I. Lesson Overview

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

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

III. Materials & Resources

Textbooks:	CBC Grade 10 Mathematics Learner's Book CBC Grade 10 Mathematics Teacher's Book

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, $t = \sqrt{10}$

$t \approx 3.16$ 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:

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

   Multiply by -1: $5t^2 - 8t - 4 = 0$

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

   $t = 20/10 = 2$ or $t = -4/10 = -0.4$

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

2. Fencing problem:

   Let width = w, then length = w + 50

   Perimeter: $2w + 2(w + 50) = 200$

   $4w + 100 = 200$

   $4w = 100$

   $w = 25$ meters

Length = 25 + 50 = 75 meters

Dimensions: 25 m × 75 m

Area = 25 × 75 = 1875 m^2

3. Profit function (break-even):

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

Multiply by −1: $x^2 - 30x + 100 = 0$

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

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

$x \approx 26.18$ or $x \approx 3.82$

The company breaks even at approximately 4 units or 26 units

V. Differentiation

Student Group	Strategy & Activity
Struggling Learners (Support)	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.
On-Level Learners (Core)	The core lesson activities as described above.
Advanced Learners (Challenge)	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

Area = $x(50 - x) = 50x - x^2$

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

Dimensions: 25m × 25m (a square!)

Maximum area = 625 m^2

3. Maximum revenue:

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

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

Maximum revenue = $50(50) - 0.5(50)^2 = 2500 - 1250 = 1250$

VI. Assessment

Type	Method	Purpose
Formative (During Lesson)	- Observation during group work - Questioning during exploration - Exit Ticket	To monitor progress and adjust instruction.
Summative (After Lesson)	- Homework assignment - Future quiz/test questions	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?