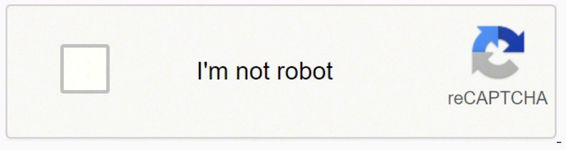


Next

# Geometric sequence formula for nth term

Quadratic sequences are sequences that include an \(n^2\) term. They can be identified by the fact that the differences in-between the terms are not equal, but the second differences between terms are equal.Example 1Work out the nth term of the sequence 2, 5, 10, 17, 26, ...Work out the first differences between the terms. The first differences are not the same, so work out the second differences.The second differences are the same. The sequence is quadratic and will contain an \(n^2\) term. The coefficient of \(n^2\) is always half of the second difference. In this example, the second difference is 2. Half of 2 is 1, so the coefficient of \(n^2\) is 1.To work out the nth term of the sequence, write out the numbers in the sequence \(n^2\) and compare this sequence with the sequence in the question.\[n^2\]14916Operation\[+ 1\]\[+ 1\]\[+ 1\]\[+ 1\]Sequence251017In this example, you need to add \(1\) to \(n^2\) to match the sequence. The sequence is therefore \(n^2 + 1\).Example 2Work out the nth term of the sequence 5, 11, 21, 35, ...Work out the first differences between the terms. The first differences are not the same, so work out the second differences.The second difference is the same so the sequence is quadratic and will contain an \(n^2\) term. The coefficient of \(n^2\) is half the second difference, which is 2. The sequence will contain \(2n^2\), so use this:\[2n^2\]281832Operation\[+ 3\]\[+ 3\]\[+ 3\]\[+ 3\]Sequence5112135The sequence is \(2n^2 + 3\).In a geometric sequence, the term to term rule is to multiply or divide by the same value. This value is called the common ratio, \(r\), which can be worked out by dividing one term by the previous term.Example 1Show that the sequence 3, 6, 12, 24, ... is a geometric sequence, and find the next three terms. Dividing each term by the previous term gives the same value: \(6 \div 3 = 12 \div 6 = 24 \div 12 = 2\). So the common ratio is 2 and this is therefore a geometric sequence.The next three terms are: \(24 \times 2 = 48\), \(48 \times 2 = 96\) and \(96 \times 2 = 192\).Example 2Find the next three terms in the geometric sequences:a) 6, 4.2, 2.94, ...b) 3, \(3\sqrt{3}\), 9, \(9\sqrt{3}\), 27, ...c) 2, -4, 8, -16,... a) To find the value of the common ratio, work out \( 4.2 \div 6 = 0.7\). The next three terms of the sequence are \(2.94 \times 0.7 = 2.058\), \(2.058 \times 0.7 = 1.4406\) and \(1.4406 \times 0.7 =1.00842\). The common ratio is less than 1. If the size of the common ratio is less than 1, the terms of the sequence will reduce in size. b) The common ratio is \(3\sqrt{3} \div3 = \sqrt{3}\). The next three terms are \(27 \times \sqrt{3} = 27\sqrt{3}\), \(27\sqrt{3} \times \sqrt{3} = 27 \times 3 = 81,\) and \(81 \times \sqrt{3} = 81\sqrt{3}\). Some of the terms of this sequence are surds, so leave your answer in surds as this is more accurate than writing them in decimal form as they would have to be rounded. c) The common ratio is \(-4 \div 2 = -2\). The next three terms of the sequence are \(-16 \times -2 = 32\), \(32 \times -2 = -64\), and \(-64 \times -2 = 128\). The common ratio is negative which means that the terms of the sequence will alternate between positive and negative. The nth term of a geometric sequence is \(ar^{n-1}\), where \(a\) is the first term and \(r\) is the common ratio.ExampleFind the nth term of the geometric sequence: 2, 2.4, 2.88, 3.456 and then find the 10th term.The first term is 2, so \(a = 2\).The common ratio is \(2.4 \div 2 = 1.2\), so \(r = 1.2\).The nth term of the geometric sequence is \(ar^{n-1} = 2 \times 1.2^{n-1}\)The 10th term is \(2 \times 1.2^9= 10.3195607\) A geometric sequenceA sequence of numbers where each successive number is the product of the previous number and some constant r., or geometric progressionUsed when referring to a geometric sequence., is a sequence of numbers where each successive number is the product of the previous number and some constant r. an=ran−1 Geometric Sequence And because anan−1=r, the constant factor r is called the common ratioThe constant r that is obtained from dividing any two successive terms of a geometric sequence; anan−1=r.. For example, the following is a geometric sequence, 9,27,81,243,729… Here a1=9 and the ratio between any two successive terms is 3. We can construct the general term an=3an−1 where, a1=9a2=3a1=3(9)=27a3=3a2=3(27)=81a4=3a3=3(81)=243a5=3a4=3(243)=729 ⋮ In general, given the first term a1 and the common ratio r of a geometric sequence we can write the following: a2=ra1a3=ra2=r(a1r)=a1r2a4=ra3=r(a1r2)=a1r3a5=ra3=r(a1r3)=a1r4 ⋮ From this we see that any geometric sequence can be written in terms of its first element, its common ratio, and the index as follows: an=a1rn−1 Geometric Sequence In fact, any general term that is exponential in n is a geometric sequence. Find an equation for the general term of the given geometric sequence and use it to calculate its 10th term: 3,6,12,24,48… Solution: Begin by finding the common ratio, r=63=2 Note that the ratio between any two successive terms is 2. The sequence is indeed a geometric progression where a1=3 and r=2. an=a1rn−1=3(2)n−1 Therefore, we can write the general term an=3(2)n−1 and the 10th term can be calculated as follows: a10=3(2)10−1=3(2)9=1,536 Answer: an=3(2)n−1; a10=1,536 The terms between given terms of a geometric sequence are called geometric meansThe terms between given terms of a geometric sequence.. Find all terms between a1=−5 and a4=−135 of a geometric sequence. In other words, find all geometric means between the 1st and 4th terms. Solution: Begin by finding the common ratio r. In this case, we are given the first and fourth terms: an=a1rn−1 Use n = 4.a4=a1r4−1a4=a1r3 Substitute a1=−5 and a4=−135 into the above equation and then solve for r. −135=−5r327=r33=r Next use the first term a1=−5 and the common ratio r=3 to find an equation for the nth term of the sequence. an=a1rn−1an=−5(3)n−1 Now we can use an=−5(3)n−1 where n is a positive integer to determine the missing terms. a1=−5(3)1−1=−5·30=−5a2=−5(3)2−1=−5·31=−15a3=−5(3)3−1=−5·32=−45 } geometric meansa4=−5(3)4−1=−5·33=−135 Answer: −15, −45, The first term of a geometric sequence may not be given. Find the general term of a geometric sequence where a2=−2 and a5=2125. Solution: To determine a formula for the general term we need a1 and r. A nonlinear system with these as variables can be formed using the given information and an=a1rn−1: {a2=a1r2−1a5=a1r5−1 ⇒ {−2=a1r2125=a1r4 Use a2=−2. Use a5=2125. Solve for a1 in the first equation, { −2=a1r ⇒ −2r=a12125=a1r4 Substitute a1=−2r into the second equation and solve for r. 2125=a1r42125=(−2r)r42125=−2r3−1125=r3−15=r Back substitute to find a1: a1=−2r=−2(−15)=10 Therefore, a1=10 and r=−15. Answer: an=10(−15)n−1 Try this! Find an equation for the general term of the given geometric sequence and use it to calculate its 6th term: 2,43,89,… Answer: an=2(23)n−1; a6=64243 A geometric seriesThe sum of the terms of a geometric sequence. is the sum of the terms of a geometric sequence. For example, the sum of the first 5 terms of the geometric sequence defined by an=3n+1 follows: S5=Σn=153n+1=31+1+32+1+33+1+34+1+35+1=32+33+34+35+36=9+27+81+243+729=1,089 Adding 5 positive integers is managable. However, the task of adding a large number of terms is not. Therefore, we next develop a formula that can be used to calculate the sum of the first n terms of any geometric sequence. In general, Sn=a1+a1r+a1r2+…+a1rn−1 Multiplying both sides by r we can write, rSn= a1r+a1r2+a1r3+…+a1rn Subtracting these two equations we then obtain, Sn−rSn=a1−a1rnSn(1−r)=a1(1−rn) Assuming r≠1 dividing both sides by (1−r) leads us to the formula for the nth partial sum of a geometric sequenceThe sum of the first n terms of a geometric sequence, given by the formula: Sn=a1(1−rn)1−r, r≠1.: Sn=a1(1−rn)1−r(r≠1) In other words, the nth partial sum of any geometric sequence can be calculated using the first term and the common ratio. For example, to calculate the sum of the first 15 terms of the geometric sequence defined by an=3n+1, use the formula with a1=9 and r=3. S15=a1(1−r15)1−r=9·(1−315)1−3=9(−14,348,906)−2=64,570,077 Find the sum of the first 10 terms of the given sequence: 4, −8, 16, −32, 64,... Solution: Determine whether or not there is a common ratio between the given terms. r=−84=−2 Note that the ratio between any two successive terms is −2; hence, the given sequence is a geometric sequence. Use r=−2 and the fact that a1=4 to calculate the sum of the first 10 terms, Sn=a1(1−rn)1−rS10=4[1−(−2)10]1−(−2)=4(1−1,024)1+2=4(−1,023)3=−1,364 Answer: S10=−1,364 Evaluate: Σn=162(−5)n. Solution: In this case, we are asked to find the sum of the first 6 terms of a geometric sequence with general term an=2(−5)n. Use this to determine the 1st term and the common ratio r: a1=2(−5)1=−10 To show that there is a common ratio we can use successive terms in general as follows: r=anan−1=2(−5)n2(−5)n−1=(−5)n−(n−1)=(−5)1=−5 Use a1=−10 and r=−5 to calculate the 6th partial sum. Sn=a1(1−rn)1−rS6=−10[1−(−5)6]1−(−5)=−10(1−15,625)1+5=−10(−15,624)6=26,040 Answer: 26,040 Try this! Find the sum of the first 9 terms of the given sequence: −2, 1, −1/2,... Answer: S9=−171128 If the common ratio r of an infinite geometric sequence is a fraction where |r|

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