Name:_____   **Advanced Algebra with Trig**

Preview: Murder Most Fowl   **Newton's Law of Cooling**

Newton's Law of Cooling loosely states that the temperature of an object that is cooling can be modeled by an exponential equation of the form

$$T - T_R = (T_O - T_R) \cdot e^{-rt}$$

Where:

- T is the *final* temperature of the object

- T_0 is the *initial* temperature of the object

- T_R is the *surrounding room* temperature

- r is the rate of cooling
- t is the time (in hours) that the object has been cooling

At 3:00 PM, a park ranger discovered a bald eagle that had been impaled by an arrow. Only two archers were found in the region. The first archer is able to establish that, between 11:00 AM and 1:00 PM, he was in a nearby diner having lunch. The second archer can show that he in camp with friends between 9:00 AM and 11:00 AM. The air temperature in the park has remained at a constant 62 degrees F all morning. Beginning at 3:00 PM, the temperature of the dead eagle was measured. Here is the data.

Time	Temperature (Fahrenheit)
3:00 PM	88.83
4:00 PM	86.42
5:00 PM	84.22
6:00 PM	82.22
7:00 PM	80.40
8:00 PM	78.74

$T_R = 62$ $t = ?$

$T_0 = 105$

$r = -0.0943$

$T = 78.74$ @ 8pm

This data, together with the fact that the body temperature of a living bald eagle is 105°, exonerates one of the archers, but the other may remain suspect. Use the equation $T - T_R = (T_0 - T_R)e^{-0.0943t}$ to

establish the time of the eagle's death. Which archer's innocence is established? Include in your explanation: your model for the temperature difference and your estimate of the time of death of the eagle.

$$78.74 - 62 = (105 - 62)e^{-0.0943t}$$

$$\frac{16.74}{43} = \frac{43(e^{-0.0943t})}{43}$$

$$0.389 = e^{-.0943t}$$

@10am the eagle was shot

2nd archer is innocent

$$45$$

$$.3893 = e^{-.0943t}$$

$$-.0943t = \log_e .3893$$

$$-.0943t = \ln .3893$$

$$-.0943t = -.943$$

$$\frac{-.0943t}{-.0943} = \frac{-.943}{-.0943}$$

$$t = 10$$

So the eagle was shot 10 hours before 8pm