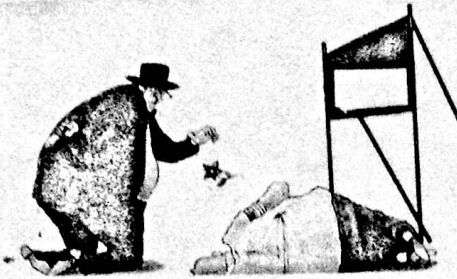


Name: _____

The Death of Mr. Kal Q. Luss



CSI-Denver has just been contacted about a possible murder in Longmont. The lifeless body of Mr. Kal Q. Luss, a prominent mathematics teacher and innovator, was discovered at 6:30 p.m. last night in his high school mathematics classroom. He was found clutching a protractor in one hand and a TI-84 in the other.

It was also discovered that his body temperature upon CSI arrival was 85.9 degrees F. After sixty minutes of investigation, his body temperature was 83.78 degrees F. One bright young CSI agent also recorded the temperature in the room to be 68 degrees.



Three main suspects were immediately identified upon the initial investigation. Mr. Al Jabra, a middle school teacher in Longmont has been said to have always been jealous of Mr. Luss because he was given the opportunity to work with the high school students over Mr. Jabra. Al Jabra has an airtight alibi for portions of yesterday. He was teaching from 8:15-4:00 and then had dinner with Mrs. Bola, a Para in his school from 5:00-8:00.

Another suspect of interest is the technology professional for the school district, Teddy Issac (his friends call him T.I.). T.I. has always held a grudge against Mr. Luss for his refusal to incorporate graphing calculators within his classroom. T.I. also has an alibi for most of the day. From 10:30-1:30 he was helping keep order in the operations of the school cafeteria. In addition he spent the afternoon, 3:30-8:30 with his wife Mrs. Casio relaxing and recharging his battery. However, he may have seen Kal Q. later in the day.



The last suspect in the death of Mr. Luss was Polly Nogh the cafeteria lunch lady at his school. Polly Nogh held a grudge against Mr. Luss ever since she took a night class from him at the local community college. Polly was never able to finish her second degree because she couldn't pass the final exam given by Kal Q. late in the semester. Mr. Luss had forgotten to pack a lunch yesterday, so he ate at the school cafeteria. Although this was not the first time he experienced a Polly Nogh meal, it was definitely the last. Polly's alibi holds strong from 11:00-5:00 as she was serving in the cafeteria and from 6:00-10:00 when she was seen in the library having fun.



Luckily your CSI Training has prepared you with the mathematics skills you need to solve the problem. Consider the following information about the rate at which an object cools.

If a person is believed to have died within a day or so of the body's discovery, it's possible to estimate the time of death using body temperatures. Isaac Newton's idea was that since hot things cool much faster than cool things, the rate of cooling is more or less proportional to the temperature of the object, resulting in an exponential decay model.

Newton's Law of Cooling:

The temperature T at time x of a cooling object follows the function

$$T(x) = A + Be^{kx}$$

A is the ambient (or room) temperature. B and k are constants that depend on the object.

A forensics technician from your CSI team arrived at the murder scene and recorded the temperature of the surroundings as well as the body. The technician decides it is fair to assume that the room temperature has been holding steady at about 68° F. A thermometer was placed in the liver of the corpse and the following table of values was recorded.

Actual Time	Minutes Elapsed (x)	Temperature, T , of the Body (° F)
6:30 pm	0	85.90
6:50 pm	20	85.17
7:10 pm	40	84.47
7:30 pm	60	83.78

The key to estimating time of death is to estimate A , B , k , and T in the formula above. This is done one step at a time.

1) Recall that the technician thinks the room temp was 68°F . By substituting this number and the first recording $(0, 85.9)$ into the Cooling Equation, find A and B (*show your work*).

$A =$

$B =$

2) Once you know A and B , substitute some **OTHER** data point into the equation so that k is the only variable. Solve the resulting equation using the following logarithm method:

Step 1: Isolate the exponential term.

Step 2: Take the natural logarithm, $\ln()$ of both sides.

Step 3: Since the $\ln()$ and the exponential function are inverses, simplify and solve for k .

$k =$

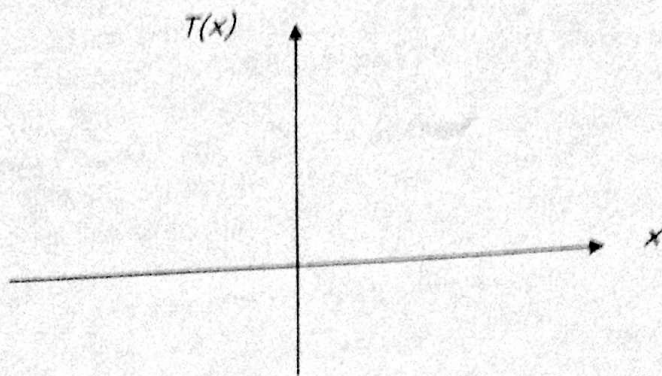
(round to 6 decimal places)

Note: The number k is called the *cooling (or warming) constant*. If an object cools, k should be negative.

3) Using the numbers you found for A , B , and k , write the equation for the temperature at any time x .

$T(x) =$

Draw a graph of the temperature function $T(x)$. Pick a viewing window for your graph so that temperatures ranging from 60 to 100 degrees are shown.



5) The graph of T has a horizontal asymptote. What is the height of this asymptote and what does it tell you about the way corpses cool?

6) Assuming that the temperature of Mr. Luss at the time of death (TOD) was 98.6 degrees, set up a TOD equation using the values of A , B , and k you've already calculated. Then, solve the equation using the same logarithm method you used to solve for k .

Estimated TOD:

7) How accurate do you think the TOD estimate is? What new information would change the estimate?

8) It is now up to you to solve the crime. Determine which of the three suspects was Mr. Luss' murderer.