BRADLEY'S MATHS

GCSE Higher Level Mathematics

NUMBER

1.2: Squares and Cubes

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Abstract

This worksheet and answer sheet are, together, a stand alone teaching and learning document aimed directly at the GCSE syllabus item N1 6 Use positive integer powers and associated real roots (square, cube).

This booklet has been fully updated with our unique colour coded box system to facilitate teaching and learning:

- Violet for Deeper Insights into the subject matter
- Green for Methods and Examples
- Blue for Pro-Tips - how to approach questions
- Yellow for Caution - avoiding common pitfalls
- Cyan for Reminders

The worksheets have been designed with enough space for students to answer the questions directly in the booklet.

1.2 SQUARES AND CUBES WORKSHEET AND ANSWER SHEET

Instructions

- Answer all questions.
- Show all your working clearly in the spaces provided.
- The number of marks for each question or part question is shown in brackets [ ].
- Do not use an electronic calculator for this worksheet.

Key Concepts: Squares, Cubes, and their Roots

This worksheet covers powers and roots. A **power** tells you to multiply a number by itself a certain number of times. A **root** is the reverse operation.

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1. Square Numbers and Square Roots

Core Concept: Squaring and Square Rooting

- To **square** a number, you multiply it by itself. This is also called raising it to the power of 2.

$$5^2 = 5 \times 5 = 25$$

- A **square number** is the result of squaring an integer. (e.g., 25 is a square number).
- A **square root** ($\sqrt{\ }$) is the opposite of squaring. It finds the number that was multiplied by itself to get the original number.

$$\sqrt{25} = 5$$

2. Cube Numbers and Cube Roots

Core Concept: Cubing and Cube Rooting

- To **cube** a number, you multiply it by itself three times. This is also called raising it to the power of 3.

$$4^3 = 4 \times 4 \times 4 = 64$$

- A **cube number** is the result of cubing an integer. (e.g., 64 is a cube number).
- A **cube root** ($\sqrt[3]{\ }$) is the opposite of cubing. It finds the number that was multiplied by itself three times to get the original number.

$$\sqrt[3]{64} = 4$$

Caution: Dealing with Negative Numbers

Be very careful with the signs when working with negative numbers.

- **Squaring a negative gives a POSITIVE result**:
  A negative times a negative is a positive.

$$(-5)^2 = (-5) \times (-5) = 25$$

- **Cubing a negative gives a NEGATIVE result**:
  (negative $\times$ negative) $\times$ negative = positive $\times$ negative = negative.

$$(-2)^3 = (-2) \times (-2) \times (-2) = 4 \times (-2) = -8$$

- This also means you **can** find the cube root of a negative number: $\sqrt[3]{-8} = -2$.

Common Error: The Position of the Negative Sign

Pay very close attention to the brackets. There is a critical difference between -5^2 and $(-5)^2$.

- $(-5)^2$ means "square the number -5". The result is positive.

$$(-5)^2 = (-5) \times (-5) = 25$$

- -5^2 means "square the number 5, then make the result negative". The power is attached only to the 5, not the negative sign.

$$-5^2 = -(5 \times 5) = -25$$

This is a rule from the order of operations (BODMAS/BIDMAS): Indices are calculated before the negative sign (which acts like a subtraction from zero) is applied.

Reference: First 12 Square and Cube Numbers

Square Numbers

It is extremely useful to memorise these common values.

$$
\begin{aligned}
1^2 &= 1 \\
2^2 &= 4 \\
3^2 &= 9 \\
4^2 &= 16 \\
5^2 &= 25 \\
6^2 &= 36 \\
7^2 &= 49 \\
8^2 &= 64 \\
9^2 &= 81 \\
10^2 &= 100 \\
11^2 &= 121 \\
12^2 &= 144
\end{aligned}
$$

Cube Numbers

$$
\begin{aligned}
1^3 &= 1 \\
2^3 &= 8 \\
3^3 &= 27 \\
4^3 &= 64 \\
5^3 &= 125 \\
6^3 &= 216
\end{aligned}
$$

$$10^3 = 1000$$

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1. From the list below, identify:

$$1, \quad 8, \quad 12, \quad 16, \quad 25, \quad 27, \quad 30, \quad 64, \quad 100$$

(a) the square numbers. [1]

(b) the cube numbers. [1]

(c) the numbers that are both square numbers and cube numbers. [1]

Total: [3]

2. Calculate the following:

   (a) 7^2 [1]

   (b) 11^2 [1]

   (c) $(-5)^2$ [1]

   (d) 1^2 [1]

   (e) 20^2 [1]

Total: [5]

3. Calculate the following:

   (a) 4^3 [1]

   (b) 1^3 [1]

   (c) $(-2)^3$ [1]

   (d) 5^3 [1]

   (e) 10^3 [1]

Total: [5]

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4. Find the value of the following:

   (a) $\sqrt{49}$ [1]

   (b) $\sqrt{144}$ [1]

   (c) $\sqrt{1}$ [1]

   (d) $\sqrt{81}$ [1]

   (e) $\sqrt{400}$ [1]

Total: [5]

5. Find the value of the following:

   (a) $\sqrt[3]{8}$ [1]

   (b) $\sqrt[3]{64}$ [1]

   (c) $\sqrt[3]{-27}$ [1]

   (d) $\sqrt[3]{1}$ [1]

   (e) $\sqrt[3]{1000}$ [1]

Total: [5]

6. Work out the value of:

   (a) $3^2 + 2^3$ [2]

   (b) $\sqrt{100} - \sqrt[3]{64}$ [2]

   (c) $(-1)^3 + (-1)^2$ [2]

Total: [6]

7. (a) A square field has an area of 121 m^2. What is the length of one side of the field? [1]

   (b) A cube-shaped box has a volume of 216 cm^3. What is the length of one edge of the box? [1]

   (c) Find two consecutive square numbers that have a difference of 15. [2]

Total: [4]

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8. List the first five cube numbers. [2]

Total: [2]

End of Worksheet

1) a) 1, 16, 25, 64, 100

b) 1, 8, 27, 64

c) 1,   64

2)

Reminder: Powers of Negative Numbers

- Squaring a negative number gives a **positive** result: $(-5)^2 = (-5) \times (-5) = +25$.
- Cubing a negative number gives a **negative** result: $(-2)^3 = (-2) \times (-2) \times (-2) = -8$.

a) $7^2 = 7 \times 7 = 49$

b) $11^2 = 11 \times 11 = 121$

c) $(-5)^2 = (-5) \times (-5) = 25$

d) $1^2 = 1 \times 1 = 1$

e) $20^2 = 20 \times 20 = 400$

3) a) $4^3 = 4 \times 4 \times 4 = 64$

b) $1^3 = 1 \times 1 \times 1 = 1$

c) $(-2)^3 = (-2) \times (-2) \times (-2) = -8$

d) $5^3 = 5 \times 5 \times 5 = 125$

e) $10^3 = 10 \times 10 \times 10 = 1000$

4)

Reminder: Finding a Square Root

To find the square root of a number (e.g., $\sqrt{49}$), we ask the question: "What positive number, when multiplied by itself, gives 49?" Since $7 \times 7 = 49$, the answer is 7.

a) $\sqrt{49} = 7$

b) $\sqrt{144} = 12$

c) $\sqrt{1} = 1$

d) $\sqrt{81} = 9$

e) $\sqrt{400} = 20$

5)

Reminder: Finding a Cube Root

To find the cube root of a number (e.g., $\sqrt[3]{8}$), we ask the question: "What number, when multiplied by itself three times, gives 8?" Since $2 \times 2 \times 2 = 8$, the answer is 2.

a) $\sqrt[3]{8} = 2$

b) $\sqrt[3]{64} = 4$

c) $\sqrt[3]{-27} = -3$

d) $\sqrt[3]{1} = 1$

e) $\sqrt[3]{1000} = 10$

6) a) $$\begin{aligned} 3^2 + 2^3 &= (3 \times 3) + (2 \times 2 \times 2) \\ &= 9 + 8 \\ &= 17 \end{aligned}$$

b) $$\begin{aligned} \sqrt{100} - \sqrt[3]{64} &= 10 - 4 \\ &= 6 \end{aligned}$$

c) $$\begin{aligned} (-1)^3 + (-1)^2 &= (-1) + (1) \\ &= 0 \end{aligned}$$

7) a)

Method: Finding Side Length from Area of a Square

The area of a square is side^2. To find the side length from the area, you must calculate the square root of the area.

$$
\begin{aligned}
\text{Side length} &= \sqrt{121} \\
&= 11\,\text{m}
\end{aligned}
$$

b)

Method: Finding Edge Length from Volume of a Cube

The volume of a cube is edge^3. To find the edge length from the volume, you must calculate the cube root of the volume.

$$
\begin{aligned}
\text{Edge length} &= \sqrt[3]{216} \\
&= 6\,\text{cm}
\end{aligned}
$$

c) The two consecutive square numbers are 49 and 64, since $64 - 49 = 15$.

Deeper Insight: The Algebraic Approach

We are looking for two consecutive integers, n and $n+1$, such that the difference between their squares is 15.

$$
\begin{aligned}
(n+1)^2 - n^2 &= 15 \\
(n^2 + 2n + 1) - n^2 &= 15 \\
2n + 1 &= 15 \\
2n &= 14 \\
n &= 7
\end{aligned}
$$

The integers are 7 and 8. Their squares are $7^2 = 49$ and $8^2 = 64$.

8) The first five cube numbers are: 1, 8, 27, 64, 125.