P1 Algebra: exam questions

10 questions · 32 marks · full mark schemes

Name _____ Date _____ Score / 32

- Indices, surds, quadratics (discriminant, completing the square), simultaneous equations, inequalities.
- Try every question before you look at the mark schemes. They start after the questions: M marks for method, A marks for accuracy, B marks for a correct result on its own.
- Online, with more practice: alevelmathrevision.com/alevel-frontend/units/p1/algebra-questions

1. **2 marks · warm-up**

Express $\frac{2}{\sqrt{x}}$ in the form kx^n.

2. **2 marks · warm-up**

Write $x^2 + 12x - 5$ in the form $(x + p)^2 + q$, where p and q are constants to be found.

3. **2 marks · standard**

Simplify fully $4x^2 \times 3x^{-4}$.

4. 3 marks · standard

Simplify $\sqrt{45} + 2\sqrt{20}$. Give your answer in the form $a\sqrt{5}$.

5. 3 marks · standard

Prove that $x^2 + 6x + 12 > 0$ for all real values of x.

6. 5 marks · standard

Express $\frac{5+\sqrt{7}}{3-\sqrt{7}}$ in the form $a + b\sqrt{7}$, where a and b are integers.

7. 3 marks · harder

Factorise completely $3x^3 - 27x$.

8. 3 marks · harder

A quadratic curve has the equation $y = ax^2 + bx + c$. The curve crosses the x-axis at $x = 1$ and $x = 5$, and crosses the y-axis at $(0, -5)$. Find the values of a, b, and c.

9. 4 marks · harder

Solve the equation $x^4 - 13x^2 + 36 = 0$.

10. 5 marks · harder

Solve the simultaneous equations:

$2x^2 - y^2 = -7$

$2x - y = 1$

Answers and worked solutions

Question 1

2 marks

1. M1 for rewriting $\sqrt{x}$ as $x^{1/2}$.
2. A1 for $2x^{-1/2}$.

Question 2

2 marks

1. M1 for identifying the correct squared bracket $(x+6)^2$ and subtracting 6^2.
2. A1 for the final correct expression $(x+6)^2 - 41$.

Question 3

2 marks

1. M1 for multiplying coefficients to get 12 and adding indices $2 + (-4)$.
2. A1 for $12x^{-2}$ or $\frac{12}{x^2}$.

Question 4

3 marks

1. M1 for simplifying $\sqrt{45}$ to $3\sqrt{5}$.
2. M1 for simplifying $2\sqrt{20}$ to $4\sqrt{5}$.
3. A1 for $7\sqrt{5}$.

Question 5

3 marks

1. M1 for completing the square on the expression: $(x+3)^2 - 9 + 12$.
2. M1 for simplifying to $(x+3)^2 + 3$.
3. A1 for stating that since $(x+3)^2 \geq 0$ for all real x, it follows that $(x+3)^2 + 3 \geq 3$, which is always strictly greater than zero.

Question 6

5 marks

Answer: $11 + 4\sqrt{7}$

M1 Multiplies both numerator and denominator by $3 + \sqrt{7}$.

1. M1 Expands the numerator: $(5)(3) + 5\sqrt{7} + 3\sqrt{7} + (\sqrt{7})^2 = 15 + 8\sqrt{7} + 7$.
2. A1 Correctly simplifies the numerator to $22 + 8\sqrt{7}$.
3. M1 Expands and simplifies the denominator: $3^2 - (\sqrt{7})^2 = 9 - 7 = 2$.
4. A1 Divides the numerator by 2 to obtain the final answer $11 + 4\sqrt{7}$.

Question 7

3 marks

1. M1 for taking out the common factor $3x$ to get $3x(x^2 - 9)$.
2. M1 for factorising the difference of two squares $(x^2 - 9)$.
3. A1 for $3x(x-3)(x+3)$.

Question 8

3 marks

1. M1 for writing the equation in factored form $y = k(x-1)(x-5)$.
2. M1 for substituting $(0, -5)$ to find k: $-5 = k(-1)(-5) \implies 5k = -5 \implies k = -1$.
3. A1 for expanding $y = -1(x^2 - 6x + 5) = -x^2 + 6x - 5$, giving $a = -1, b = 6, c = -5$.

Question 9

4 marks

1. M1 for recognising the equation as a hidden quadratic and substituting $u = x^2$: $u^2 - 13u + 36 = 0$.
2. M1 for factorising the quadratic in u: $(u-4)(u-9) = 0 \implies u = 4$ or $u = 9$.
3. M1 for replacing u with x^2: $x^2 = 4$ and $x^2 = 9$.
4. A1 for finding all four solutions: $x = \pm 2$ and $x = \pm 3$.

Question 10

5 marks

1. M1 for rearranging to $y = 2x - 1$ and substituting: $2x^2 - (2x-1)^2 = -7$.
2. M1 for expanding the square correctly: $2x^2 - (4x^2 - 4x + 1) = -7$.
3. M1 for simplifying to a 3-term quadratic: $-2x^2 + 4x - 1 = -7 \implies 2x^2 - 4x - 6 = 0 \implies x^2 - 2x - 3 = 0$.
4. M1 for factorising $(x-3)(x+1) = 0$ to get $x = 3, -1$.
5. A1 for the corresponding y values giving the pairs: $x = 3, y = 5$ and $x = -1, y = -3$.

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