**W3 InLab Activity: Name: Cole Bardin**

*first*

*last*

A picture containing mammal, outdoor, grass, herd

Description automatically generated**Problem 1: Rabbit Island!** Sailors introduced a group of rabbitts on an island with no predators and ample food supply. The rabbit population increases at a rate proportional to the number of rabbits. The population doubles every two years and after years the sailors stop by the island and find the population is .

**a.** Write a differential equation for the number of rabbits using *k* for the rate of growth.

**b.** Find the specific solution with an initial population of .

**c.** Find *k* given the population doubles every two years. Give an exact expression.

**d.** Find the initial number of rabbits the sailors left on the island given .

**Problem 2: Tank Problem** A 400-gallon tank is initially full, so that gallons. The tank contains a brine solution and initially the amount of dissolved salt is pounds. At time 0, a brine solution with a concentration of 2 pounds/gallon is pumped in at the rate of gallons/minute and the well-stirred mixture is pumped out at double that rate, or gallons/minute.

**Underlying model:**  where is the amount of salt in the tank at time *t* in pounds.

gal/min

lb/gal

**![A picture containing icon

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**gal**

**gal**

***Q*(0) = 800 lb**

**Tank is Empty!**

gal/min

**a.** The volume is **not constant** but decreases at a constant rate from an initial value of , until the tank is empty at time minutes. Express as a linear function from the time to the moment the tank is empty.

**b.** Salt flows into the tank at the rate:

**c.** Salt flows out of the tank at the rate:

**d.** The differential equation governing the amount of salt *Q*(*t*) up until the tank is empty is:

**i.** **ii.** **iii.** **iv.**

**e.** The integrating factor for this DE can be chosen as:

**i.** **ii.** **iii.** **iv.**

**Tip:** Any multiple of an integrating factor is also an integrating factor. It's not unique.

The general solution can be shown to be:

**f.** Solve the DE for the quantity of salt *Q*(*t*) given that .

See the small dot and dashed line on the graph. This solution is only valid up until the tank is empty.

**i.** **ii.**

**iii.** **iv.**

**g.** The equation of the **nullcline** (shown as a dotted line through the local maxima)is:

**i.** **ii.** **iii.** **iv.**

**h.** Using the general solution shown at the top, what is the value of *c* for this new solution curve that satisfies? That is the tank starts off filled with **fresh water** instead.

This corresponds to the lowest solution displayed in the previous plot.

**i.** **ii.** **iii.** **iv.**