Exponential Growth and Decay Problems

by George Ballinger

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

   In the early stages of the H1N1 epidemic in Canada in 2009, the number of cases increased exponentially. There were 719 cases reported on May 20 and 1,530 cases reported on June 1 (12 days later). Approximate the number of people infected with H1N1 on June 29, 2009 (40 days after the May 20 report).

   [Note: The actual number of recorded cases on June 29, 2009 was 7,987.]

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 24,210 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?