

# Pure Y2 Summary

along with the original equation to find  $x$  and  $y$  values.

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## Integration using Partial Fractions

$$\int \frac{x-1}{(x+1)(x-2)^2} dx = \int \frac{-2}{9(x+1)} + \frac{2}{9(x-2)} + \frac{1}{3(x-2)^2} dx$$

$$= -\frac{2}{9} \ln|x+1| + \frac{2}{9} \ln|x-2| - \frac{1}{3(x-2)} + c$$

$$= \frac{2}{9} \ln \left| \frac{x-2}{x+1} \right| - \frac{1}{3(x-2)} + c$$

Area between curve and x-axis

Area between curve and y-axis

Area between 2 curves

Top function - bottom function

$$\text{Area} = \int_a^b (f(x) - g(x)) dx$$

## Numerical Methods

- Change of Sign:** To show that a root of an equation  $f(x) = 0$  lies in the interval  $[a, b]$ . Show that there is a change of sign between  $f(a)$  and  $f(b)$ .
- Fixed Point Iteration:** Rearrange  $f(x) = 0$  into  $x = g(x)$  to give the iteration  $x_{n+1} = g(x_n)$ . From a starting value of  $x_0$  (or  $x_1$ ), use the iteration to get closer approximations to the root. The iteration will converge to a root  $\alpha$  if  $|g'(\alpha)| < 1$  ( $-1 < g'(\alpha) < 1$ ) and  $x_0$  is sufficiently close to  $\alpha$ .

Graphically:

The iteration converges or diverges in a staircase or cobweb fashion

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

- Newton Raphson:** this uses the iteration:

Graphically, this method uses tangents to the curve - next iterations is where the tangent crosses the x-axis. Problems - if the gradient of the curve is too steep where it crosses the x-axis or if the iteration finds a turning point.

## The Trapezium Rule

The area between the curve  $y = f(x)$ , the x-axis and the lines  $x = a$  and  $x = b$  can be approximated using the trapezium rule:

$$\int_a^b y dx \approx \frac{1}{2} h [(y_0 + y_n) + 2(y_1 + y_2 + \dots + y_{n-1})]$$

where  $n$  is the number of divisions, each of width  $h = \frac{b-a}{n}$ .

## Partial Fractions

$$(1) \frac{x+3}{(x-2)(x+4)} = \frac{A}{x-2} + \frac{B}{x+4}$$

$$(2) \frac{x-1}{(x+1)(x-2)^2} = \frac{A}{x+1} + \frac{B}{x-2} + \frac{C}{(x-2)^2}$$

## General Binomial Expansion

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!} x^2 + \frac{n(n-1)(n-2)}{3!} x^3 + \dots$$

provided  $|x| < 1$ .

$$\text{e.g. } (2+x)^{-3} = (2+x)^{-3} = \left[ 2 \left( 1 + \frac{x}{2} \right) \right]^{-3} = 2^{-3} \left( 1 + \frac{x}{2} \right)^{-3}$$

$$= \frac{1}{8} \left\{ 1 + (-3) \left( \frac{x}{2} \right) + \frac{(-3)(-4)}{2!} \left( \frac{x}{2} \right)^2 + \dots \right\} = \frac{1}{8} - \frac{3x}{16} + \frac{3x^2}{16} \quad [1^{st} \text{ 3 terms}]$$

Valid for  $\left| \frac{x}{2} \right| < 1 \Rightarrow |x| < 2$  or  $-2 < x < 2$

## Sequences and Series

A **sequence** is a set of numbers in a given order, each number is called a **term**. When the terms of a sequence are added together, the resulting sum is called a **series**.

A sequence which repeats itself at regular intervals is called **periodic**. In an **oscillating** sequence the terms lie above and below a middle number.

### 1. Arithmetic Progressions

Each term may be obtained from the previous term by adding the **common difference**  $d$ . The first term is called  $a$ .

e.g. 1, 3, 5, 7, ...  $a = 1, d = 2$

In an A.P.: 1<sup>st</sup> term  $a$ , 2<sup>nd</sup> term  $a + d$ , ...

$$k^{th} \text{ term is } a + (k-1)d$$

If  $S_n$  is the sum of the first  $n$  terms and  $l$  is the last term.

$$S_n = \frac{1}{2} n(a + l) = \frac{1}{2} n[2a + (n-1)d]$$

### 2. Geometric Progressions

The ratio of a term to the previous one is a constant, called the **common ratio**  $r$ .

3, 6, 12, 24, 48, ...  $a = 3, r = 2$

1<sup>st</sup> term:  $a$ ; 2<sup>nd</sup> term  $ar$ ; 3<sup>rd</sup> term:  $ar^2$

$$k^{th} \text{ term is } ar^{k-1}$$

If  $S_n$  is the sum of the first  $n$  terms

$$S_n = \frac{a(1-r^n)}{1-r} \quad \text{for } r > 1$$

for  $-1 < r < 1$

If  $|r| < 1$  then the terms of a G.P. get progressively smaller (i.e.  $r \rightarrow 0$  as  $n \rightarrow \infty$ ) and the series **converges**. The sum is

$$S = \frac{a}{1-r} \quad \text{e.g. in } 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots, a = 1, r = \frac{1}{2}$$

$$S = \frac{1}{1-\frac{1}{2}} = \frac{1}{\frac{1}{2}} = 2$$

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## Radians: $180^\circ = \pi$ radians

To convert from degrees to radians, multiply by  $\frac{\pi}{180}$ .

To convert from radians to degrees, multiply by  $\frac{180}{\pi}$ .



$$\text{Length of arc} = r\theta$$

$$\text{Area of sector} = \frac{1}{2} r^2 \theta$$

## Parametric Equations

$y^2 = x$  (one to many) can be represented as:  $x = t^2 \rightarrow x = y^2$

each **one** parameter value of  $t$  gives **one** coordinate value.

$$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} \quad \text{or} \quad \frac{dy}{dx} = \frac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}} \quad \text{Parametric Differentiation.}$$

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**Didier Musso**



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