Exploring some more Progressions (Advanced)

Standard difficulty · 20 questions · 40 marks · Time: 34 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. The sum of the first 8 terms of 1, 3, 9, … is:

(a) 6,560 **(b)** 6,561 **(c)** 9,841 **(d)** 3,280

2. The sum to infinity of the GP 19, −76/5, 304/25, … is:

(a) 171/5 **(b)** 95 **(c)** 104/9 **(d)** 95/9

3. The sum of the first n terms of a GP with first term a and ratio r ≠ 1 is:

(a) $n(a + ar^n) \div 2$ **(b)** $ar^n \div (1 - r)$

(c) $a(1 - r) \div (1 - r^n)$ **(d)** $a(1 - r^n) \div (1 - r)$

4. The sequence 9, 22, 41, 66, 97, … has constant second differences. Its 11th term is:

(a) 409 **(b)** 482 **(c)** 342 **(d)** 283

5. The sum of the first n terms of 3, 9, 27, … is 3,279. Then n is:

(a) 9 **(b)** 8 **(c)** 6 **(d)** 7

6. The first differences of 3, 7, 13, 21, 31 are:

(a) 10, 20, 34, 52 **(b)** 3, 4, 6, 8 **(c)** 2, 2, 2, 2 **(d)** 4, 6, 8, 10

7. An infinite GP has first term 5 and sum 25/3. Its common ratio is:

(a) 5/3 **(b)** −2/5 **(c)** 2/5 **(d)** 3/5

8. A ball dropped from 70 m rebounds to 4/5 of the height it falls each time. The total distance it travels before coming to rest is:

(a) 560 m **(b)** 700 m **(c)** 350 m **(d)** 630 m

Section B — Short answer — 8 × 2 = 16 marks

9. Find the exact sum of the first 8 terms of the GP 24, 12, 6, …

10. Use differences to find the nth term of 10, 24, 46, 76, 114, …, and hence its 12th term.

11. Find the sum of the first 7 terms of 7 + 77 + 777 + …

12. The sum to infinity of a GP is 5/2, and the sum to infinity of the squares of its terms is 25/6. Find the first term a and the common ratio r.

13. Find the sum of the first 14 terms of 4 + 12 + 22 + 34 + 48 + …

14. Find the 8th term of 4, 6, 13, 27, 50, … (the third differences are constant).

15. Find the value of 64^(1/4) × 64^(1/16) × 64^(1/64) × … to infinity.

16. For the infinite GP 8, 24/5, 72/25, 216/125, …, find $(t_1 + t_3 + t_5 + \ldots) \div (t_2 + t_4 + t_6 + \ldots)$.

Section C — Word problems — 4 × 4 = 16 marks

17. A square of side 24 cm is cut from card. The midpoints of its sides are joined to make a second square, which is cut and pasted on it, and so on. Find (a) the area of the 8th square (b) the total area of card for the first 8 squares (c) the total area if this went on forever.

18. The midpoints of the sides of an equilateral triangle of side 36 cm are joined to make a smaller triangle, and this is repeated forever. Find (a) the side of the 6th triangle (b) the sum of the perimeters of all the triangles.

19. A ball is dropped from a height of 216 m. Each time it hits the floor it rebounds to 2/3 of the height it fell. Find (a) the height it reaches after the 3rd bounce (b) the total distance it travels before coming to rest.

20. For the series −1 + 8 + 23 + 44 + 71 + …, find (a) the nth term (b) the 8th term (c) the sum of the first 8 terms.

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Answer key

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Q	Answer	Working
1	**(d) 3,280**	$a(r^n - 1)/(r - 1) = 1(3^8 - 1)/2$
2	**(d) 95/9**	a ÷ (1 − r) = 19 ÷ (1 − (−4/5))
3	**(d) $a(1 - r^n) \div (1 - r)$**	subtract rS_n from S_n
4	**(a) 409**	$t_n = 3n^2 + 4n + 2$; $t_{11} = 409$
5	**(d) 7**	$3(3^n - 1)/2 = 3{,}279$ gives $3^n = 2{,}187$
6	**(d) 4, 6, 8, 10**	subtract each term from the next
7	**(c) 2/5**	25/3 = 5 ÷ (1 − r), so r = 1 − 5 ÷ 25/3
8	**(d) 630 m**	70 + 2 × 70 × (4/5) ÷ (1 − 4/5) = 630
9	**765/16**	$a(1 - r^n)/(1 - r) = 24(1 - (1/2)^8) \div (1 - (1/2))$
10	**$t_n = 4n^2 + 2n + 4$; $t_{12} = 604$**	b = 10, a = 14, d = 8; $t_n = b + a(n - 1) + d(n - 1)(n - 2)/2$
11	**8,641,969**	$7/9 \times (9 + 99 + 999 + \ldots) = 7/9 \times [10(10^7 - 1)/9 - 7]$
12	**a = 2, r = 1/5**	$S^2 \div S_2 = (1 + r)/(1 - r) = 3/2$, so r = 1/5; a = S(1 − r) = 2
13	**1,512**	b = 4, a = 8, d = 2; $S_n = bn + a \cdot n(n - 1)/2 + d \cdot n(n - 1)(n - 2)/6$
14	**193**	b = 4, a = 2, d = 5, $d_1 = 2$; $t_8 = 4 + 2 \times 7 + 5 \times C(7, 2) + 2 \times C(7, 3)$
15	**4**	the powers add to 1/4 ÷ (1 − 1/4) = 1/3; 64^(1/3) = 4
16	**5/3**	both are GPs with ratio r^2; the ratio of their sums is $t_1 \div t_2 = 1/r = 5/3$
17	**(a) 9/2 cm^2; (b) 2295/2 cm^2; (c) 1,152 cm^2**	the areas form a GP 576, 288, … with r = 1/2; (b) $576(1 - (1/2)^8) \div (1/2)$; (c) 576 ÷ (1 − 1/2)
18	**(a) 9/8 cm; (b) 216 cm**	(a) $36 \times (1/2)^5$; (b) perimeters 108, 54, …: 108 ÷ (1 − 1/2) = 216
19	**(a) 64 m; (b) 1080 m**	(a) $216 \times (2/3)^3$; (b) 216 + 2 × [144 ÷ (1 − 2/3)]
20	**(a) $t_n = 3n^2 - 4$; (b) 188; (c) 580**	first differences 9, 15, 21, 27; second differences 6; b = −1, a = 9, d = 6

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