Projection (in millions):	2020 Projection (in millions):

Convert the "in millions" to actual population estimates.

$e = (\text{Pre-Policy Projection}) - (\text{Post-Policy Projection}) \dots$ choose the closest clue

a = -459,129,000	b = 254,239,000	e = 743,390,000
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Scene #2 Muay Thai Training Facility -- Bangkok, Thailand

After taking a muay thai class, The Natural One stole their entire supply of ankle supports and shin guards. It is unclear to investigators how these will be used in the world conquering device at this time.

All this switching between striking and grappling reminded me of my amazing advanced math teacher and switching between logarithmic and exponential form. I'm sure you can imagine.

Figure out t and you get your next clue. Make a mistake and you start all over.

t = _____



A vault at the largest bank in Asia was robbed. In place of all the money, investigators found half of a turkey sandwich and this note.



While Americans spend every last penny they see, most people in East Asia are saving around 30% of their money. You better go spend the rest of your piggy bank before we conquer the world because it's coming soon!



I pulled this off the desk of a financial analyst who was comparing themselves against the other big banks in the region.

SUPPOSE: There's an investment of ¥1,000,000 for five years. Which provides the best return?

NOTE TO SELF...

$$A = P\left(1 + \frac{r}{n}\right)^{nt} \text{ or } A = Pe^{rt} \text{ for continuously compounded interest}$$

A = amount of money in the account

P = principal (initial) amount

r = annual interest rate as a decimal

n = number of compounds in a year

t = number of years

AGRICULTURAL BANK OF CHINA	BOC HONG KONG	ICBC	SUMITOMO MITSUI FINANCIAL
4.94% interest compounded weekly	4.97% interest compounded monthly for a year	4.92% interest compounded continuously	5% interest compounded yearly for a year

WHICH BANK EARNED THE MOST INTEREST?

(The first letter of the bank) = (the amount in the account after 5 years rounded to the nearest yen)

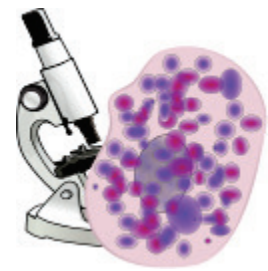
_____ = _____

Scene #4 Institut Pasteur Korea -- Seoul, South Korea



The Natural One stole vials in 195 difference diseases from a state of the art laboratory.

Cutting edge science is happening in Korea. From stem cells to cloning the envelope is being pushed over here. I stumbled upon a file which strikes me as the most powerful element ever created...



RADIOACTIVE TESTING – CONFIDENTIAL

Synthetic Element: Chucknorrisidium (radioactive)

Procedures: 5 grams of Chucknorrisidium was created and our team estimates it decays at a half-life of 16,000,000 years. We are able to conduct experiments as long as we have 1 gram of the element.

Half Life Equation: $P(t) = P_0 \left(\frac{1}{2}\right)^{\frac{T}{H}}$ where P_0 is the initial amount of the decaying quantity, H is the half-life of the quantity and T is the amount of time that has passed in the same units of the half-life.

Approximately, how many years will it be until the researchers have exactly one gram remaining?

21,771,120 YEARS	29,762,960 YEARS	37,150,850 YEARS
a = 21,771,120	b = 29,762,960	i = 37,150,850

Scene #5 National Museum of India -- New Delhi, India

Archivists were shocked to find that their collection of bronze and terracotta sculptures were taken.



You have a right to remain silent. You have violated a Log Law! Everyone is bound to violate these laws at some time, but can they spot mistakes?



Who has all three problems correct? Select the clue below their name.

	Adding & Subtracting Laws	Product Laws	E & ln Rules
Aarav a = 1	$\log_3 2 + \log_3 4 = \log_3 8$	$\log_6 5^2$ $= 5\log_6 2$	$e^{\ln 15x} = 15x$
Ishaan i = 9	$\log_5 12 - \log_5 3 = \log_5 4$	$2\log_3 a - 3\log_3 b =$ $\log_3 \frac{a^2}{b^3}$	$\ln e^{4t} = 4$
Saanvi s = 19	$\log_8 6 + \log_8 4 - \log_8 8$ $= \log_8 3$	$\log_4 5^3$ $= 3\log_4 5$	$\ln \frac{1}{e} = -1$



The Natural One snuck in the famed park after hours and made off with the remains of the area's rich sulfur deposits. Later investigators were sent a cryptic text message.



I'm running out of time, so I think I should rock your world with an Earthquake debate. The locals are debating which earthquake was more powerful, the Chinese Sichuan Earthquake or the Taiwanese Sumatra-Andraman.

Geologist Charles Richter defined the magnitude M of an earthquake to be:

$$M = \log \frac{I}{S}$$

where I is the intensity of the earthquake and S is the intensity of a "standard".

Two earthquakes are described below...

Richter Value	Description
1-3	Cannot be felt except by instruments
4	Like vibrations from a passing train
5	Strong enough to wake sleepers
6	Very strong: walls crack, people hurt
7	Ruinous: ground cracks, houses fall
8	Disastrous: few buildings survive

Which **EARTHQUAKE** was more powerful?

In China, the Sichuan Earthquake was 13,489.63 times more powerful, than the Chernobyl Nuclear Powerplant Explosion which registered a 3.87 magnitude on the Richter Scale. **Round it's magnitude to the nearest tenth.**

s = _____ (its magnitude)

The Sumatra-Andaman earthquake was 31.62 times more powerful than the 1999 Jiji quake in Taiwan which had a magnitude of 7.7. **Round it's magnitude to the nearest tenth.**

a = _____ (its magnitude)

CRYPTIC PUZZLE SOLVER TEXT MESSAGE

Good luck lol.

$$B \div E \div (A \cdot S \div T) + A - S \div i + A$$

The Natural One