1. It’s March of 2020 and Dan Goldin’s successor at NASA has just received a communication from the crew of the *Hippocrates*, on the first live expedition to Mars. The purpose of this emergency mission is to locate and bring back to earth a supply of a new radioactive isotope, Goldinite discovered by a previous, unpeopled expedition. Scientists believe that a sufficient quantity of Goldinite in a reaction with Earth-native carbon will produce enough of a new drug to eradicate a newly discovered deadly communicable disease called R.T.W.D. Unfortunately, the sample of Goldinite retrieved by the previous mission wasn’t large enough for the scientists to properly study. Although they know it is radioactive they were unable to determine its half-life. The astronauts have located a source of Goldinite. They brought 20 lbs to the ship’s laboratory and after one day 15 lbs of Goldinite remained, the other 5 lbs had decayed into the inert new element Drossite. The scientists back on earth need 40 lbs to eradicate the disease. It takes time to mine the Goldinite and in this case time isn’t money it’s human lives back on earth being lost to RTWD. If the return trip to Earth will take 30 days, how much Goldinite must they have on board at lift off in order to have the necessary 40 lbs left when they touch down on Earth? The payload limit on the Hippocrates is 200 tons; what did the message say?

\[20e^{a} = 15 \Rightarrow e^{a} = 3/4 \Rightarrow -a = \ln(3/4) \approx -0.2877 \text{ so } a \approx 0.2877\]

\[Ae^{(\text{2.877})(30)} = 40 \Rightarrow A(e^{8.61}) = 40 \Rightarrow A = 40/e^{8.61} = 40/0.000179 = 223986.6 \text{ lbs}\]

Now we need to know how many pounds in a ton:
It depends upon which “ton” you mean: 1 long (or gross) ton = 2240 pounds; 1 short (or net) ton = 2000 pounds; 1 tonne (i.e., a metric ton) = 2204.6 pounds. In the United States, when people say “a ton,” they’re thinking the short ton, or 2000 pounds. So let’s assume that.

223986.6 lbs = 111.99 tons. So the message says: “Houston, we’re on our way with 112 tons of Goldonite. See you in 30 days.” or something to that effect.

2. Dr. Jeckle and his undergraduate research students wish to perform a DNA extraction experiment on a certain type of bacteria. As of yesterday at 5 pm they had isolated 100 of these bacteria in a growth medium. By 5 pm today there were 275 of them. They need at least 1000 to run the experiment. Assuming the bacteria population grows exponentially, when is the earliest that they would be able to perform their experiment?

\[275 = 100e^{a} \Rightarrow 2.75 = e^{a} \Rightarrow a = \ln(2.75) \approx 1.0116\]

\[1000 = 275e^{1.0116t} \Rightarrow 3.63636 = e^{1.0116t} \Rightarrow \ln(3.63636) = 1.0116t \Rightarrow 1.29098 = 1.0116t \Rightarrow t = 1.2762\]

They should be able to do the experiment in 1.28 days or by quarter to midnight tomorrow.

3. After beaming on board a contaminated shipment, Dr. McCoy (with the help of the Enterprise computer) noticed that 50 unidentified organisms (UO’s) were inhabiting the ship. One hour later than that there were 275 UO’s. Assuming an exponential population growth, How many UO’s will there be 24 hours after the shipment was beamed aboard?

\[P(t) = 50 \ e^{r} \quad P(1) = 50 \ e^{r} = 275 \quad \text{so } e^{r} = 275/50 = 11/2 = 5.5 \quad \text{so } r = \ln(5.5) = 1.7 \quad \text{so } P(t) = 50 \ e^{1.7t}\]

\[P(24) = 50 \ e^{(1.7)(24)} = 50 \ e^{40.8} = (50)(5.24 \times 10^{17}) = 2.62 \times 10^{19} \text{ There will be approximately 2.62 times } 10^{19} \text{ UO’s after 24 hours!}\]