1. [12 points] Suppose that a bucket with a capacity of 20 liters containing 1.3 kg of sand (which has a volume of 1 liter) is left outside in a very heavy rainstorm with a rainfall rate of 10 cm/hour. For a standard bucket, this results in water being added to the bucket at a rate of about 7 liters/hour.[1]

    a. [6 points] Until the bucket fills, the amount of sand in the bucket is constant. Suppose that the rain fills the bucket before the end of the storm. Write an initial value problem for the amount of sand in the bucket after the bucket fills. You may take $t = 0$ as the time at which the bucket fills, and should assume that the sand is uniformly distributed through the water in the bucket.

    b. [6 points] What equilibrium solution, or solutions, does your equation in (a) have? Are they stable? Explain why this makes sense physically.

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[1]For those who prefer English units, this is, approximately, a 5 gallon bucket with a bit less than 3 lb, or a quarter gallon, of sand. The rainfall is about 4 in/hour.