A Square and a Cube: Thinking Puzzles

Standard difficulty · 20 questions · 40 marks · Time: 36 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. A perfect square can never end in which digit?
(a) 4 **(b)** 9 **(c)** 1 **(d)** 7

2. 50 × k is a perfect cube. What is the smallest natural number k?
(a) 40 **(b)** 2 **(c)** 50 **(d)** 20

3. What is the smallest natural number k such that 1,400 ÷ k is a perfect square?
(a) 16 **(b)** 28 **(c)** 14 **(d)** 100

4. How many perfect squares lie between 138 and 554?
(a) 14 **(b)** 12 **(c)** 13 **(d)** 11

5. 157,464 is a perfect cube. What is its cube root?
(a) 59 **(b)** 64 **(c)** 44 **(d)** 54

6. A number machine takes the input, squares it, adds 20, then multiplies by 4. What comes out when 6 goes in?
(a) 224 **(b)** 228 **(c)** 56 **(d)** 596

7. $1 = 1^2$, $1 + 3 = 2^2$, $1 + 3 + 5 = 3^2$. Following the pattern, what is $1 + 3 + 5 + \ldots + 21$?
(a) 121 **(b)** 144 **(c)** 100 **(d)** 132

8. How many whole numbers lie strictly between 15^2 and 16^2?
(a) 30 **(b)** 31 **(c)** 29 **(d)** 15

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

9. Why can 2,000 not be a perfect square? Use its last digits.

10. Find the cube root of 29,791 using prime factorisation.

11. Find √6,241.

12. What is the smallest whole number that must be added to 1,109 to make a perfect square?

13. How many perfect cubes are there from 1 to 6,910?

14. $1^3 = 1^2$, $1^3 + 2^3 = 3^2$, $1^3 + 2^3 + 3^3 = 6^2$. Use the pattern to find $1^3 + 2^3 + \ldots + 12^3$.

15. Which of these are perfect squares? Write them in the order given: 606, 576, 16, 149, 246, 400

16. How many numbers from 1 to 30,874 are both perfect squares and perfect cubes?

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

17. A gardener has 195 square tiles and wants to lay the largest possible square with them. (a) How many tiles long is each side? (b) How many tiles are left over? (c) How many more tiles would she need for a square one tile longer on each side?

18. A cube of side 10 cm is built from 1,000 unit cubes, and its outside is painted. How many unit cubes have (a) three painted faces (b) exactly two (c) exactly one (d) none?

19. For n = 300: (a) find the smallest k for which n × k is a perfect square (b) the square root of that square (c) the smallest m for which n × m is a perfect cube (d) the cube root of that cube.

20. 3,842 lies between two consecutive perfect squares. (a) What is the smaller one? (b) the larger one? (c) How many whole numbers lie strictly between them? (d) How many of those are less than 3,842?

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Answer key

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Q	Answer	Working
1	**(d) 7**	squares end in 0, 1, 4, 5, 6 or 9
2	**(d) 20**	$50 = 2 \times 5^2$; raise every exponent to a multiple of 3: k = 20, and $50 \times 20 = 1{,}000 = 10^3$
3	**(c) 14**	$1{,}400 = 2^3 \times 5^2 \times 7$; remove one of each prime with an odd exponent: k = 14, and $1{,}400 \div 14 = 100 = 10^2$
4	**(b) 12**	144, 169, 196, 225, 256, 289, 324, 361, 400, 441, 484, 529
5	**(d) 54**	units digit 4 → cube root ends in 4; 157 lies between 5^3 and 6^3 → tens digit 5
6	**(a) 224**	6 → 36 → 56 → 224
7	**(a) 121**	21 is the 11th odd number, so the sum is $11^2 = 121$
8	**(a) 30**	256 − 225 − 1 = 30
9	**A perfect square ends in an even number of zeros; 2,000 ends in three zeros.**	—
10	**31**	$29{,}791 = 31^3$; take one prime from each group of three: 31 = 31
11	**79**	$6{,}241 = 79^2$; halve each exponent: 79
12	**47**	$33^2 = 1{,}089 < 1{,}109 < 1{,}156 = 34^2$; 1,156 − 1,109
13	**19**	$19^3 = 6{,}859 \le 6{,}910 < 8{,}000$
14	**6,084**	1 + 2 + … + 12 = 78; $78^2 = 6{,}084$
15	**576, 16, 400**	$576 = 24^2$; $16 = 4^2$; $400 = 20^2$
16	**5**	such numbers are sixth powers: 1, 64, 729, 4,096, 15,625
17	**(a) 13; (b) 26; (c) 1**	$13^2 = 169 \le 195 < 196$
18	**(a) 8; (b) 96; (c) 384; (d) 512**	corners 8; edges 12 × 8; faces 6×8^2; inside 8^3; check: $1000 = 10^3$
19	**(a) 3; (b) 30; (c) 90; (d) 30**	$300 = 2^2 \times 3 \times 5^2$
20	**(a) 3,721; (b) 3,844; (c) 122; (d) 120**	61^2 and 62^2; between them 2 × 61 numbers

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