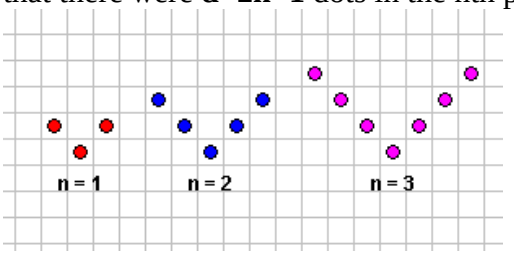
Some problems that use patterns. Solve these on a separate sheet of paper.

1. In the dot pattern V-numbers, we discovered that there were **d=2n+1** dots in the nth pattern.



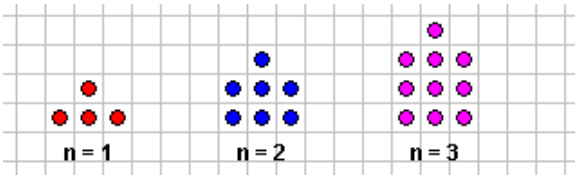
There is 1 dot at the bottom of the pattern, and 2 sets of n dots, one on either side.

a. At what step (n) of the pattern are there 101 dots?
b. What is the highest pattern step (n) that you could make with 84 dots?
c. What is the highest pattern step (n) that you can make with A dots? (make sure you explain what to do if you have a remainder when dividing)
d. What is the smallest pattern step (n) that would include at least 140 dots?
e. What is the smallest pattern step (n) that would include at least B dots? (explain remainders)
f. If you solved e using an equation, show how to solve by reasoning about the pattern. If you solved e by reasoning, show how to solve using the equation.

2. At the convention, each attendee gets a badge. There are 3 badge holders left over from the previous convention, and then new packages of badge holders are opened. Badge holders come in packages of 8.

a. Find an equation telling how many badge holders there are available if n packages are opened. Explain the equation.
b. If there are 20 people at the convention, how many packages of badge holders will be opened?
c. If there are 100 people at the convention, how many packages of badge holders will be opened?
d. If there are N people at the convention, how many packages of badge holders will be opened?
e. If you solved d using an equation, show how to solve by reasoning about the pattern. If you solved d by reasoning, show how to solve using the equation.

3. For the dot pattern tower numbers:



a. Find and explain an equation for tower numbers (how many dots in pattern n)
b. Is there a tower that has exactly 100 dots? If so, how many stories does it have? If not, how do you know?
c. How many stories tall (n) would the shortest tower be that had at least 264 dots?
d. How many stories tall (n) would the shortest tower be that had at least A dots?
e. How many stories tall (n) would the highest tower you could make with 126 dots be?
f. How many stories tall would the highest tower you could make with B dots be?
g. If you solved f using an equation, show how to solve by reasoning about the pattern. If you solved f by reasoning, show how to solve using the equation.

4. In a pattern block train made with trapezoids, the perimeter of a train made with n blocks is **p=3n+2**, because each of the n trapezoids have 3 units on the top and bottom, and there are 2 more units on the left and right ends of the train.

a. Is there a trapezoid train that has a perimeter of exactly 100 units? If so, how many blocks does it take the make the train? If not, how do you know it's impossible?
b. How many pattern blocks would it take to make a train that has a perimeter of at least 234 units?
c. How many pattern blocks would it take to make a train that has a perimeter of at least P units?
d. If you are only allowed a maximum perimeter of 150 units, how many pattern blocks would it take to make the longest such train?
e. If you are only allowed a maximum perimeter of P units, how many pattern blocks would it take to make the longest such train?
f. If you solved e using an equation, show how to solve by reasoning about the pattern. If you solved e by reasoning, show how to solve using the equation.