Honours GSE Advanced Algebra Name: _____
Unit 5: Exponential and Logarithmic Functions Date: _____ Period: _____
Newton's Law of Cooling-Coffee and Corpses. (Spotlight Task)

*(Two parts – Coffee and Death)*

**NEWTON'S LAW OF COOLING-Two Cups of Coffee**
***Modified from www.haverford.edu***

Sir Isaac Newton found that the temperature of something heated will cool down at different rates, depending on the rate of the environment in which it is cooling. The "Newton's Law of Cooling" equation was derived based on this function:

$$T(t) = T_e + (T_0 - T_e)\, e^{-kt},$$

where $T(t)$ is the temperature of the object at time $t$, $T_e$ is the constant temperature of the environment, $T_0$ is the initial temperature of the object, and $k$ is a constant that depends on the material properties of the object.

1. Look at the statement about k. It is saying that k is a constant that depends on the material. Can you think of two liquids that would cool at different rates? What physical properties of the two liquids make that happen?

**NEWTON'S LAW OF COOLING (student notes)Vocabulary and Variables:**

| | |
|---|---|
| **($T_0$) pronounced: "T-sub-zero"** | |
| **($T_e$) pronounced "T-sub-e"** | |
| **k** | |
| **t** | |
| **T(t)** | |

**PART 1: COFFEE:SAMPLE PROBLEM: In a 72° room, my 180° coffee will be 150° after two minutes. I like my coffee at 120°. How long should I wait? Use the info about how long it takes for my coffee to get to find *k***

**Challenges**

1. In a 72° room, my 180° coffee will be 150° after two minutes. How long will it take to get 75°?
2. What is the temperature after 30 minutes?
3. Boiling water (212° at sea level) is left in a 70° and after 5 minutes it is 180° What is the constant of cooling?
4. Using this info from the previous question, how long will it take to have it cool to 98°?
5. Heating is cooling in reverse. Use the same constant $k$ as in #3. If an ice cube is placed in the same room. How long will it take to become 50°? (Presume the ice is 32° when frozen).

**PART 2: CORPSES**
**Newton's Law of Cooling and CSI: REAL APPLICATION**


**Crime Scene**

A detective is called to the scene of a crime in a college science lab where the dead body of an unnamed chemistry student has just been found in a closet. It is clear the body was there for some time-possibly even while students were working in the lab the previous night. The detective arrives on the scene at 5:41 am and begins her investigation. Immediately, the temperature of the body is taken and is found to be 78.0$^{o}$F. The detective checks the programmable thermostat and finds that the lab has been kept at a constant 71$^{o}$ F for several days.

After evidence from the crime scene is collected, the temperature of the body is taken once more and found to be 76.6$^{o}$ F. This last temperature reading was taken exactly one hour after the first one.

Based on key-card entry records, it is clear that there were only four students in the lab the night before:

- The dead chemistry student arrived at the lab at 7pm the previous night and never left the lab.
- Edgar got into the science lab at 6pm, but he left at 10pm.
- Franny got into the science lab at midnight and worked until 2am.
- Geoffrey got into the science lab at 10 pm and worked until midnight.

The next day the detective is asked by another investigator, "What time did our victim die?" Assuming that the victim's body temperature was normal (98.6$^{o}$ F) prior to death, what is her answer to this question? Newton's Law is how detectives determine time of death! Solve the crime. Find the dead student's constant of cooling, her time of death, and name the murderer.