

# Step by step guide: Perfect Squares

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## Grade 10 Mathematics | 40-Minute Lesson

### Before Class Begins

#### Preparation Checklist:

- Write the two perfect square identities on the board (covered until Phase 2)
- Prepare group discussion prompts
- Prepare exit tickets for distribution
- Set timer for phase transitions
- Have worked examples ready

### PHASE 1: Problem-Solving and Discovery (15 Minutes)

#### Opening (2 minutes)

[SAY]:

*"Good morning/afternoon, class! Today we're going to learn about PERFECT SQUARES. These are special patterns in algebra that will help you factor and expand expressions much faster!"*

[SAY]:

*"Here's our key question: How do we apply the concept of quadratic equations? Perfect squares are everywhere in quadratic equations!"*

#### Anchor Activity Introduction (3 minutes)

[SAY]:

*"In your groups, I want you to define, discuss, and work on:*

- 1. Perfect square identities*
- 2. Expanding perfect squares*
- 3. Recognizing perfect square trinomials*
- 4. Factoring perfect square trinomials*

*Copy these two identities and observe them:*

(i)  $(a + b)^2 = a^2 + 2ab + b^2$

(ii)  $(a - b)^2 = a^2 - 2ab + b^2$

**[EMPHASIZE]:**

*"Pay special attention to the MIDDLE TERM. What do you notice about it?"*

### Group Work (7 minutes)

**[SAY]:**

*"Discuss in your groups:*

- *How can you verify these identities by expanding?*
- *How do perfect square identities make factoring easier?*
- *What happens if you don't recognize the pattern?*
- *Can you think of real-world applications?*

*You have 6 minutes. Begin!"*

**[DO]:** Walk around the room, observing group discussions.

**[ASK probing questions as you circulate]:**

- "Can you expand  $(a + b)^2$  to verify the identity?"
- "What do you notice about the middle term?"
- "How is  $2ab$  related to  $a$  and  $b$ ?"
- "What's the difference between  $(a + b)^2$  and  $(a - b)^2$ ?"
- "How would you check if  $x^2 + 6x + 9$  is a perfect square?"

**[TIME CHECK]:** At 5 minutes, announce: "One more minute!"

### Class Discussion (3 minutes)

**[SAY]:**

*"Let's share what you discovered. What did you notice about the middle term?"*

**[Expected answer]:** "The middle term is TWICE the product of  $a$  and  $b$ !"

**[ASK]:**

*"What's the difference between the two identities?"*

**[Expected answer]:** "One has a positive middle term, one has a negative middle term!"

**[TRANSITION]:**

*"Excellent! Let me formalize these perfect square identities."*

## PHASE 2: Structured Instruction (10 Minutes)

### The Two Perfect Square Identities (5 minutes)

[REVEAL identities on board]:

[SAY]:

*"A PERFECT SQUARE is a special trinomial that can be factored into the square of a binomial.*

*There are TWO perfect square identities:"*

[WRITE Identity 1]:

*"Identity 1 (Positive middle term):*

$$a^2 + 2ab + b^2 = (a + b)^2$$

*Use this when the middle term is POSITIVE."*

[WRITE Identity 2]:

*"Identity 2 (Negative middle term):*

$$a^2 - 2ab + b^2 = (a - b)^2$$

*Use this when the middle term is NEGATIVE."*

### How to Recognize a Perfect Square (3 minutes)

[SAY]:

*"How do you know if a trinomial is a perfect square? Check THREE things:*

- 1. Is the FIRST term a perfect square? (Can you take its square root?)*
- 2. Is the LAST term a perfect square? (Can you take its square root?)*
- 3. Is the MIDDLE term equal to  $2 \times \sqrt{\text{first}} \times \sqrt{\text{last}}$ ?*

*If all three are YES, it's a perfect square!"*

### Addressing Misconceptions (2 minutes)

[SAY - IMPORTANT]:

*"COMMON MISTAKE: Not every trinomial is a perfect square!*

*For example:  $x^2 + 5x + 6$  is NOT a perfect square.*

- First term  $x^2$  ✓
- Last term 6 is NOT a perfect square ✗

You *MUST* check all three conditions!"

**[TRANSITION]:**

"Now let's practice factoring perfect squares!"

### PHASE 3: Practice and Application (15 Minutes)

#### Worked Example (4 minutes)

**[SAY]:**

"Let's factor  $x^2 + 6x + 9$ ."

**[WRITE step by step]:**

"Step 1: Check if it's a perfect square

- First term:  $x^2$  is a perfect square ( $\sqrt{x^2} = x$ ) ✓
- Last term: 9 is a perfect square ( $\sqrt{9} = 3$ ) ✓
- Middle term:  $6x = 2 \times x \times 3 = 2ab$  ✓

Step 2: Identify  $a$  and  $b$

- $a = x$
- $b = 3$

Step 3: Apply the identity

Since the middle term is positive:

$$x^2 + 6x + 9 = (x + 3)^2$$

#### Guided Practice (5 minutes)

**[SAY]:**

"Try these with your partner:

- a) Factor:  $x^2 - 10x + 25$
- b) Expand:  $(2x + 5)^2$ "

**[GIVE 4 minutes, then review]:**

"a)  $x^2 - 10x + 25$

- $a = x$ ,  $b = 5$

- Middle term:  $-10x = -2(x)(5)$  ✓
- Since negative:  $(x - 5)^2$

$$\begin{aligned} b) (2x + 5)^2 \\ &= (2x)^2 + 2(2x)(5) + 5^2 \\ &= 4x^2 + 20x + 25 \end{aligned}$$

### Independent Practice (6 minutes)

**[SAY]:**

"Now try these on your own:

a) Factor:  $x^2 + 8x + 16$

b) Factor:  $4y^2 + 12y + 9$

c) Is  $x^2 + 5x + 6$  a perfect square?"

**[GIVE 5 minutes, then quickly check]:**

"a)  $(x + 4)^2$

b)  $(2y + 3)^2$

c) NO! 6 is not a perfect square. It factors as  $(x + 2)(x + 3)$ ."

**[TRANSITION]:**

"Now I want to see what each of you has learned."

## PHASE 4: Assessment / Checkpoint (8 Minutes)

### Checkpoint exploration (5 minutes)

**[DO]** Project the digital textbook on the screen. Navigate to the "Checkpoint" section.

**[SAY]** "This is our digital mathematics textbook. It has something special called checkpoints. Watch what happens when I click this button..."

**[DO]** Click "Show new example question" on Checkpoint

**[SAY]** "See? A new number appeared! And if I click again..."

**[DO]** Click the button again to show randomization

**[SAY]** "A different number! This means you can practice with hundreds of different examples. The computer never runs out of problems to give you."

**[SAY]** "Now it's your turn. With your partner, open the digital textbook and find the checkpoint.

**[SAY]** Click "Show new example question" to load the problem

**[SAY]** Solve the displayed question

**[SAY]** Click "submit" to check your answer

**[SAY]** If incorrect, carefully read the feedback and analyse the error before trying a new question. The immediate feedback from checkpoint submissions allows students to identify and correct errors in real-time.

**[SAY]** Complete at least 5 questions

**[DO]** Circulate among pairs. Ask probing questions, for example, what patterns do you notice?

### Independent Work (5 minutes)

**[DISPLAY questions]:**

"1. Factor:  $x^2 - 14x + 49$

2. Expand:  $(3y - 2)^2$

3. Complete the square:  $x^2 + 10x + \underline{\hspace{1cm}} = (x + \underline{\hspace{1cm}})^2$ "

**[SAY]:**

"You have 5 minutes. Begin."

### Collection and Closure (2 minutes)

**[SAY]:**

"Time's up. Please pass your exit tickets forward."

**[COLLECT all tickets]**

**[SAY]:**

"Today you learned the TWO perfect square identities:

- $a^2 + 2ab + b^2 = (a + b)^2$
- $a^2 - 2ab + b^2 = (a - b)^2$

Remember: The middle term is ALWAYS twice the product of  $a$  and  $b$ !"

**[SAY]:**

*"Great work today! For homework, practice more factoring problems."*

## Differentiation Notes

### For Struggling Learners:

- Provide identity reference cards
- Use color coding to highlight  $a^2$ ,  $2ab$ , and  $b^2$
- Start with numerical examples (e.g.,  $4 + 4 + 1 = 9 = 3^2$ )
- Allow peer support during practice

### For Advanced Learners:

#### [GIVE these extensions]:

- Factor:  $x^4 + 4x^2 + 4$
- If  $(x + k)^2 = x^2 + 12x + c$ , find  $k$  and  $c$
- Use completing the square to solve:  $x^2 + 6x + 5 = 0$

## Answer Key

### Exit Ticket Answers:

1.  $x^2 - 14x + 49$ :  $(x - 7)^2$

2.  $(3y - 2)^2$ :  $9y^2 - 12y + 4$

3. Complete the square:  $x^2 + 10x + 25 = (x + 5)^2$

### Extension Answers:

1.  $x^4 + 4x^2 + 4 = (x^2 + 2)^2$

2.  $k = 6$ ,  $c = 36$

3.  $x^2 + 6x + 5 = 0 \rightarrow (x + 3)^2 = 4 \rightarrow x = -1$  or  $x = -5$

## Post-Lesson Reflection Prompts

1. **What went well?** Did students recognize the pattern in the middle term?
2. **What would I change?** Was the three-step check clear enough?

**3. Student Understanding:** Could students distinguish perfect squares from non-perfect squares?

**4. Next Steps:** Which students need more practice with expanding?