Worsheet Part 2
Module: Separation of Variables
Ebola Outbreak in West Africa

Modeling an Epidemic

If we solve the differential logistic equation: $dN/dt = rN(1-N/k)$
We get: $N(t) = (k/\ 1+cke^{-rt})$ (see hw video and hw sheet)

Using data given we can solve for c and if we use the r (proportional constant) from the logistic model in part 1 we only need values for c and k. C we can find as we did in a similar manner that we found c in the exponential model. We can arrive at a value for k if we take the second derivative and see where the inflection points would be. These would be given in terms of k. Using the inflection point of the data we can conclude that we can use 28766 for the value of k (the carrying capacity). We use these values of the parameters in the question below

4. A new model to consider
In a January 2016 news release, the World Health Organization officially declared the Ebola outbreak over for all three countries [WHO]. The number of Ebola cases totaled 28,602 at the end of the epidemic.
Because we have the data for the actual epidemic, we now know that the predictions by the CDC vastly overestimated the impact of the outbreak. Based on the data we have through t =9, and the estimated parameters from above, the following logistic or limited growth model can be developed:

$$N(t) = 2876/(1 + 586e^{-.7924t})$$

Using the following table:

Date	t (months)	Total Cases
2/15/2015	11	23,218
3/15/2015	12	24,666
4/12/2015	13	25,791
5/10/2015	14	26,724
6/14/2015	15	27,305
7/12/2015	16	27,642
8/16/2015	17	27,952
9/13/2015	18	28,220
10/11/2015	19	28,454
11/15/2015	20	28,598
12/13/2015	21	28,604
1/17/2016	22	28,602

TABLE 2: Ebola cases reported by WHO and published on Wikipedia.

where $N(t)$ is the total number of cases at time t months.

After 7 months: Model estimate: _____ Actual number of cases: _____

After 10 months: Model estimate: _____ Actual number of cases: _____

After 15 months: Model estimate: _____ Actual number of cases: _____

After 20 months: Model estimate: _____ Actual number of cases: _____

b. Remark on whether you expect this model be accurate for the duration of the epidemic.

5. Graph your logistic model and your exponential model and the data from the World Health Organization on the same set of axis for 1<t<24 months. Compare.
Consider the impact of the carrying capacity on the accuracy of the logistic model and address whether it is reasonable to develop and use this model during an outbreak, in particular early on before the inflection point appears in the data.

Adapted from SIMIODE modeling scenario: "1-038-T-Ebola," Lisa Driskell (2016)
by Lisa Driskell, Catherine Bonan-Hamada, Tracii Friedman; Colorado Mesa University.
Distributed at SCUDEM 2018 Faculty Professional Development Workshop.
Other references include CDC and World Health Organization and can be found in the article listed above.