

Exponential Growth and Decay Problems

1. [**Population Growth**] A wide variety of populations (e.g. bacteria, fruit flies, rabbits, etc.) can exhibit exponential growth.

In the early stages of the COVID-19 novel coronavirus pandemic in 2020, the number of cases of infection increased exponentially in Canada before significant efforts were made to “flatten the curve.” There were 58 cases reported on March 14, 2020, the day Camosun College announced it would suspend all face-to-face instruction and move to online classes. Five days later, on March 19, 2020, there were 146 new cases of COVID-19 reported in Canada. Approximately how many new cases would be expected on April 1, 2020 (18 days after the March 14 report)?

Note: The actual number of recorded cases on April 1, 2020 was 1,599.

Source: <https://covid19tracker.ca/>

2. [**Radioactive Decay**] Radioactive isotopes decay at a rate proportional to the amount of material present. The term “half-life” refers to the amount of time it takes for half the atoms in a sample of radioactive material to decay.

Plutonium-239 (^{239}Pu) is used in nuclear power plants. Its half-life is 24,110 years.

- (a) How much radioactive material remains from a 5kg fuel rod of ^{239}Pu after 10,000 years?
 - (b) How long will it take for a 5kg fuel rod of ^{239}Pu to lose 90% of its radioactive material?
3. [**Newton’s Law of Cooling**] According to Newton’s Law of Cooling, the rate of change in temperature of an object is proportional to the difference between the temperature of the object and the temperature of the surrounding medium.

A murder victim is discovered in a sealed room where the thermostat is set to 70°F . At 2PM the medical examiner finds that the temperature of the body is 84.3°F . At 3PM the body temperature is 77.15°F . Assuming that the victim had a body temperature of 98.6°F at the time of death and after death the body cooled according to Newton’s Law of Cooling, at what time did the victim die?