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VCE Mathematical Methods ½
Quadratics [1.3]
Test Solutions

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Section A: Test Questions (21 Marks)

INSTRUCTION: 21 Marks. Y Minutes Reading. Z Minutes Writing.

Question 1 (4 marks)

Tick whether the following statements are **true** or **false**.

Statement	True	False
a. Every quadratic can be factorised as the product of two real linear factors.		✓
b. If the discriminant of a quadratic is negative, then the quadratic has two real solutions.		✓
c. We can find the turning point of a quadratic if we know only the coordinates of two x-intercepts.		✓
d. All quadratics have a turning point form.	✓	
e. The solution to the quadratic inequality $x^2 > 4$ is $x \leq -2$ or $x \geq 2$.		✓
f. The axis of symmetry of $y = 3x^2 - 12x + 13$ is at $x = 2$.	✓	
g. The equation $x^4 - 2x^2 + 1 = 0$ has two distinct real solutions.	✓	✓
h. The graph of $y = ax^2 + bx + c$ is symmetric about the line $x = \frac{b}{2a}$.		

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Question 2 (3 marks)

The sum of two numbers is 8 and the product of the two numbers is 15.

a. Write down a quadratic equation in the form $ax^2 + bx + c = 0$ that can be solved to find the numbers. (1 mark)

$$x(8 - x) = 15$$
$$8x - x^2 = 15$$
$$x^2 - 8x + 15 = 0$$

b. Find the two numbers. (2 marks)

Solution: $(x-3)(x-5) = 0 \implies x = 3, 5$
The two numbers are 3 and 5.

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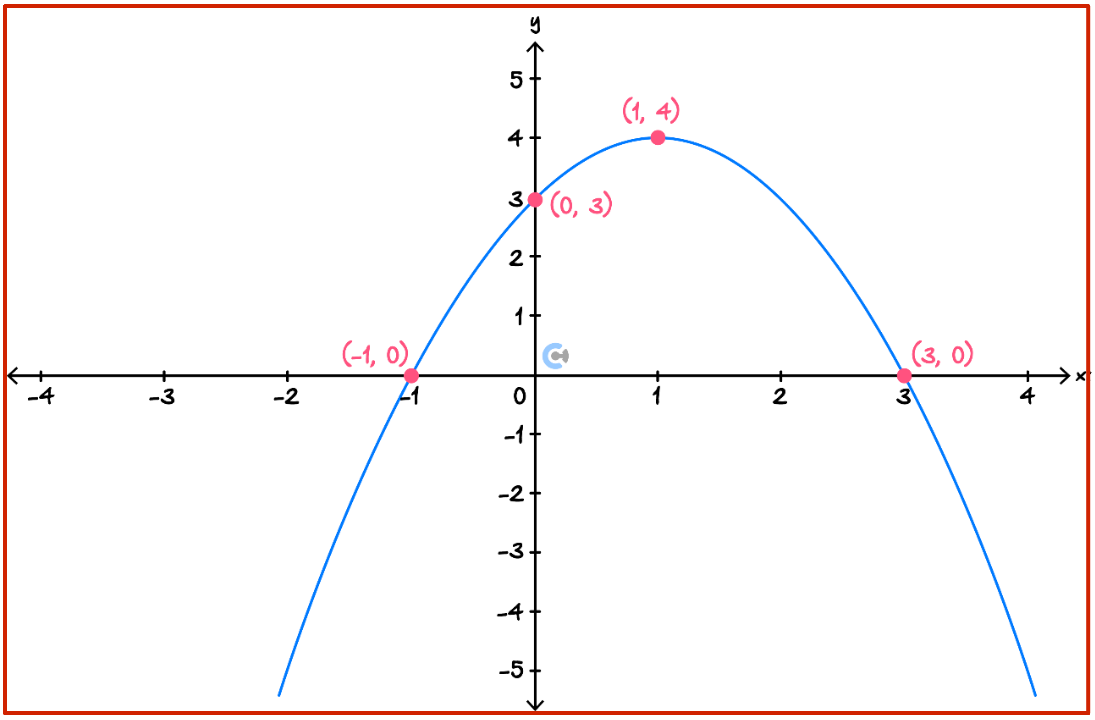
Question 3 (5 marks)

Consider the function $f(x) = -x^2 + 2x + 3$.

a. Write $f(x)$ in the form $a(x-h)^2 + k$. (1 mark)

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

b. Sketch the graph of $y = f(x)$ on the axes below. Label the turning point and all axes intercepts with coordinates. (2 marks)



c. Hence, find the value(s) of x, such that $f(x) > 3$. (2 marks)

Solution: $0 < x < 2$

Question 4 (4 marks)

Sam is competing in a shotput competition. The trajectory of the shot (name of the spherical ball used), is modelled by a quadratic equation $y = ax^2 + bx + c$, where $y \geq 0$ is the height of the shot above the ground in metres and $x \geq 0$ is the horizontal distance of the shot in metres.

The shot reaches a maximum height of $\frac{7}{2}$ metres when it has travelled two metres horizontally, and it has a height of $\frac{3}{2}$ when it is released ($x = 0$).

a. Write down the trajectory of the shot in turning point form. (2 marks)

Solution: $y = a(x-2)^2 + \frac{7}{2}$ from the description. We sub in the point $\left(0, \frac{3}{2}\right)$ to find a

$$\frac{3}{2} = 4a + \frac{7}{2}$$
$$4a = -2$$
$$a = -\frac{1}{2}$$

Therefore, $y = -\frac{1}{2}(x-2)^2 + \frac{7}{2}$

b. Find the horizontal distance that Sam's shot travels. (2 marks)

Solution: Find when $y = 0$. Solve

$$-\frac{1}{2}(x-2)^2 + \frac{7}{2} = 0$$
$$(x-2)^2 = 7$$
$$x = 2 \pm \sqrt{7}$$

Since $x > 0$, the horizontal distance that the shot travels is $2 + \sqrt{7}$ metres.

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Question 5 (5 marks)

Consider the function $f(x) = x^4 - 6x^2 + 8$.

a. Solve the equation $f(x) = 0$. (3 marks)

Solution: Let $x^2 = a$

$$\begin{aligned} a^2 - 6a + 8 &= 0 \\ (a-3)^2 &= 1 \\ a &= 3 \pm 1 \\ a &= 2, 4 \end{aligned}$$

Therefore, $x = \pm\sqrt{2}, \pm 2$

b. Use the discriminant to determine the value(s) of k, such that $f(x) + k = 0$ has no real solutions. (2 marks)

Solution: Let $x^2 = a$, now consider the quadratic

$$a^2 - 6a + 8 + k = 0$$

If this quadratic has no real solutions then $f(x) = k = 0$ will have no real solutions.

$$\begin{aligned} \Delta < 0 \implies 36 - 4(8+k) &< 0 \\ 4 - 4k &< 0 \\ k &> 1 \end{aligned}$$

Our solution is $k > 1$.

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Section B: Extension Test Question (5 Marks)

INSTRUCTION: 5 Marks. Y Minutes Reading. Z Minutes Writing.

Question 6 (5 marks)

a. Solve $x^4 - 2kx^2 + 4 = 0$ for x, in terms of k, where $k \in R$. (3 marks)

Solution: Let $x^2 = a^2$

$$a^2 - 2ak + 4 = 0$$
$$(a-k)^2 = k^2 - 4$$
$$a = k \pm \sqrt{k^2 - 4}$$

Therefore,

$$x = \sqrt{k + \sqrt{k^2 - 4}}, \sqrt{k - \sqrt{k^2 - 4}}, -\sqrt{k + \sqrt{k^2 - 4}}, -\sqrt{k - \sqrt{k^2 - 4}}$$

b. Hence, determine the values of k for which $x^4 - 2kx^2 + 4 = 0$ has 4 real solutions. (2 marks)

Solution: Firstly, require $k^2 - 4 > 0 \implies k > 2$ or $k < -2$.
Then we require that $k - \sqrt{k^2 - 4} > 0 \implies k > 2$
Therefore, $k > 2$.

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