

# MATH 302

## CHAPTER 4

### SECTION 4.2: COOLING AND MIXING

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NEWTON'S LAW OF COOLING: A REMATCH

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Recall that Newton's law of cooling is given by

$$T' = -k(T - T_m) \tag{1}$$

where  $k > 0$  is a constant,  $T$  is the temperature of the object, and  $T_m$  is the temperature of the medium (surrounding).

**EXAMPLE 1.** Find the solution to (1) subject to the additional condition  $T_0 = T(0)$ .

**EXAMPLE 2.** A ceramic insulator is baked at  $400^{\circ}\text{C}$  and cooled in a room in which the temperature is  $25^{\circ}\text{C}$ . After 4 minutes the temperature of the insulator is  $200^{\circ}\text{C}$ . What is its temperature after 8 minutes?

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**EXAMPLE 3.** A tank initially contains 40 pounds of salt dissolved in 600 gallons of water. Starting at  $t_0 = 0$ , water that contains  $1/2$  pound of salt per gallon is poured into the tank at the rate of 4gal/min and the mixture is drained from the tank at the same rate. We assume that the mixture is stirred instantly so that the salt is always uniformly distributed throughout the mixture.

1. Find a differential equation for the quantity  $Q(t)$  of salt in the tank at time  $t > 0$ , and solve the equation to determine  $Q(t)$ .
2. Find  $\lim_{t \rightarrow \infty} Q(t)$ .