MATH 150 — Quadratic Functions

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Learning Objectives

- Solve quadratic equations by factoring, completing the square, and the quadratic formula
- Write quadratic functions in vertex form $a(x - h)^2 + k$
- Use the discriminant to classify roots (real, complex, repeated)
- Solve applied quadratic problems (projectile motion)

For each problem, identify which method is most efficient. Factoring is fastest when the polynomial factors nicely; use the quadratic formula otherwise.

1. Solve by factoring.

$$x^2 - 7x + 12 = 0$$

Answer: _____

2. Solve using the quadratic formula.

$$2x^2 - 5x - 3 = 0$$

Answer: _____

3. Complete the square to solve.

$$x^2 + 6x - 7 = 0$$

Answer: _____

4. Write in vertex form $a(x-h)^2 + k$ by completing the square.

$$f(x) = x^2 - 4x + 1$$

Answer: _____

5. Find the vertex, axis of symmetry, and x-intercepts.

$$f(x) = -2x^2 + 8x - 5$$

Answer: _____

6. Use the discriminant to classify the roots.

$$3x^2 - 4x + 5 = 0$$

Answer: _____

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7. Solve.

$$(x+3)^2 = 25$$

Answer: _____

8. A ball is thrown upward. Its height (in feet) is h(t) = –16t² + 64t + 5. Find the maximum height and when it is reached.

$$h(t) = -16t^2 + 64t + 5$$

Answer: _____

9. Solve by factoring.

$$6x^2 + x - 2 = 0$$

Answer: _____

10. Solve by any method.

$$x^2 - 5 = 0$$

Answer: _____

Problem 3 (completing the square) is the foundation for the quadratic formula — show the derivation. Problem 6 (discriminant): emphasize Δ<0 gives complex roots, not "no solution."

Solutions

1. Solve by factoring.

$x^2 - 7x + 12 = 0$

→ *Find two numbers that multiply to 12 and add to –7: –3 and –4.*
→ *(x–3)(x–4)=0 → x=3 or x=4.*

Answer: $x = 3$ or $x = 4$

2. Solve using the quadratic formula.

$2x^2 - 5x - 3 = 0$

→ *a=2, b=–5, c=–3. Discriminant: 25+24=49.*
→ *x=(5±7)/4. x=12/4=3 or x=–2/4=–1/2.*

Answer: $x = 3$ or $x = -\frac{1}{2}$

3. Complete the square to solve.

$x^2 + 6x - 7 = 0$

→ *Move constant: x²+6x=7.*
→ *Add (6/2)²=9 to both sides: x²+6x+9=16.*
→ *(x+3)²=16 → x+3=±4 → x=1 or x=–7.*

Answer: $x = 1$ or $x = -7$

4. Write in vertex form a(x–h)² + k by completing the square.

$f(x) = x^2 - 4x + 1$

→ *x²–4x+1 = (x²–4x+4)–4+1 = (x–2)²–3.*
→ *Vertex: (h, k) = (2, –3). Opens upward (a=1>0).*

Answer: $f(x) = (x-2)^2 - 3,\ \text{vertex } (2, -3)$

5. Find the vertex, axis of symmetry, and x-intercepts.

$f(x) = -2x^2 + 8x - 5$

→ *Vertex x-coord: h=–b/2a=–8/–4=2. k=–2(4)+8(2)–5=3.*
→ *Vertex (2, 3). Opens downward (a=–2<0).*
→ *x-intercepts: –2x²+8x–5=0 → x=(–8±√(64–40))/(–4)=(4±√6)/2.*

Answer: $\text{Vertex } (2, 3),\ x = \frac{4 \pm \sqrt{6}}{2}$

6. Use the discriminant to classify the roots.

$3x^2 - 4x + 5 = 0$

→ *Discriminant: b²–4ac = 16–60 = –44.*
→ *Δ<0 → two complex (non-real) roots.*
→ *x=(4±√(–44))/6=(4±2i√11)/6=(2±i√11)/3.*

Answer: $\Delta = 16 - 60 = -44 < 0 \Rightarrow 2 \text{ complex roots}$

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7. Solve.

$(x + 3)^2 = 25$

→ *Take square root of both sides: x+3=±5.*
→ *x=5–3=2 or x=–5–3=–8.*

Answer: $x = 2 \text{ or } x = -8$

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8. A ball is thrown upward. Its height (in feet) is h(t) = –16t² + 64t + 5. Find the maximum height and when it is reached.

$h(t) = -16t^2 + 64t + 5$

→ *Maximum at vertex: t=–b/2a=–64/(–32)=2 seconds.*
→ *h(2)=–16(4)+64(2)+5=–64+128+5=69 feet.*

Answer: $t = 2 \text{ s},\ h_{\max} = 69 \text{ ft}$

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9. Solve by factoring.

$6x^2 + x - 2 = 0$

→ *Find factors of ac=–12 that add to 1: +4 and –3.*
→ *6x²+4x–3x–2=0 → 2x(3x+2)–1(3x+2)=0 → (2x–1)(3x+2)=0.*
→ *x=1/2 or x=–2/3.*

Answer: $x = \frac{1}{2} \text{ or } x = -\frac{2}{3}$

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10. Solve by any method.

$x^2 - 5 = 0$

→ *x²=5 → x=±√5.*
→ *Exact answers: x=√5 ≈ 2.236 and x=–√5 ≈ –2.236.*

Answer: $x = \pm\sqrt{5}$