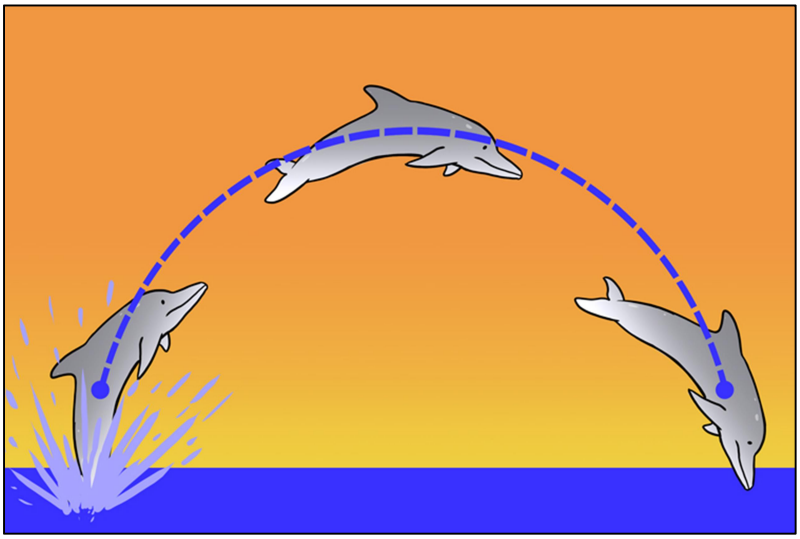
CASE STUDY BASED QUESTIONS
CLASS X
SUB: MATHEMATICS
Chapter: 4
Quadratic Equations

Case Study 1: The Leaping Dolphin



A marine biologist is tracking the jumps of dolphins in the ocean. The path of a leaping dolphin follows a curved trajectory that can be mathematically modeled. The height h (in meters) of the dolphin above the water level after t seconds is given by the quadratic polynomial equation: $\mathbf{h\ (t) = -5}t^2 + \mathbf{20}t$

1. What is the maximum height reached by the dolphin during its jump?
a) 10 m
b) 15 m
c) 20 m
d) 25 m

2. How many seconds does the dolphin stay in the air before it hits the water again?
a) 2 s
b) 4 s
c) 5 s
d) 8 s

3. If the biologist wants to know when the dolphin is exactly 15m above the water, they form the equation $-\mathbf{5t^2 + 20t - 15 = 0}$. What is the nature of the roots of this equation?
a) Real and distinct
b) Real and equal
c) No real roots
d) Cannot be determined

4. At what exact times during the jump is the dolphin exactly 15m above the water?
a) 2s and 4s
b) 1s and 4s
c) 2s and 3s
d) 1s and 3s

5. The geometrical shape of the path traced by the leaping dolphin is known as a:
a) Straight line
b) Circle
c) Parabola
d) Ellipse

Case Study 2: The Green City Project

A city municipal corporation is developing a right-angled triangular green park in the middle of a busy intersection to reduce pollution. The longest side (hypotenuse) of the triangular park, which will be used as a main walking path, is 13 meters long. The engineers noted that the difference between the lengths of the other two perpendicular sides is exactly 7 meters. Let the shortest side of the park be x meters.

1. What is the length of the longer perpendicular side in terms of x?
a) (x - 7) m
b) (x + 7) m
c) (7 - x) m
d) (13 - x) m

2. Which of the following quadratic equations correctly represents the mathematical formulation of the park's dimensions?
a) $x^2 + 7x - 60 = 0$
b) $x^2 - 7x - 60 = 0$
c) $x^2 + 7x + 60 = 0$
d) $x^2 - 7x + 60 = 0$

3. What is the length of the shortest side of the triangular park?
a) 12 m
b) 7 m
c) 5 m
d) 8 m

4. What is the total area of this green triangular park?
a) 60 sq m
b) 30 sq m
c) 45 sq m
d) 25 sq m

5. If the corporation wants to put a decorative iron fence around the entire boundary of the park at the rate of ₹150 per meter, what will be the total cost of fencing?
a) ₹3000
b) ₹4000
c) ₹4500
d) ₹5000

Case Study 3: Smart City Water Management (Time & Work)

A smart city utilizes a modern water treatment plant to supply clean water. The plant has a large main distribution tank that is filled by two inlet pipes of different diameters. When both pipes are opened together, they can fill the completely empty tank in $9\frac{3}{8}$ hours . The engineers observed that the pipe of larger diameter takes 10 hours less than the smaller diameter pipe to fill the tank separately. Let the time taken by the smaller pipe to fill the tank completely on its own be x hours.

1. What is the portion of the tank filled by the smaller pipe in 1 hour?
a) x
b) 1/x
c) x - 10
d) 1/(x-10)

2. Which of the following quadratic equations correctly represents the total time taken to fill the tank?

a) $4x^2 - 115x + 375 = 0$

b) $4x^2 + 115x - 375 = 0$

c) $8x^2 - 230x - 750 = 0$

d) $8x^2 + 230x + 750 = 0$

3. How much time does the smaller pipe take to fill the tank completely on its own?

a) 15 hours

b) 20 hours

c) 35 hours

d) 25 hours

4. How much time does the larger pipe take to fill the tank completely on its own?

a) 5 hours

b) 10 hours

c) 15 hours

d) 25 hours

5. If the plant manager decides to use only the larger pipe for 5 hours and then turns it off, what fraction of the tank will be filled?

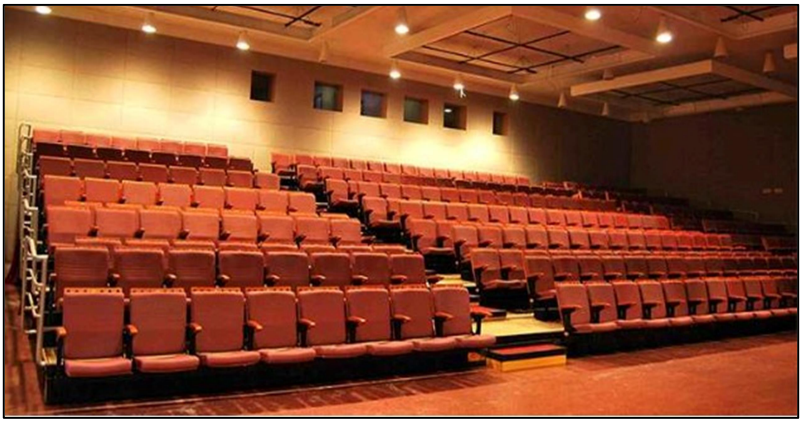
a) 1/2

b) 1/3

c) 1/4

d) 1/5

Case Study 4: The School Auditorium



The principal of a school decides to arrange chairs in the auditorium for the annual function. Initially, the chairs were arranged in rows and columns such that the number of rows was equal to the number of seats in each row. On realizing the expected audience was larger, the principal changed the arrangement: the number of rows was doubled, and the number of seats in each row was reduced by 10. This new arrangement increased the total number of seats by 300.

1. Formulate the quadratic equation based on the given situation. (Let the original number of rows be x).

2. Find the original number of rows in the auditorium.

3. Find the original total number of seats in the hall.

4. If the principal wants to add 120 more seats to the original square arrangement, how many extra rows are needed?

Case Study 5: The Poultry Farm

A local farmer wants to fence his rectangular poultry farm. He strategically plans to use an existing brick wall as one of the boundaries to save costs. He has exactly 20 meters of wire fencing to cover the remaining three sides. He wants the enclosed area of the poultry farm to be exactly 48 square meters.

1. Let the two sides perpendicular to the wall be x meters. Formulate the quadratic equation representing the area of the farm.
2. Find the discriminant of the formed equation and comment on the nature of its roots.
3. Find the possible dimensions of the poultry farm.
4. If the wire fencing costs ₹50 per meter, what is his total cost for the fence?

If he later wants an enclosed area of 55 sq meters using the same 20m of fencing on the 3 sides, is it mathematically possible? Justify your answer.

Case Study 6: Flight through Bad Weather

A commercial flight covering a distance of 600 km was delayed due to an unexpected thunderstorm. For safety, the pilot had to slow down, reducing the average speed of the aircraft for the trip by 200 km/hr. As a result, the total time of the flight increased by 30 minutes.

1. Let the original average speed of the aircraft be x km/hr. Express the original flight time and the new flight time in terms of x.

2. Formulate the quadratic equation for the given scenario.

3. Solve the quadratic equation to find the original speed of the aircraft.

4. What would have been the duration of the flight if the weather was clear? What was the actual duration of the flight under the bad weather conditions?