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Additional Math with Ali Hashir
Solving Cubic Equations
Answers

CIE O Level Additional Mathematics 4037 • Total: 65 marks

Easy (Q1–Q2)

Q1. $x = 1, \quad x = 2, \quad x = 3$

Q2. $x = -3, \quad x = -1, \quad x = 2$

Medium (Q3–Q7)

Q3. $x = -2, \quad x = \frac{1}{2}, \quad x = 3$

Q4. $x = -3, \quad x = -2, \quad x = 2$

Q5. $(1, 1), \quad (2, 8), \quad (-3, -27)$

Q6. $x = 1$ and $x = 2$ (repeated); **two** distinct roots

Q7. $x = -2, \quad x = \frac{1 + \sqrt{13}}{6} = 0.77, \quad x = \frac{1 - \sqrt{13}}{6} = -0.43$ (2 d.p.)

Hard (Q8–Q10)

Q8. $x = \frac{1}{2}$ only; $2x^3 - x^2 + 4x - 2 = (2x - 1)(x^2 + 2)$ and $x^2 + 2 = 0$ has no real solution

Q9. $f(x) = (x + 1)^2(x - 4)$

Q9 (a). $x = -1$ (repeated), $x = 4$

Q9 (b). $x = -1, \quad x = 0, \quad x = 4$

Q9 (c). $x = -2, \quad x = -1, \quad x = 5$

Q10 (i). $a = 4, \quad b = -16$

Q10 (ii). $x = -3, \quad x = -2, \quad x = -1, \quad x = 2$

Challenge 1

(i). $Q(x) = x^3 + x^2 - 4x - 4$

(ii). $Q(-1) = 0; \quad P(x) = (x - 3)(x + 1)(x - 2)(x + 2)$, so $x = 3, -1, 2, -2$

(iii). If $P(k) = 0$ then $c_0 = -k(k^{n-1} + c_{n-1}k^{n-2} + \cdots + c_1)$, and the bracket is an integer, so k divides c_0 . Here $c_0 = 12$, and each of $3, -1, 2, -2$ divides 12 .

Challenge 2

(i). $f(a) = -10a^3 \neq 0$, so $x - a$ is **not** a factor; $f(-a) = 0$, so $x + a$ **is** a factor

(ii). $f(x) = (x + a)(x - 2a)(2x + 3a)$

(iii). $x = -a, \quad x = 2a, \quad x = -\frac{3a}{2}$

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Full worked solutions available at the website.

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