Sequences based on the set of prime numbers

**2, 3, 5, 7, 11, 13, 17,19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 8
3, 89, 97,….**

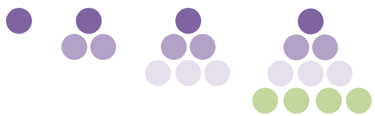
Find the next three terms in the following sequences

1. 4, 9, 25, 49,…
2. (3, 5), (5, 7), (11, 13), (17, 19), (29, 31),…
3. (5,11), (7,13), (11,17), (13,19), (17,23), (23,29),…
4. 3, 4, 6, 8, 12,…
5. 1, 2, 2, 4, 2, 4, 2, 4, 6, 2,…
6. 5, 8, 12, 18, 24,…
7. 199, 409, 619, 829, 1039,…
8. 0.5, $0.\dot{3}$, 0.2, $0.\dot{1}4285\dot{7}$,…
9. $0.\dot{6}, 0.6, 0.\dot{7}1428\dot{5}, 0.\dot{6}\dot{3}, \ldots$
10. 1, 2, 2, 3, 4,….

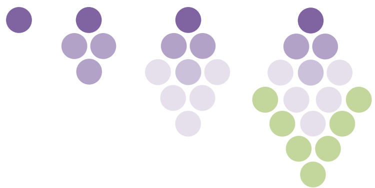
Sequences based on the polygonal numbers

Add the next two numbers and diagrams to these sequences

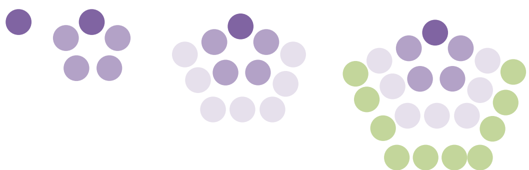
11. The triangular numbers: 1, 3, 6, 10, …



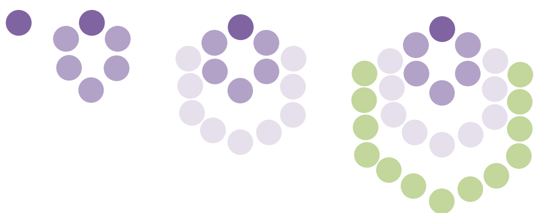
12. The square numbers: 1, 4, 9, 16, …



13. The pentagonal numbers: 1, 5, 12, 22, …



14. The hexagonal numbers: 1, 6, 15, 28, …



15. Find the *n*th term for each of the given polygonal sequences

16. There is a pattern for the sequence of *n*th terms of the polygonal numbers. Can you find it and give the formula for the next two polygonal sequences – the heptagonal numbers and the octagonal numbers?

Sequences based on Fibonacci numbers

The Fibonacci sequence 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987,…

The ratio of successive terms, starting with 1/1, of the Fibonacci sequence converges on the 'golden number' 1·61803 39887... which is given the Greek letter Φ [Phi]

1/1 = 1　　2/1 = 2　　3/2 = 1.5　　5/3 = 1.666 …　　8/5 = 1.6

987/610 ≈ 1.6180327868852459016393442

The exact value of Φ is $\frac{\sqrt{5}+1}{2}$

17. Search for the following sequences inside Pascal's triangle
    - The triangular numbers
    - The square numbers
    - The tetrahedral numbers
    - The Fibonacci numbers

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1
1 8 28 56 70 56 28 8 1
1 9 36 84 126 126 84 36 9 1
1 10 45 120 210 252 210 120 45 10 1

This image of cannon balls demonstrates how to generate the tetrahedral numbers

18. The Lucas sequence is generated in the same way as the Fibonacci sequence. It begins with 1, 3

Fibonacci: 0 1 1 2 3 5 8 13……

Lucas: 1 3 4 7 11 18 29……

These two sequences can be combined to create the *Wythoff Array*. David Morrison, in 1980, discovered that *every* positive integer appears in the array [the numbers to the right of the dividing line below] *exactly* once [2].

0	1	1	2	3	5	8	13 …
1	3	4	7	11	18	29 …	
2	4	6	10	16	26	42	68 …
3	6						
4	8						
5	9						
6	11						

Complete the first 6 columns of the array

How are the numbers in the first two columns generated? The second column is the challenging one! Find the next 2 rows.

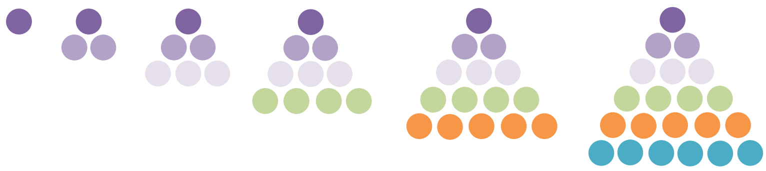
Teacher votes

Sequences based on the set of prime numbers

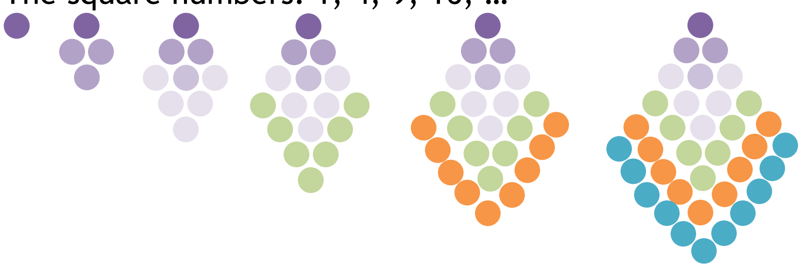
1. 4, 9, 25, 49, **121, 169, 289 (squares of primes from 2)**
2. (3, 5), (5, 7), (11, 13), (17, 19), (29, 31), **(41, 43), (59, 61), (71, 73) twin primes - gaps of 2** youtu.be/VSw5RUy9W5E
3. (5,11), (7,13), (11,17), (13,19), (17,23), (23,29), **(31,37), (37,43), (41,47) ('Sexy' primes - gaps of 6)**
4. 3, 4, 6, 8, 12, **14, 18, 20 (primes plus 1)**
5. 1, 2, 2, 4, 2, 4, 2, 4, 6, 2, **6, 4, 2 (gaps between primes)**
6. 5, 8, 12, 18, 24, **30, 36, 42 (Adding adjacent primes)**
7. 199, 409, 619, 829, 1039, **1249, 1459, 1669 (A ten term arithmetic sequence of primes with common difference 210)**
8. 0.5, $0.\dot{3}$, 0.2, $0.\dot{1}4285\dot{7}$, $0.\dot{0}\dot{9}, 0.\dot{0}7692\dot{3}, 0.\dot{0}58823529411764\dot{7}$ **(The reciprocals of the primes.Division by primes frequently produces maximum recurring decimal cycles - the number of digits in the cycle being 1 less than the denominator)**
9. $0.\dot{6}, 0.6, 0.\dot{7}1428\dot{5}, 0.\dot{6}\dot{3}, 0.\dot{6}\dot{3}, 0.\dot{8}4615\dot{3}, 0.\dot{7}64705882352941\dot{1}$ **(ratios 2/3, 3/5,…)**
10. 1, 2, 2, 3, 4, **4, 4, 5 (Square root of primes to 1 significant figure)**

Sequences based on the polygonal numbers

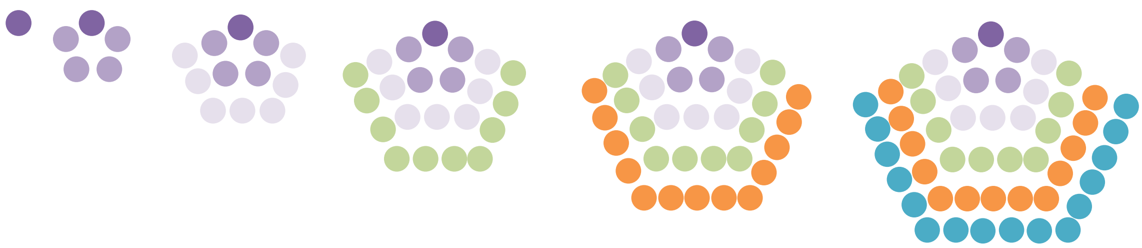
11. The triangular numbers: 1, 3, 6, 10, …



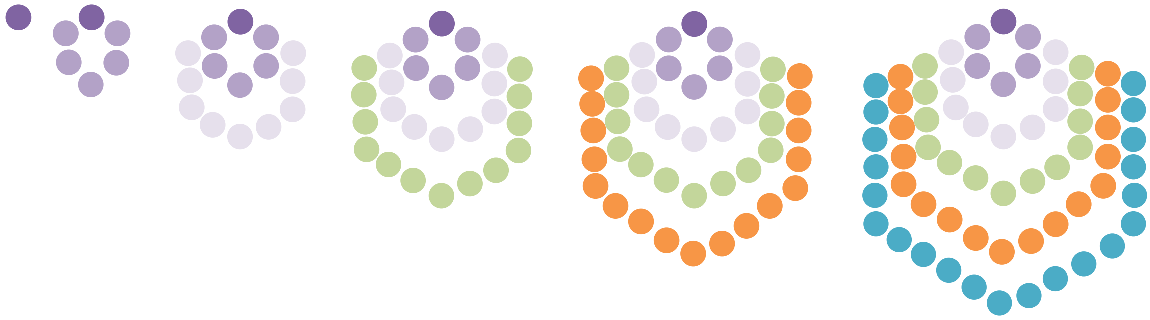
12. The square numbers: 1, 4, 9, 16, …



13. The pentagonal numbers: 1, 5, 12, 22, …



14. The hexagonal numbers: 1, 6, 15, 28, …



15. Find the *n*th term for each of the given polygonal sequences

Triangular $\frac{n(n+1)}{2}$

Square n^2

16.

Pentagonal $\frac{n(3n-1)}{2}$

Hexagonal $n(2n-1)$

Triangular $\frac{n(1n+1)}{2}$

Square $n^2 \equiv \frac{n(2n+0)}{2}$

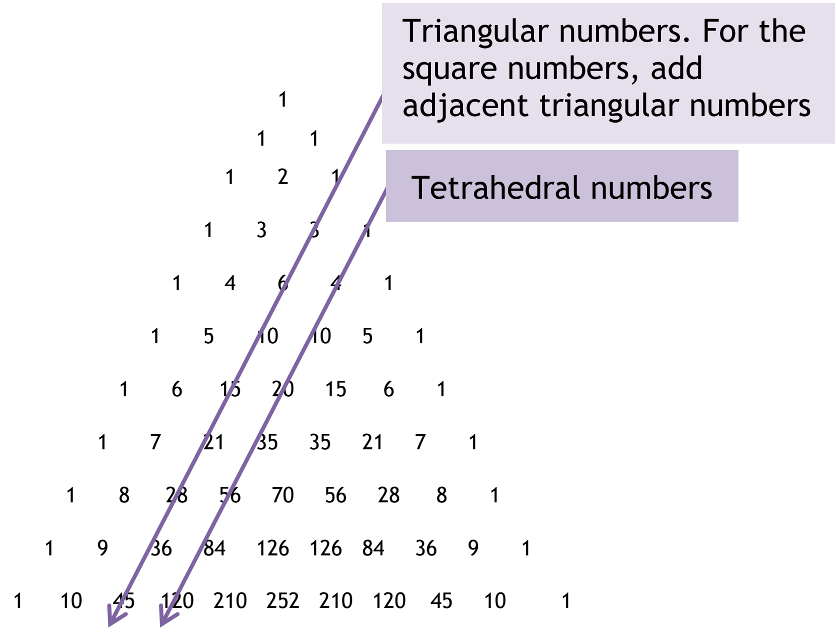
Pentagonal $\frac{n(3n-1)}{2}$

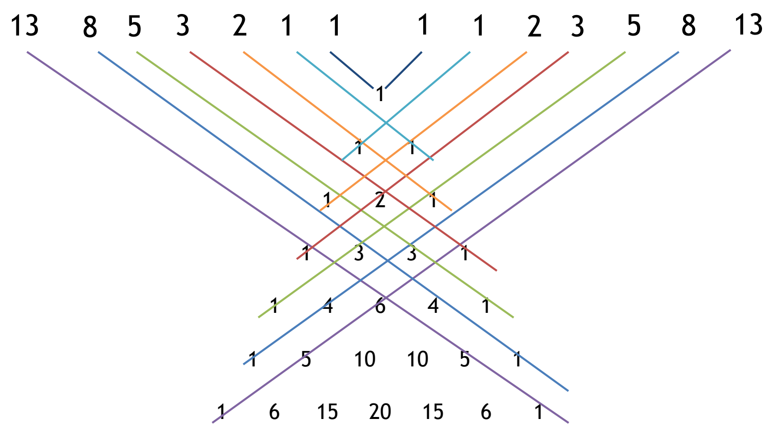
Hexagonal $n(2n-1) \equiv \frac{n(4n-2)}{2}$

Heptagonal $\frac{n(5n-3)}{2}$

Octagonal $\frac{n(6n-4)}{2} \equiv n(3n-2)$

17. Search for the following sequences inside Pascal's triangle





18.

0	1	1	2	3	5	8	13 …
1	3	4	7	11	18	29 …	
2	4	6	10	16	26	42	68 …
3	6	9	15	24	39	63	102
4	8	12	20	32	52	84	136
5	9	14	23	37	60	97	157
6	11	17	28	45	73	118	191
7	12	19	31	50	81	131	212
8	14	22	36	58	94	152	246

Example for how to generate the second column:

- First column fourth row entry is 3
- Find 3 in the array [row 1]
- Go to the next number in the row, 5
- Add 1, = 6
- 6 is the entry for row 4, column 2