

## I. Lesson Overview

<b>Lesson Title:</b>	Application Of Quadratic Equations To Real Life Situations
<b>Strand:</b>	Numbers and Algebra
<b>Sub-Strand:</b>	Quadratic Expressions and Equations 1
<b>Grade Level:</b>	10
<b>Estimated Duration:</b>	40 minutes

### Key Inquiry Question

*How do we apply the concept of Quadratic equations?*

## II. Learning Objectives & Standards

### Learning Objectives

Upon completion of this lesson, students will be able to:

1. **Know (Conceptual Understanding):** Understand that quadratic equations model real-life situations involving squared relationships such as projectile motion, area optimization, and profit/loss analysis.
2. **Do (Procedural Skill):** Set up and solve quadratic equations from word problems using factorisation, the quadratic formula, or completing the square.
3. **Apply (Application/Problem-Solving):** Apply quadratic equations to solve practical problems in physics (motion), geometry (area), and business (profit optimization).

### Curriculum Alignment

<b>Strand:</b>	Numbers and Algebra
<b>Sub-Strand:</b>	Quadratic Expressions and Equations 1
<b>Specific Learning Outcome:</b>	Apply quadratic equations to real life situations

## III. Materials & Resources

<b>Textbooks:</b>	<a href="#">CBC Grade 10 Mathematics Learner's Book</a> <a href="#">CBC Grade 10 Mathematics Teacher's Book</a>
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## IV. Lesson Procedure

### Phase 1: Problem-Solving and Discovery / Engage & Explore (15 minutes)

**Objective:** To explore how quadratic equations appear in real-life situations.

#### Anchor Activity: Real-World Quadratics Investigation

Work in Groups. Each group receives a different real-life scenario:

##### Scenario Cards:

Group 1 - Projectile Motion:

"A ball is thrown upward from the ground with an initial velocity of 20 m/s. Its height after  $t$  seconds is  $h(t) = 20t - 5t^2$ . When does the ball hit the ground?"

Group 2 - Area Problem:

"A farmer wants to fence a rectangular garden using 60 meters of fencing. What dimensions give the maximum area?"

Group 3 - Business Profit:

"A company's profit is  $P(x) = -2x^2 + 40x - 150$ , where  $x$  is the number of items sold. How many items must be sold to break even?"

Group 4 - Falling Object:

"A stone is dropped from a 45-meter cliff. Its height is  $h(t) = 45 - 5t^2$ . When does it hit the ground?"

##### Group Tasks:

1. Identify the quadratic equation in your scenario
2. What does each variable represent?
3. Try to solve the problem
4. What does your answer mean in real life?

##### Discussion Questions:

- What makes these problems "quadratic"?
- Why do some answers need to be rejected (negative time, negative length)?
- What patterns do you notice across different scenarios?

**Teacher's Role:** Circulate among groups, asking probing questions. Help students identify the quadratic structure in each problem. Use student discoveries to bridge to formal instruction.

**Phase 2: Structured Instruction / Explain (10 minutes)**

**Objective:** To formalize the process of applying quadratic equations to real-life situations.

**Key Takeaways:**

**What are Real-Life Quadratics?**

Quadratic equations can describe many real-life situations:

- Throwing a ball in the air (projectile motion)
- Maximizing the area of a garden (optimization)
- Calculating profits for a business (economics)
- Objects falling under gravity (physics)

**The Standard Form:**

A quadratic equation has the form:  $ax^2 + bx + c = 0$

where:

- a, b, and c are real numbers (constants)
- x is the unknown variable
- $a \neq 0$  (if  $a = 0$ , it's not quadratic)

**Common Real-Life Applications:**

Application	Typical Equation Form	What We Find
Projectile Motion	$h(t) = -5t^2 + v_0t + h_0$	Time to hit ground, max height
Area Problems	$A = x(P/2 - x)$	Dimensions for max area
Profit/Revenue	$P(x) = ax^2 + bx + c$	Break-even point, max profit

**Problem-Solving Steps:**

Step 1: Read the problem and identify what's being asked

Step 2: Define variables (what does x represent?)

Step 3: Set up the quadratic equation

Step 4: Solve using factorisation, quadratic formula, or completing the square

Step 5: Interpret the answer in context (reject impossible values)

**Addressing Misconceptions:** "Remember: Always check if your answer makes sense! Negative time or negative lengths are usually not valid in real-life problems."

### Phase 3: Practice and Application / Elaborate (15 minutes)

**Objective:** To apply quadratic equations to solve real-life problems.

#### Worked Example: Falling Rock Problem

Problem: A rock is dropped from a height of 50 meters. Its height above the ground at time  $t$  is given by:

$$h(t) = -5t^2 + 50$$

Use factorization to determine how long it will take for the rock to reach the ground.

Solution:

Step 1: Understand the problem

- The rock reaches the ground when  $h(t) = 0$
- We need to find the value of  $t$

Step 2: Set up the equation

$$-5t^2 + 50 = 0$$

Step 3: Solve the equation

$$-5t^2 + 50 = 0$$

$$-5t^2 = -50$$

$$t^2 = 10$$

$$t = \pm\sqrt{10}$$

Step 4: Interpret the answer

Since time cannot be negative,  $t = \sqrt{10}$

$$t \approx 3.16 \text{ seconds}$$

**Therefore: The rock will take approximately 3.16 seconds to reach the ground.**

**Teacher's Role:** Monitor students, emphasizing the importance of interpreting answers in real-world context.

#### Phase 4: Assessment / Evaluate (Exit Ticket)

**Objective:** To formatively assess individual student understanding.

##### Exit Ticket Questions:

1. A stone is thrown into the air from a height of 4 meters with an initial velocity of 8 meters per second. The height of the stone at time  $t$  is given by:

$$h(t) = -5t^2 + 8t + 4$$

Find when the stone reaches the ground.

2. A farmer has 200 meters of fencing. He wants to build a rectangular garden. The length is 50 meters longer than the width. What should the dimensions be to maximize the area?

3. A school's profit function is given by:

$$P(x) = -x^2 + 30x - 100$$

Find the number of units the company must sell to achieve zero profit (break-even).

##### Answer Key:

1. Stone thrown into the air:

$$h(t) = -5t^2 + 8t + 4 = 0$$

$$\text{Multiply by } -1: 5t^2 - 8t - 4 = 0$$

$$\text{Using quadratic formula: } t = (8 \pm \sqrt{(64 + 80)})/10 = (8 \pm \sqrt{144})/10 = (8 \pm 12)/10$$

$$t = 20/10 = 2 \text{ or } t = -4/10 = -0.4$$

Since time cannot be negative,  $t = 2$  seconds

2. Fencing problem:

$$\text{Let width} = w, \text{ then length} = w + 50$$

$$\text{Perimeter: } 2w + 2(w + 50) = 200$$

$$4w + 100 = 200$$

$$4w = 100$$

$$w = 25 \text{ meters}$$

$$\text{Length} = 25 + 50 = 75 \text{ meters}$$

$$\text{Dimensions: } 25 \text{ m} \times 75 \text{ m}$$

$$\text{Area} = 25 \times 75 = 1875 \text{ m}^2$$

3. Profit function (break-even):

$$P(x) = -x^2 + 30x - 100 = 0$$

$$\text{Multiply by } -1: x^2 - 30x + 100 = 0$$

$$\text{Using quadratic formula: } x = (30 \pm \sqrt{(900 - 400)})/2 = (30 \pm \sqrt{500})/2$$

$$x = (30 \pm 22.36)/2$$

$$x \approx 26.18 \text{ or } x \approx 3.82$$

The company breaks even at approximately 4 units or 26 units

## V. Differentiation

Student Group	Strategy & Activity
<b>Struggling Learners (Support)</b>	Scaffolding: Provide problem-solving templates with steps. Use simpler numbers. Allow calculator use. Start with problems where factorisation is straightforward. Provide visual diagrams for area problems.
<b>On-Level Learners (Core)</b>	The core lesson activities as described above.
<b>Advanced Learners (Challenge)</b>	Extension Activity: 1) A ball is thrown upward with velocity 25 m/s from a 30m building. When does it pass the 50m mark (going up and coming down)? 2) Find the dimensions of a rectangle with a perimeter 100m that has maximum area. 3) A company's revenue is $R(x) = 50x - 0.5x^2$ . Find the price that maximizes revenue.

## Extension Activity Solutions:

1. Ball passing 50m mark:

$$h(t) = -5t^2 + 25t + 30 = 50$$

$$-5t^2 + 25t - 20 = 0$$

$$t^2 - 5t + 4 = 0$$

$$(t - 1)(t - 4) = 0$$

$t = 1$  second (going up) and  $t = 4$  seconds (coming down)

2. Maximum area rectangle:

Let width =  $x$ , length =  $50 - x$

$$\text{Area} = x(50 - x) = 50x - x^2$$

Maximum at  $x = 25$  (vertex of parabola)

Dimensions: 25m  $\times$  25m (a square!)

$$\text{Maximum area} = 625 \text{ m}^2$$

3. Maximum revenue:

$$R(x) = 50x - 0.5x^2$$

$$\text{Maximum at } x = -b/(2a) = -50/(2 \times -0.5) = 50 \text{ units}$$

$$\text{Maximum revenue} = 50(50) - 0.5(50)^2 = 2500 - 1250 = 1250$$

## VI. Assessment

Type	Method	Purpose
<b>Formative (During Lesson)</b>	<ul style="list-style-type: none"> <li>- Observation during group work</li> <li>- Questioning during exploration</li> <li>- Exit Ticket</li> </ul>	To monitor progress and adjust instruction.
<b>Summative (After Lesson)</b>	<ul style="list-style-type: none"> <li>- Homework assignment</li> <li>- Future quiz/test questions</li> </ul>	To evaluate mastery of learning objectives.

**Teacher's Role:** Collect and review the exit tickets to gauge student understanding and identify any common misconceptions that need to be addressed in the next lesson.

## VII. Teacher Reflection

*To be completed after the lesson.*

1. What went well?

2. What would I change?

3. Student Understanding: Did students successfully connect quadratic equations to real-world contexts?

4. Next Steps: Which students need more practice with setting up equations from word problems?