All questions were True/False.

1. There were two possible questions, but they both have the same answer (the ordering of a, b, and c was randomized for each quiz and might have been in a different order):

   o Consider a two-input perceptron being applied to the following set of data:
     - $x_1 ((-1,-2),+1)$
     - $x_2 ((-1,-3),0)$
     - $x_3 ((-3,-1),0)$

     Which of the following sets of weights would correctly label this data? Check off all that apply.
     (In case it is of help, I’m including below a drawing of a two-input perceptron, which you can also find at http://www.cs.cornell.edu/courses/cs4700/2020sp/2InputPerceptron.JPG.)

     a. $w_0 = 0.8$
        $w_1 = 0.3$
        $w_2 = 0.2$
     b. $w_0 = 87$
        $w_1 = 21$
        $w_2 = 32$
     c. $w_0 = 7$
        $w_1 = 2$
        $w_2 = 2$

   o Consider a two-input perceptron being applied to the following set of data:
     - $x_1 ((-2,-1),+1)$
     - $x_2 ((-1,-3),0)$
     - $x_3 ((-3,-1),0)$

     Which of the following sets of weights would correctly label this data? Check off all that apply.
     (In case it is of help, I’m including below a drawing of a two-input perceptron, which you can also find at http://www.cs.cornell.edu/courses/cs4700/2020sp/2InputPerceptron.JPG.)

     a. $w_0 = 0.8$
        $w_1 = 0.2$
        $w_2 = 0.3$
     b. $w_0 = 87$
        $w_1 = 31$
        $w_2 = 22$
     c. $w_0 = 7$
        $w_1 = 2$
        $w_2 = 2$
For both of these the answer is all three. If you compute \( \mathbf{w} \cdot \mathbf{x} \) for each of these for the first one you get a number that is greater than or equal to zero, yielding a 1 output, and for the other two you get a negative number, yielding a 0 output.

2. There were two possible questions:
   - If the perceptron is initialized with all weights set to 0 then at the start of learning the perceptron will return a label of +1 for any example that you give it.
     True. If each \( w_i = 0 \) then \( \mathbf{w} \cdot \mathbf{x} = 0 \). This means that the perceptron outputs a 1.
   - If all of the weights for a perceptron are positive then any example \( \mathbf{x} \) that has only positive values for all of its features (all \( x_i > 0 \)) the perceptron will give a label of +1.
     True. If all the weights are positive and all the \( x_i \) are positive then \( \mathbf{w} \cdot \mathbf{x} > 0 \), which means the perceptron outputs a +1.

3. There were two possible questions, but they had the same answer:
   - Imagine we have a set of points in \( n \) dimensions where each attribute \( x_j \) for an example \( \mathbf{x} \) takes on a non-negative integer value. We can label these points by creating an \( n \)-dimensional "checkerboard", where we label a point as +1 if \( 0 \leq (x_1 + x_2 + ... + x_n) \mod 2 \leq 1 \) and as 0 otherwise.
     It is impossible for this function to label a set of data so that it is linearly separable.
   - Recall that the formula for the points that fall on the surface of a unit \( n \)-dimensional sphere is \( x_1^2 + x_2^2 + ... + x_n^2 = 1 \). We can label points that fall inside the sphere as +1 and those that are outside as 0 using the following function \( f(\mathbf{x}) = +1 \) if \( x_1^2 + x_2^2 + ... + x_n^2 \leq 1 \), 0 otherwise.
     It is impossible for this function to label a set of data so that it is linearly separable.

False. Imagine you have a data set of just two items. For either problem you can easily have that one of them satisfies the rule for outputting +1 and the other doesn’t and gives a 0. Linear separability is a property of a collection of data, not of the function that may have been labeling them.