Section 4.2 Cooling and Mixing

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Part 2: Mini Lesson

a)

Section 4.2 which reflects on the topic of Cooling and Mixing utilizes Newton's Law of Cooling to solve its equations. This law outlines the cooling of a hot object to its surrounding, ambient lower temperature environment. Outside of math problems found in a textbook, however, Newton's Law of Cooling can be applied in the real world. For example, it can help an electrician determine how fast hot water cools down in pipes or a water heater if you turn off the breaker. Or, it can help a forensic scientist to determine a victim's time of death in a crime scene. They are able to accomplish this because the rate at which heat is lost from the body is directly correlated with the temperature differential between the body and its environment.

Newton's Law of Cooling can even be applied to warming, or heating. For example, when you take ice cream out of the freezer, it does not get cooler with the new environment. Instead, it warms when removed from the original cold surroundings since the ambient temperature is now hotter than before. In conclusion, whether it is about a hot object cooling due to its new cold surroundings or a cold object warming due to its new warm surroundings, the objective of Newton's Law of Cooling is to solve the change that occurs to an object's temperature from its original environment to its new environment.

b)

- T(t) is the temperature at time t
- T0 is the initial temperature (which is 70F)
- Ta is the ambient temperature (which is 12F, in the freezer)
- K is the cooling constant
- t is the time in seconds

The problem involves the use of ordinary differential equations (ODEs), specifically in the context of Newton's Law of Cooling. In this scenario, the ODE describes how the temperature of an object changes over time when placed in a different environment.

To solve this type of ODE, you can use techniques like separation of variables, integrating factors, or, as in this case, taking advantage of the exponential decay properties. You might also need initial conditions (temperature at t=0) to find the specific solution.

The ODE is used to determine the temperature of a thermometer (T(t) over time (t) as it cools down from an initial temperature (T0) to the ambient temperature (Ta) in a freezer. The cooling constant (k) represents the rate at which the temperature decreases, and it was determined based on the given information. The goal was to find the temperature (T) at a specific time(t).

Example Question
An ice cream popsicle is removed from a freezer where the temperature is 18F to a room where the temperature is 80F. After 1 minute, the ice cream has warmed to 38F. What is the ice cream's temperature after 3 minutes?

Links to Videos
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