

Maths Ext year Eleven

Topic 1: Methods in Algebra

Index Laws

- $a^m \times a^n = a^{(m+n)}$
- $a^m \div a^n = a^{(m-n)}$
- $(a^m)^n = a^{mn}$
- $a^{-1} = \frac{1}{a}$
- $a^0 = 1$
- $(\frac{a}{b})^x = \frac{a^x}{b^x}$
- $(\frac{a}{b})^{-1} = \frac{b}{a}$
- $x^{\frac{1}{n}} = \sqrt[n]{x^1}$ OR $(\sqrt[n]{x})^1$

Binomial Products

In general,

$$(a + b + c + \dots)^2 = (a^2 + b^2 + c^2 + \dots + 2ab + 2ac + 2bc + \dots)$$

Thus

- $(a + b)^2 = a^2 + 2ab + b^2$
- $(a - b)^2 = a^2 - 2ab + b^2$

Difference of Two Squares:

- $(a + b)(a - b) = a^2 - b^2$

Algebraic Fractions

- Always factorise first.
- When adding/subtracting fractions, square the denominator.

$$\begin{aligned} \text{e.g. } & \frac{a^2b - 2b^2}{6a^2b} + \frac{a^2 - 4ab + 4b^2}{3a} \\ &= \frac{b(a - 2b)}{6a^2b} \times \frac{3a}{(a - 2b)^2} \\ &= \frac{1}{2a(a - 2b)} \end{aligned}$$

Cubics

In general, $(a + b + c + d + \dots)^3 =$

$$a^3 + b^3 + c^3 + \dots + 3a^2b + 3a^2c + 3a^2d + 3b^2a + \dots + 6abc + 6abd + \dots$$

Thus

- $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$
- $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$

In general,

$$a^n - b^n = (a - b)(a^{n-1} + a^{n-2}b + \dots + ab^{n-2} + b^{n-1})$$

And when n is odd,

$$a^n + b^n = (a + b)(a^{n-1} - a^{n-2}b + \dots - ab^{n-2} + b^{n-1})$$

Thus

- $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$
- $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$

Linear Equations

Make pronumerals the subject of formulae:

$$3z + 2 = z - 9$$

$$z = -\frac{11}{2}$$

Quadratic Equations

- After factorising, if $ab = 0$ then $a = 0$ or $b = 0$

$$x^2 + 9x + 18 = 0$$

$$(x + 6)(x + 3) = 0$$

$$\therefore x = -6, -3$$

- Use quadratic formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

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

$$x = \frac{-5 \pm \sqrt{25 + 32}}{4}$$

$$x = \frac{-5 \pm \sqrt{57}}{4}$$

To derive the quadratic formula: $ax^2 + bx + c = 0$

$$x^2 + \frac{b}{a}x + \frac{c}{a} = 0$$

$$x^2 + \frac{b}{a}x + (\frac{b}{2a})^2 - (\frac{b}{2a})^2 + \frac{c}{a} = 0$$

$$(x + \frac{b}{2a})^2 - \frac{b^2}{4a^2} + \frac{c}{a} = 0$$

$$(x + \frac{b}{2a})^2 = \frac{b^2 - 4ac}{4a^2}$$

$$x + \frac{b}{2a} = \pm \sqrt{\frac{b^2 - 4ac}{4a^2}}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

- Complete the square: add $(\frac{b}{2})^2$ to both sides of equation.

$$\text{E.g. } x^2 + 6x - 7 = 0$$

$$x^2 + 6x + 9 - 7 = 9$$

$$(x + 3)^2 = 16$$

$$x + 3 = \pm 4$$

$$x = 1, -7$$

Simultaneous Equations

- Amount of equations required = number of pronumerals.
- Eliminate a variable:

$$\bullet 2x + 3y = 21 \rightarrow (1)$$

$$5x + 2y = 3 \rightarrow (2)$$

$$(1) \times 2 \text{ and } (2) \times 3$$

$$4x + 6y = 42 \rightarrow (3)$$

$$15x + 6y = 9 \rightarrow (4)$$

$$(4) - (3)$$

$$11x = -33$$

$$x = -3$$

Substitute $x = -3$ into (2)

$$3y = 27$$

$$\therefore x = -3, y = 9$$

- Solving by substitution:

$$x = 7 \rightarrow (1), y + \frac{1}{x} = 9 \rightarrow (2)$$

$$y = 9 - \frac{1}{7} = \frac{62}{7}$$

Extension Maths 1

David Baker



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