

MEMORIAL UNIVERSITY OF NEWFOUNDLAND  
DEPARTMENT OF MATHEMATICS AND STATISTICS

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SECTION 4.2

Math 1001 Worksheet

FALL 2025

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**For practice only. Not to be submitted.**

1. Solve each of the following separable differential equations.

(a)  $\frac{t}{y^2 + 1} \frac{dy}{dt} + \frac{t^2}{e^t} = 0$

(b)  $\frac{5 \cos(t)}{y + 2} \frac{dy}{dt} = \frac{y - 3}{\csc(t)}$

2. Solve the initial value problem

$$t \frac{dy}{dt} - \sqrt{4 - y^2} = 0, \quad y(1) = 2.$$

3. The half-life of Einsteinium-254 is 270 days. A sample initially has a mass of 3 mg.

- (a) How much is left in the sample after 30 days?  
(b) After how many days will the sample be reduced to 0.5 mg?

4. A group of “castaways” arrives on a deserted island for a reality game show. While there, they learn that a number of parakeets were relocated to the island 2 years before; this population now numbers roughly 50 birds. Three years later, some of the “castaways” return to the island for an “all-star” edition of the show. They discover that there are now about 150 parakeets. If the population has been growing at a rate proportional to its size, how many parakeets were there originally?

5. A flu virus passes through the people living in a city at an exponential rate. If 10% of the population is infected after 10 days, how long will it take for 40% of the people to contract the flu?

6. Newton’s Law of Cooling states that the rate of change of the temperature of a warm object in a cool environment is proportional not to the temperature of the object, but to the *difference* in the temperature between the object and the environment.

- (a) Let  $y$  be the temperature of the object,  $y_0$  be its initial temperature,  $T$  be the temperature of the environment, and  $k$  be the constant of proportionality. Identify a differential equation to model Newton’s Law of Cooling and find its solution.  
(b) Foul play befalls a math professor who failed one too many students. The police discover his body (which has cooled from 37°C to 25°C) half an hour after his demise, on a MUN parking lot where the temperature is  $-8^\circ\text{C}$ . The medical examiner arrives on the scene 15 minutes after the police. Use Newton’s Law of Cooling to find the temperature of the math prof’s body at this time.