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CLASS X · MATHEMATICS STANDARD (041) · CBSE BOARD EXAMINATION 2027

CHAPTER 5

Arithmetic Progressions

$3, 7, 11, 15, \ldots$ $d = 4$ $a_n = 4n - 1$

Answer Booklet · Full worked solutions with CBSE-style step marks

Every question of the Standard booklet | Step marks shown line by line | MCQ keys with working

INSIDE THIS BOOKLET

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HOW TO USE THE ANSWERS

1. Solve the question in your notebook **first**. Open this booklet only to check.
2. The orange number beside each line is the **step mark** an examiner gives for that line, as in the CBSE marking scheme.
3. Give yourself marks line by line. A right final answer without the working can lose step marks.
4. Check a term by counting on from the first term with d, and check that every n is a positive whole number.
5. Copy every wrong answer to the My Mistakes page of your booklet.

READ THIS FIRST

Marking Guide

Full worked solutions to every question in the chapter booklet, set out the way a CBSE examiner marks them.

HOW MARKS ARE GIVEN IN ARITHMETIC PROGRESSIONS ANSWERS

1. **1-mark MCQ / assertion–reason:** only the correct option scores. The working here is for your understanding.
2. **nth term (2 marks):** formula with the values put in 1 · answer 1.
3. **a and d from two facts (3 marks):** two equations 1 · a and d 1 · the term or sum asked for 1.
4. **Sum (2–3 marks):** number of terms 1 · formula with values 1 · answer 1.
5. **Word problem or case (4–5 marks):** a, d, n identified · formula · working · answer in words with units.
6. Lines with no number are working that earns no separate mark but must be shown.

PART A · SOLUTIONS

A NCERT Practice – Solutions

Worked solutions with step marks for every question in Part A.

Is it an AP?

A1. Which of these are APs? For each AP, write the common difference. **(i)** 3, 7, 11, 15, … **(ii)** 1, 4, 9, 16, … **(iii)** $-6,\ -2.5,\ 1,\ 4.5,\ \ldots$ [3]

(i) differences $4, 4, 4$: an AP, $d = 4$ — 1

(ii) differences $3, 5, 7$: **not** an AP — 1

(iii) differences $3.5, 3.5, 3.5$: an AP, $d = 3.5$ — 1

A2. Write the first four terms of the AP: **(i)** $a = 5,\ d = -3$ **(ii)** $a = -1.5,\ d = 0.5$ [2]

(i) $5,\ 2,\ -1,\ -4$ — 1

(ii) $-1.5,\ -1,\ -0.5,\ 0$ — 1

A3. Write the first term and the common difference: **(i)** $\frac{1}{4},\ \frac{3}{4},\ \frac{5}{4},\ \frac{7}{4},\ \ldots$ **(ii)** $0.7,\ 0.3,\ -0.1,\ -0.5,\ \ldots$ [2]

(i) $a = \frac{1}{4},\ d = \frac{3}{4} - \frac{1}{4} = \frac{1}{2}$ — 1

(ii) $a = 0.7,\ d = 0.3 - 0.7 = -0.4$ — 1

Q	Answer	Working / reason
A4	**(c)** a, 2a, 3a, …	$a, 2a, 3a$ has the same difference a each time. The others have unequal differences.

The nth term

A5. Find: **(i)** the 25th term of 7, 11, 15, … **(ii)** the 15th term of $12,\ 7,\ 2,\ \ldots$ [2]

(i) $a = 7,\ d = 4$: $a_{25} = 7 + 24 \times 4 = 103$ — 1

(ii) $a = 12,\ d = -5$: $a_{15} = 12 + 14(-5) = -58$ — 1

A6. Which term of the AP 5, 11, 17, … is 251? [2]

$5 + (n-1)6 = 251 \to n - 1 = 41$ 1

$n = 42$: the 42nd term 1

A7. Is 184 a term of the AP 3, 7, 11, …? Justify. [2]

$3 + (n-1)4 = 184 \to n - 1 = 45.25$ 1

n is not a whole number, so 184 is **not** a term 1

A8. The 5th term of an AP is 23 and its 12th term is 51. Find its 30th term. [3]

$a + 4d = 23$, $a + 11d = 51$ 1

Subtract: $7d = 28 \to d = 4$, $a = 7$ 1

$a_{30} = 7 + 29 \times 4 = 123$ 1

A9. How many two-digit numbers are divisible by 6? [2]

12, 18, …, 96: $96 = 12 + (n-1)6$ 1

$n - 1 = 14 \to n = 15$ 1

A10. Find the 12th term from the end of the AP 4, 9, 14, …, 254. [2]

$l = 254$, $d = 5$: 12th from the end $= l - 11d$ 1

$= 254 - 55 = 199$ 1

A11. For what value of n are the nth terms of the APs 50, 53, 56, … and 2, 9, 16, … equal? [3]

$50 + 3(n-1) = 2 + 7(n-1)$ 1

$48 = 4(n-1) \to n = 13$ 1

The 13th terms are equal (both are 86) 1

A12. Two APs have the same common difference. The difference between their 100th terms is 80. What is the difference between their 1000th terms? [2]

$(a + 99d) - (b + 99d) = a - b = 80$ 1

$(a + 999d) - (b + 999d) = a - b = 80$ 1

Sum of n terms

A13. Find the sum: **(i)** of the first 18 terms of 3, 8, 13, … **(ii)** $7 + 10.5 + 14 + \cdots + 84$ [2]

(i) $S_{18} = 9[6 + 17 \times 5] = 9 \times 91 = 819$ 1

(ii) $d = 3.5$, $n = \dfrac{84 - 7}{3.5} + 1 = 23$; $S = \dfrac{23}{2}(7 + 84) = 1046.5$ 1

A14. How many terms of the AP 30, 27, 24, … must be taken so that their sum is 165? Explain the double answer. [3]

$\frac{n}{2}[60 - 3(n-1)] = 165 \to n(63 - 3n) = 330 \to n^2 - 21n + 110 = 0$ 1

$(n-10)(n-11) = 0 \to n = 10$ or 11 1

Both work: the 11th term is $30 - 30 = 0$, so adding it does not change the sum 1

A15. In an AP, $a = 5$, $d = 3$ and $a_n = 50$. Find n and S_n. [2]

$5 + 3(n-1) = 50 \to n = 16$ 1

$S_{16} = 8(5 + 50) = 440$ 1

A16. Find the sum of the first 30 positive multiples of 7. [2]

$7 + 14 + \cdots + 210 = 7(1 + 2 + \cdots + 30)$ 1

$= 7 \times \frac{30 \times 31}{2} = 3255$ 1

A17. The sum of the first n terms of an AP is $3n^2 + 5n$. Find the first term, the common difference and the n th term. [3]

$a_1 = S_1 = 8$; $S_2 = 22$, so $a_2 = 14$ 1

$d = 14 - 8 = 6$ 1

$a_n = 8 + (n-1)6 = 6n + 2$ 1

Word problems

A18. ₹1,600 is to be given as 8 prizes for punctuality. Each prize is ₹20 less than the one before it. Find the value of each prize. [3]

$S_8 = \frac{8}{2}[2a + 7(-20)] = 1600 \to 2a - 140 = 400$ 1

$a = 270$ 1

Prizes: ₹270, 250, 230, 210, 190, 170, 150, 130 1

A19. Bricks are stacked in rows: 25 in the bottom row, 23 in the next, 21 in the next, and so on. How many rows hold 168 bricks, and how many bricks are in the top row? [3]

$\frac{n}{2}[50 - 2(n-1)] = 168 \to n(26 - n) = 168 \to n^2 - 26n + 168 = 0$ 1

$(n-12)(n-14) = 0$; $n = 14$ would make the top row $25 - 26 = -1$, so reject it 1

12 rows; top row $25 - 22 = 3$ bricks 1

B

PART B · SOLUTIONS

Exemplar Practice – Solutions

Worked solutions with step marks for every question in Part B.

Multiple choice

Q	Answer	Working / reason
B1	**(c)** 29	$5 = a + 8(-3) \to a = 29$.
B2	**(d)** 21	$d = \frac{5}{2}$: $a_{11} = -4 + 10 \times \frac{5}{2} = 21$.
B3	**(a)** 0	$9(a + 8d) = 13(a + 12d) \to 4a = -84d \to a = -21d$, so $a_{22} = a + 21d = 0$.
B4	**(b)** 13	14, 21, …, 98: $n = \frac{84}{7} + 1 = 13$.
B5	**(c)** –330	$S_{20} = 10[24 + 19(-3)] = 10(-33) = -330$.
B6	**(b)** 20	$\frac{n}{2}(2 + 40) = 420 \to 21n = 420 \to n = 20$.
B7	**(d)** 0	$S_8 = 4[-14 + 7 \times 2] = 0$.

Short answer with reasons

B8. Is 0 a term of the AP 31, 28, 25, …? Justify. [2]

$31 + (n - 1)(-3) = 0 \to n - 1 = \frac{31}{3}$ — 1

n is not a whole number, so 0 is **not** a term — 1

B9. Show that the list defined by $a_n = 3n^2 + 1$ is not an AP. [2]

$a_1 = 4, a_2 = 13, a_3 = 28$ — 1

$a_2 - a_1 = 9$ but $a_3 - a_2 = 15$: the differences are not equal, so it is not an AP — 1

B10. Find x so that $2x$, $x + 10$, $3x + 2$ are three consecutive terms of an AP. [2]

$2(x + 10) = 2x + (3x + 2) \to 2x + 20 = 5x + 2$ — 1

$x = 6$ (terms 12, 16, 20) — 1

B11. The sum of three numbers in AP is 21 and their product is 231. Find the numbers. [3]

Take $a - d, a, a + d$: $3a = 21 \to a = 7$ — 1

$7(49 - d^2) = 231 \to d^2 = 16 \to d = \pm 4$ — 1

The numbers are 3, 7, 11 (or 11, 7, 3) — 1

B12. Find the sum of all odd numbers between 100 and 200. [2]

101, 103, …, 199: $n = \frac{98}{2} + 1 = 50$ — 1

$S = 25(101 + 199) = 7500$ — 1

B13. The first and last terms of an AP are 8 and 350, and the common difference is 9. How many terms are there, and what is their sum? **[3]**

$8 + 9(n-1) = 350 \to n - 1 = 38 \to n = 39$ — 1

$S = \frac{39}{2}(8 + 350)$ — 1

$= 39 \times 179 = 6981$ — 1

Long answer

B14. The sum of the first 5 terms of an AP and the sum of its first 7 terms together make 160. The sum of its first 10 terms is 210. Find the sum of its first 20 terms. **[4]**

$S_5 + S_7 = (5a + 10d) + (7a + 21d) = 160 \to 12a + 31d = 160$ — 1

$S_{10} = 5(2a + 9d) = 210 \to 2a + 9d = 42$ — 1

$12a = 252 - 54d \to 252 - 23d = 160 \to d = 4,\ a = 3$ — 1

$S_{20} = 10[6 + 19 \times 4] = 820$ — 1

B15. Find the sum of the integers between 200 and 300 that are (i) divisible by 7 (ii) not divisible by 7. **[4]**

(i) 203, 210, …, 294: $n = \frac{91}{7} + 1 = 14$ — 1

$S = 7(203 + 294) = 3479$ — 1

(ii) All integers 201 to 299: $\frac{99}{2}(201 + 299) = 24750$ — 1

Not divisible by 7: $24750 - 3479 = 21271$ — 1

B16. An open-air theatre has 20 rows of seats. The first row has 30 seats and each row has 4 more seats than the row in front of it. How many seats are in the last row, and how many in all? **[3]**

$a = 30,\ d = 4$: $a_{20} = 30 + 19 \times 4 = 106$ — 1

$S_{20} = 10(30 + 106)$ — 1

$= 1360$ seats — 1

C

PART C · SOLUTIONS

Board Pattern Practice – Solutions

Worked solutions with step marks for every question in Part C.

Common difference · nth term · middle term

Q	Answer	Working / reason
C1	**(b)** $2\sqrt{5}$	$3\sqrt{5} - \sqrt{5} = 2\sqrt{5}$.
C2	**(c)** x + 9y	$a_{10} = a + 9d = x + 9y$.
C3	**(a)** 15th	$18 + (n-1)18 = 270 \to 18n = 270 \to n = 15$.
C4	**(d)** k + 2	$(4k+1) - (3k-1) = k+2$ and $(5k+3) - (4k+1) = k+2$.
C5	**(b)** 46	$n = \frac{80}{4} + 1 = 21$, so the 11th term: $6 + 10 \times 4 = 46$.
C6	**(c)** 73	$101 - 7 \times 4 = 73$.
C7	**(a)** –3	$a_{n+1} - a_n = (5 - 3n - 3) - (5 - 3n) = -3$.
C8	**(a)**	The differences are 3, 4, 5. Both are true and R explains A.
C9	**(d)**	$25 - 4(n-1) = 0$ gives $n = 7.25$, not whole, so A is false. R is true.

C10. The 3rd term of an AP is 11 and its 7th term exceeds its 5th term by 8. Find its 20th term. **[2]**

$a_7 - a_5 = 2d = 8 \to d = 4$; $a + 2d = 11 \to a = 3$ — 1

$a_{20} = 3 + 19 \times 4 = 79$ — 1

C11. How many terms are there in the AP 7, 13, 19, …, 205? **[2]**

$205 = 7 + (n-1)6 \to n - 1 = 33$ — 1

$n = 34$ — 1

C12. Which term of the AP 3, 15, 27, 39, … is 120 more than its 21st term? **[2]**

$d = 12$; $a_{21} = 3 + 240 = 243$, so the term is 363 — 1

$3 + (n-1)12 = 363 \to n = 31$: the 31st term — 1

C13. The mth term of an AP is $\frac{1}{n}$ and its nth term is $\frac{1}{m}$ $(m \neq n)$. Show that its (mn)th term is 1. **[3]**

$a + (m-1)d = \frac{1}{n}$, $a + (n-1)d = \frac{1}{m}$; subtract: $(m-n)d = \frac{m-n}{mn} \to d = \frac{1}{mn}$ — 1

$a = \frac{1}{n} - \frac{m-1}{mn} = \frac{1}{mn}$ — 1

$a_{mn} = \frac{1}{mn} + (mn-1)\frac{1}{mn} = 1$ — 1

Sum of n terms

Q	Answer	Working / reason
C14	**(b)** 11	$a_2 = S_2 - S_1 = 18 - 7 = 11$.

C15	**(a)** 20	$\frac{n}{2}(5+95)=1000 \to 50n=1000 \to n=20.$
C16	**(d)** 400	$S_{20}=10[2+19\times 2]=400$ (also $n^2=400$).

C17. Find the sum of the first 22 terms of the AP $8,\ 3,\ -2,\ \ldots$ **[2]**

$a=8, d=-5$: $S_{22}=11[16+21(-5)]$ — 1

$=11\times(-89)=-979$ — 1

C18. Find the sum of all multiples of 15 between 1 and 300. **[3]**

15, 30, …, 285 (300 is left out) — 1

$n=\frac{285-15}{15}+1=19$ — 1

$S=\frac{19}{2}(15+285)=2850$ — 1

C19. How many terms of the AP 5, 9, 13, … must be taken to give a sum of 275? **[3]**

$\frac{n}{2}[10+4(n-1)]=275 \to n(2n+3)=275 \to 2n^2+3n-275=0$ — 1

$D=9+2200=2209=47^2 \to n=\frac{-3+47}{4}$ — 1

$n=11$ (the other root is negative) — 1

C20. The sum of the first 7 terms of an AP is 63 and the sum of its next 7 terms is 161. Find the AP. **[3]**

$S_7=\frac{7}{2}(2a+6d)=63 \to a+3d=9$ — 1

$S_{14}=63+161=224 \to 7(2a+13d)=224 \to 2a+13d=32$ — 1

$18+7d=32 \to d=2, a=3$: the AP is 3, 5, 7, … — 1

C21. The sum of the 2nd and 7th terms of an AP is 30 and their product is 200. Find the sum of the first 15 terms. **[5]**

a_2 and a_7 are the roots of $t^2-30t+200=0$, i.e. 10 and 20 — 1

Case 1: $a_2=10, a_7=20$: $5d=10 \to d=2, a=8$ — 1

$S_{15}=\frac{15}{2}[16+14\times 2]=330$ — 1

Case 2: $a_2=20, a_7=10$: $d=-2, a=22$ — 1

$S_{15}=\frac{15}{2}[44-28]=120$ — 1

C22. An AP has 30 terms. The sum of its first 8 terms is 100 and the sum of its last 8 terms is 628. Find the AP. **[5]**

$S_8=4(2a+7d)=100 \to 2a+7d=25$ — 1

The last 8 terms are the 23rd to the 30th; their sum $=\frac{8}{2}(a_{23}+a_{30})$ — 1

$4(2a+51d)=628 \to 2a+51d=157$ — 1

Subtract: $44d=132 \to d=3, a=2$ — 1

The AP is 2, 5, 8, 11, … — 1

Word problems

C23. The interior angles of a polygon are in AP. The smallest angle is 120° and the common difference is 5°. Find the number of sides. [3]

$\frac{n}{2}[240 + 5(n-1)] = (n-2)180 \to 5n^2 - 125n + 720 = 0 \to n^2 - 25n + 144 = 0$ 1

$(n-9)(n-16) = 0 \to n = 9$ or 16 1

For $n = 16$ the largest angle is $120^\circ + 75^\circ = 195^\circ$, more than 180°: reject. The polygon has 9 sides 1

C24. Priya saves ₹50 in the first week, ₹60 in the second, ₹70 in the third, and so on. In how many weeks will her total savings be ₹2,000? [3]

$\frac{n}{2}[100 + 10(n-1)] = 2000 \to n^2 + 9n - 400 = 0$ 1

$D = 81 + 1600 = 1681 = 41^2 \to n = \frac{-9 + 41}{2}$ 1

$n = 16$ weeks 1

C25. A library charges a fine of ₹5 for the first day a book is late, ₹7 for the second day, ₹9 for the third, and so on. (i) What is the total fine for a book returned 15 days late? (ii) On which day is the day's fine ₹41? [3]

(i) $S_{15} = \frac{15}{2}[10 + 14 \times 2] = \frac{15}{2} \times 38$ 1

$= ₹285$ 1

(ii) $5 + 2(n-1) = 41 \to n = 19$: the 19th day 1

C26. A gardener plants 3 saplings in the first row, 5 in the second, 7 in the third, and so on. He plants 120 saplings in all. How many rows are there, and how many saplings are in the last row? [3]

$\frac{n}{2}[6 + 2(n-1)] = n(n+2) = 120 \to n^2 + 2n - 120 = 0$ 1

$(n+12)(n-10) = 0 \to n = 10$ rows 1

Last row: $3 + 9 \times 2 = 21$ saplings 1

PART D · SOLUTIONS

D Case-Based Questions – Solutions

Worked solutions with step marks for every question in Part D.

D1. Case Study · Savings Jar [4]

(i) How much does he put in during the 10th week? **[1]**

$a_{10} = 20 + 9 \times 5 = ₹65$ 1

(ii) In which week does he put in ₹100? **[1]**

$20 + 5(n-1) = 100 \rightarrow n = 17$: the 17th week 1

(iii) How much is in the jar after 20 weeks? **[2]**

$S_{20} = 10[40 + 19 \times 5]$ 1

$= 10 \times 135 = ₹1{,}350$ 1

OR

(iii) In how many weeks will the jar hold ₹825? **[2]**

$\frac{n}{2}[40 + 5(n-1)] = 825 \rightarrow n^2 + 7n - 330 = 0$ 1

$(n+22)(n-15) = 0 \rightarrow 15$ weeks 1

D2. Case Study · Supermarket Display [4]

(i) How many cans are in the 5th row from the bottom? **[1]**

$a_5 = 24 + 4(-2) = 16$ cans 1

(ii) How many rows are there? **[1]**

$24 - 2(n-1) = 2 \rightarrow n = 12$ rows 1

(iii) How many cans are there in the display? **[2]**

$S_{12} = \frac{12}{2}(24 + 2)$ 1

$= 156$ cans 1

OR

(iii) If the display is stopped after 8 rows, how many cans does it use? **[2]**

$S_8 = 4[48 + 7(-2)]$ 1

$= 4 \times 34 = 136$ cans 1

D3. Case Study · Cycling Training [4]

(i) How far does she ride on the 8th day? **[1]**

$a_8 = 12 + 7 \times 2 = 26$ km 1

(ii) On which day does she ride 40 km? **[1]**

$12 + 2(n-1) = 40 \rightarrow n = 15$: the 15th day 1

(iii) Find the total distance she rides in the first two weeks. **[2]**

$S_{14} = 7[24 + 13 \times 2]$ 1

$= 7 \times 50 = 350$ km 1

OR

(iii) In how many days will her total distance be 210 km? **[2]**

$\frac{n}{2}[24 + 2(n-1)] = n(n+11) = 210 \rightarrow n^2 + 11n - 210 = 0$ 1

$(n+21)(n-10) = 0 \rightarrow 10$ days 1

D4. Case Study · School Quiz [4]

(i) How many points does the 10th question carry? **[1]**

$a_{10} = 5 + 9 \times 3 = 32$ 1

(ii) Which question carries 62 points? **[1]**

$5 + 3(n-1) = 62 \rightarrow n = 20$: the 20th question 1

(iii) Find the total points for the first 20 questions. **[2]**

$S_{20} = 10[10 + 19 \times 3]$ 1

$= 670$ points 1

OR

(iii) A team answered the first few questions correctly and scored 390 points. How many questions did it answer? **[2]**

$\frac{n}{2}[10 + 3(n-1)] = 390 \rightarrow 3n^2 + 7n - 780 = 0$ 1

$D = 9409 = 97^2 \rightarrow n = \frac{-7 + 97}{6} = 15$ questions 1

E PART E · SOLUTIONS
Challenge Questions – Solutions

Worked solutions with step marks for every question in Part E.

E1. The sum of the first p terms of an AP equals the sum of its first q terms ($p \neq q$). Show that the sum of its first $(p+q)$ terms is 0. **[3]**

$\frac{p}{2}[2a + (p-1)d] = \frac{q}{2}[2a + (q-1)d] \rightarrow 2a(p-q) + d(p^2 - q^2 - p + q) = 0$ 1

$(p-q)[2a + (p+q-1)d] = 0$; since $p \neq q$, $2a + (p+q-1)d = 0$ 1

$S_{p+q} = \frac{p+q}{2}[2a + (p+q-1)d] = 0$ 1

E2. The sums of the first n terms of two APs are in the ratio $(5n+3) : (3n+4)$. Find the ratio of their 6th terms. **[3]**

$\frac{S_n}{S'_n} = \frac{2a + (n-1)d}{2a' + (n-1)d'} = \frac{5n+3}{3n+4}$ 1

The 6th terms have $a + 5d$; so take $\frac{n-1}{2} = 5$, i.e. $n = 11$ 1

Ratio $= \frac{5(11)+3}{3(11)+4} = \frac{58}{37}$, i.e. 58 : 37 1

E3. Find the sum of all three-digit numbers that leave a remainder of 3 when divided by 5. **[3]**

$103, 108, \ldots, 998$ — 1

$n = \dfrac{998 - 103}{5} + 1 = 180$ — 1

$S = 90(103 + 998) = 99090$ — 1

E4. The houses in a row are numbered 1 to 288. Show that there is a house numbered x such that the sum of the numbers before it equals the sum of the numbers after it, and find x. **[3]**

$\dfrac{(x-1)x}{2} = \dfrac{288 \times 289}{2} - \dfrac{x(x+1)}{2}$ — 1

$x^2 = \dfrac{288 \times 289}{2} = 41616$ — 1

$x = 204$ — 1

E5. The pth, qth and rth terms of an AP are a, b, c. Show that $a(q-r) + b(r-p) + c(p-q) = 0$. **[3]**

$a = A + (p-1)D$, $b = A + (q-1)D$, $c = A + (r-1)D$ — 1

The A terms give $A[(q-r) + (r-p) + (p-q)] = 0$ — 1

The D terms give $D[p(q-r) + q(r-p) + r(p-q)] - D \cdot 0 = 0$, so the whole sum is 0 — 1

E6. The 5th term of an AP is 0. Prove that its 20th term is three times its 10th term. **[2]**

$a + 4d = 0 \to a = -4d$ — 1

$a_{20} = -4d + 19d = 15d$ and $a_{10} = -4d + 9d = 5d$, so $a_{20} = 3a_{10}$ — 1

E7. The angles of a triangle are in AP and the largest is twice the smallest. Find the angles. **[3]**

Angles $a - d$, a, $a + d$: $3a = 180^\circ \to a = 60^\circ$ — 1

$60 + d = 2(60 - d) \to d = 20$ — 1

The angles are 40°, 60°, 80° — 1