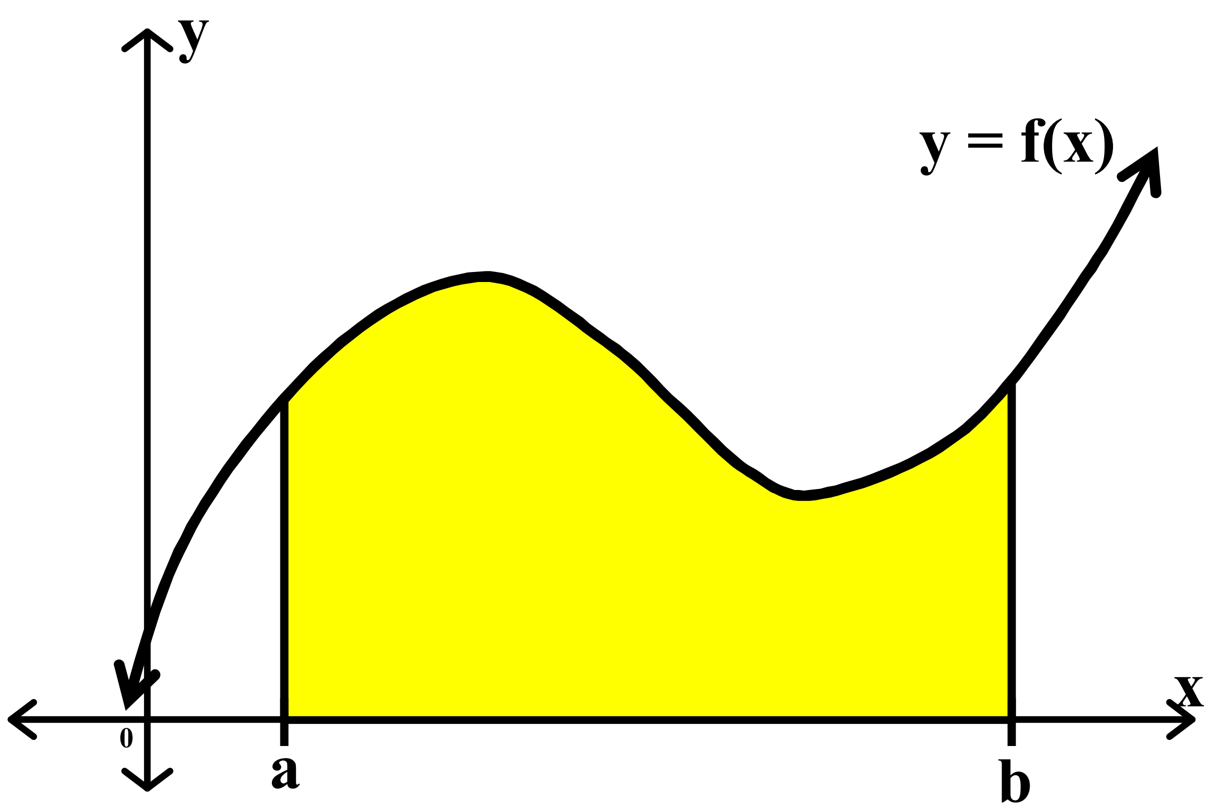
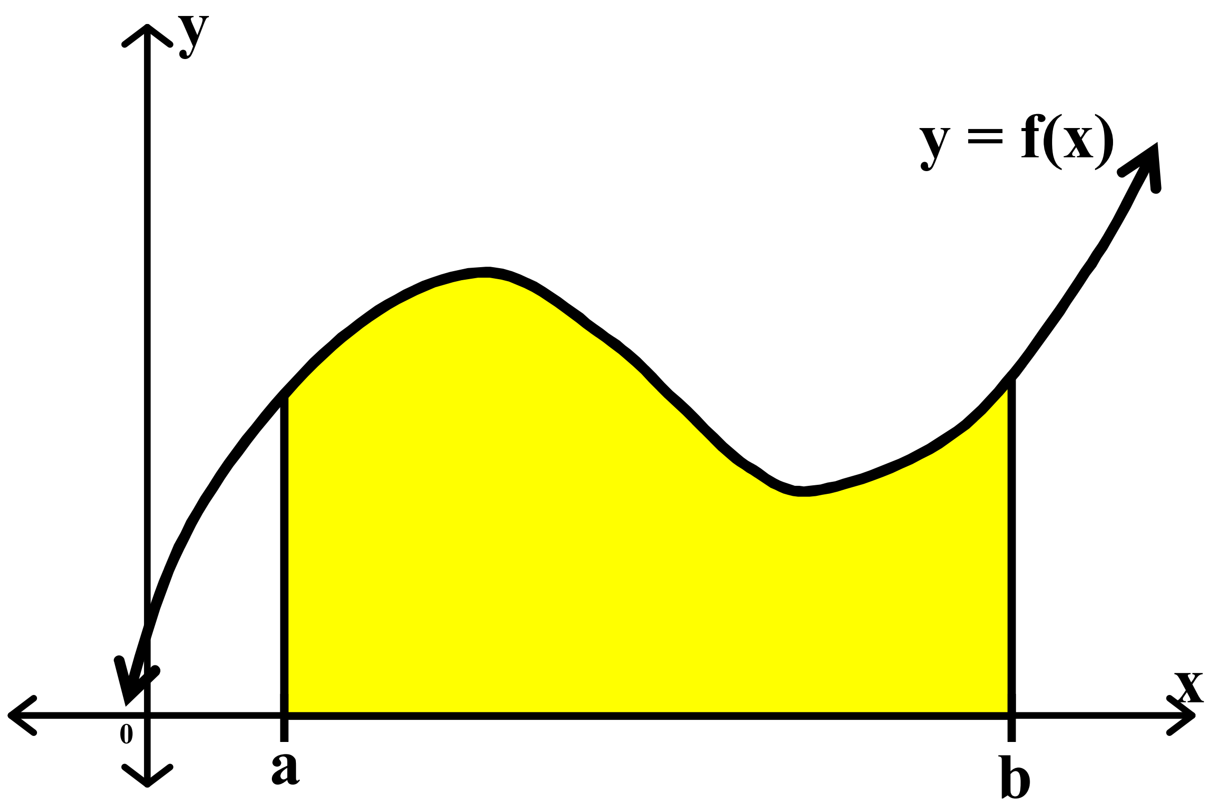
Calculus Lesson #5 Unit 11

Class Worksheet #5

Numerical Methods for Approximating Definite Integrals

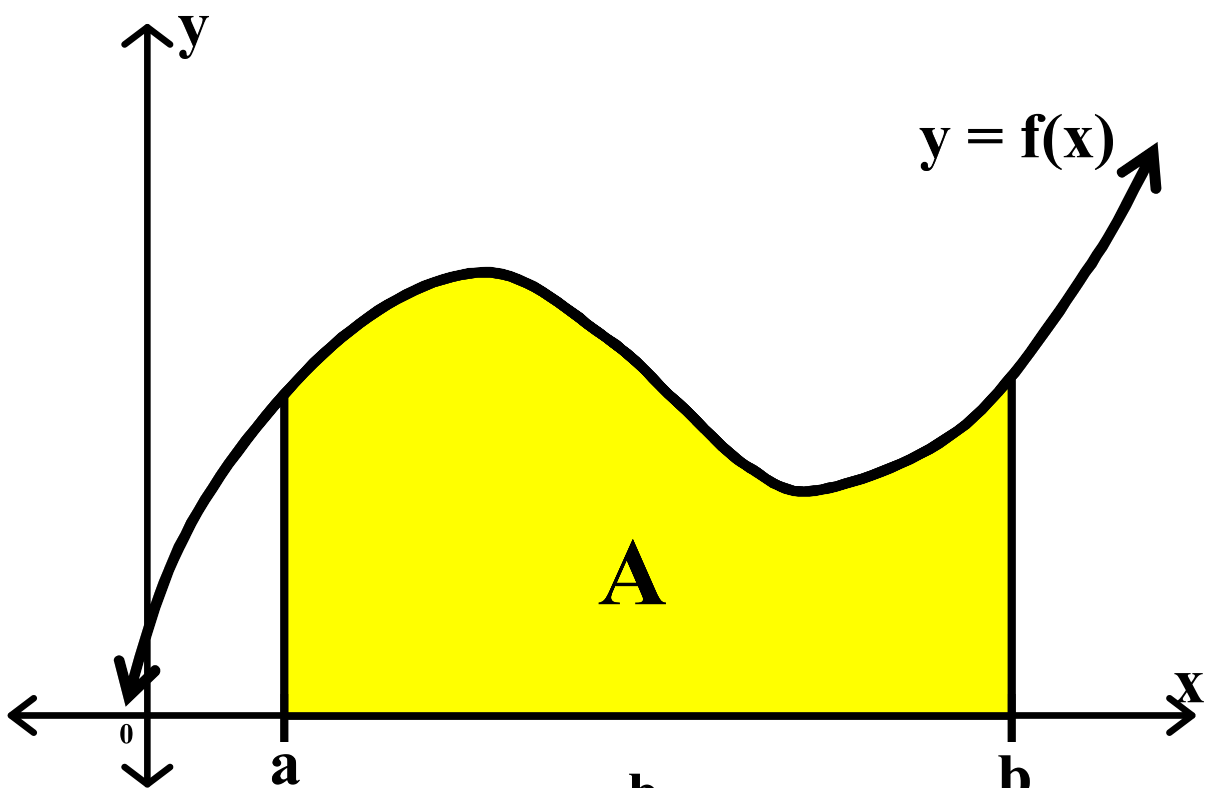


Consider the shaded region between the x-axis, the graph of the function y = f(x), and the vertical lines x = a and x = b.

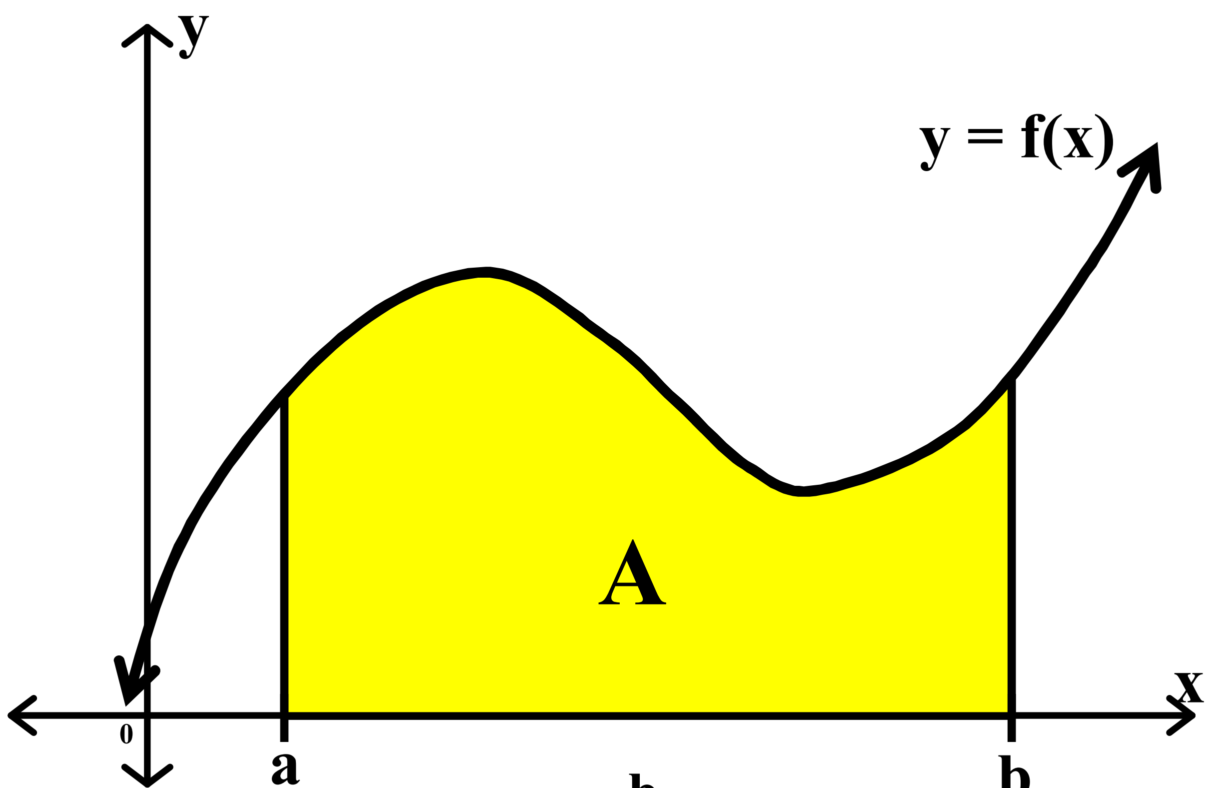


Consider the shaded region between the x-axis, the graph of the function $y = f(x)$, and the vertical lines $x = a$ and $x = b$. The area of this region can be represented by the definite integral

$$\int_a^b f(x)dx.$$

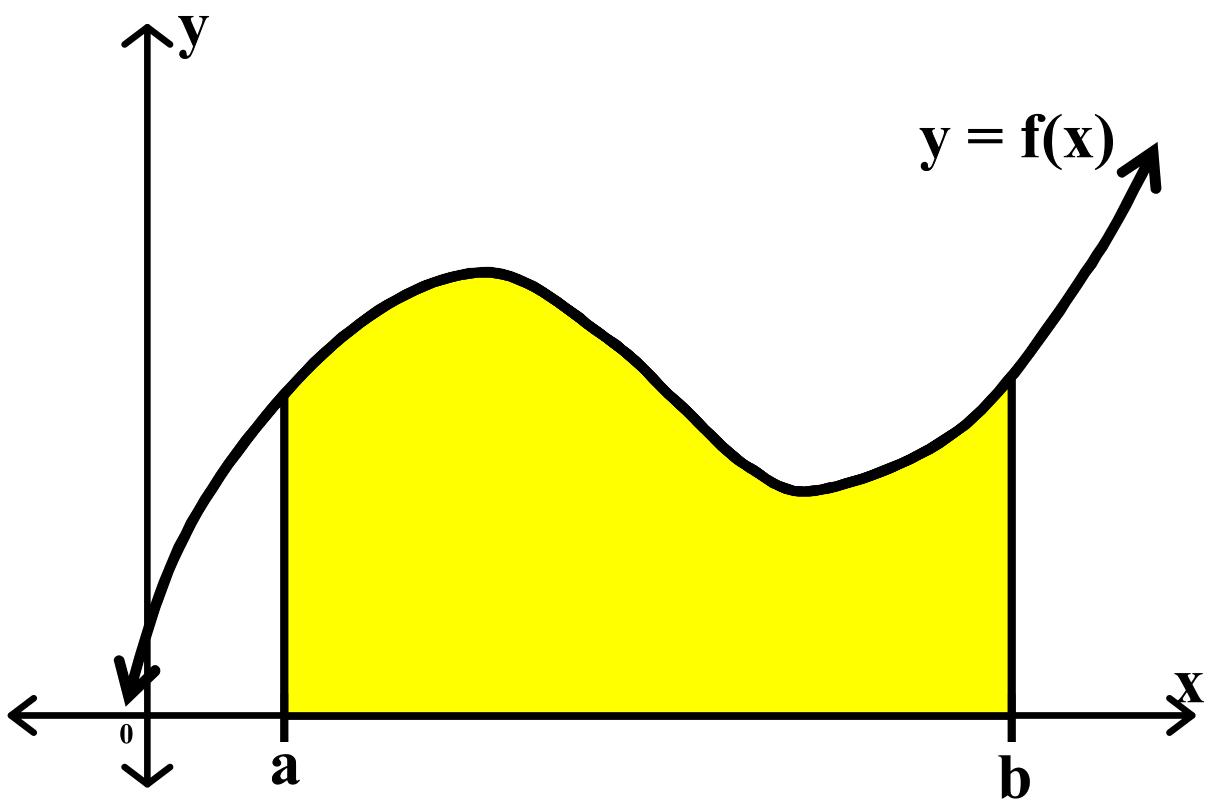


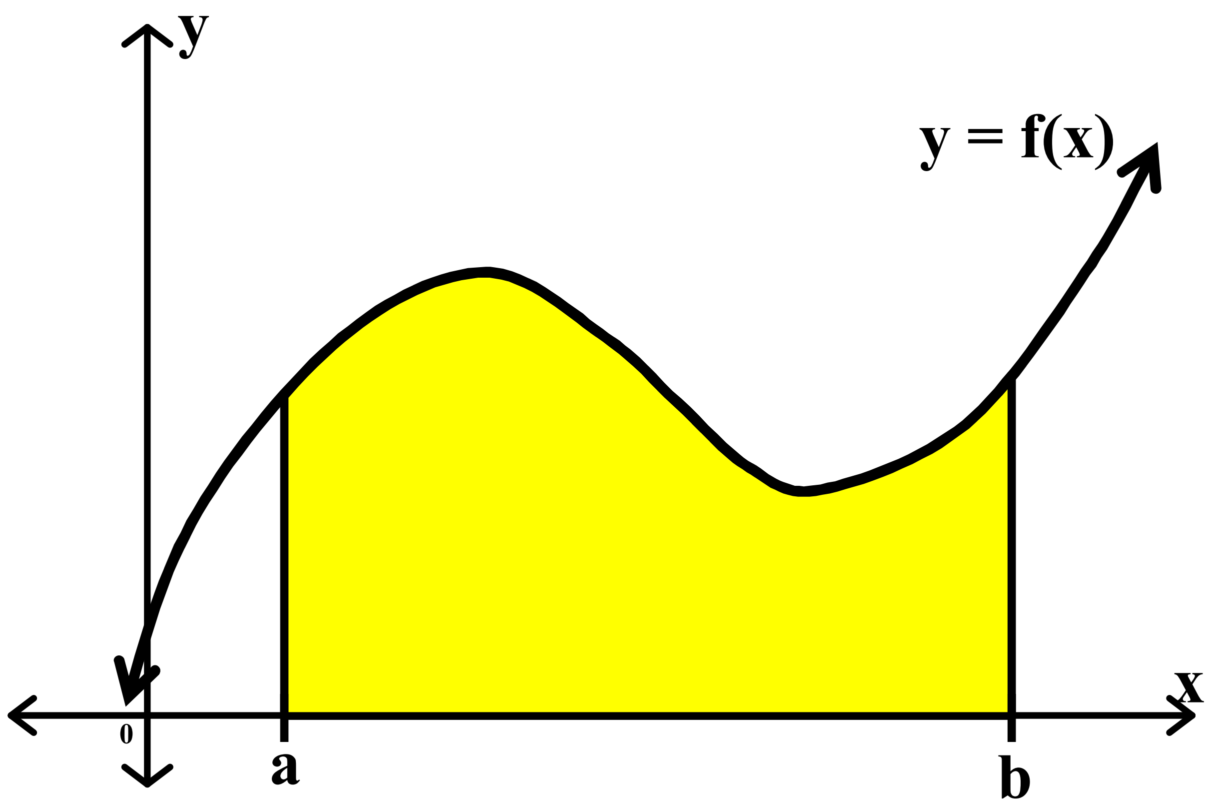
$$A = \int_a^b f(x)dx$$



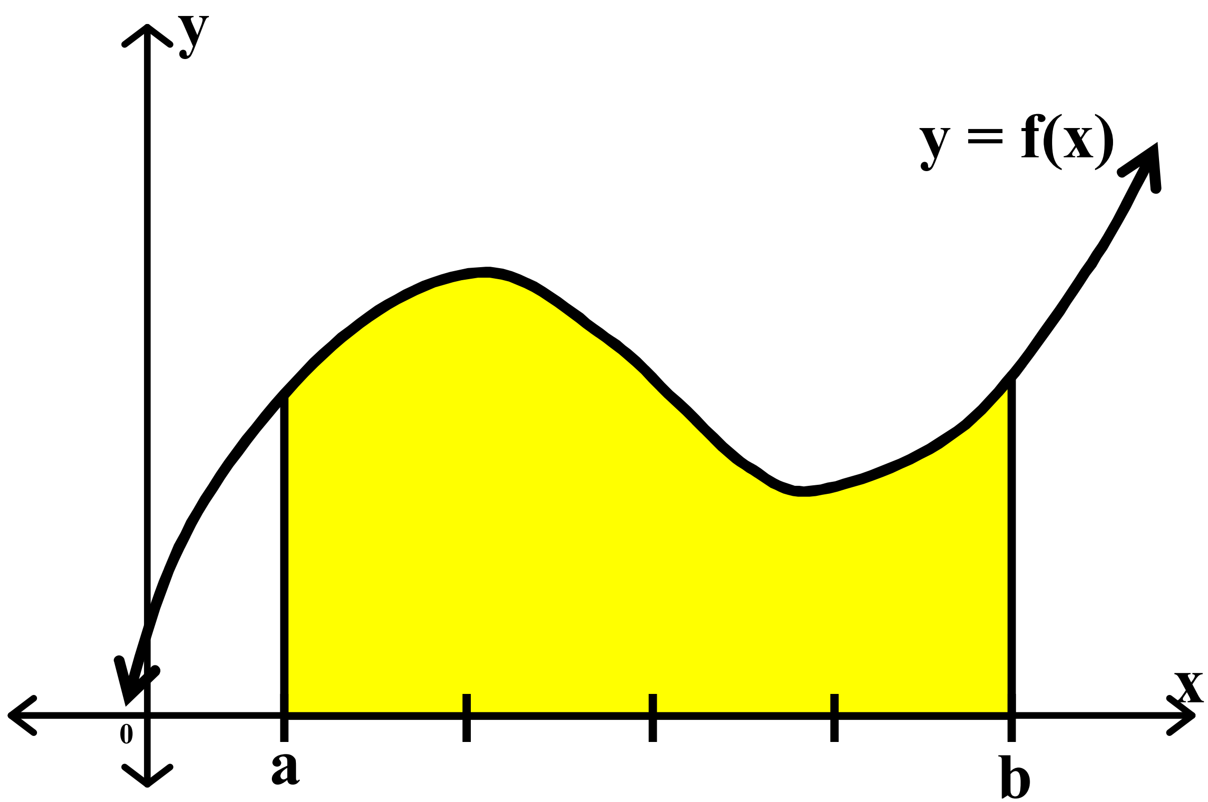
$$A = \int_a^b f(x)dx$$

The purpose of this lesson is to introduce several numerical methods that can be used to approximate the value of a definite integral.


y
y = f(x)
x
0
a
b



Divide the interval [a, b] into n sub-intervals



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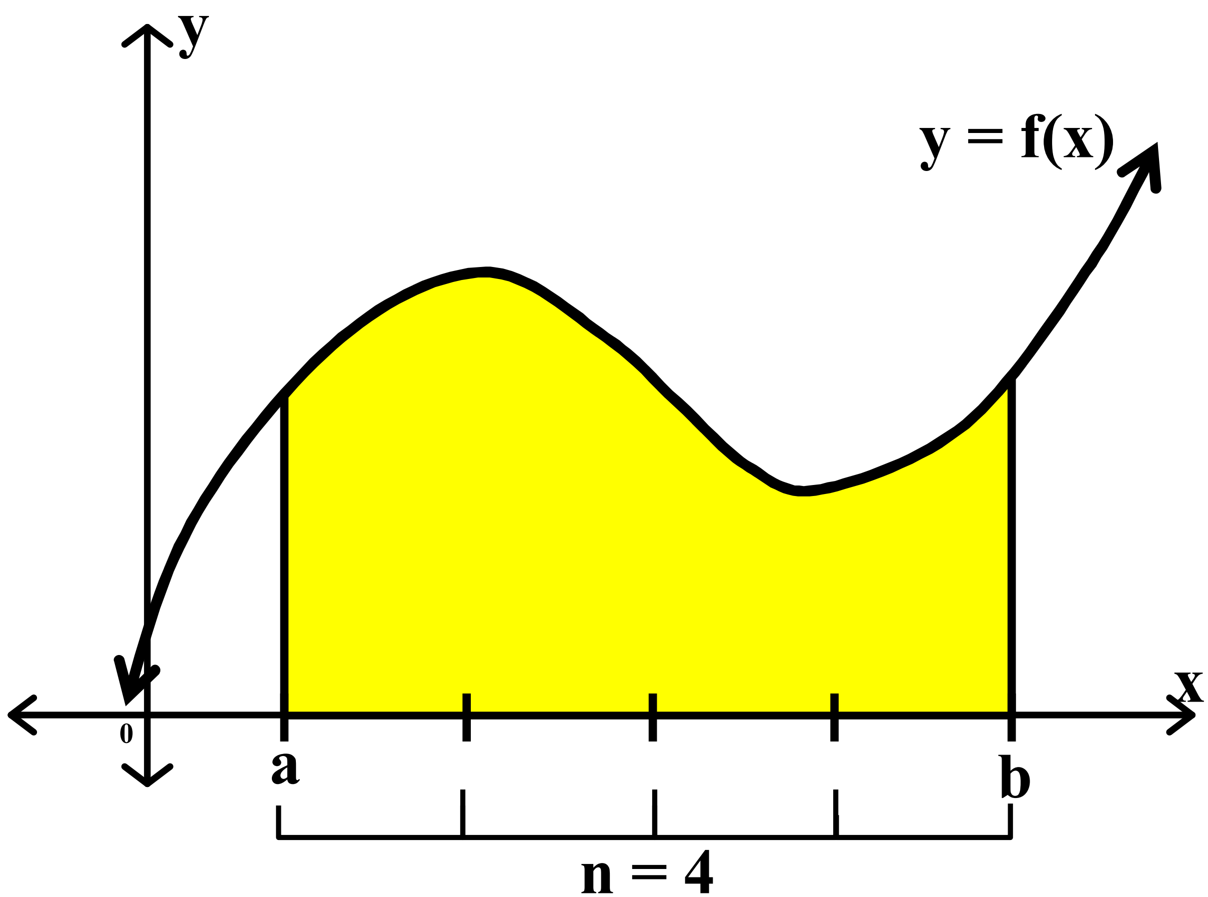
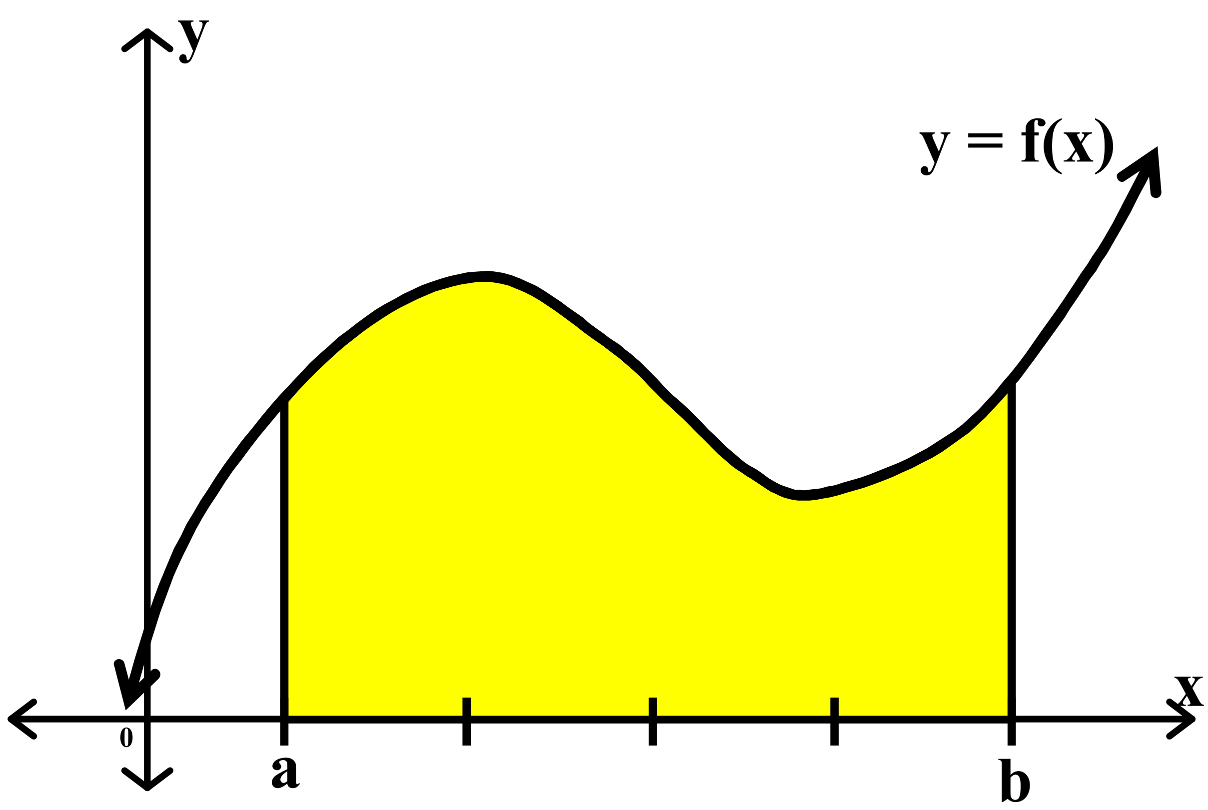
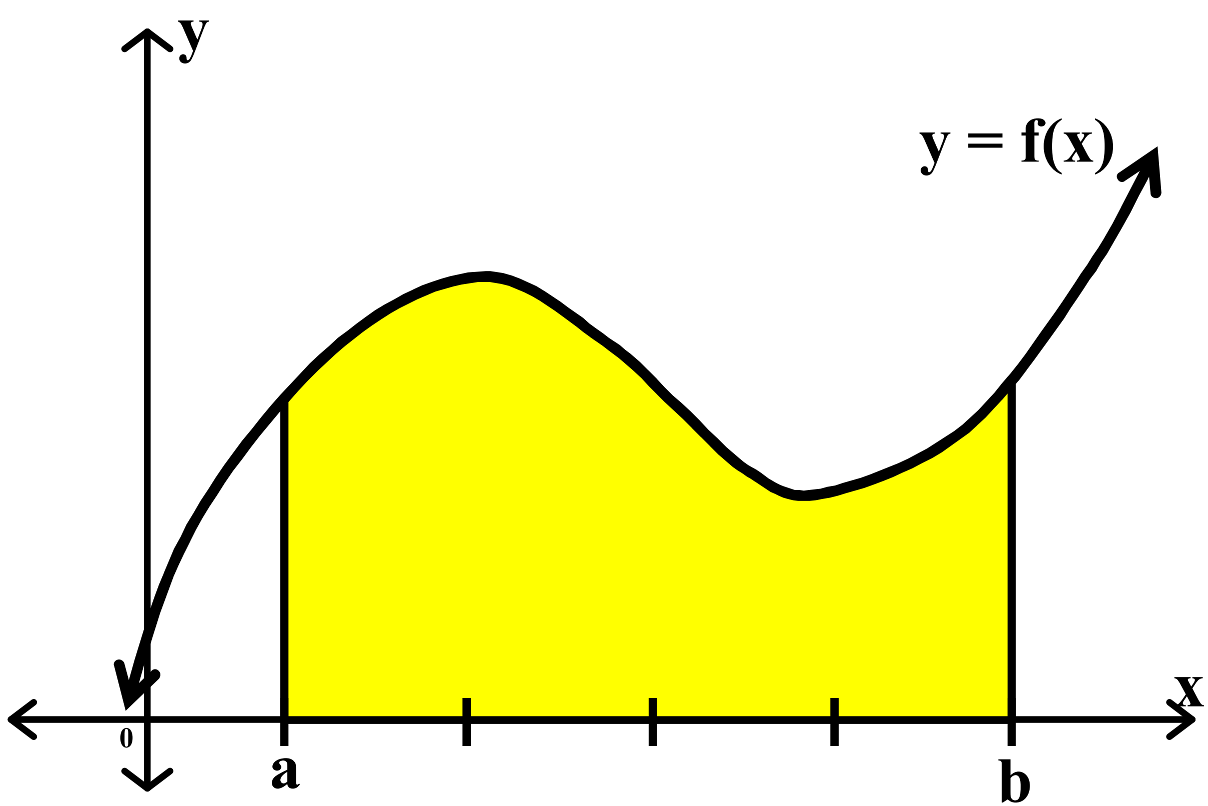


Divide the interval [a, b] into n sub-intervals



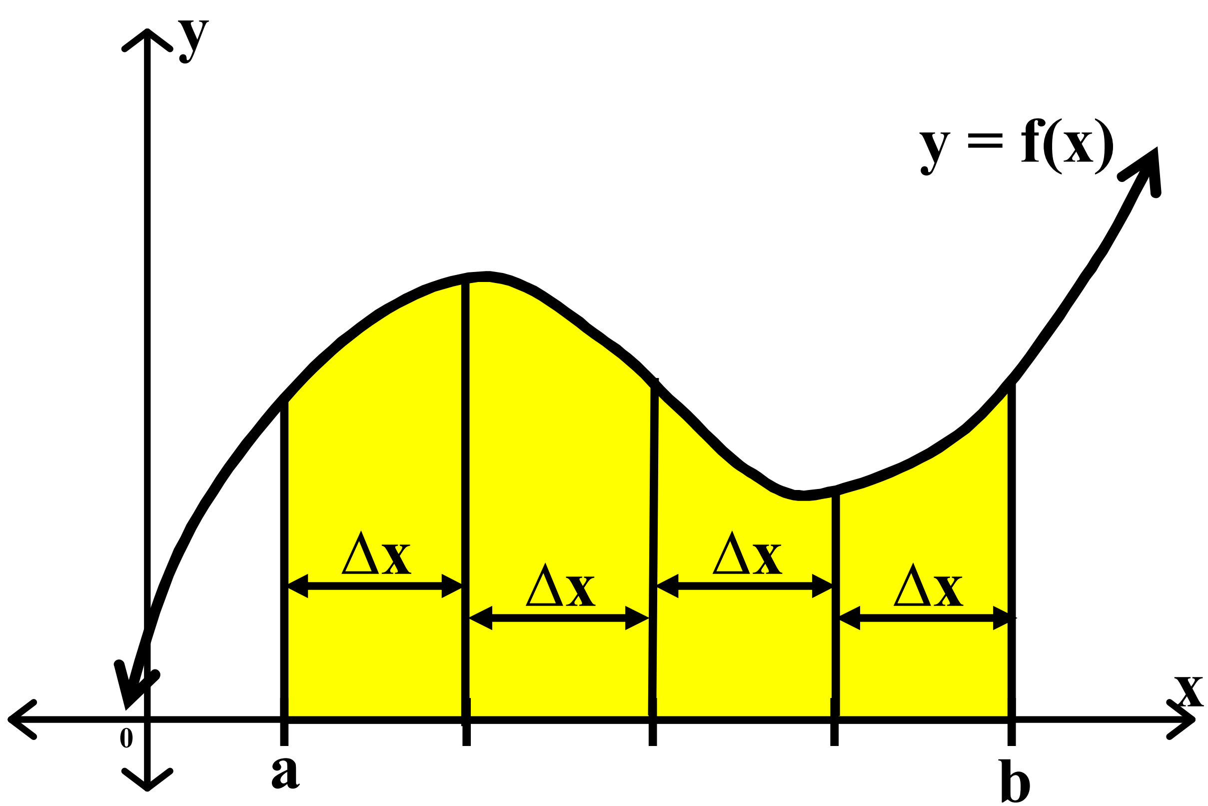
n = 4

Divide the interval [a, b] into n sub-intervals



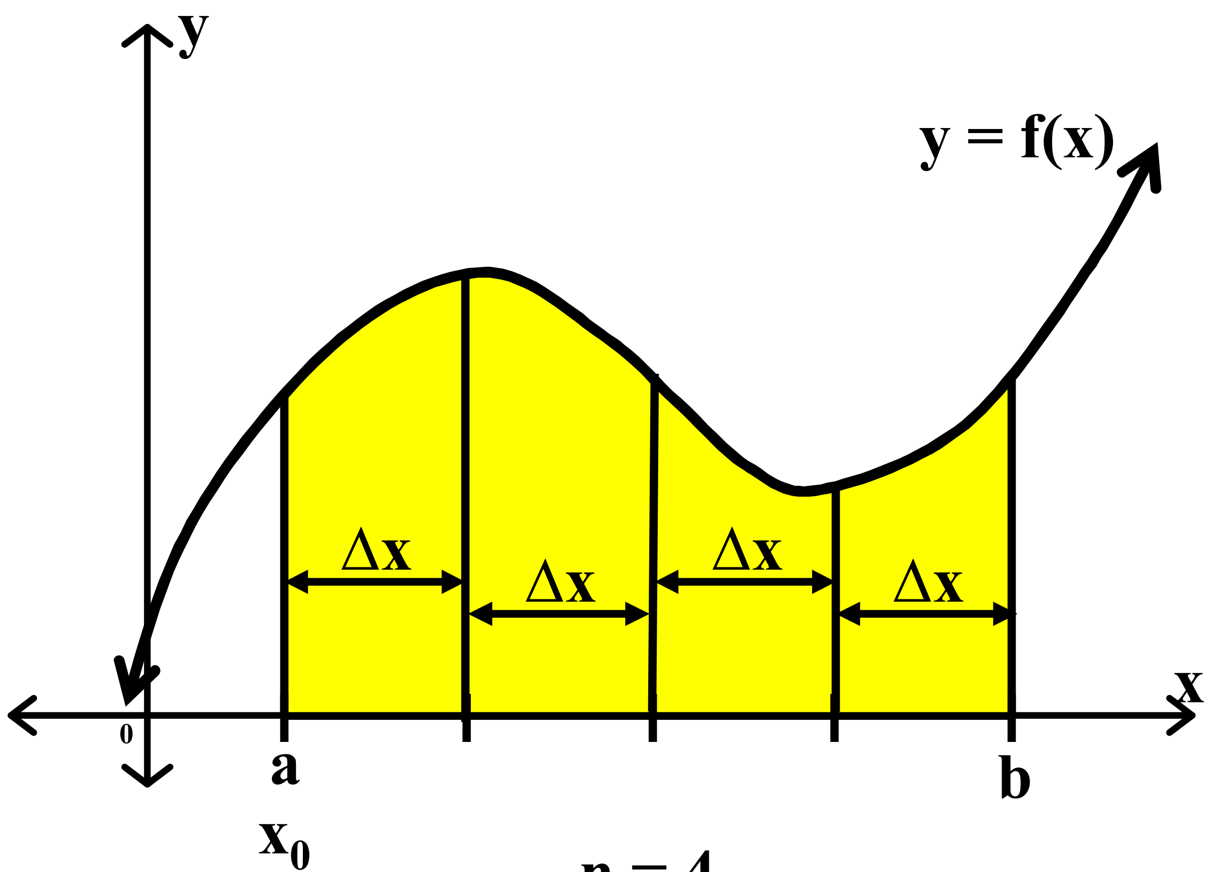
n = 4

Divide the interval [a, b] into n sub-intervals each of width Δx



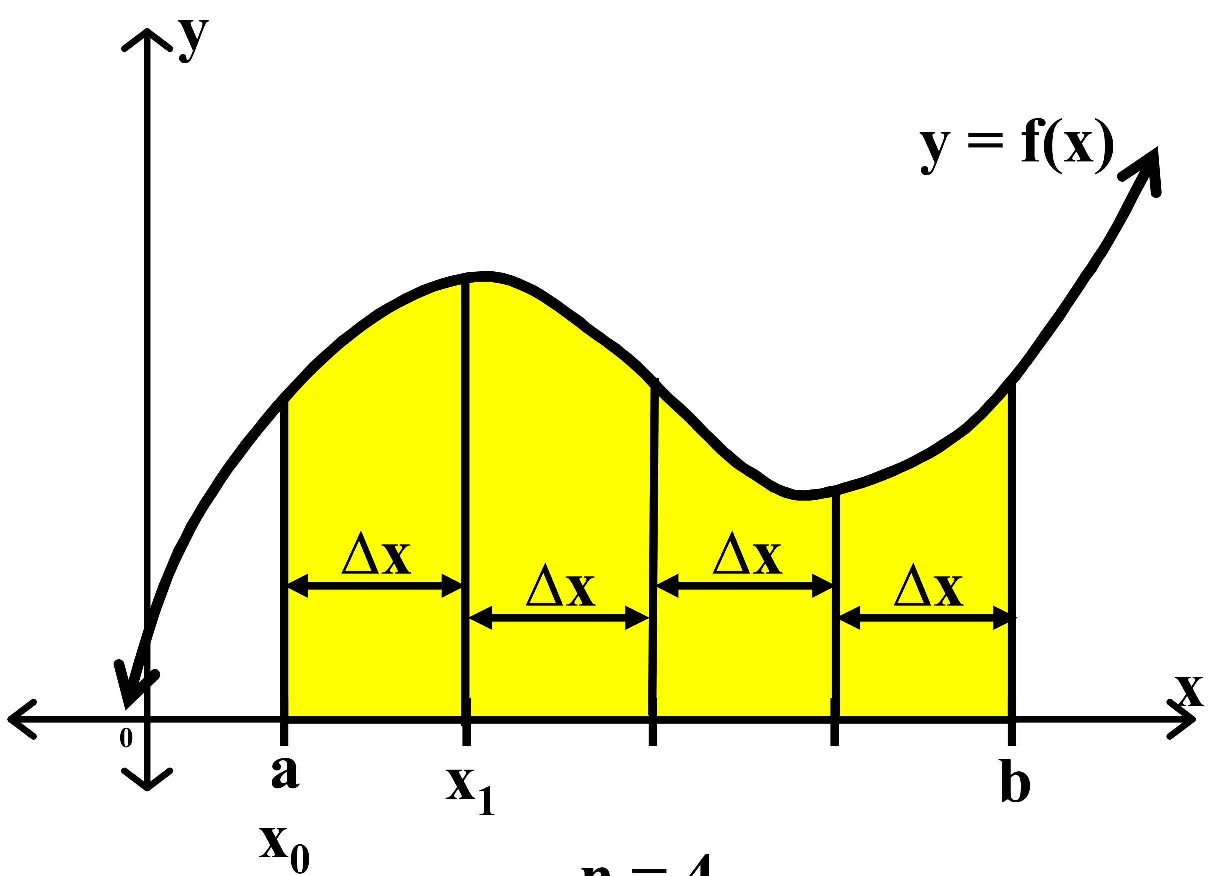
n = 4

Divide the interval [a, b] into n sub-intervals each of width Δx



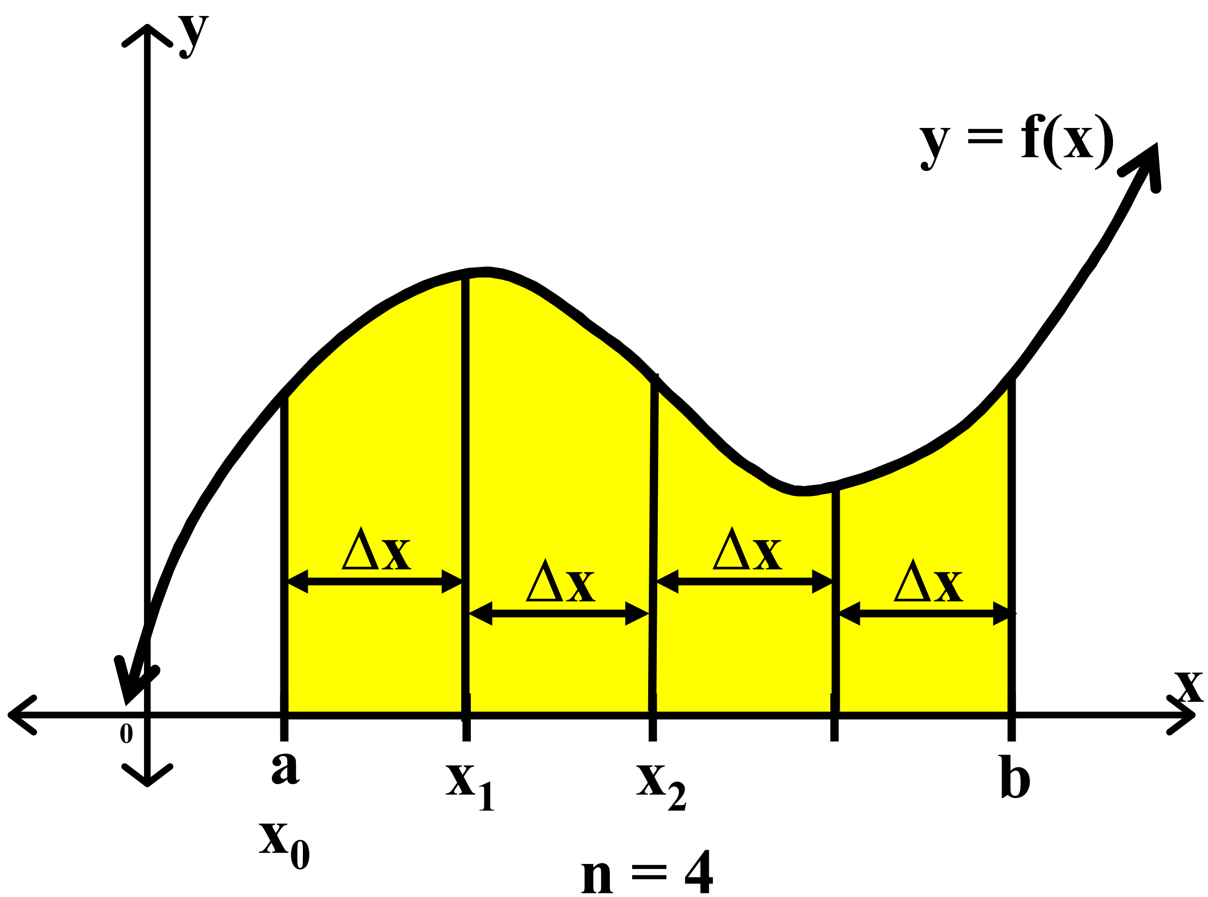
n = 4

Divide the interval [a, b] into n sub-intervals each of width Δx by the numbers $x_0 = a$,

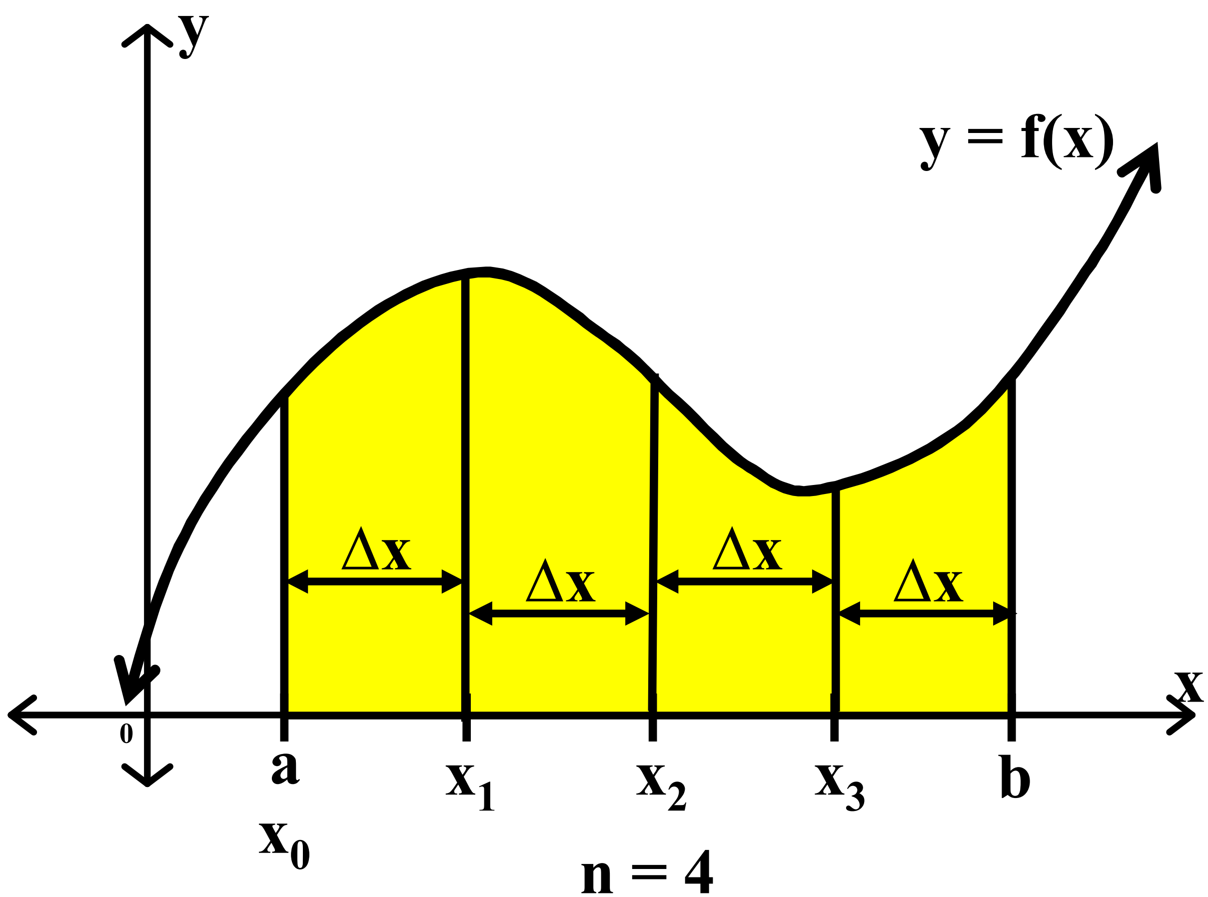


n = 4

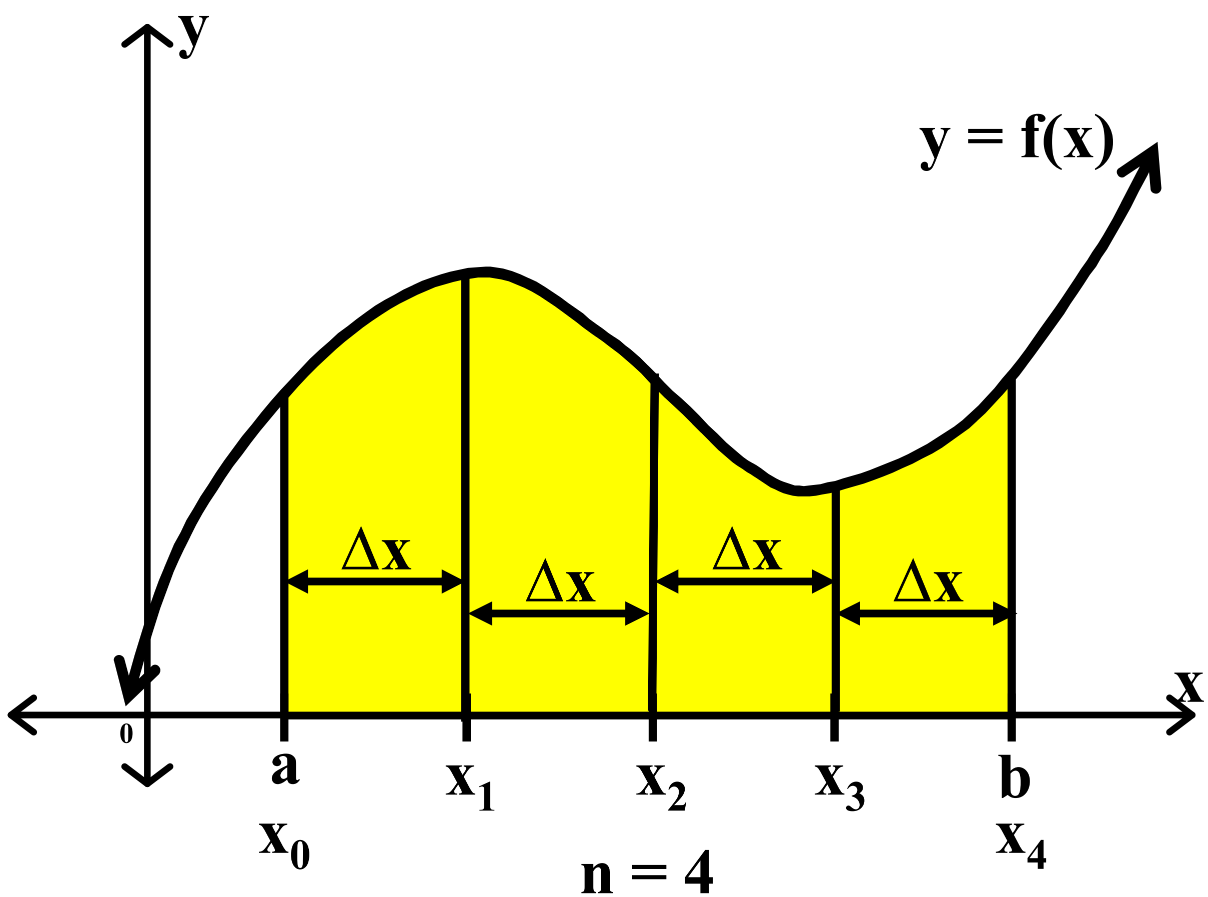
Divide the interval [a, b] into n sub-intervals each of width Δx by the numbers $x_0 = a$, x_1,



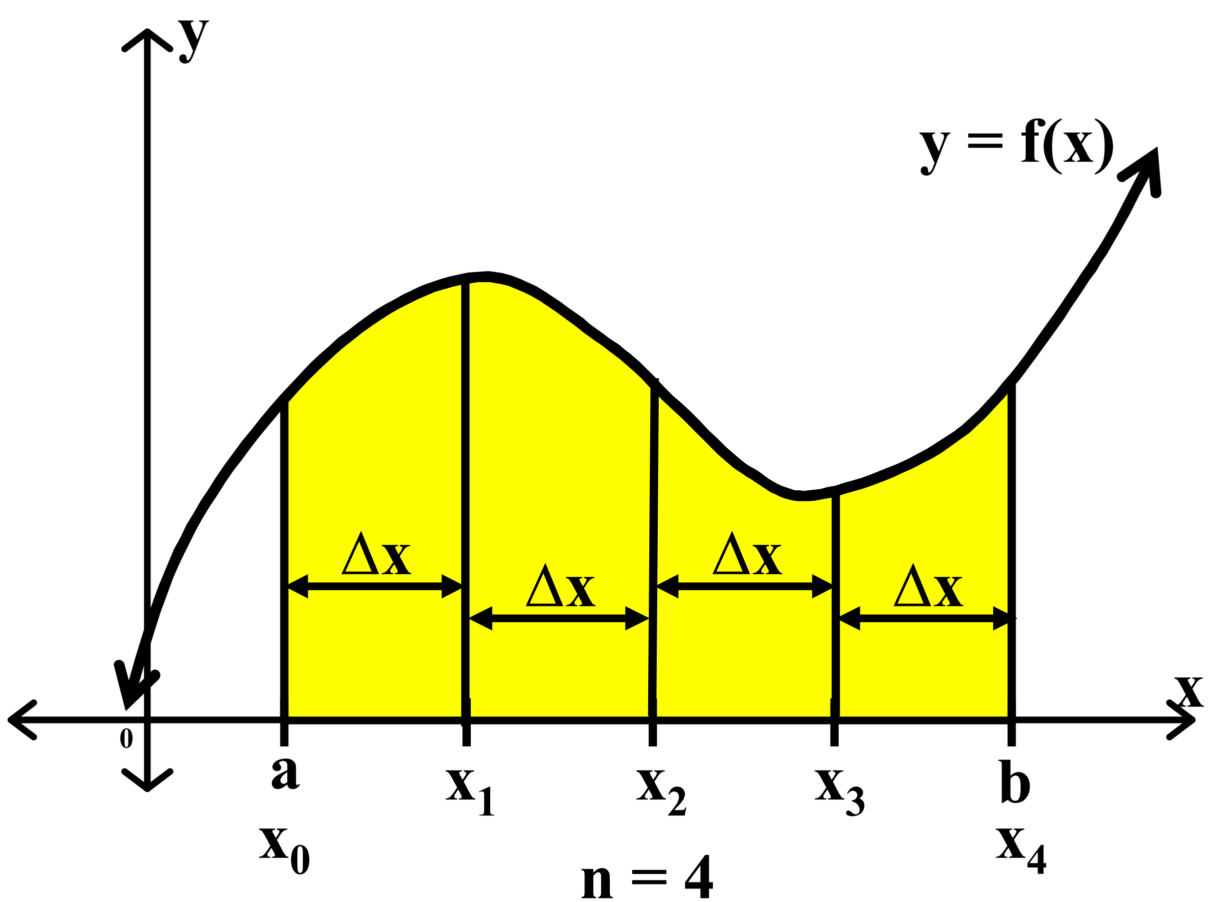
Divide the interval [a, b] into n sub-intervals each of width Δx by the numbers $x_0 = a$, x_1, x_2,



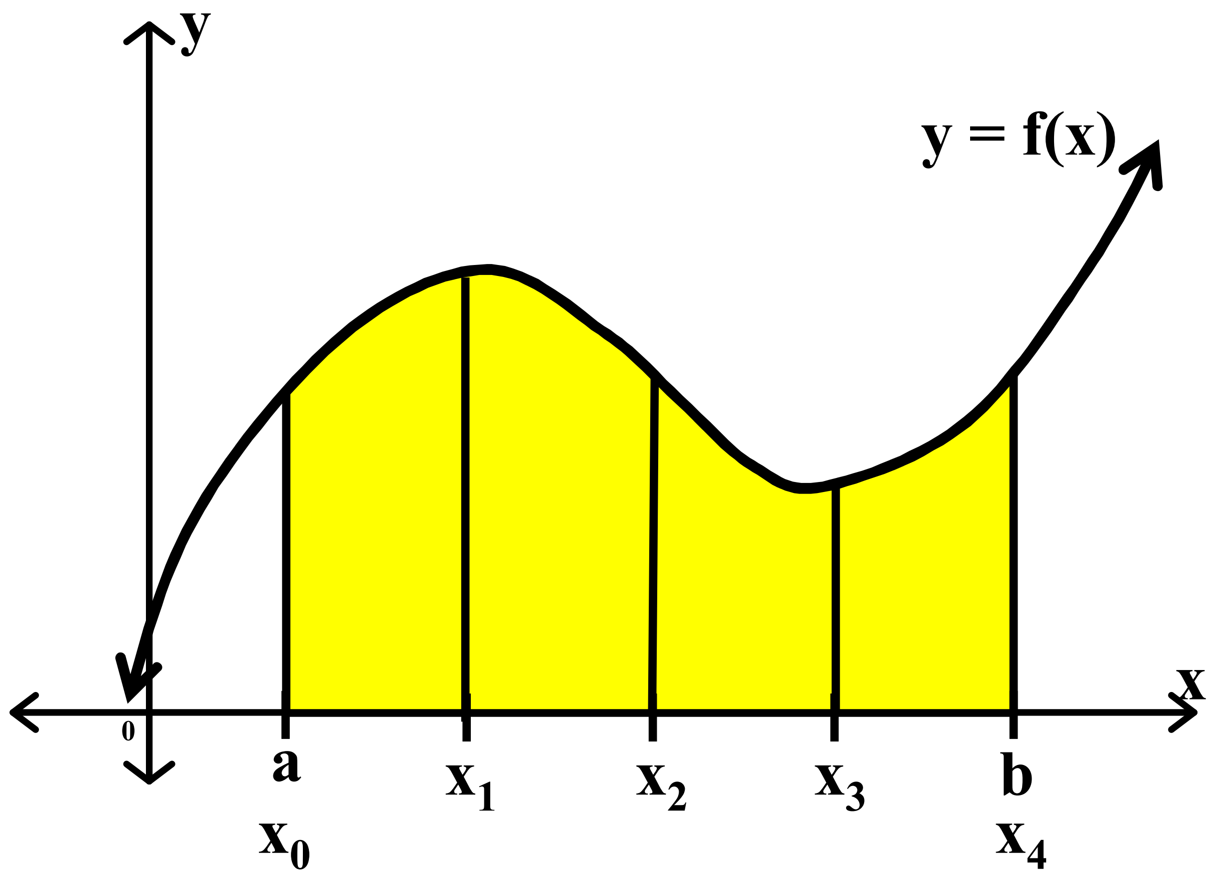
Divide the interval [a, b] into n sub-intervals each of width Δx by the numbers $x_0 = a, x_1, x_2, \ldots,$



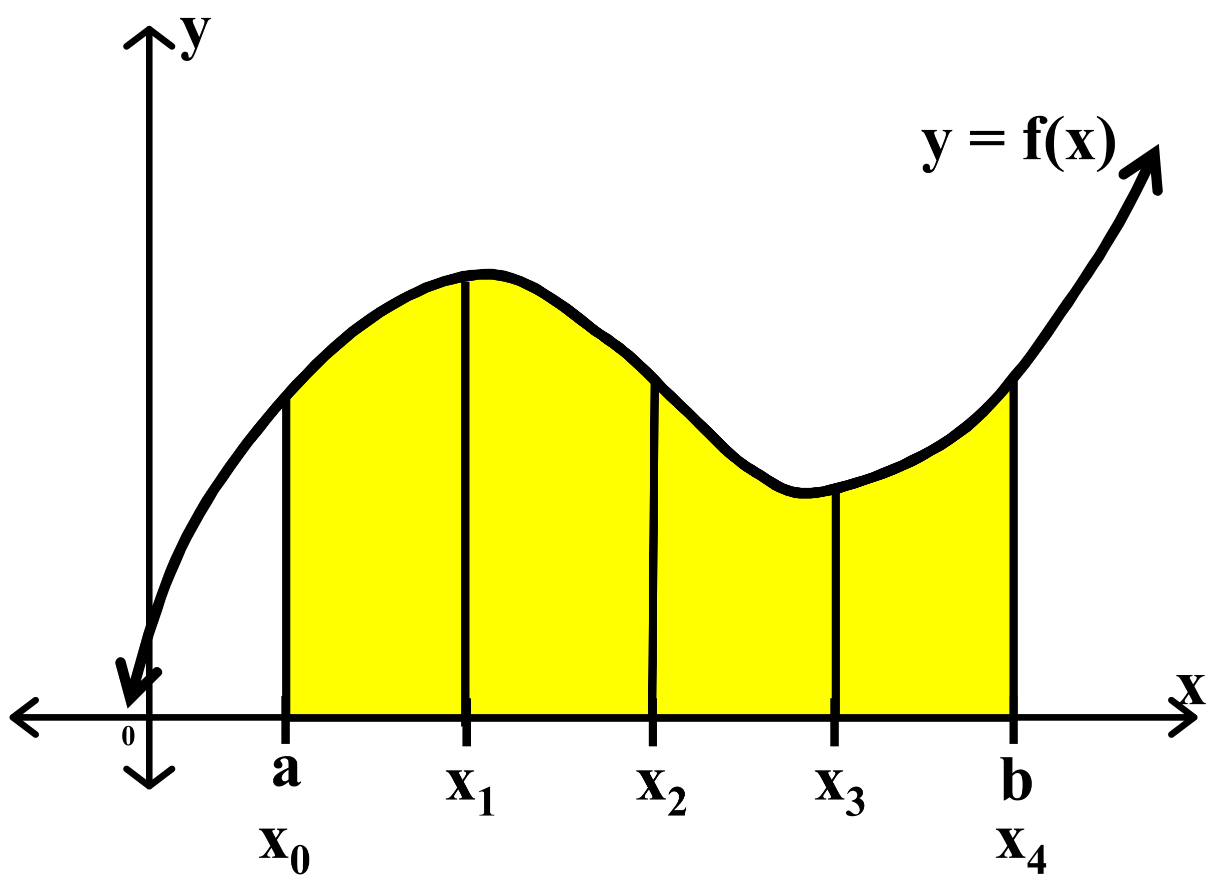
Divide the interval [a, b] into n sub-intervals each of width Δx by the numbers $x_0 = a$, x_1, x_2, …, $x_n = b$.



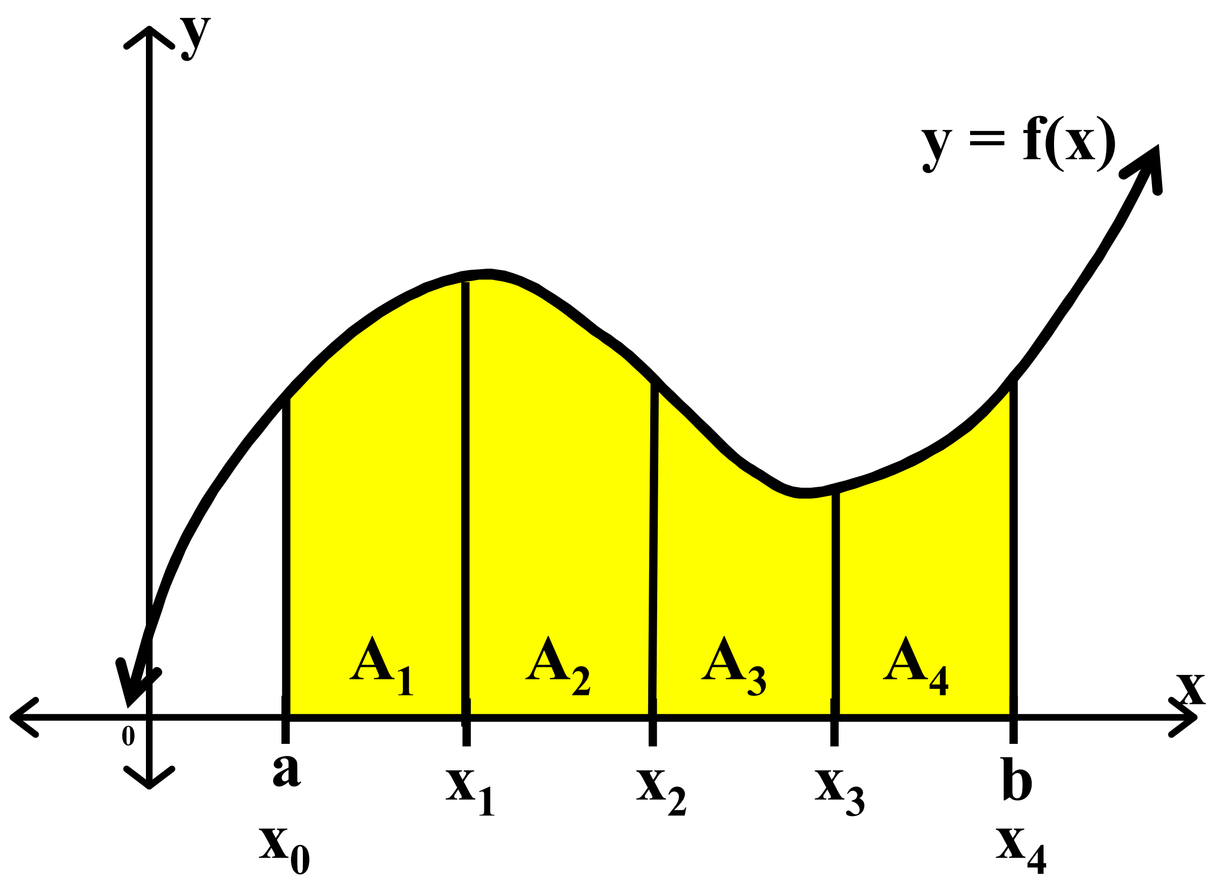
Divide the interval [a, b] into n sub-intervals each of width Δx by the numbers $x_0 = a$, x_1, x_2, …, $x_n = b$. Clearly, $\Delta x = (b - a)/n$.



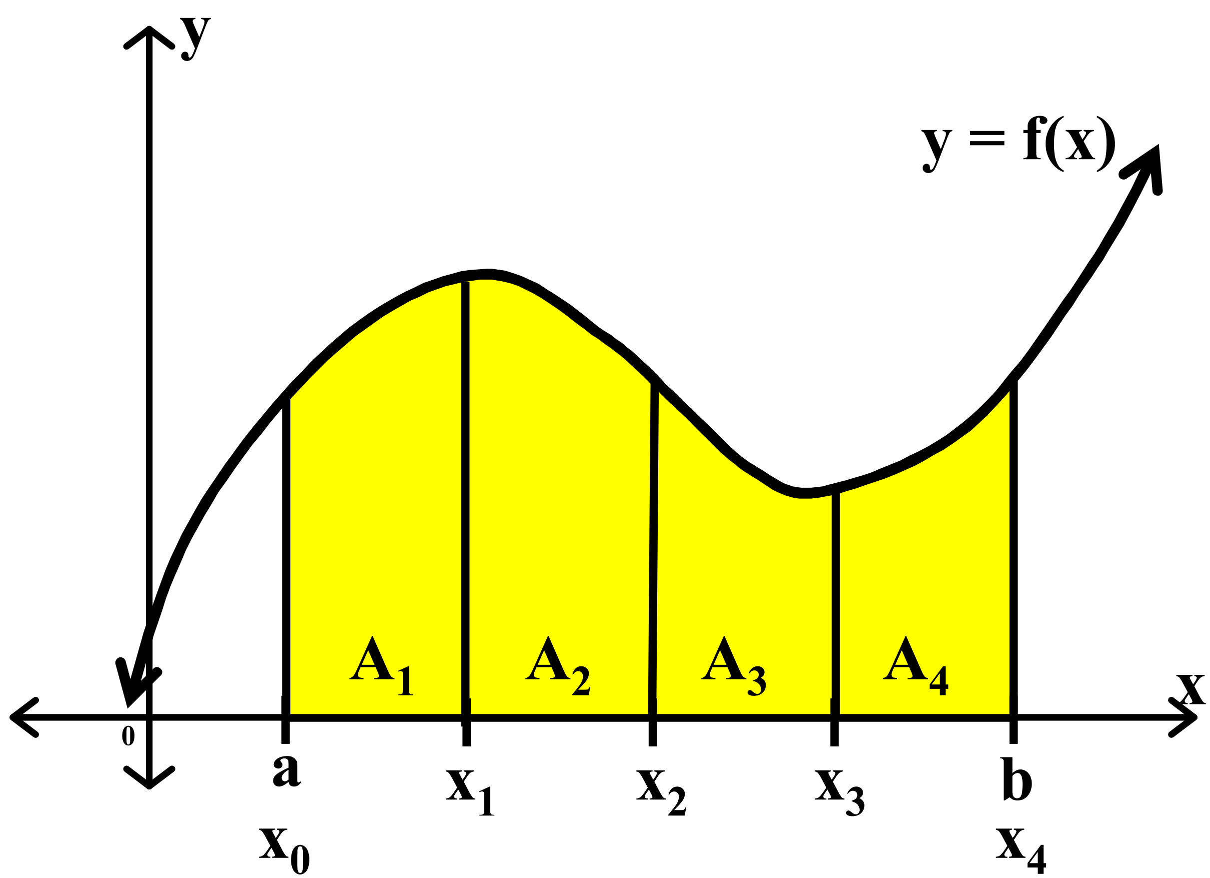
y
y = f(x)
x
0
a
x_0
x_1
x_2
x_3
b
x_4



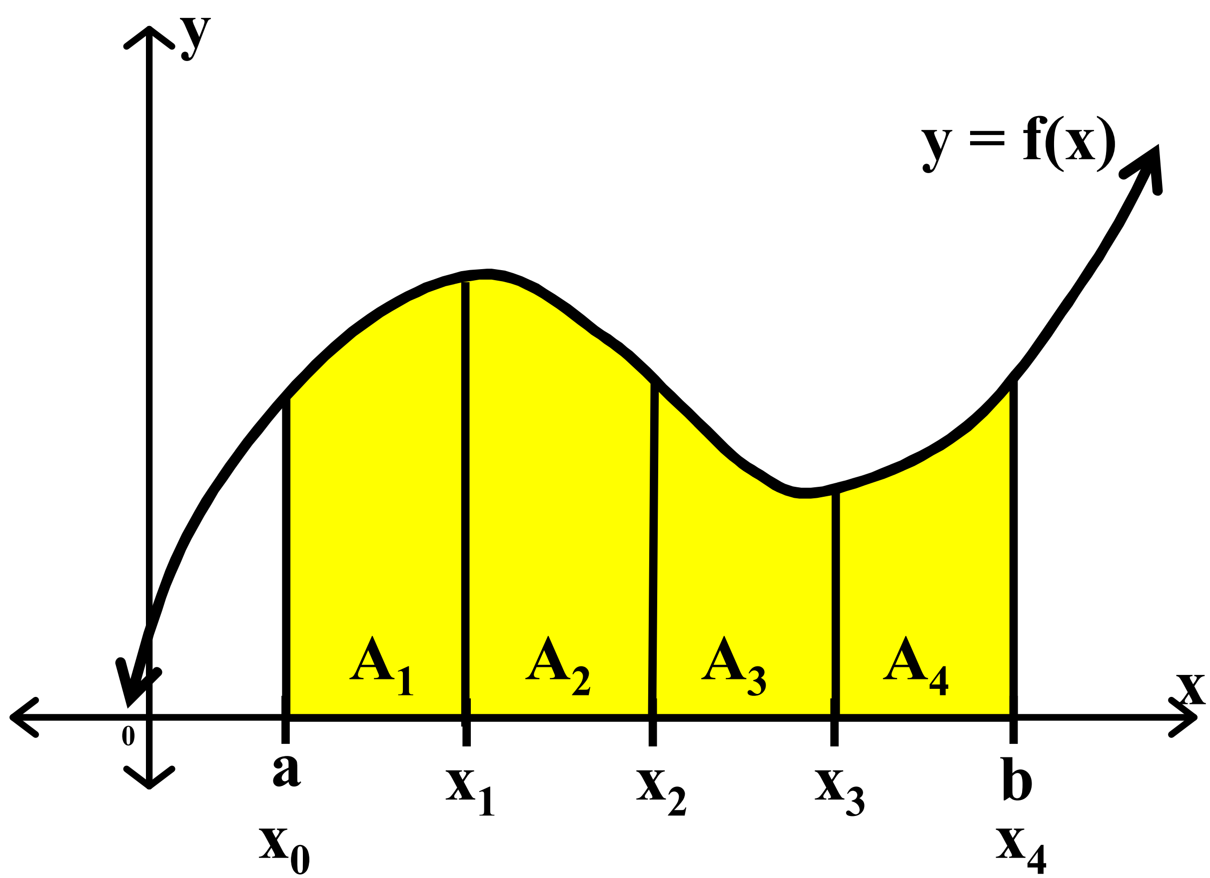
Notice that the region is divided into n ‘strips’,

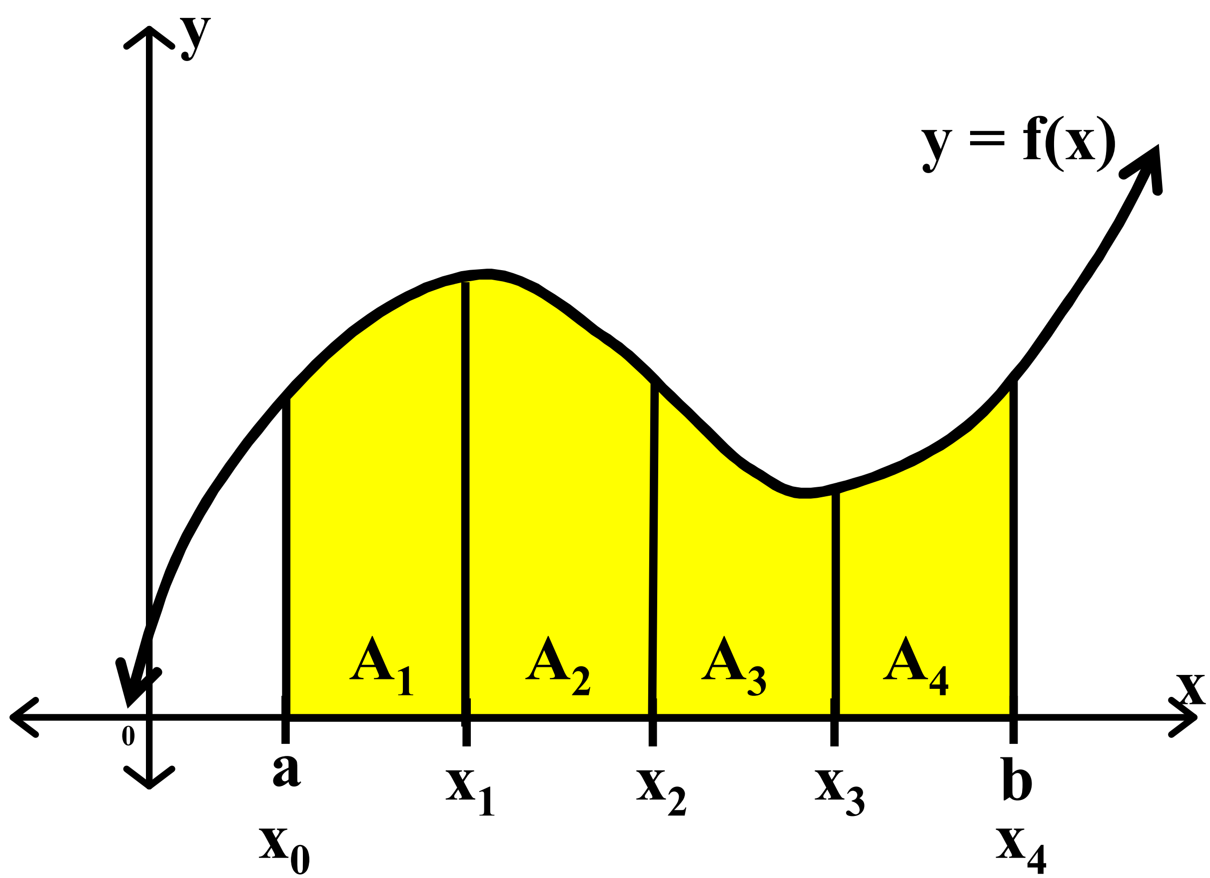


Notice that the region is divided into n ‘strips’, with areas A_1, A_2, A_3, …, A_n.

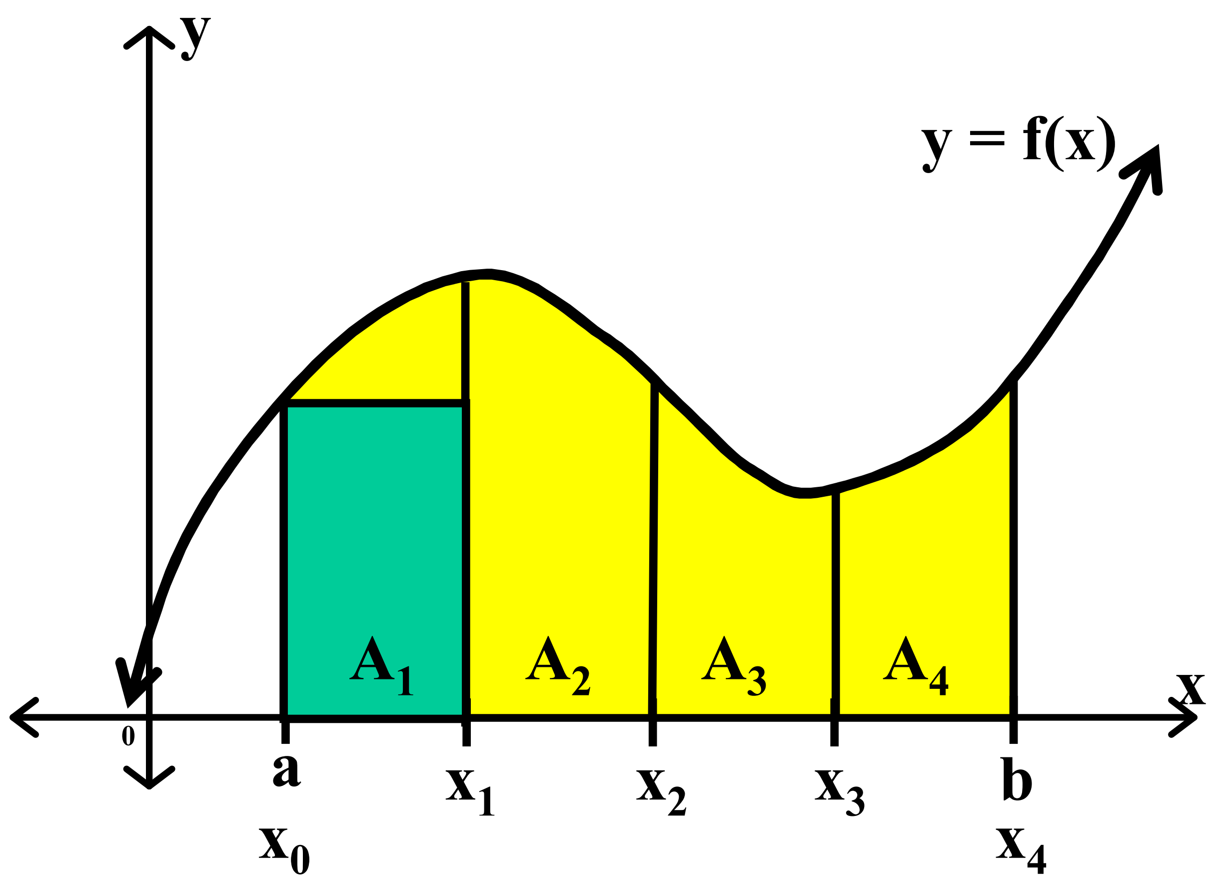


Notice that the region is divided into n ‘strips’, with areas A_1, A_2, A_3, …, A_n. Rectangles can be used to approximate the area of these strips.

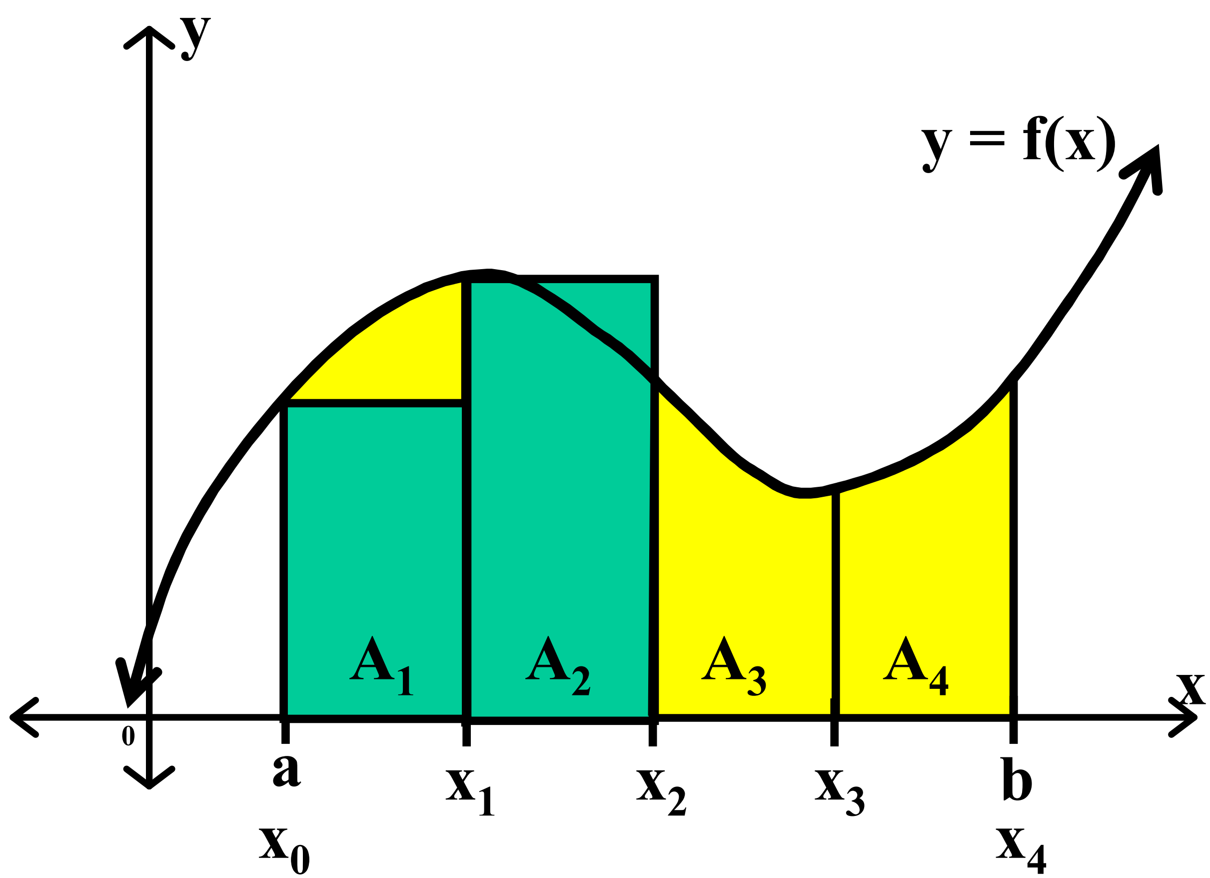

y
y = f(x)
A1
A2
A3
A4
x
0
a
x0
x1
x2
x3
b
x4



The first of the 'rectangular' approximations uses the length of the left hand side of each strip as the length of the rectangle.



The first of the ‘rectangular’ approximations uses the length of the left hand side of each strip as the length of the rectangle.



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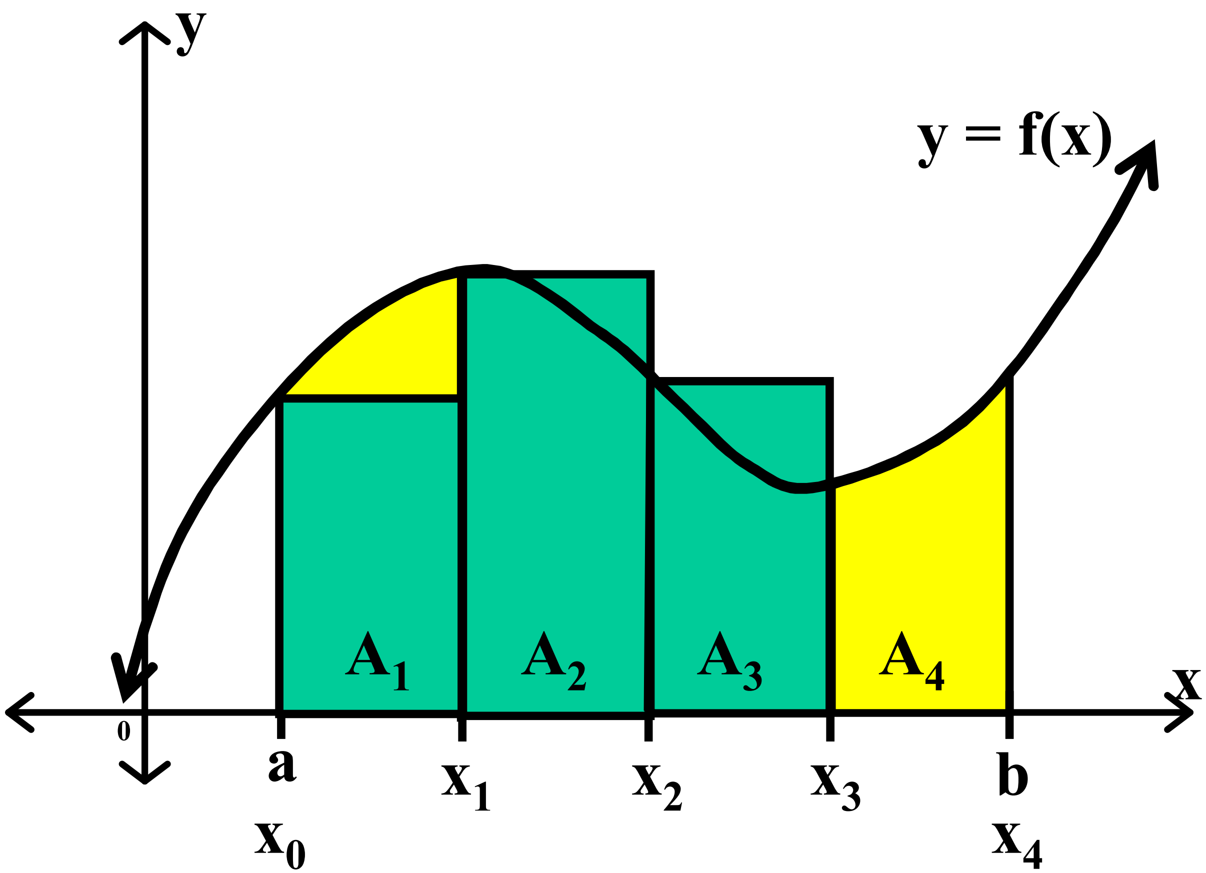
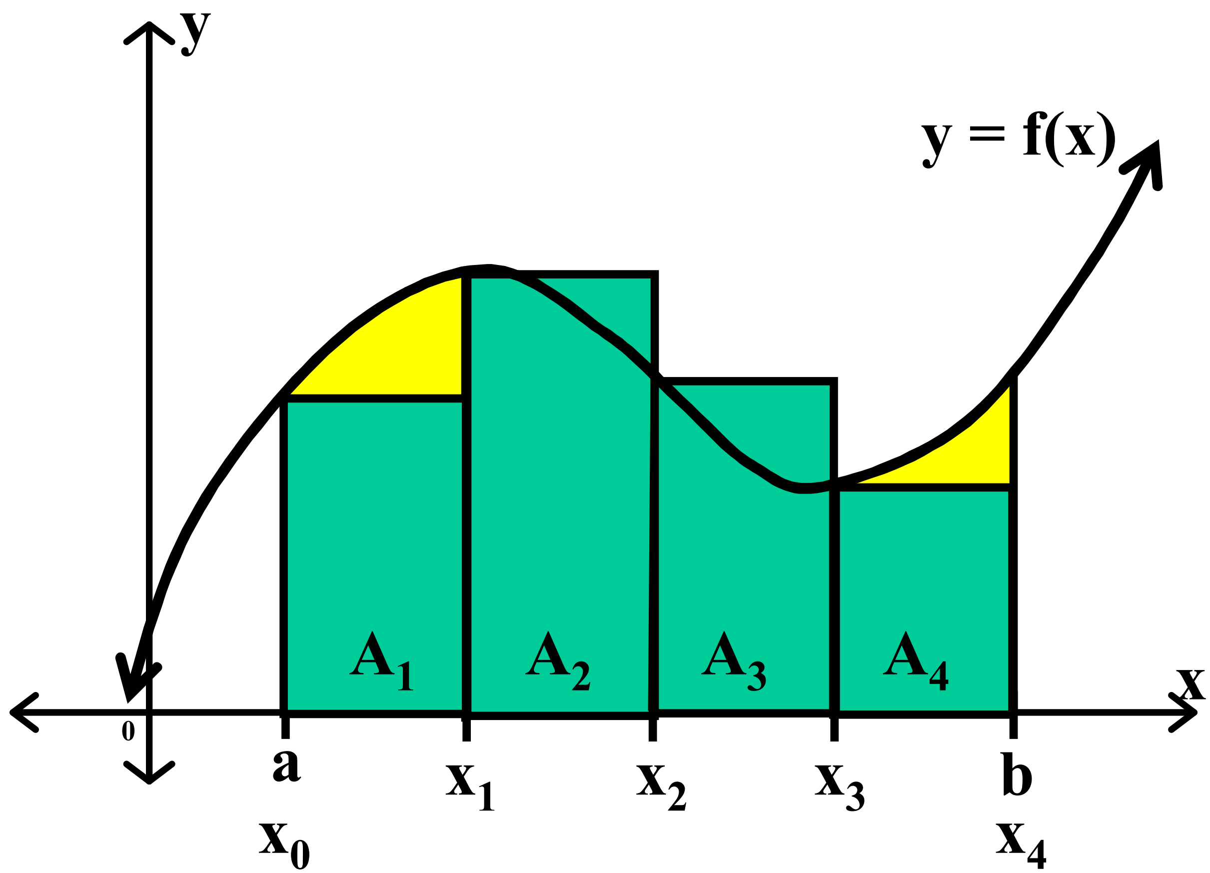
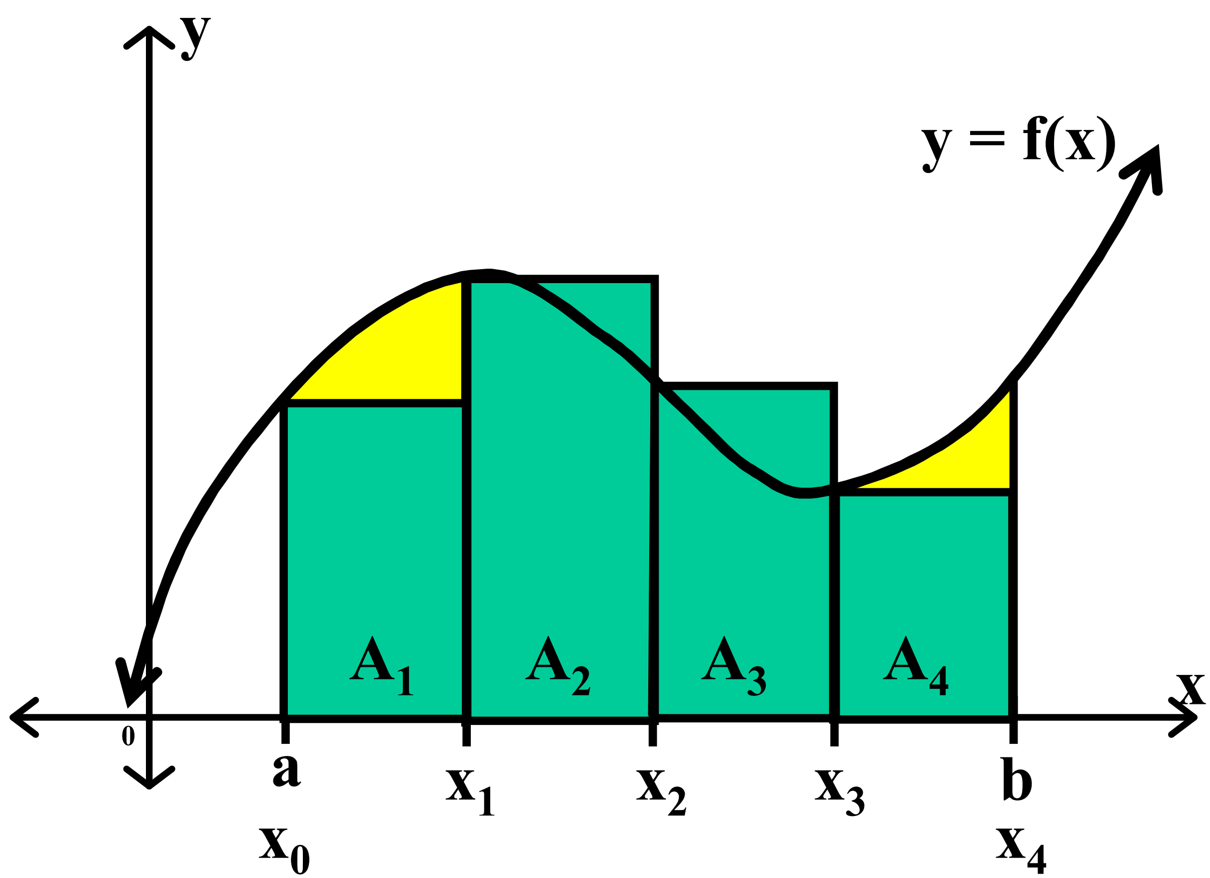


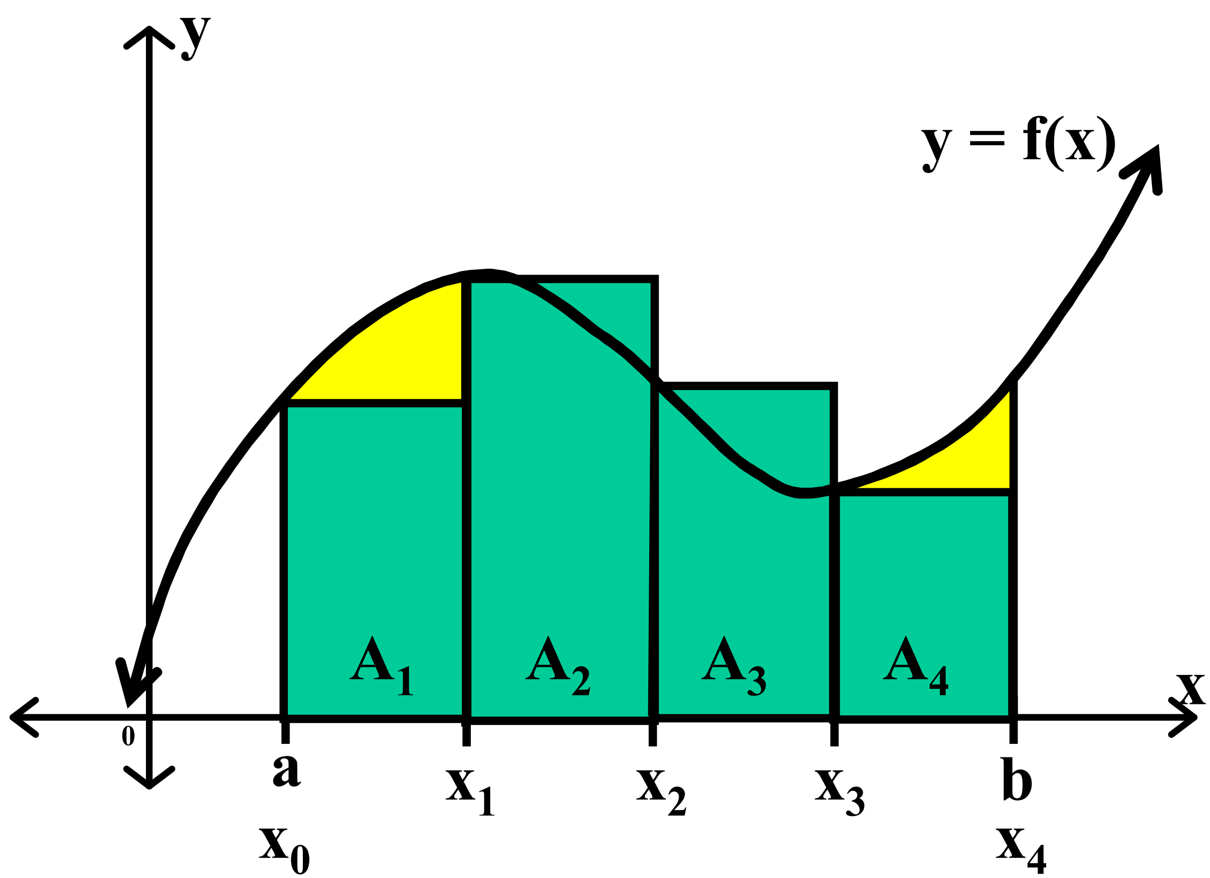
The first of the 'rectangular' approximations uses the length of the left hand side of each strip as the length of the rectangle.



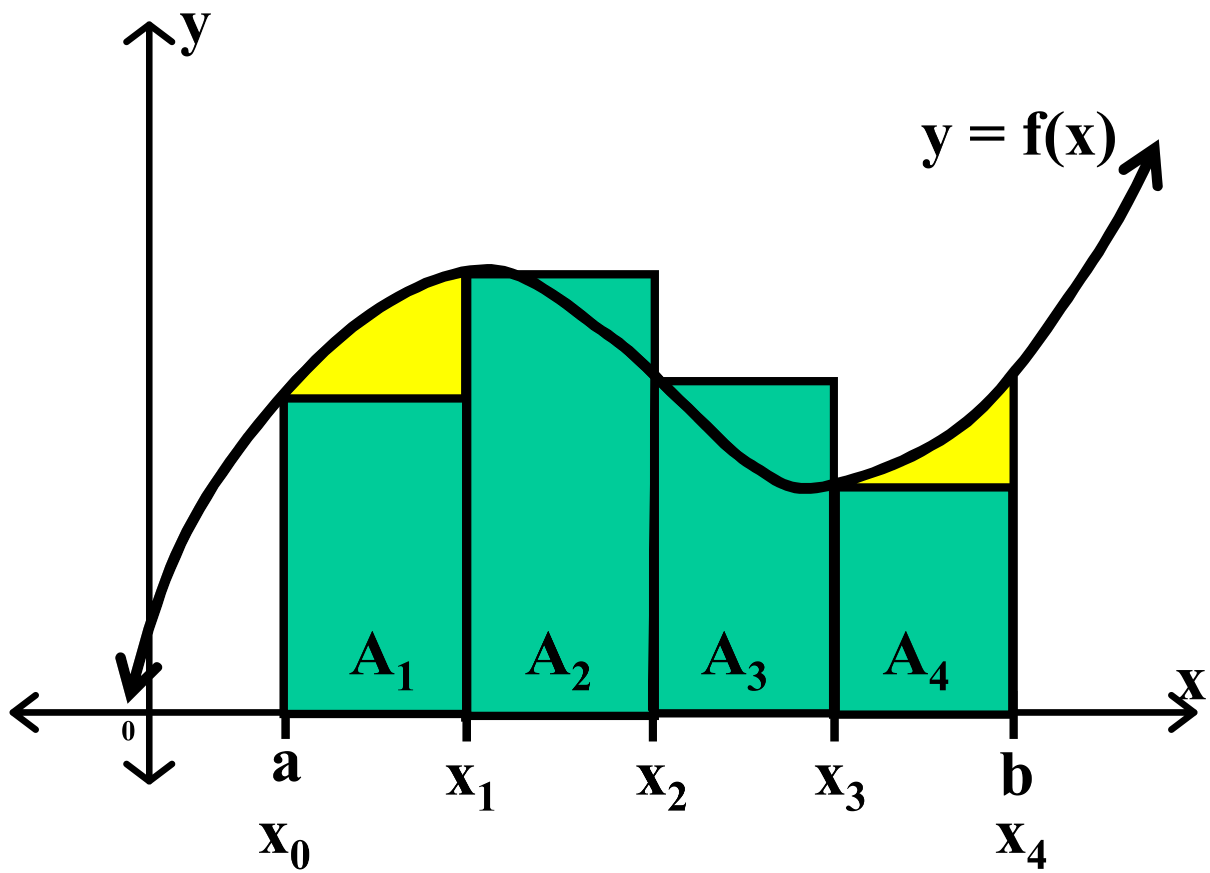
The first of the ‘rectangular’ approximations uses the length of the left hand side of each strip as the length of the rectangle.



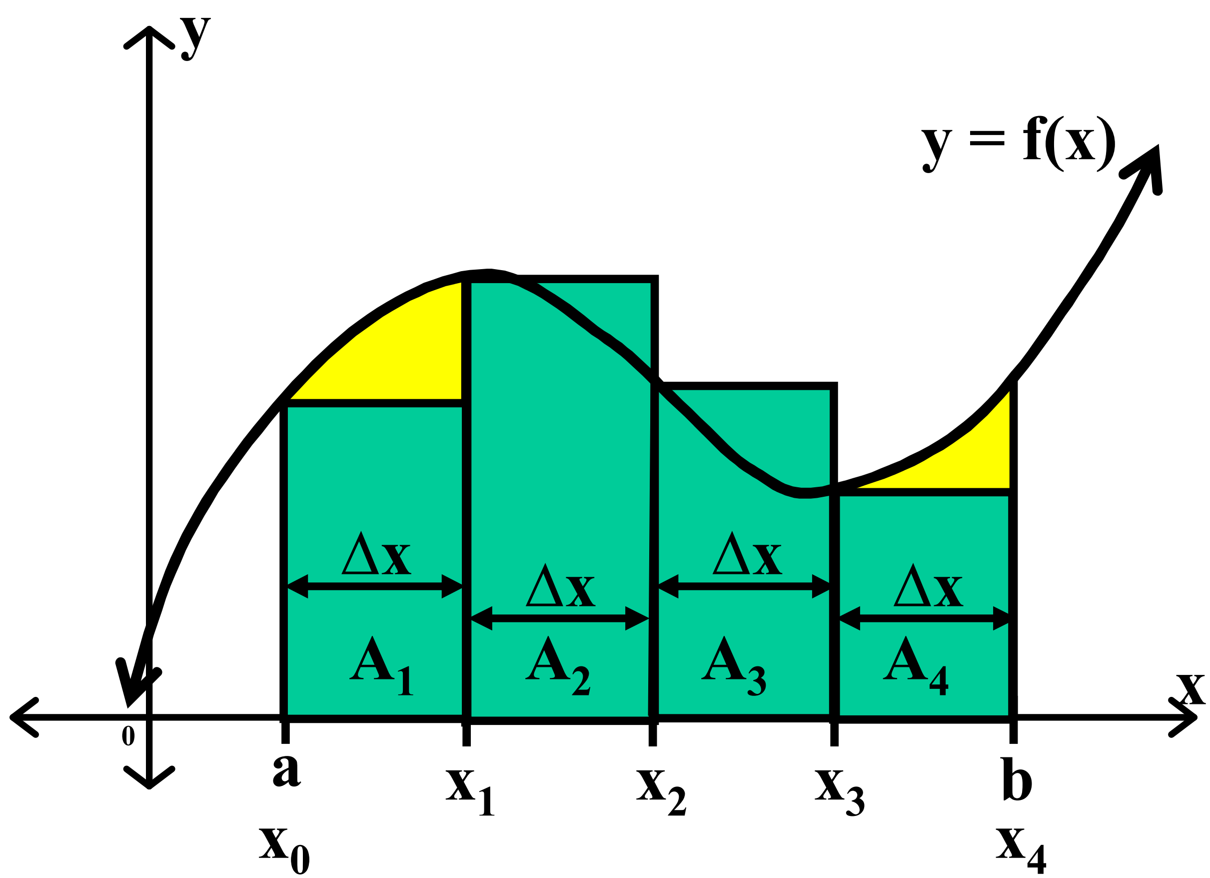
The first of the 'rectangular' approximations uses the length of the left hand side of each strip as the length of the rectangle. This is called the 'left rectangular' approximation.



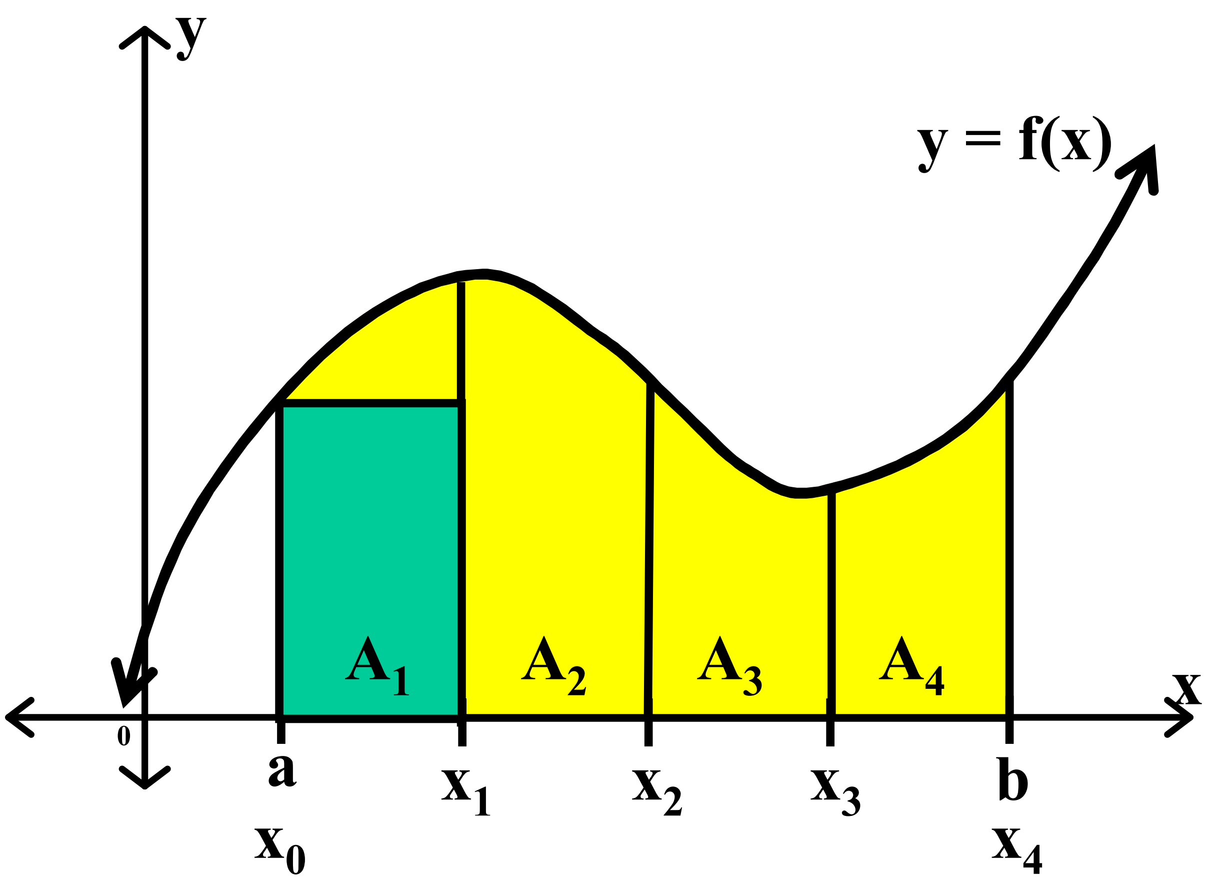
The first of the ‘rectangular’ approximations uses the length of the left hand side of each strip as the length of the rectangle. This is called the ‘left rectangular’ approximation, S_L.



y
y = f(x)
A1
A2
A3
A4
x
0
a
x1
x2
x3
b
x0
x4



The width of each rectangle is Δx.



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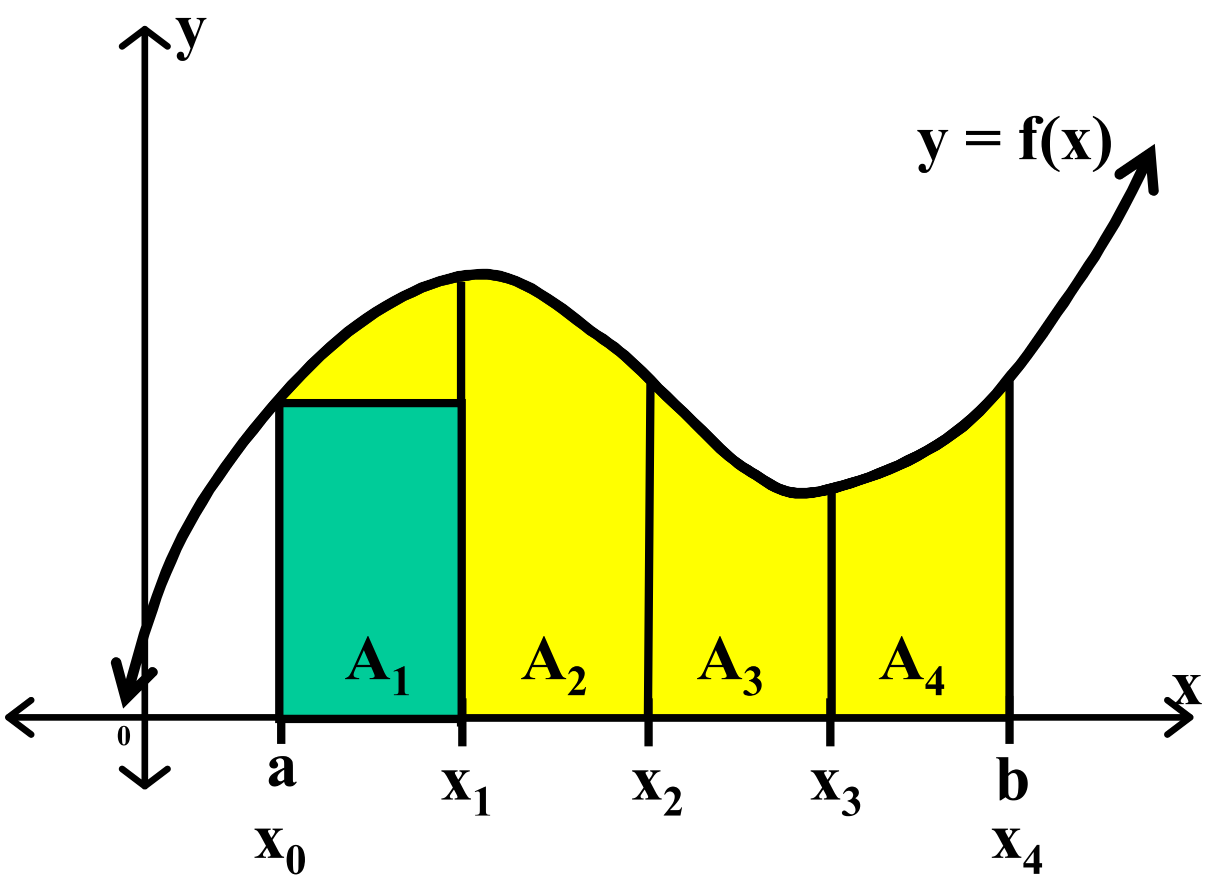
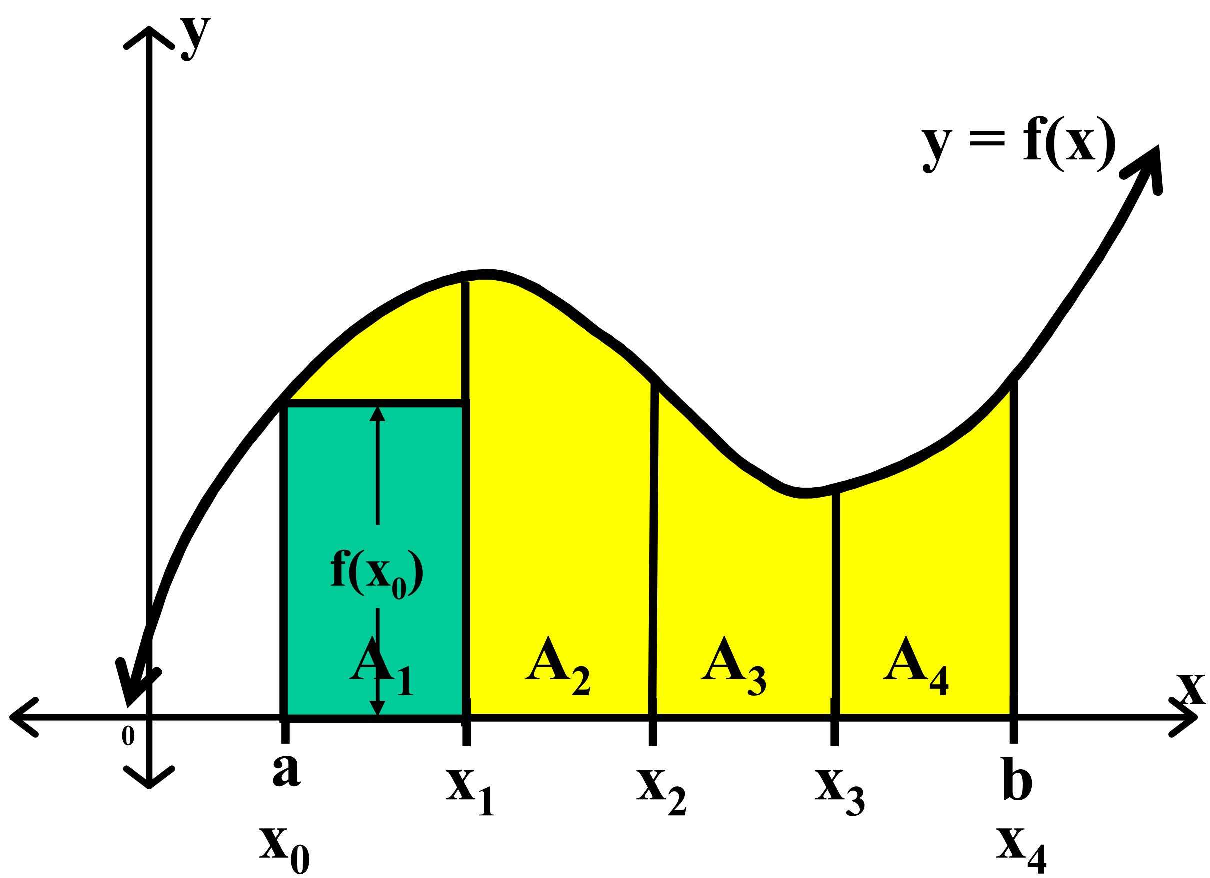


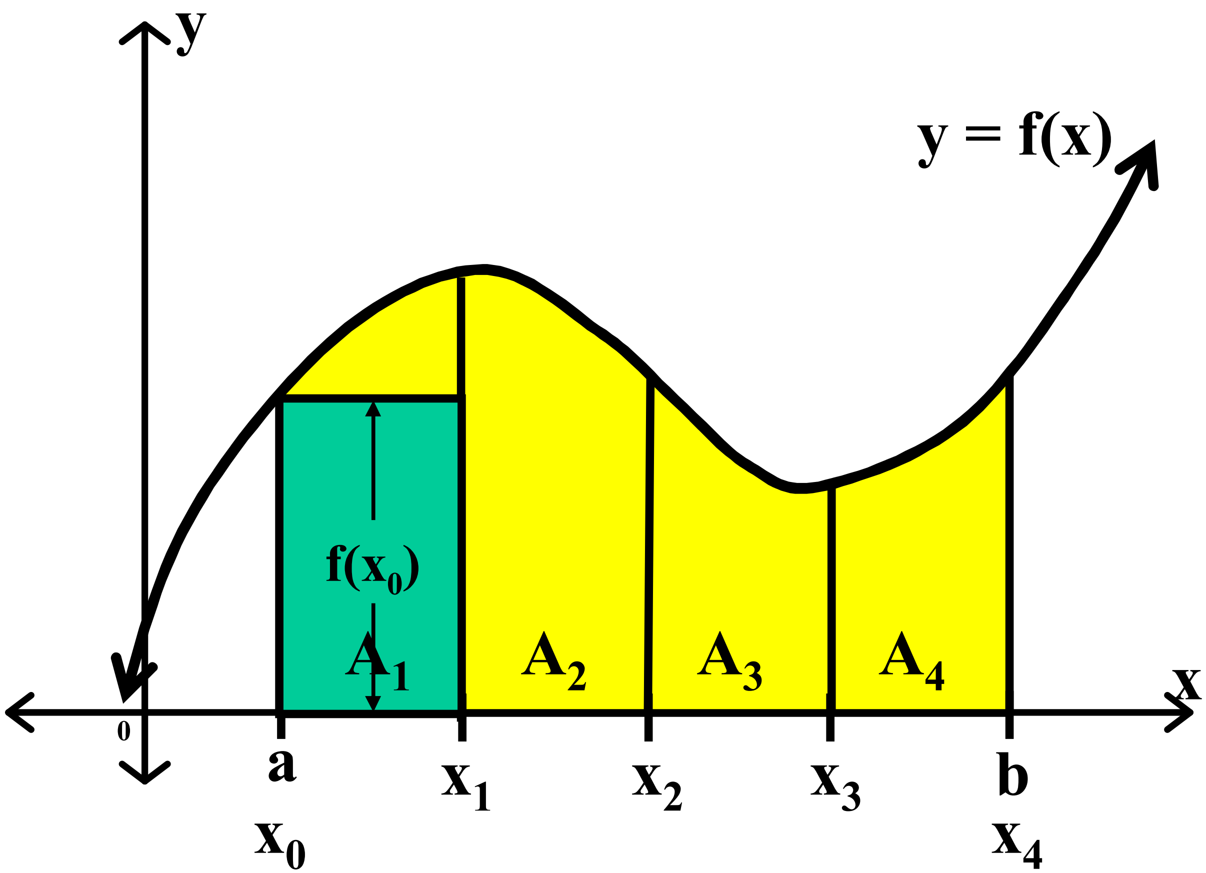
The width of each rectangle is Δx.

$A_1 \approx$



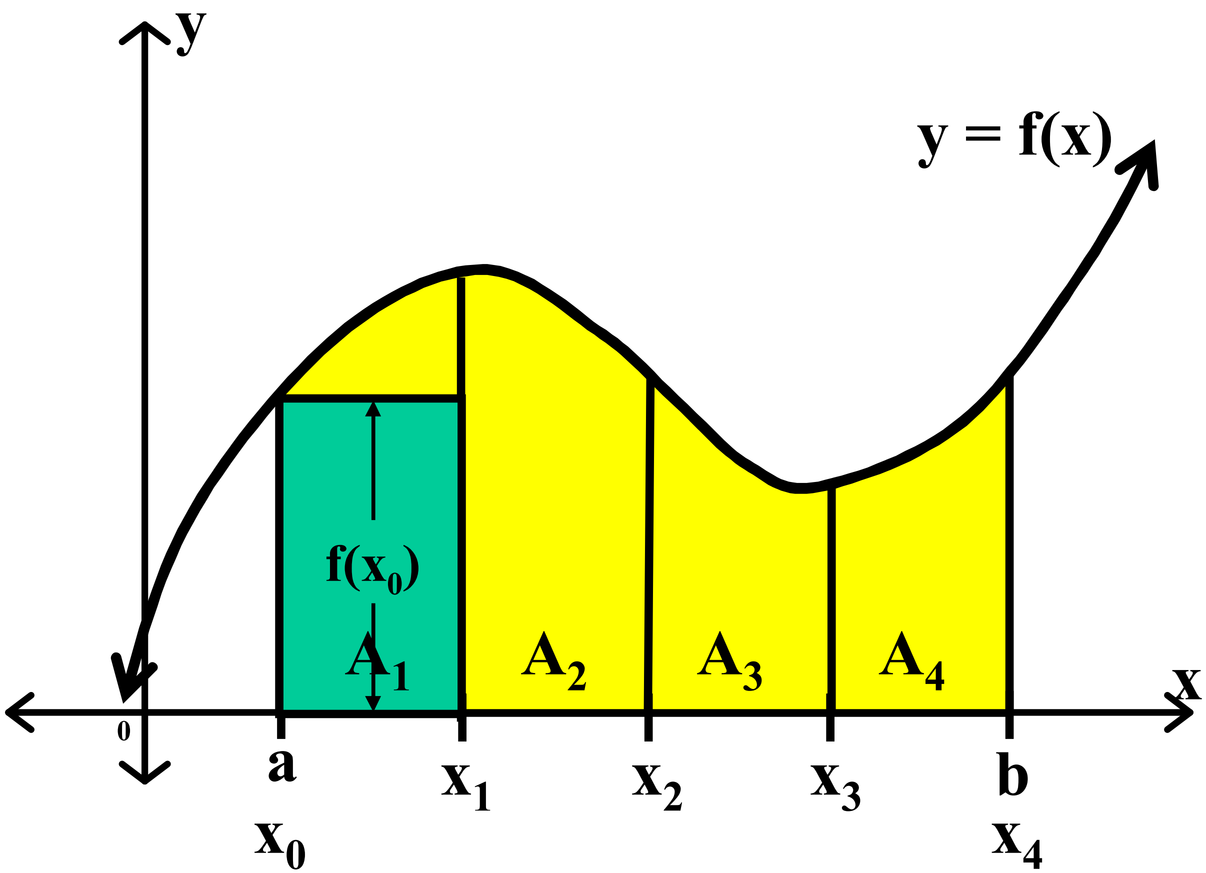
The width of each rectangle is Δx.

$A_1 \approx$



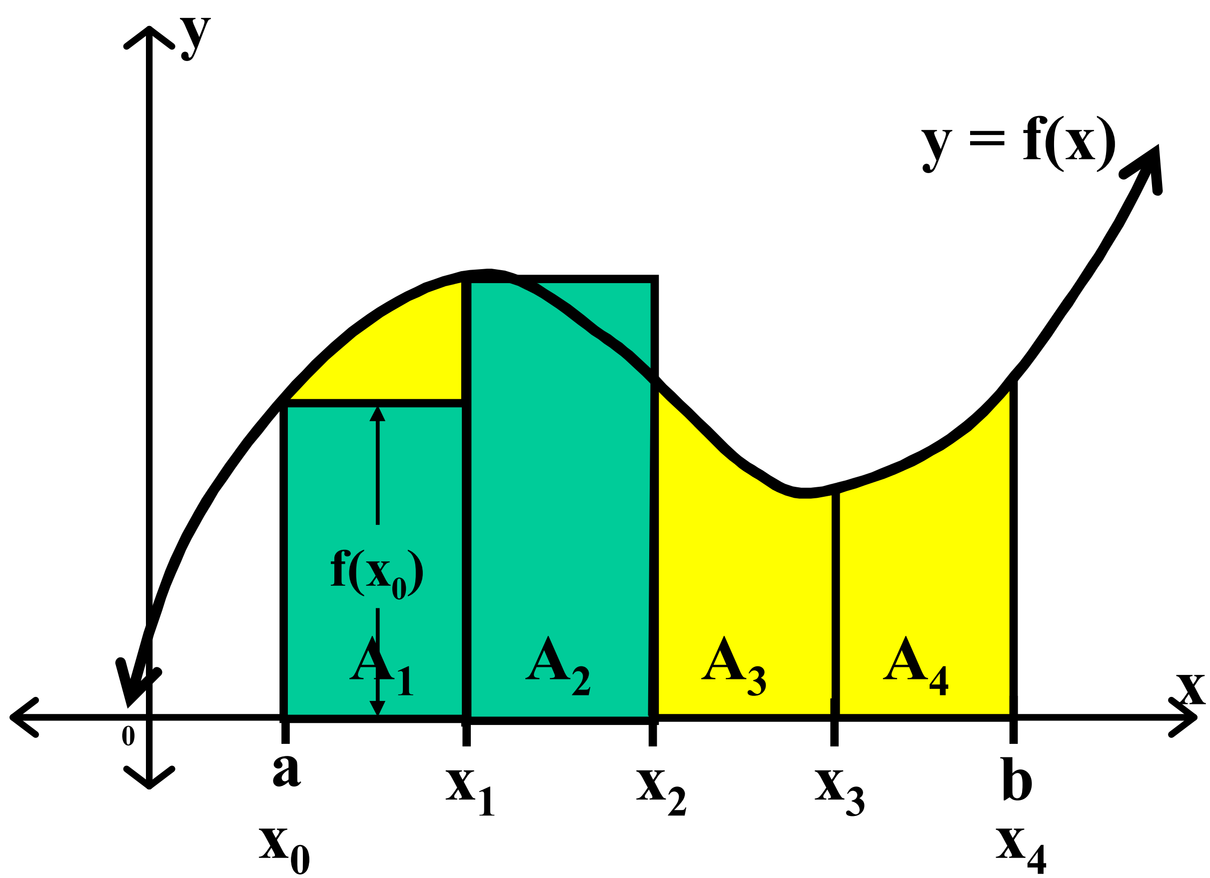
The width of each rectangle is Δx.

$A_1 \approx f(x_0)$



The width of each rectangle is Δx.

$A_1 \approx f(x_0)\Delta x$



The width of each rectangle is Δx.

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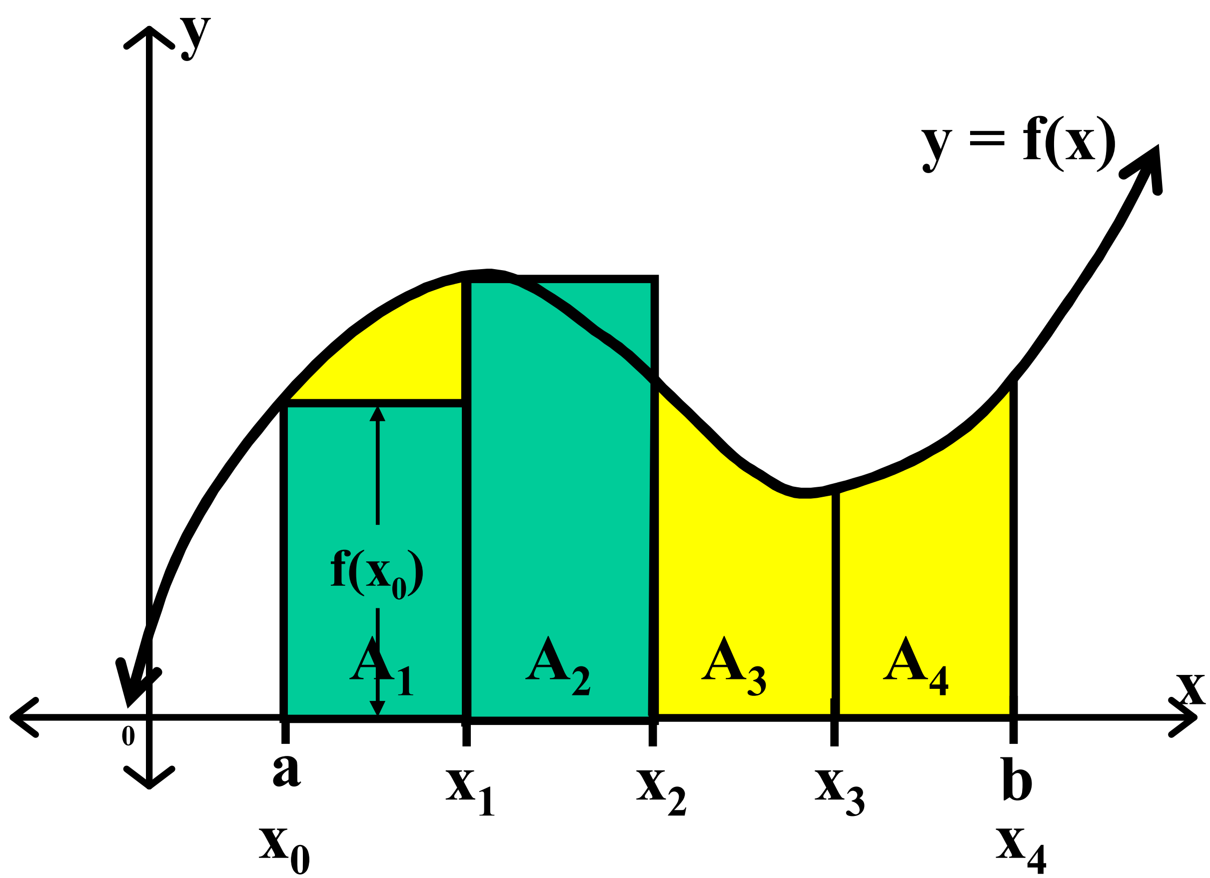
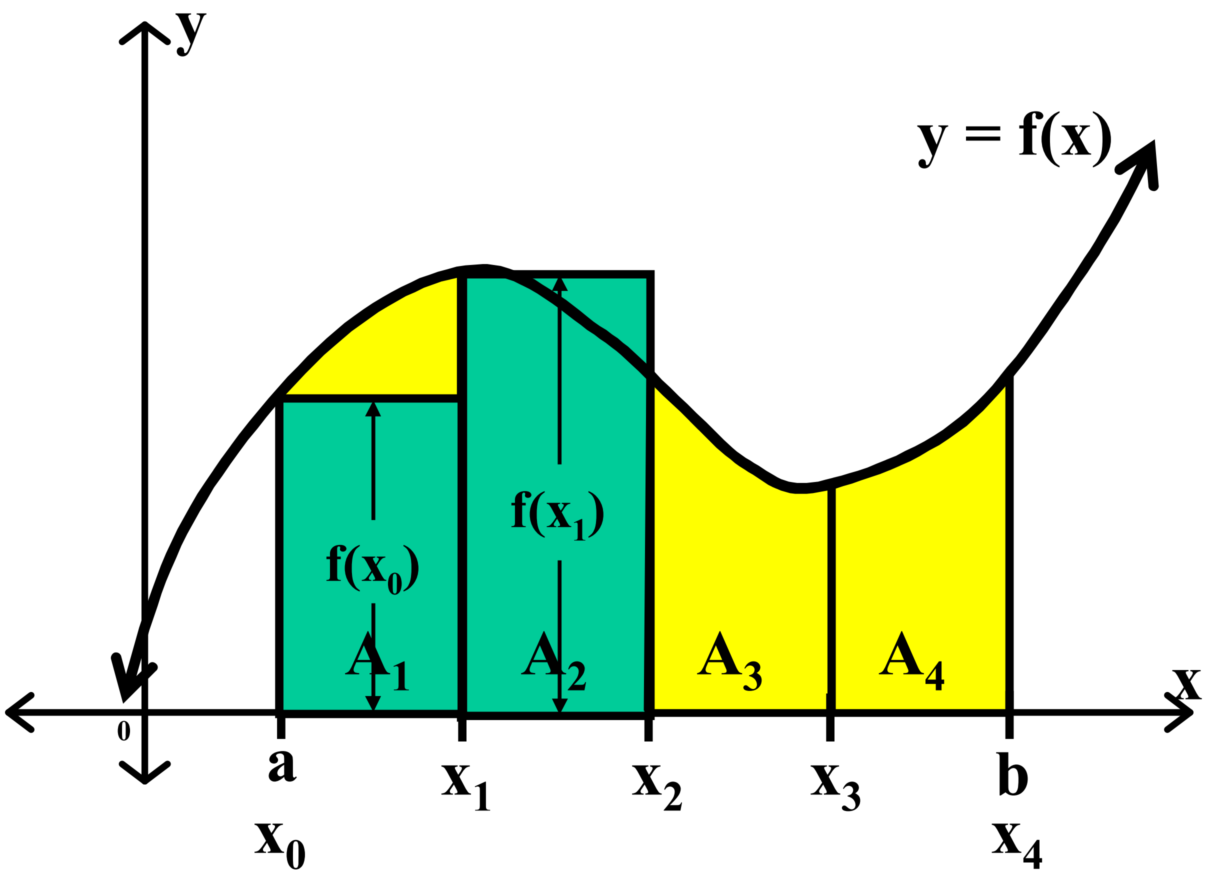


The width of each rectangle is Δx.

$A_1 \approx f(x_0)\Delta x$ $\quad$ $A_2 \approx$



The width of each rectangle is Δx.

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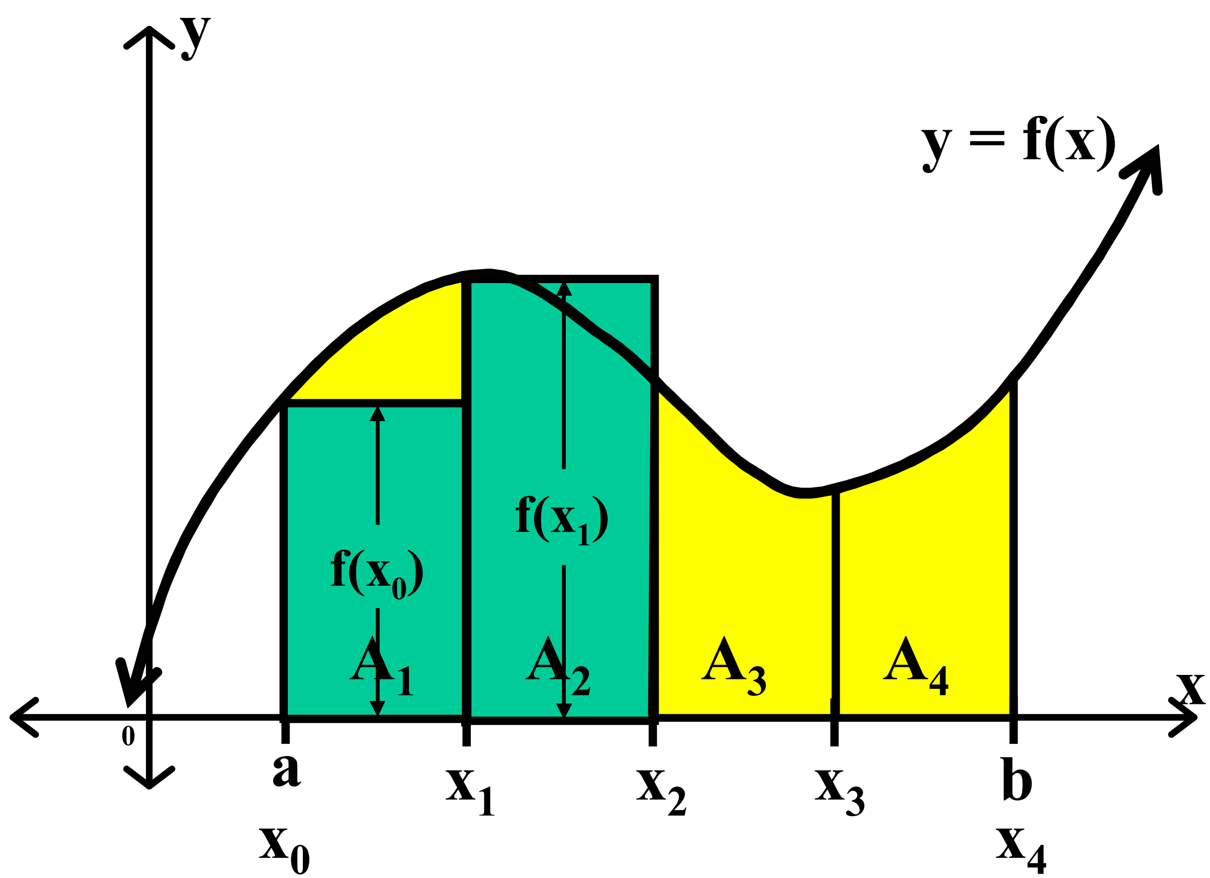
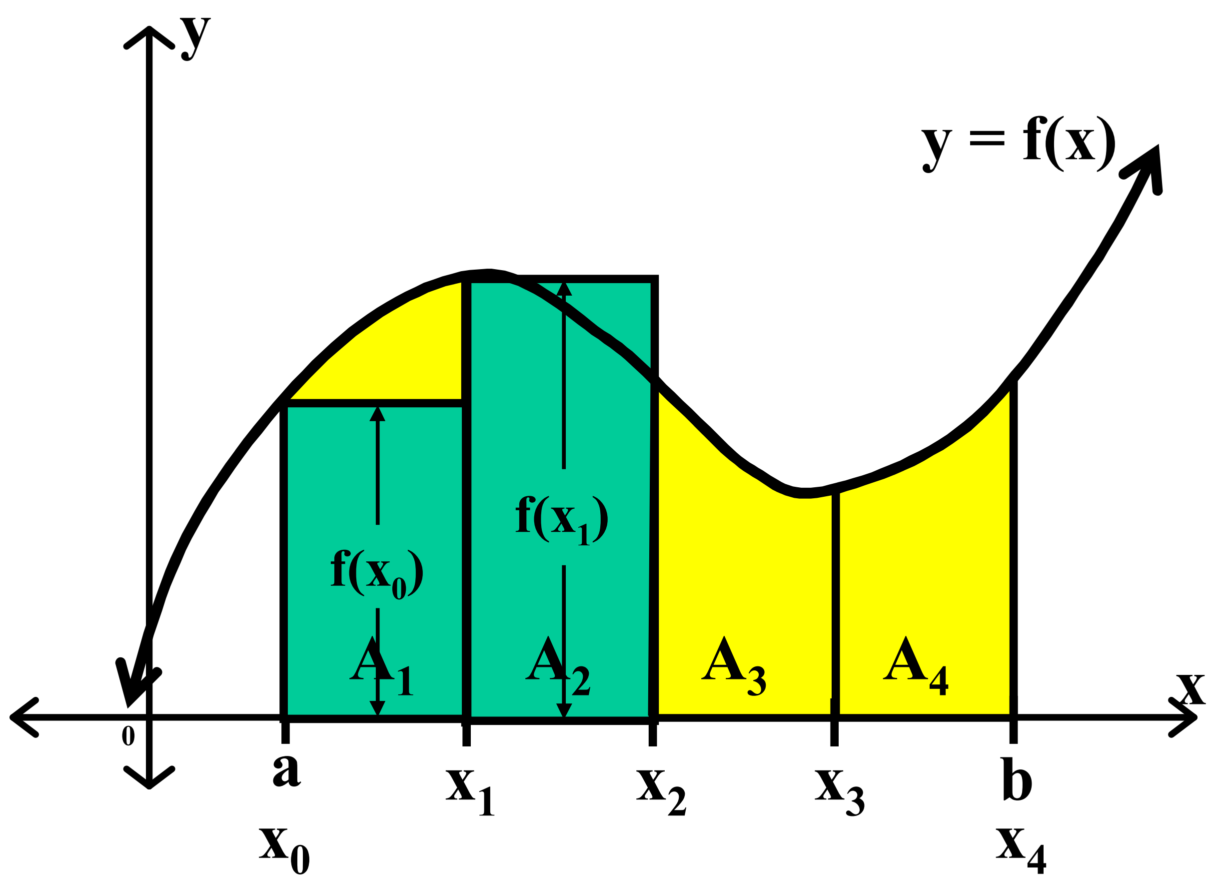


The width of each rectangle is Δx.

$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)$



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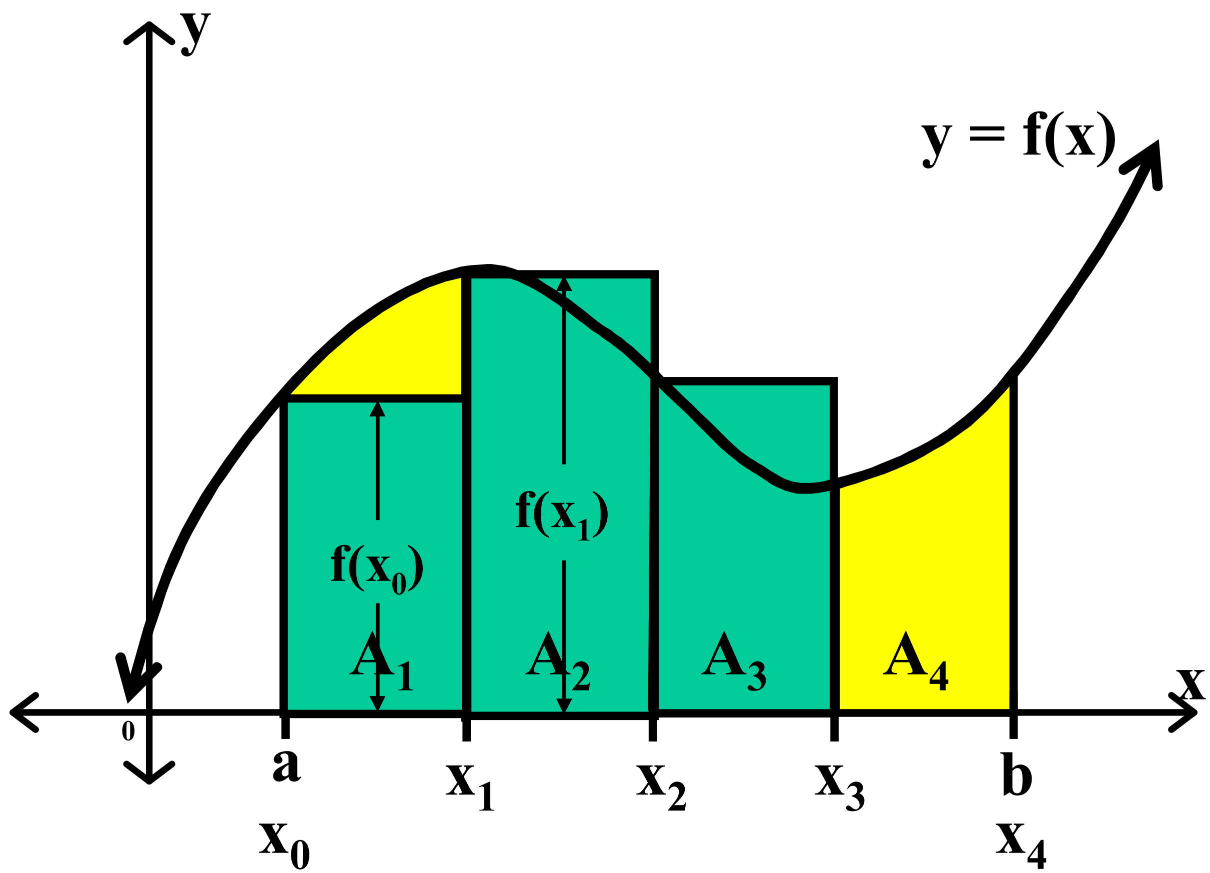

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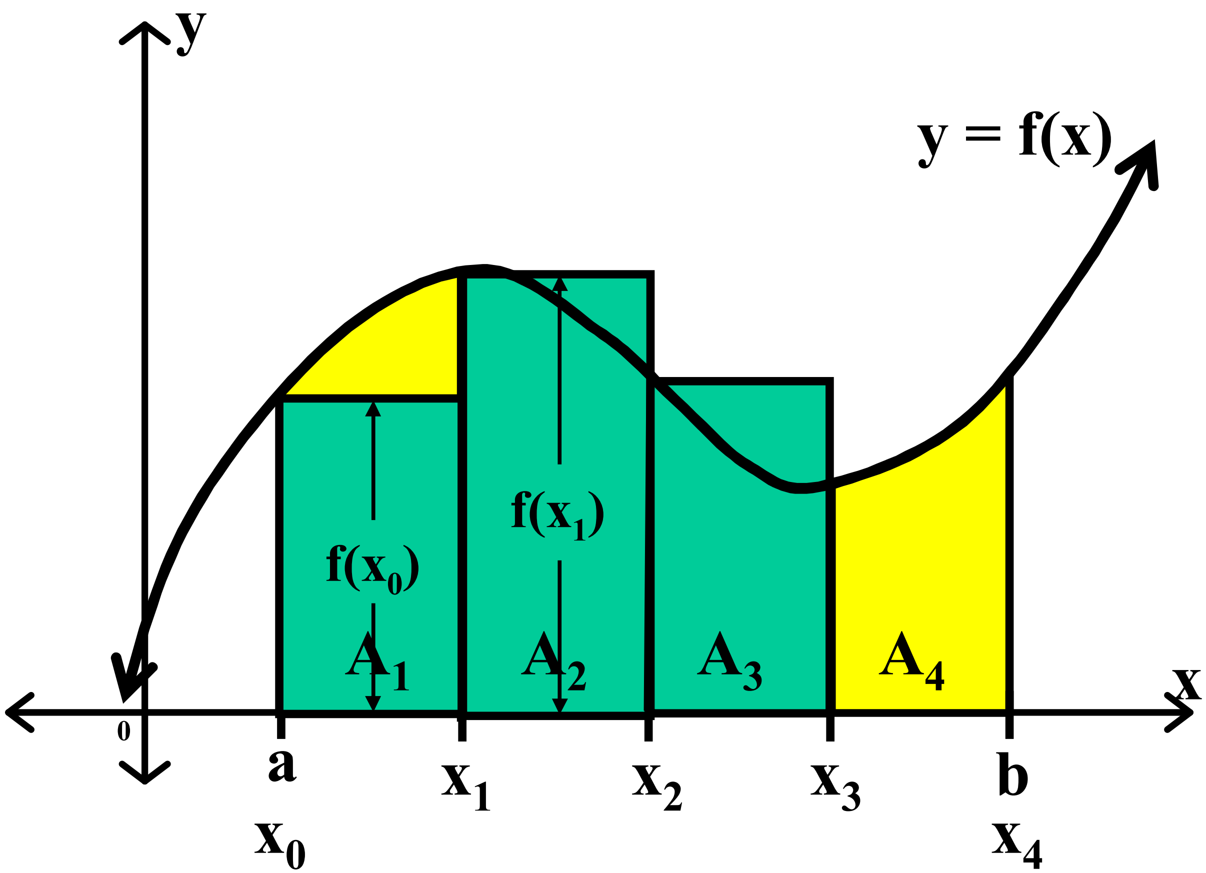
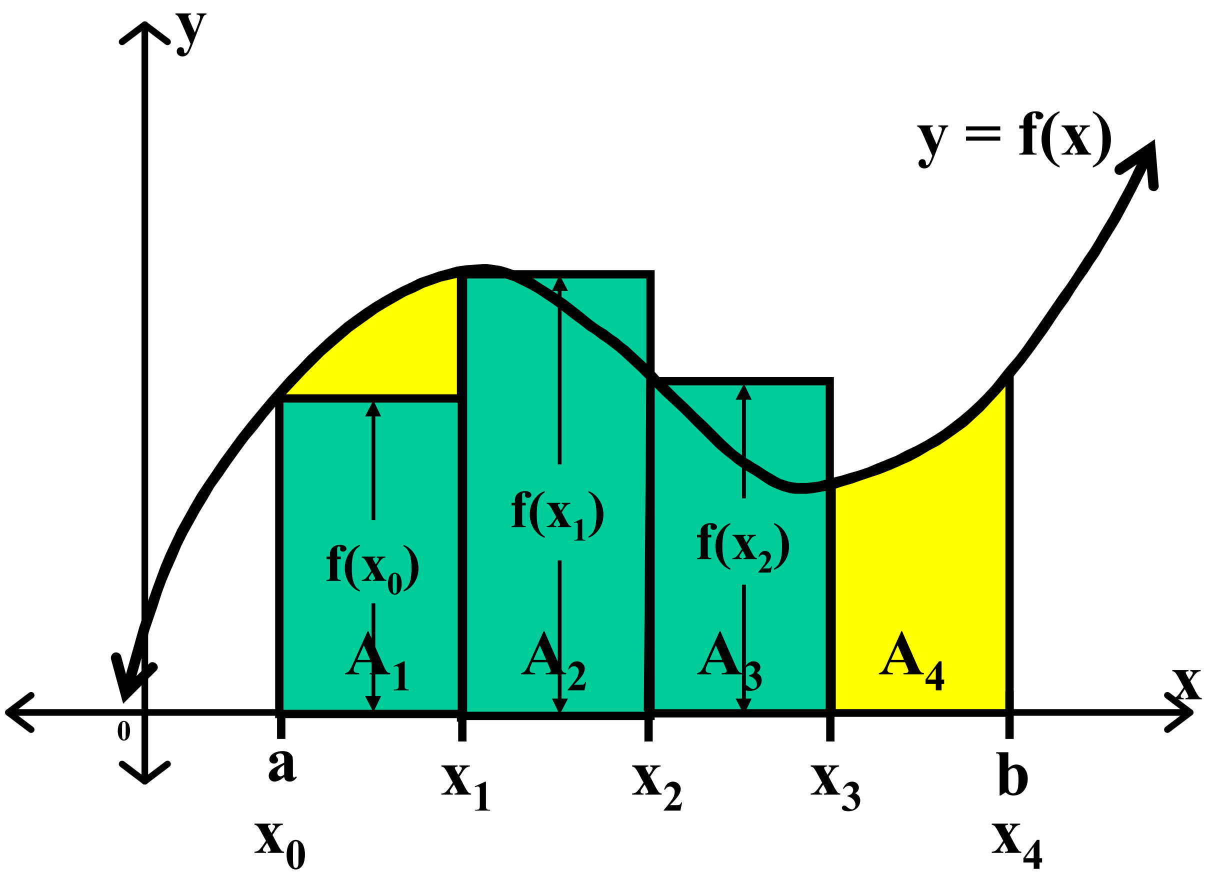


The width of each rectangle is Δx.

$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)\Delta x \quad A_3 \approx$



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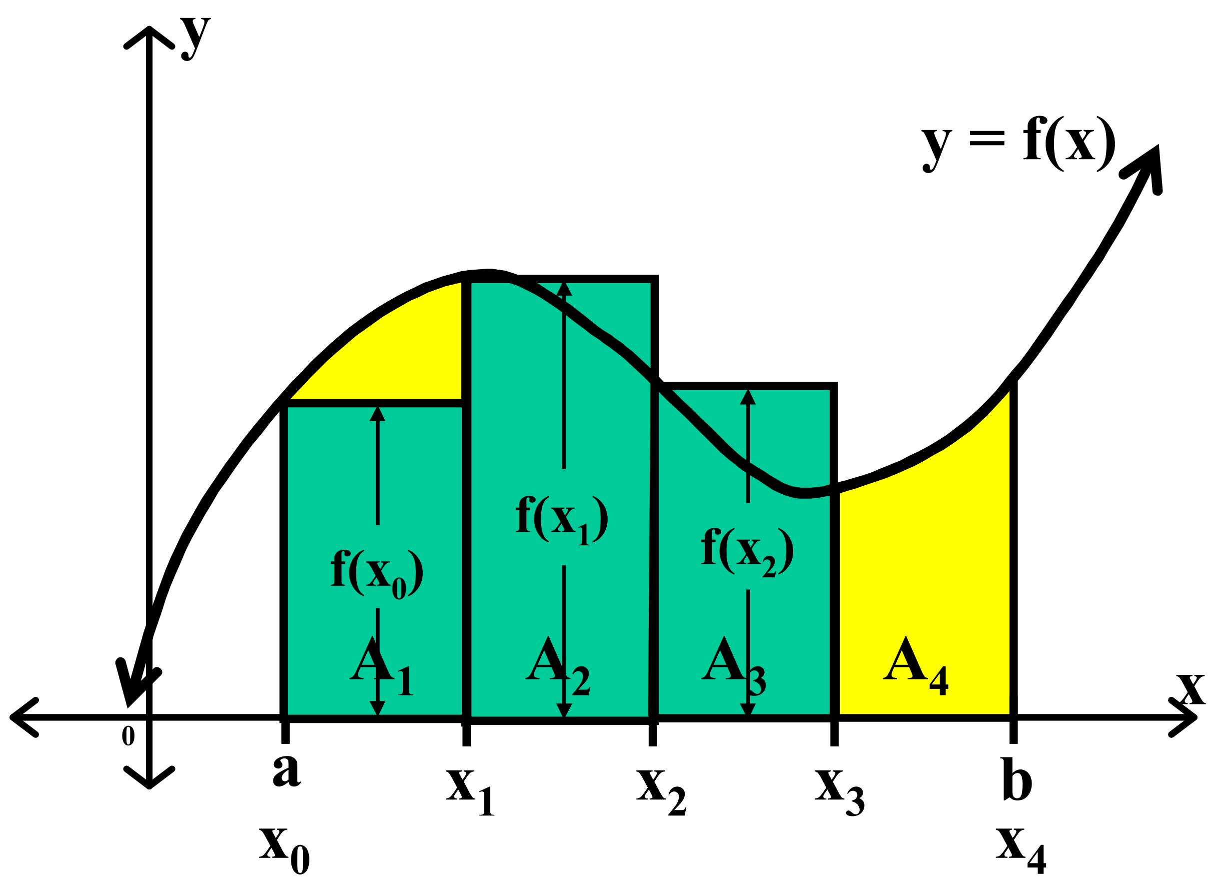

The width of each rectangle is Δx.

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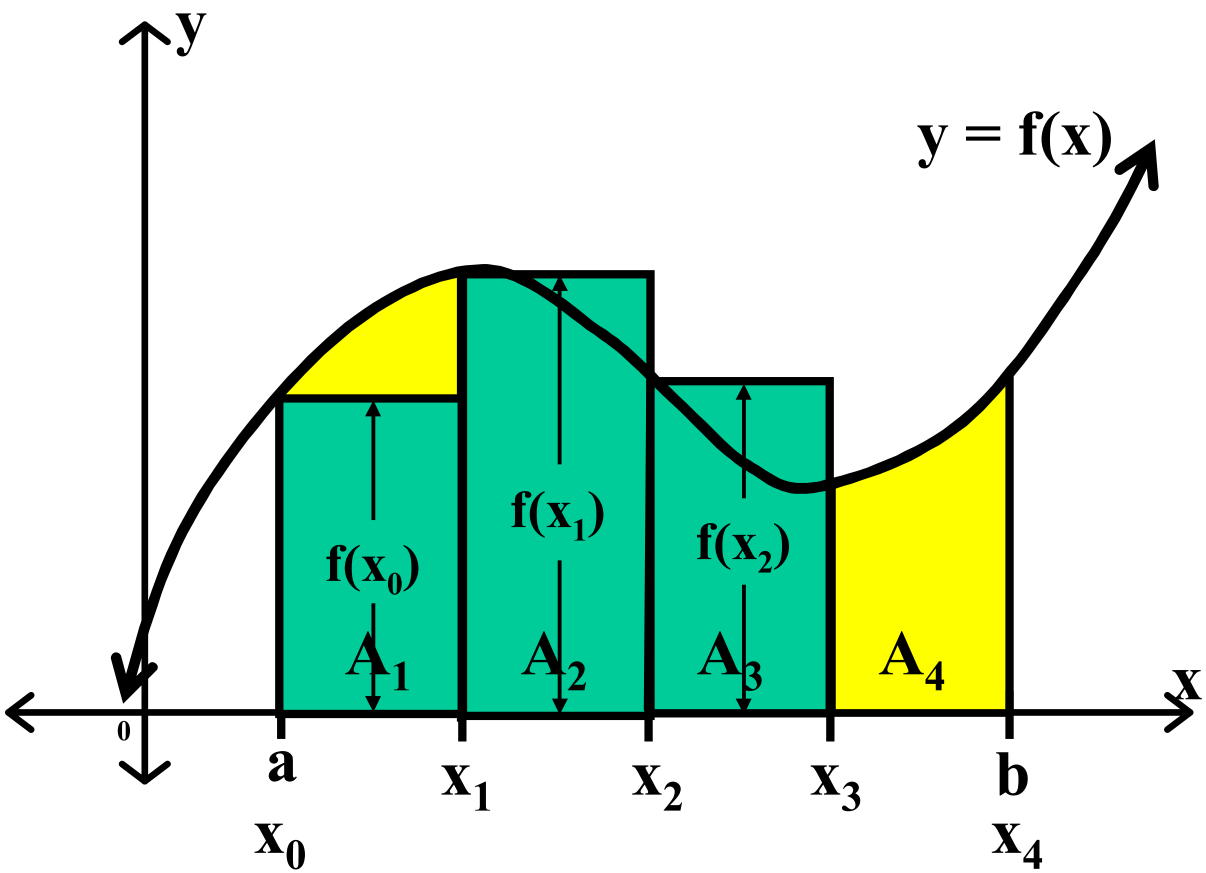

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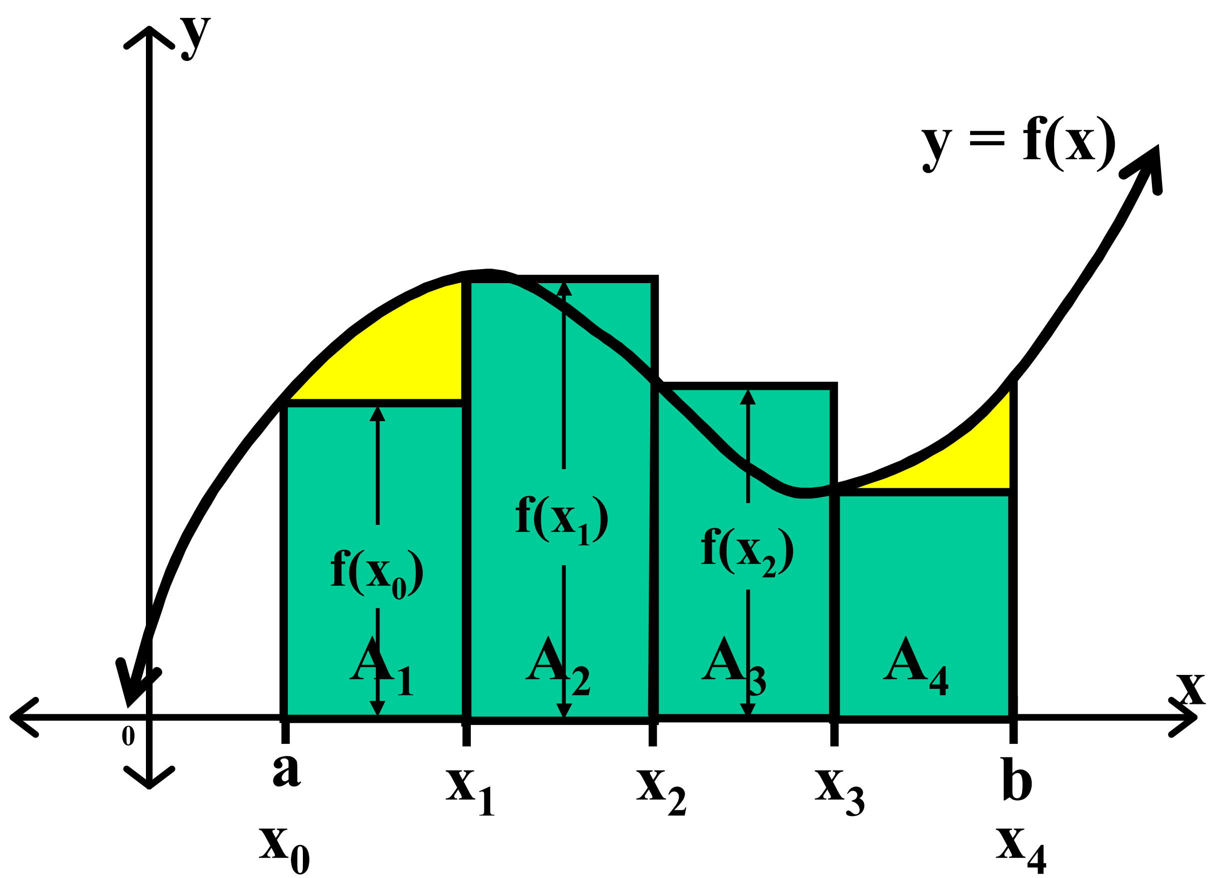

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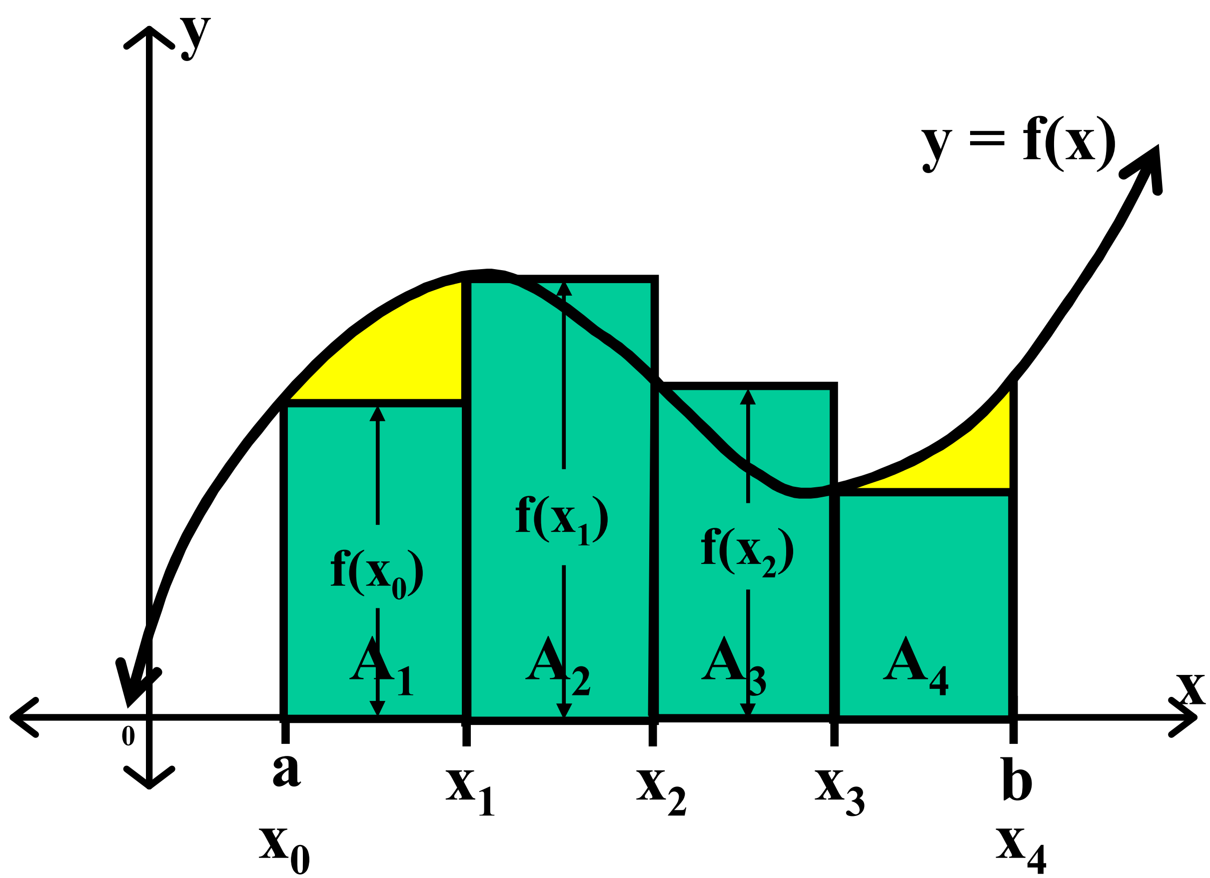
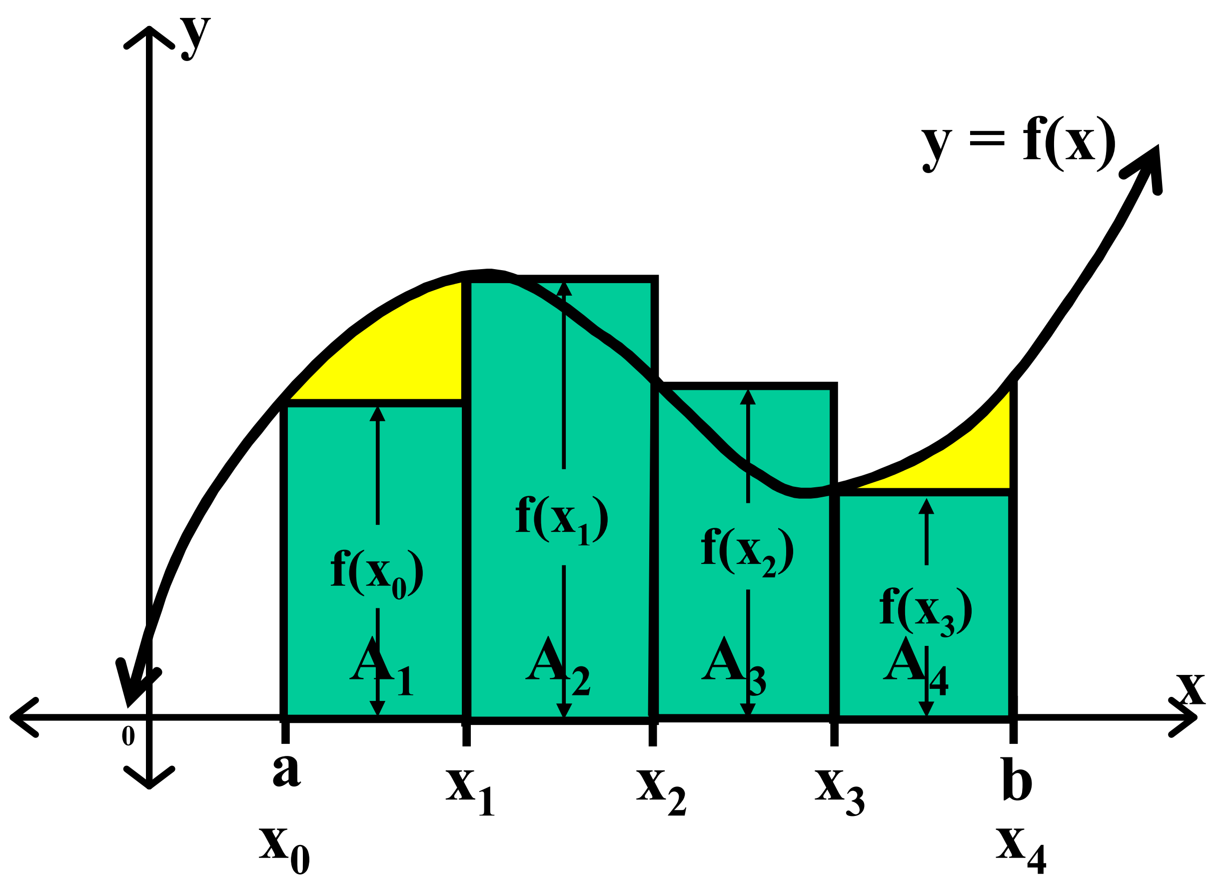


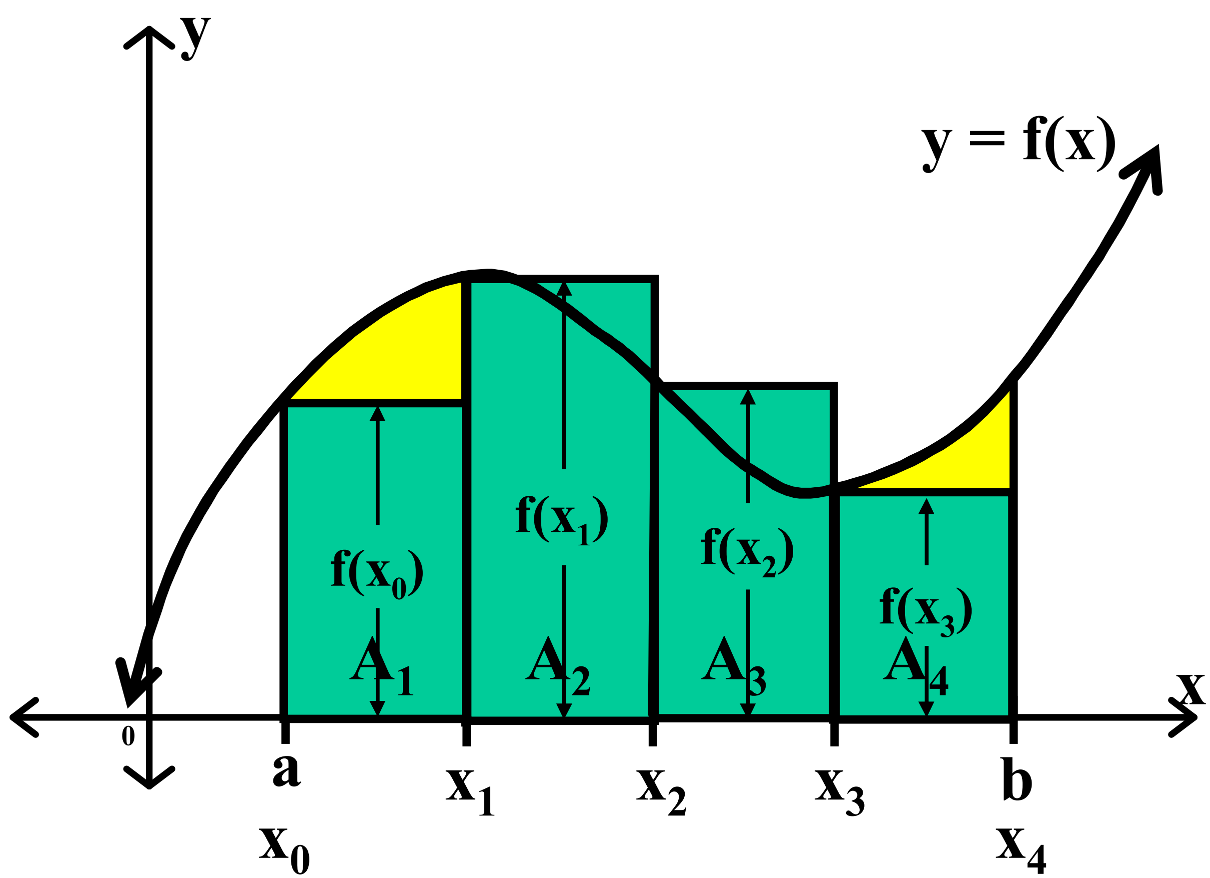
The width of each rectangle is Δx.

$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)\Delta x \quad A_3 \approx f(x_2)\Delta x \quad A_4 \approx$



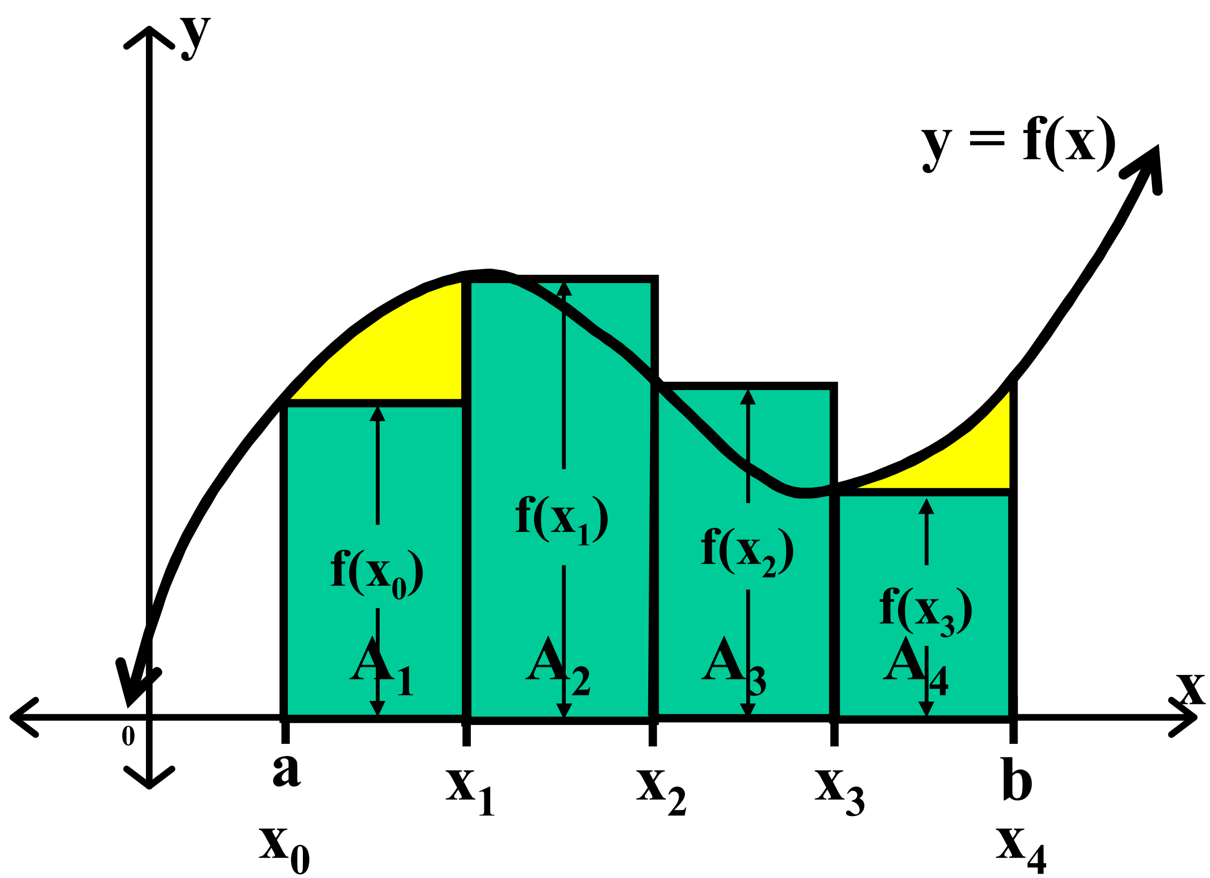
The width of each rectangle is Δx.

$A_1 \approx f(x_0)\Delta x$ $A_2 \approx f(x_1)\Delta x$ $A_3 \approx f(x_2)\Delta x$ $A_4 \approx$



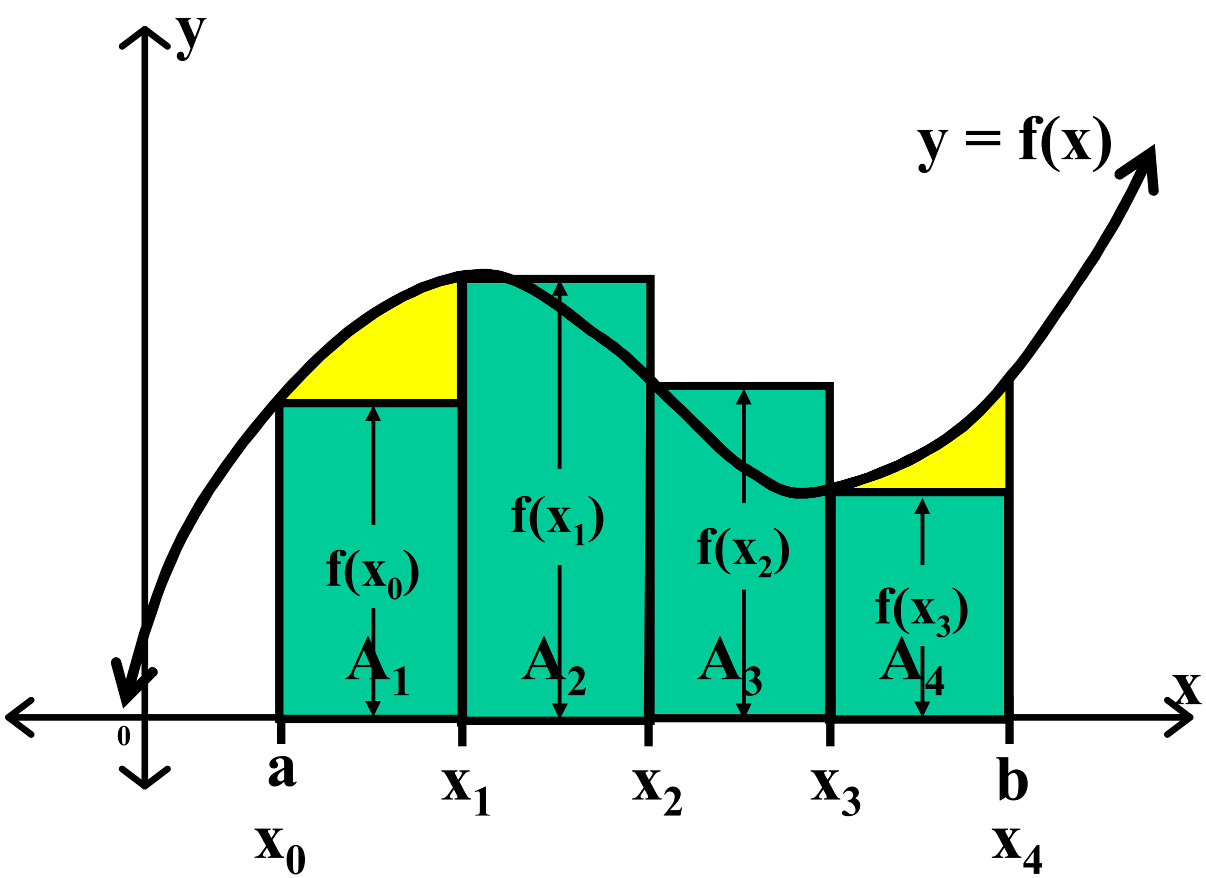
The width of each rectangle is Δx.

$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)\Delta x \quad A_3 \approx f(x_2)\Delta x \quad A_4 \approx f(x_3)$

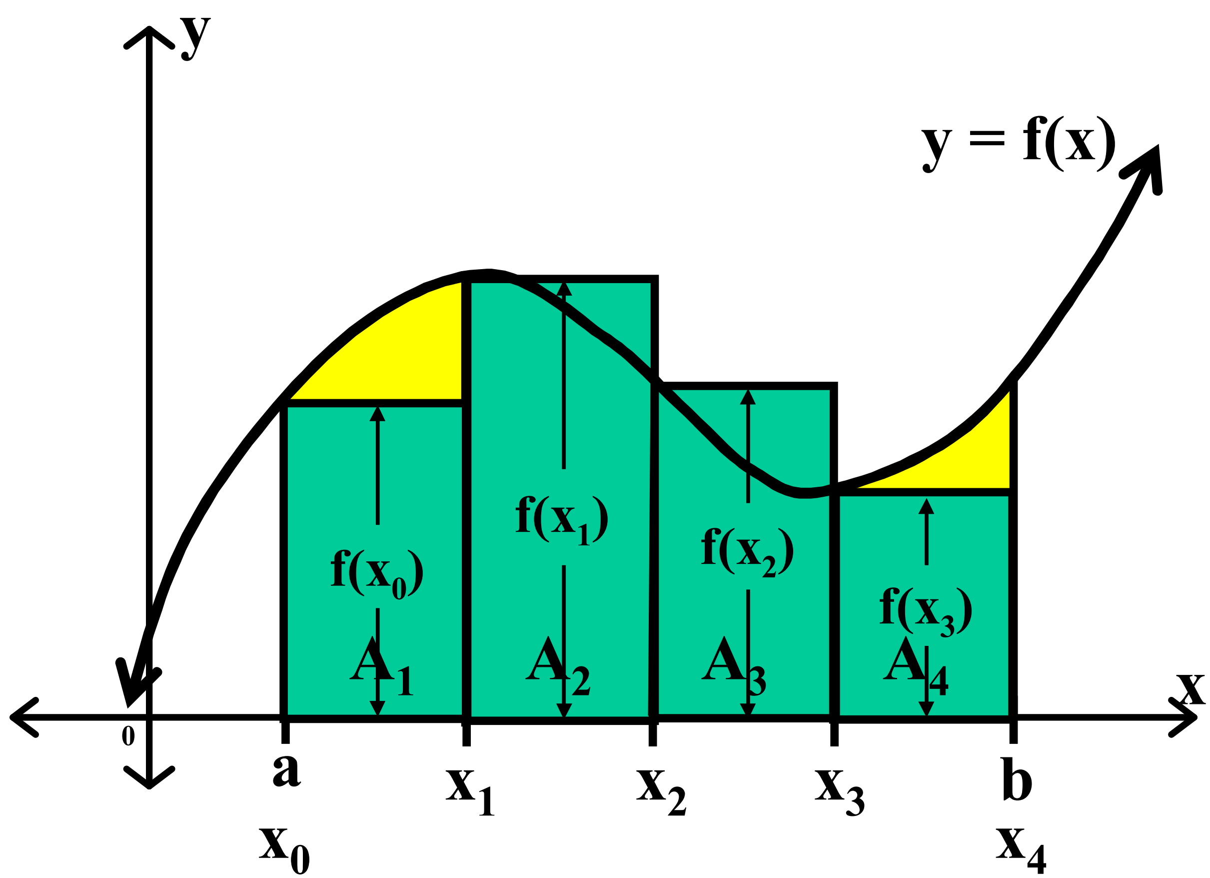


The width of each rectangle is Δx.

$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)\Delta x \quad A_3 \approx f(x_2)\Delta x \quad A_4 \approx f(x_3)\Delta x$

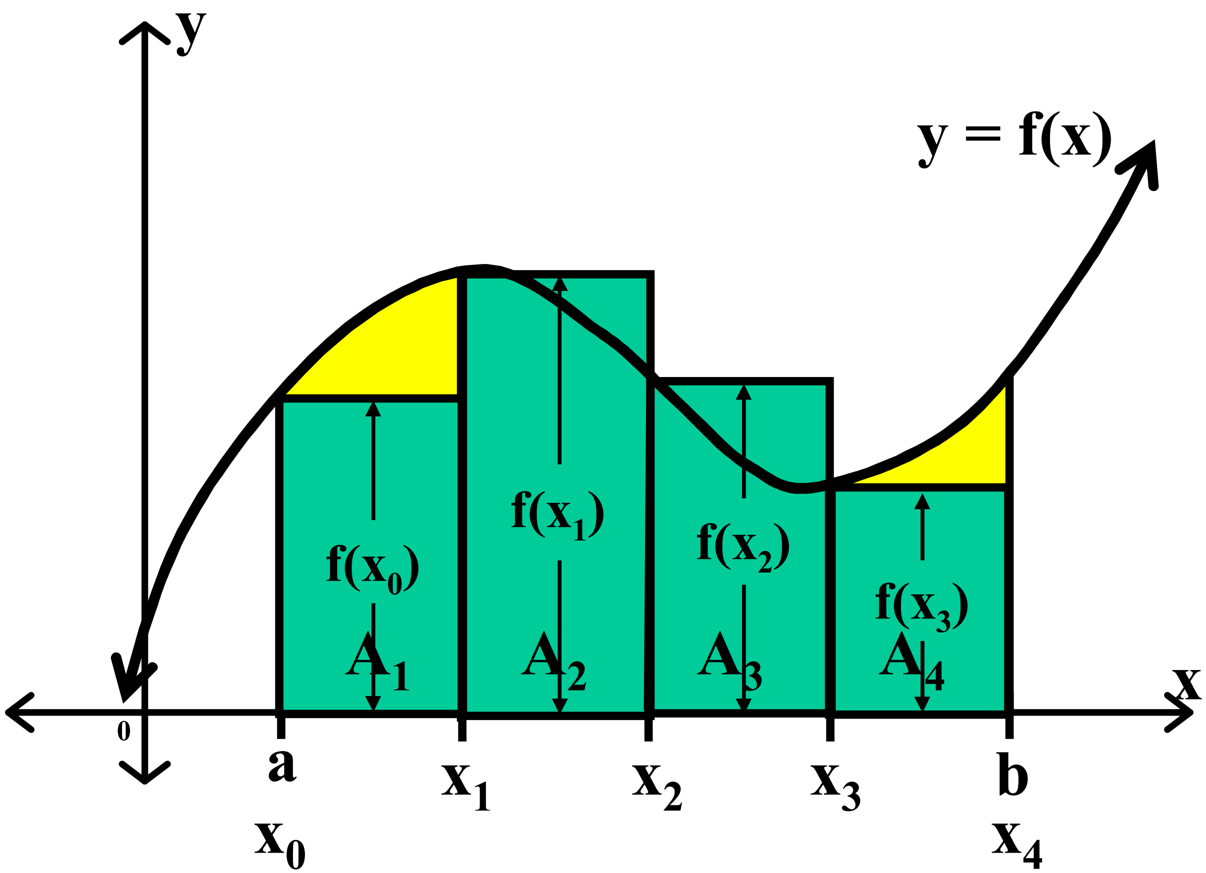


$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)\Delta x \quad A_3 \approx f(x_2)\Delta x \quad A_4 \approx f(x_3)\Delta x$



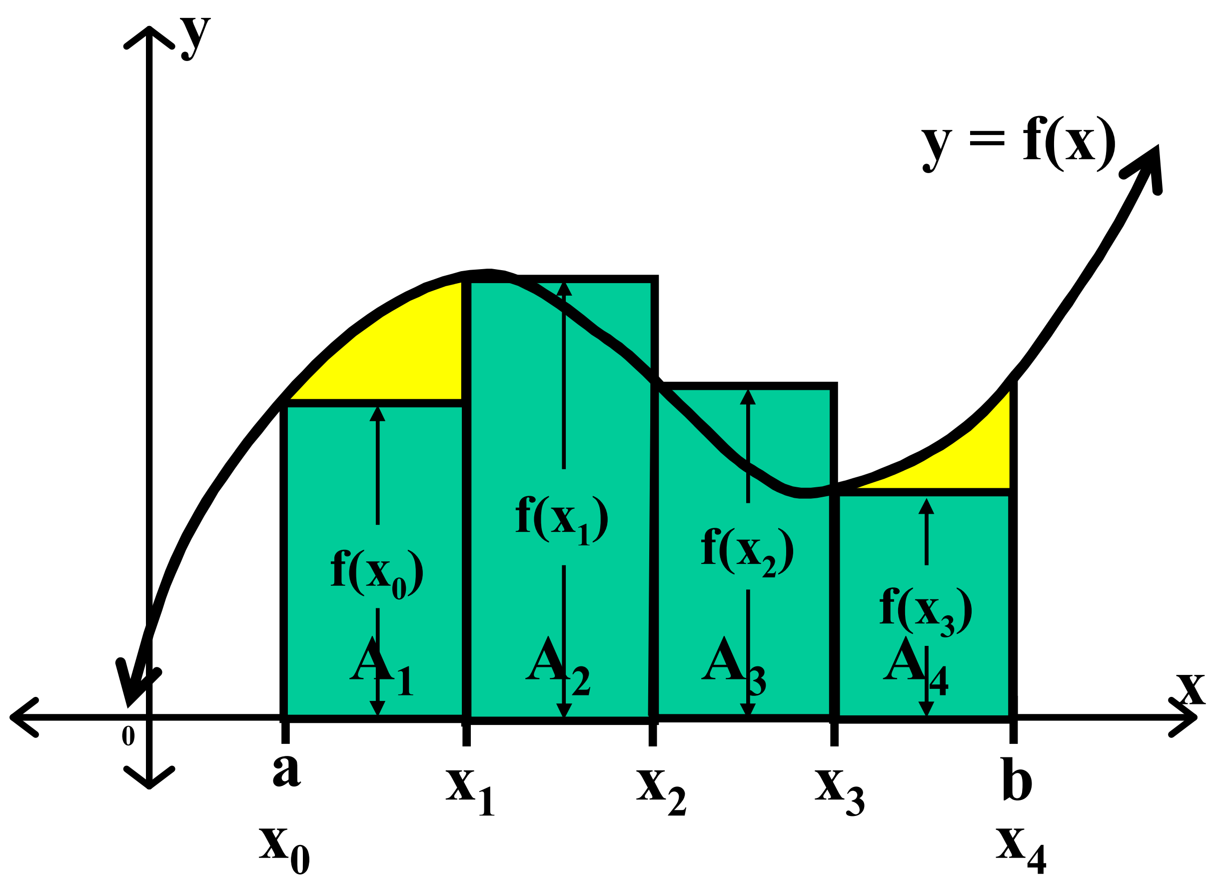
$$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)\Delta x \quad A_3 \approx f(x_2)\Delta x \quad A_4 \approx f(x_3)\Delta x$$

Notice that, in general, A_i



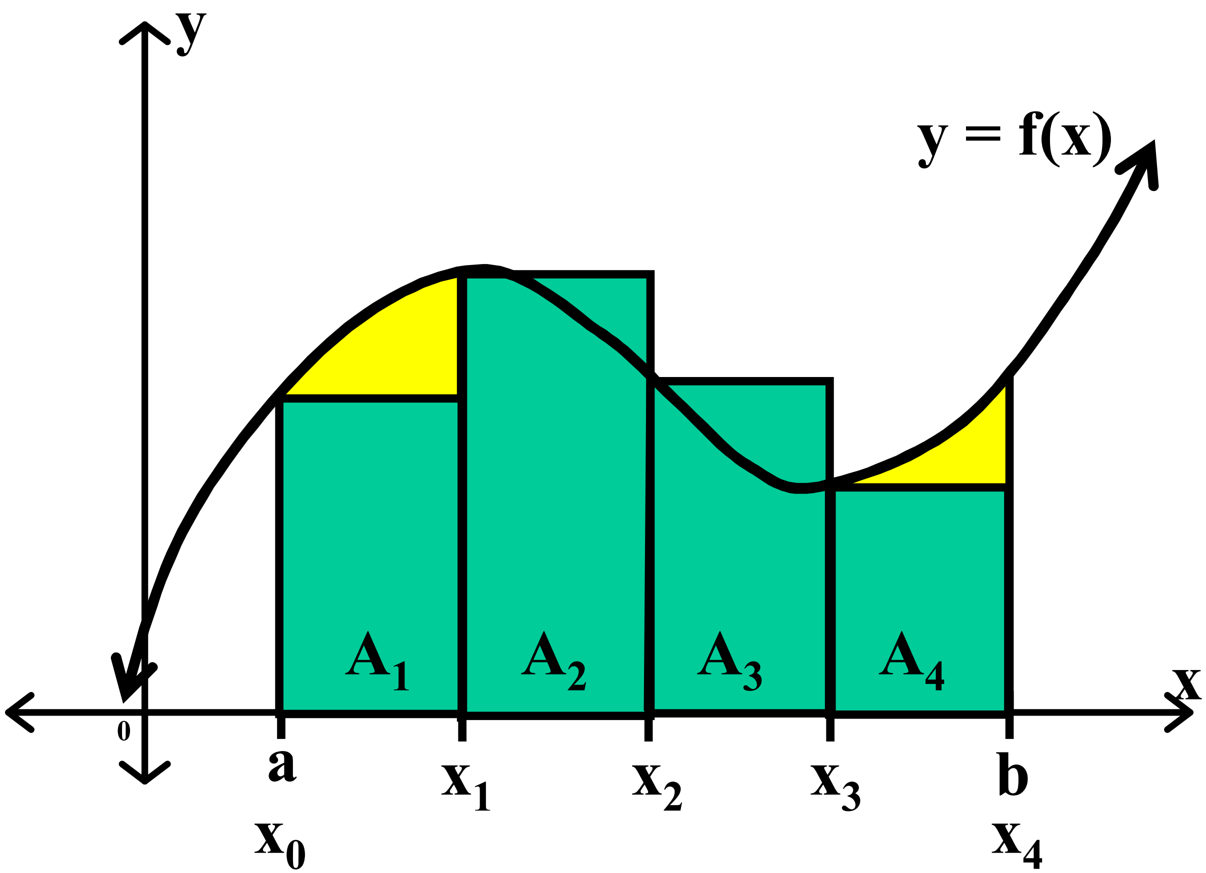
$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)\Delta x \quad A_3 \approx f(x_2)\Delta x \quad A_4 \approx f(x_3)\Delta x$

Notice that, in general, $A_i \approx f(x_{i-1})$

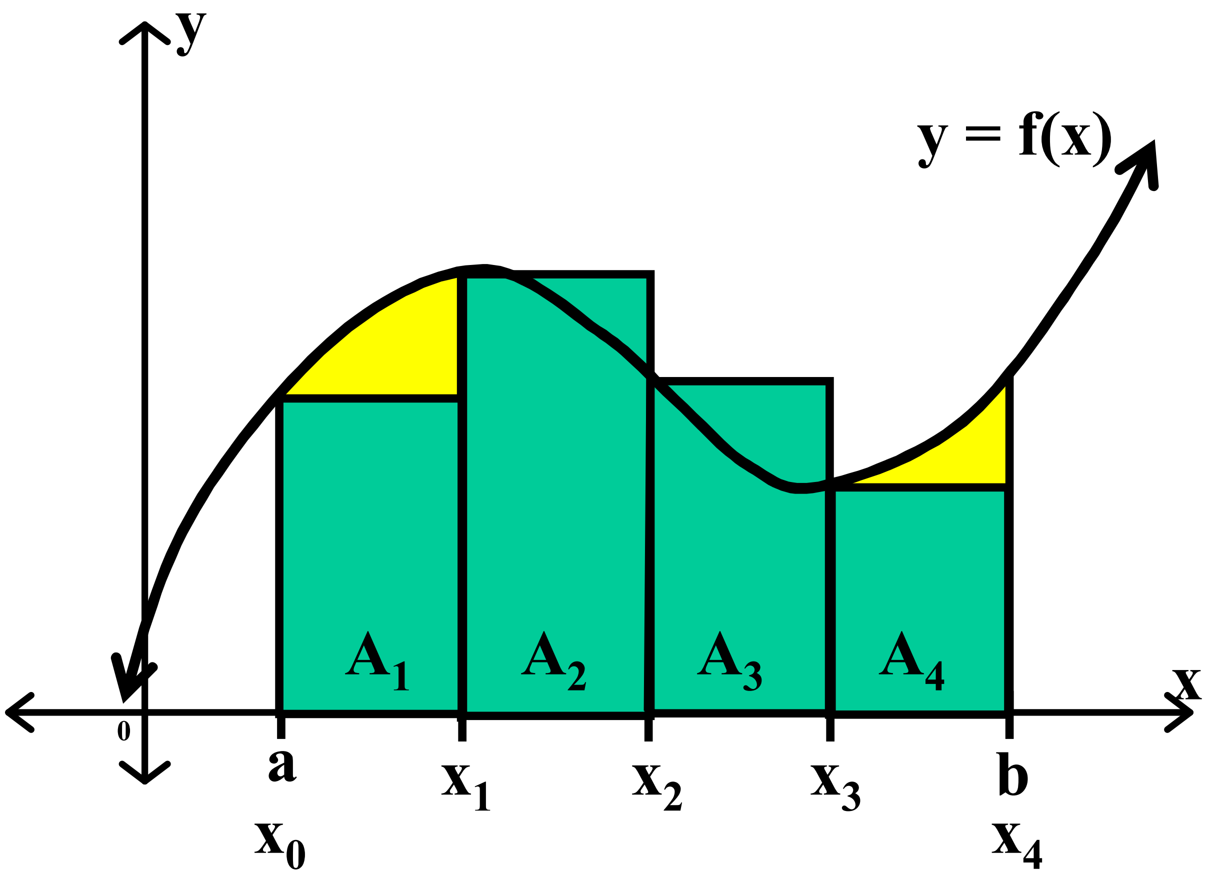


$A_1 \approx f(x_0)\Delta x \quad A_2 \approx f(x_1)\Delta x \quad A_3 \approx f(x_2)\Delta x \quad A_4 \approx f(x_3)\Delta x$

Notice that, in general, $A_i \approx f(x_{i-1})\Delta x$.

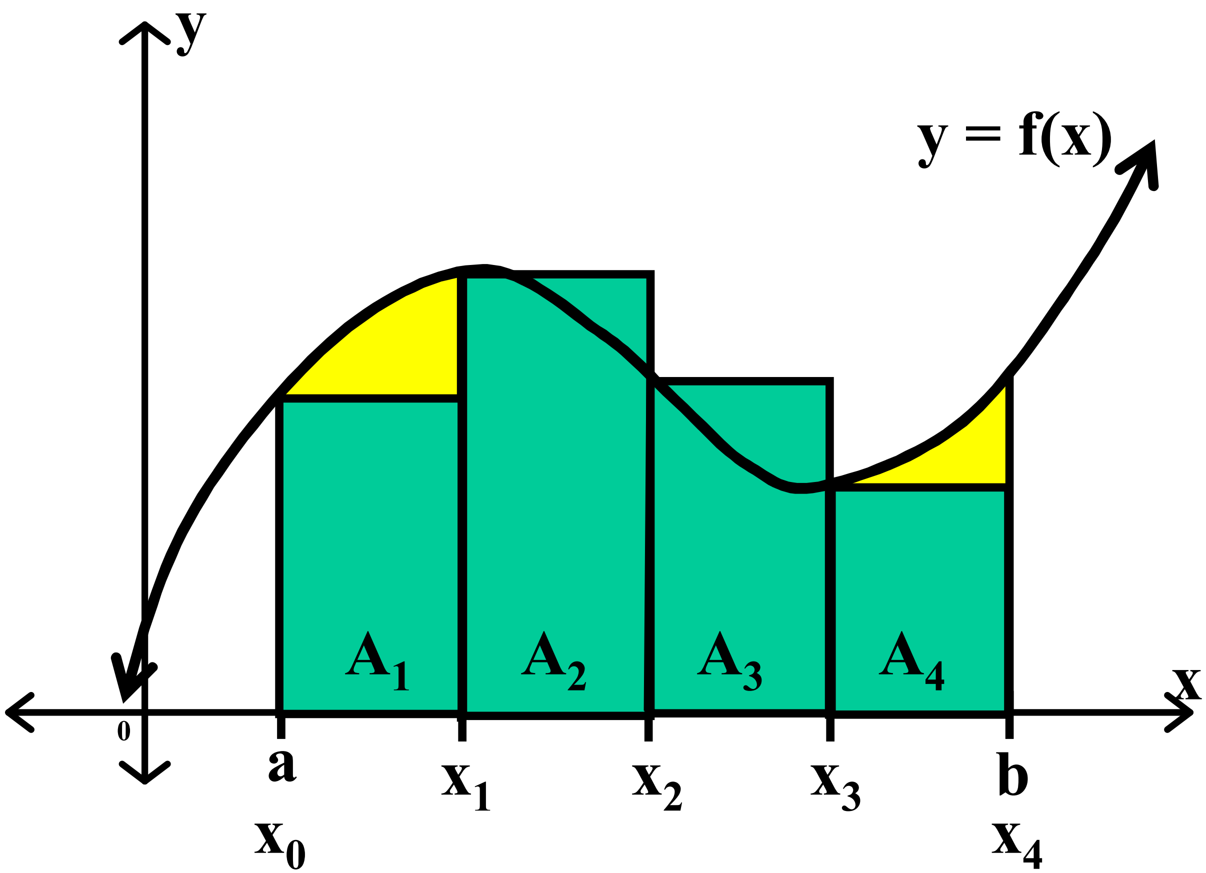


$$A_i \approx f(x_{i-1})\Delta x$$



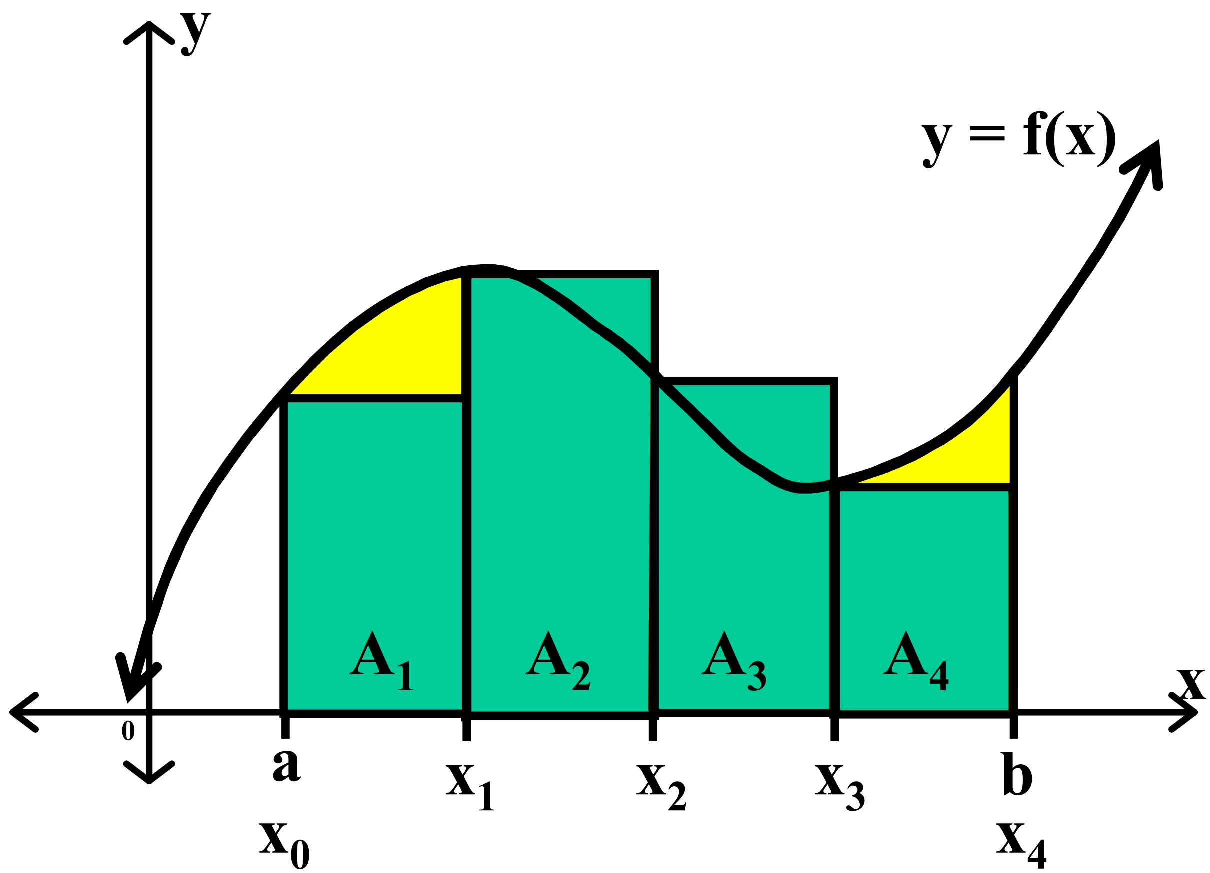
$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx$$



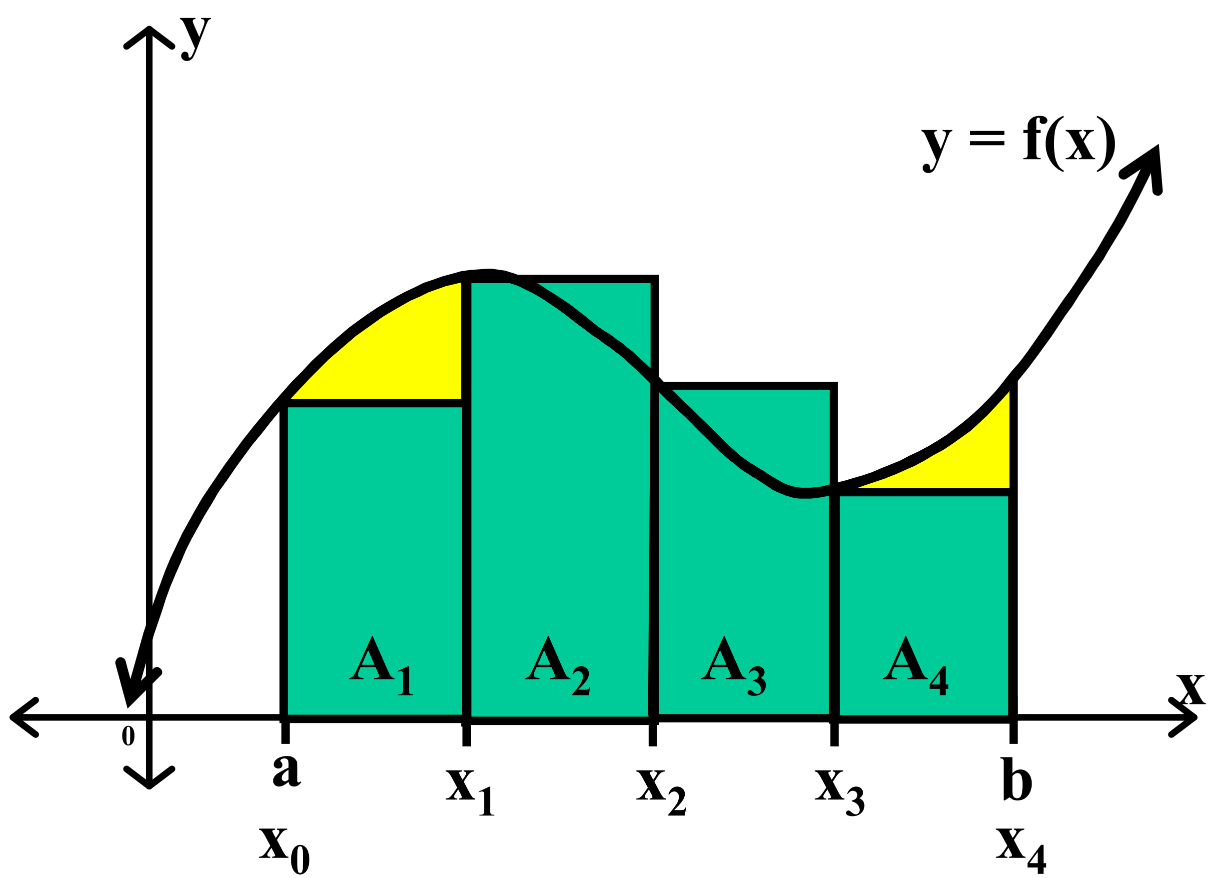
$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4$$



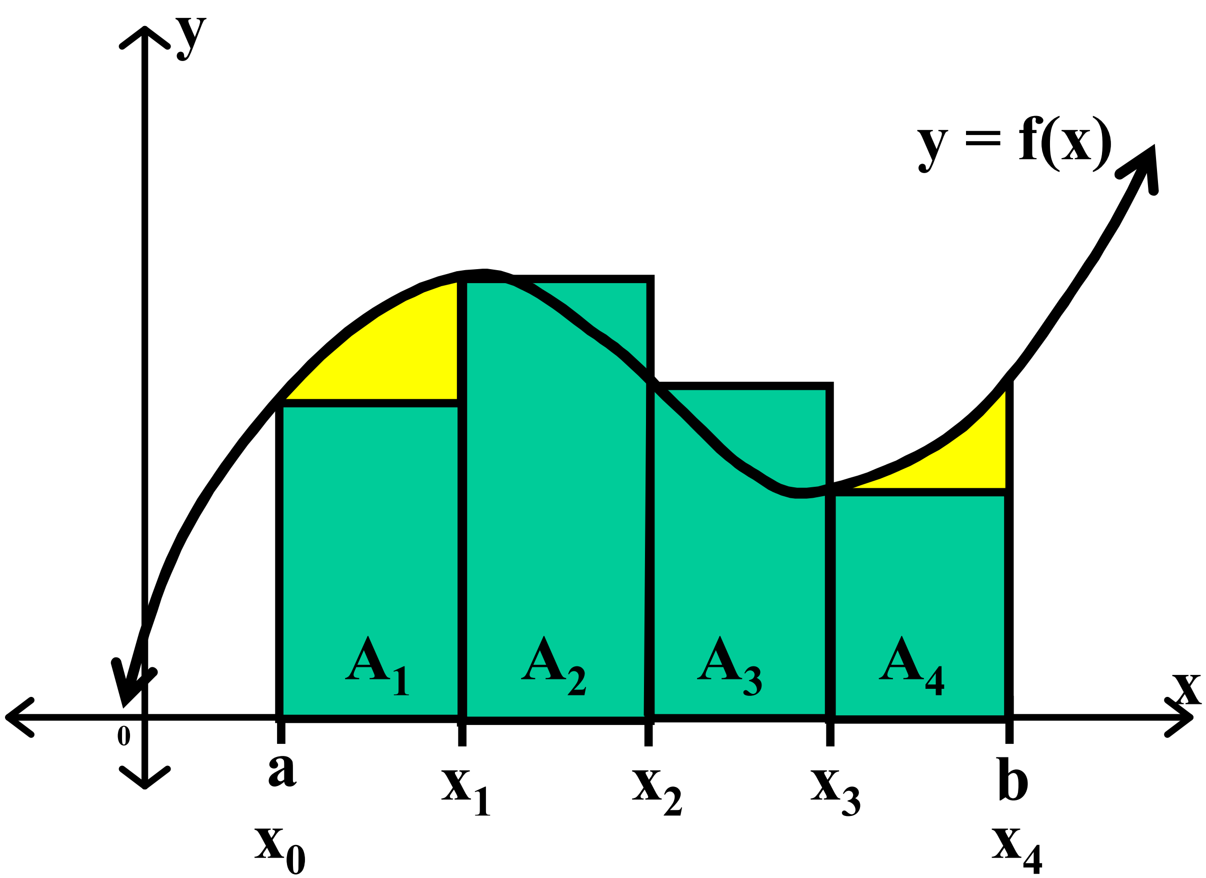
$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4 = \sum_{i=1}^{n} A_i$$



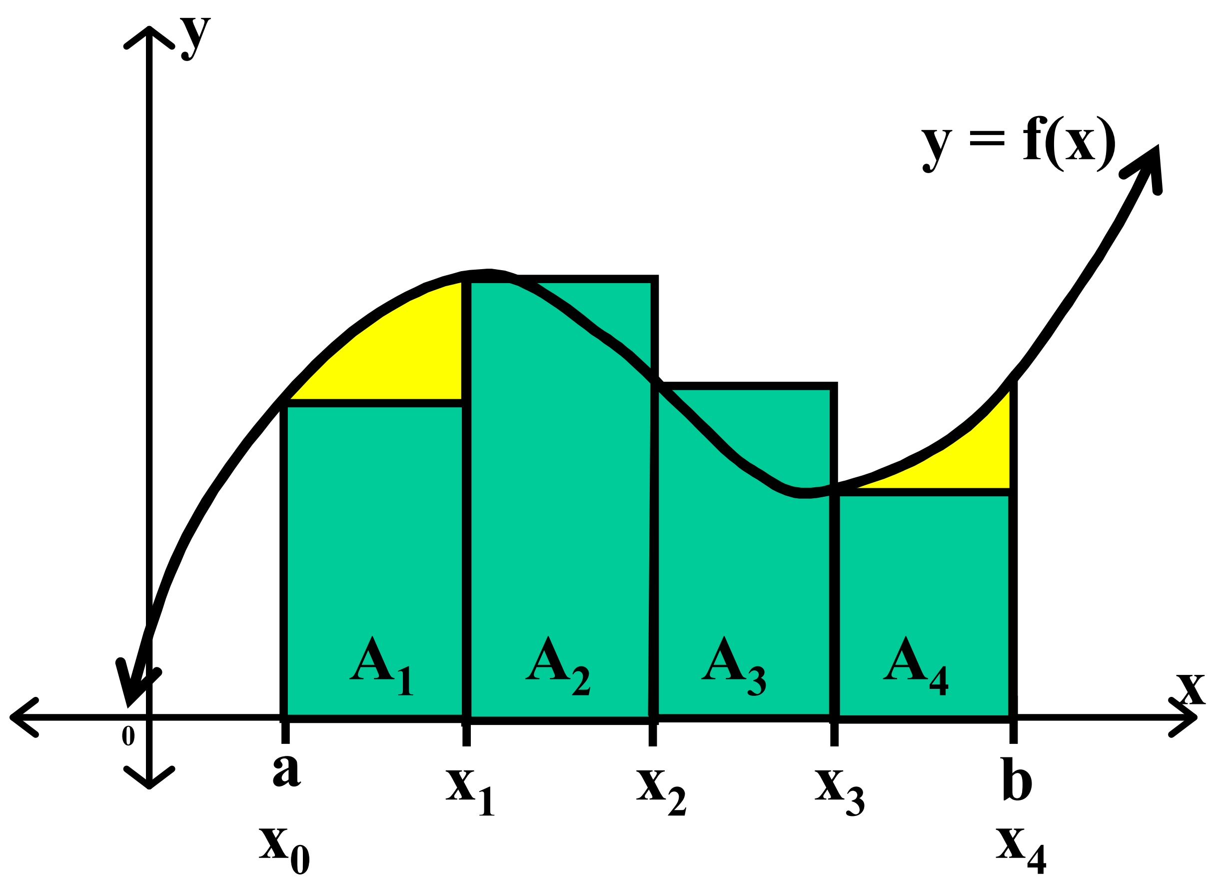
$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4 = \sum_{i=1}^{n} A_i \quad \text{(In this case, n = 4.)}$$



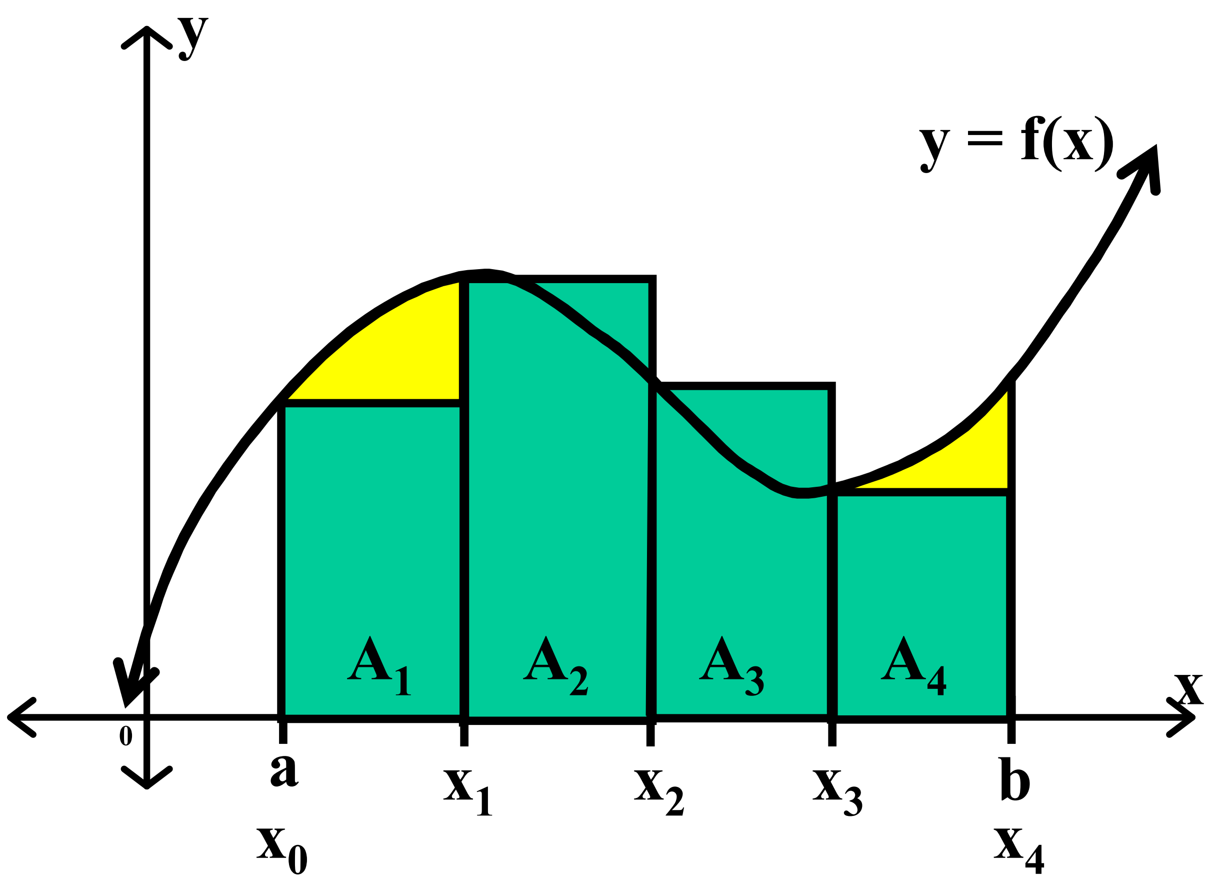
$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$



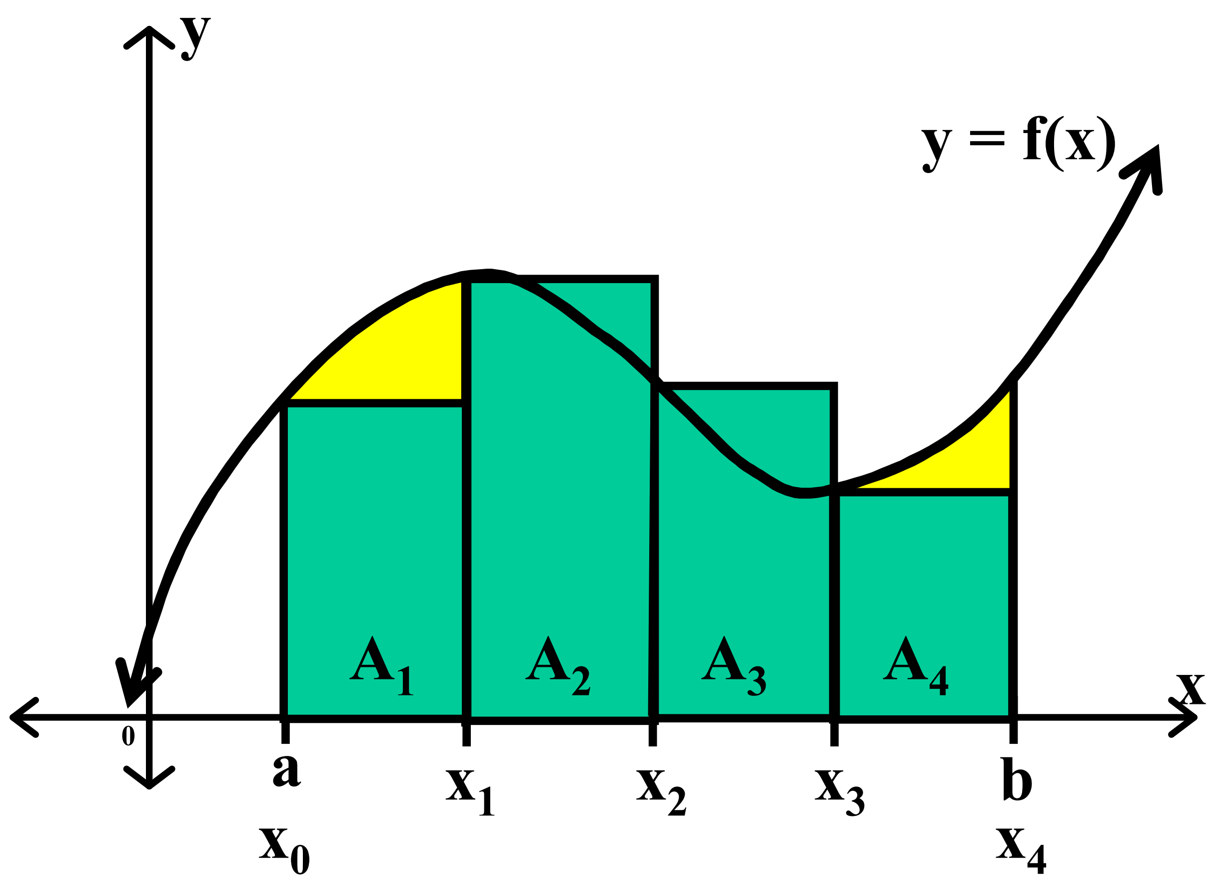
$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx$$



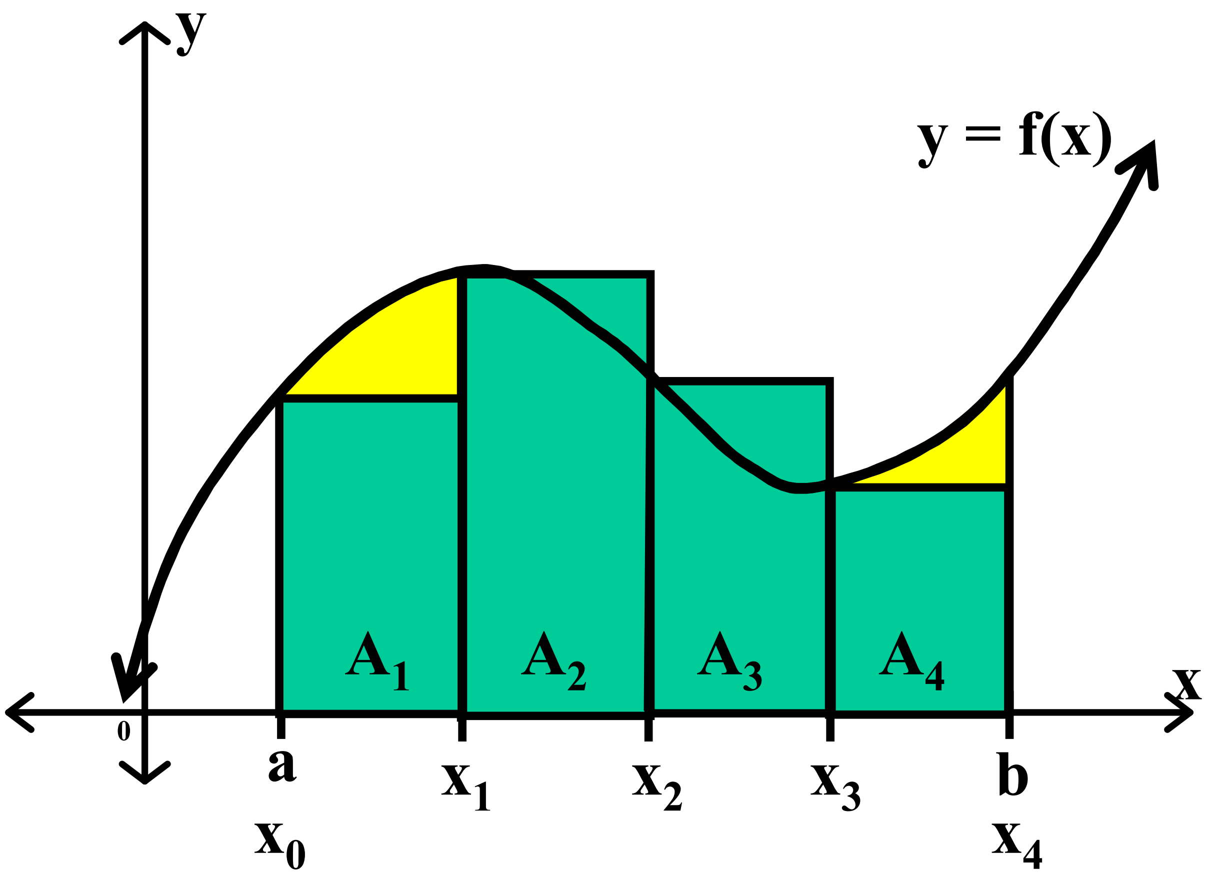
$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n}$$



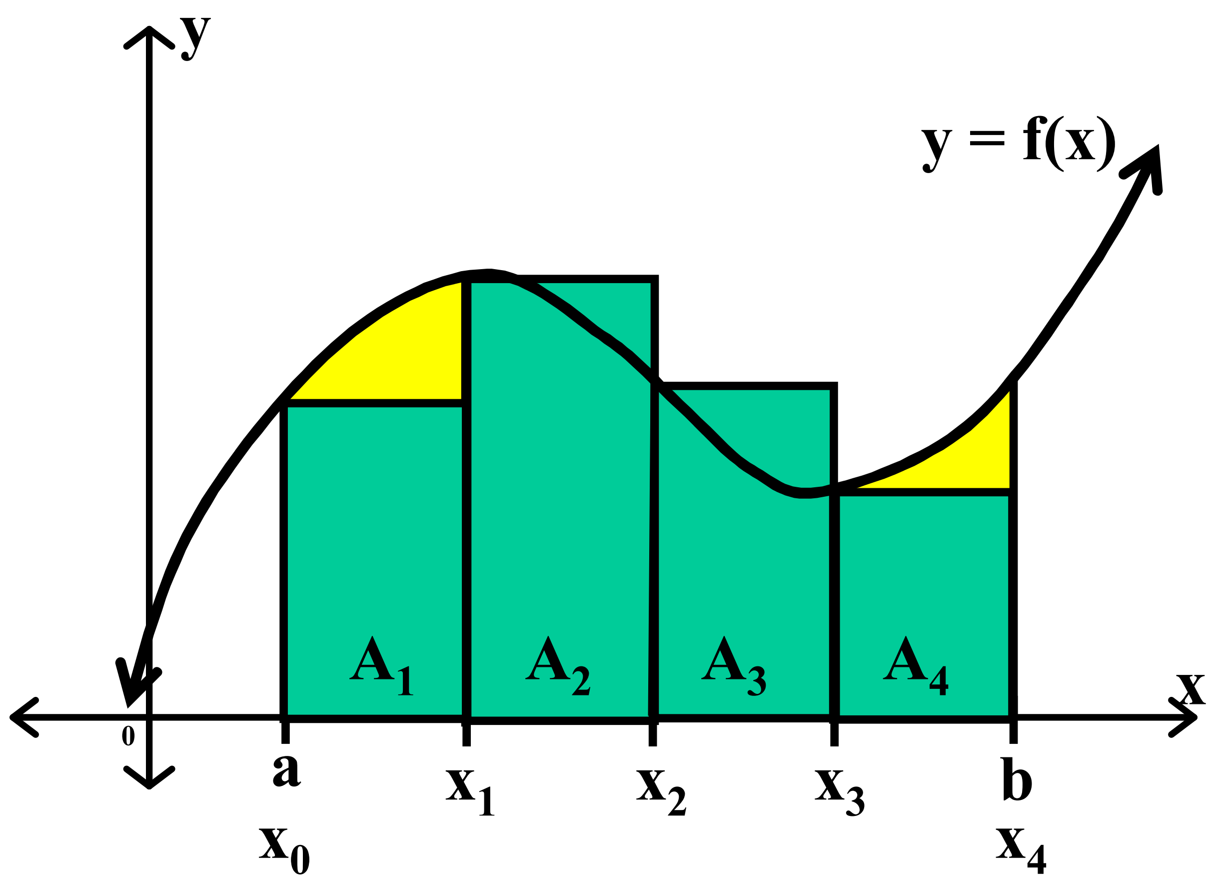
$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n} f(x_{i-1})\Delta x$$



$$A_i \approx f(x_{i-1})\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n} f(x_{i-1})\Delta x = S_L$$



$$S_L = \sum_{i=1}^{n} f(x_{i-1})\Delta x$$

The Left Rectangular Approximation

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx$$

Step 1: Find Δx.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b - a}{n}$$

Step 1: Find Δx.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b - a}{n} = \frac{5 - 2}{6}$$

Step 1: Find Δx.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

Step 1: Find Δx.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\ dx \qquad \Delta x = \frac{b - a}{n} = \frac{5 - 2}{6} = 0.5$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b - a}{n} = \frac{5 - 2}{6} = 0.5$$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 =$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 =$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 =$

Add Δx.

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

Add Δx.

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b - a}{n} = \frac{5 - 2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 =$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 =$

Add Δx.

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

Add Δx.

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 =$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$\int_2^5 \sqrt{x^3 - 3}\, dx$ $\quad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Step 2: Calculate the x_i's.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b - a}{n} = \frac{5 - 2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Step 3: Calculate the $f(x_i)$'s.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) =$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Step 3: Calculate the $f(x_i$'s).

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Step 3: Calculate the $f(x_i$'s).

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\qquad f(x_0) =$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Step 3: Calculate the $f(x_i)$'s).

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$

$x_0 = a = 2 \qquad f(x_0) = f(a) =$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Step 3: Calculate the $f(x_i$'s).

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$\int_2^5 \sqrt{x^3 - 3}\, dx$ $\quad \Delta x = \dfrac{b-a}{n} = \dfrac{5-2}{6} = 0.5$ $\quad f(x) = \sqrt{x^3 - 3}$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) =$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Step 3: Calculate the $f(x_i$'s).

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2 \qquad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

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Step 3: Calculate the $f(x_i)$'s.

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$x_2 = 3$

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Step 3: Calculate the $f(x_i)$'s.

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$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$

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Step 3: Calculate the $f(x_i$'s).

Class Worksheet #5 Unit 11

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Step 3: Calculate the $f(x_i)$'s).

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$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$

Step 3: Calculate the $f(x_i)$'s.

Class Worksheet #5 Unit 11

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$x_6 = b = 5 \qquad f(x_6) =$

Step 3: Calculate the $f(x_i)$'s).

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$x_6 = b = 5$ $\quad f(x_6) = f(b) =$

Step 3: Calculate the $f(x_i)$'s).

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$x_5 = 4.5 \qquad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5 \qquad f(x_6) = f(b) = f(5) =$

Step 3: Calculate the $f(x_i$'s).

Class Worksheet #5 Unit 11

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$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

Step 3: Calculate the $f(x_i$'s).

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

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$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

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Class Worksheet #5 Unit 11

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$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$$S_L = \sum_{i=1}^{n} f(x_{i-1})\Delta x$$

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$$S_L = \sum_{i=1}^{n} f(x_{i-1})\Delta x$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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$$S_L = \sum_{i=1}^{6} f(x_{i-1})\Delta x$$

$$S_L = f(x_0)\Delta x + f(x_1)\Delta x + f(x_2)\Delta x + f(x_3)\Delta x + f(x_4)\Delta x + f(x_5)\Delta x$$

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$$S_L = \sum_{i=1}^{n} f(x_{i-1})\Delta x$$

$$S_L = \sum_{i=1}^{6} f(x_{i-1})\Delta x$$

$$S_L = f(x_0)\Delta x + f(x_1)\Delta x + f(x_2)\Delta x + f(x_3)\Delta x + f(x_4)\Delta x + f(x_5)\Delta x$$

$$S_L = (\sqrt{5} + \sqrt{12.625} + \sqrt{24} + \sqrt{39.875} + \sqrt{61} + \sqrt{88.125})(.5)$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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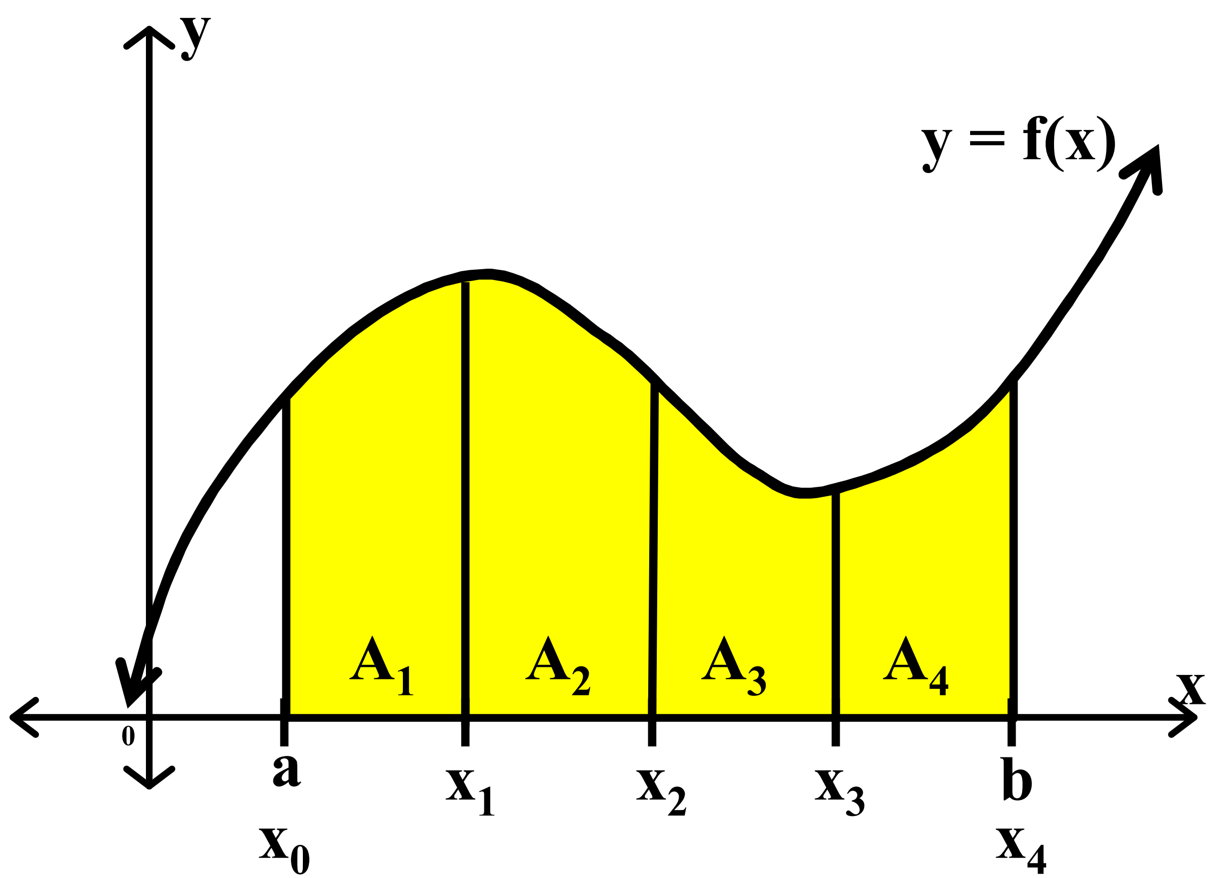
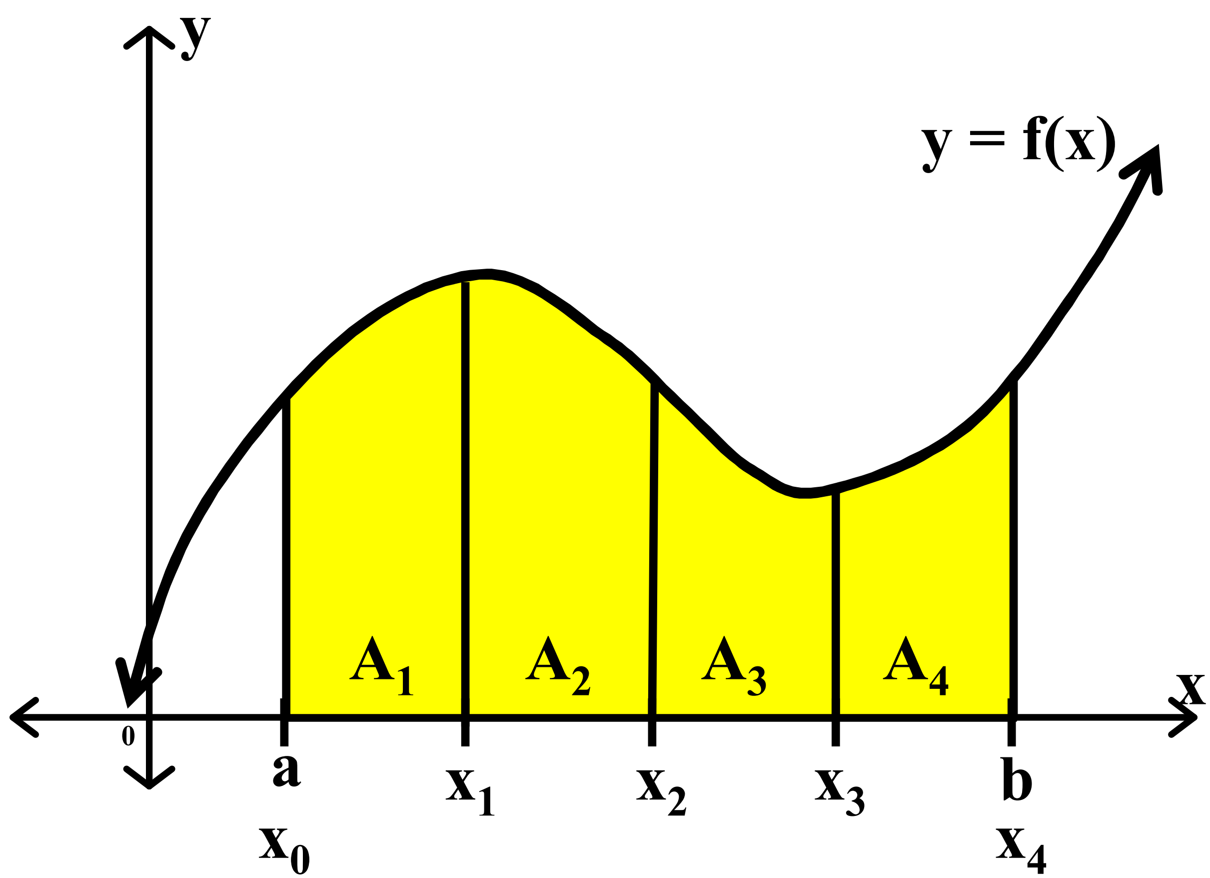
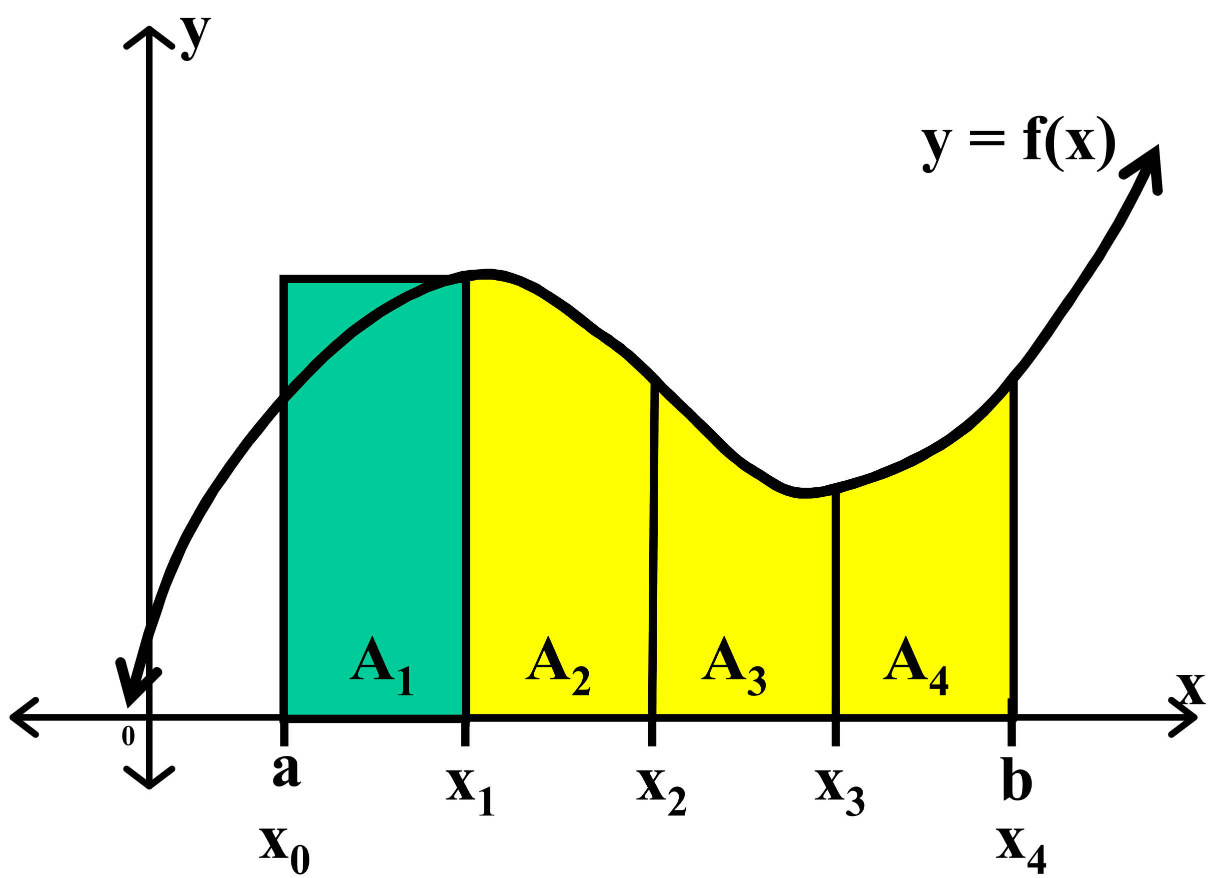
$$S_L = (\sqrt{5} + \sqrt{12.625} + \sqrt{24} + \sqrt{39.875} + \sqrt{61} + \sqrt{88.125})(.5)$$

$$S_L \approx 17.10$$

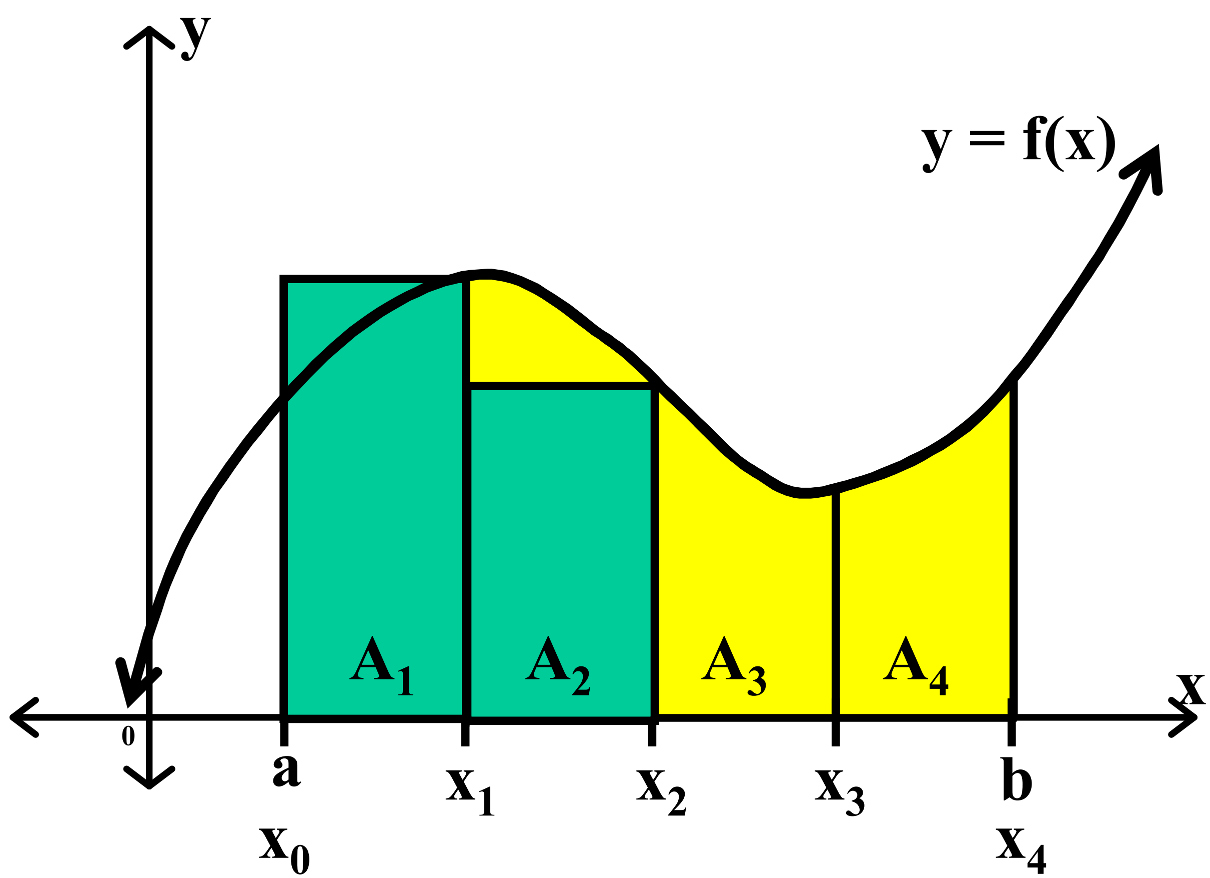

y
y = f(x)
A1
A2
A3
A4
x
0
a
x0
x1
x2
x3
b
x4



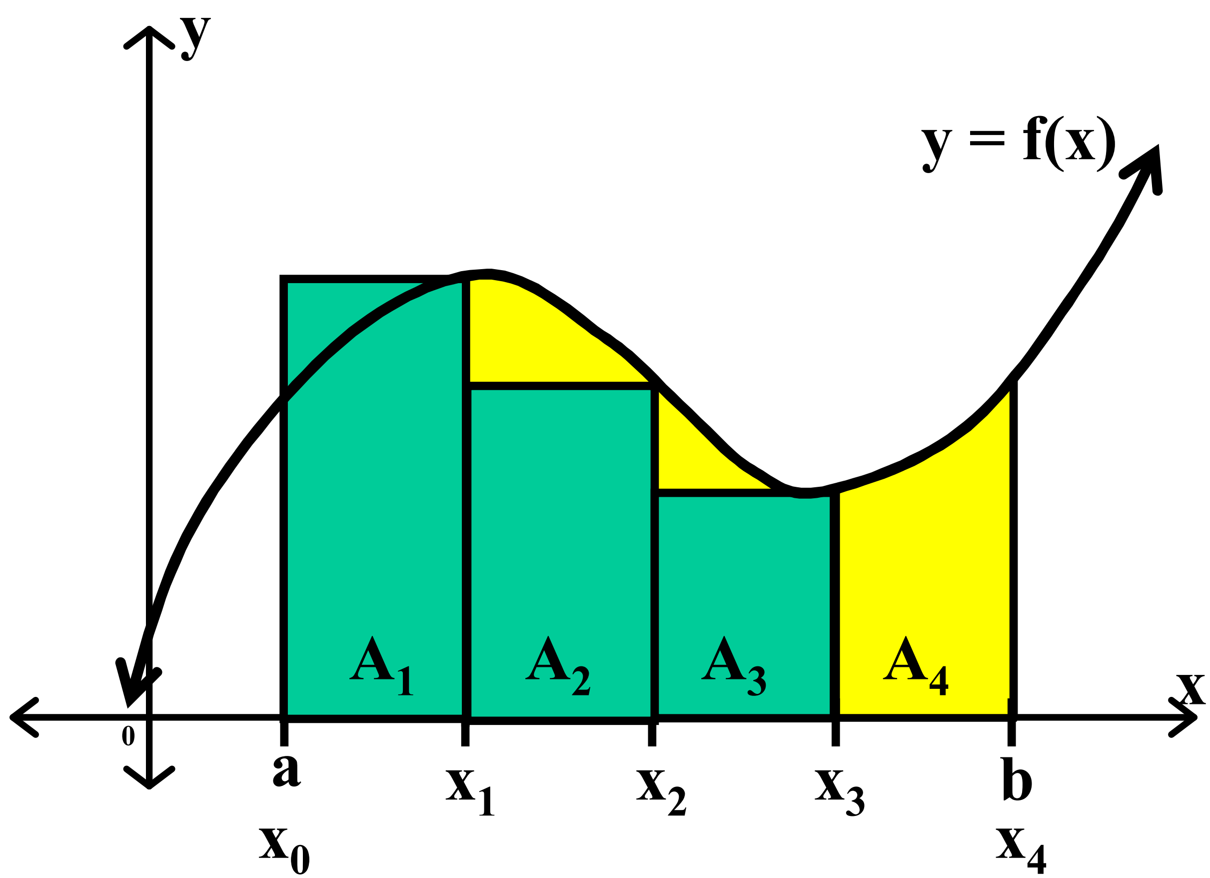
The next ‘rectangular’ approximation uses the length of the right hand side of each strip as the length of the rectangle.



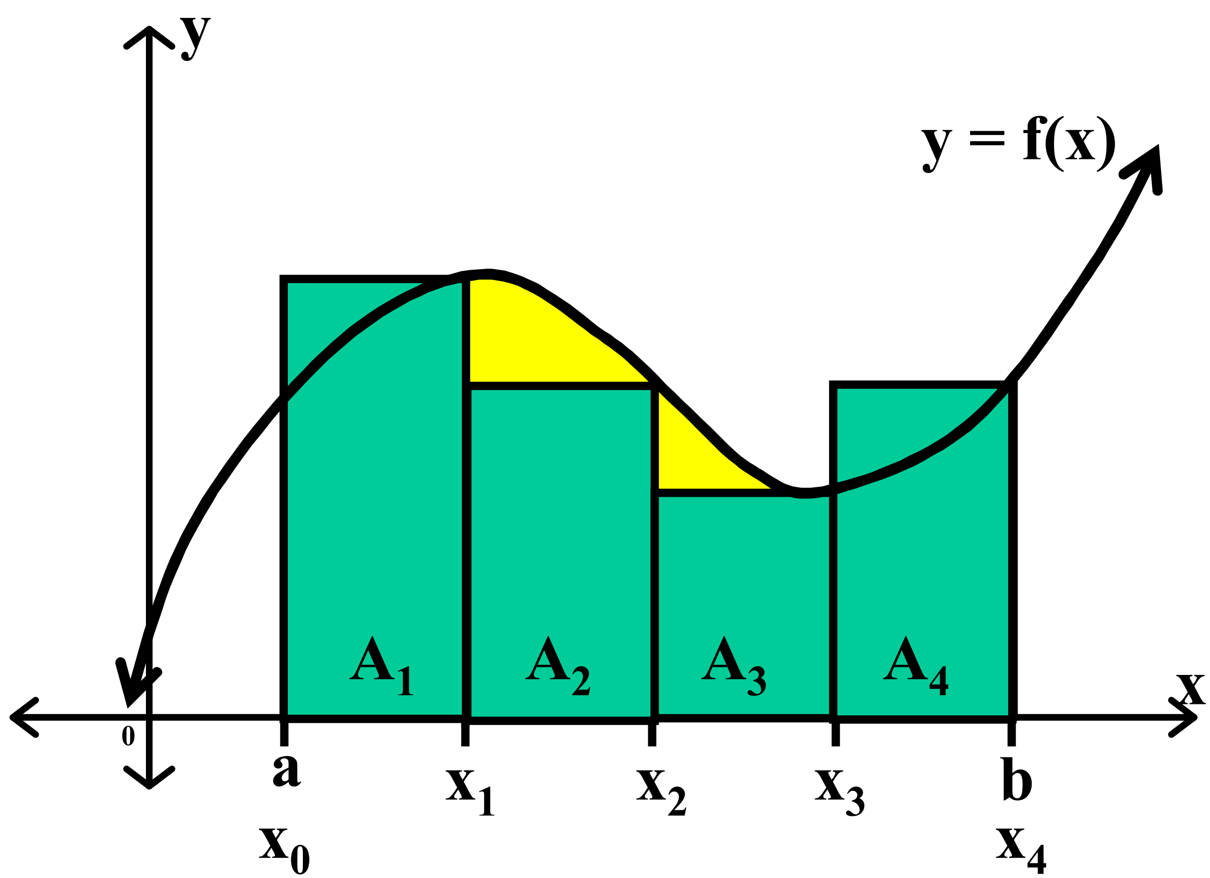
The next 'rectangular' approximation uses the length of the right hand side of each strip as the length of the rectangle.



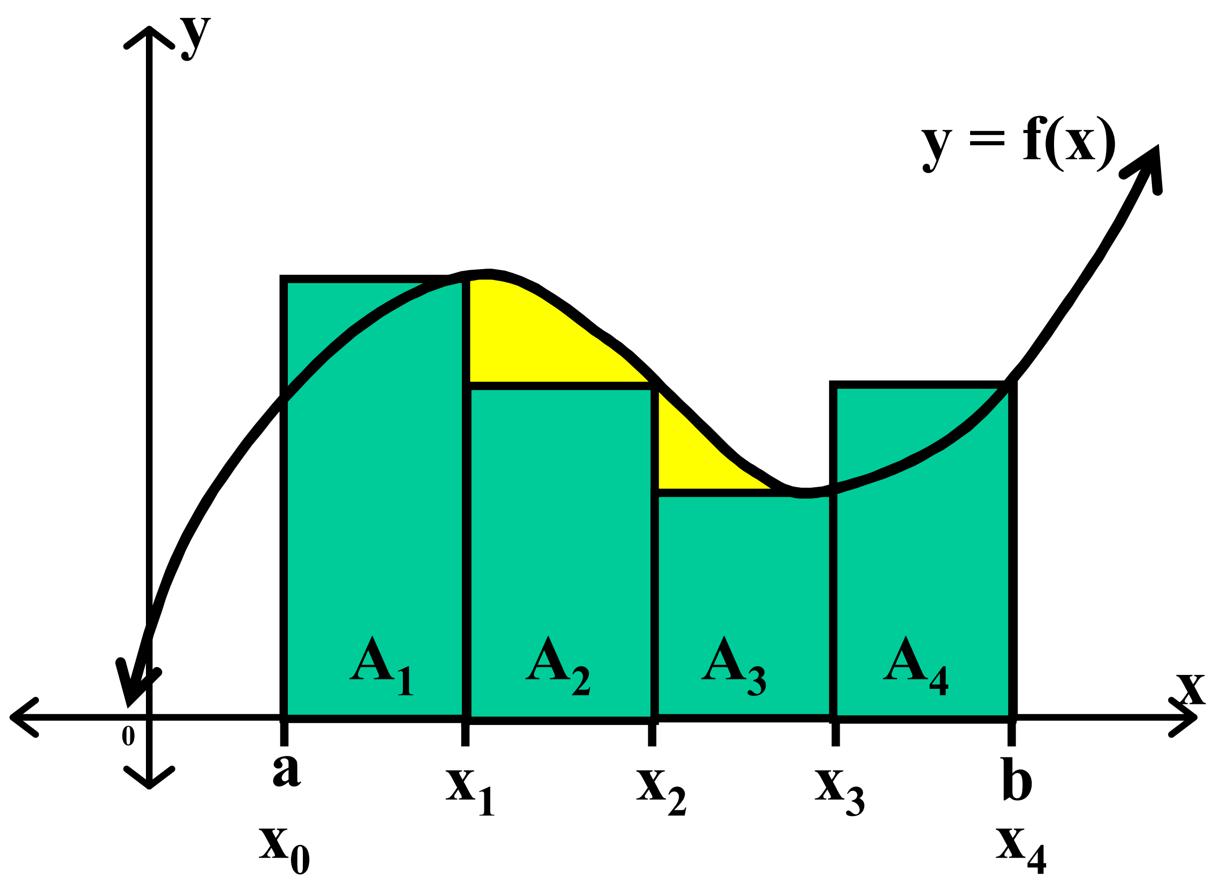
The next 'rectangular' approximation uses the length of the right hand side of each strip as the length of the rectangle.



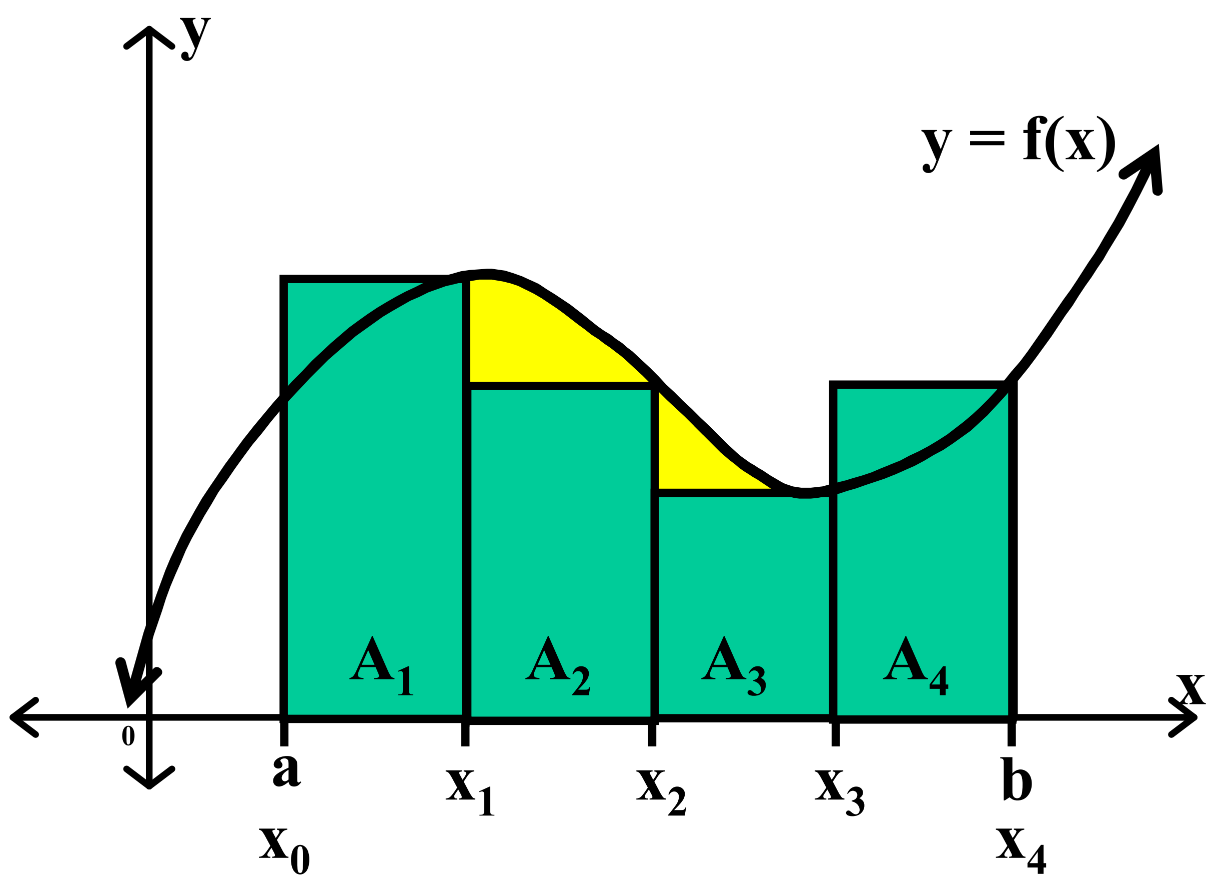
The next 'rectangular' approximation uses the length of the right hand side of each strip as the length of the rectangle.



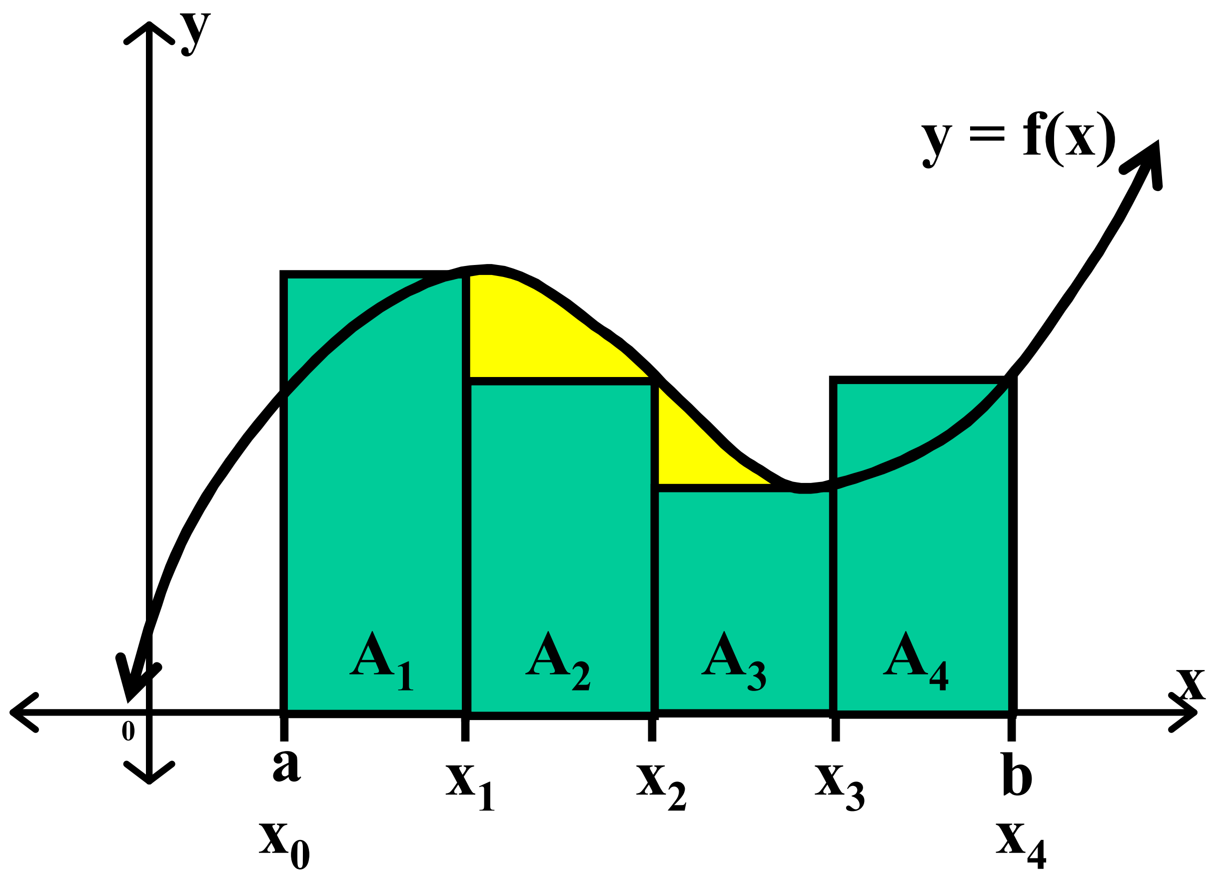
The next 'rectangular' approximation uses the length of the right hand side of each strip as the length of the rectangle.



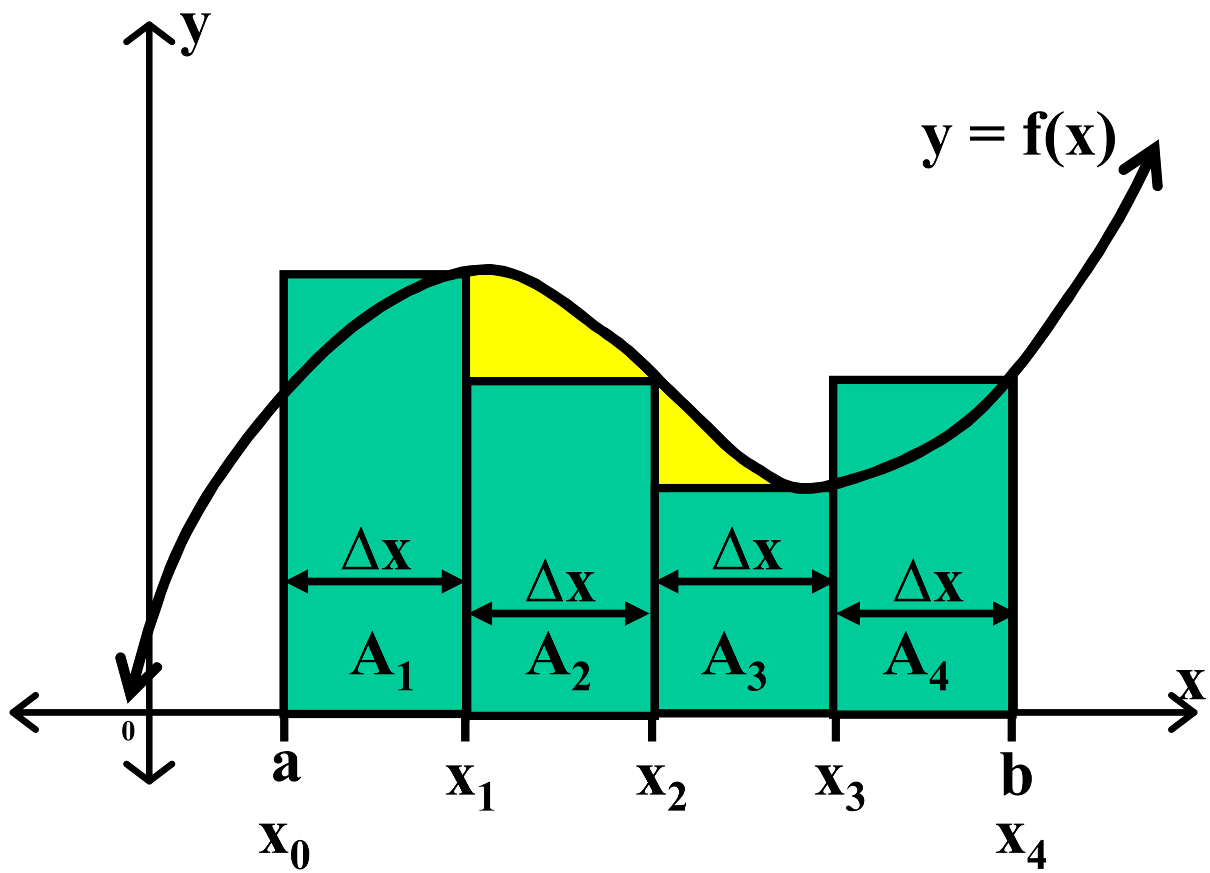
The next 'rectangular' approximation uses the length of the right hand side of each strip as the length of the rectangle. This is called the 'right rectangular' approximation.



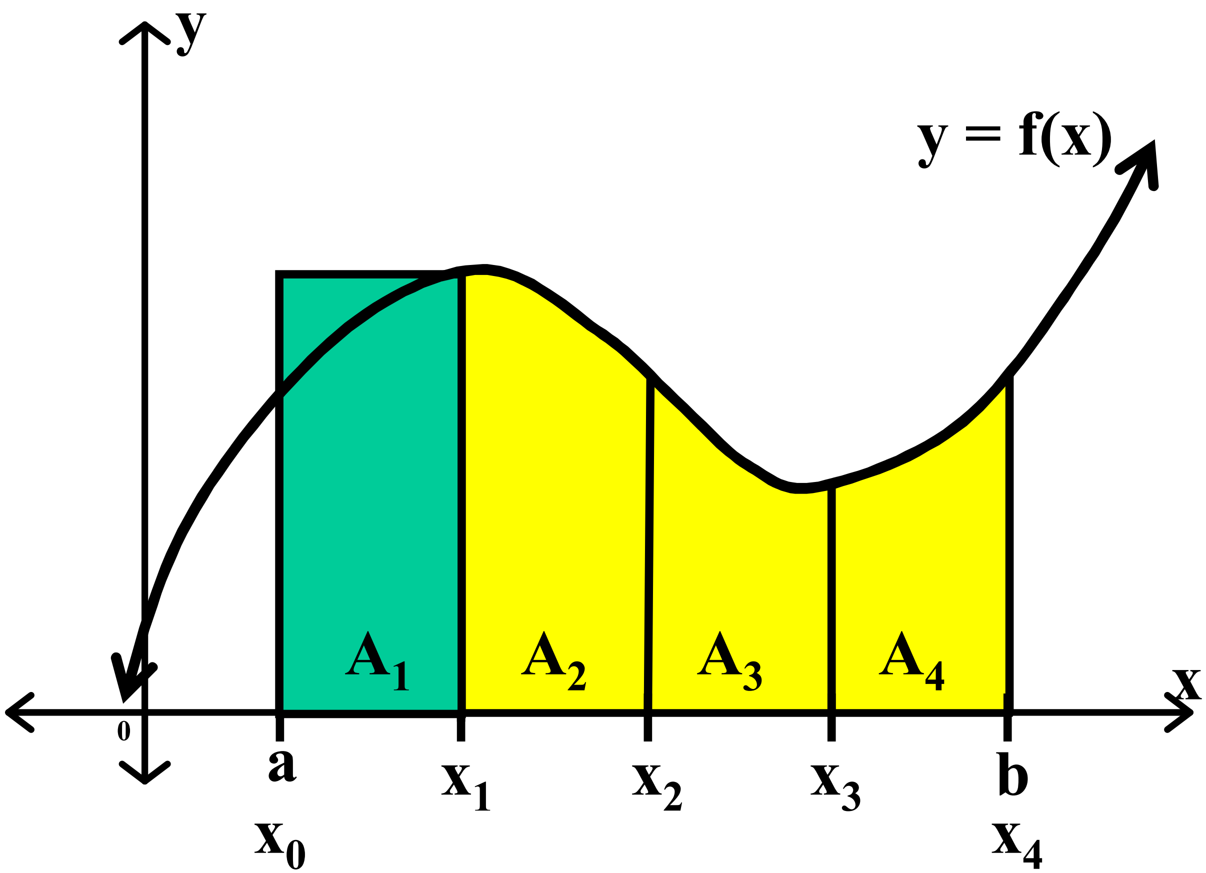
The next 'rectangular' approximation uses the length of the right hand side of each strip as the length of the rectangle. This is called the 'right rectangular' approximation, S_R.



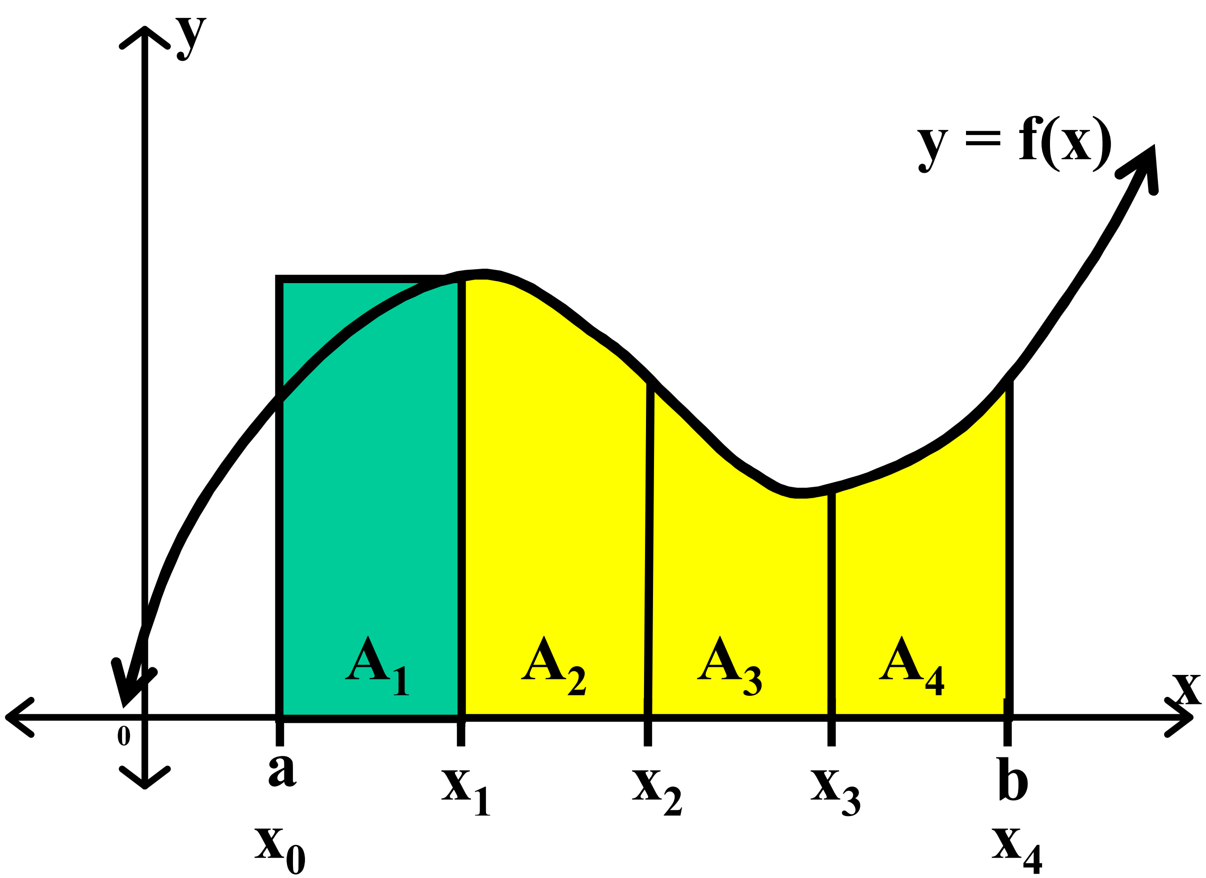
y
y = f(x)
A1
A2
A3
A4
x
0
a
x1
x2
x3
b
x0
x4



The width of each rectangle is Δx.

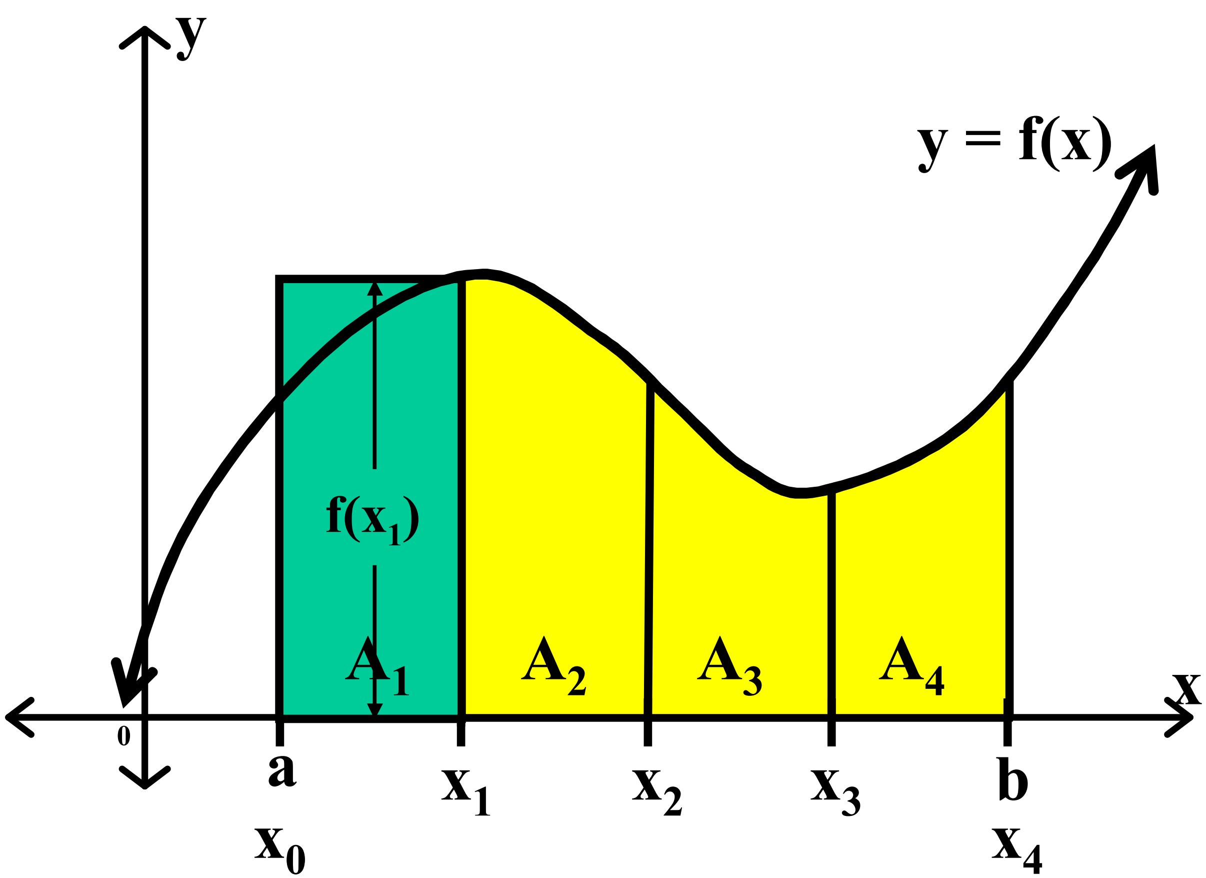


The width of each rectangle is Δx.



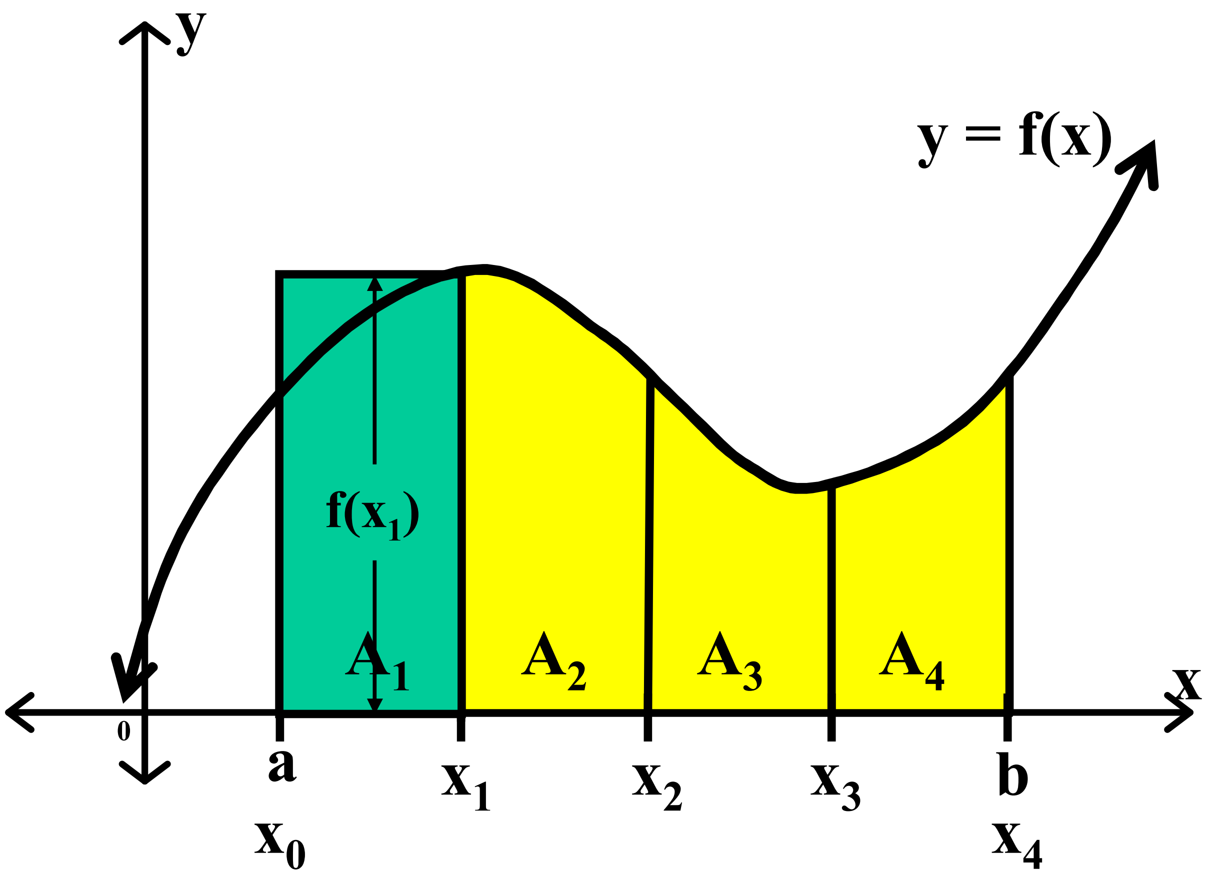
The width of each rectangle is Δx.

$A_1 \approx$



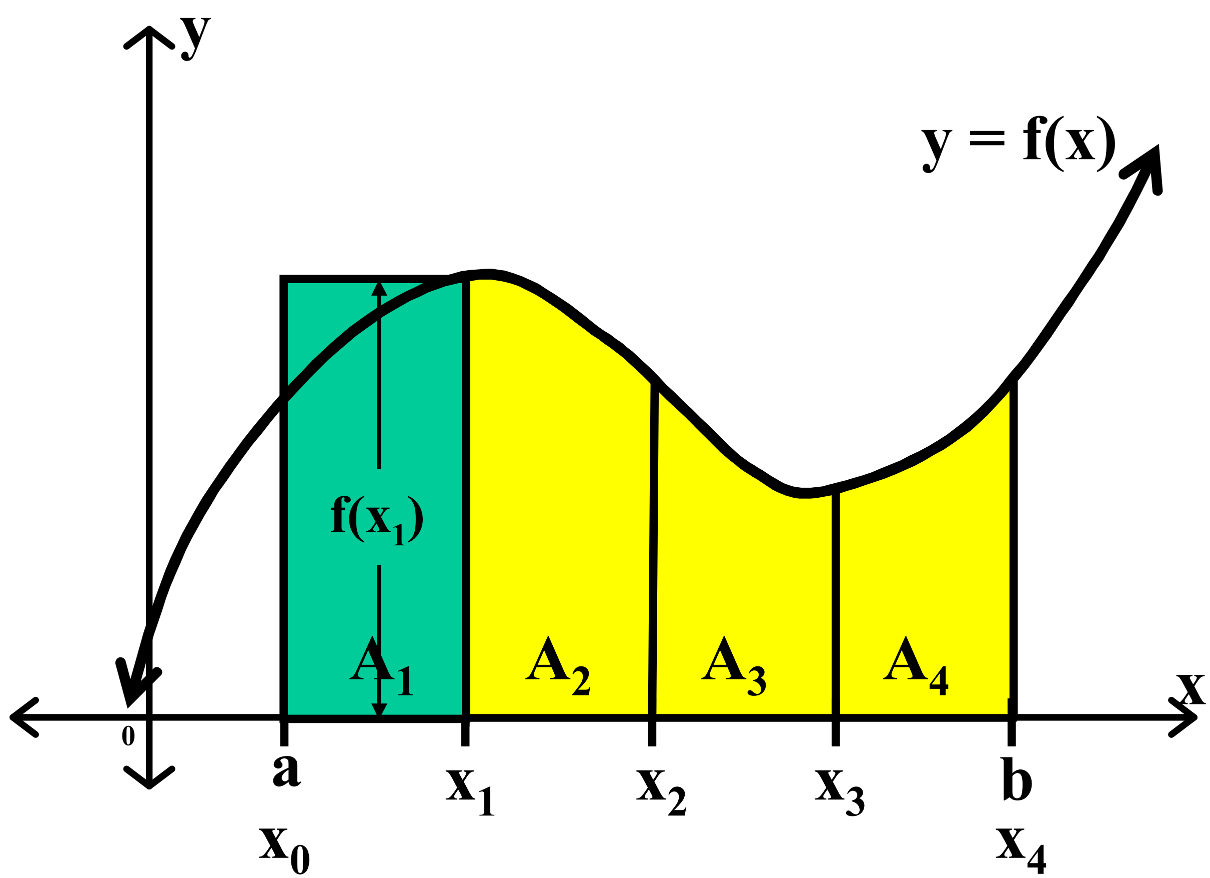
The width of each rectangle is Δx.

$A_1 \approx$



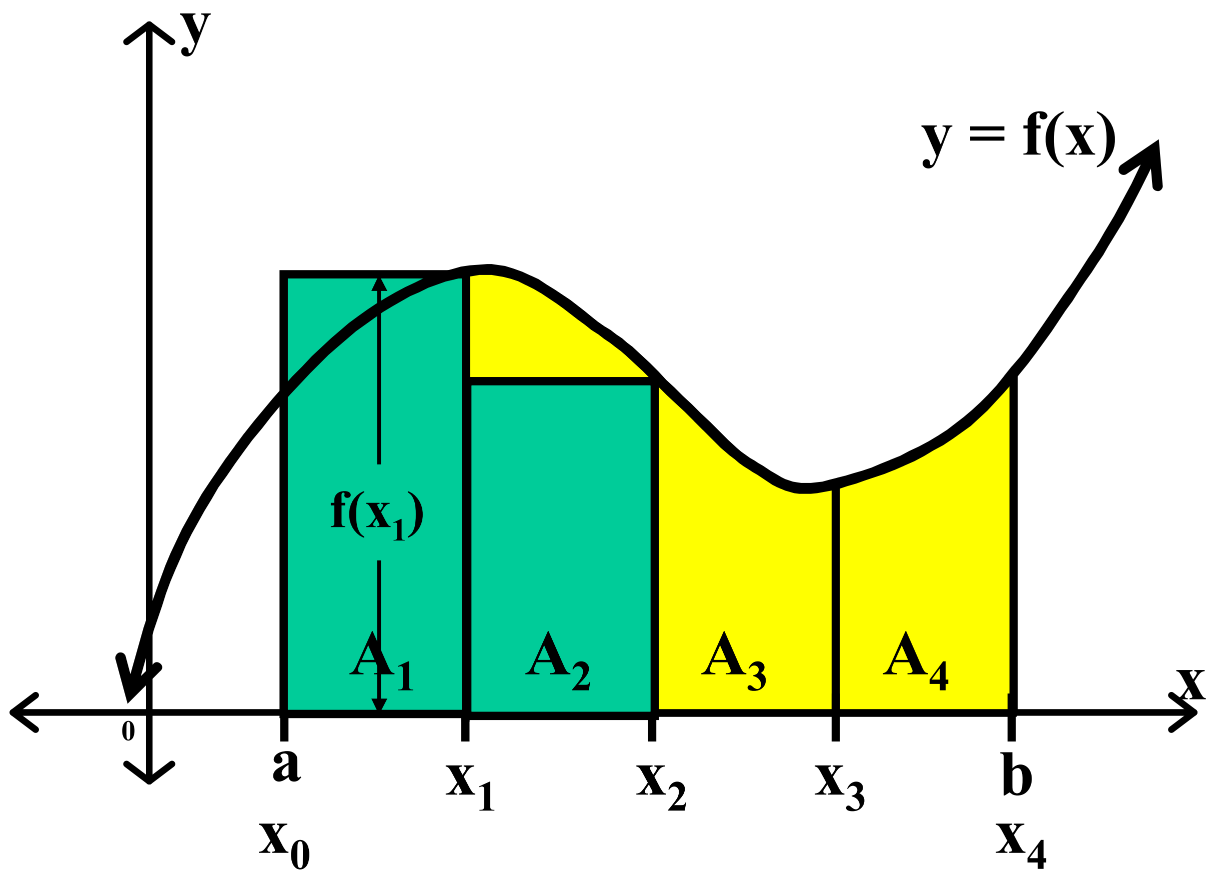
The width of each rectangle is Δx.

$A_1 \approx f(x_1)$



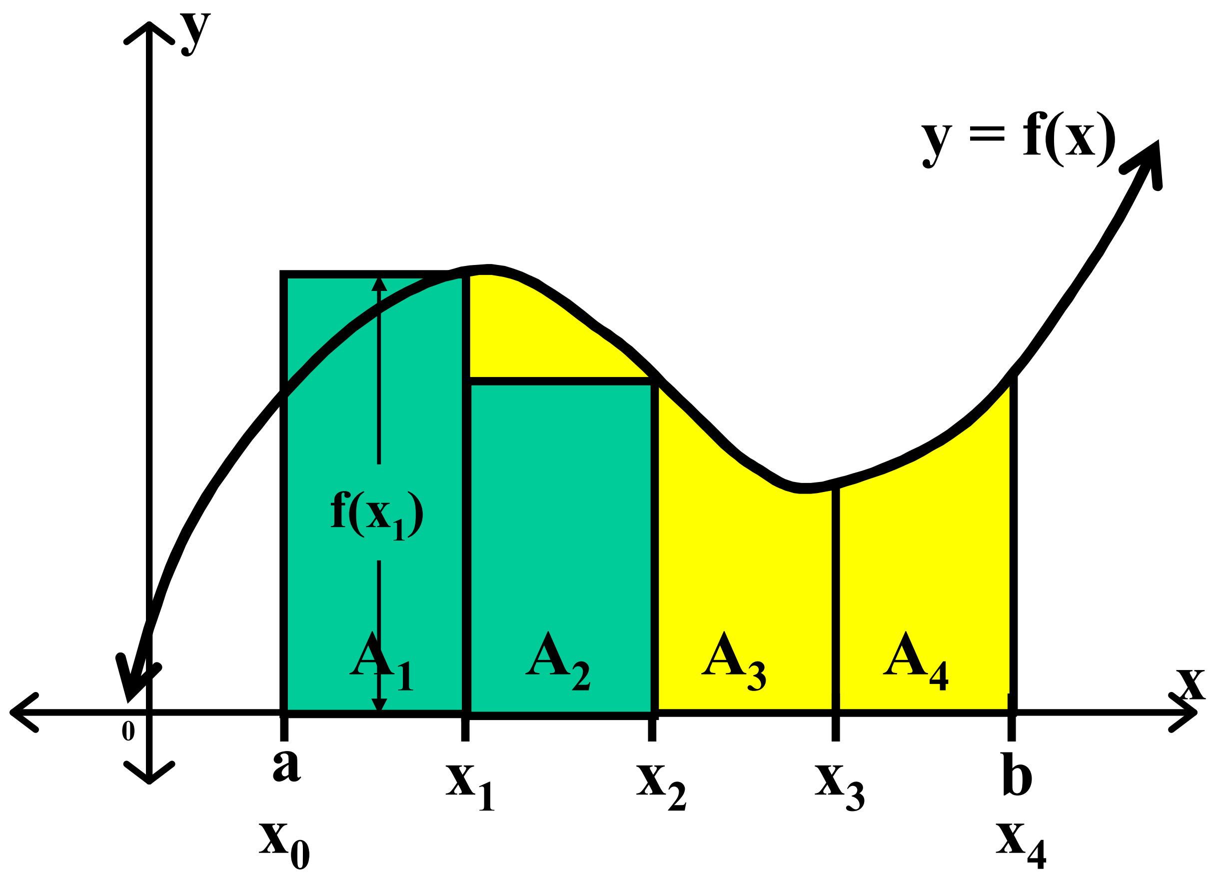
The width of each rectangle is Δx.

$A_1 \approx f(x_1)\Delta x$



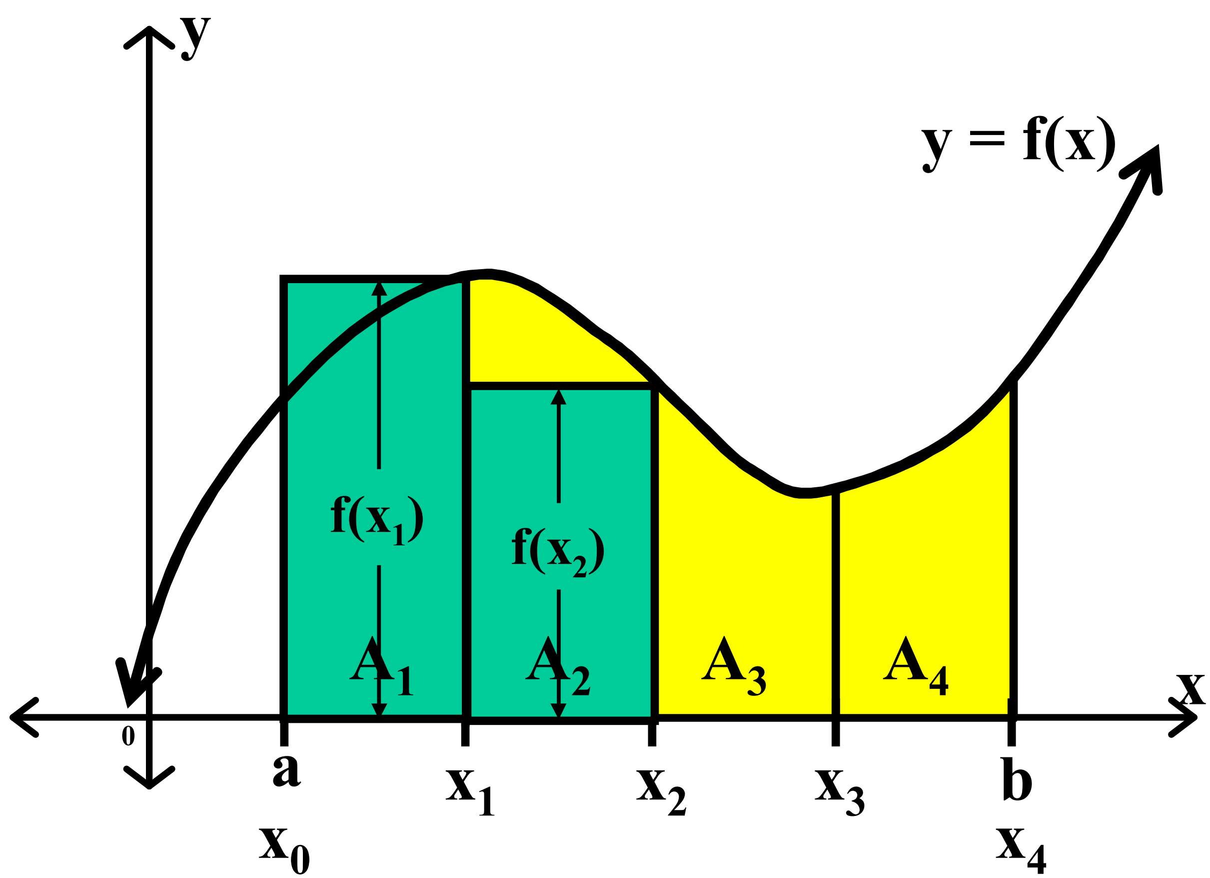
The width of each rectangle is Δx.

$A_1 \approx f(x_1)\Delta x$



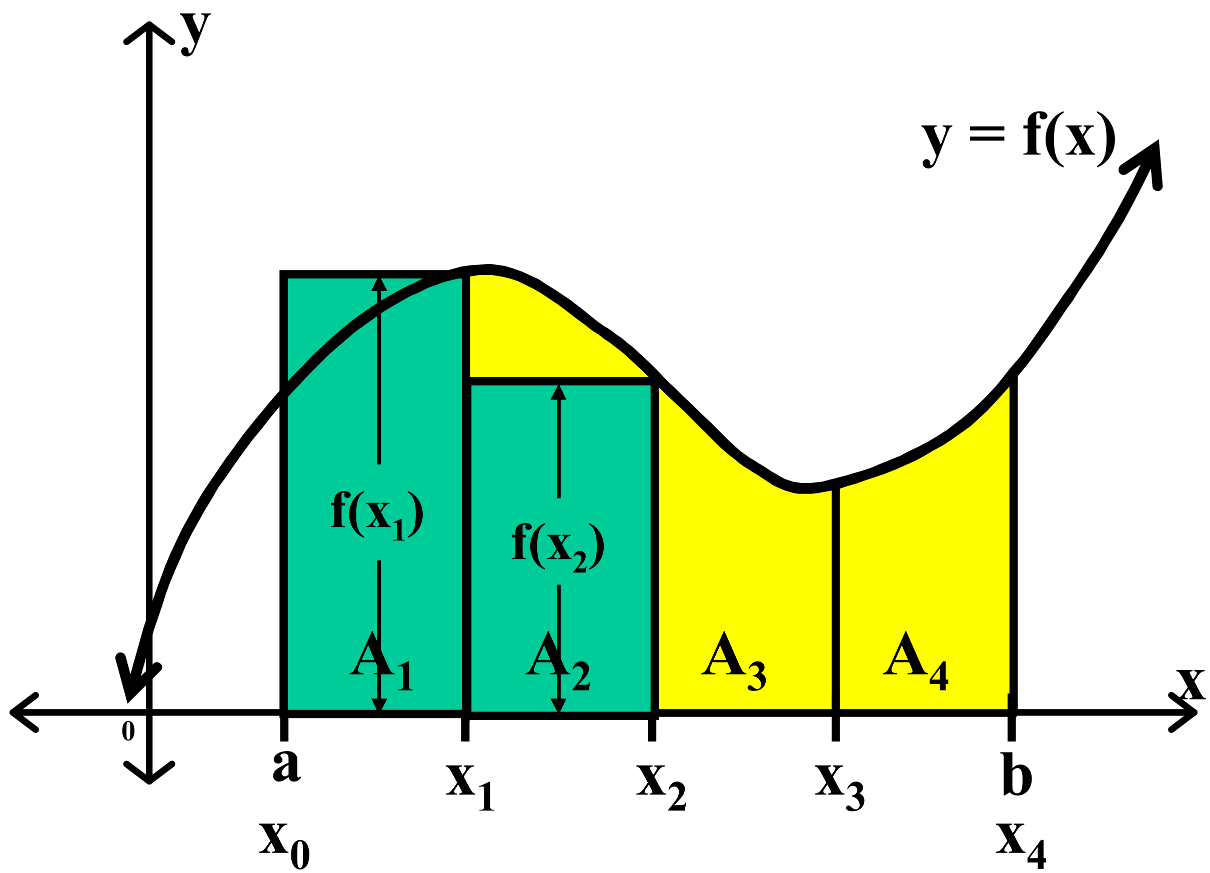
The width of each rectangle is Δx.

$A_1 \approx f(x_1)\Delta x \quad A_2 \approx$



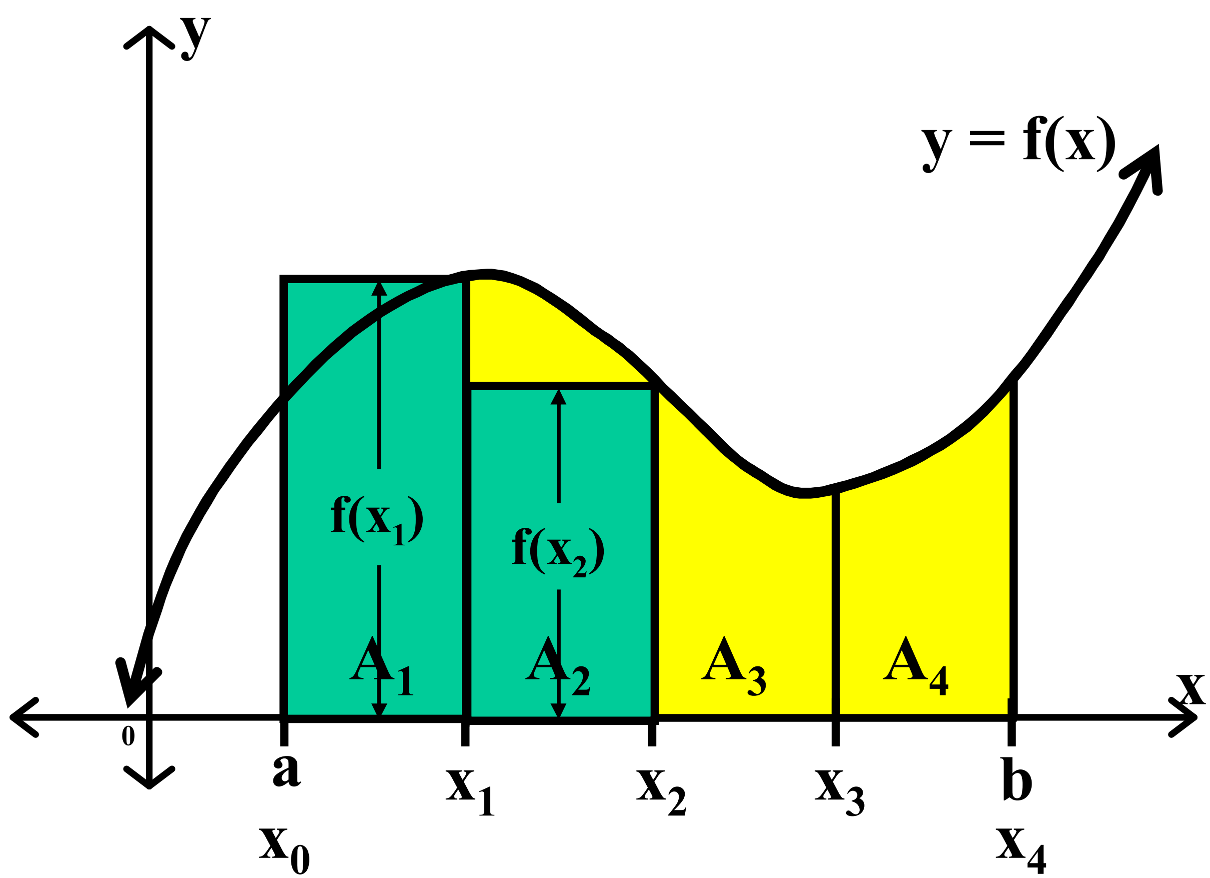
The width of each rectangle is Δx.

$A_1 \approx f(x_1)\Delta x \quad A_2 \approx$



The width of each rectangle is Δx.

$A_1 \approx f(x_1)\Delta x \quad A_2 \approx f(x_2)$



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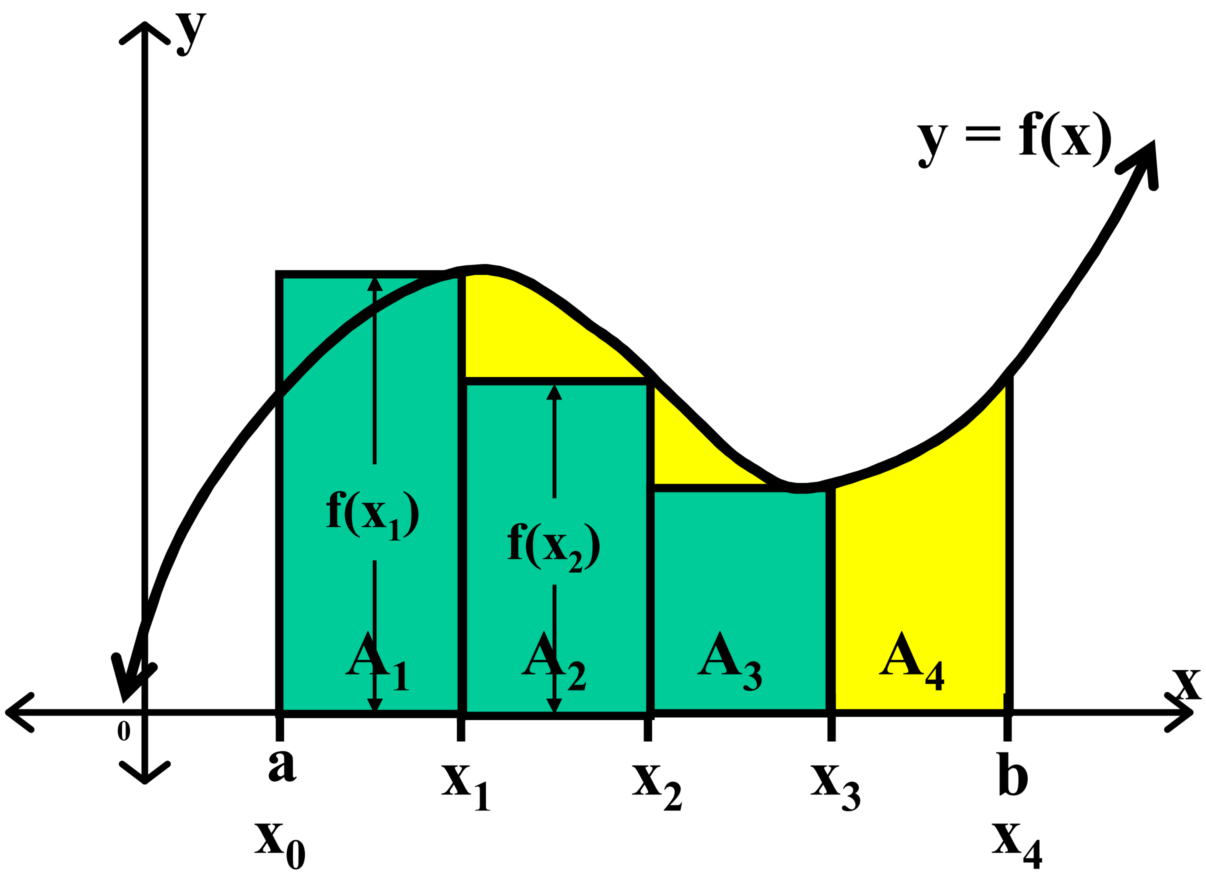
$A_1 \approx f(x_1)\Delta x \quad A_2 \approx f(x_2)\Delta x$



The width of each rectangle is Δx.

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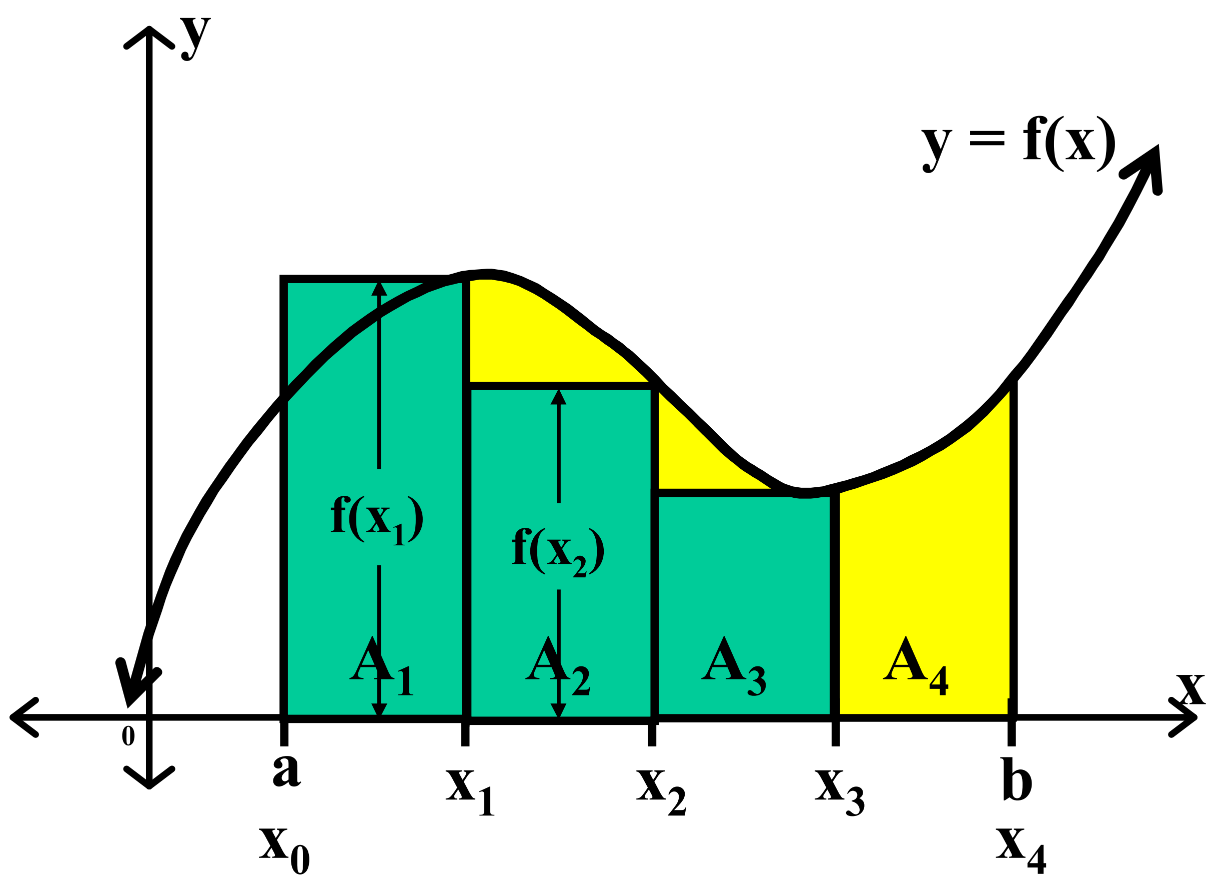

The width of each rectangle is Δx.

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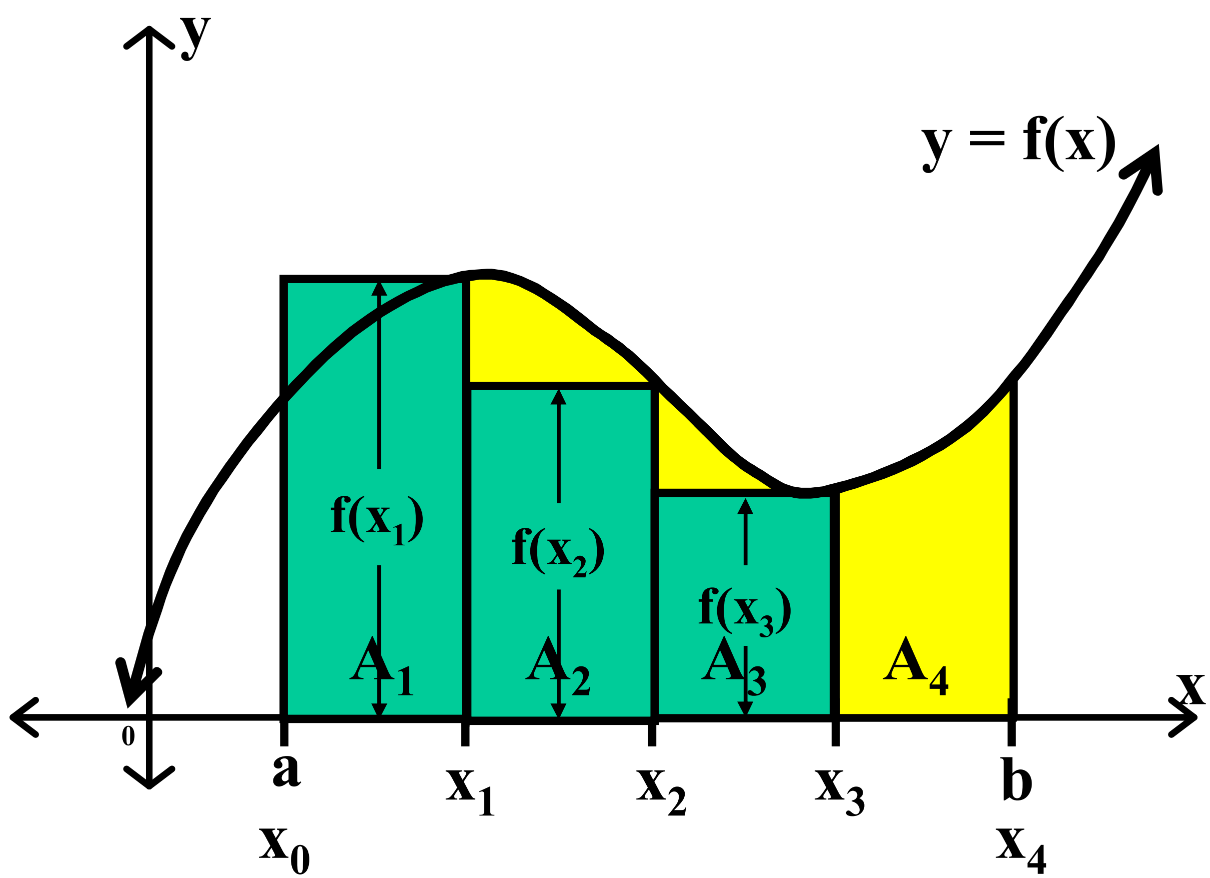

The width of each rectangle is Δx.

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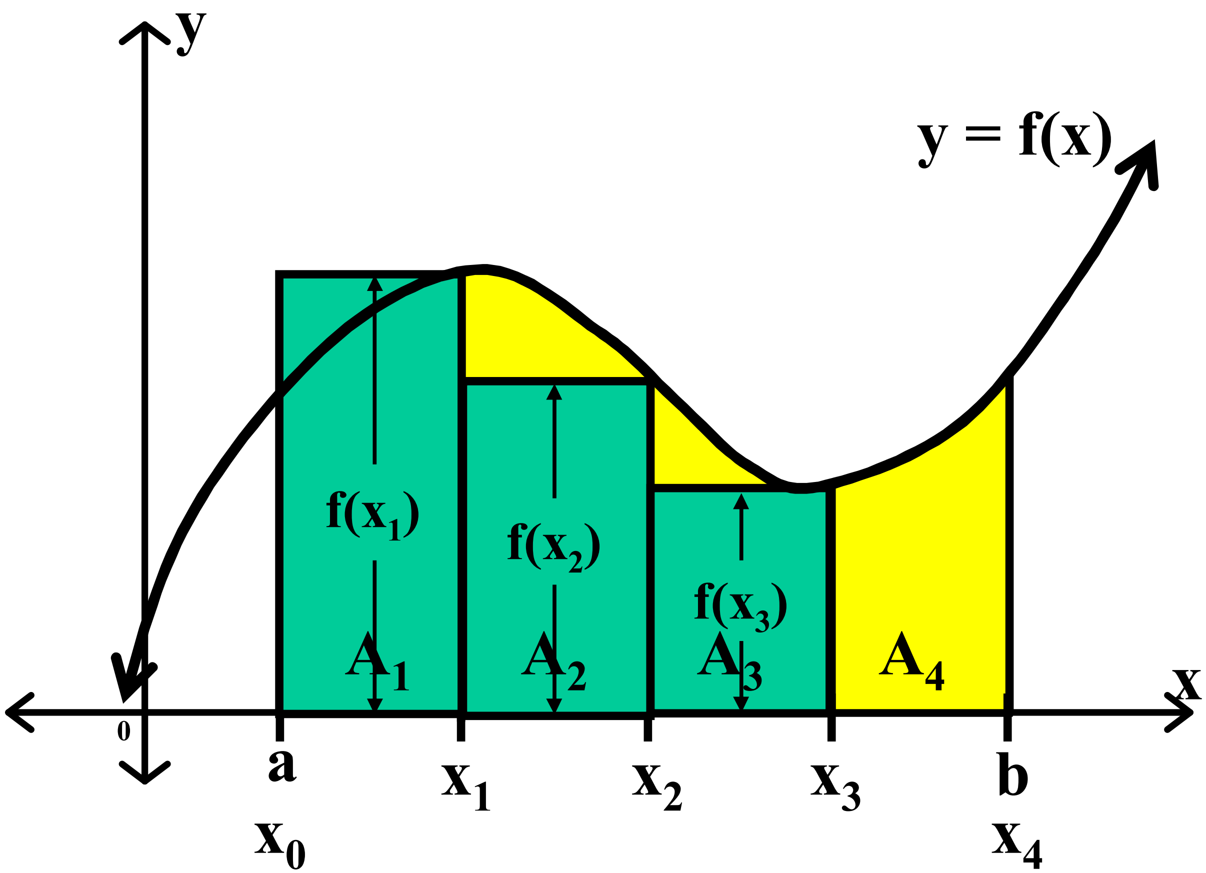

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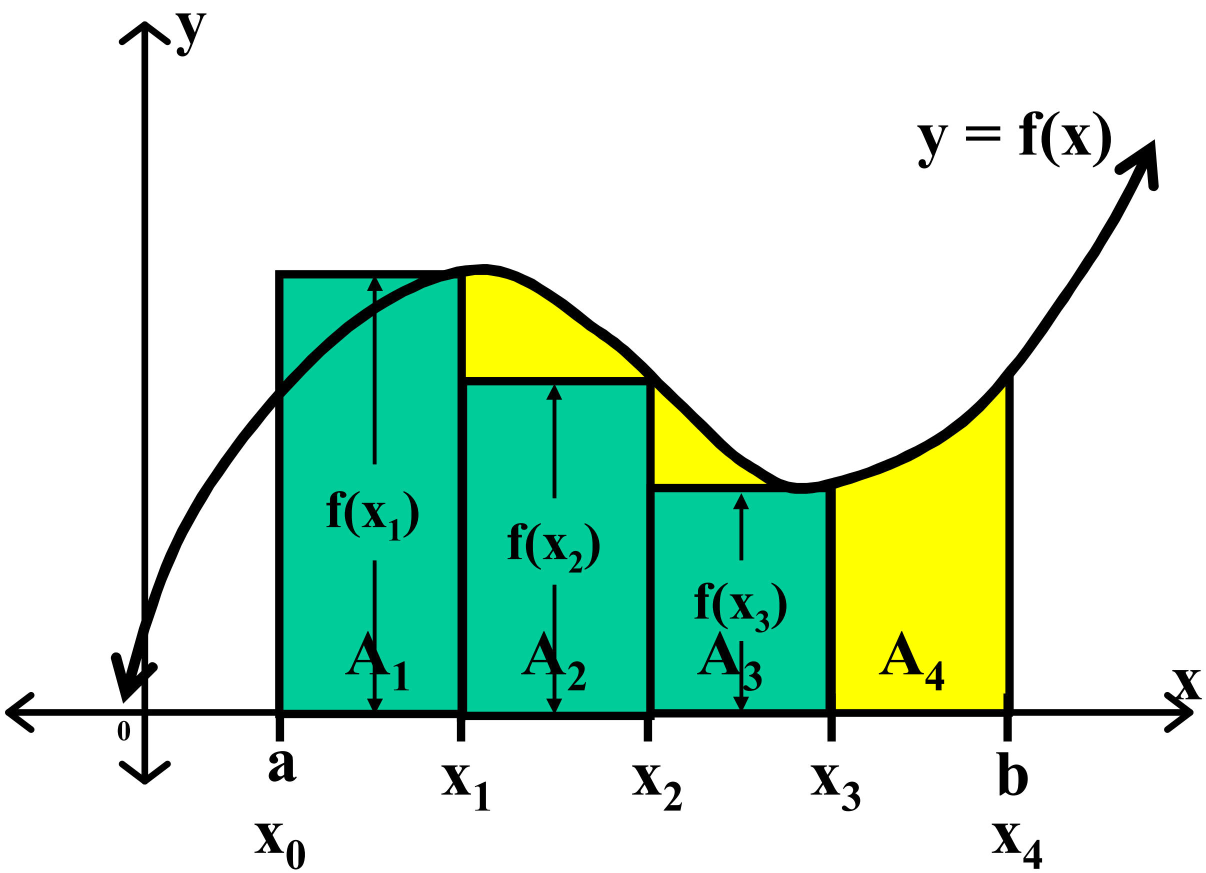

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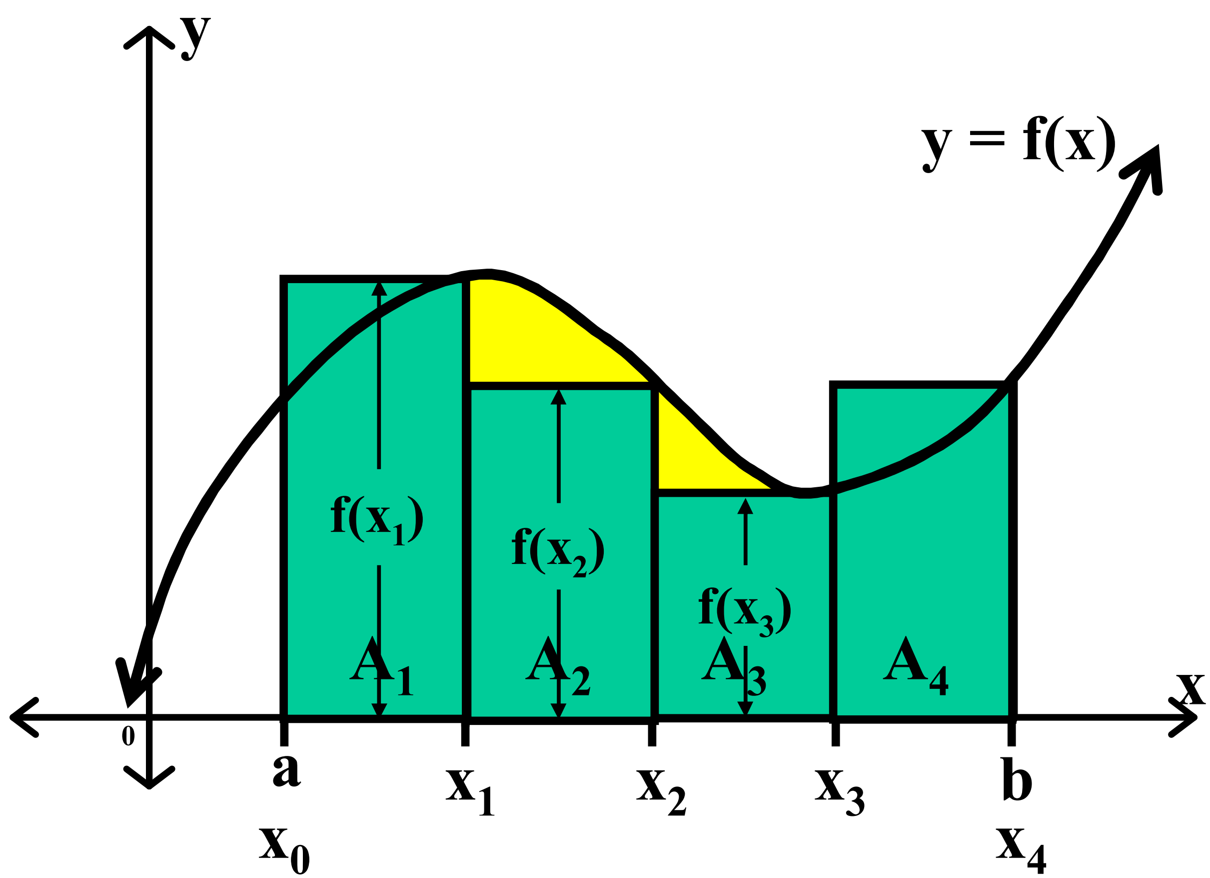

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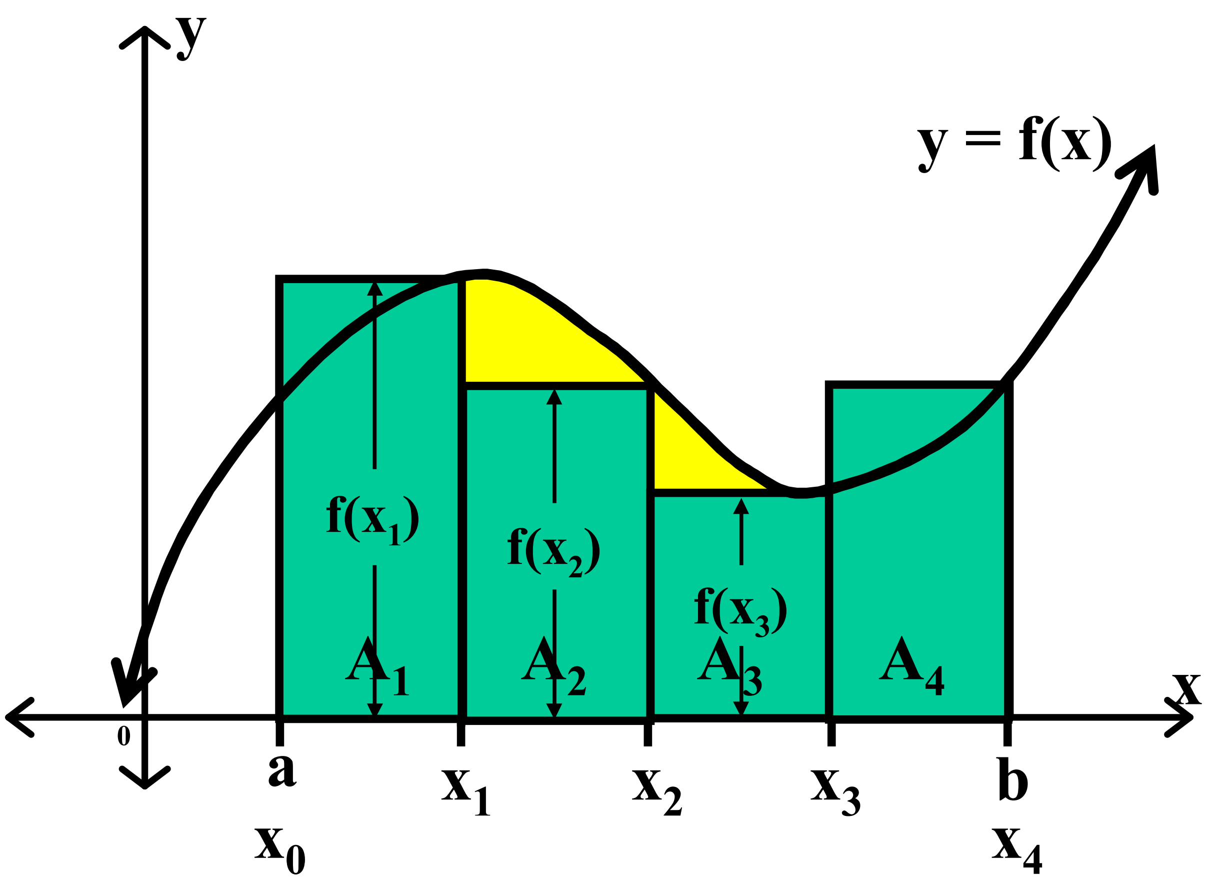

The width of each rectangle is Δx.

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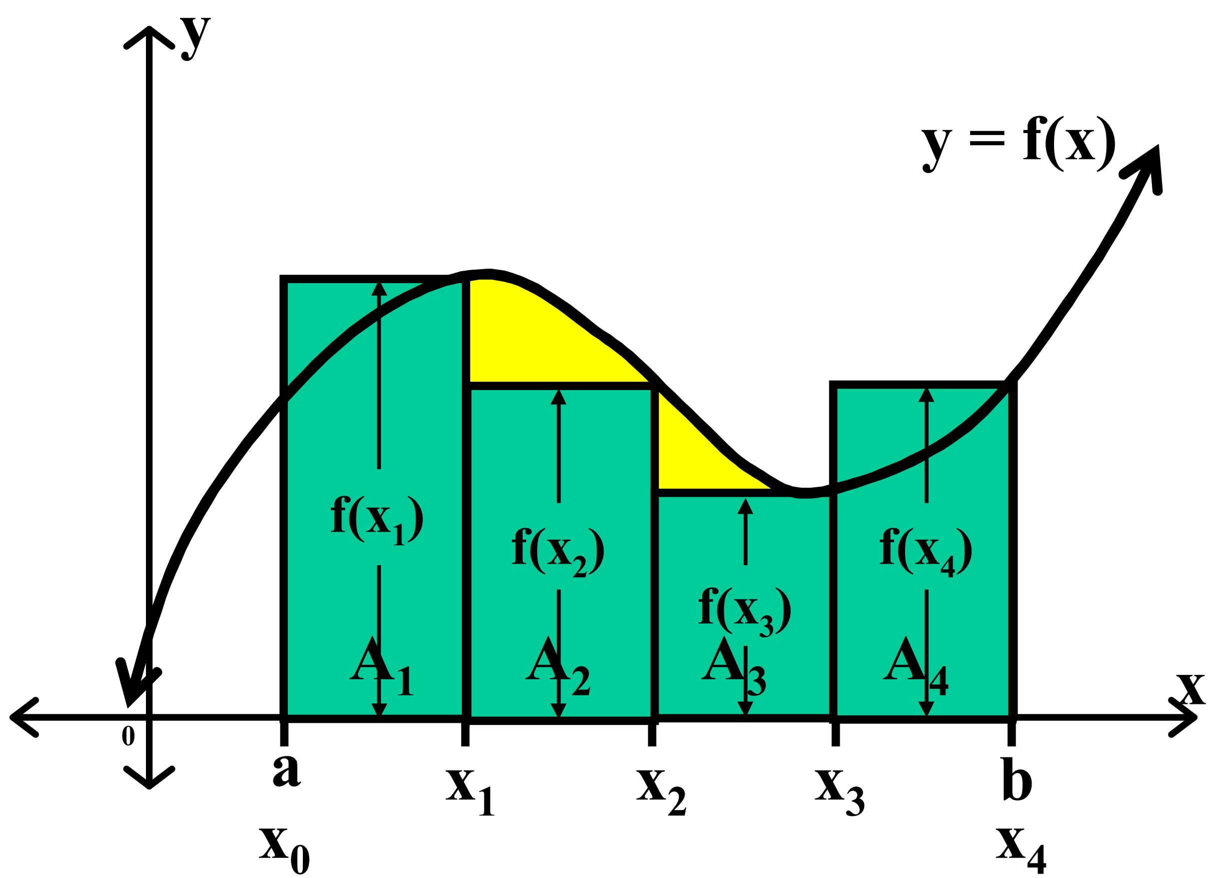

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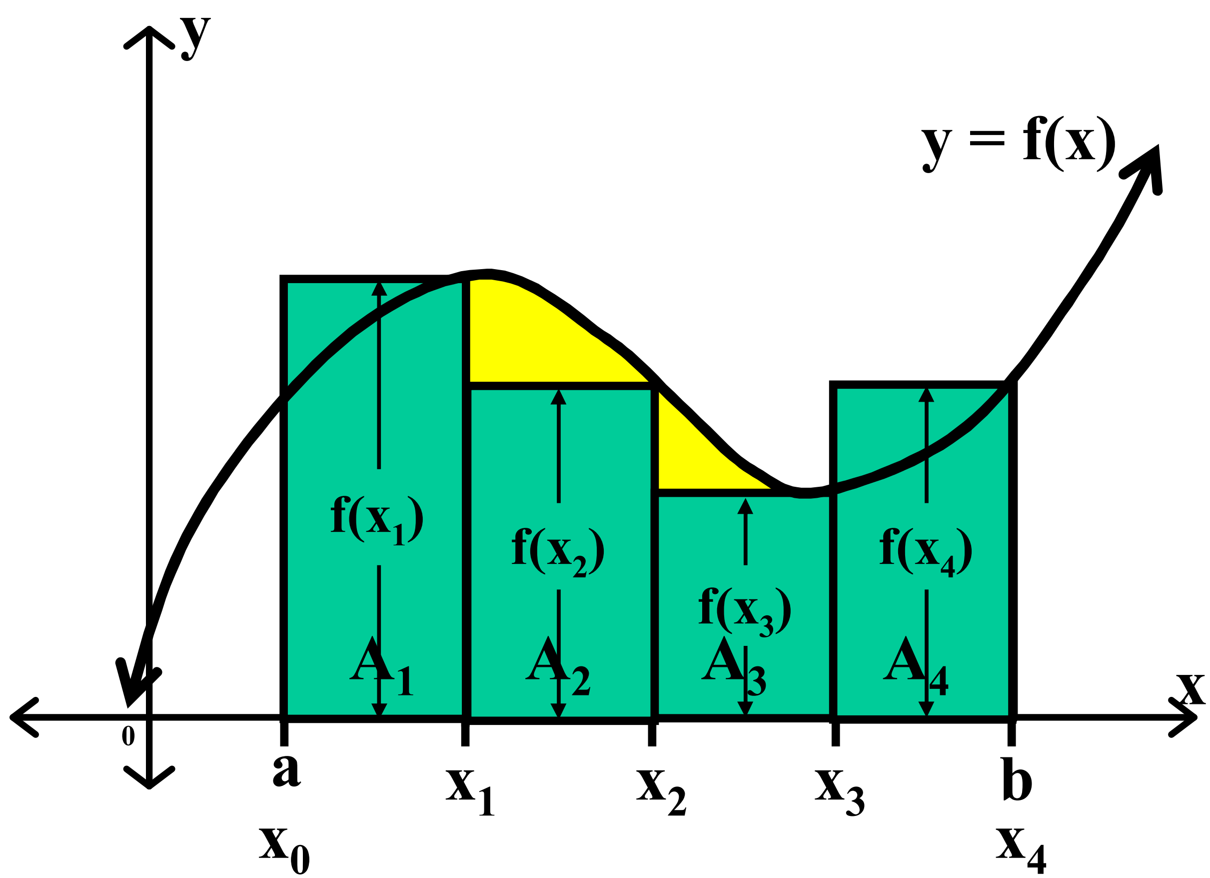

The width of each rectangle is Δx.

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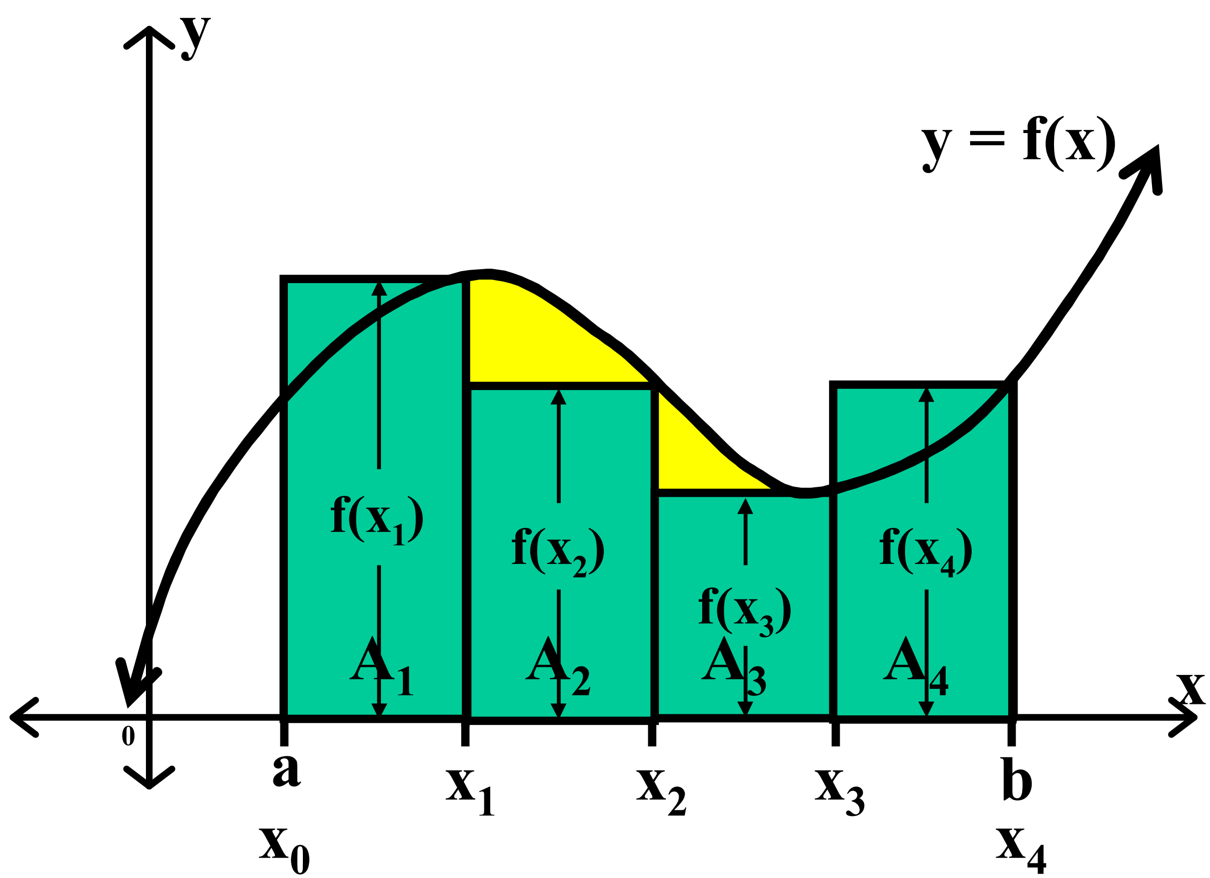

The width of each rectangle is Δx.

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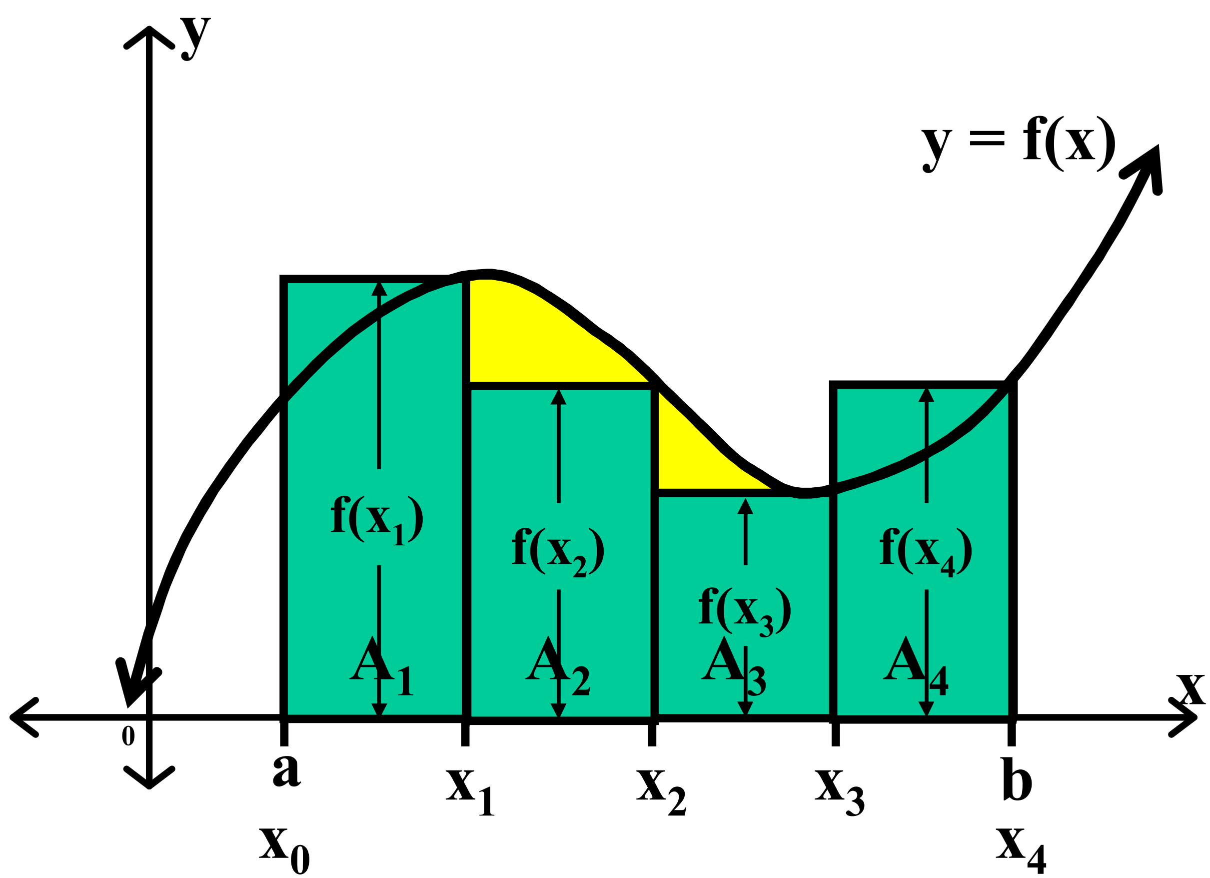
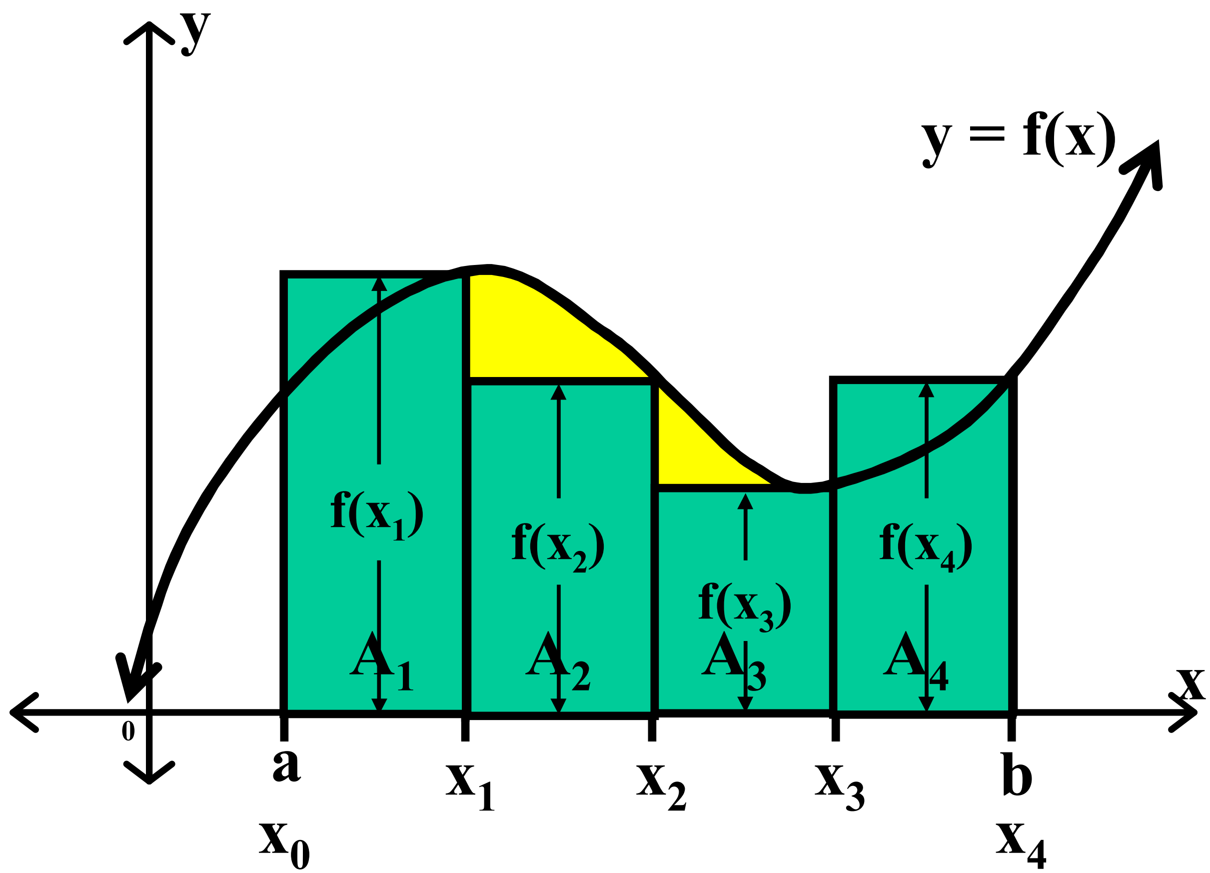
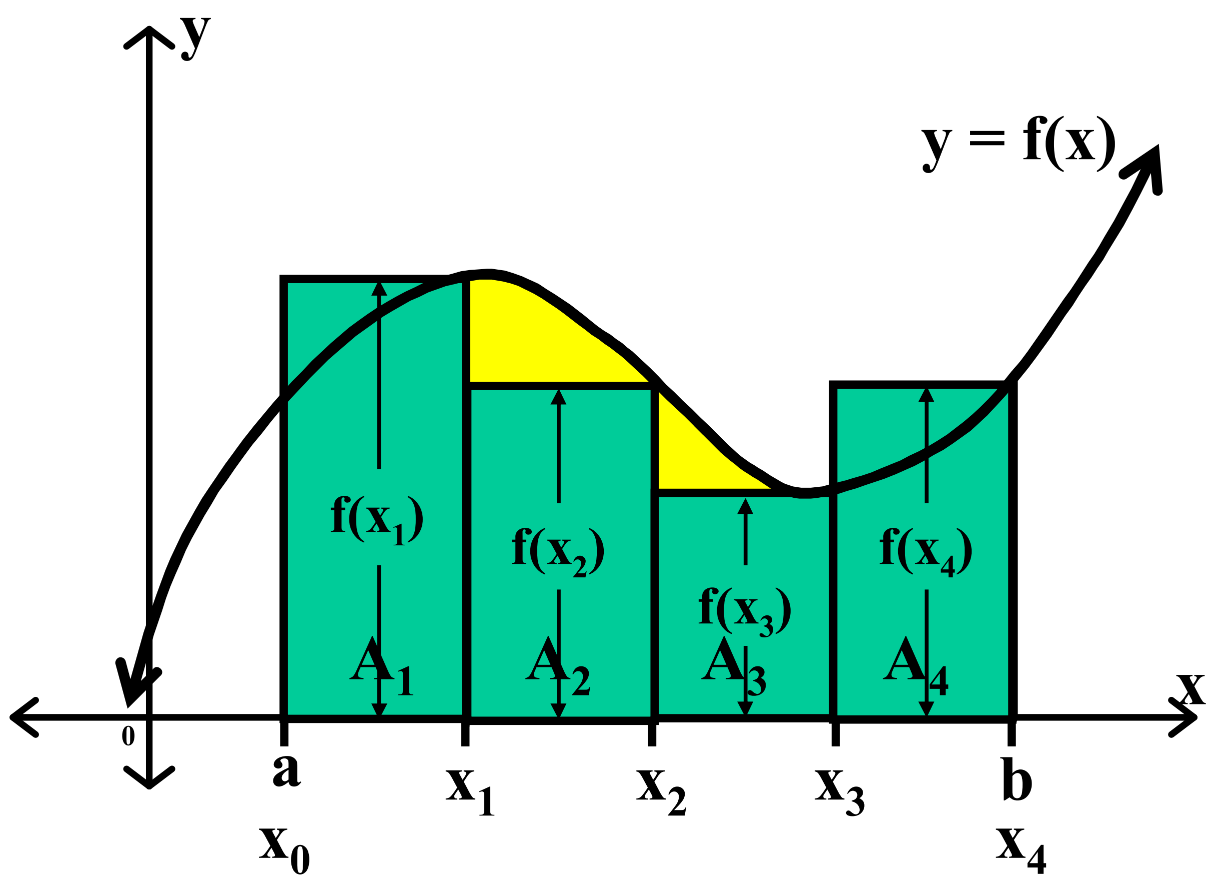


$A_1 \approx f(x_1)\Delta x \quad A_2 \approx f(x_2)\Delta x \quad A_3 \approx f(x_3)\Delta x \quad A_4 \approx f(x_4)\Delta x$



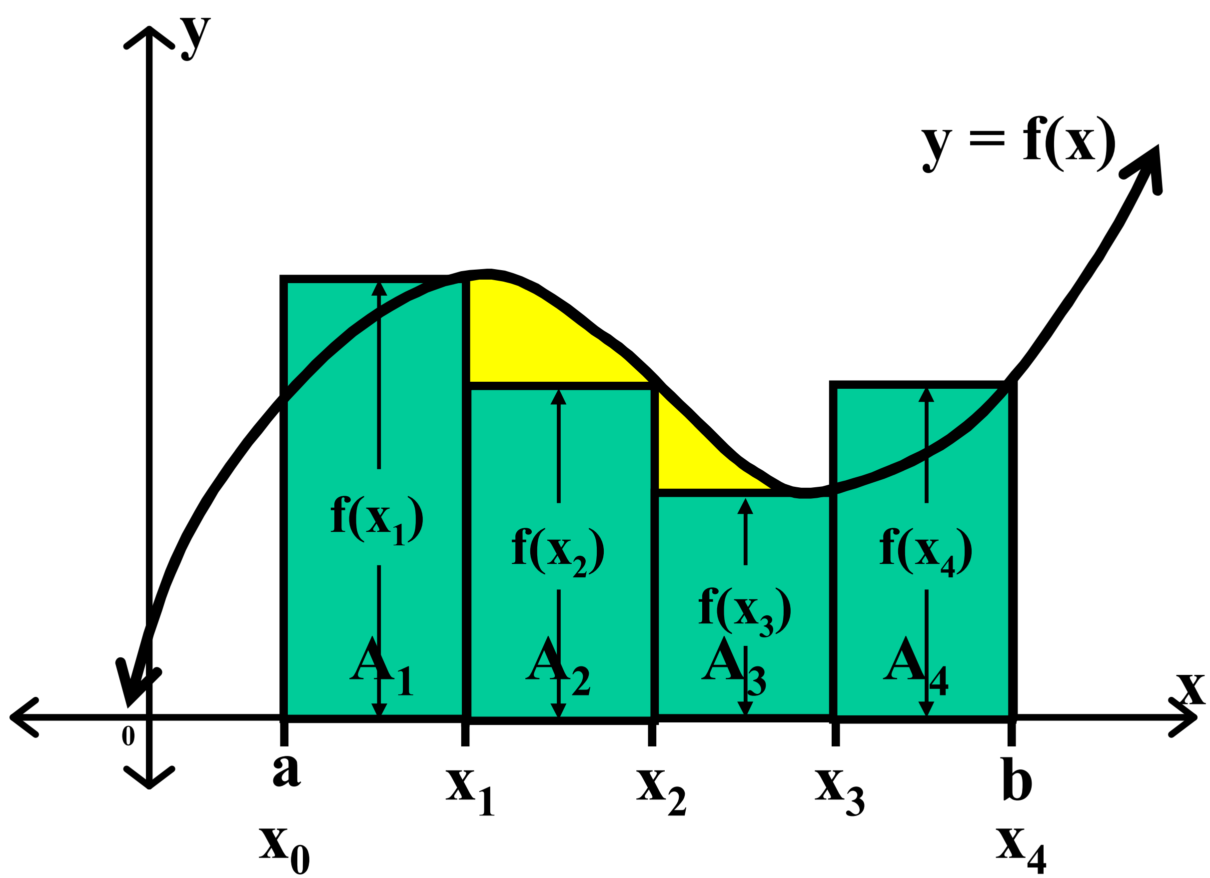
$A_1 \approx f(x_1)\Delta x \quad A_2 \approx f(x_2)\Delta x \quad A_3 \approx f(x_3)\Delta x \quad A_4 \approx f(x_4)\Delta x$

Notice that, in general,



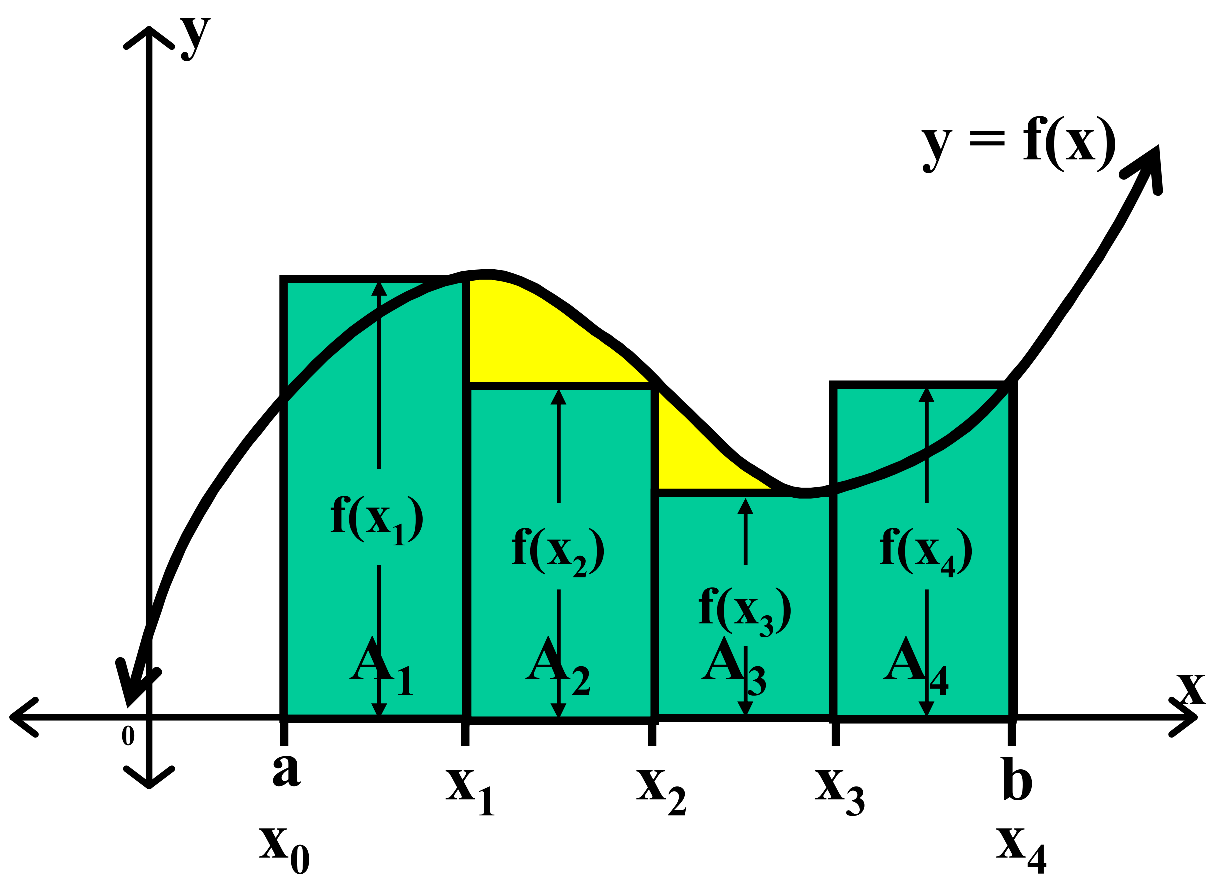
$A_1 \approx f(x_1)\Delta x$ $A_2 \approx f(x_2)\Delta x$ $A_3 \approx f(x_3)\Delta x$ $A_4 \approx f(x_4)\Delta x$

Notice that, in general, $A_i \approx$



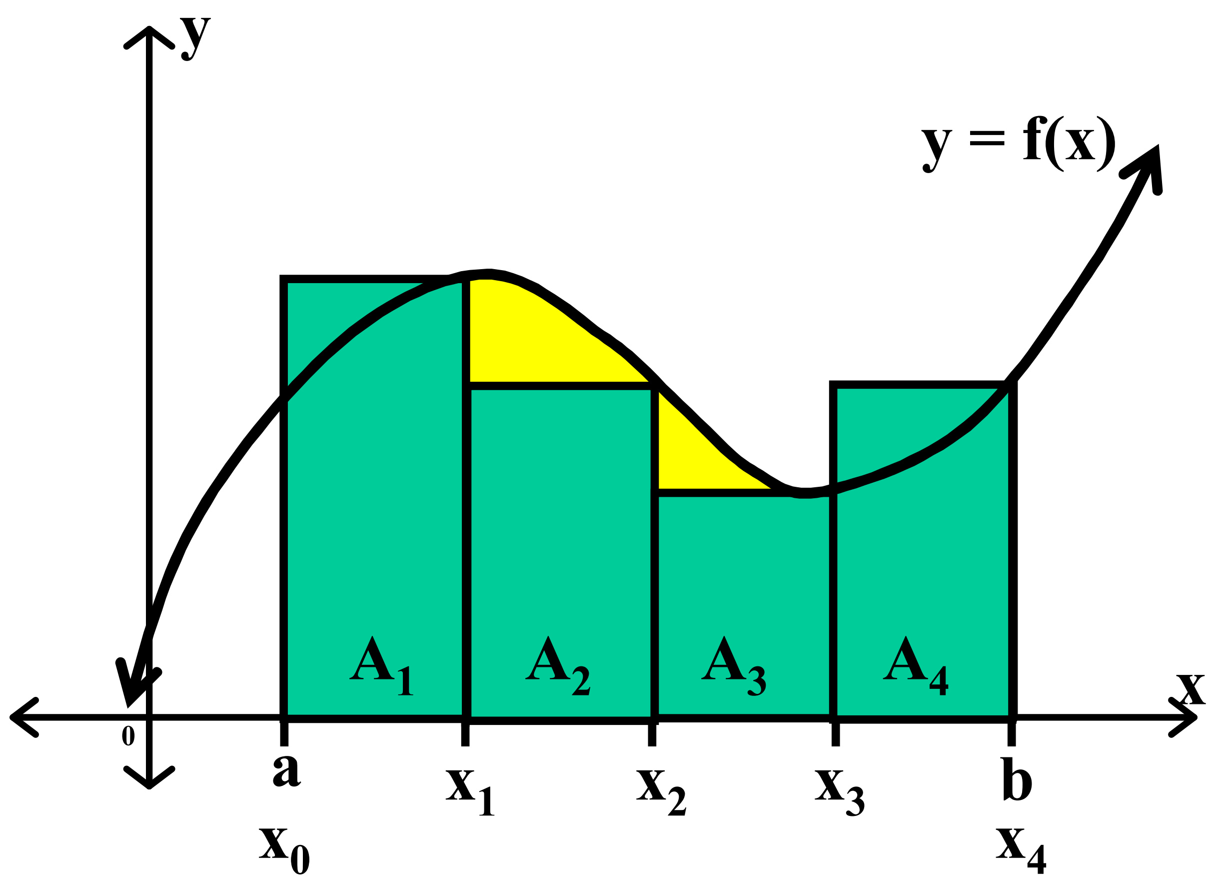
$A_1 \approx f(x_1)\Delta x \quad A_2 \approx f(x_2)\Delta x \quad A_3 \approx f(x_3)\Delta x \quad A_4 \approx f(x_4)\Delta x$

Notice that, in general, $A_i \approx f(x_i)$

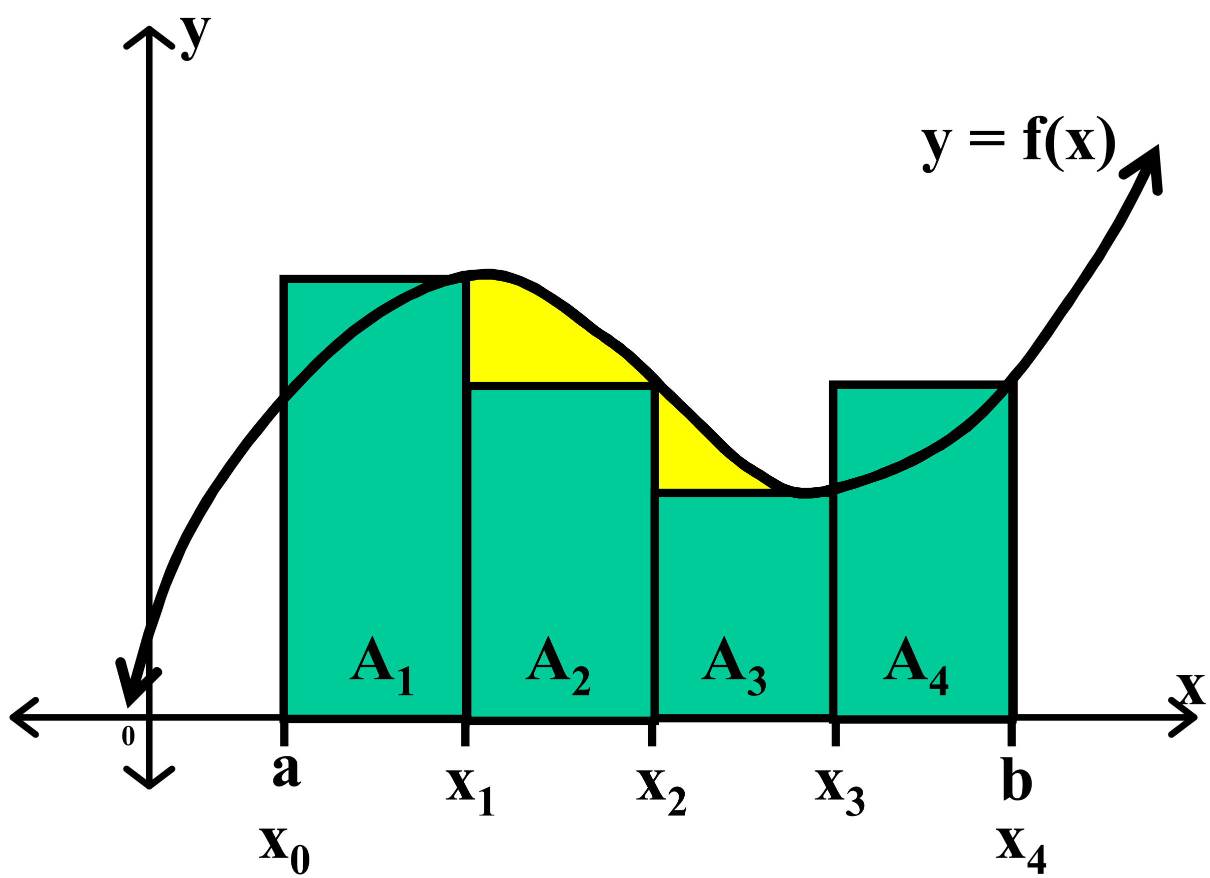


$A_1 \approx f(x_1)\Delta x \quad A_2 \approx f(x_2)\Delta x \quad A_3 \approx f(x_3)\Delta x \quad A_4 \approx f(x_4)\Delta x$

Notice that, in general, $A_i \approx f(x_i)\Delta x$.

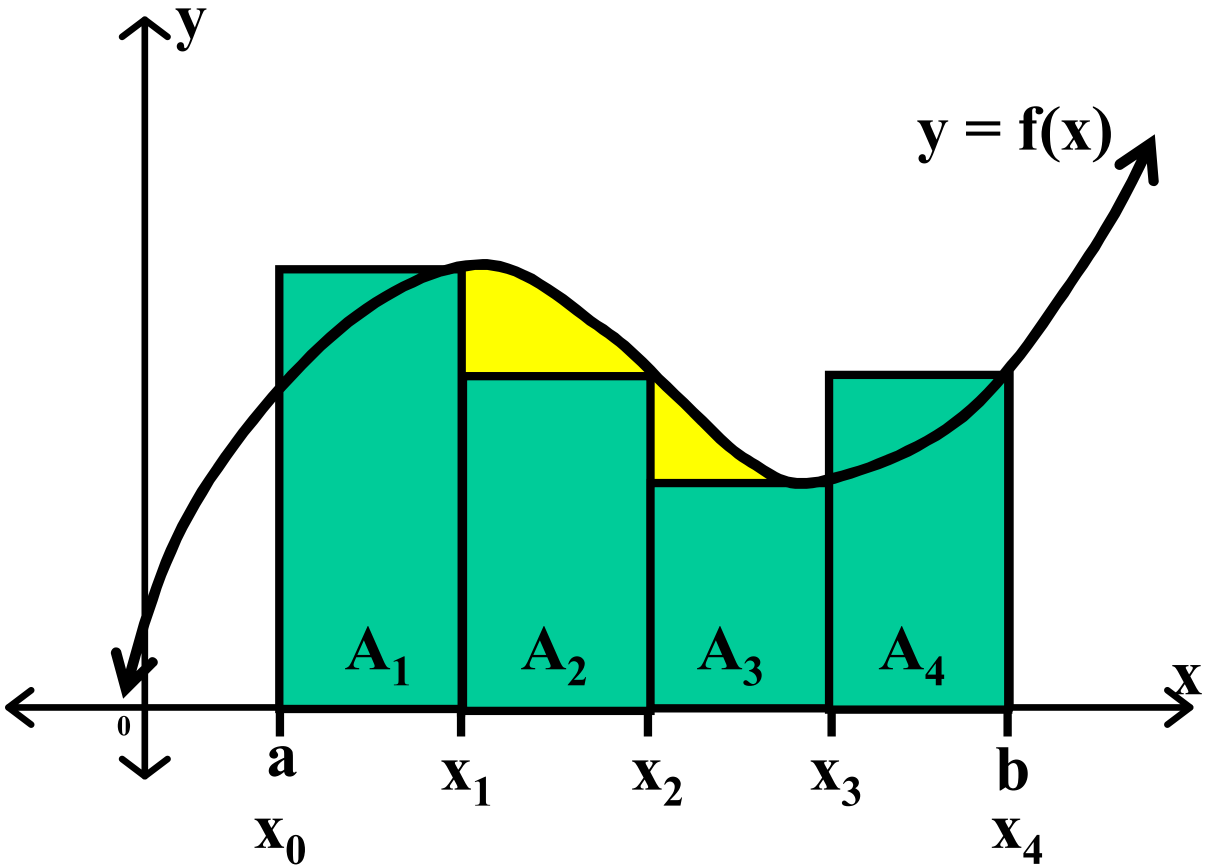


$A_i \approx f(x_i)\Delta x$



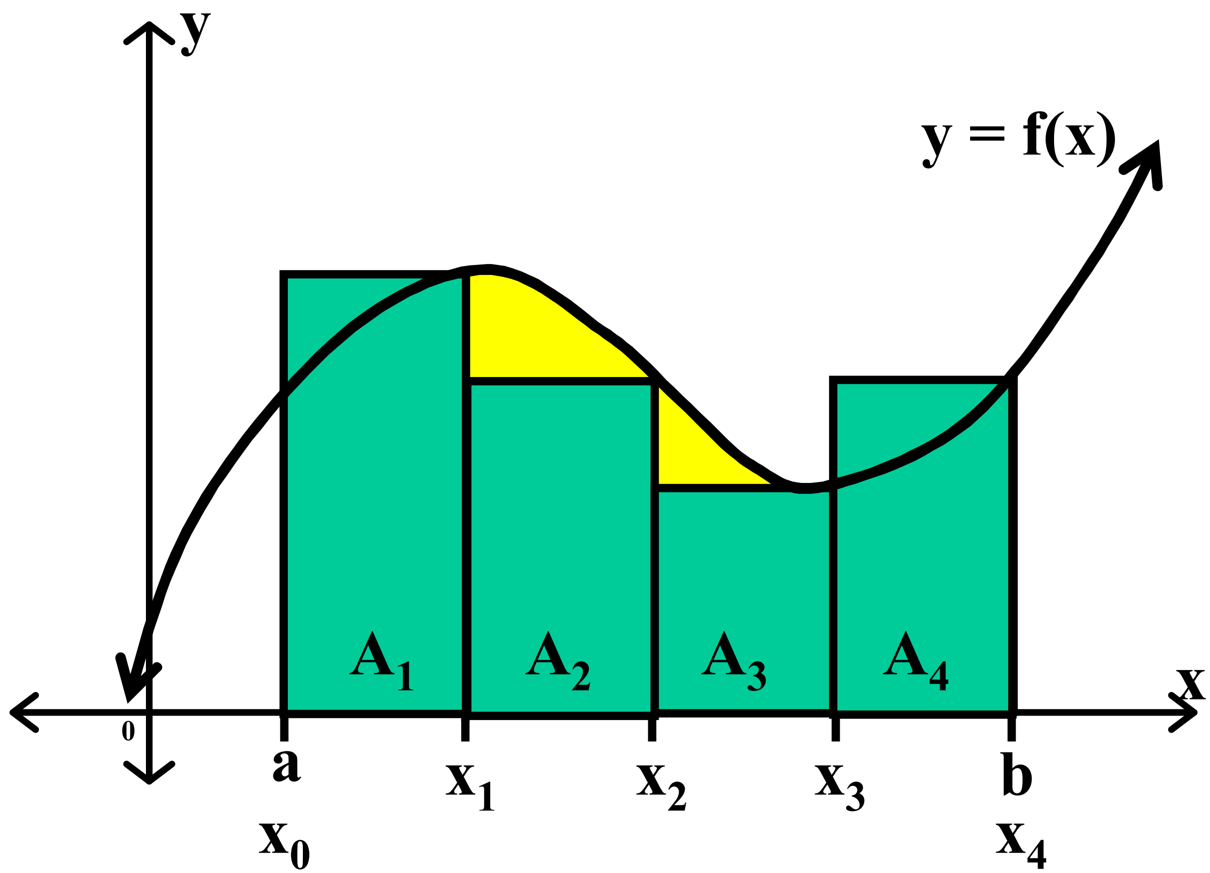
$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx$$



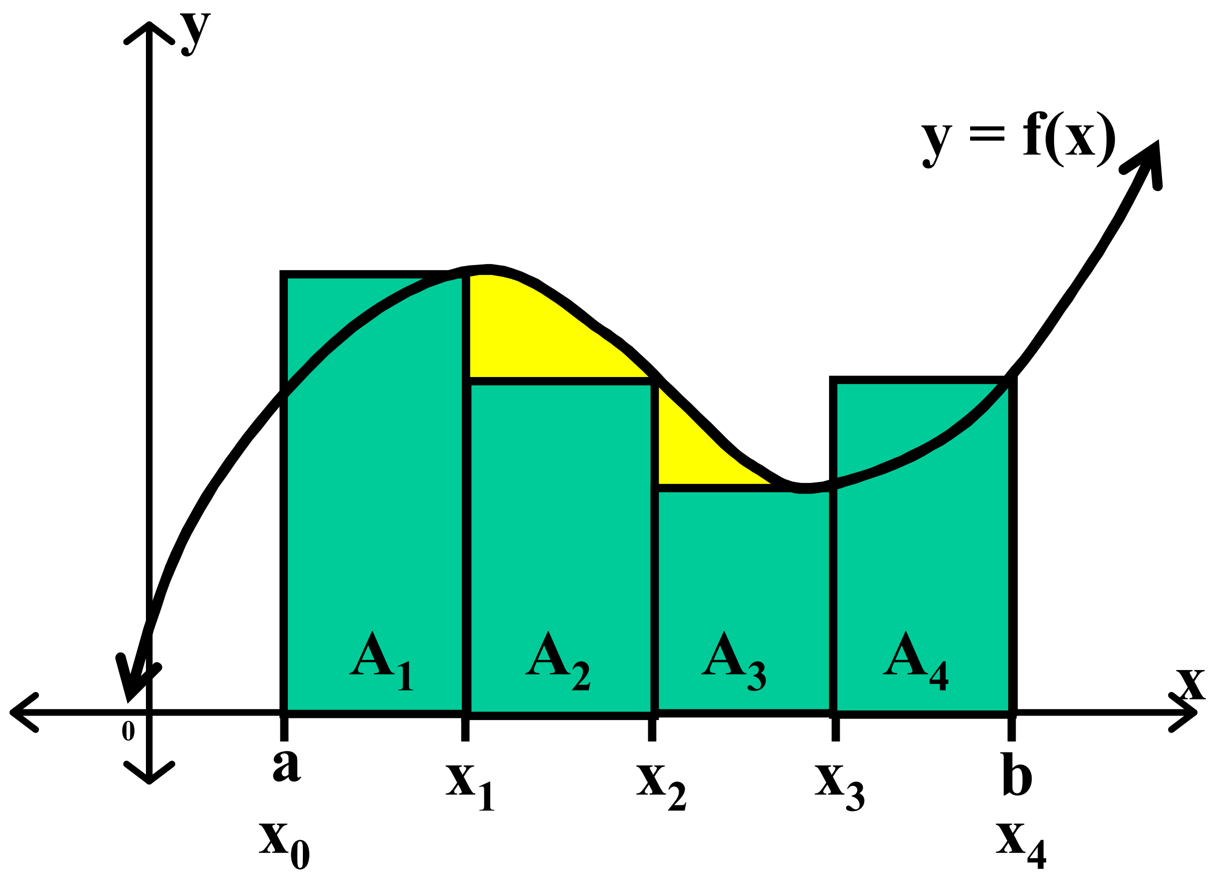
$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4$$



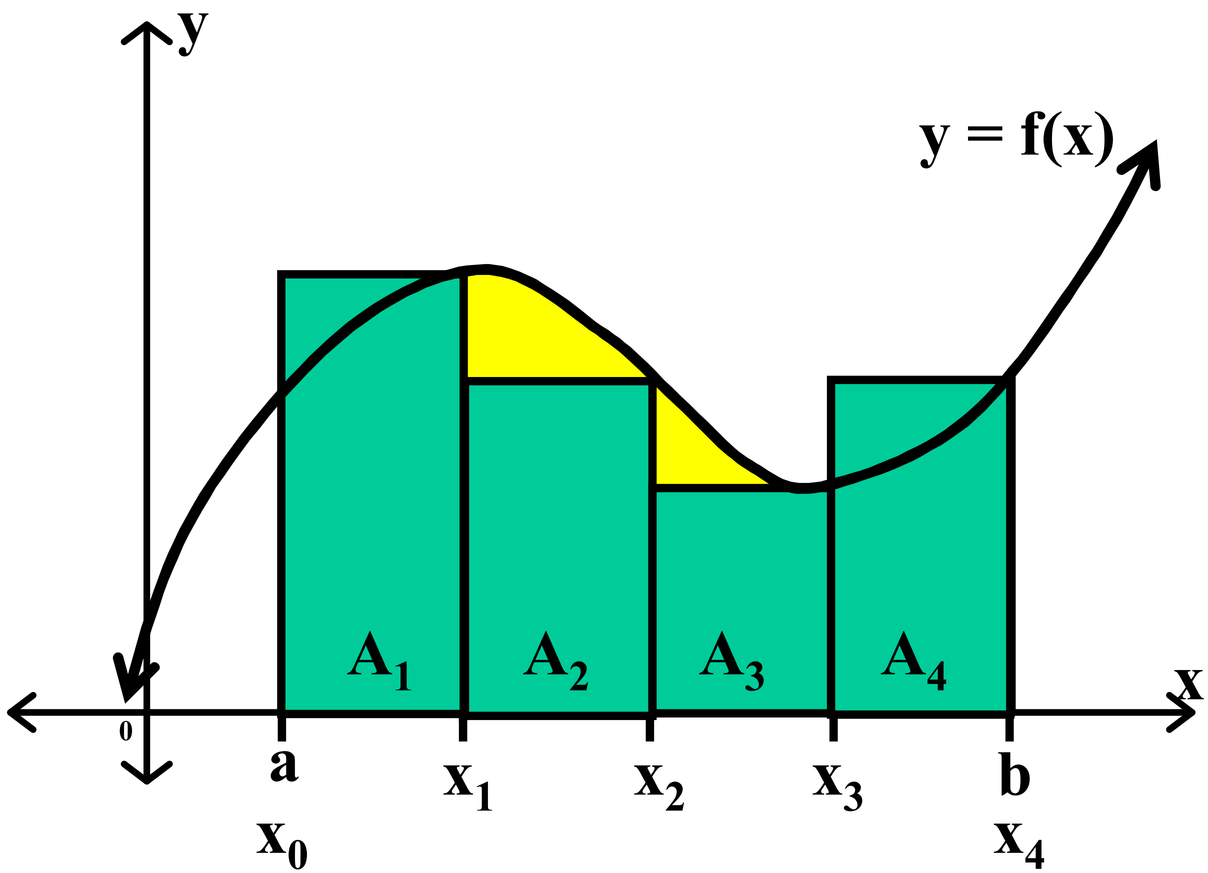
$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4 = \sum_{i=1}^{n} A_i$$



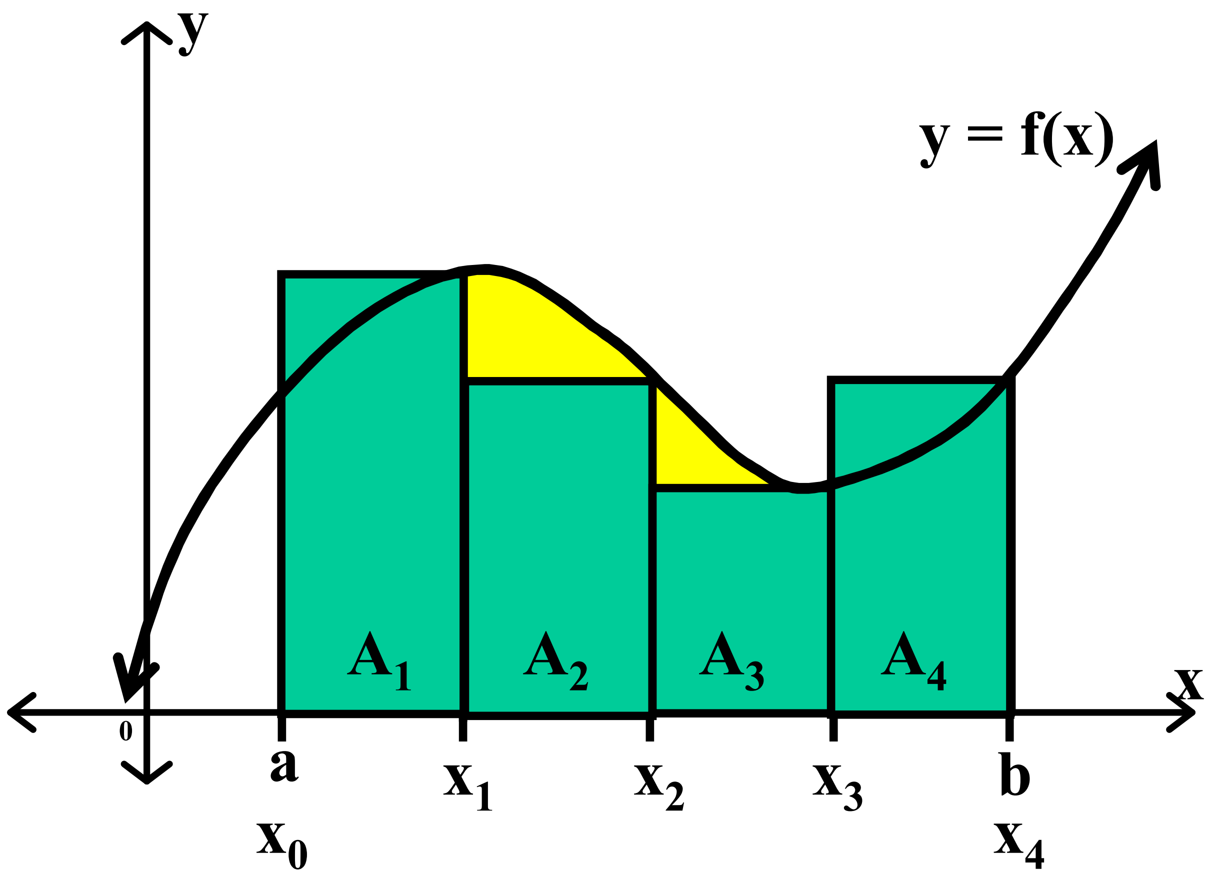
$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4 = \sum_{i=1}^{n} A_i \quad \text{(In this case, n = 4.)}$$



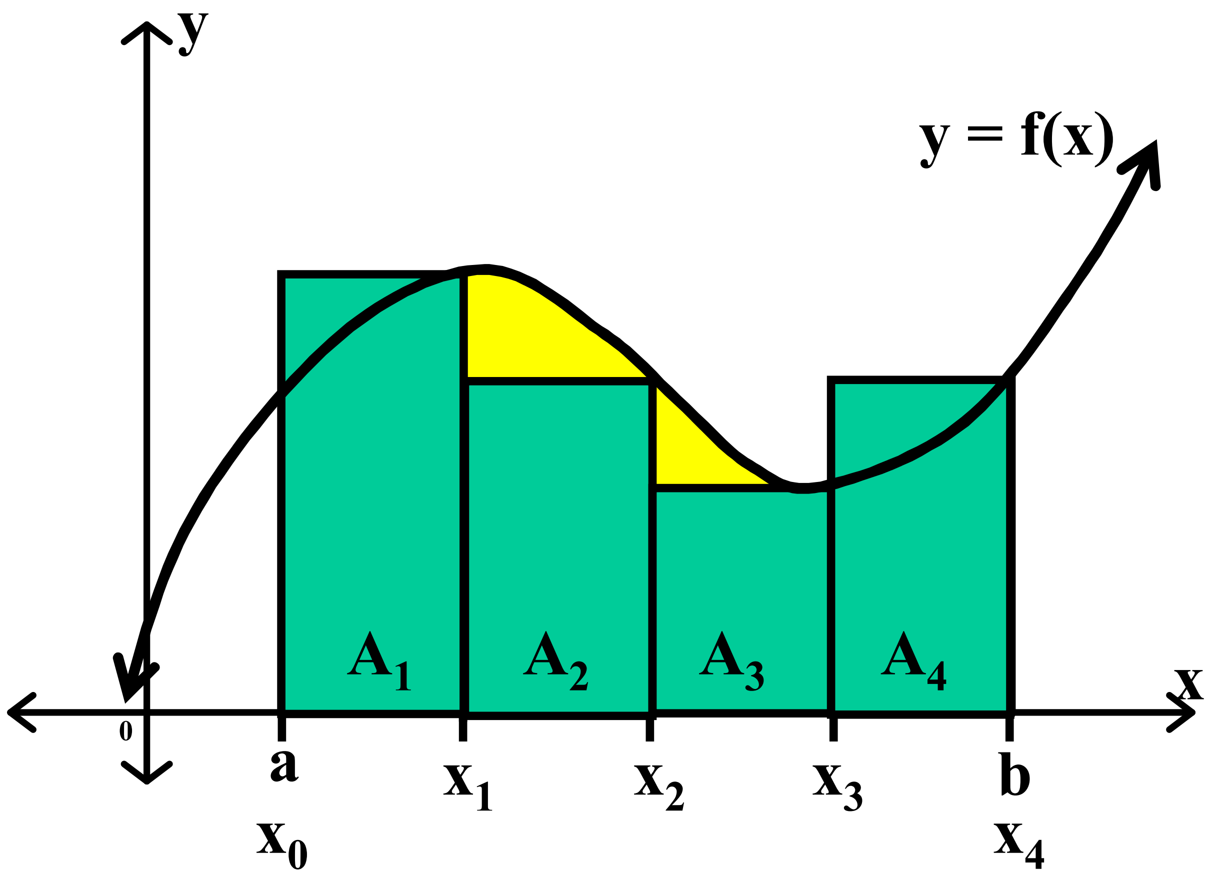
$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$



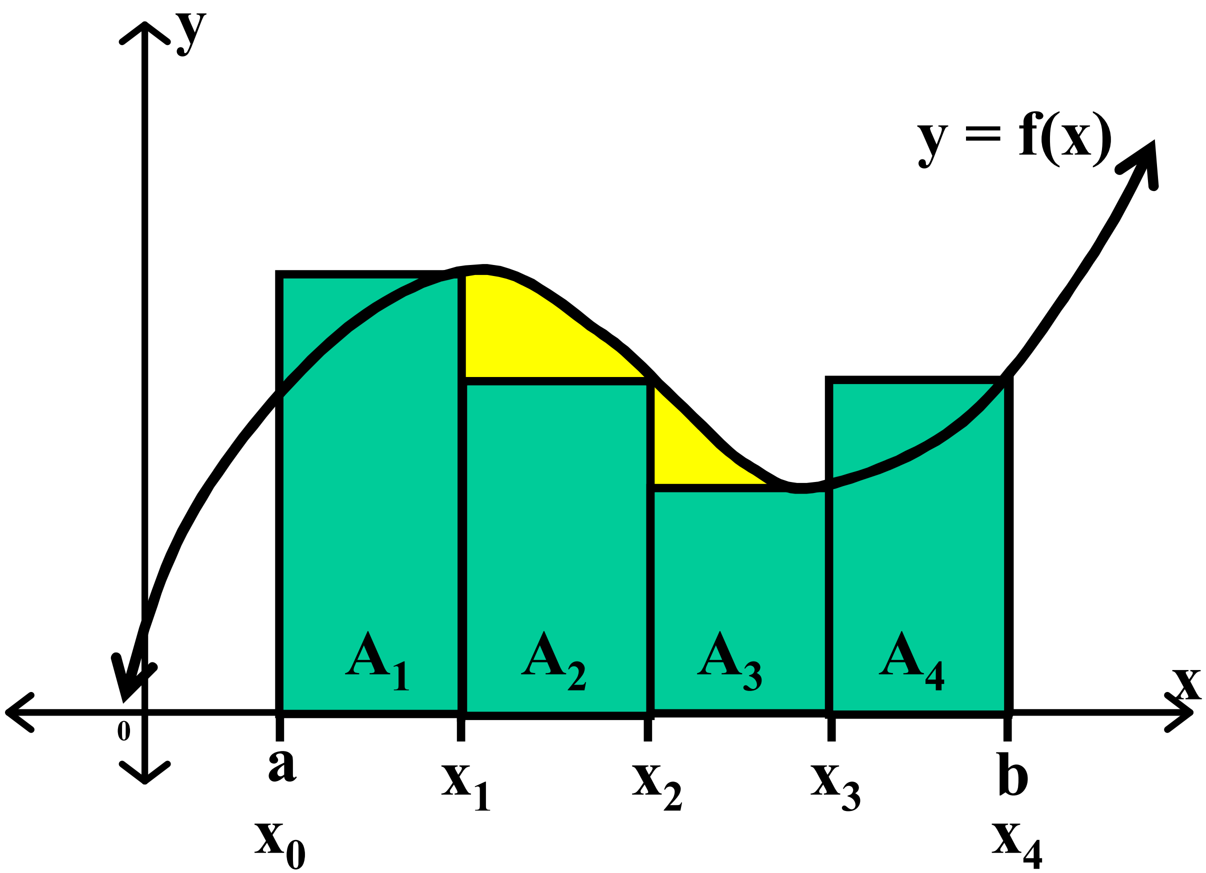
$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx$$



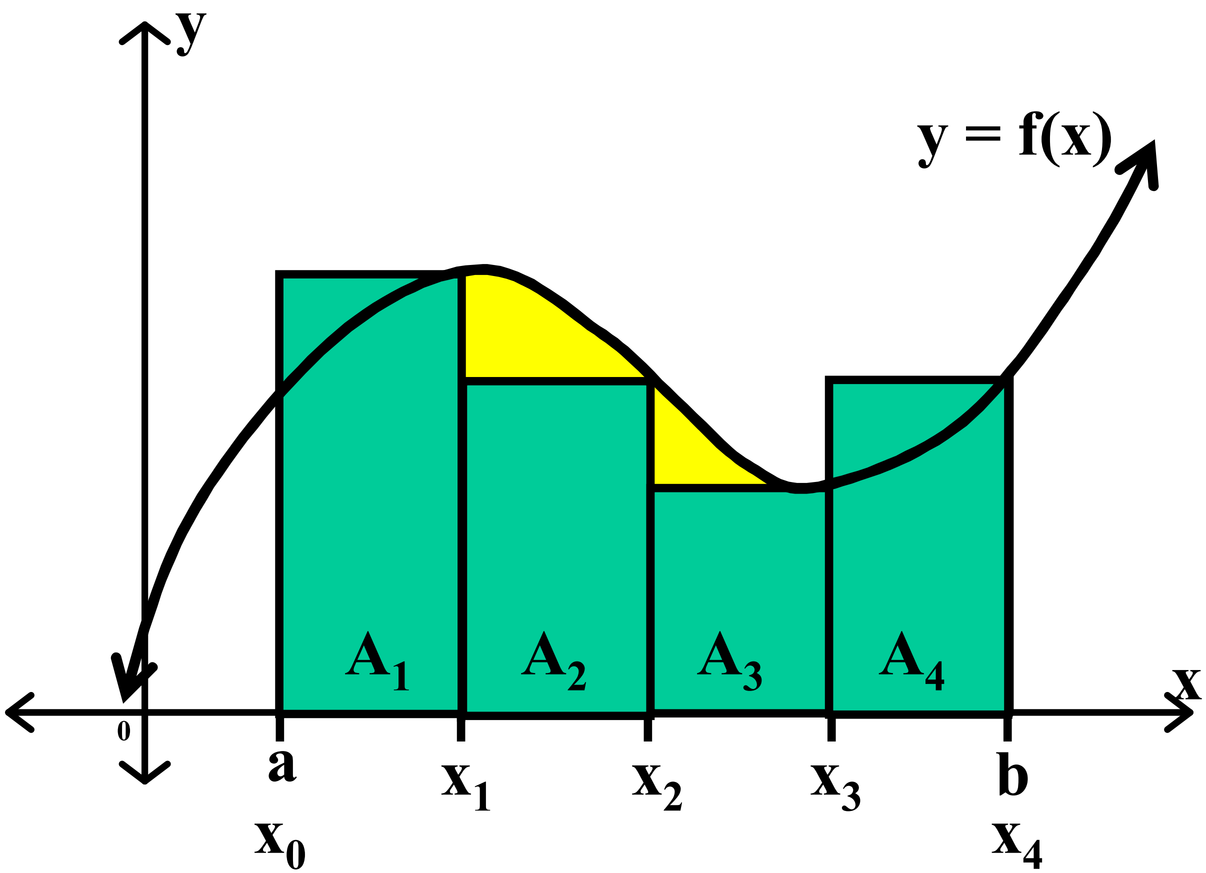
$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n}$$



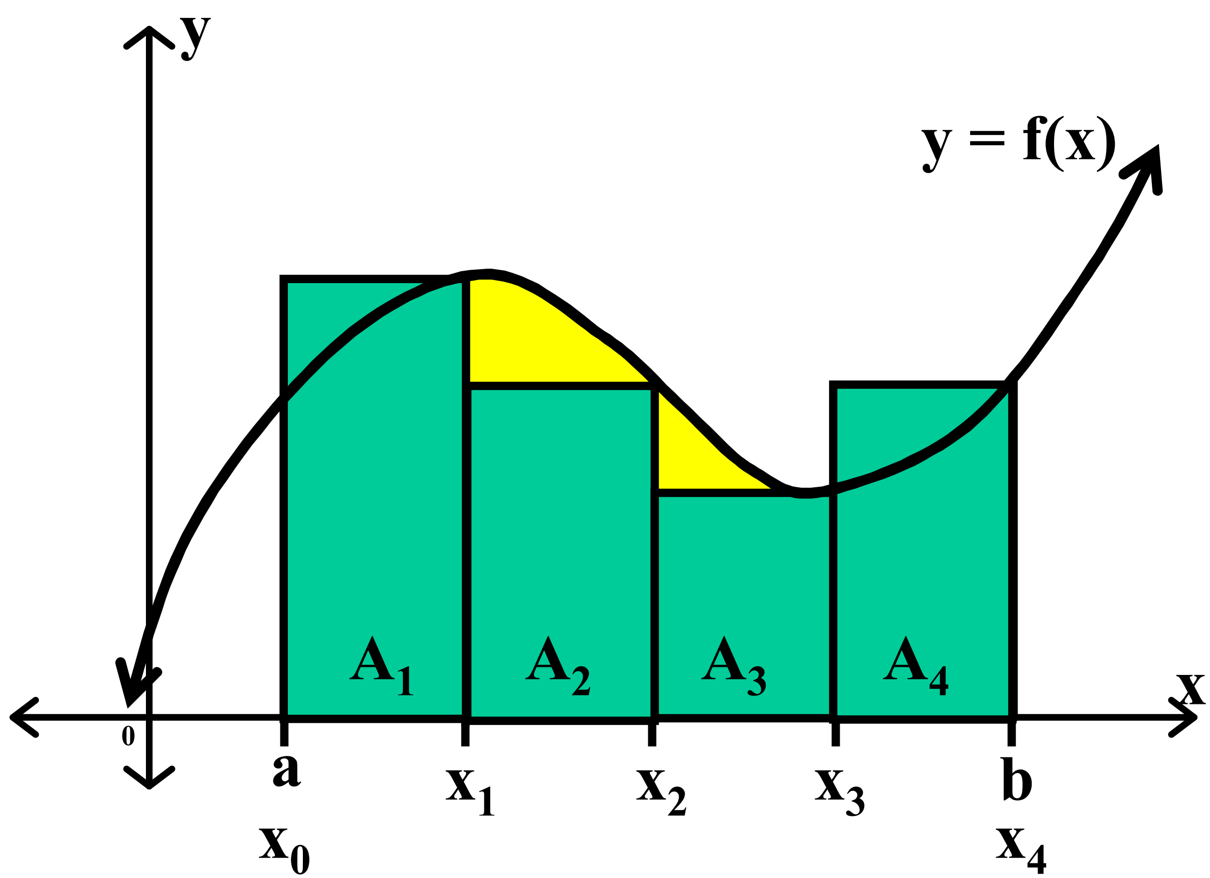
$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n} f(x_i)\Delta x$$



$$A_i \approx f(x_i)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n} f(x_i)\Delta x = S_R$$



$$S_R = \sum_{i=1}^{n} f(x_i)\Delta x$$

The Right Rectangular Approximation

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$$S_R = \sum_{i=1}^{n} f(x_i)\Delta x$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

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$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

$$S_R = \sum_{i=1}^{n} f(x_i)\Delta x$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

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$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

$$S_R = \sum_{i=1}^{n} f(x_i)\Delta x$$

$$S_R = \sum_{i=1}^{6} f(x_i)\Delta x$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

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$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

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$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

$$S_R = \sum_{i=1}^{n} f(x_i)\Delta x$$

$$S_R = \sum_{i=1}^{6} f(x_i)\Delta x$$

$$S_L = f(x_1)\Delta x + f(x_2)\Delta x + f(x_3)\Delta x + + f(x_4)\Delta x + f(x_5)\Delta x + f(x_6)\Delta x$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

$$S_R = \sum_{i=1}^{n} f(x_i)\Delta x$$

$$S_R = \sum_{i=1}^{6} f(x_i)\Delta x$$

$$S_L = f(x_1)\Delta x + f(x_2)\Delta x + f(x_3)\Delta x + + f(x_4)\Delta x + f(x_5)\Delta x + f(x_6)\Delta x$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. **n = 6**

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

$$S_R = \sum_{i=1}^{n} f(x_i)\Delta x$$

$$S_R = \sum_{i=1}^{6} f(x_i)\Delta x$$

$$S_L = f(x_1)\Delta x + f(x_2)\Delta x + f(x_3)\Delta x + + f(x_4)\Delta x + f(x_5)\Delta x + f(x_6)\Delta x$$

$$S_R = (\sqrt{12.625} + \sqrt{24} + \sqrt{39.875} + \sqrt{61} + \sqrt{88.125} + \sqrt{122})(.5)$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

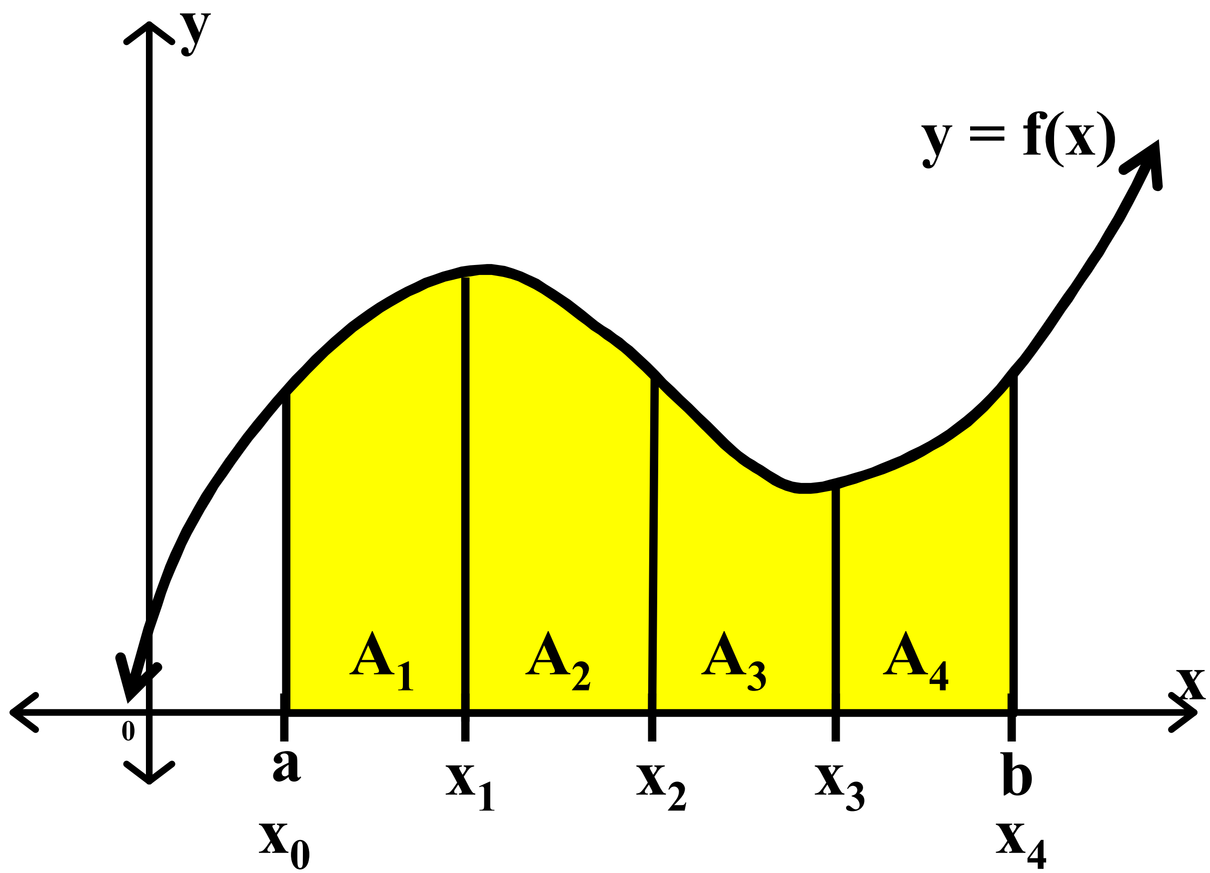
$$S_R = \sum_{i=1}^{n} f(x_i)\Delta x$$

$$S_R = \sum_{i=1}^{6} f(x_i)\Delta x$$

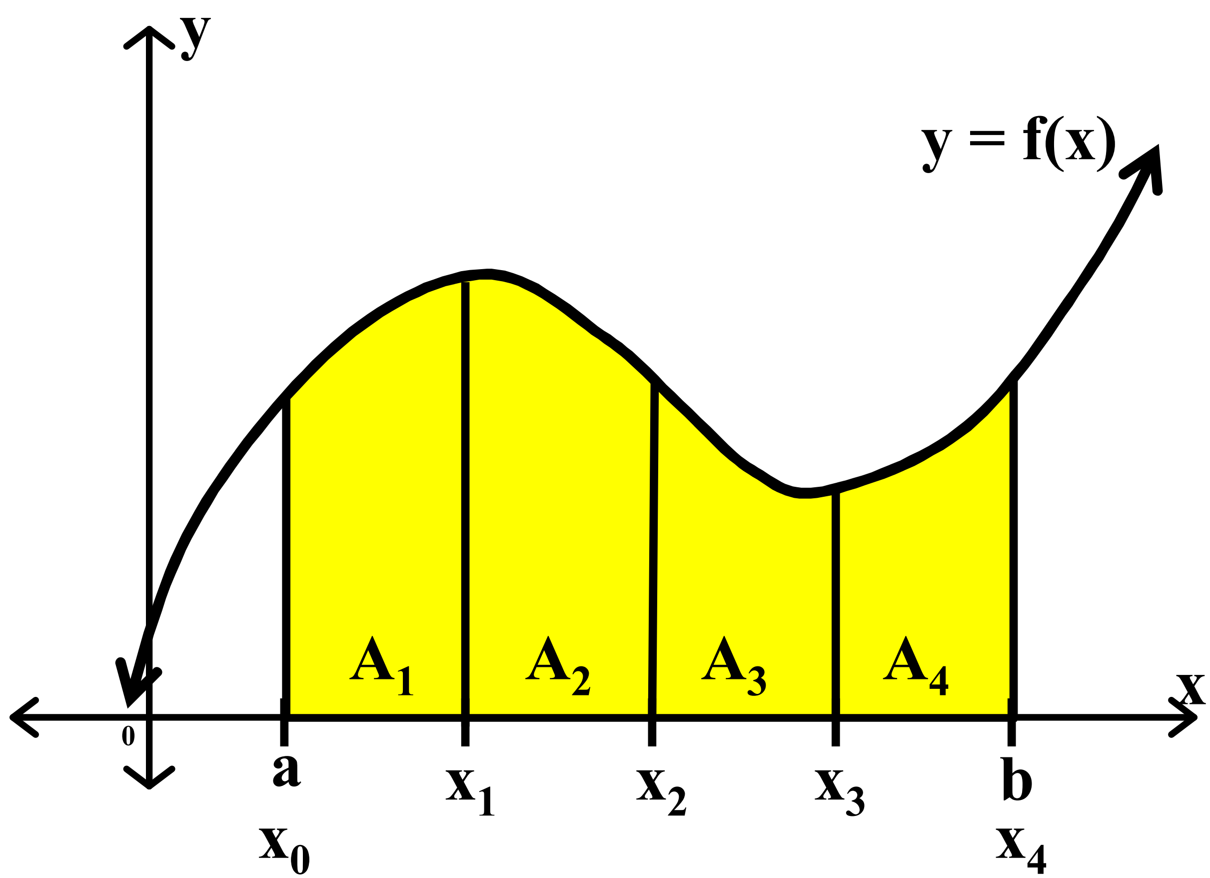
$$S_L = f(x_1)\Delta x + f(x_2)\Delta x + f(x_3)\Delta x + + f(x_4)\Delta x + f(x_5)\Delta x + f(x_6)\Delta x$$

$$S_R = (\sqrt{12.625} + \sqrt{24} + \sqrt{39.875} + \sqrt{61} + \sqrt{88.125} + \sqrt{122})(.5)$$

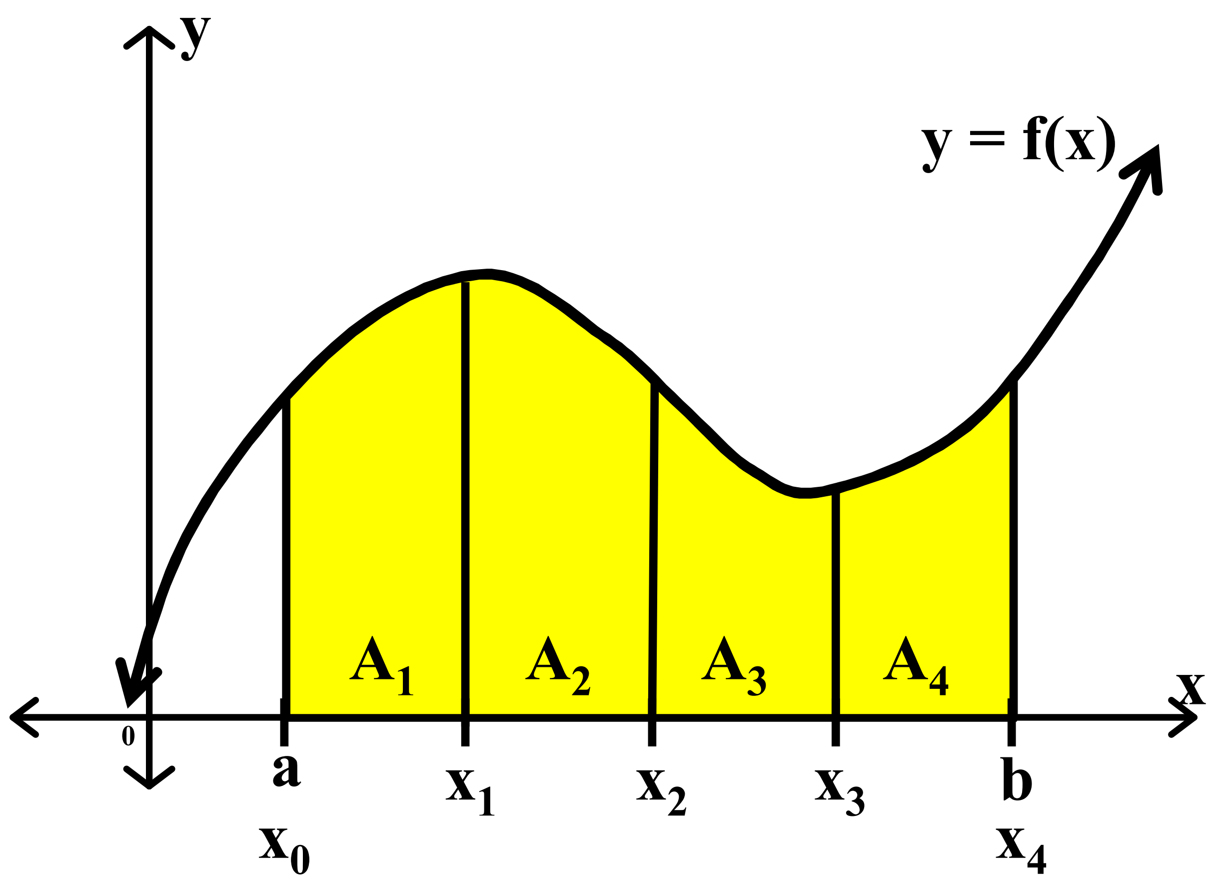
$$S_R \approx 21.50$$



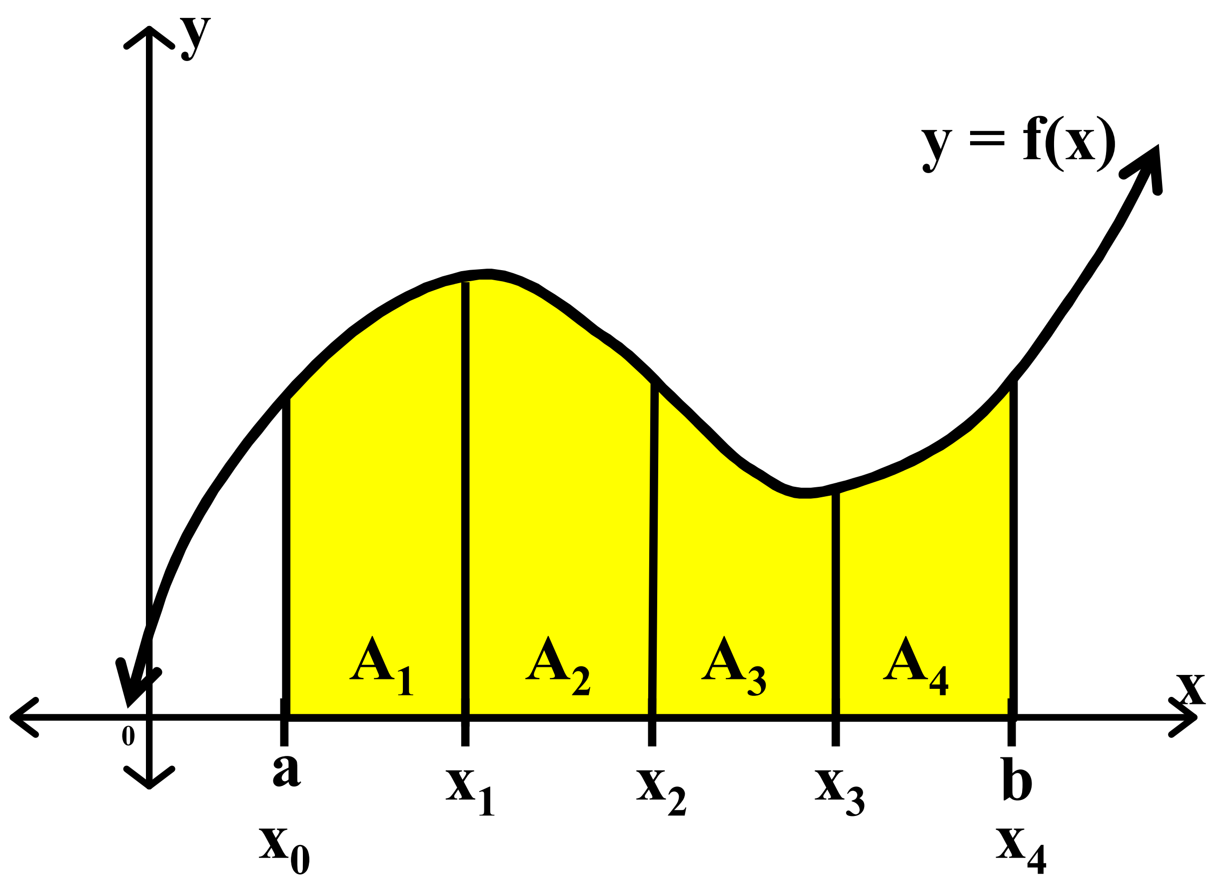
y
y = f(x)
A_1
A_2
A_3
A_4
x
0
a
x_0
x_1
x_2
x_3
b
x_4



The last Rectangular Approximation is called the Mid-Rectangular Approximation.

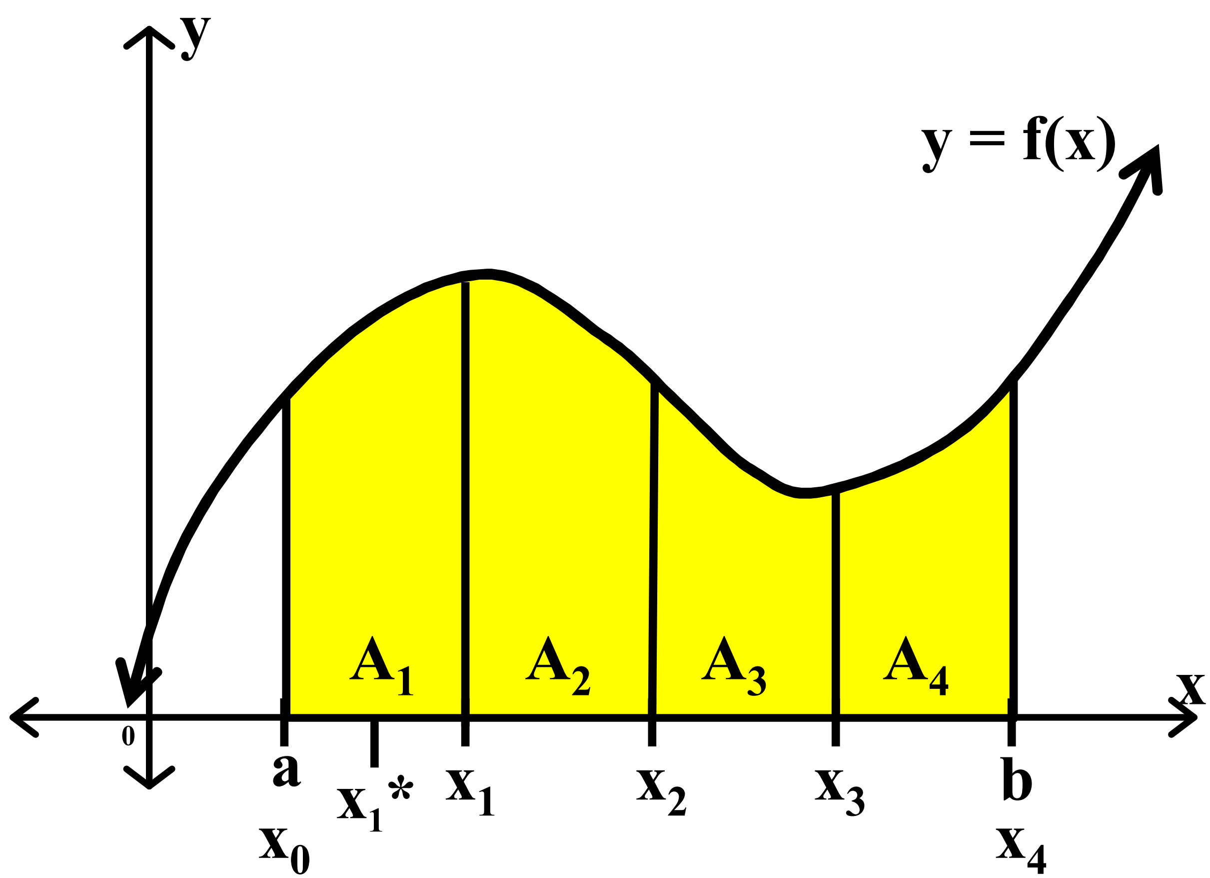


The last Rectangular Approximation is called the Mid-Rectangular Approximation, S_M.



The last Rectangular Approximation is called the Mid-Rectangular Approximation, S_M.

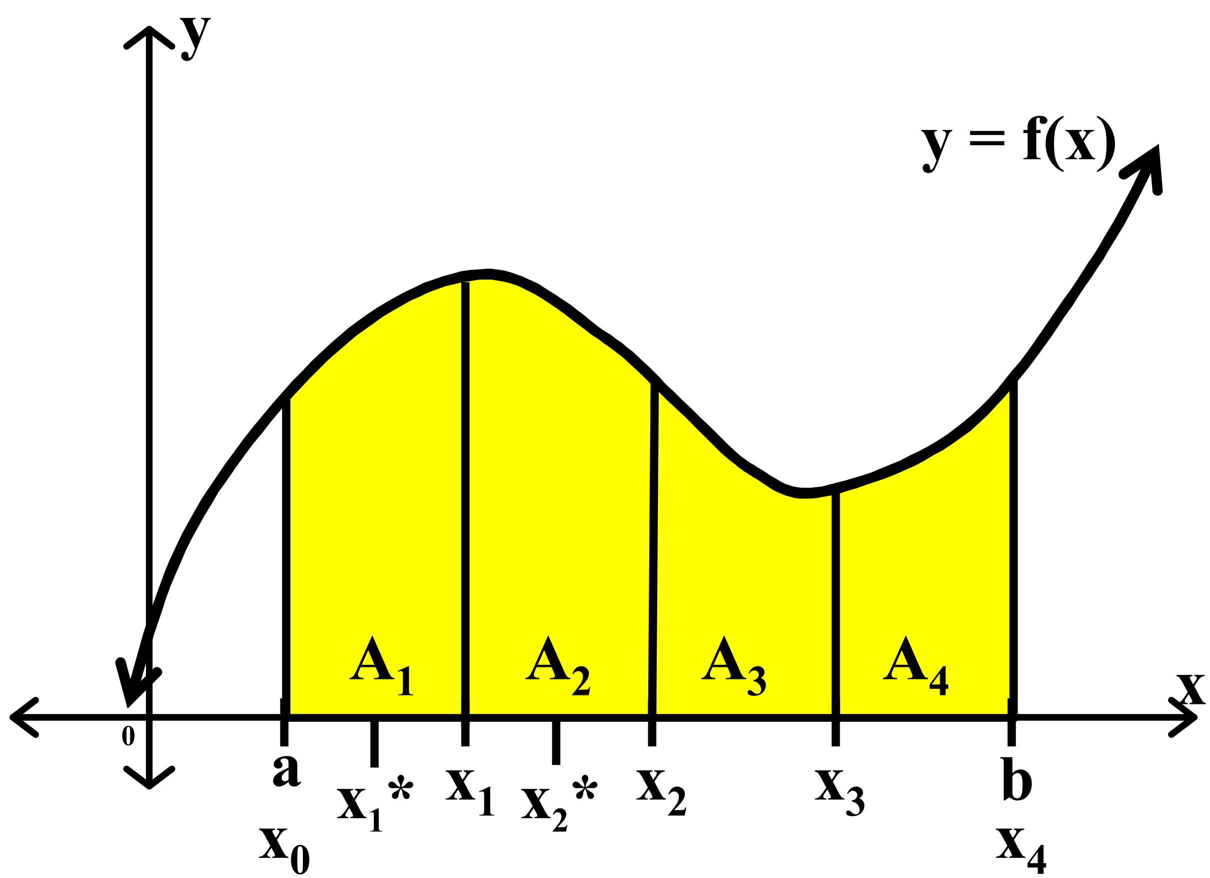
Let x_i* represent the midpoint of the i^{th} subinterval.



The last Rectangular Approximation is called the Mid-Rectangular Approximation, S_M.

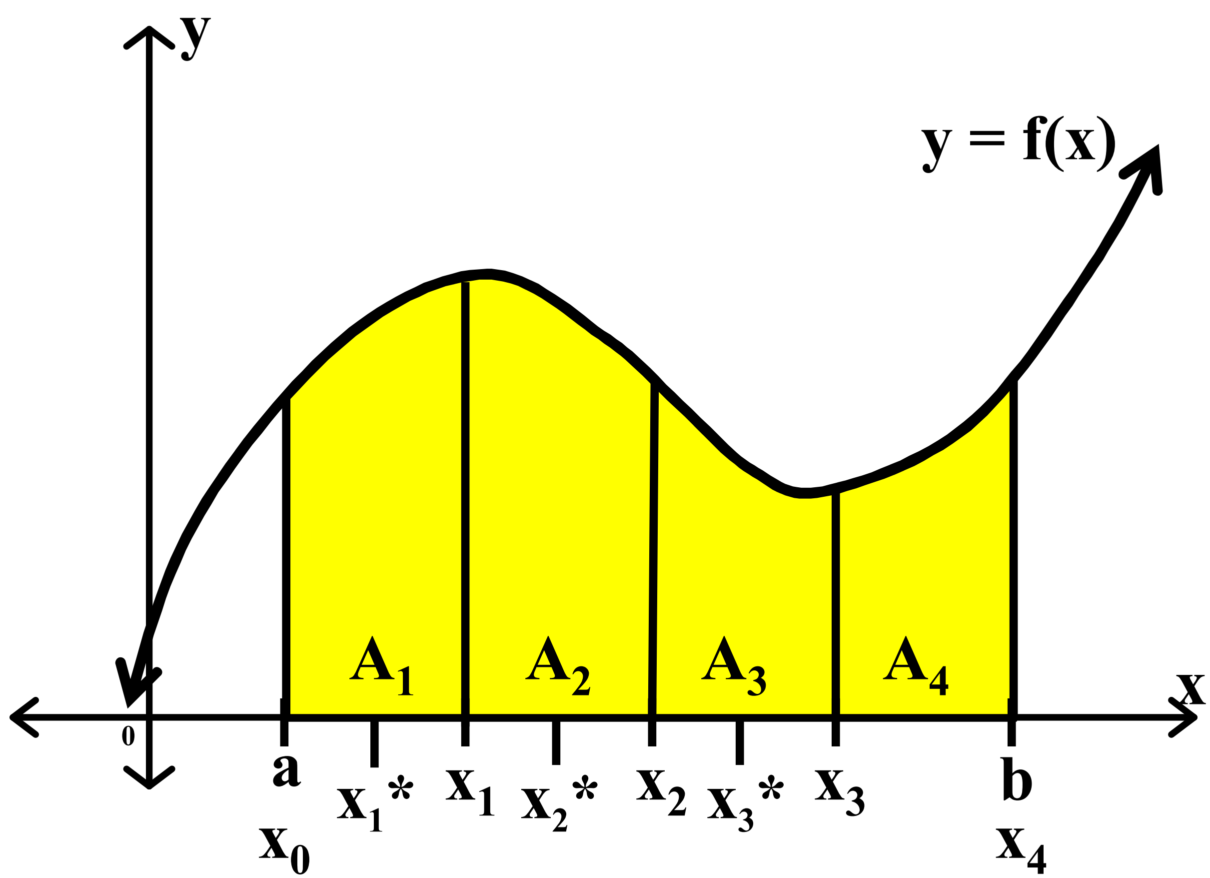
Let x_i* represent the midpoint of the i^{th} subinterval.

x_1* is the midpoint of the 1^{st} subinterval.



The last Rectangular Approximation is called the Mid-Rectangular Approximation, S_M.
Let x_i* represent the midpoint of the i^{th} subinterval.

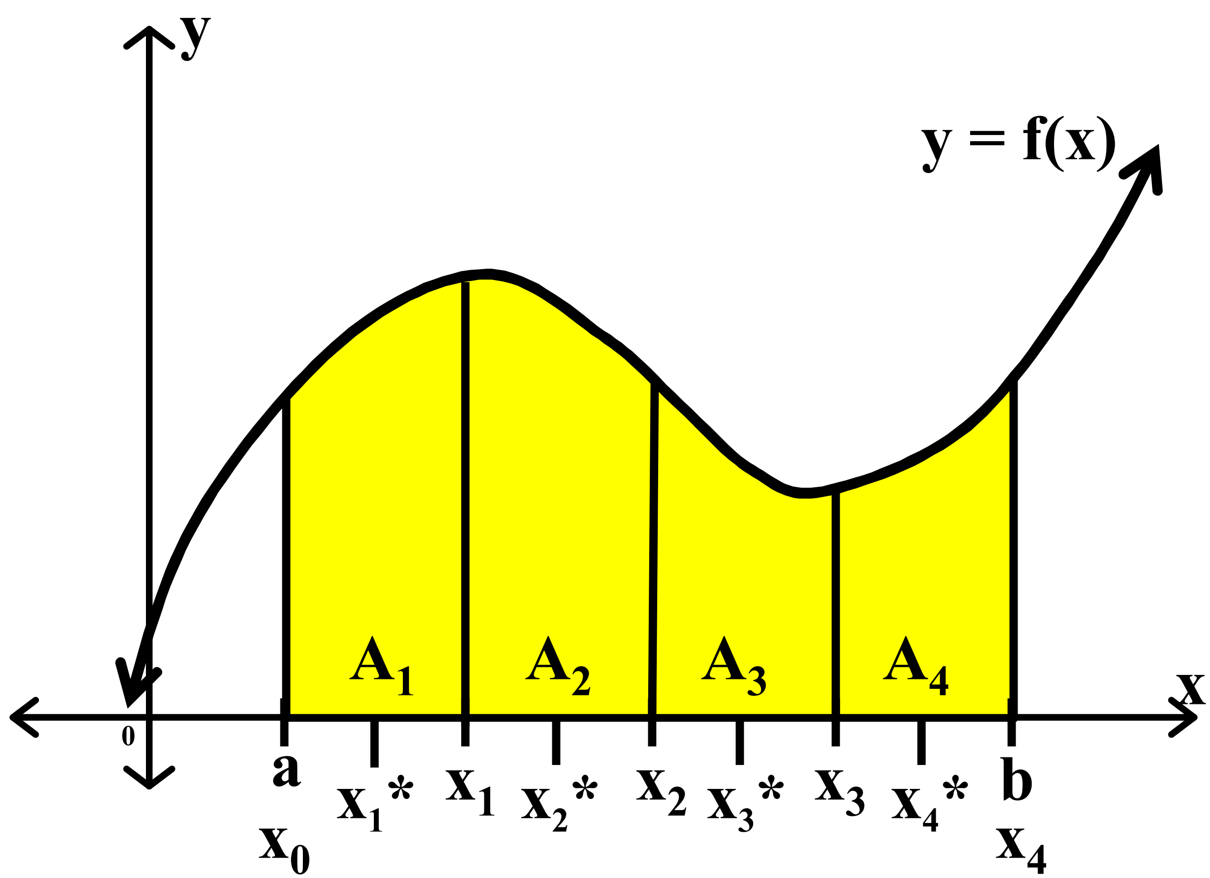
x_2* is the midpoint of the 2^{nd} subinterval.



The last Rectangular Approximation is called the Mid-Rectangular Approximation, S_M.

Let x_i* represent the midpoint of the i^{th} subinterval.

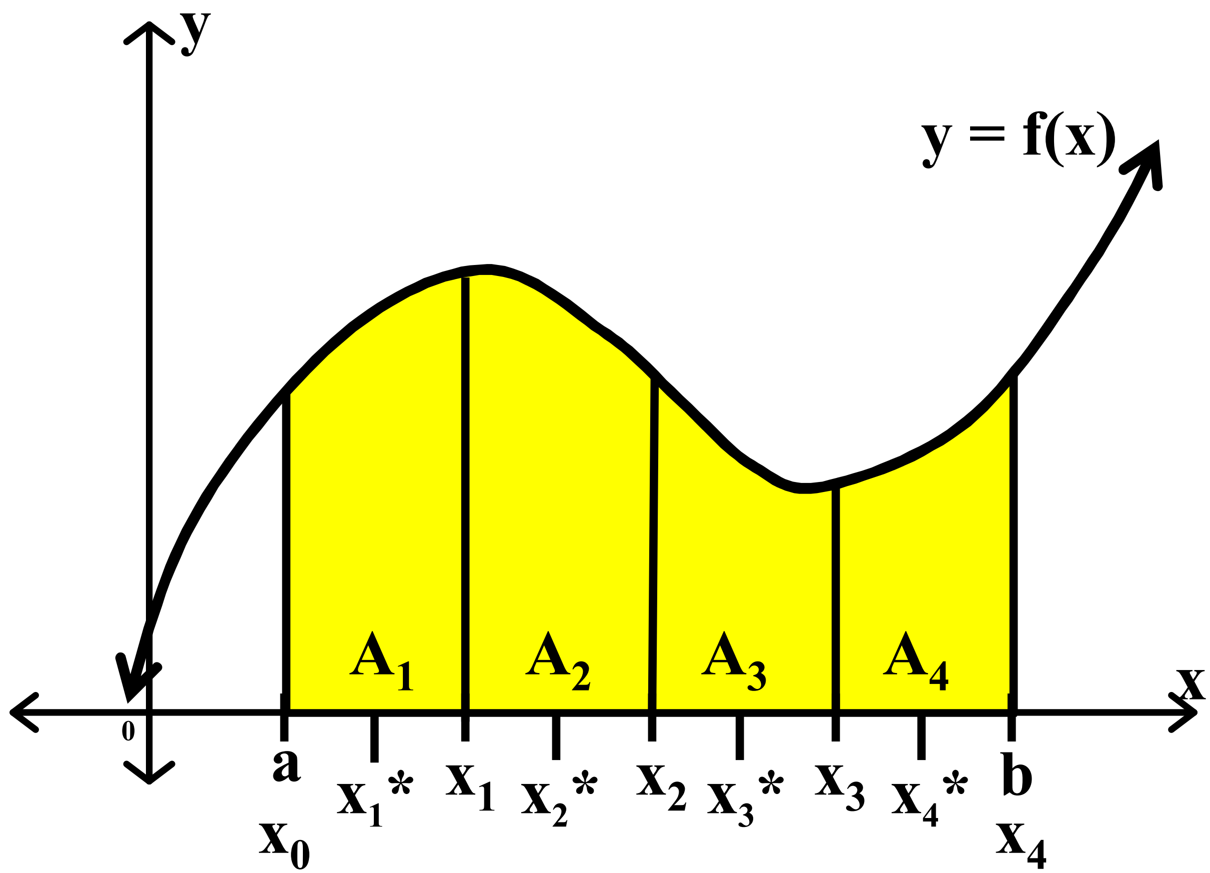
x_3* is the midpoint of the 3^{rd} subinterval.



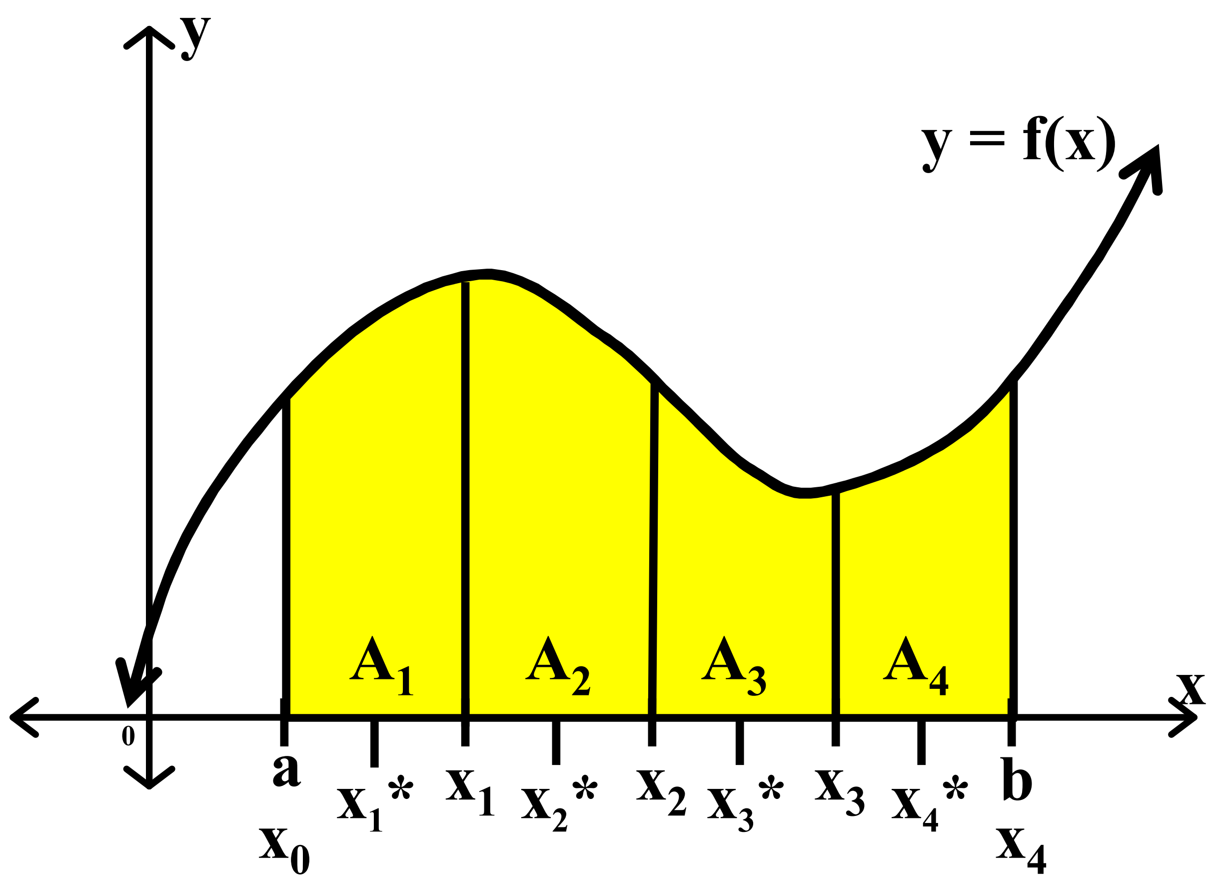
The last Rectangular Approximation is called the Mid-Rectangular Approximation, S_M.

Let x_i* represent the midpoint of the i^{th} subinterval.

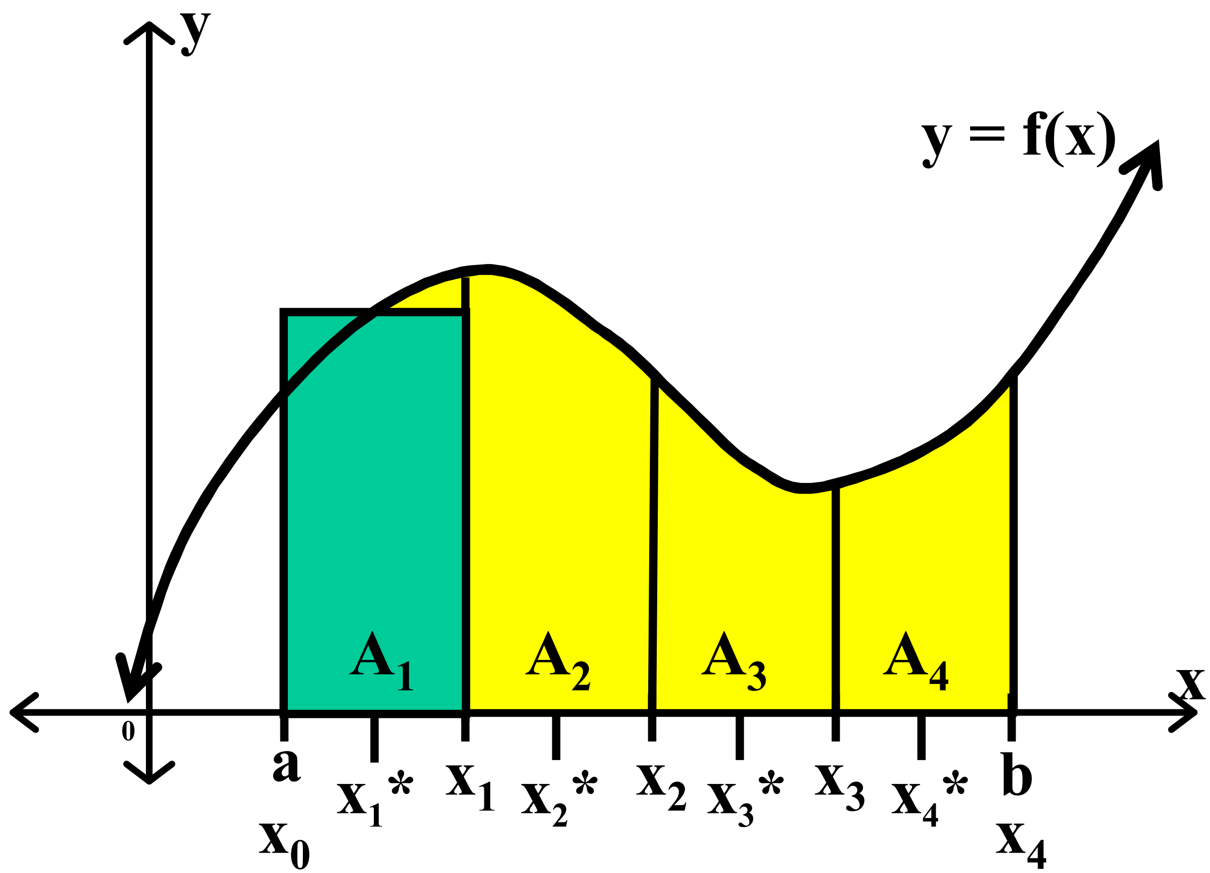
x_4* is the midpoint of the 4^{th} subinterval.



y
y = f(x)
A_1
A_2
A_3
A_4
x
0
a
x_0
x_1*
x_1
x_2*
x_2
x_3*
x_3
x_4*
b
x_4

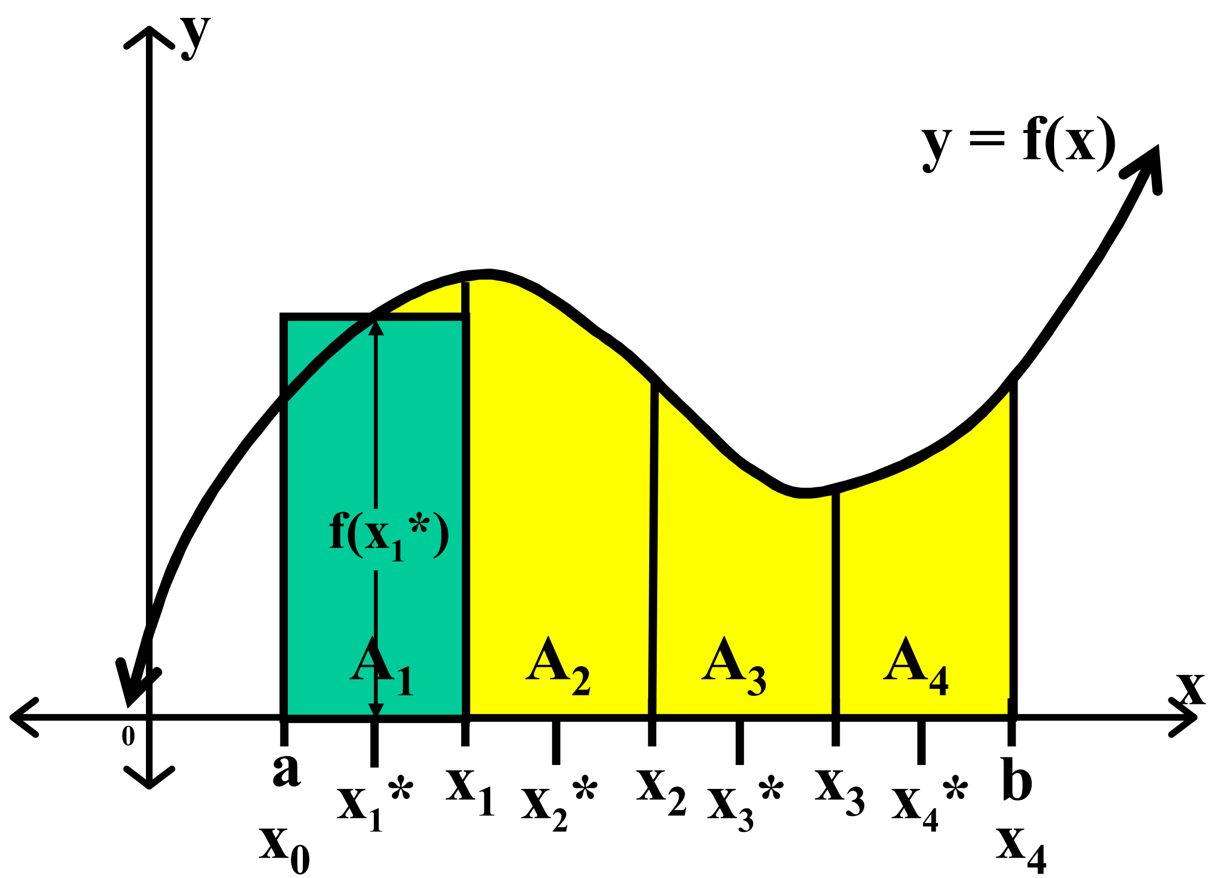


The length of the i^{th} Mid-Rectangle is $f(x_i*)$.



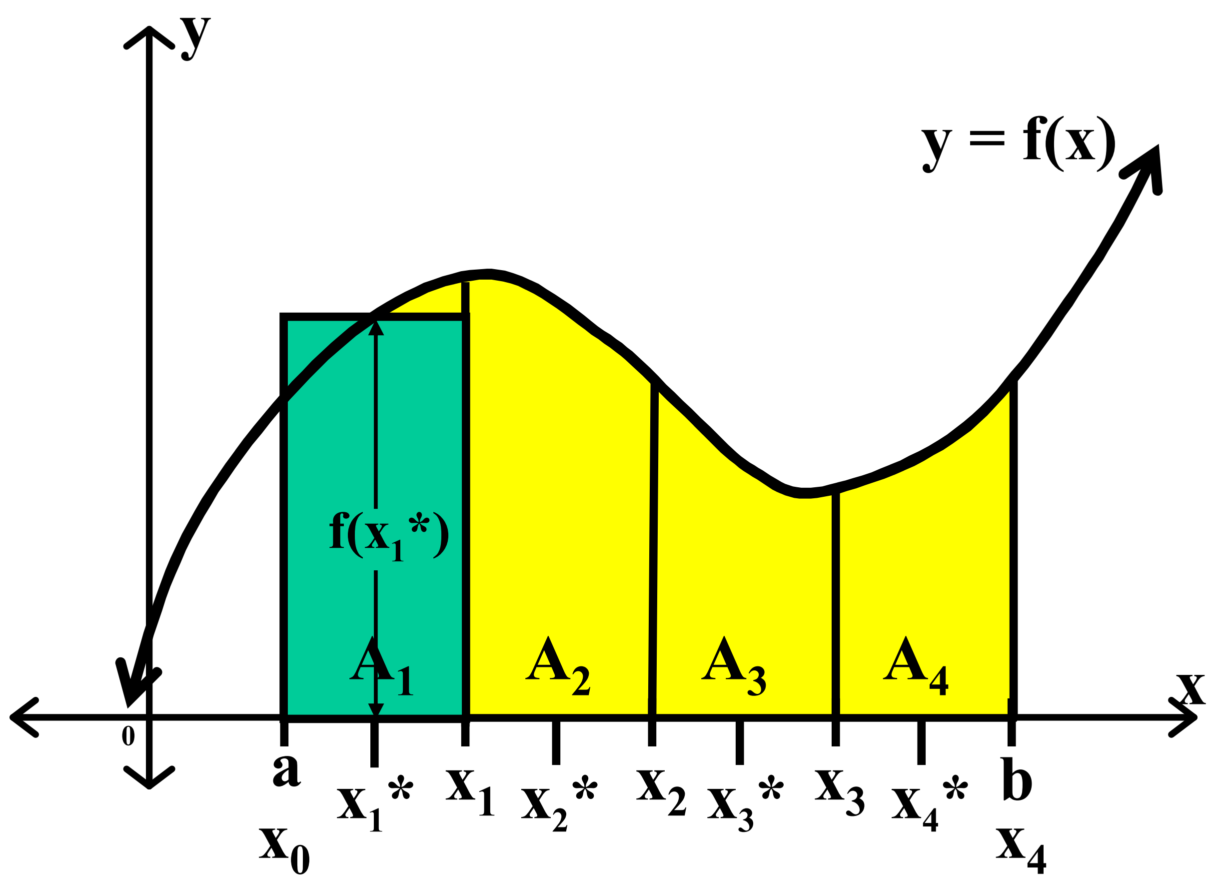
The length of the i^{th} Mid-Rectangle is $f(x_i*)$.

The length of the 1^{st} Mid-Rectangle is $f(x_1*)$.

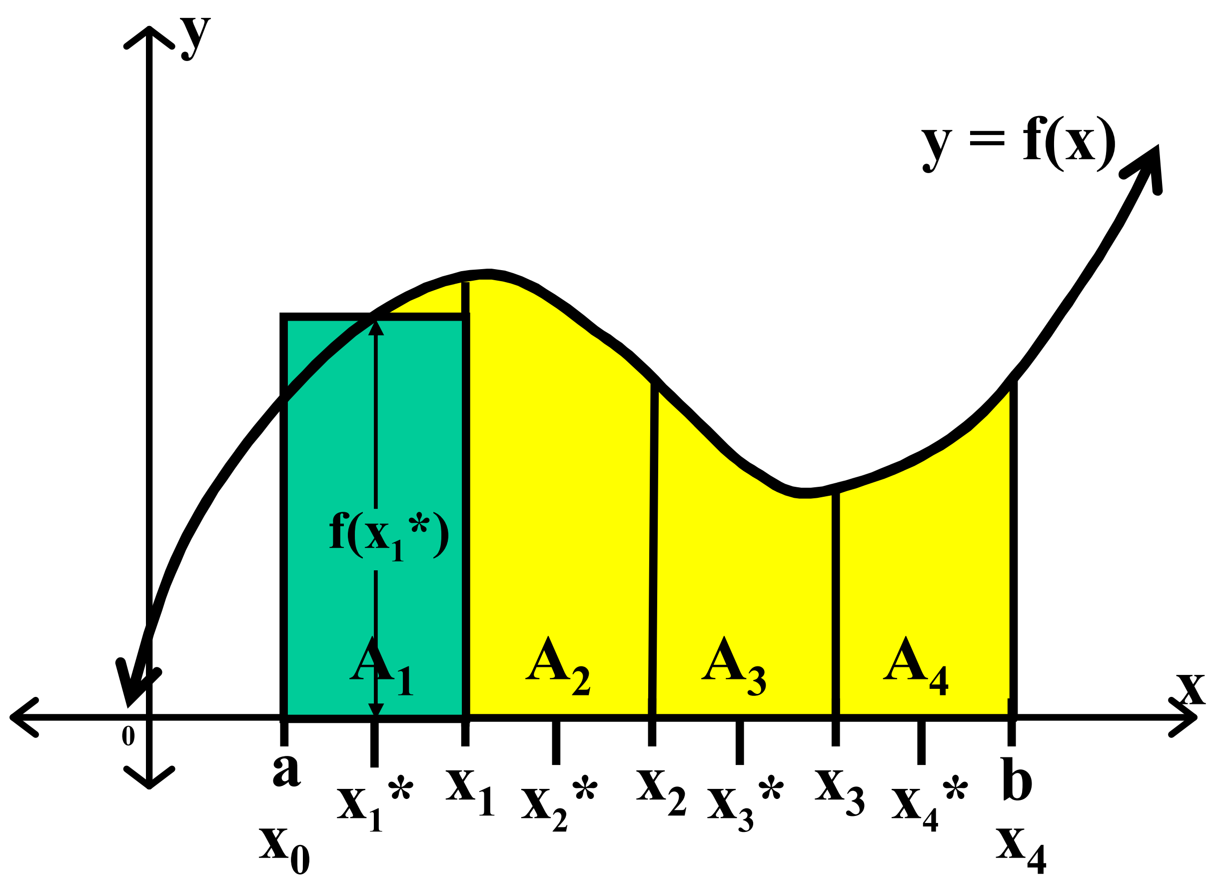


The length of the i^{th} Mid-Rectangle is $f(x_i*)$.

The length of the 1^{st} Mid-Rectangle is $f(x_1*)$.

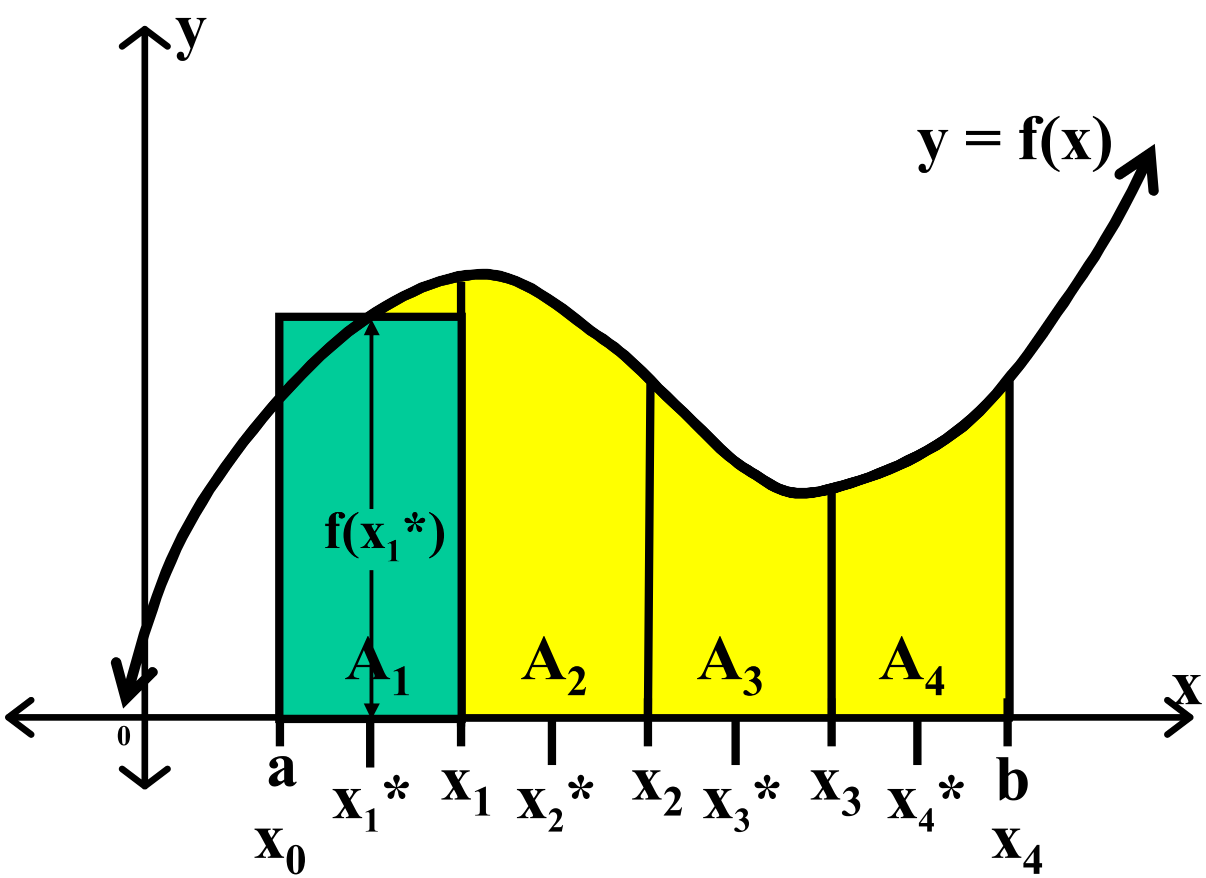


The length of the i^{th} Mid-Rectangle is $f(x_i*)$.
The length of the 1^{st} Mid-Rectangle is $f(x_1*)$. Its width is Δx.



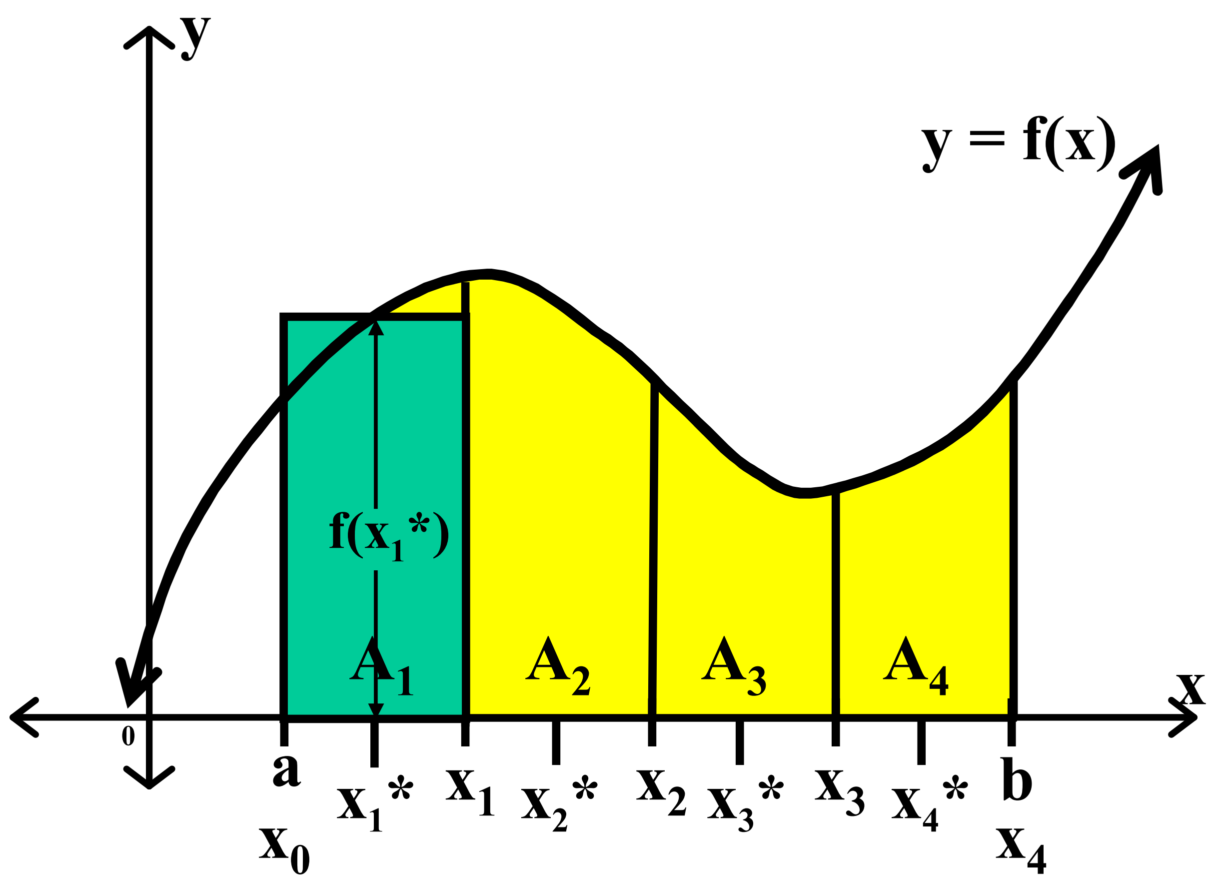
$A_1 \approx$

The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.
The length of the 1^{st} Mid-Rectangle is $f(x_1^*)$. Its width is Δx.



$A_1 \approx f(x_1{}^*)$

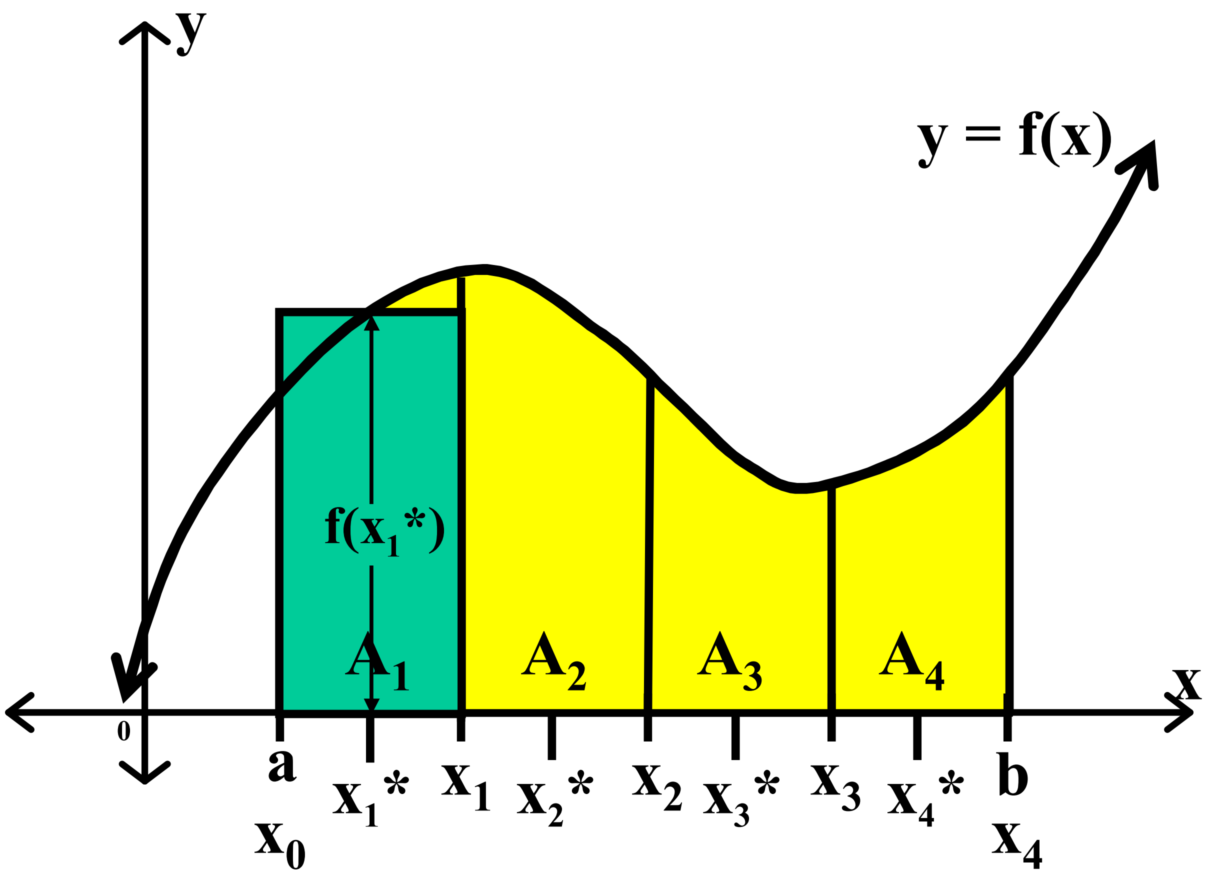
The length of the i^{th} Mid-Rectangle is $f(x_i{}^*)$.
The length of the 1^{st} Mid-Rectangle is $f(x_1{}^*)$. Its width is Δx.



$A_1 \approx f(x_1^*)\Delta x$

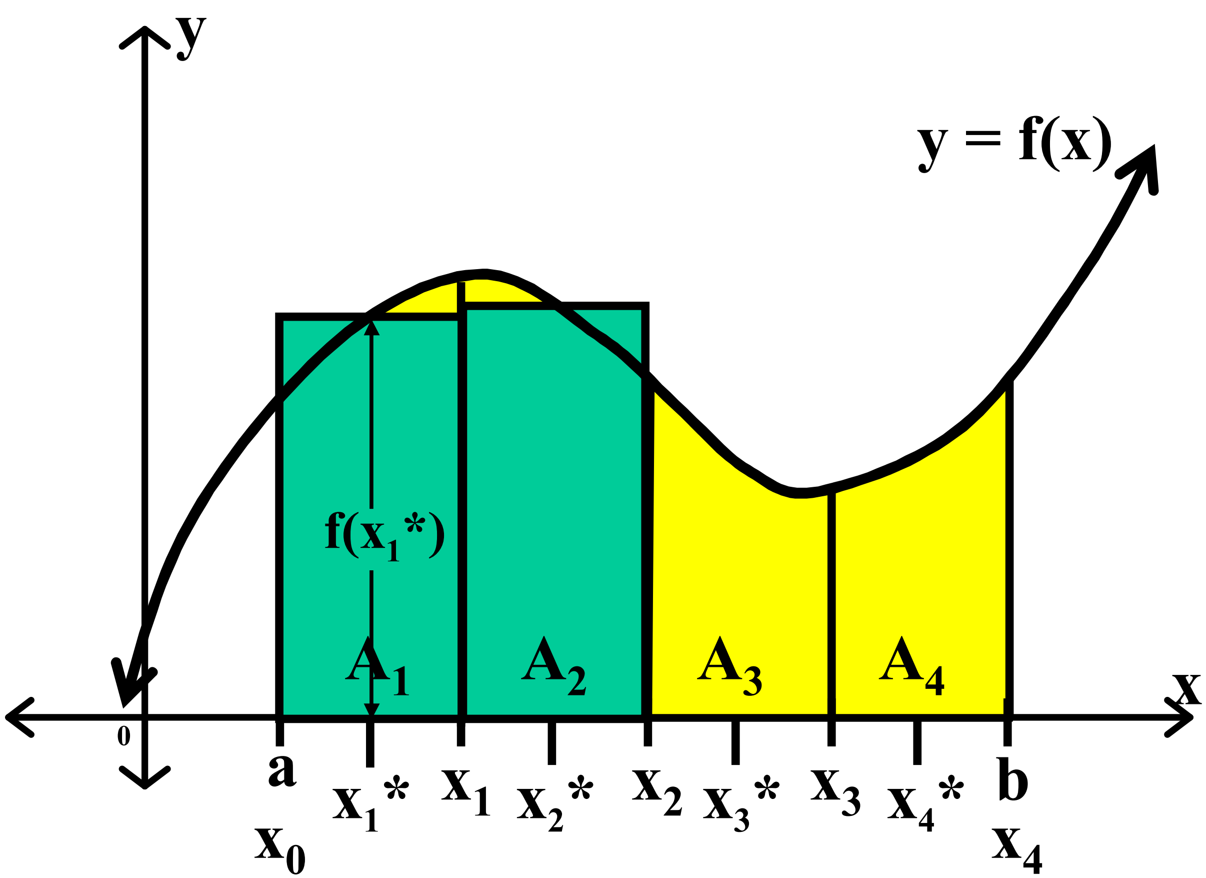
The length of the ith Mid-Rectangle is $f(x_i^*)$.

The length of the 1st Mid-Rectangle is $f(x_1^*)$. Its width is Δx.



$A_1 \approx f(x_1{}^*)\Delta x$

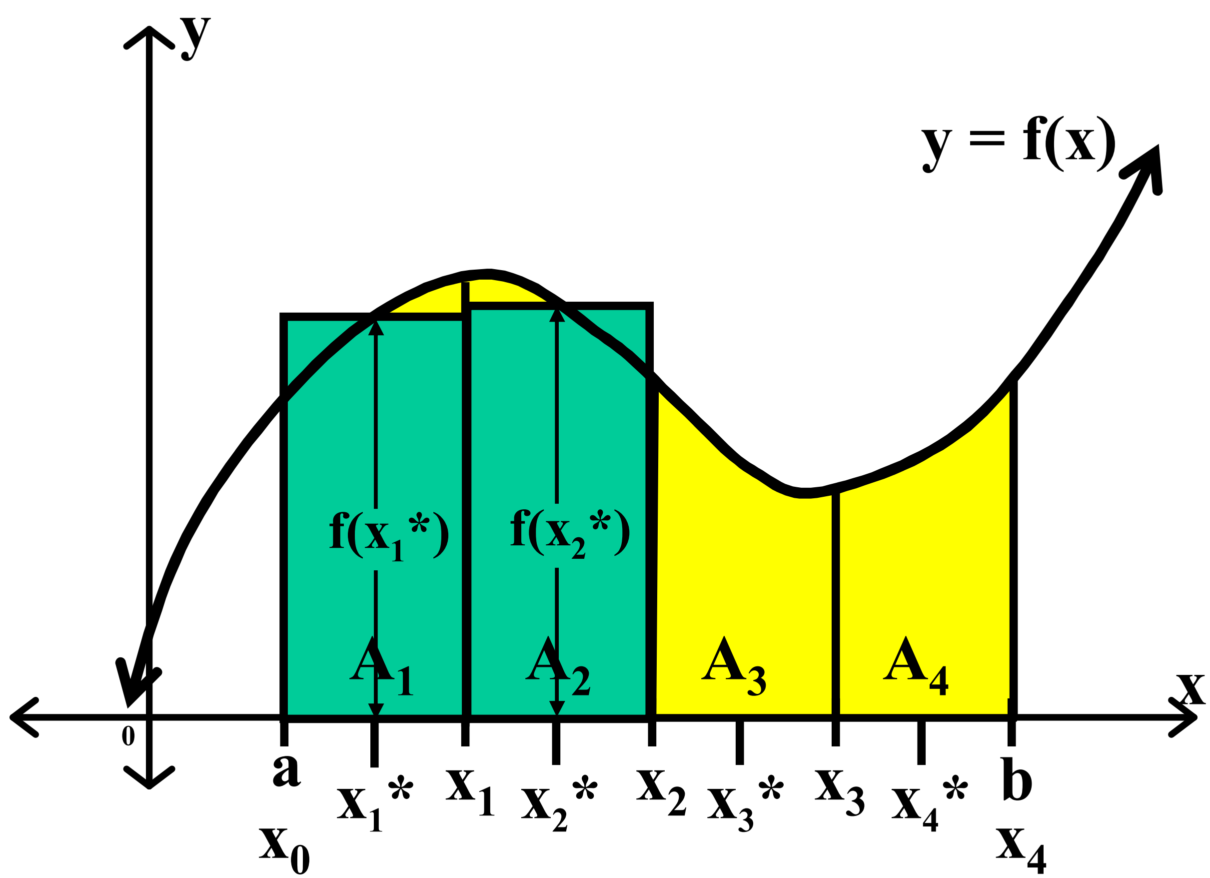
The length of the i^{th} Mid-Rectangle is $f(x_i{}^*)$.



$A_1 \approx f(x_1^*)\Delta x$

The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.

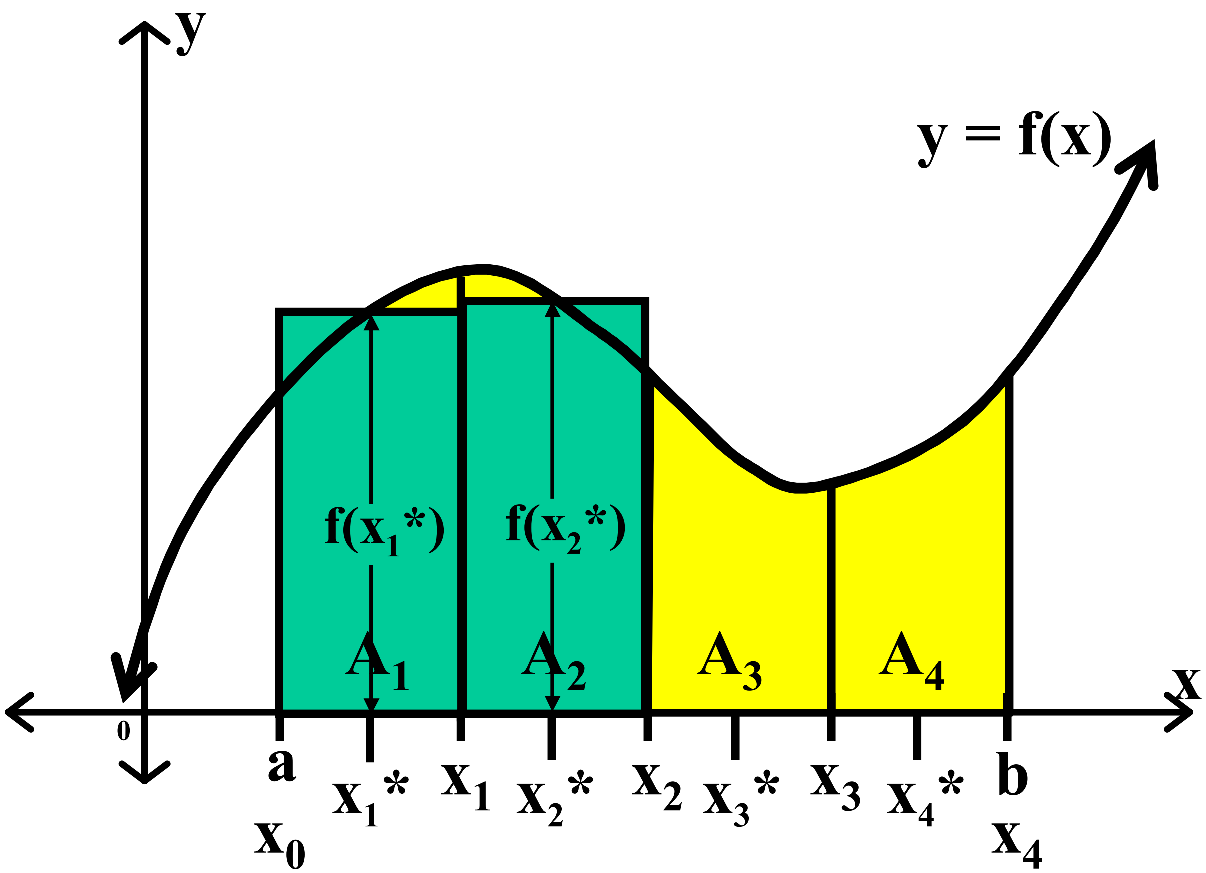
The length of the 2^{nd} Mid-Rectangle is $f(x_2^*)$.



$A_1 \approx f(x_1*)\Delta x$

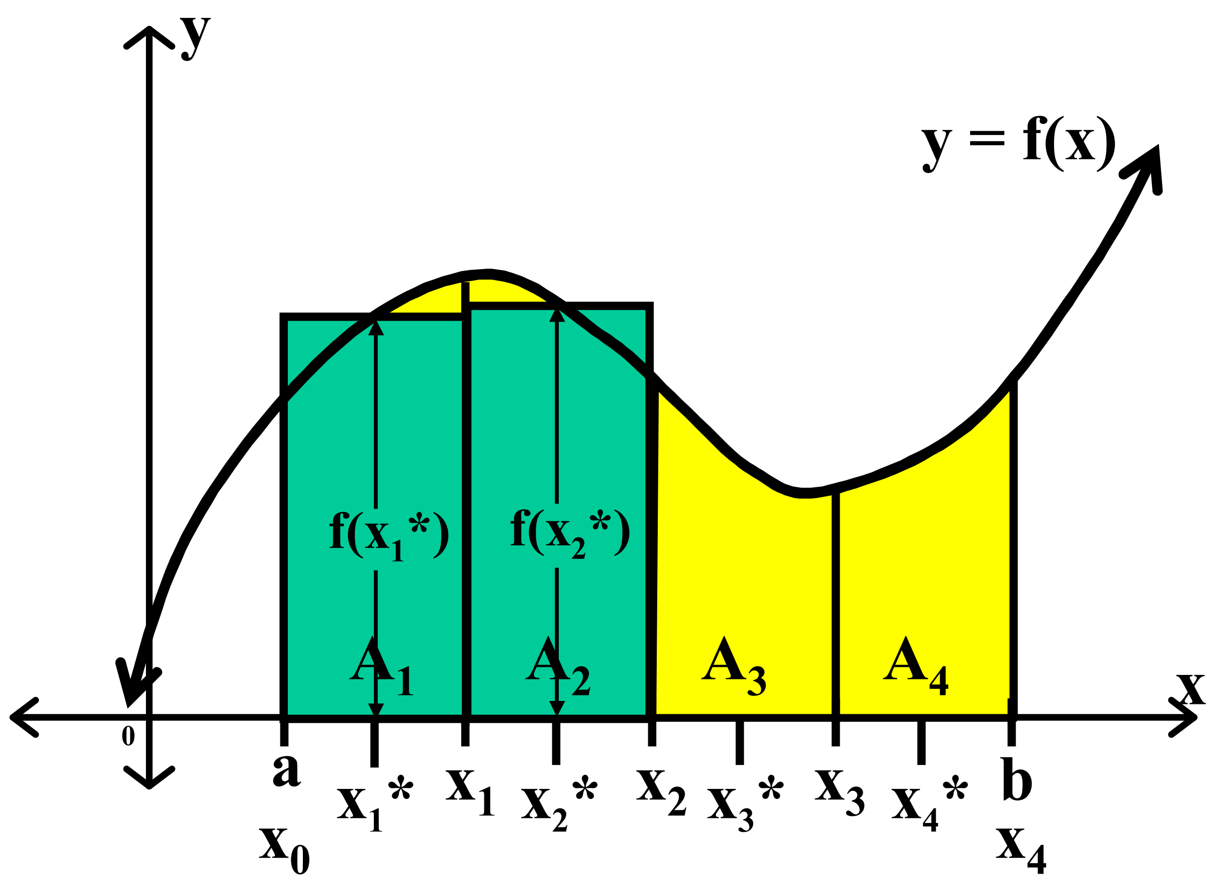
The length of the i^{th} Mid-Rectangle is $f(x_i*)$.

The length of the 2^{nd} Mid-Rectangle is $f(x_2*)$.



$A_1 \approx f(x_1^*)\Delta x$

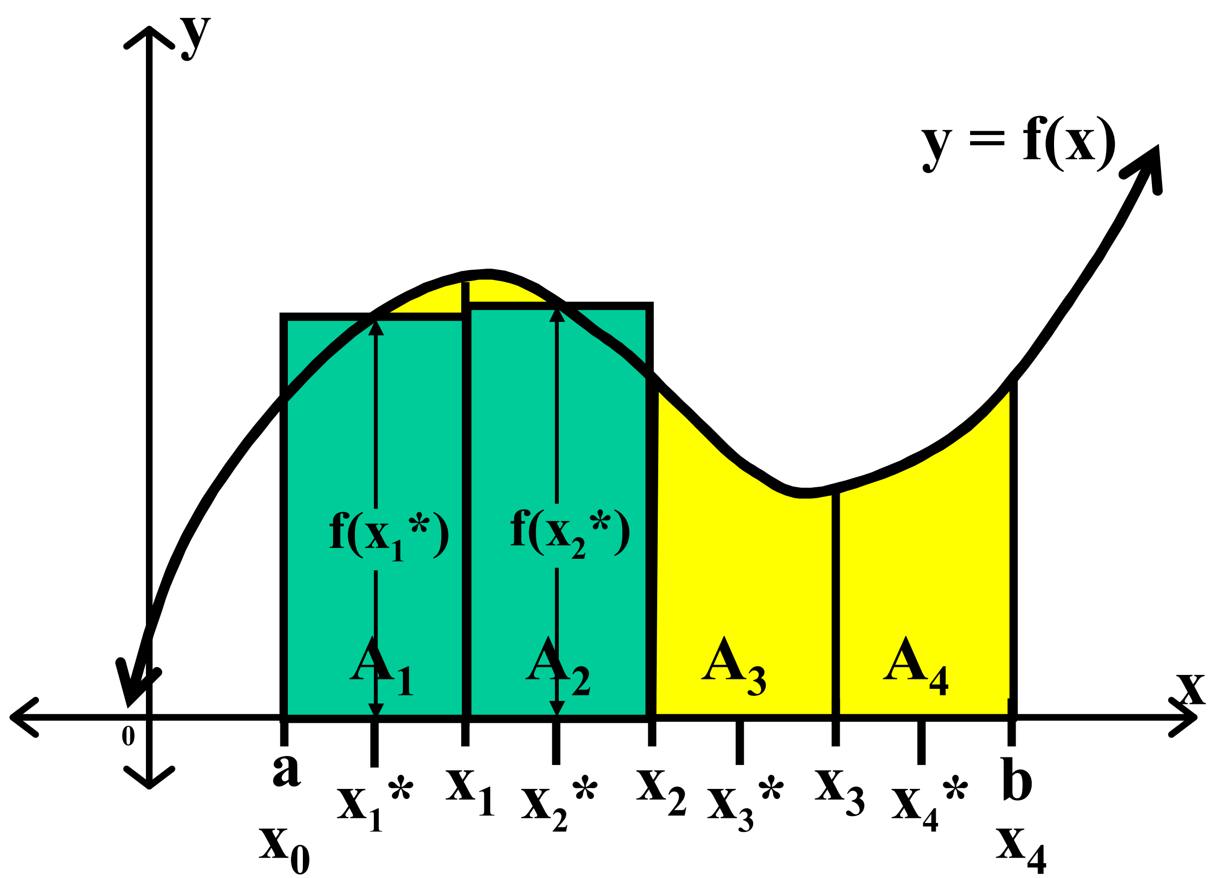
The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.
The length of the 2^{nd} Mid-Rectangle is $f(x_2^*)$. Its width is Δx.



$A_1 \approx f(x_1*)\Delta x \quad A_2 \approx$

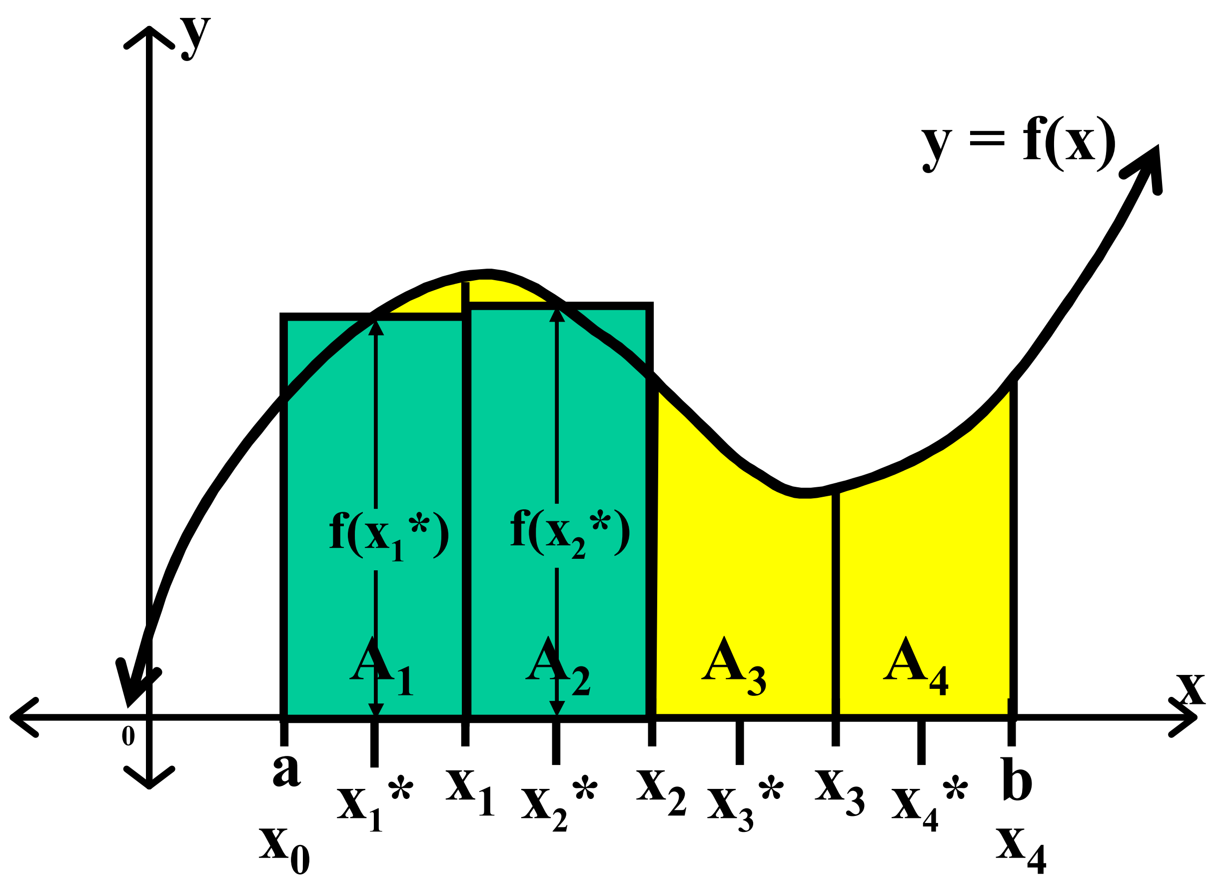
The length of the i^{th} Mid-Rectangle is $f(x_i*)$.

The length of the 2^{nd} Mid-Rectangle is $f(x_2*)$. Its width is Δx.



$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)$

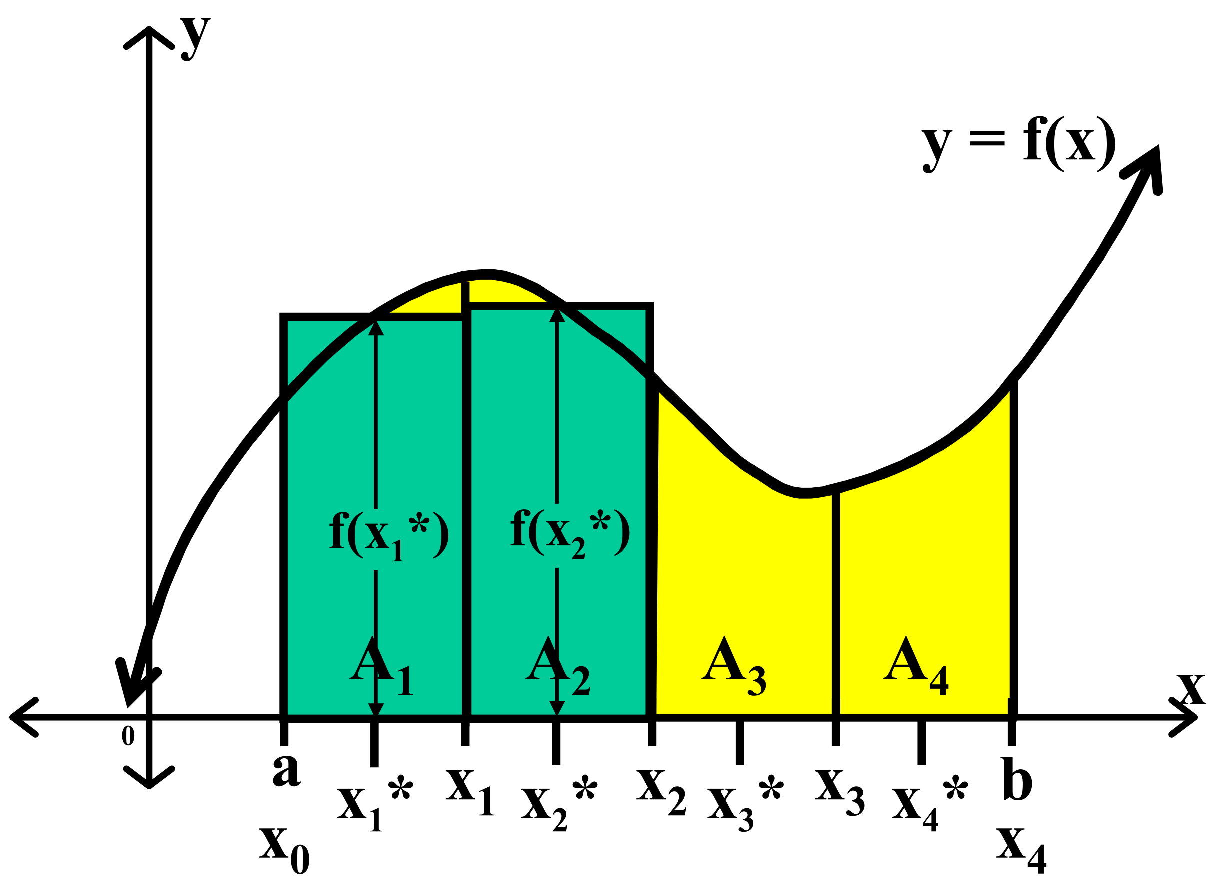
The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.
The length of the 2^{nd} Mid-Rectangle is $f(x_2^*)$. Its width is Δx.



$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x$

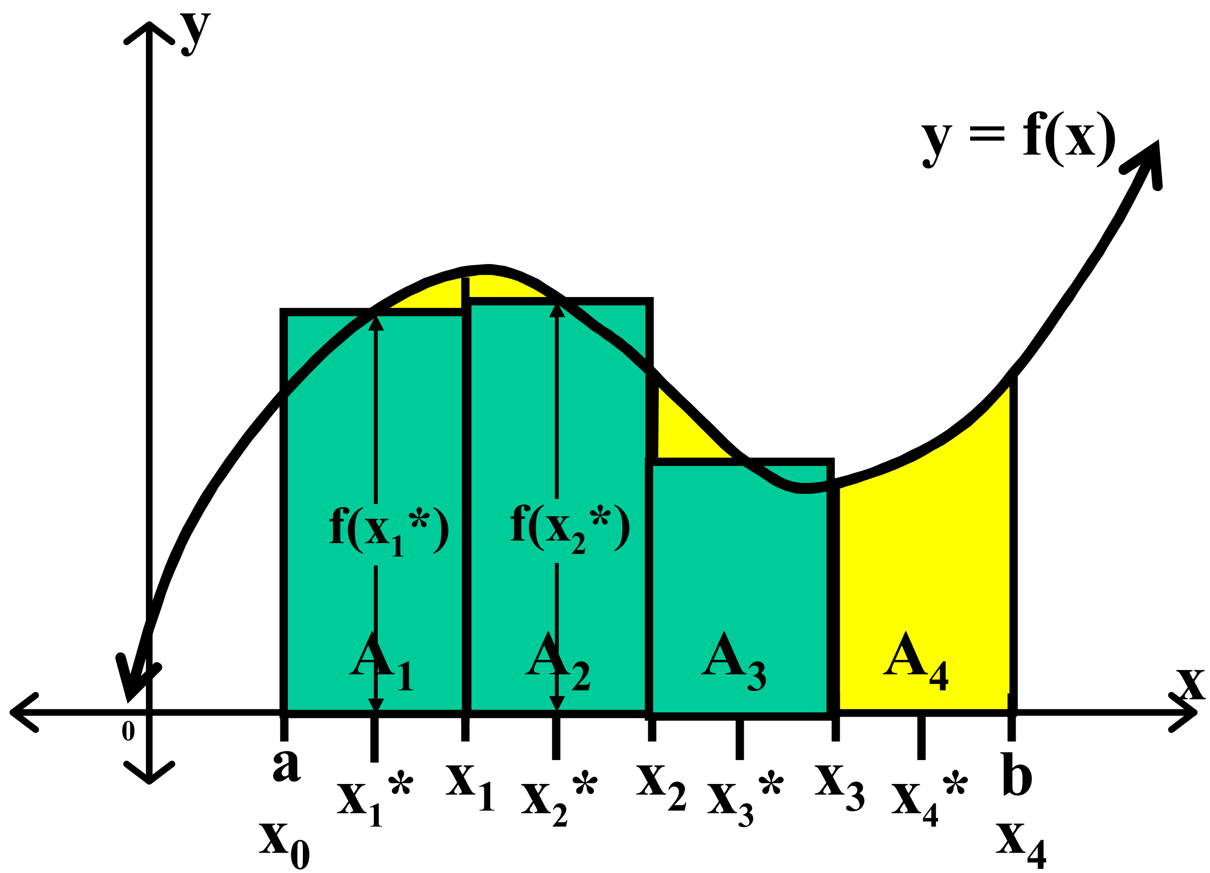
The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.

The length of the 2^{nd} Mid-Rectangle is $f(x_2^*)$. Its width is Δx.



$A_1 \approx f(x_1{}^*)\Delta x$ $\quad$ $A_2 \approx f(x_2{}^*)\Delta x$

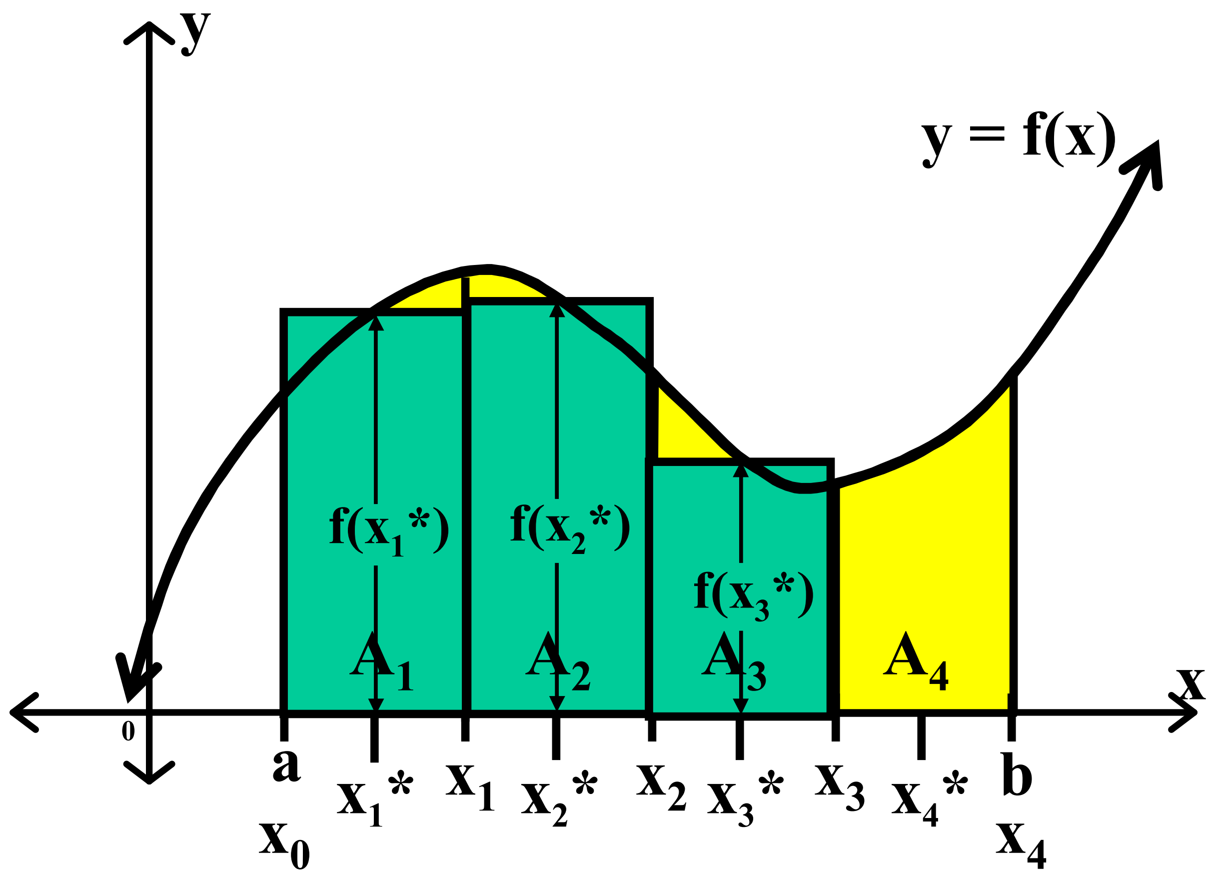
The length of the i^{th} Mid-Rectangle is $f(x_i{}^*)$.



$A_1 \approx f(x_1*)\Delta x \quad A_2 \approx f(x_2*)\Delta x$

The length of the i^{th} Mid-Rectangle is $f(x_i*)$.

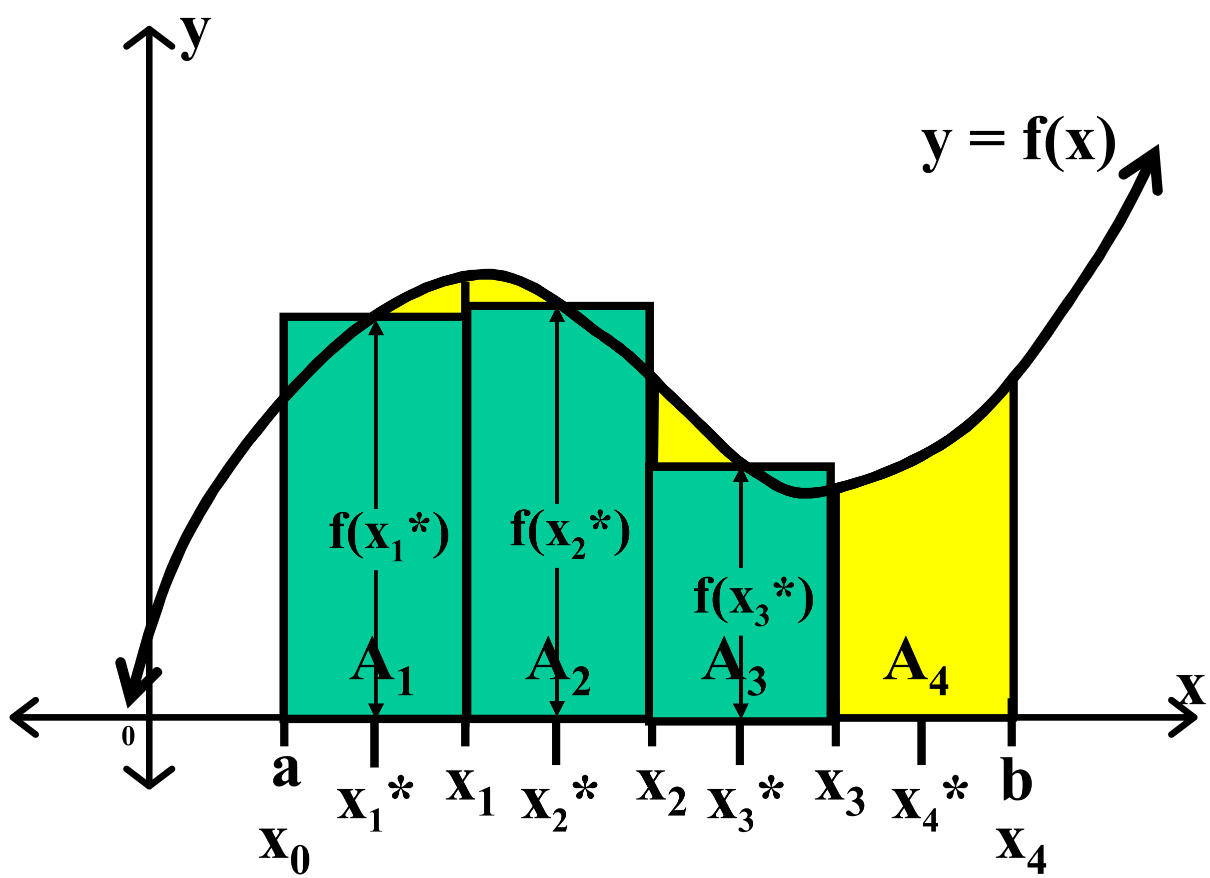
The length of the 3^{rd} Mid-Rectangle is $f(x_3*)$.



$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x$

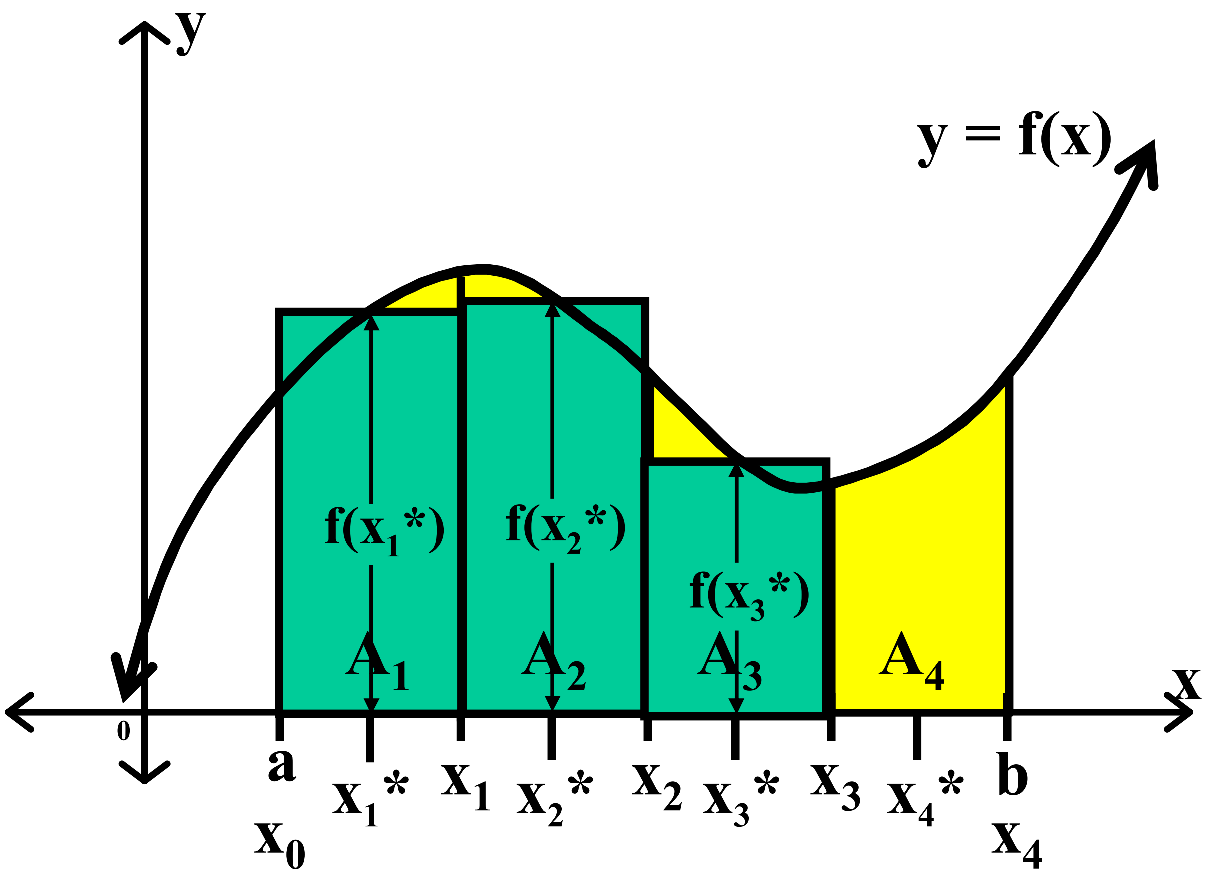
The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.

The length of the 3^{rd} Mid-Rectangle is $f(x_3^*)$.



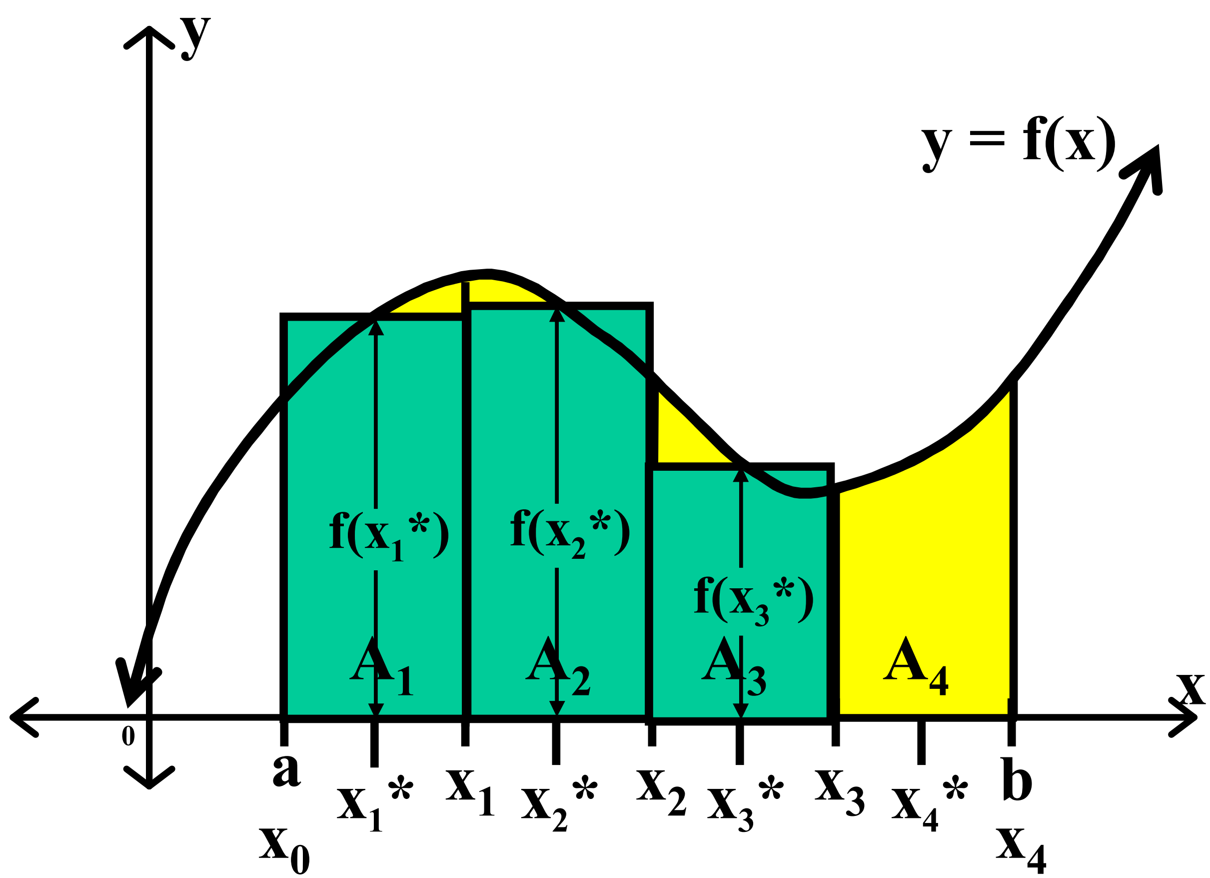
$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x$

The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.
The length of the 3^{rd} Mid-Rectangle is $f(x_3^*)$. Its width is Δx.



$A_1 \approx f(x_1{}^*)\Delta x \quad A_2 \approx f(x_2{}^*)\Delta x \quad A_3 \approx$

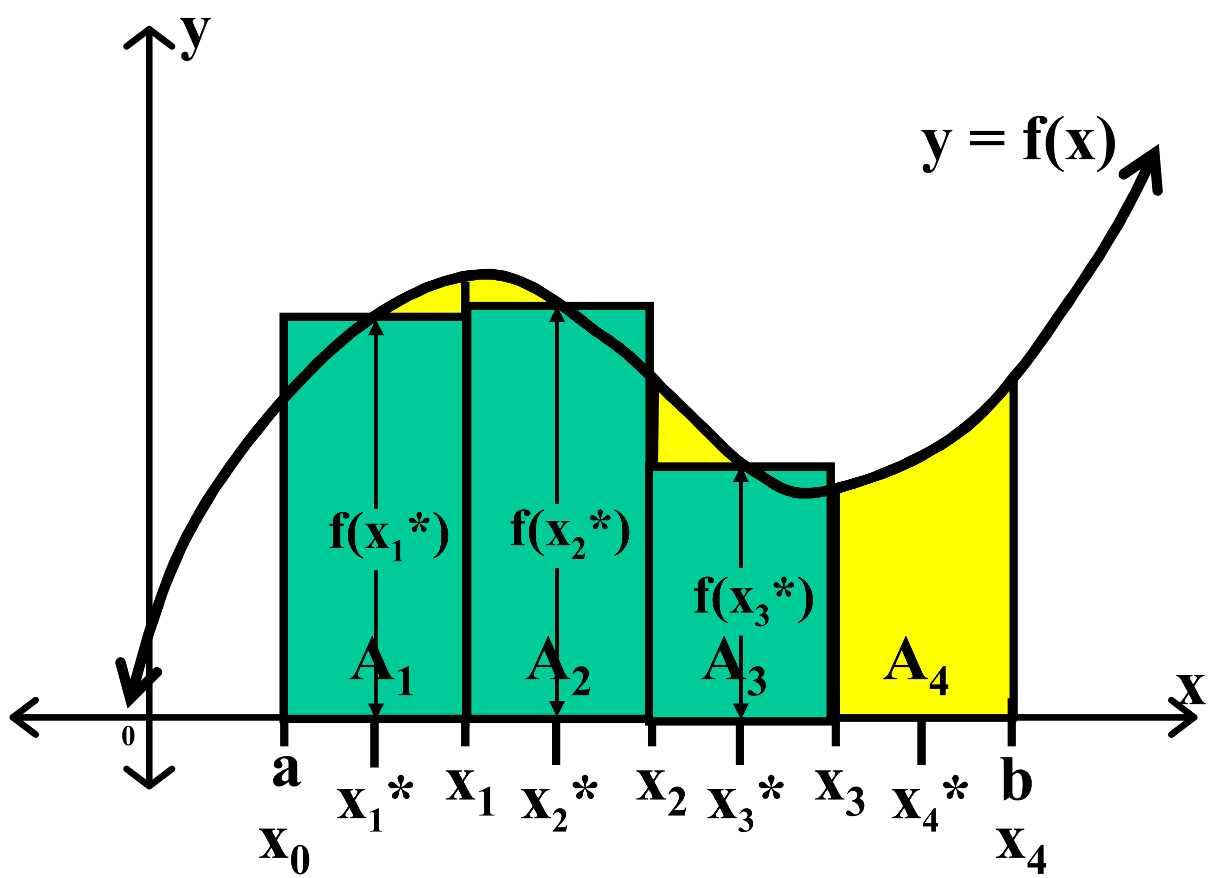
The length of the i^th Mid-Rectangle is $f(x_i{}^*)$.
The length of the 3^rd Mid-Rectangle is $f(x_3{}^*)$. Its width is Δx.



$A_1 \approx f(x_1{*})\Delta x \quad A_2 \approx f(x_2{*})\Delta x \quad A_3 \approx f(x_3{*})$

The length of the i^{th} Mid-Rectangle is $f(x_i{*})$.

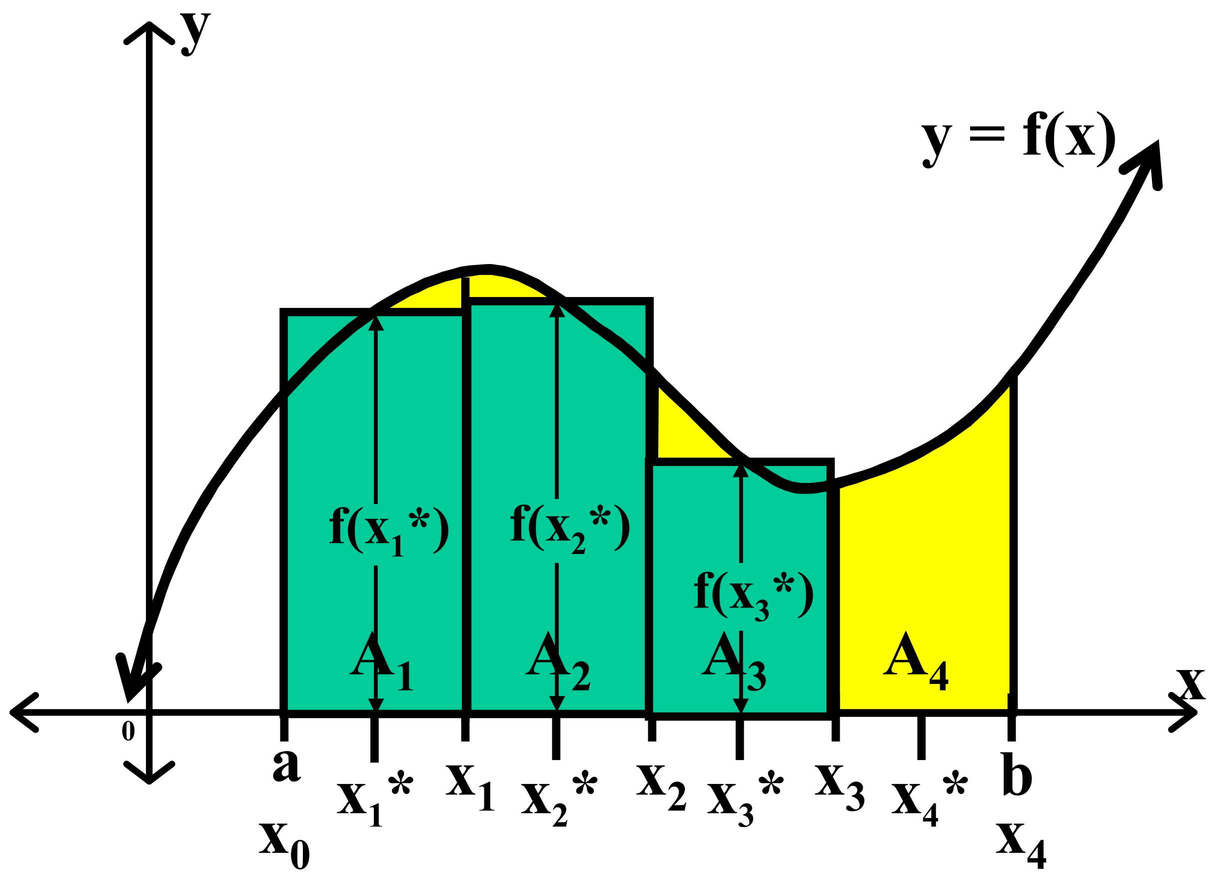
The length of the 3^{rd} Mid-Rectangle is $f(x_3{*})$. Its width is Δx.



$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x \quad A_3 \approx f(x_3^*)\Delta x$

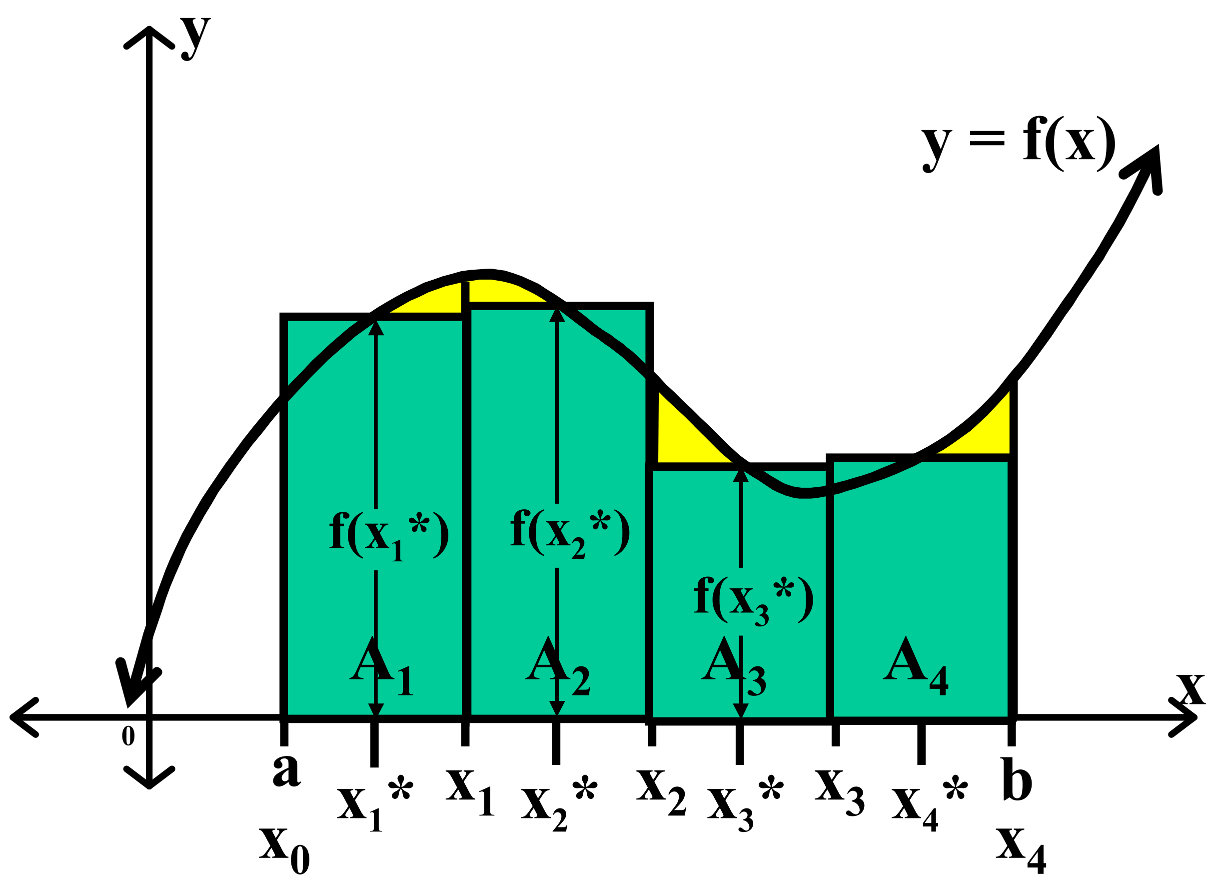
The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.

The length of the 3^{rd} Mid-Rectangle is $f(x_3^*)$. Its width is Δx.



$A_1 \approx f(x_1{}^*)\Delta x \quad A_2 \approx f(x_2{}^*)\Delta x \quad A_3 \approx f(x_3{}^*)\Delta x$

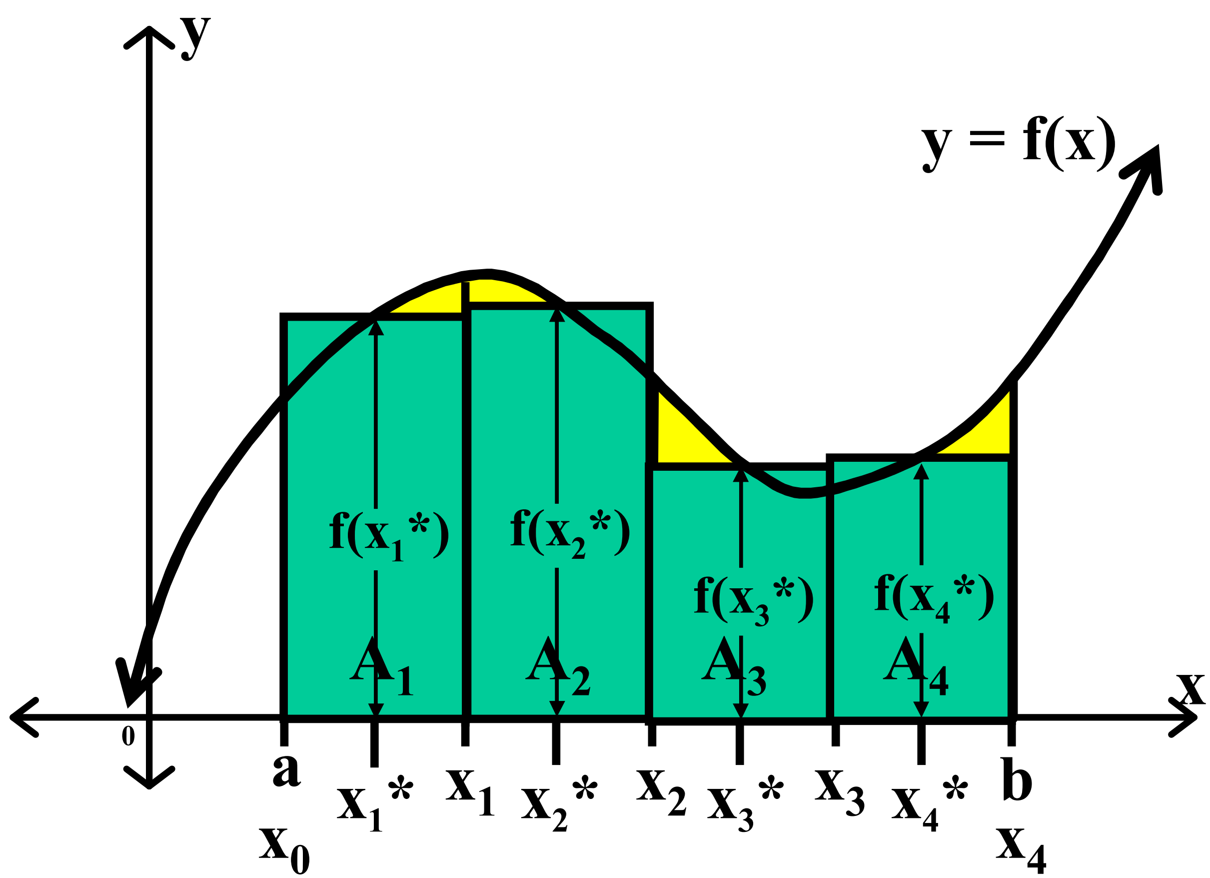
The length of the i^{th} Mid-Rectangle is $f(x_i{}^*)$.



$A_1 \approx f(x_1{}^*)\Delta x$ $A_2 \approx f(x_2{}^*)\Delta x$ $A_3 \approx f(x_3{}^*)\Delta x$

The length of the i^{th} Mid-Rectangle is $f(x_i{}^*)$.

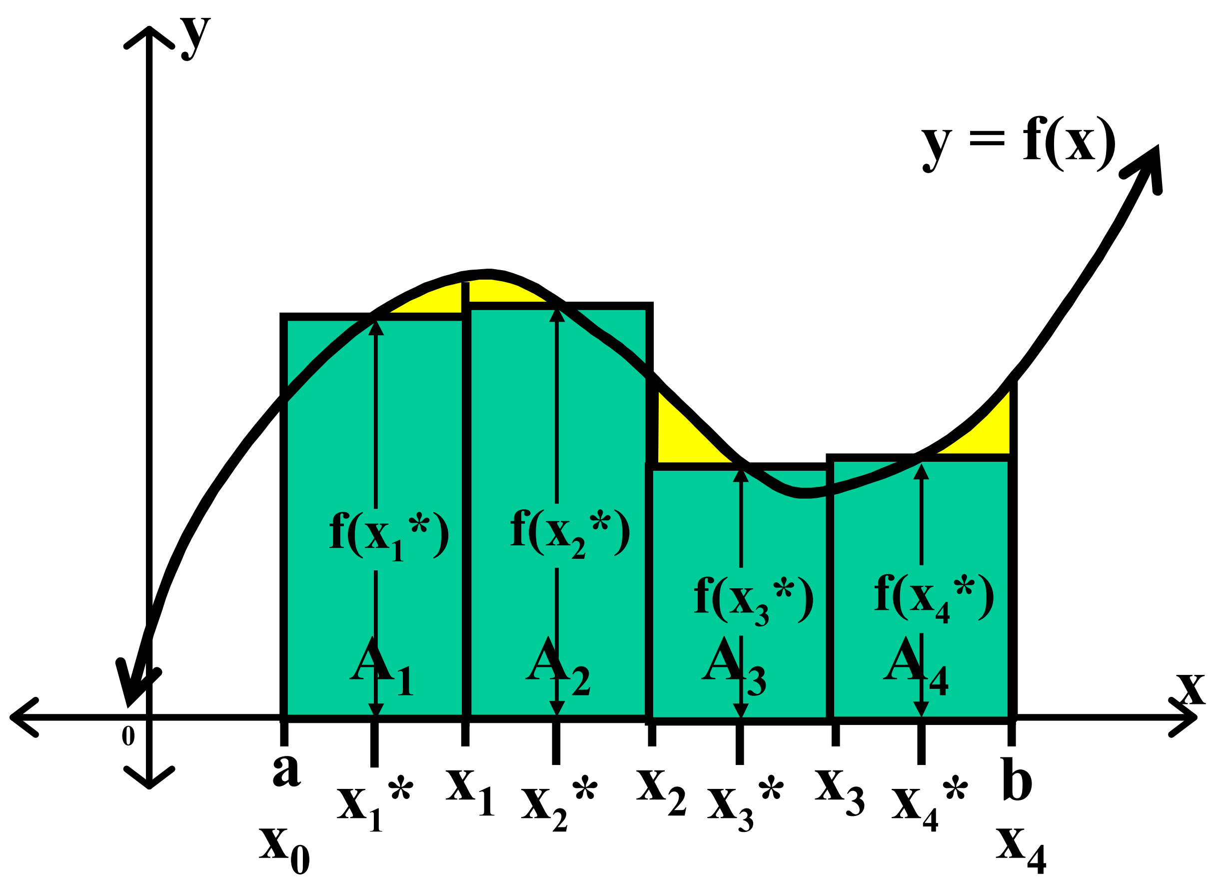
The length of the 4^{th} Mid-Rectangle is $f(x_4{}^*)$.



$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x \quad A_3 \approx f(x_3^*)\Delta x$

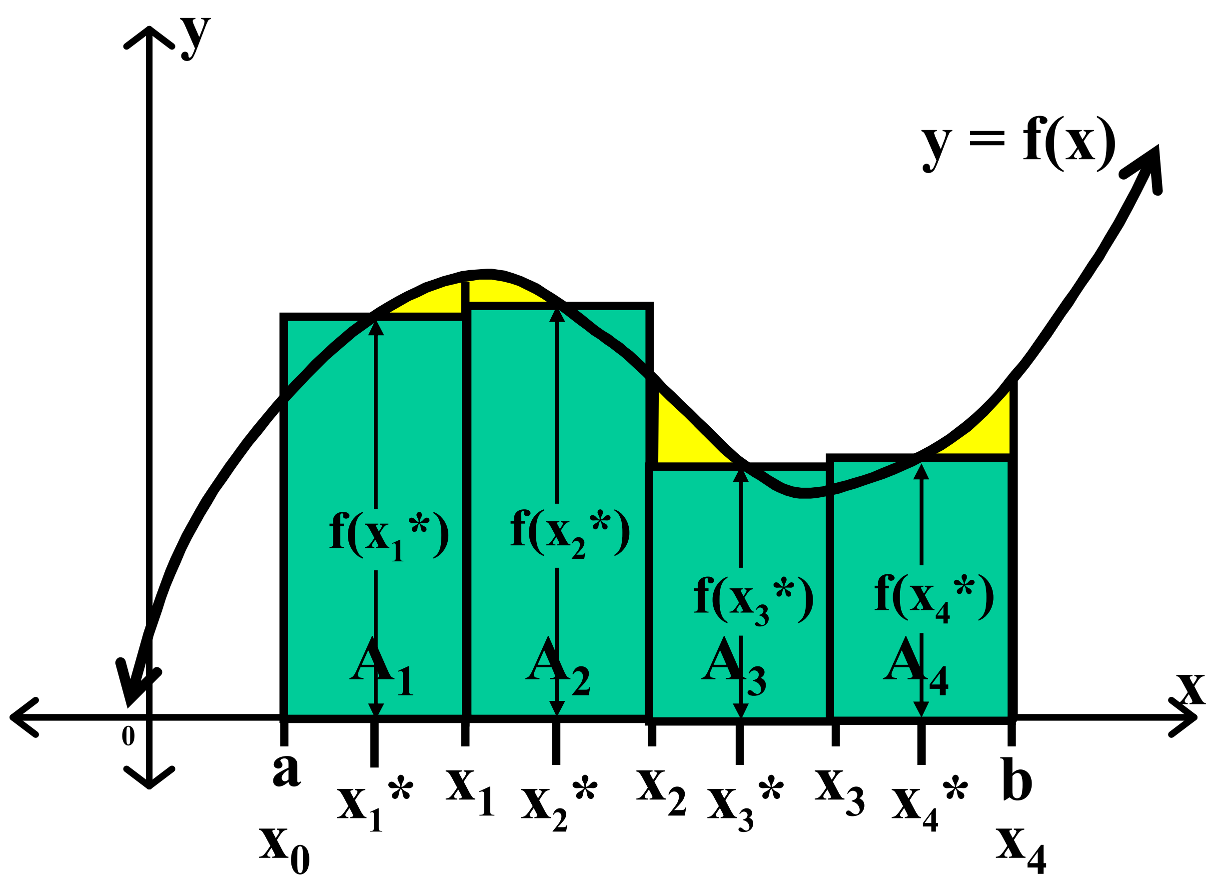
The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.

The length of the 4^{th} Mid-Rectangle is $f(x_4^*)$.



$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x \quad A_3 \approx f(x_3^*)\Delta x$

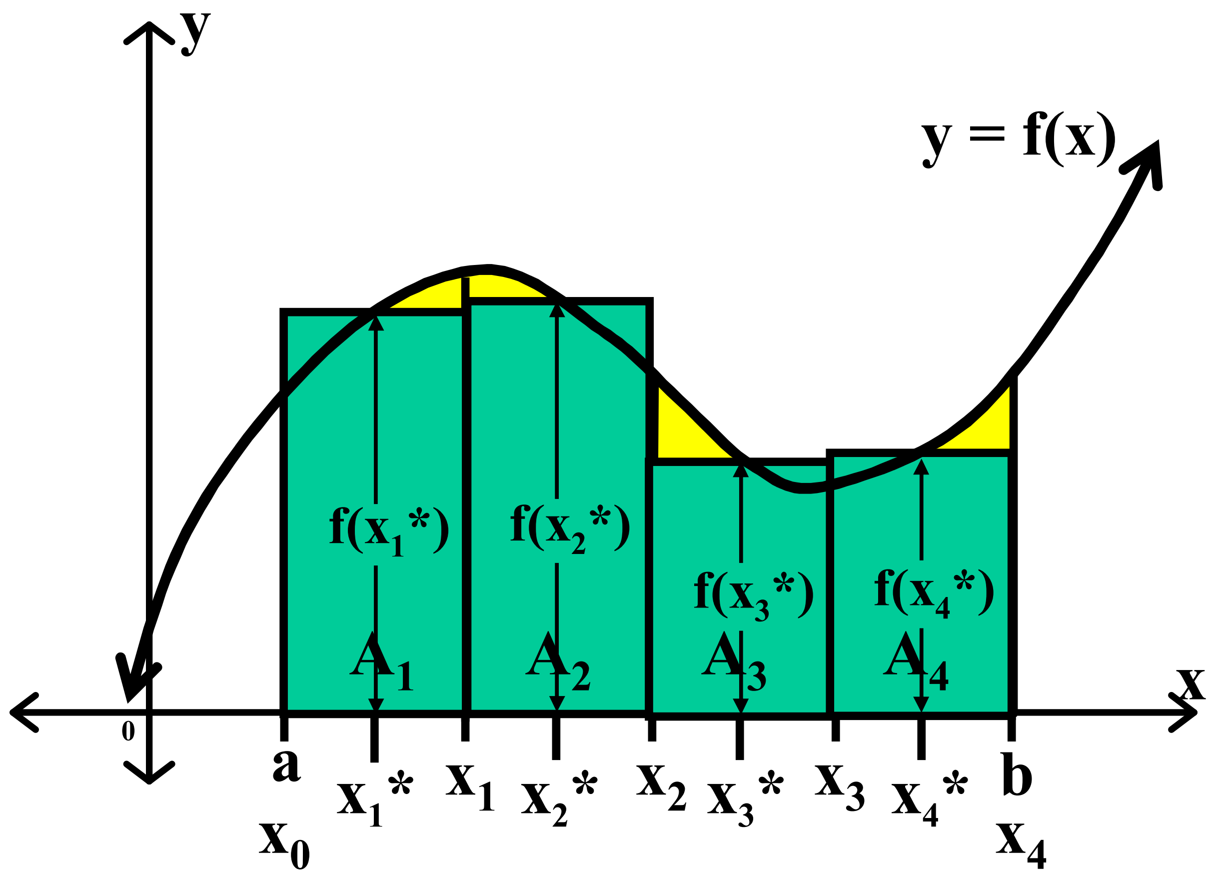
The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.
The length of the 4^{th} Mid-Rectangle is $f(x_4^*)$. Its width is Δx.



$A_1 \approx f(x_1*)\Delta x$ $A_2 \approx f(x_2*)\Delta x$ $A_3 \approx f(x_3*)\Delta x$ $A_4 \approx$

The length of the i^{th} Mid-Rectangle is $f(x_i*)$.

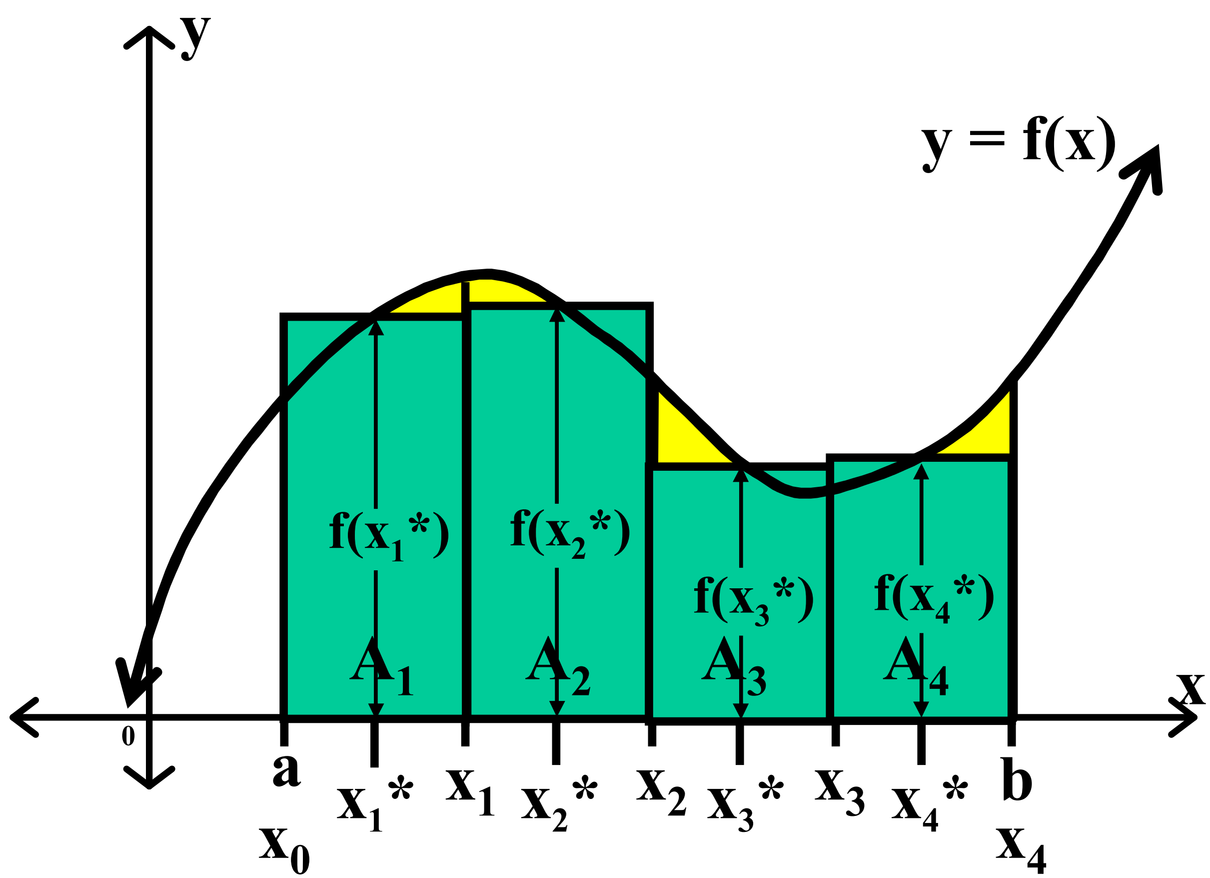
The length of the 4^{th} Mid-Rectangle is $f(x_4*)$. Its width is Δx.



$A_1 \approx f(x_1^*)\Delta x$ $\quad A_2 \approx f(x_2^*)\Delta x$ $\quad A_3 \approx f(x_3^*)\Delta x$ $\quad A_4 \approx f(x_4^*)$

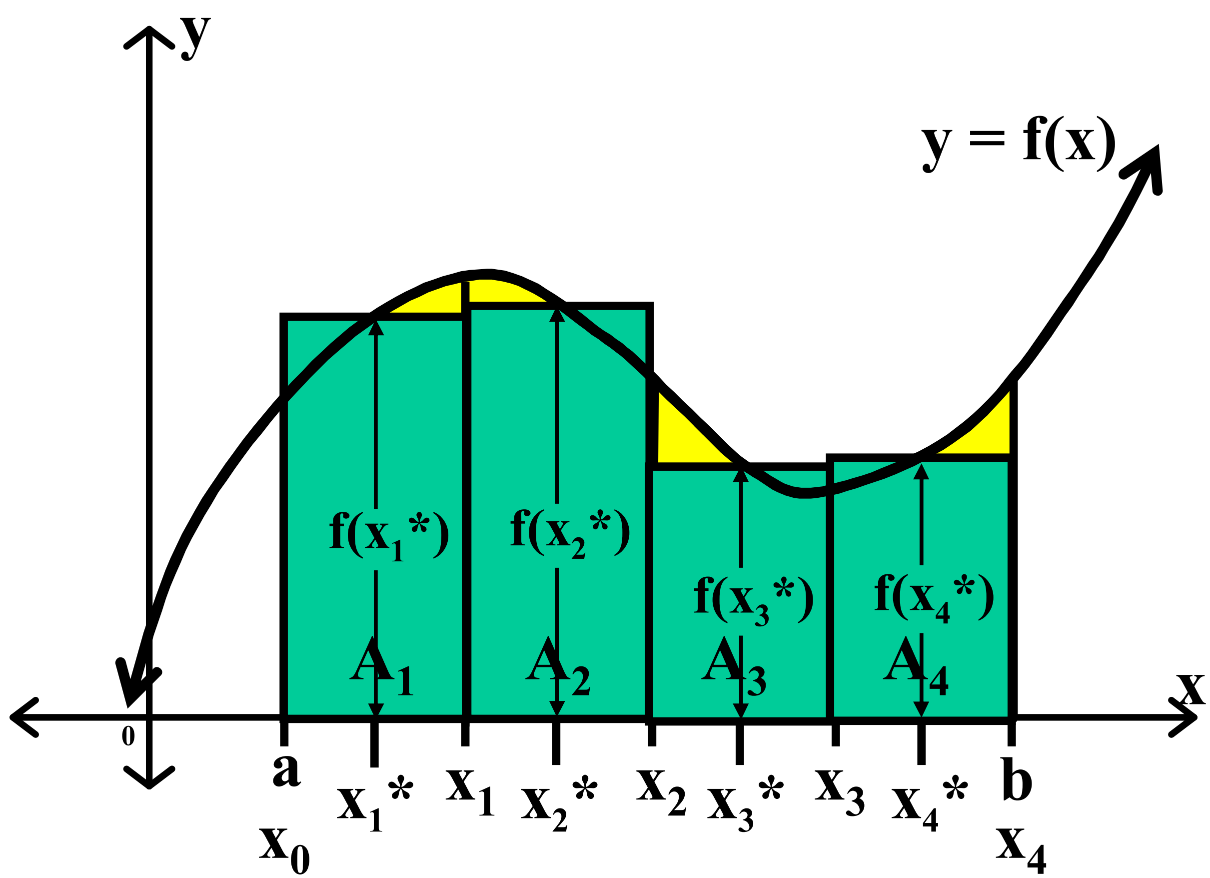
The length of the i^{th} Mid-Rectangle is $f(x_i^*)$.

The length of the 4^{th} Mid-Rectangle is $f(x_4^*)$. Its width is Δx.

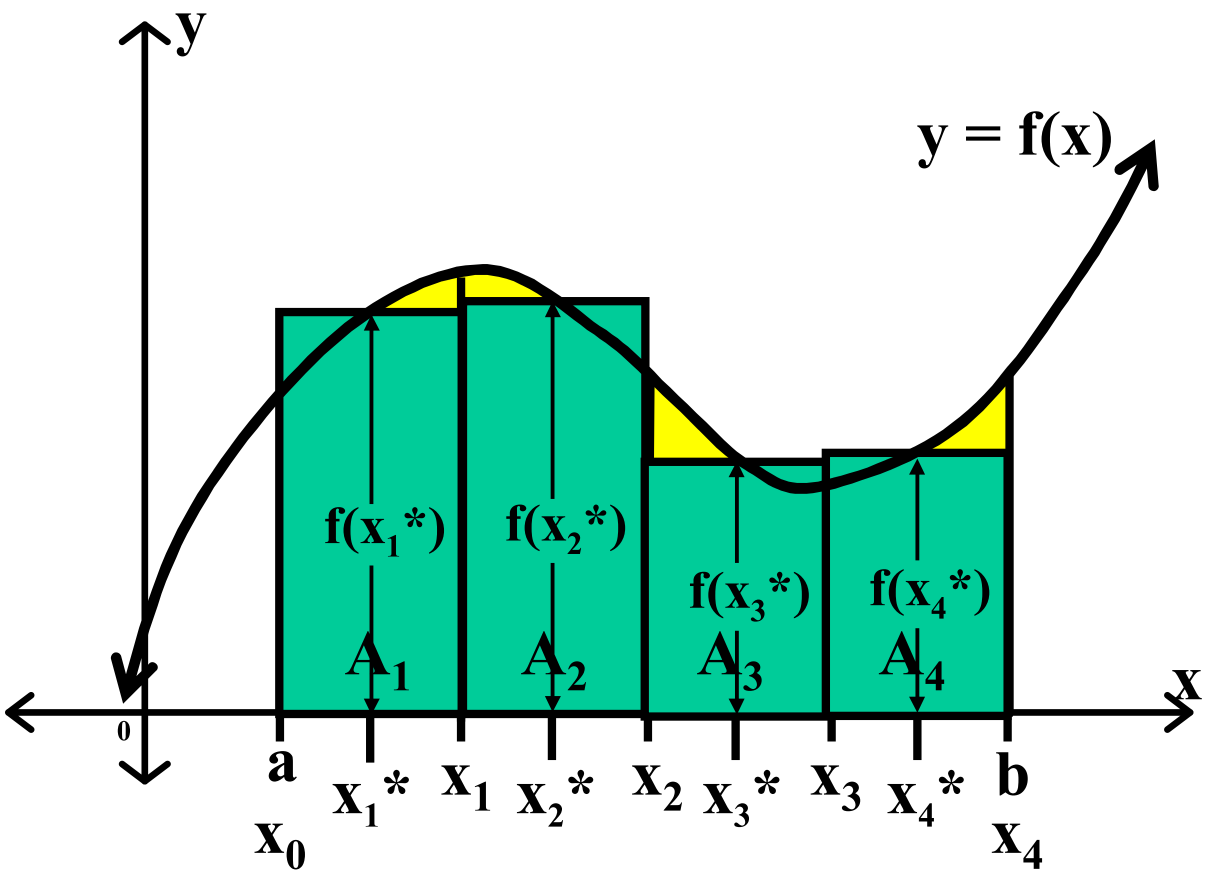


$A_1 \approx f(x_1{}^*)\Delta x$ $A_2 \approx f(x_2{}^*)\Delta x$ $A_3 \approx f(x_3{}^*)\Delta x$ $A_4 \approx f(x_4{}^*)\Delta x$

The length of the i^{th} Mid-Rectangle is $f(x_i{}^*)$.
The length of the 4^{th} Mid-Rectangle is $f(x_4{}^*)$. Its width is Δx.

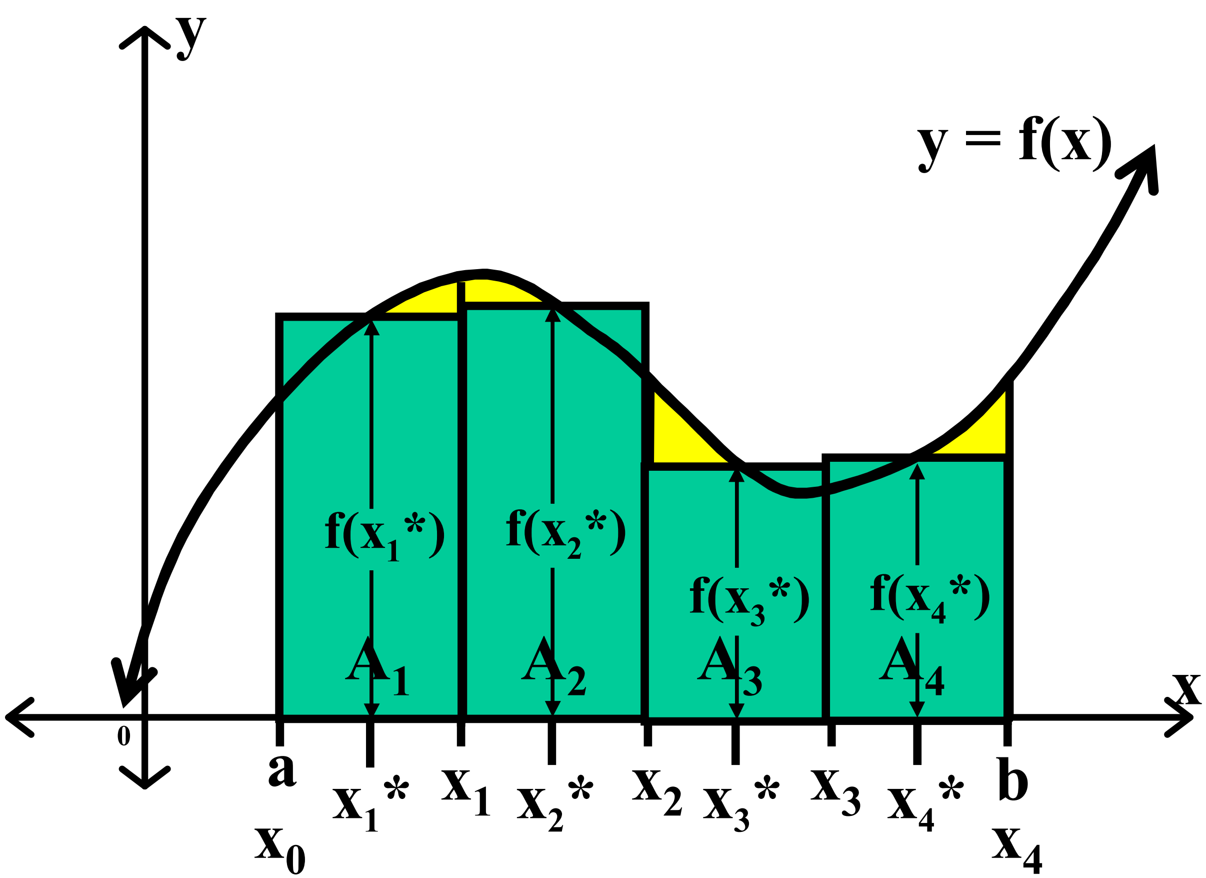


$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x \quad A_3 \approx f(x_3^*)\Delta x \quad A_4 \approx f(x_4^*)\Delta x$



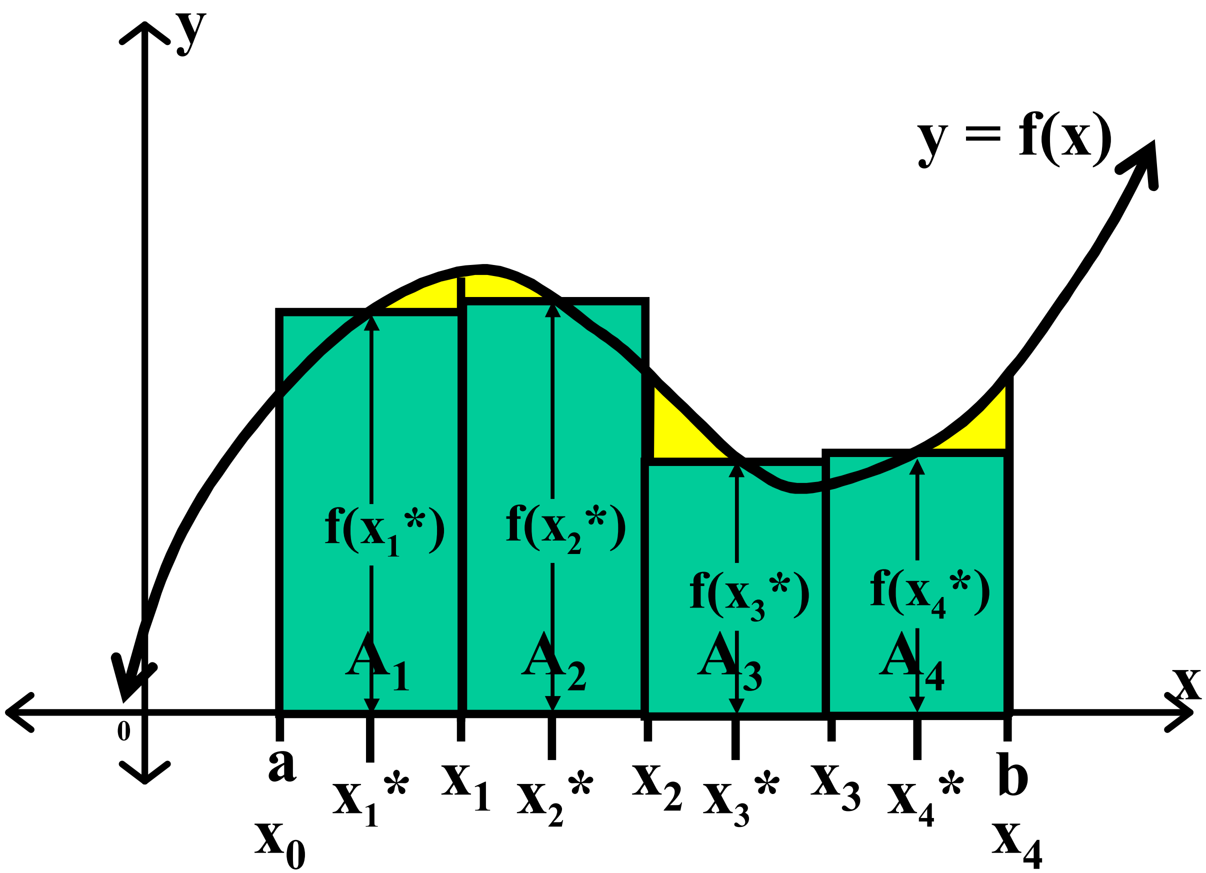
$A_1 \approx f(x_1{*})\Delta x$ $A_2 \approx f(x_2{*})\Delta x$ $A_3 \approx f(x_3{*})\Delta x$ $A_4 \approx f(x_4{*})\Delta x$

Notice that, in general,



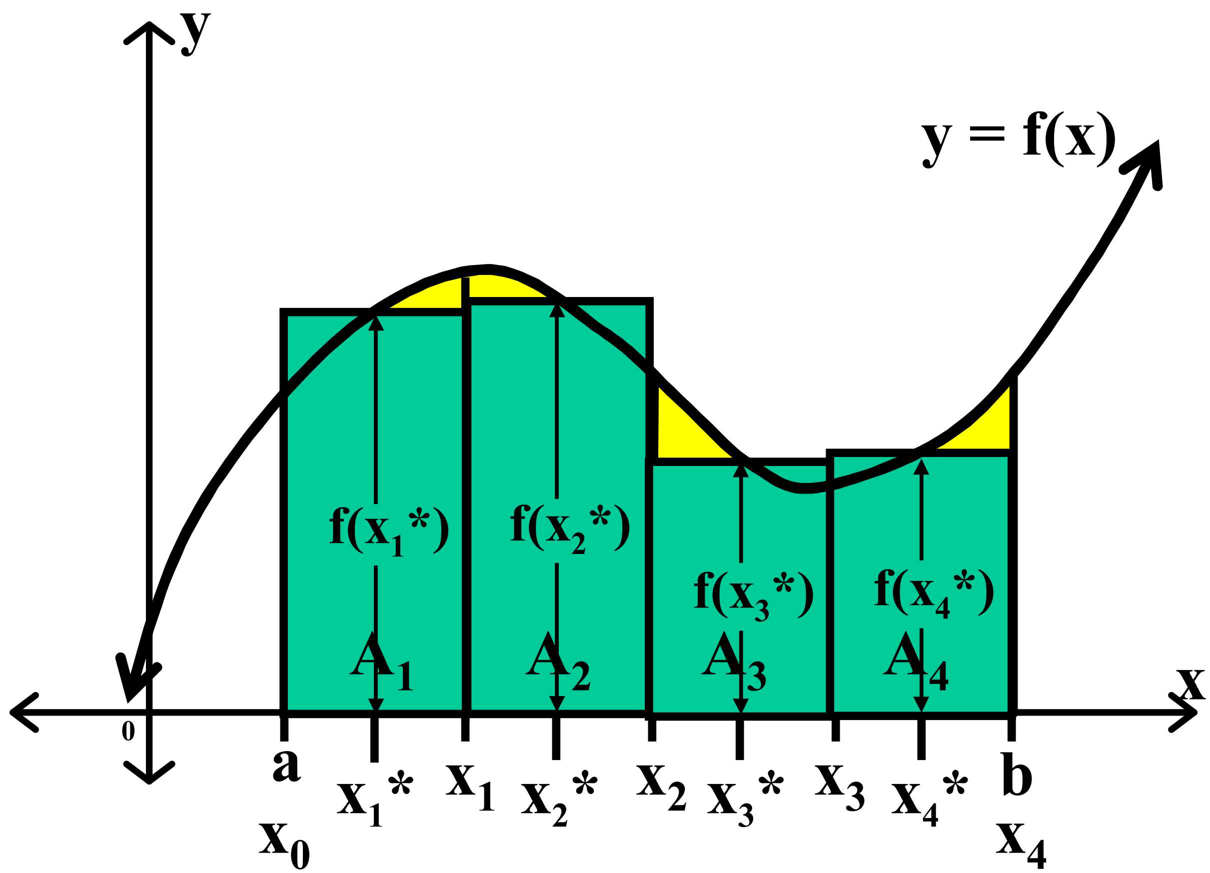
$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x \quad A_3 \approx f(x_3^*)\Delta x \quad A_4 \approx f(x_4^*)\Delta x$

Notice that, in general, $A_i \approx$



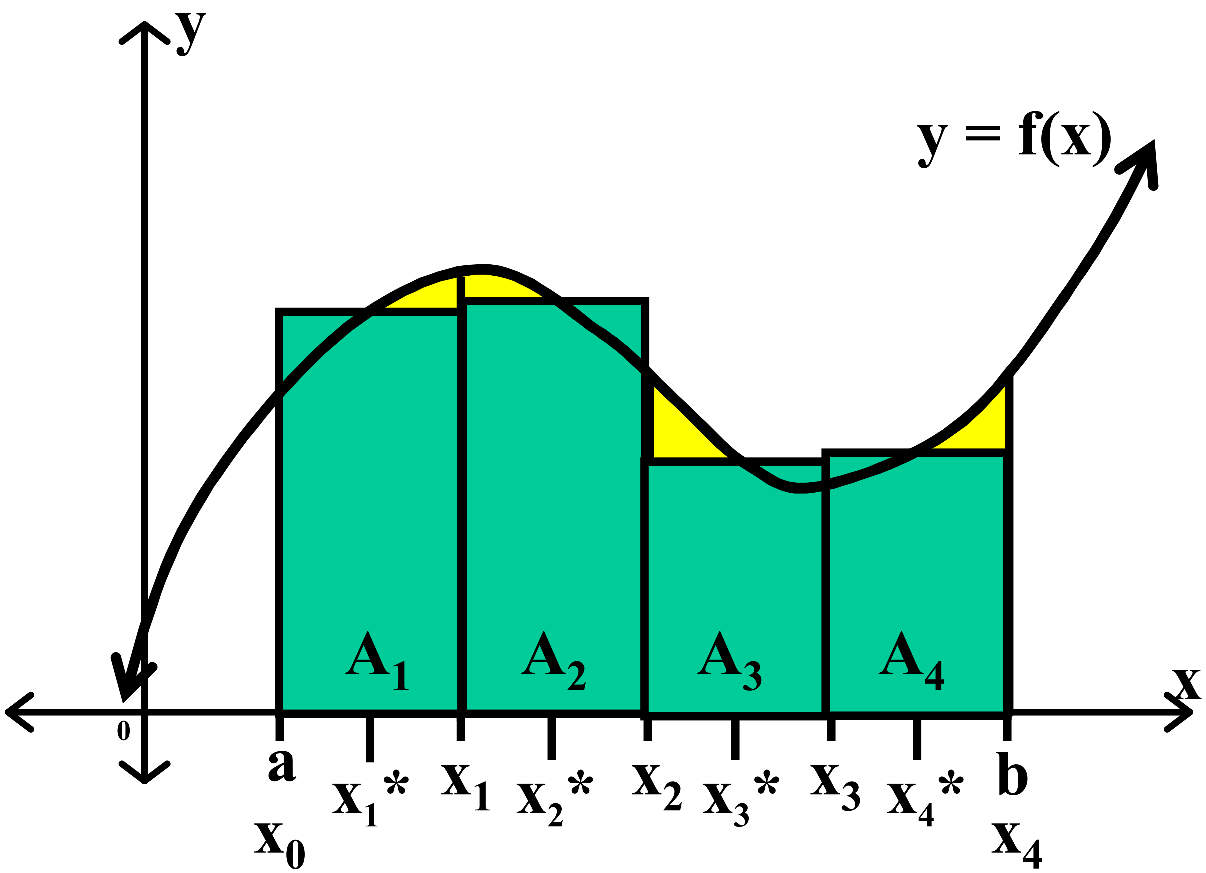
$A_1 \approx f(x_1^*)\Delta x \quad A_2 \approx f(x_2^*)\Delta x \quad A_3 \approx f(x_3^*)\Delta x \quad A_4 \approx f(x_4^*)\Delta x$

Notice that, in general, $A_i \approx f(x_i^*)$

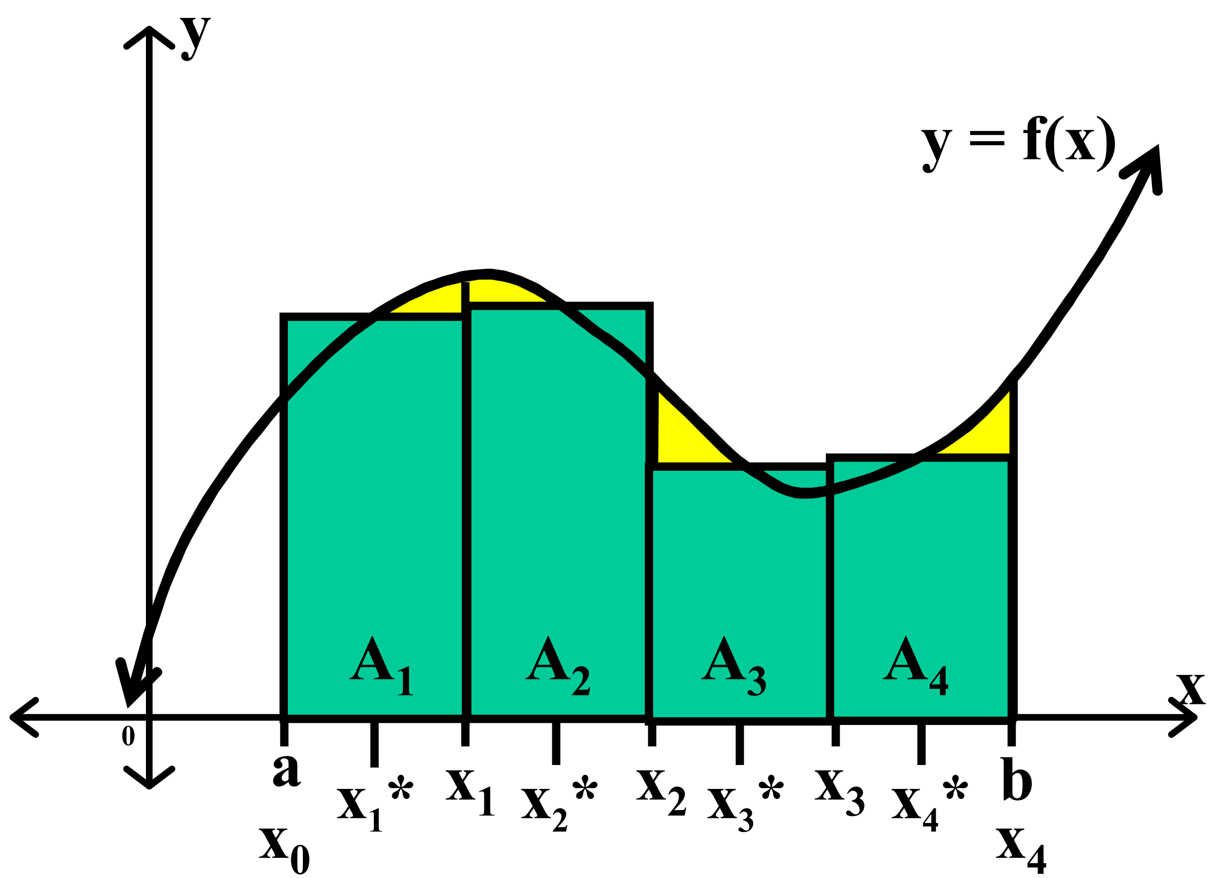


$A_1 \approx f(x_1*)\Delta x$ $A_2 \approx f(x_2*)\Delta x$ $A_3 \approx f(x_3*)\Delta x$ $A_4 \approx f(x_4*)\Delta x$

Notice that, in general, $A_i \approx f(x_i*)\Delta x$.

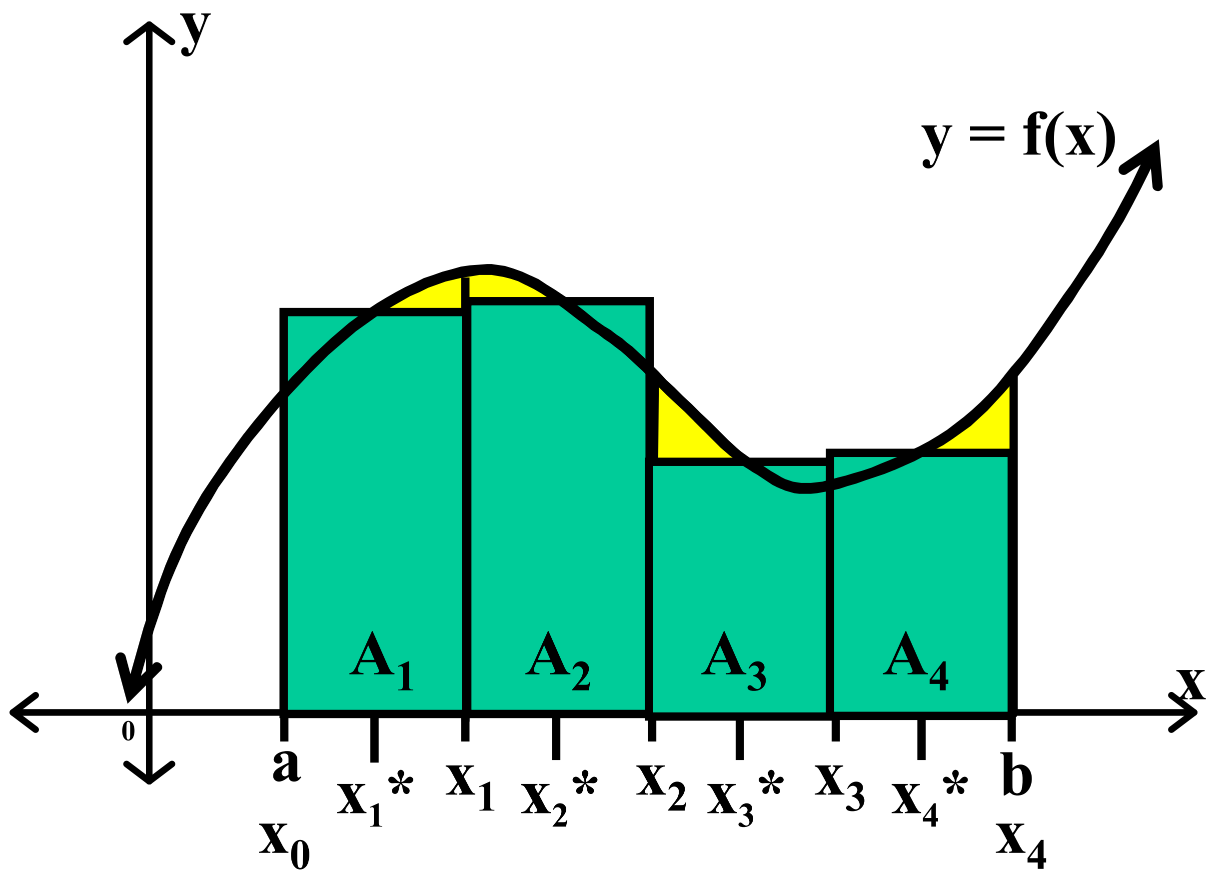


$$A_i \approx f(x_i^*)\Delta x$$



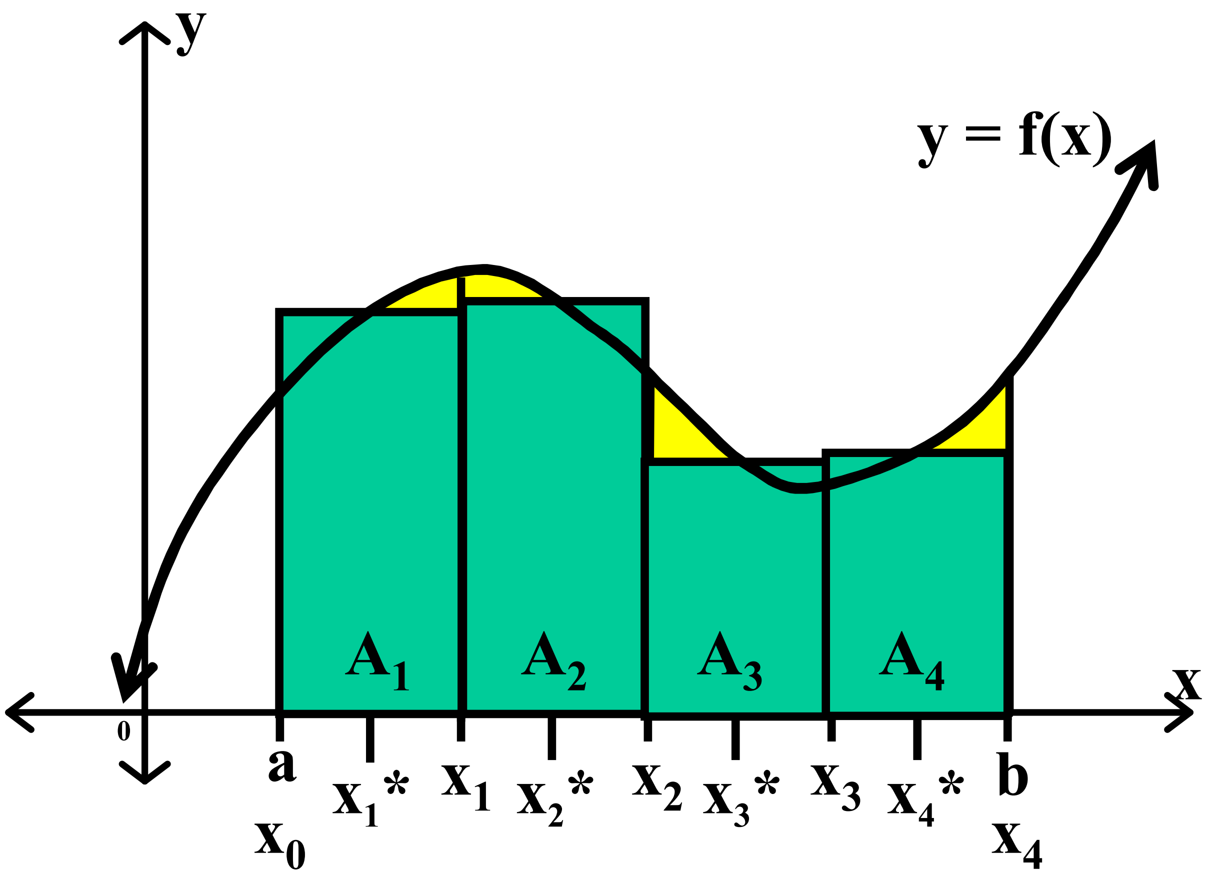
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx$$



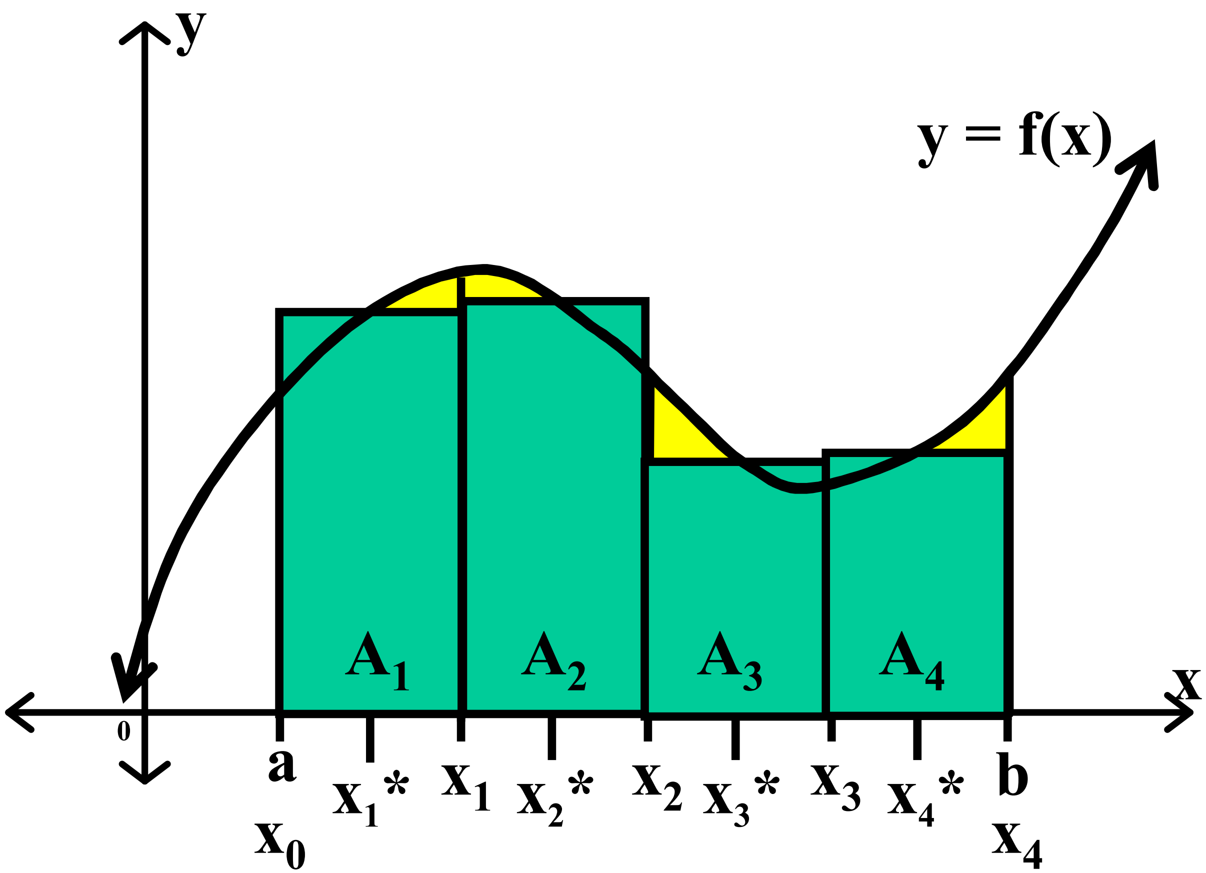
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4$$



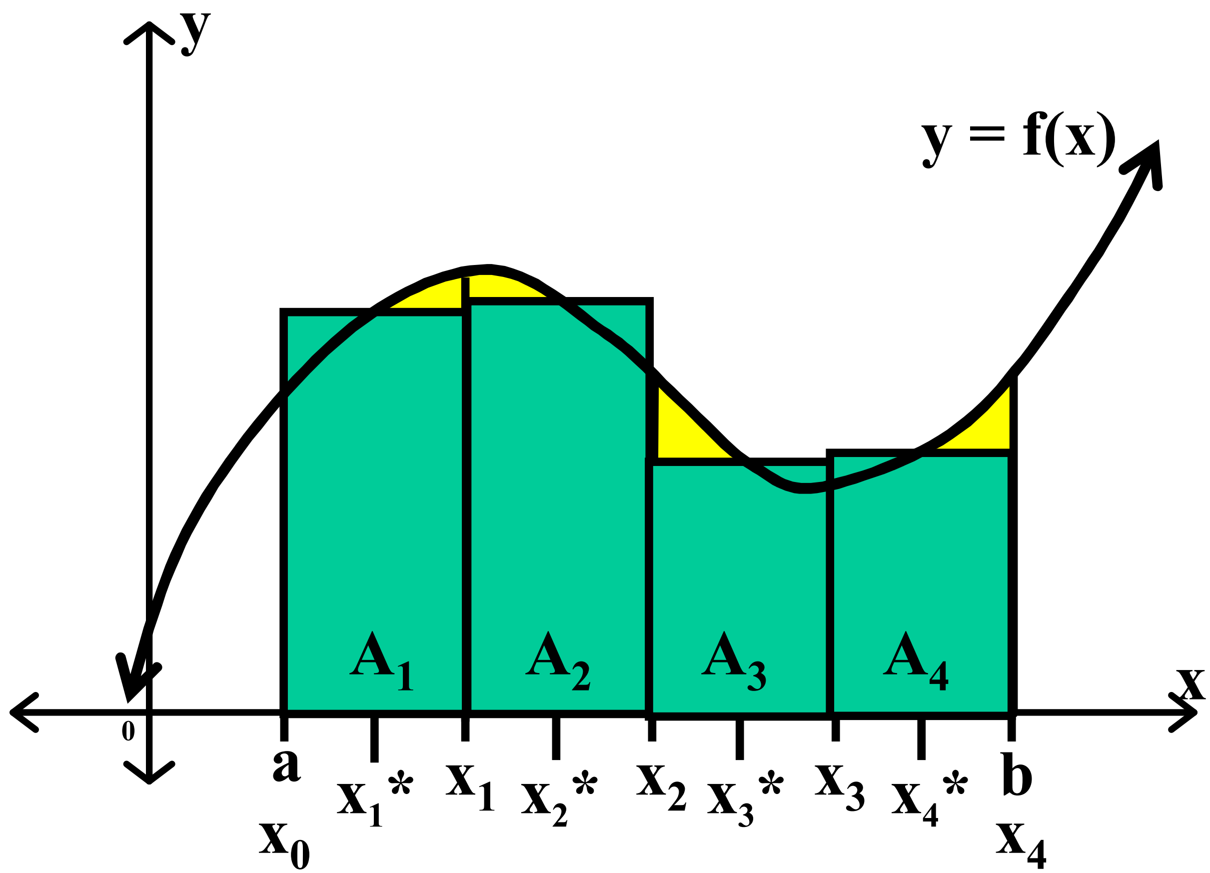
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4 = \sum_{i=1}^{n} A_i$$



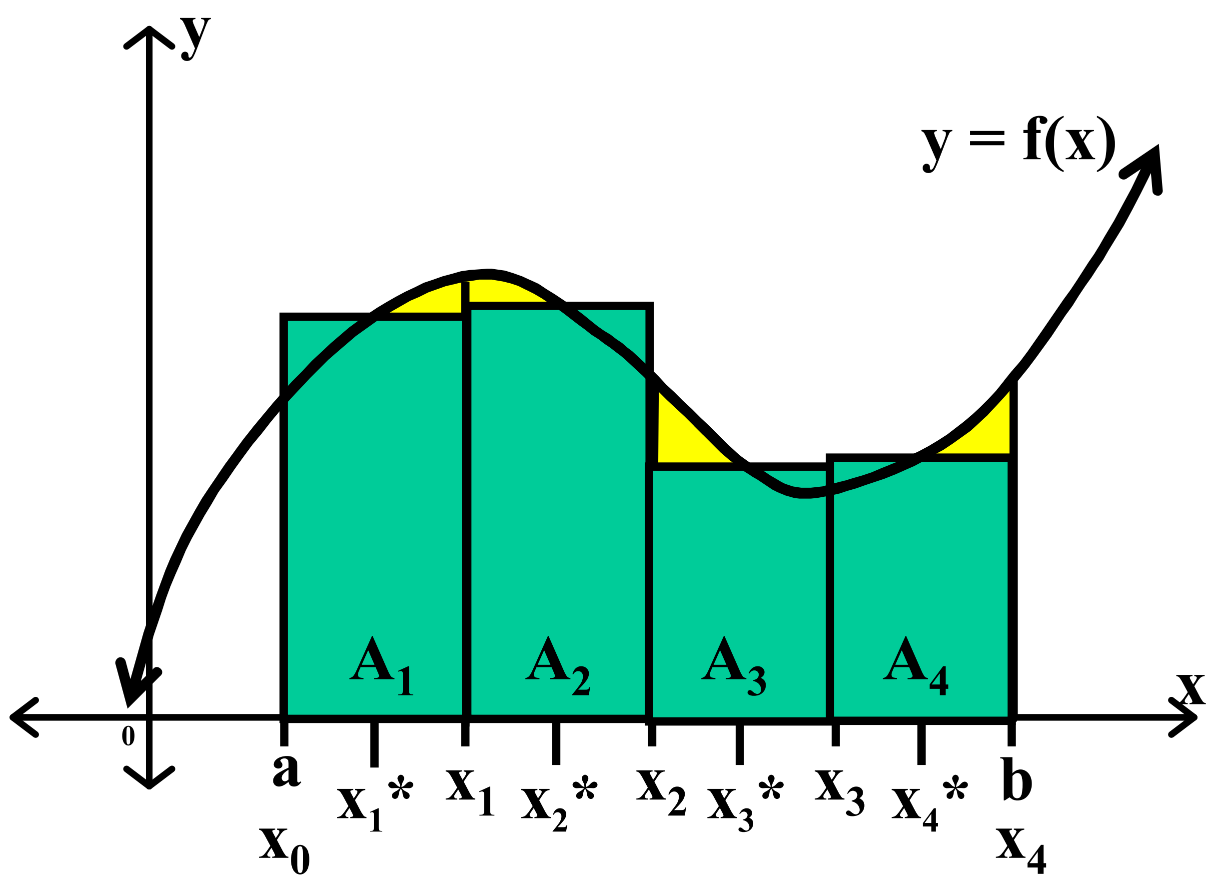
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4 = \sum_{i=1}^{n} A_i \quad \text{(In this case, n = 4.)}$$



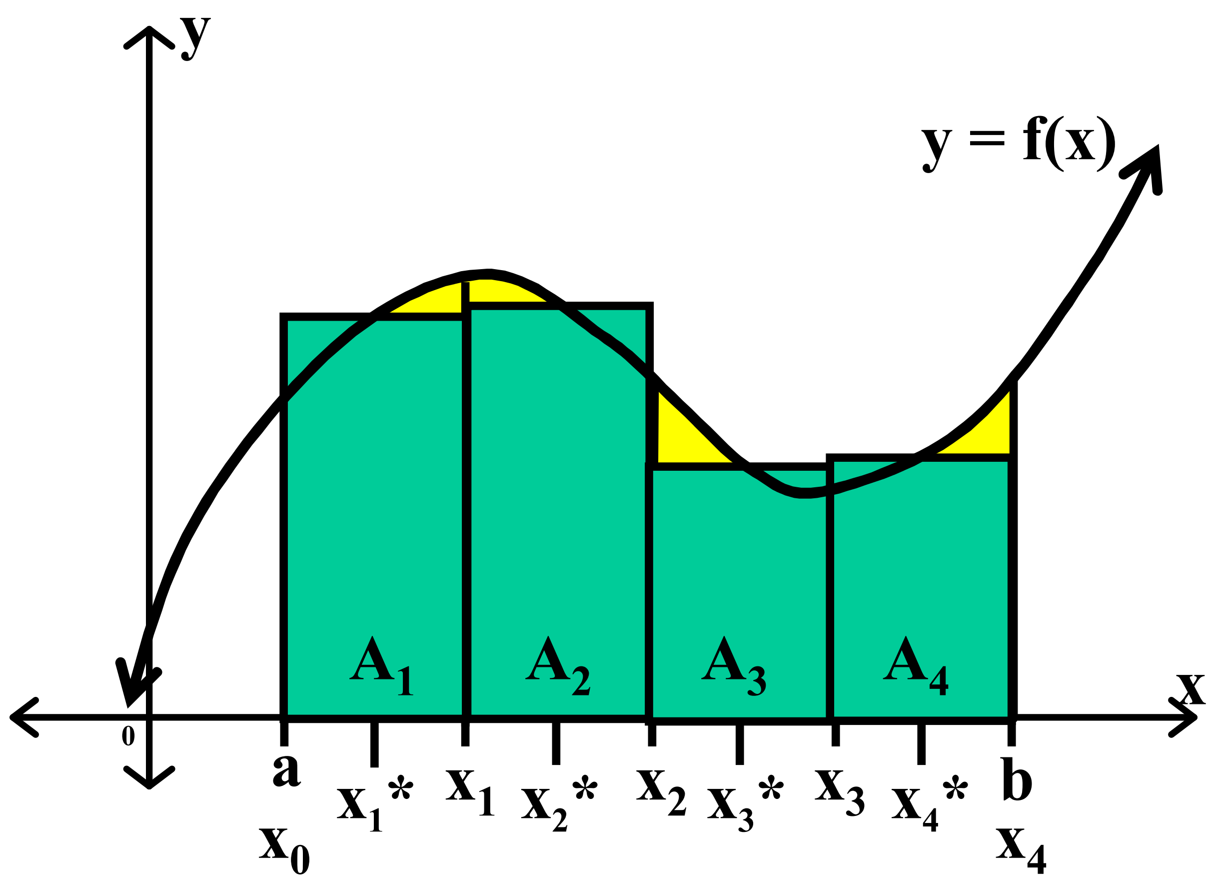
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$



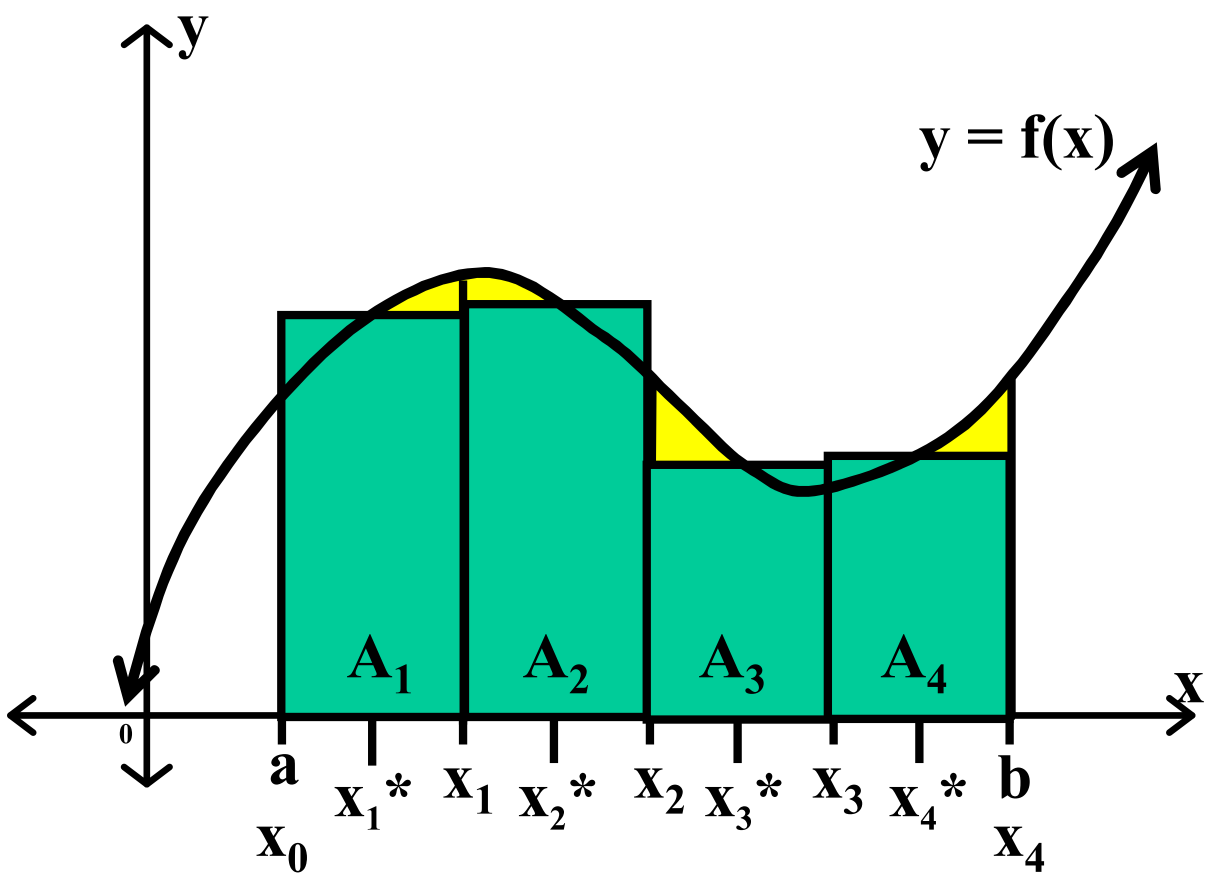
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx$$



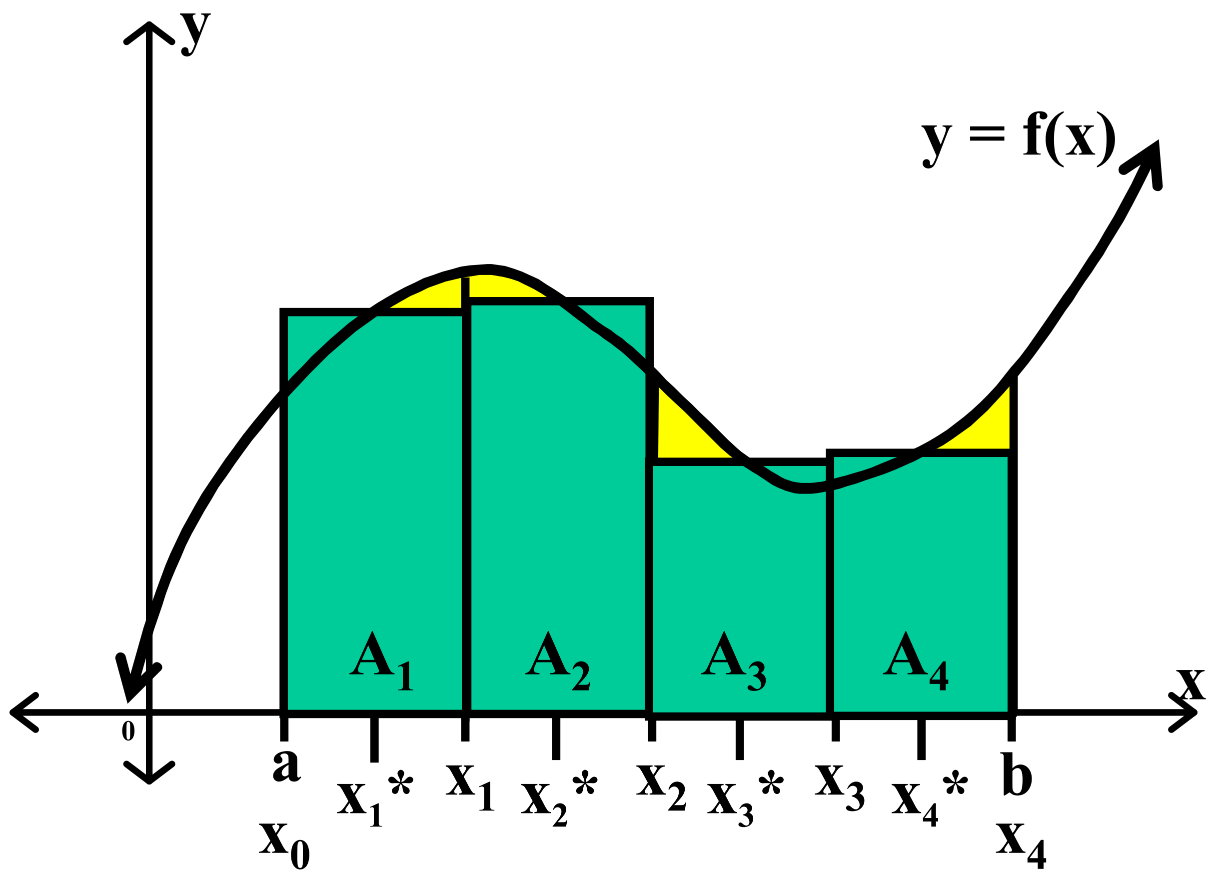
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n}$$



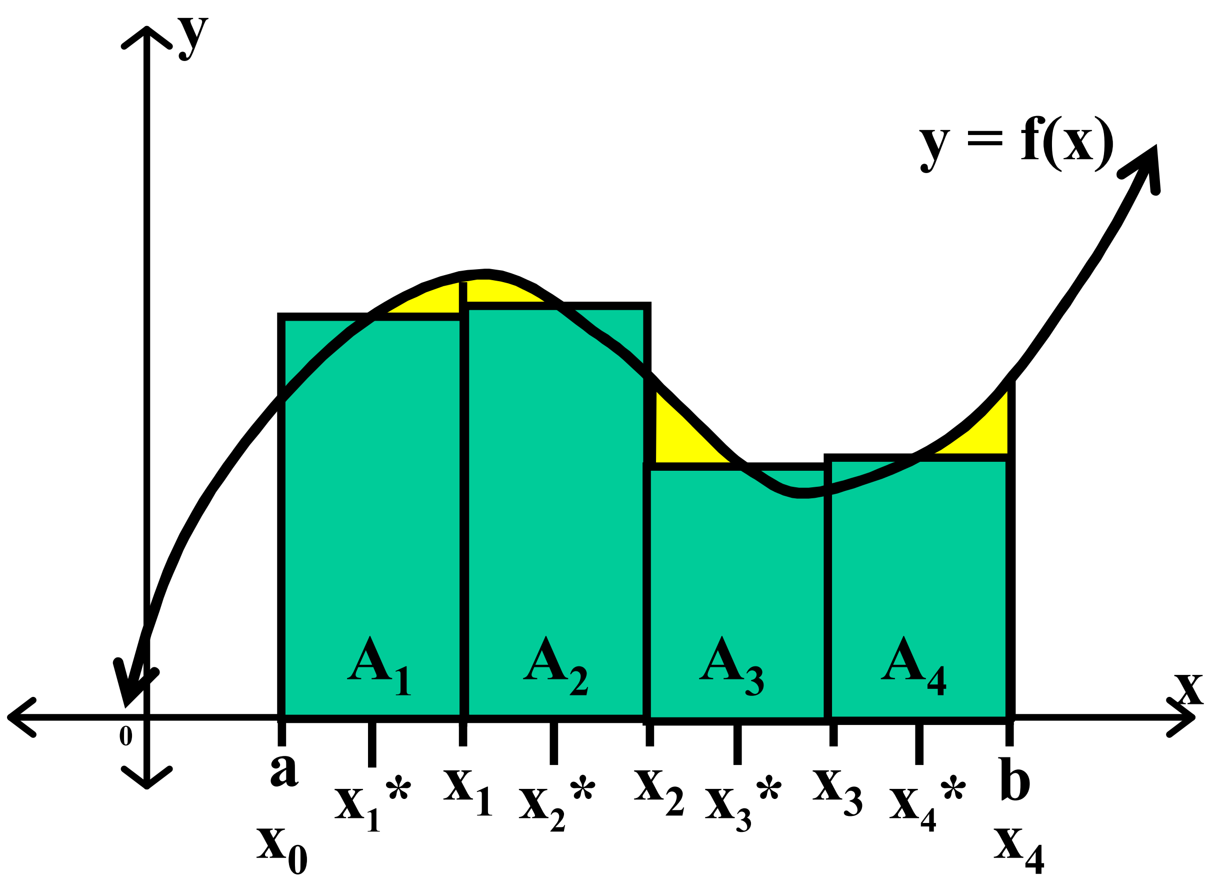
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n} f(x_i^*)$$



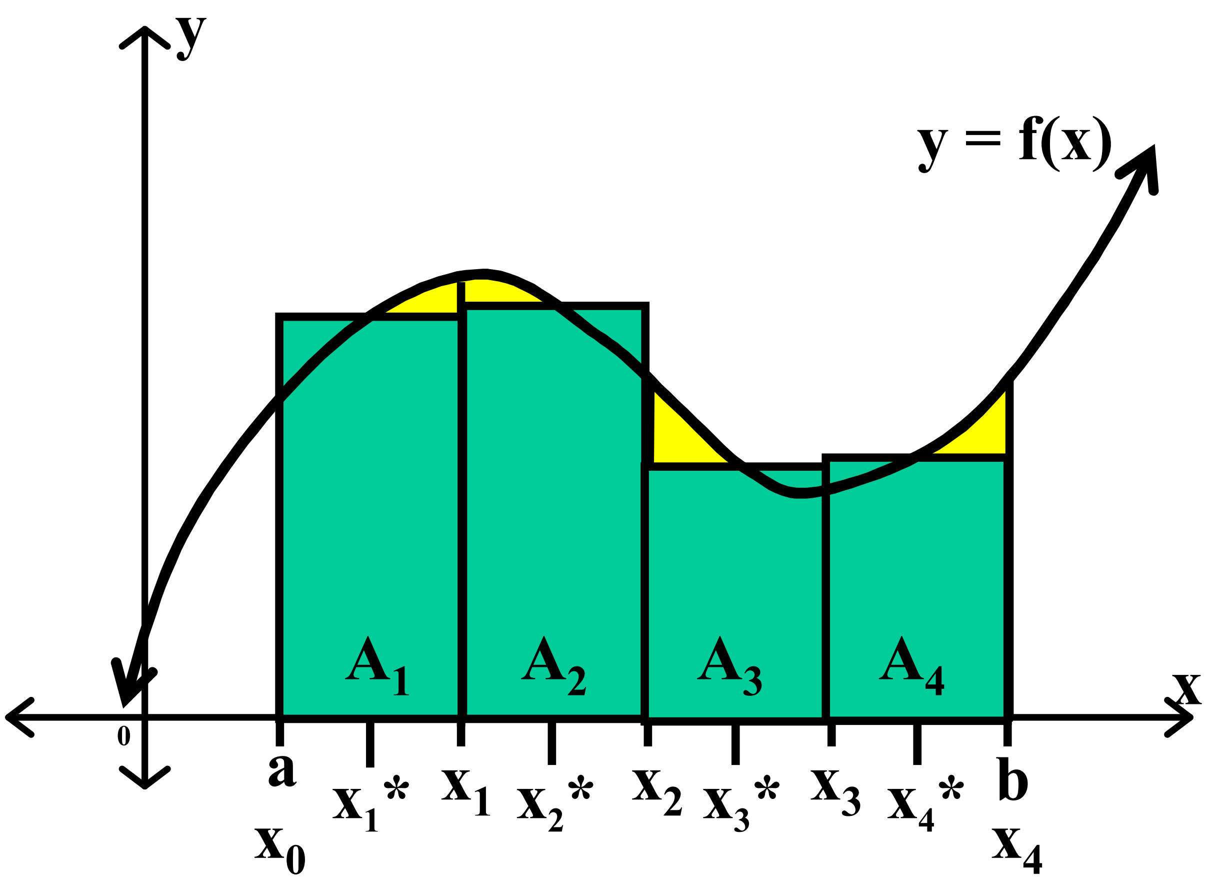
$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n} f(x_i^*)\Delta x$$



$$A_i \approx f(x_i^*)\Delta x$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i \approx \sum_{i=1}^{n} f(x_i^*)\Delta x = S_M$$



$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

The Mid-Rectangular Approximation

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

Calculate the x_i^*'s.

Class Worksheet #5 Unit 11

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$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$

$x_0 = a = 2$

$x_1 = 2.5$

$x_2 = 3$

$x_3 = 3.5$

$x_4 = 4$

$x_5 = 4.5$

$x_6 = b = 5$

$x_1^* =$

Calculate the x_i^*'s.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

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$x_1^* =$

x_1^* is the midpoint of the 1st sub-interval.

Calculate the x_i^*'s.

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

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Calculate the $f(x_i^*)$'s.

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$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25$

$x_4^* = 3.75$

$x_5^* = 4.25$

$x_6^* = 4.75$

Calculate the $f(x_i^*)$'s.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75$

$x_5^* = 4.25$

$x_6^* = 4.75$

Calculate the $f(x_i^*)$'s).

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

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$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

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$x_2^* = 2.75$ $\quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25$ $\quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75$ $\quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25$

$x_6^* = 4.75$

Calculate the $f(x_i^*)$'s.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75$

Calculate the $f(x_i^*)$'s).

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

Calculate the $f(x_i^*)$'s.

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. **n = 6**

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

$x_1^* = 2.25$ $\quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75$ $\quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25$ $\quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75$ $\quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25$ $\quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75$ $\quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

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$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

$$S_M = \sum_{i=1}^{6} f(x_i^*)\Delta x$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

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$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

$$S_M = \sum_{i=1}^{6} f(x_i^*)\Delta x$$

$$S_L = f(x_1^*)\Delta x + f(x_2^*)\Delta x + f(x_3^*)\Delta x + + f(x_4^*)\Delta x + f(x_5^*)\Delta x + f(x_6^*)\Delta x$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

$$S_M = \sum_{i=1}^{6} f(x_i^*)\Delta x$$

$$S_L = f(x_1^*)\Delta x + f(x_2^*)\Delta x + f(x_3^*)\Delta x + + f(x_4^*)\Delta x + f(x_5^*)\Delta x + f(x_6^*)\Delta x$$

$S_M =$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

$$S_M = \sum_{i=1}^{6} f(x_i^*)\Delta x$$

$$S_L = f(x_1^*)\Delta x + f(x_2^*)\Delta x + f(x_3^*)\Delta x + f(x_4^*)\Delta x + f(x_5^*)\Delta x + f(x_6^*)\Delta x$$

$S_M =$

Class Worksheet #5 Unit 11

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $n = 6$

$\int_2^5 \sqrt{x^3 - 3}\,dx$ $\quad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5$ $\quad f(x) = \sqrt{x^3 - 3}$

$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$

$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$

$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$

$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$

$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$

$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$

$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

$$S_M = \sum_{i=1}^{6} f(x_i^*)\Delta x$$

$$S_L = f(x_1^*)\Delta x + f(x_2^*)\Delta x + f(x_3^*)\Delta x + + f(x_4^*)\Delta x + f(x_5^*)\Delta x + f(x_6^*)\Delta x$$

$$S_M = (\sqrt{2.25^3 - 3} + \sqrt{2.75^3 - 3} + \sqrt{3.25^3 - 3} + \sqrt{3.75^3 - 3} + \sqrt{4.25^3 - 3} + \sqrt{4.75^3 - 3})(.5)$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$$x_1^* = 2.25 \quad f(x_1^*) = f(2.25) = \sqrt{2.25^3 - 3}$$

$$x_2^* = 2.75 \quad f(x_2^*) = f(2.75) = \sqrt{2.75^3 - 3}$$

$$x_3^* = 3.25 \quad f(x_3^*) = f(3.25) = \sqrt{3.25^3 - 3}$$

$$x_4^* = 3.75 \quad f(x_4^*) = f(3.75) = \sqrt{3.75^3 - 3}$$

$$x_5^* = 4.25 \quad f(x_5^*) = f(4.25) = \sqrt{4.25^3 - 3}$$

$$x_6^* = 4.75 \quad f(x_6^*) = f(4.75) = \sqrt{4.75^3 - 3}$$

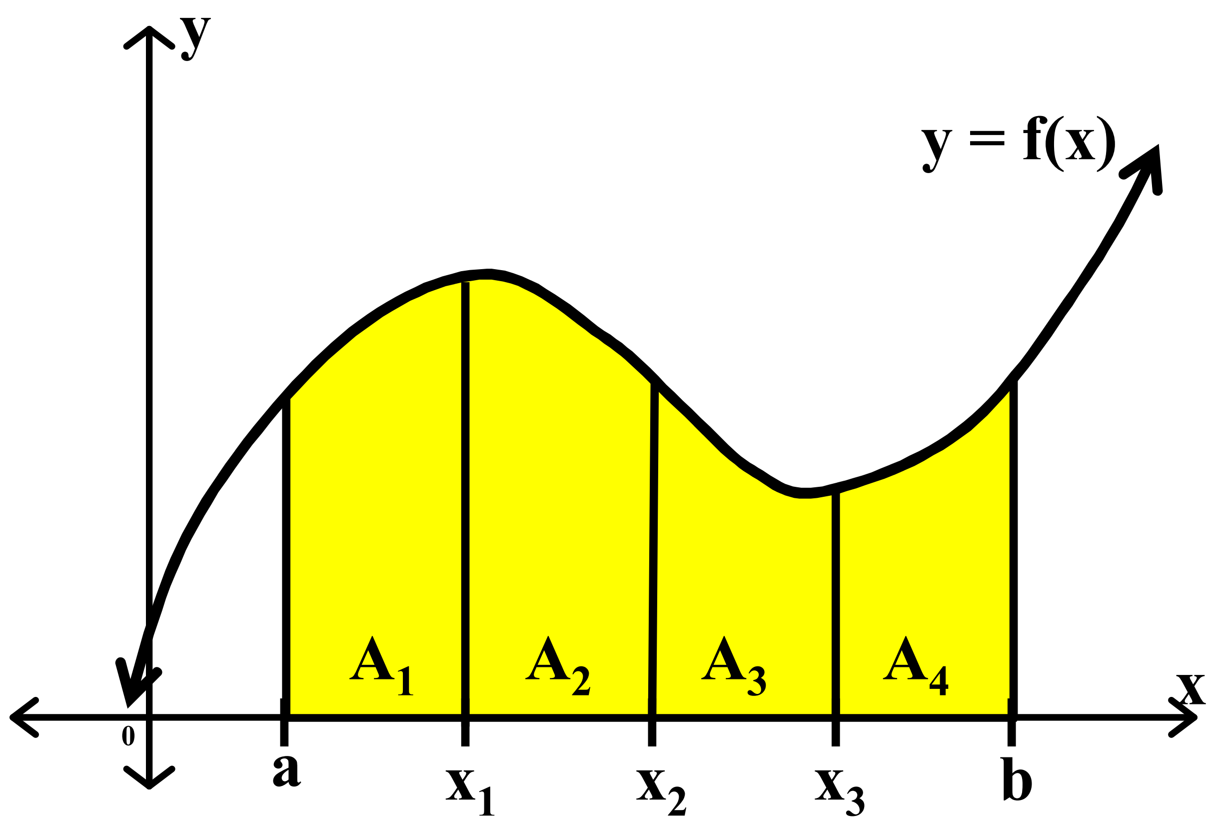
$$S_M = \sum_{i=1}^{n} f(x_i^*)\Delta x$$

$$S_M = \sum_{i=1}^{6} f(x_i^*)\Delta x$$

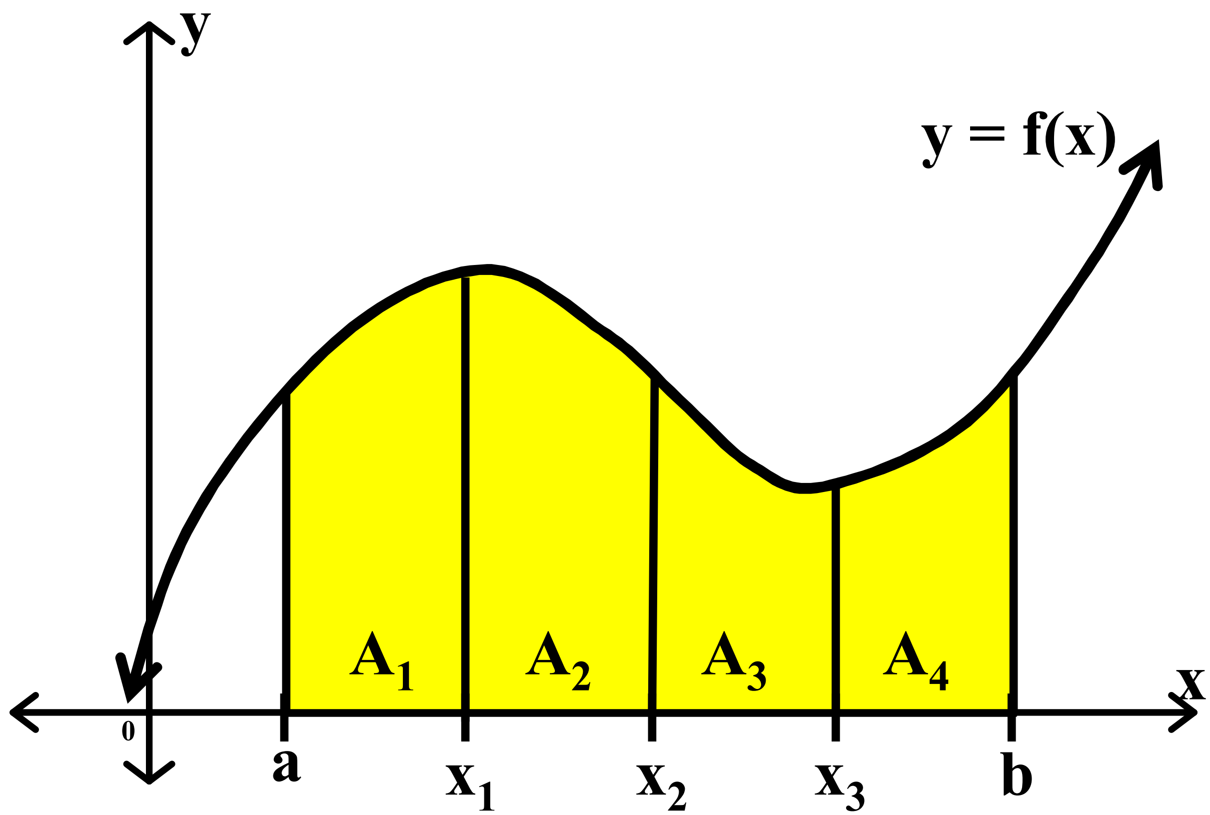
$$S_L = f(x_1^*)\Delta x + f(x_2^*)\Delta x + f(x_3^*)\Delta x + + f(x_4^*)\Delta x + f(x_5^*)\Delta x + f(x_6^*)\Delta x$$

$$S_M = \left(\sqrt{2.25^3 - 3} + \sqrt{2.75^3 - 3} + \sqrt{3.25^3 - 3} + \sqrt{3.75^3 - 3} + \sqrt{4.25^3 - 3} + \sqrt{4.75^3 - 3}\right)(.5)$$

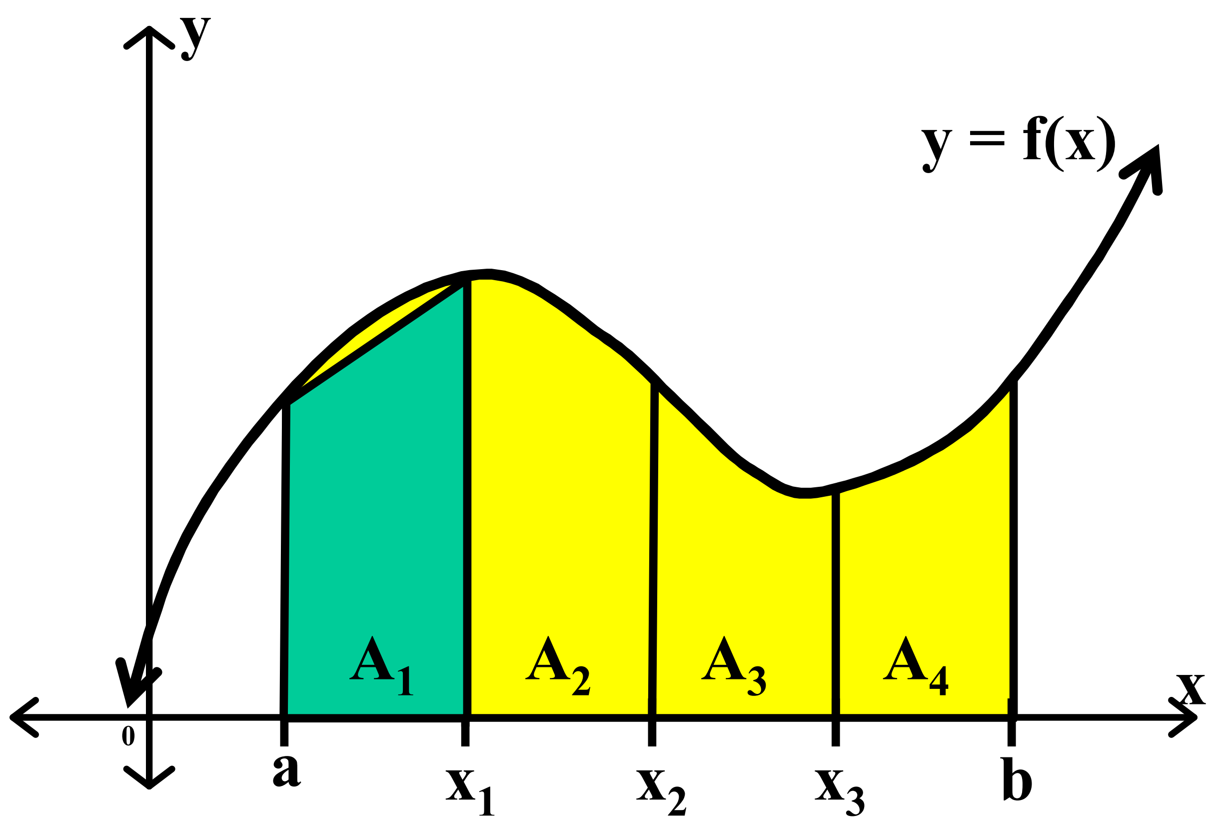
$$S_M \approx 19.28$$



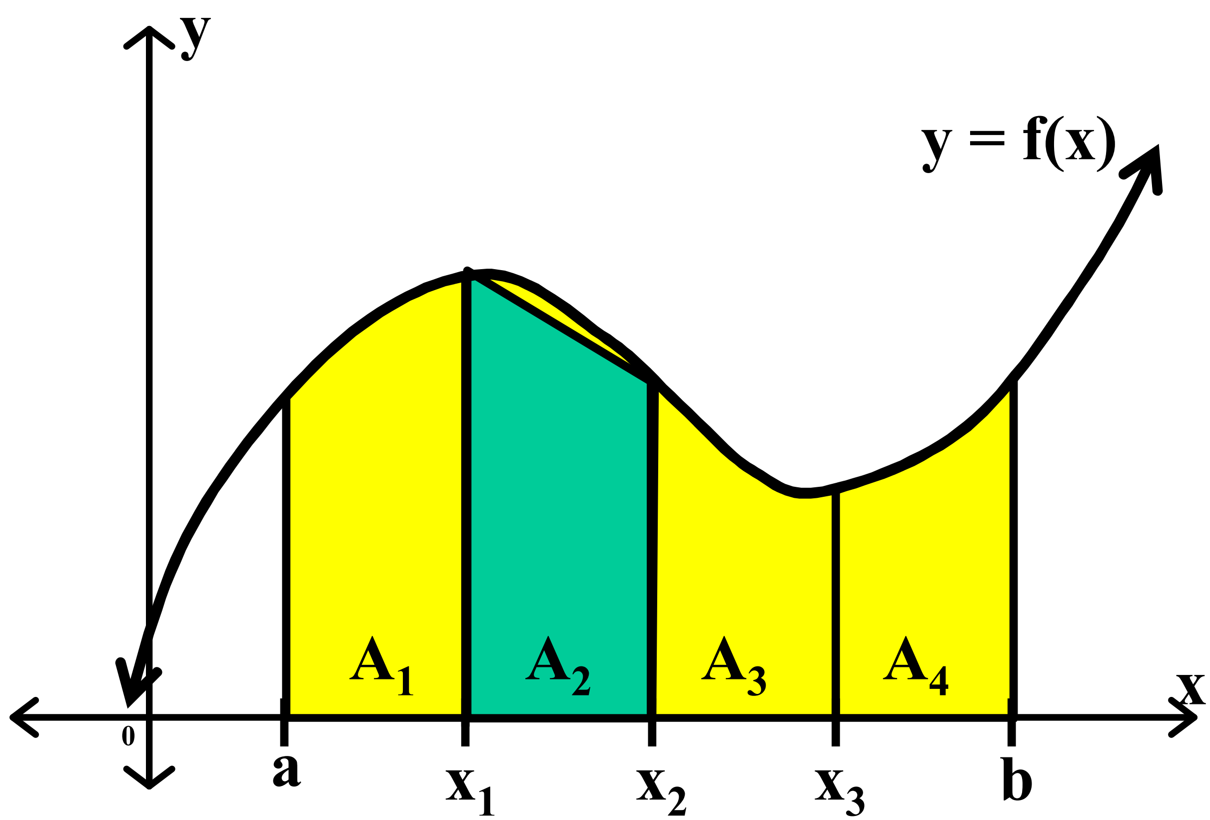
y
y = f(x)
A1
A2
A3
A4
x
0
a
x1
x2
x3
b



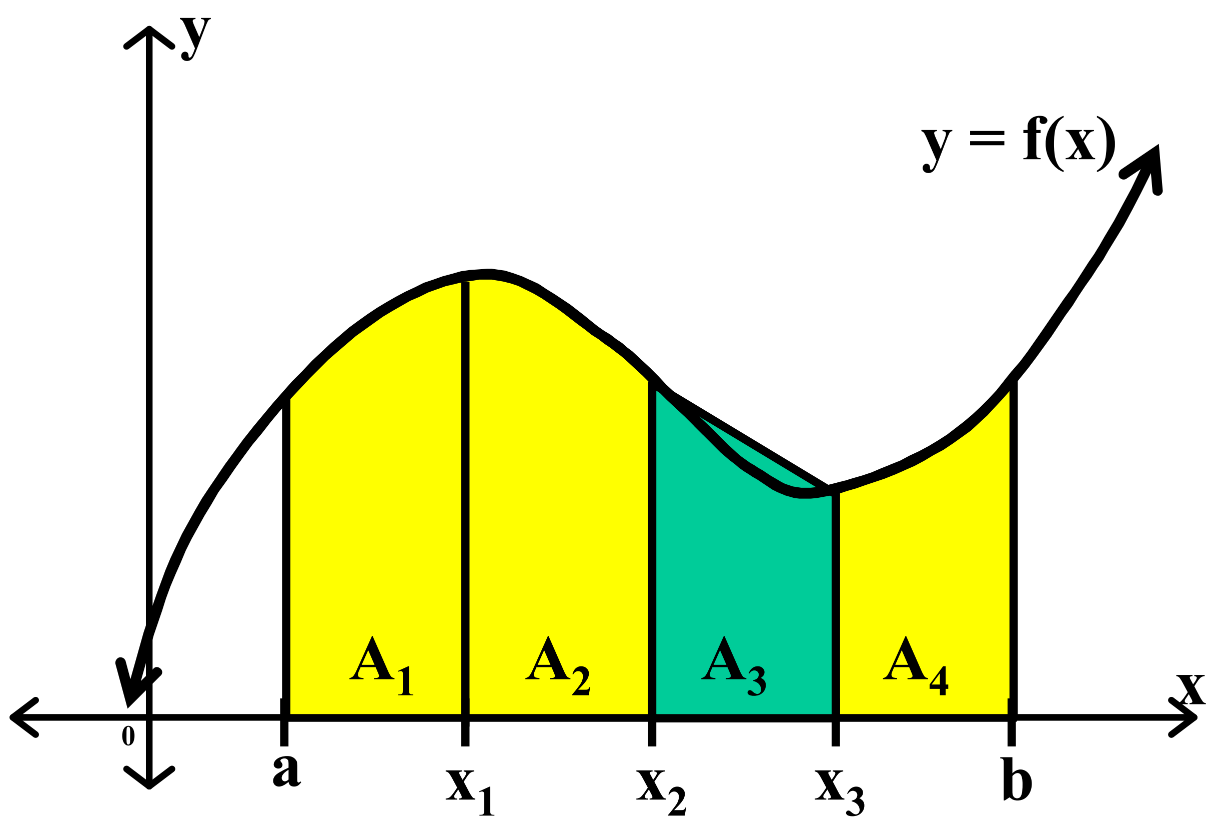
Trapezoids can also be used to approximate the area.



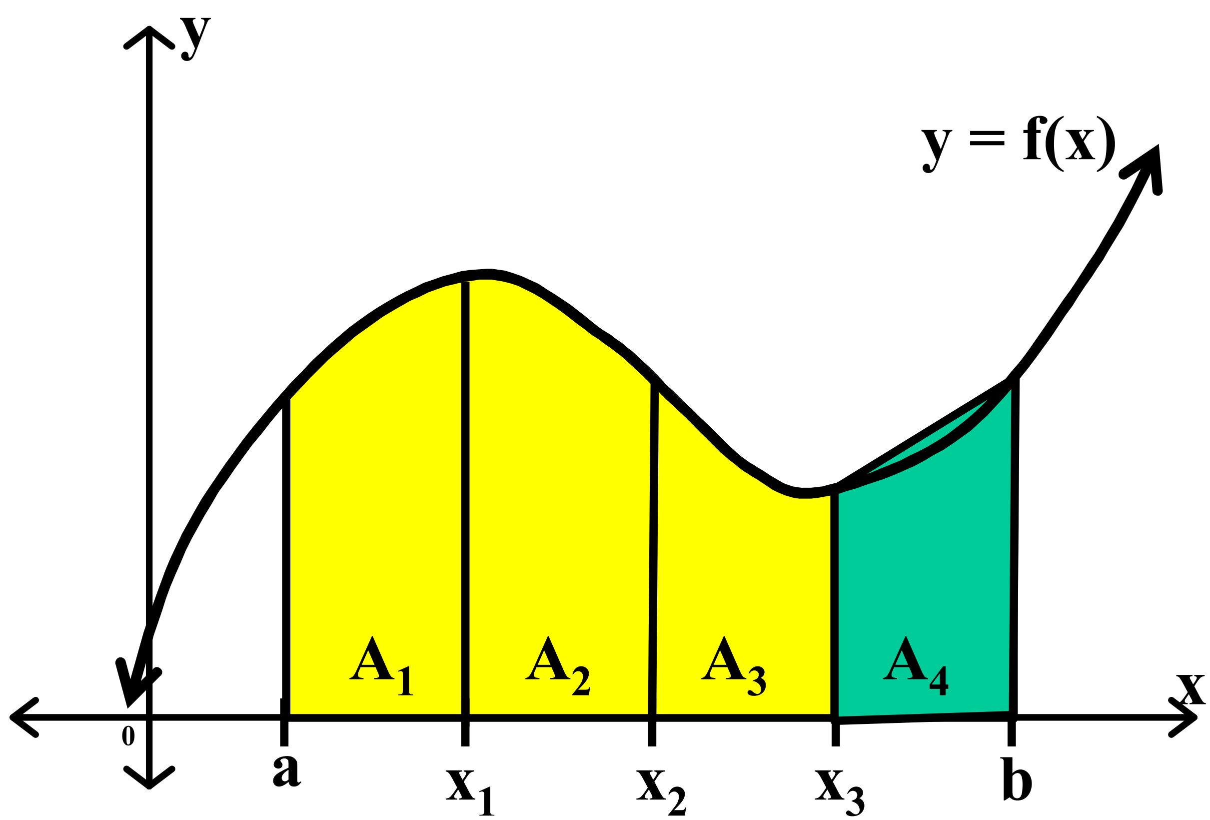
Trapezoids can also be used to approximate the area.



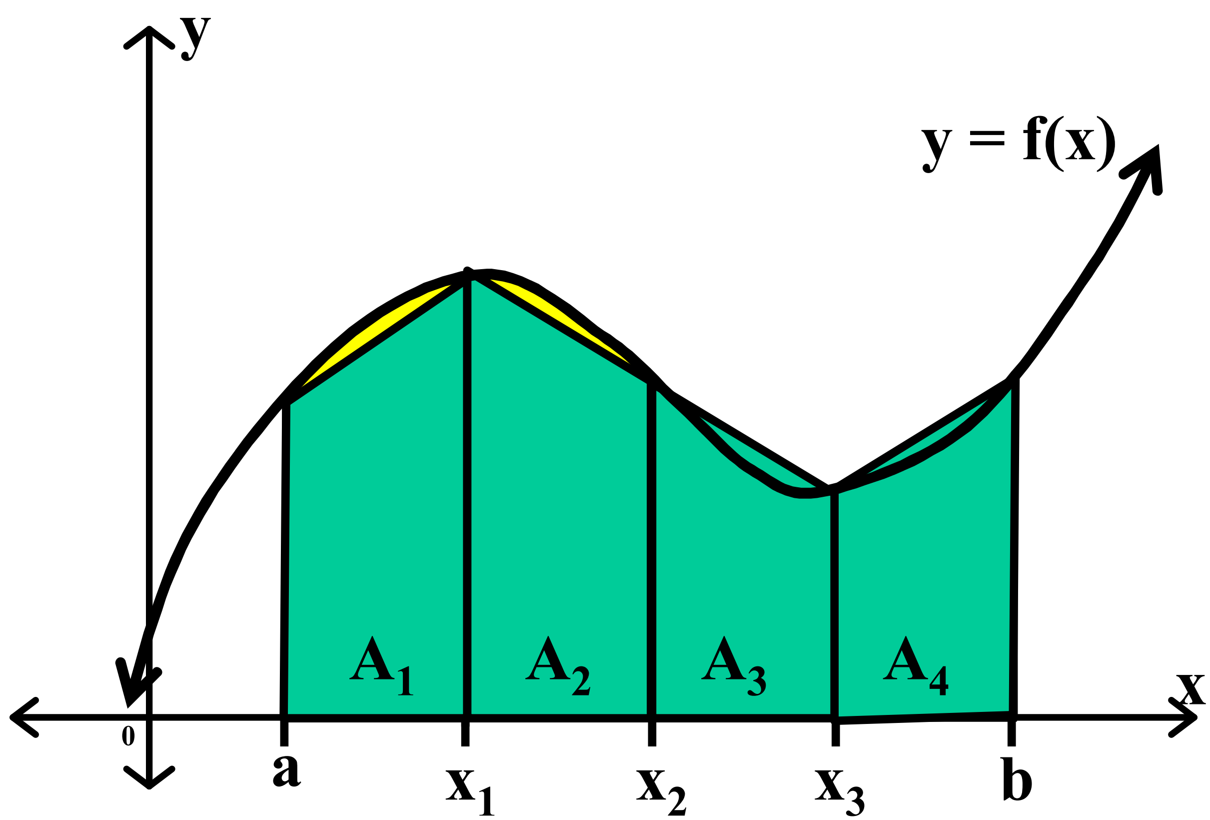
Trapezoids can also be used to approximate the area.



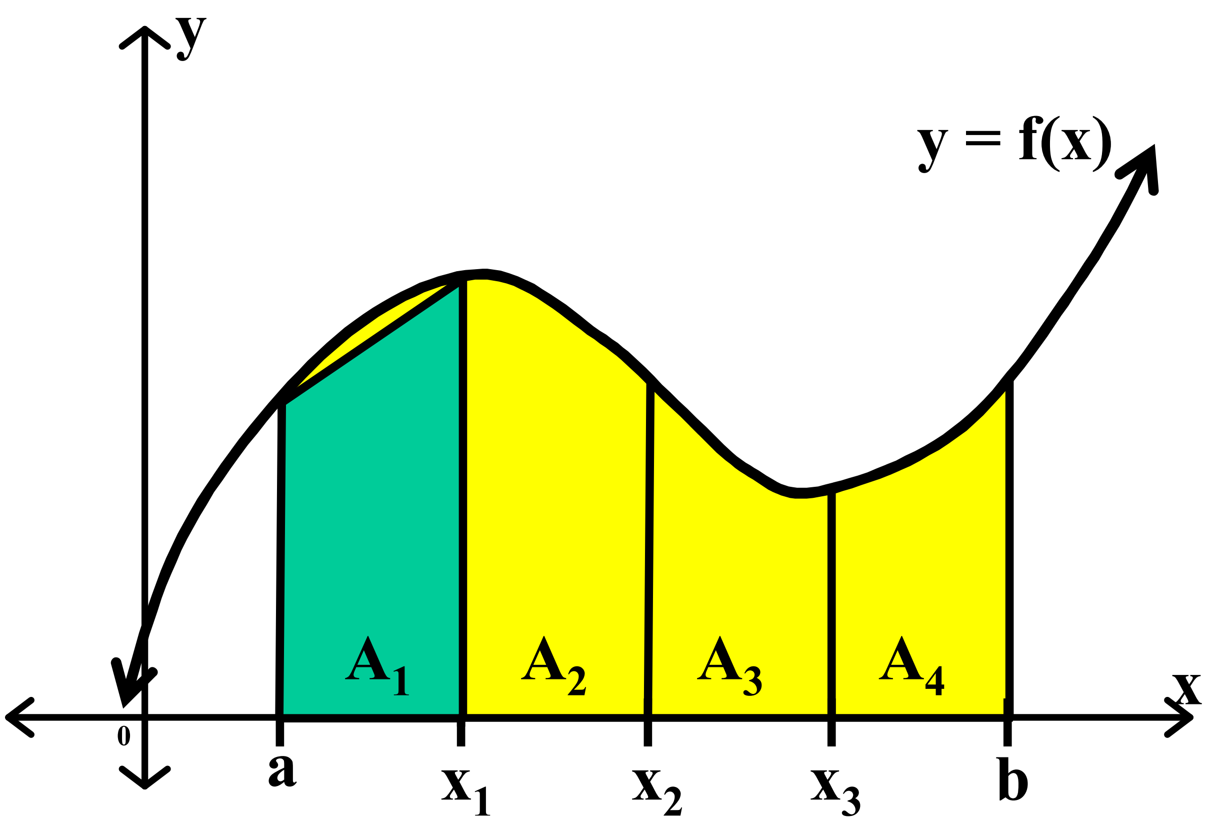
Trapezoids can also be used to approximate the area.



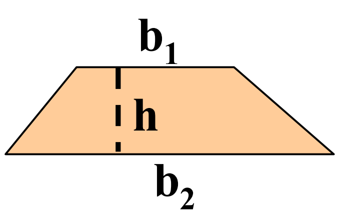
Trapezoids can also be used to approximate the area.

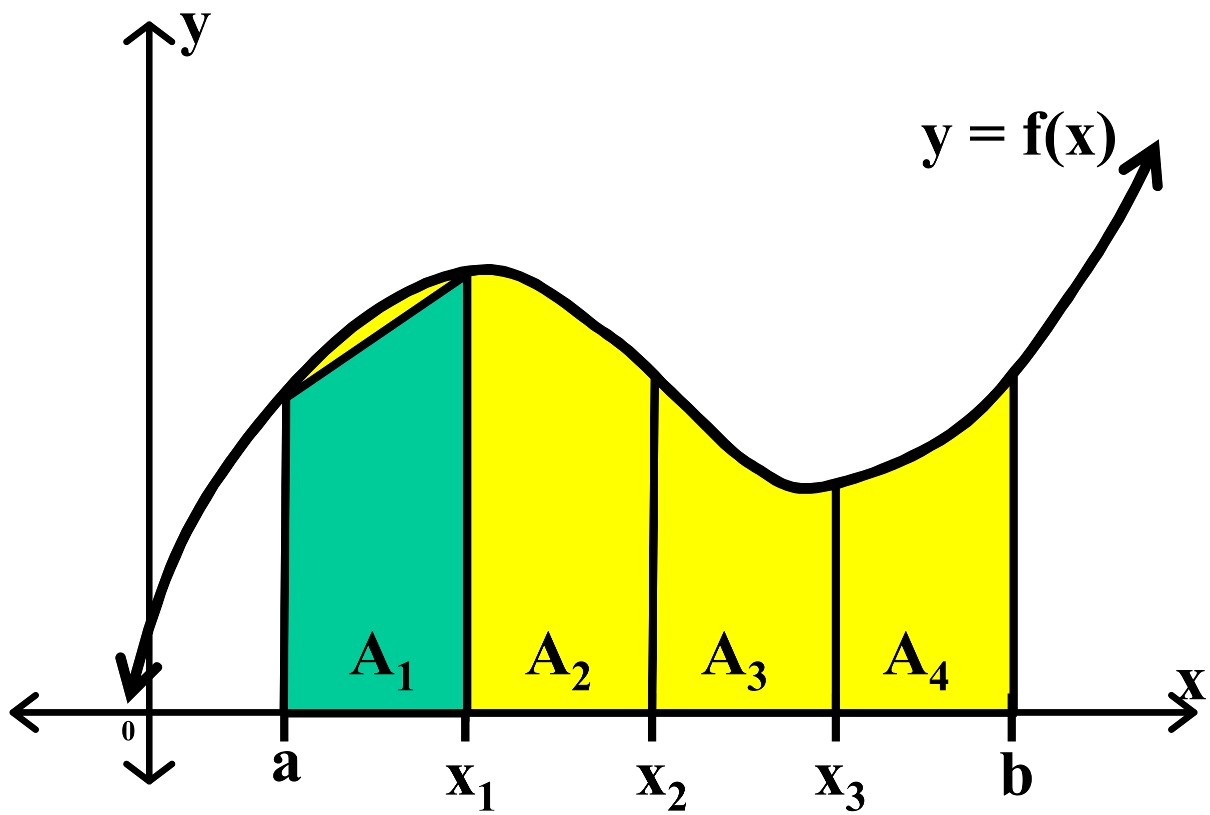


y
y = f(x)
A_1
A_2
A_3
A_4
x
0
a
x_1
x_2
x_3
b

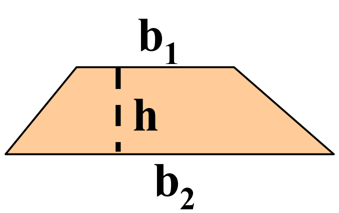


trapezoid

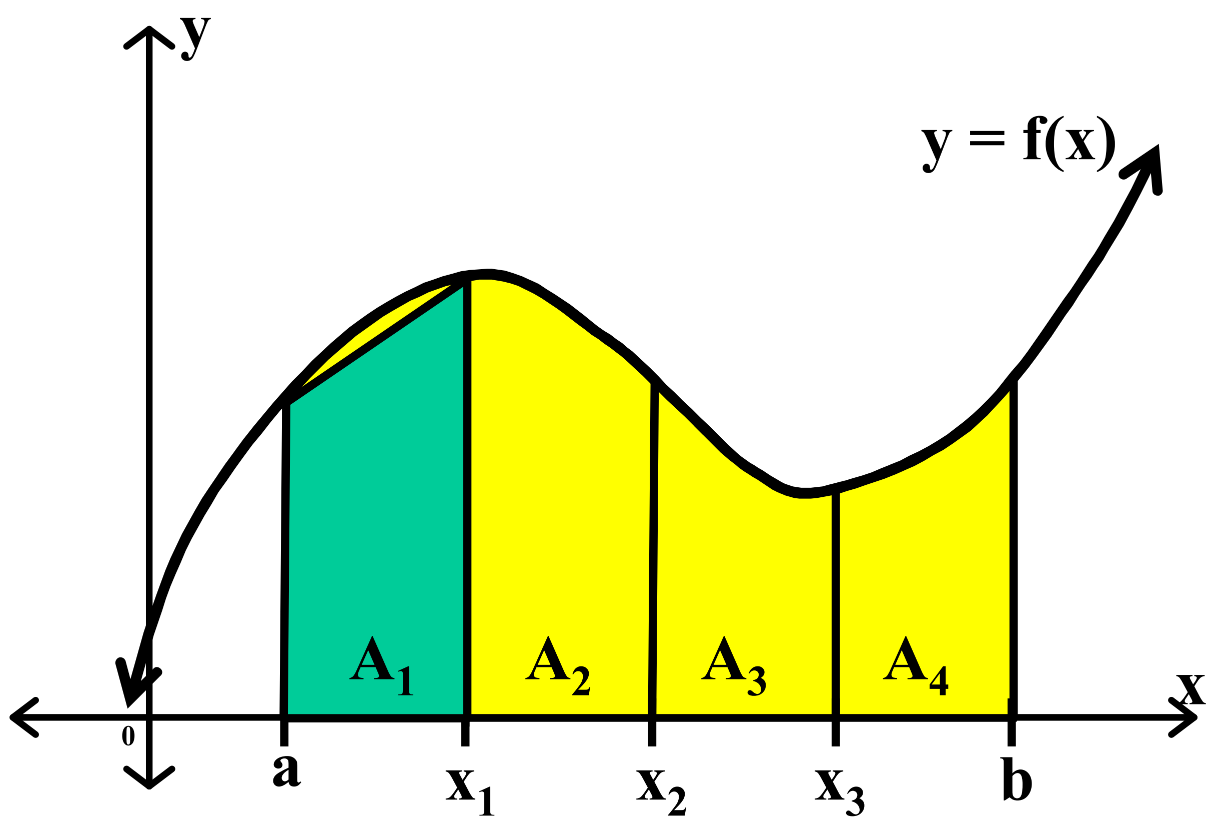




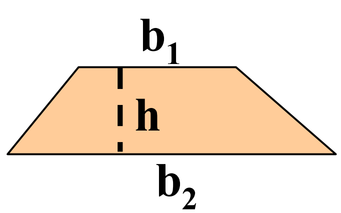
trapezoid



Area = $\frac{1}{2} * h(b_1 + b_2)$

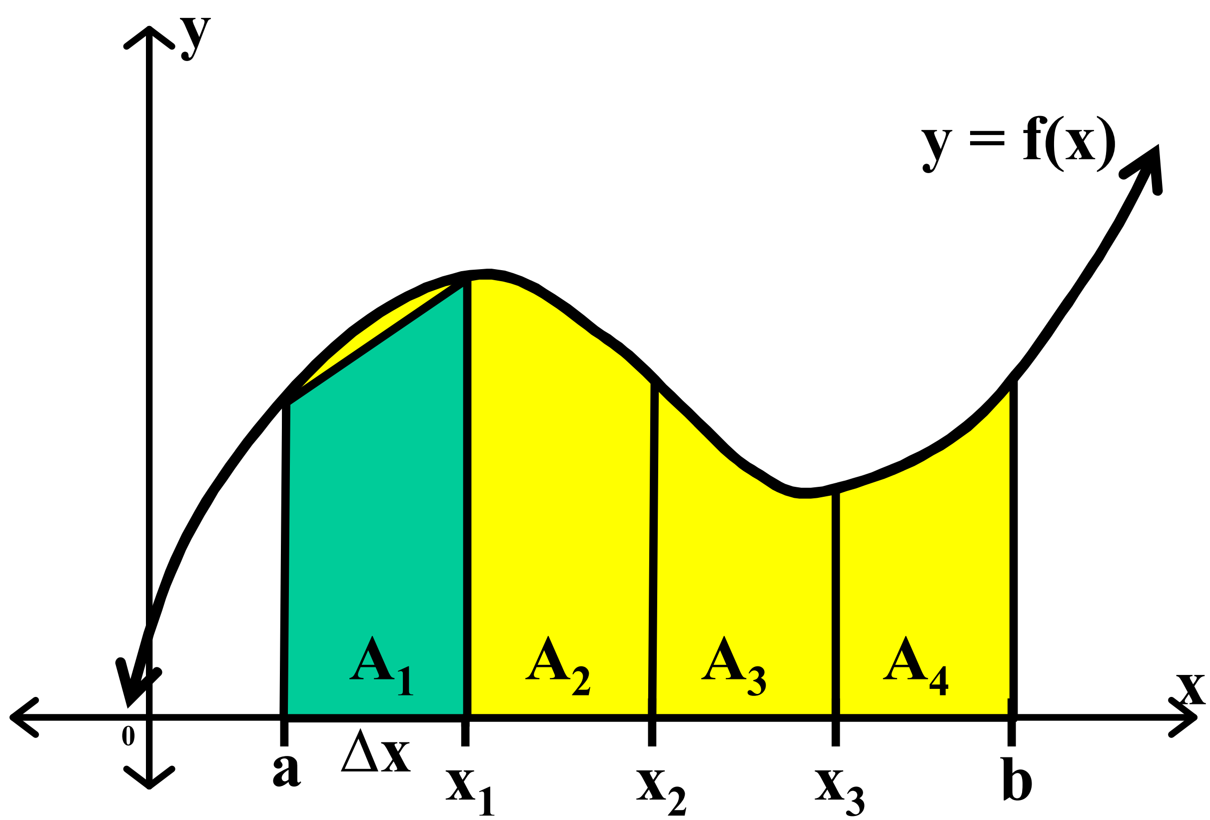


trapezoid

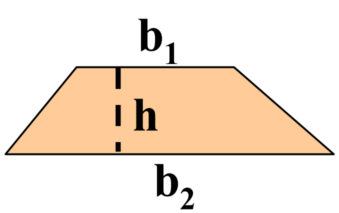


$A_1 \approx$

Area = $\frac{1}{2} * h(b_1 + b_2)$



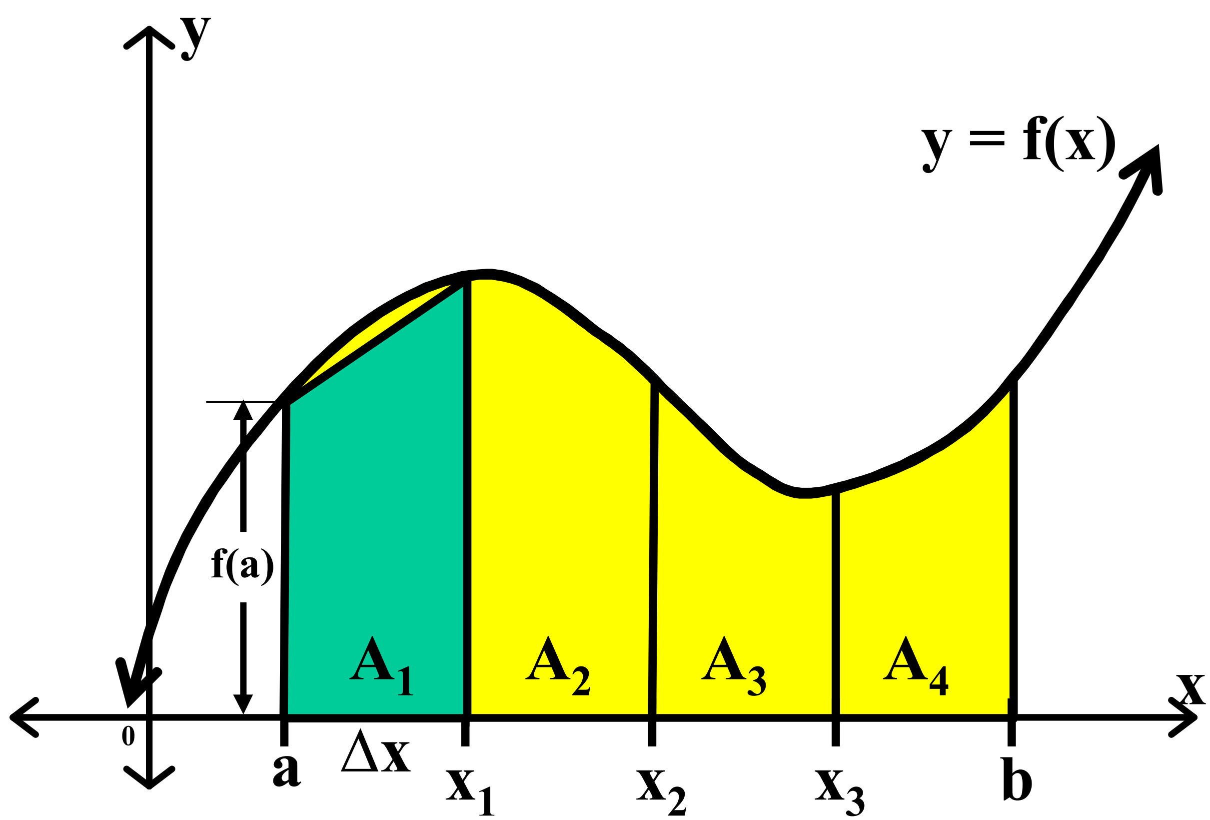
trapezoid



Area = ½*h(b_1 + b_2)

$$A_1 \approx$$

h = Δx



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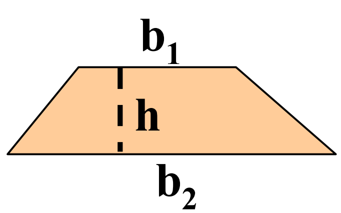

Area = ½*h(b_1 + b_2)

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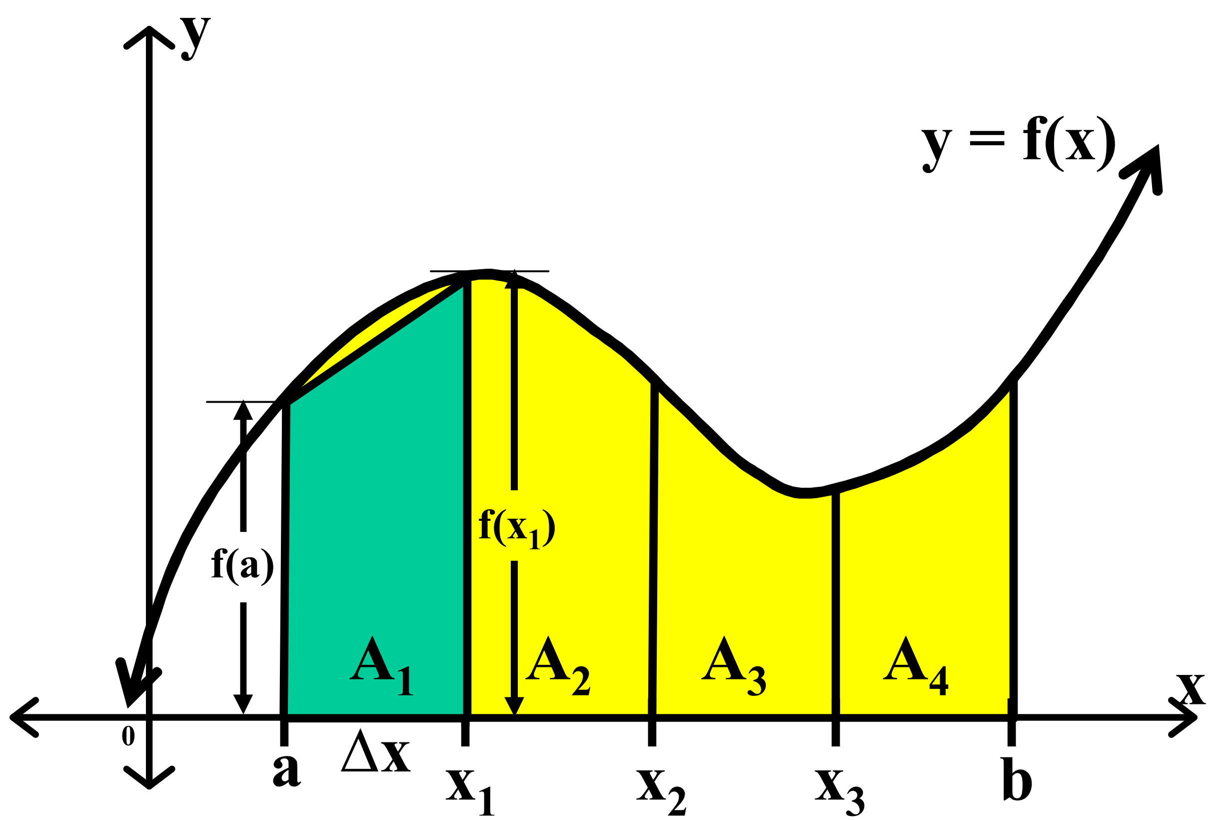
$h = \Delta x \quad b_1 = f(a)$



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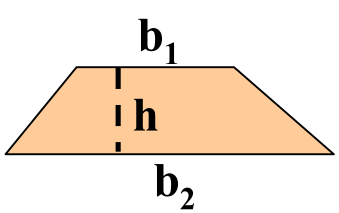
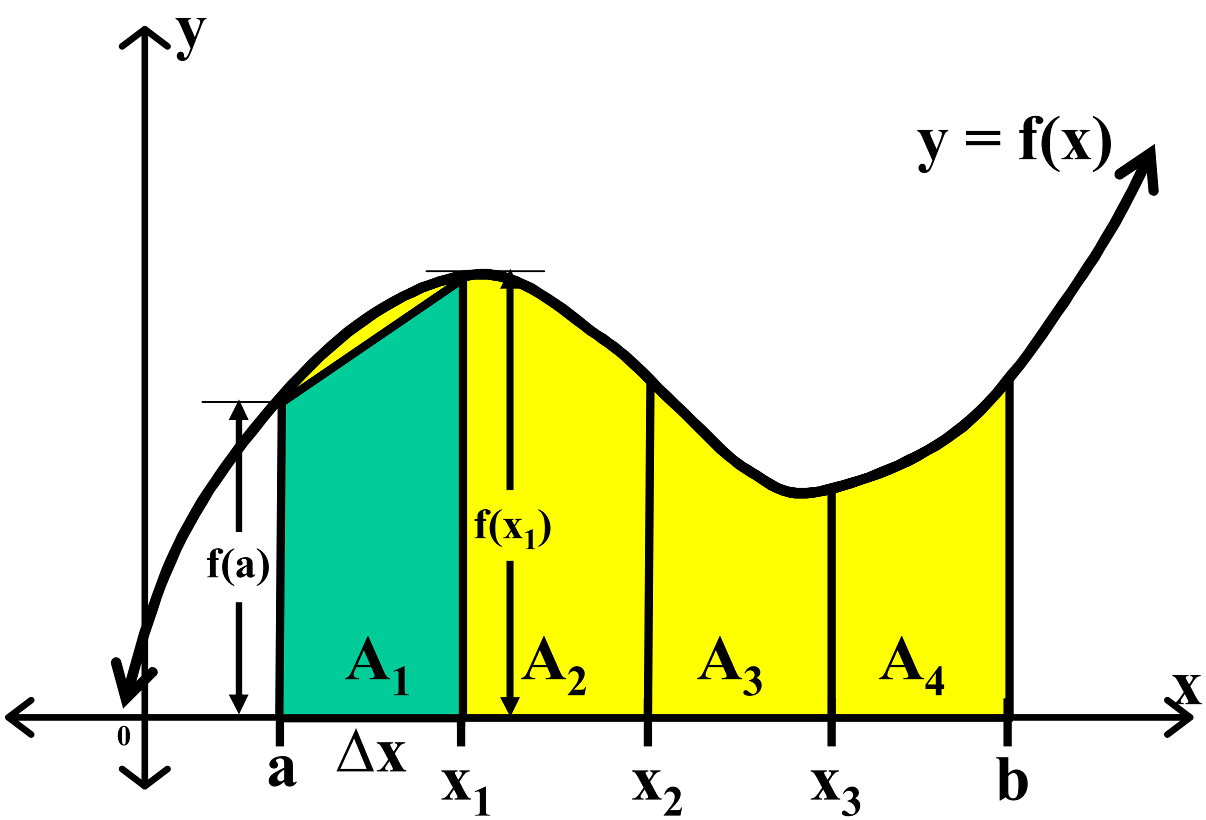


Area = $\frac{1}{2} * h(b_1 + b_2)$

$A_1 \approx$

$h = \Delta x \quad b_1 = f(a) \quad b_2 = f(x_1)$



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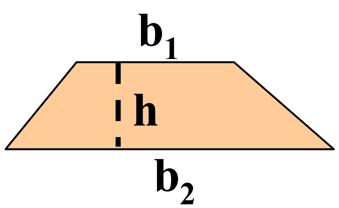
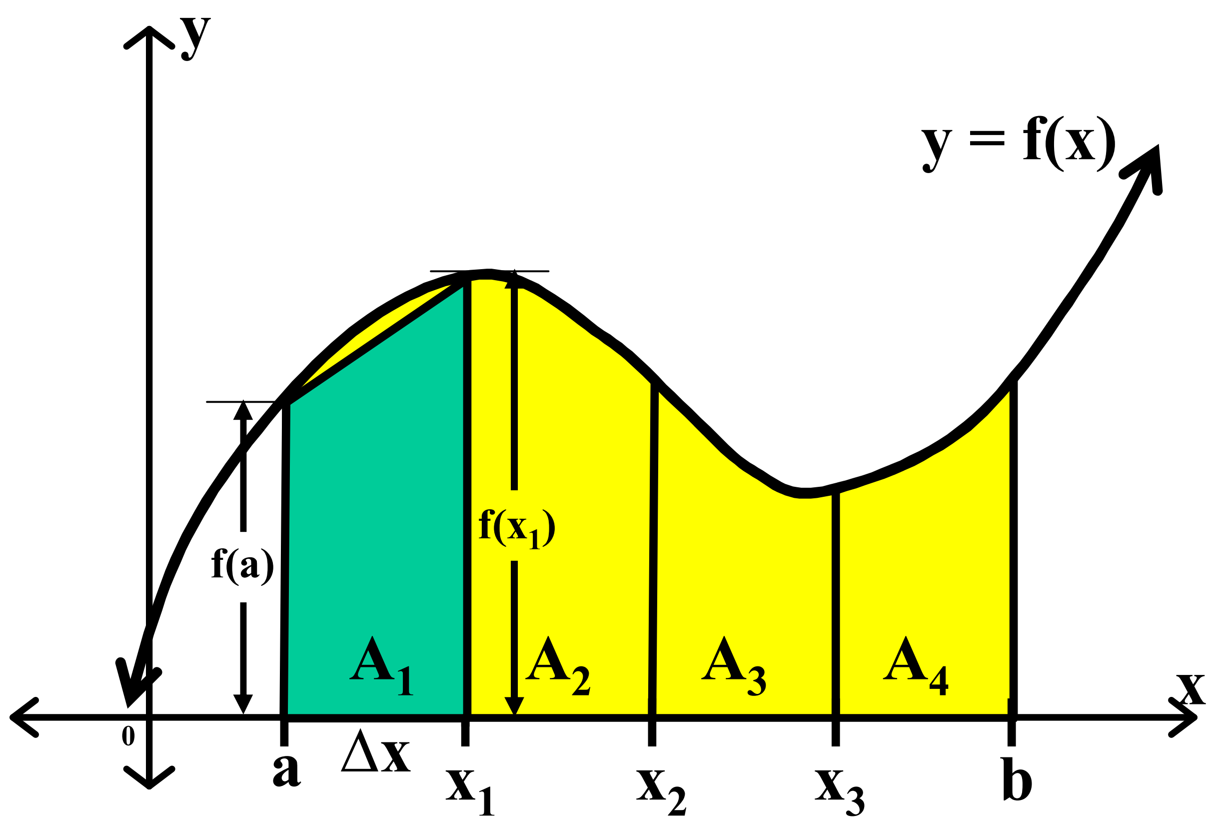


Area = $\frac{1}{2}*h(b_1 + b_2)$

$A_1 \approx \frac{1}{2}*\Delta x$

$h = \Delta x \quad b_1 = f(a) \quad b_2 = f(x_1)$



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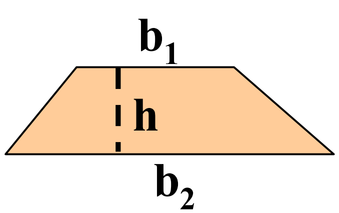
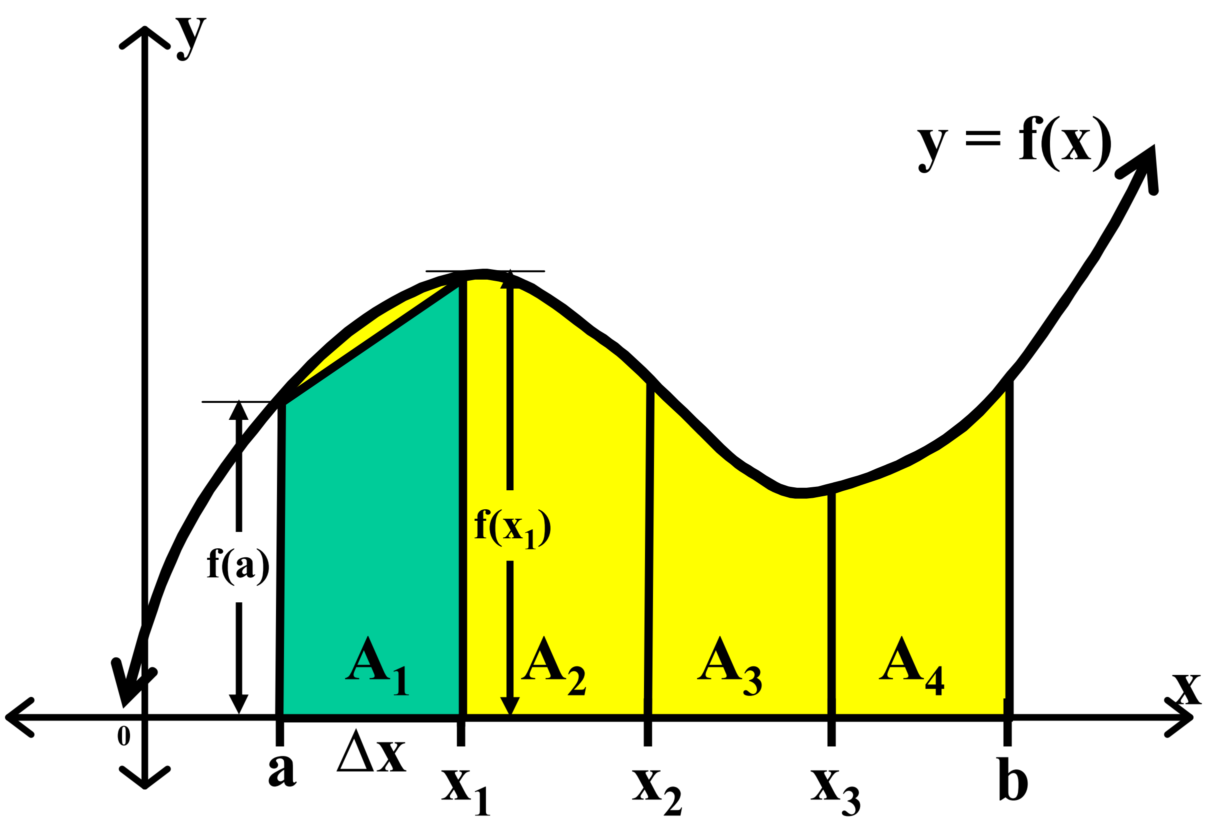


$$A_1 \approx ½*\Delta x[f(a)$$

$h = \Delta x \quad b_1 = f(a) \quad b_2 = f(x_1)$

Area = $½*h(b_1 + b_2)$



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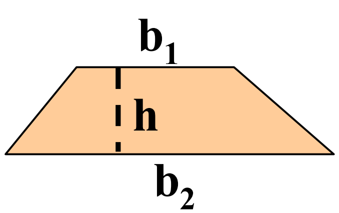

Area = $\frac{1}{2}*h(b_1 + b_2)$

$$A_1 \approx \frac{1}{2}*\Delta x[f(a) + f(x_1)]$$

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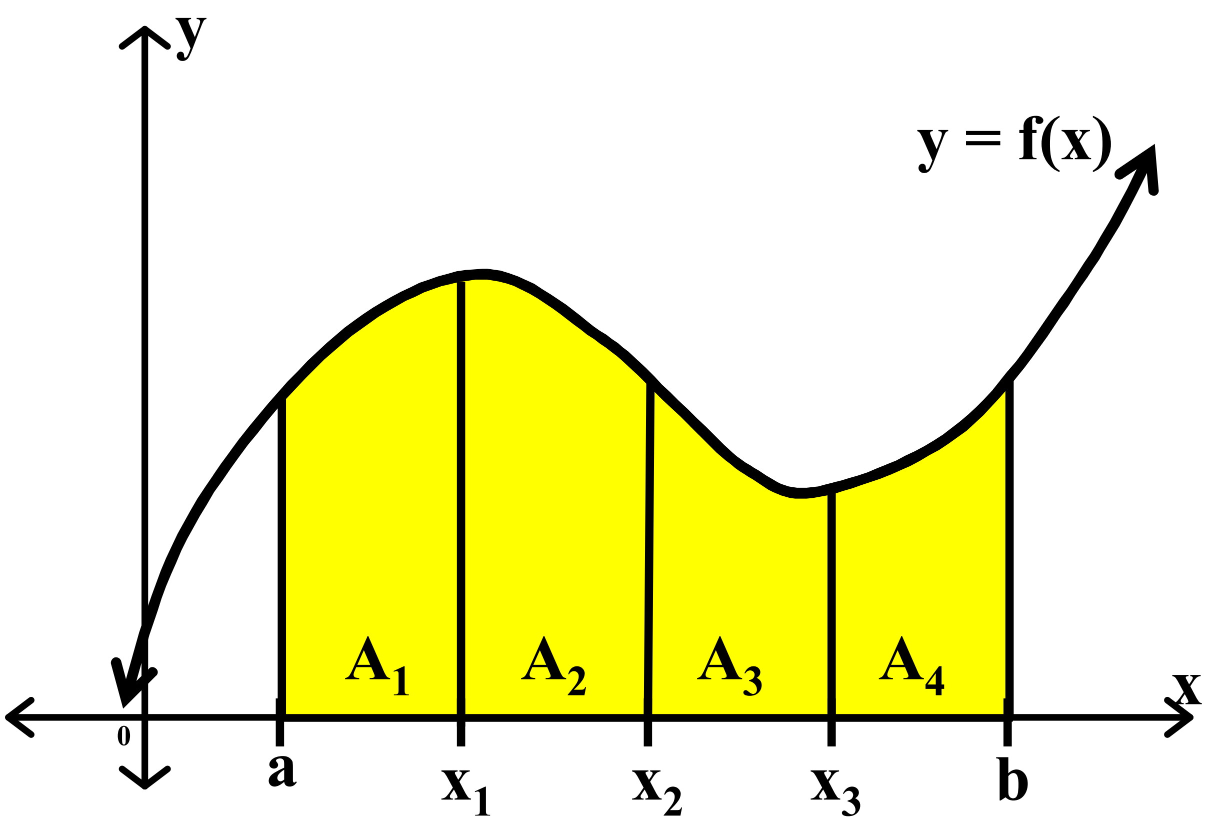

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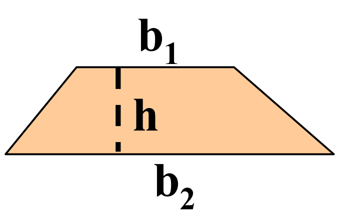

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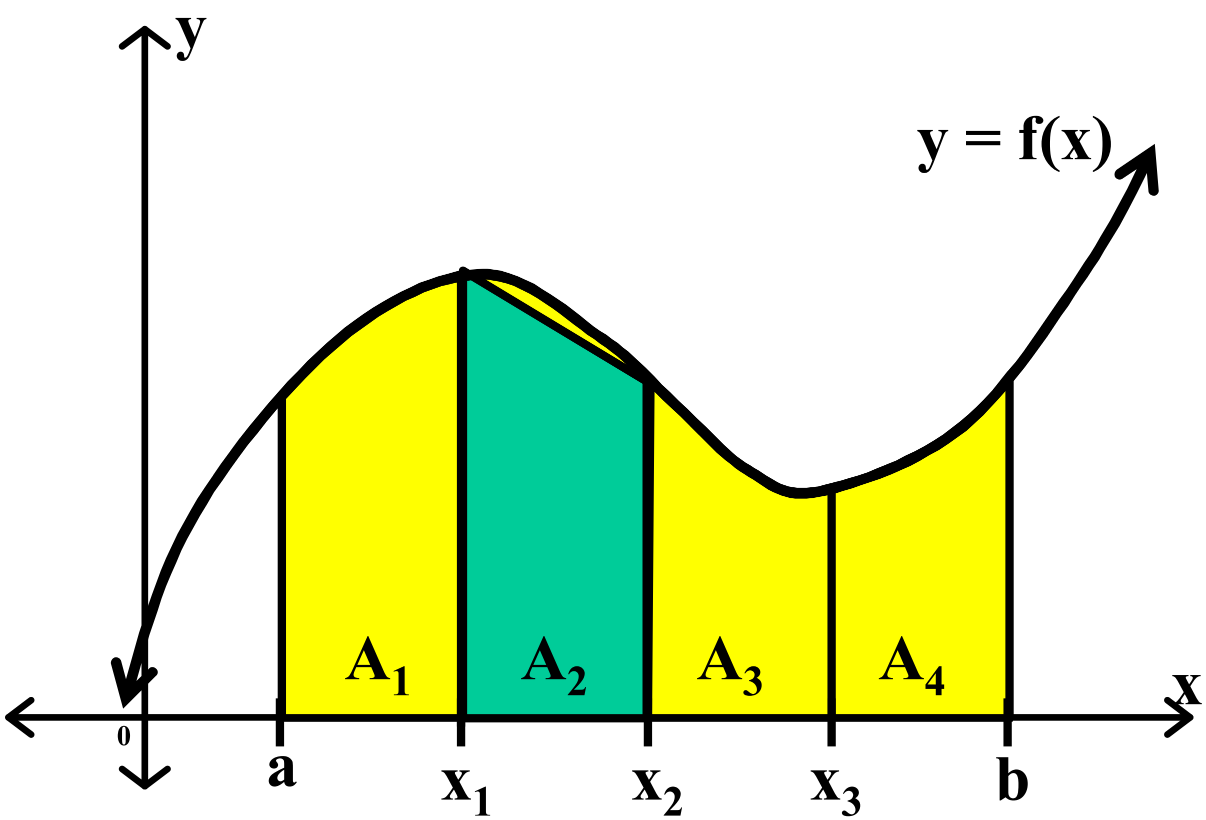

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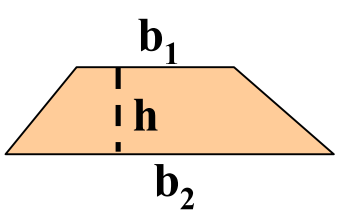

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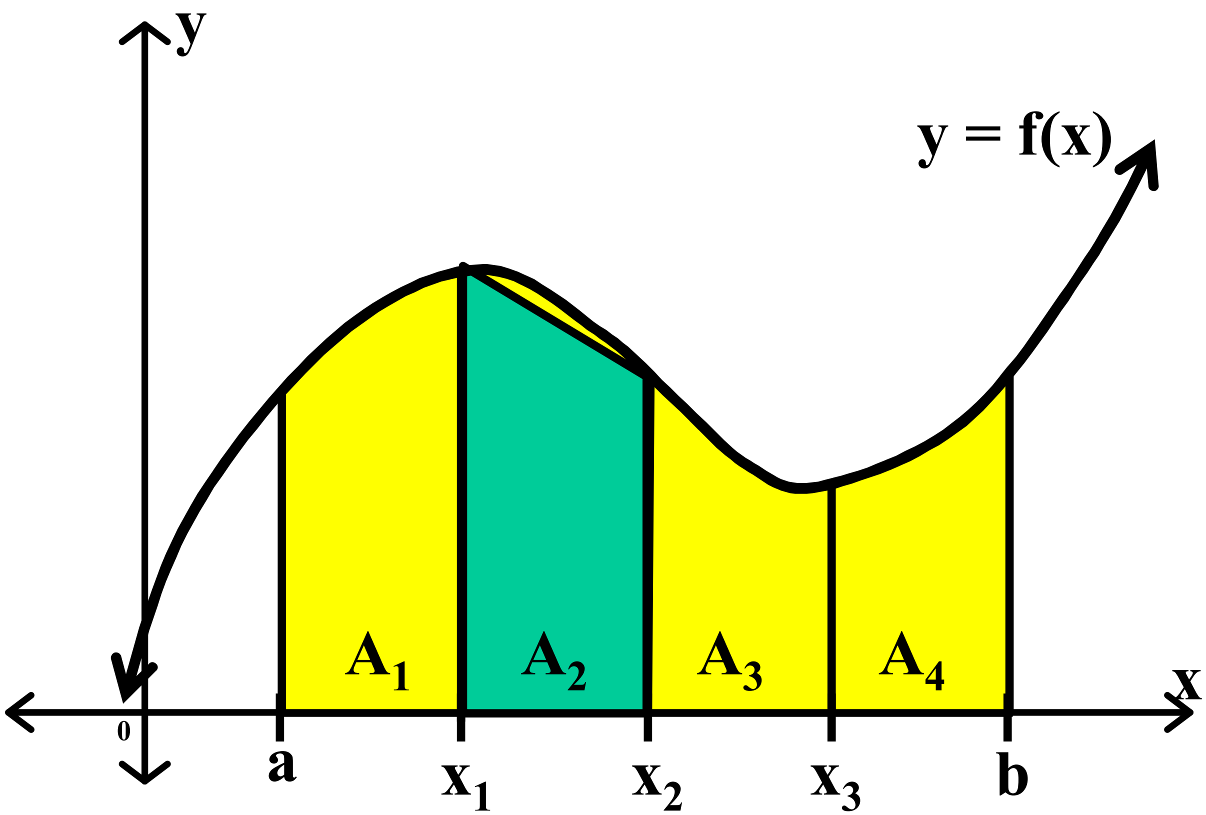

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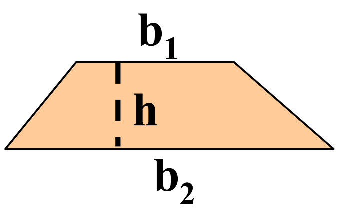
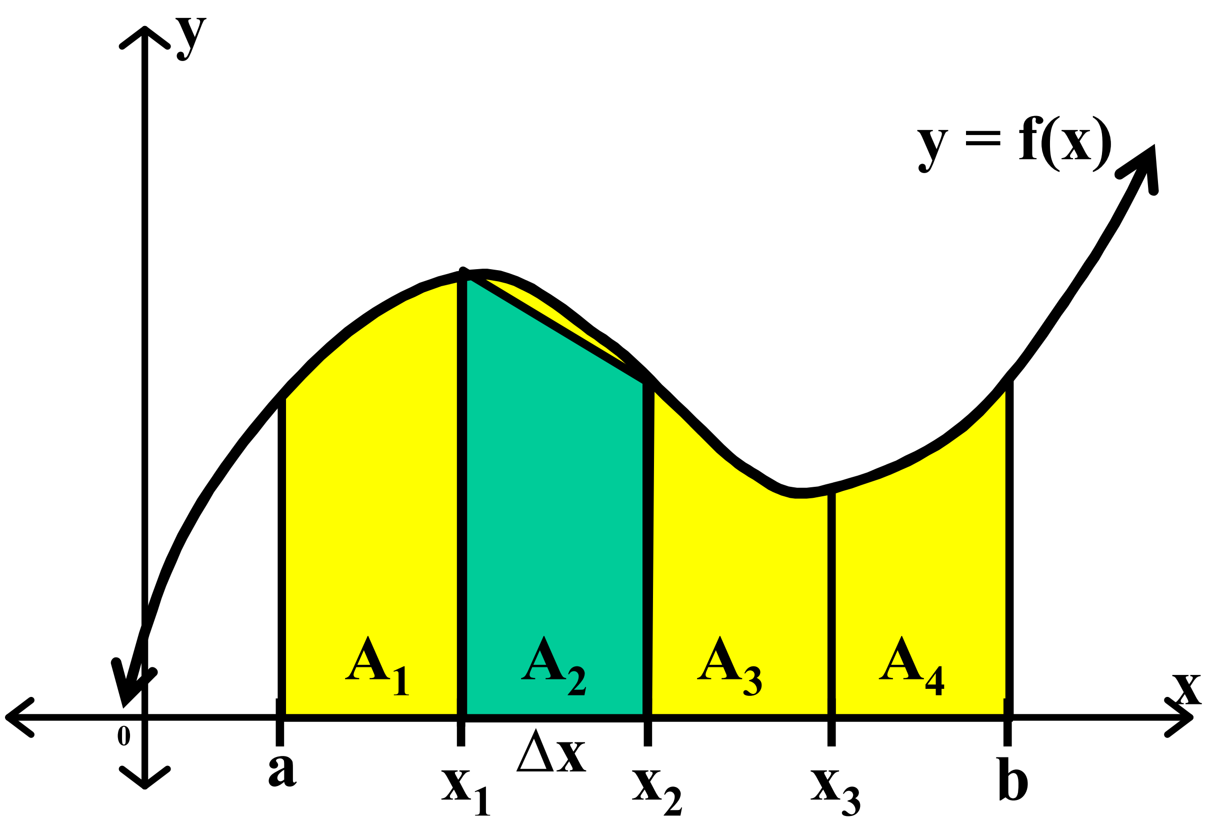


Area = $\frac{1}{2} * h(b_1 + b_2)$

$A_1 \approx \frac{1}{2} * \Delta x[f(a) + f(x_1)]$

$A_2 \approx$



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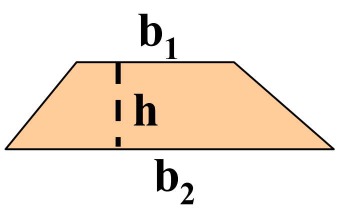

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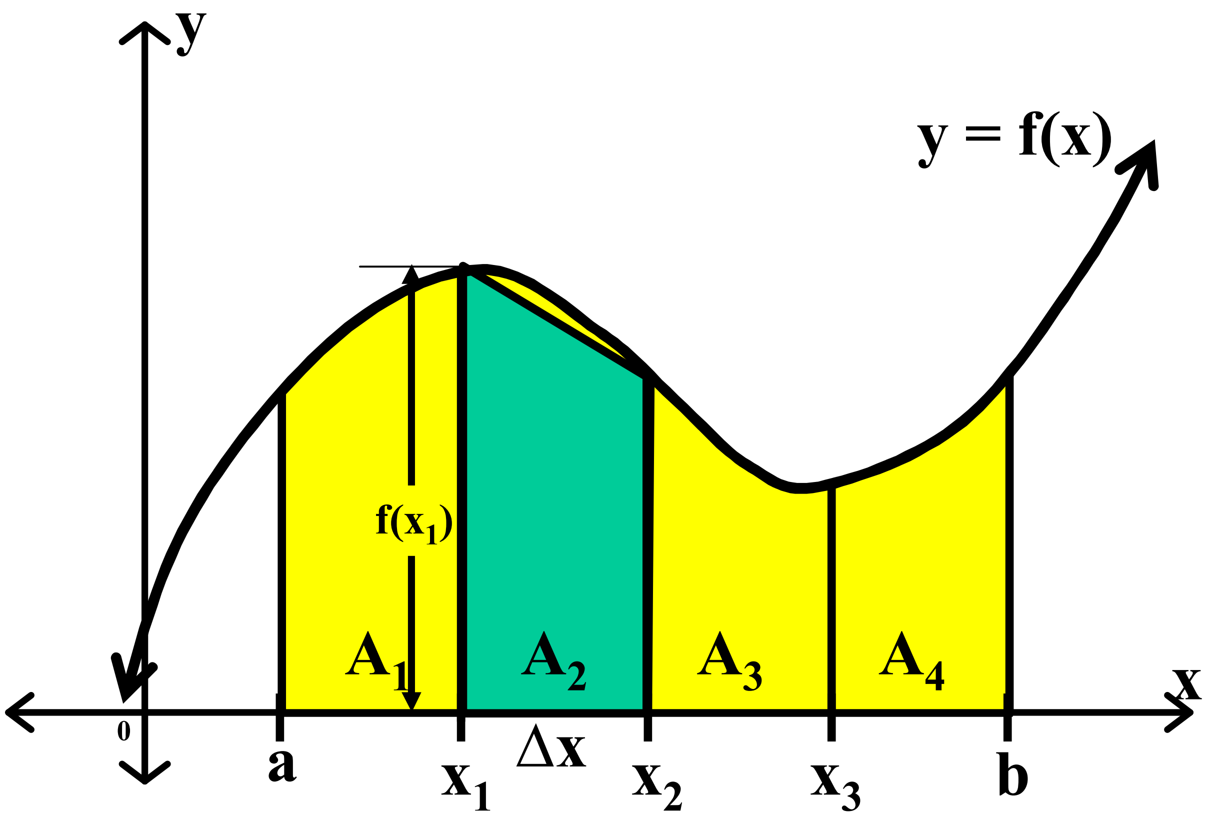

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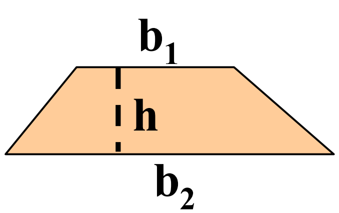

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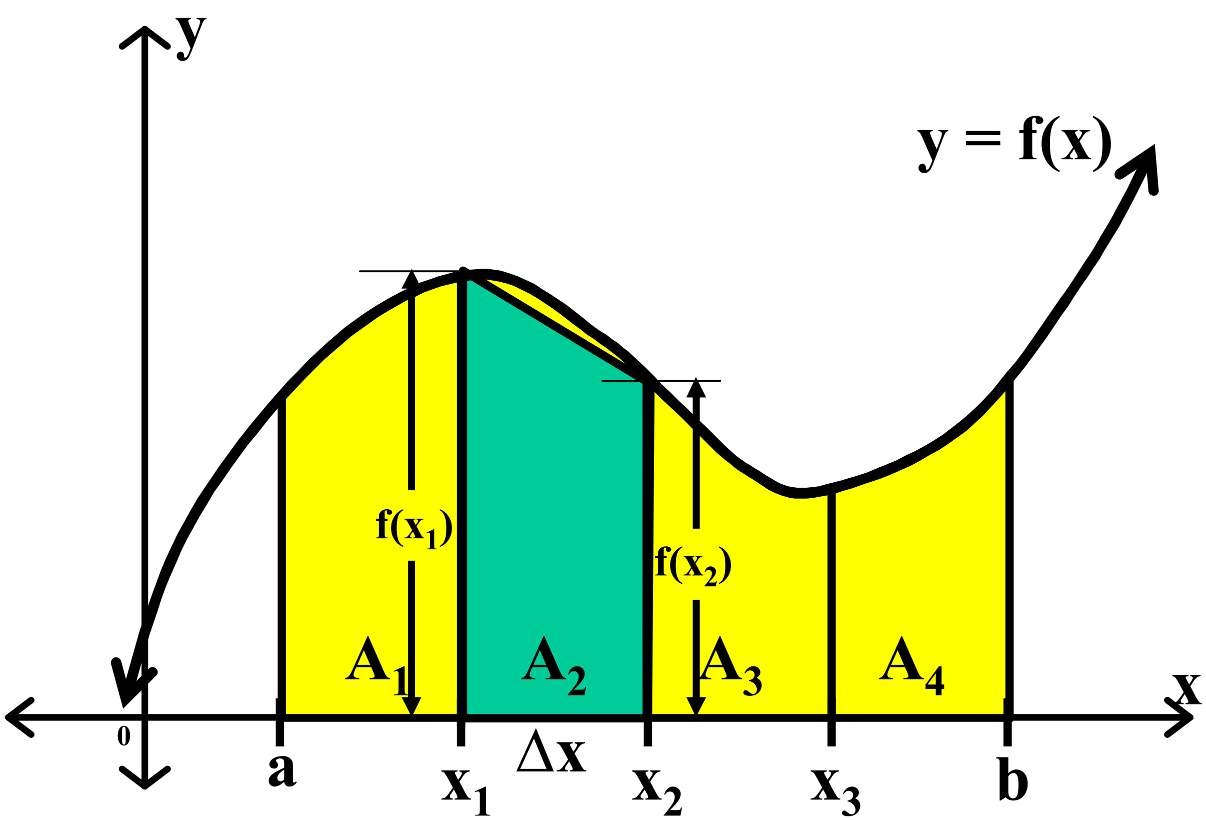

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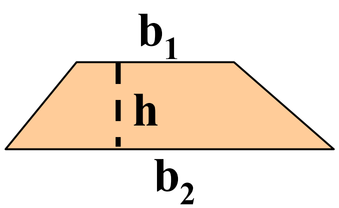

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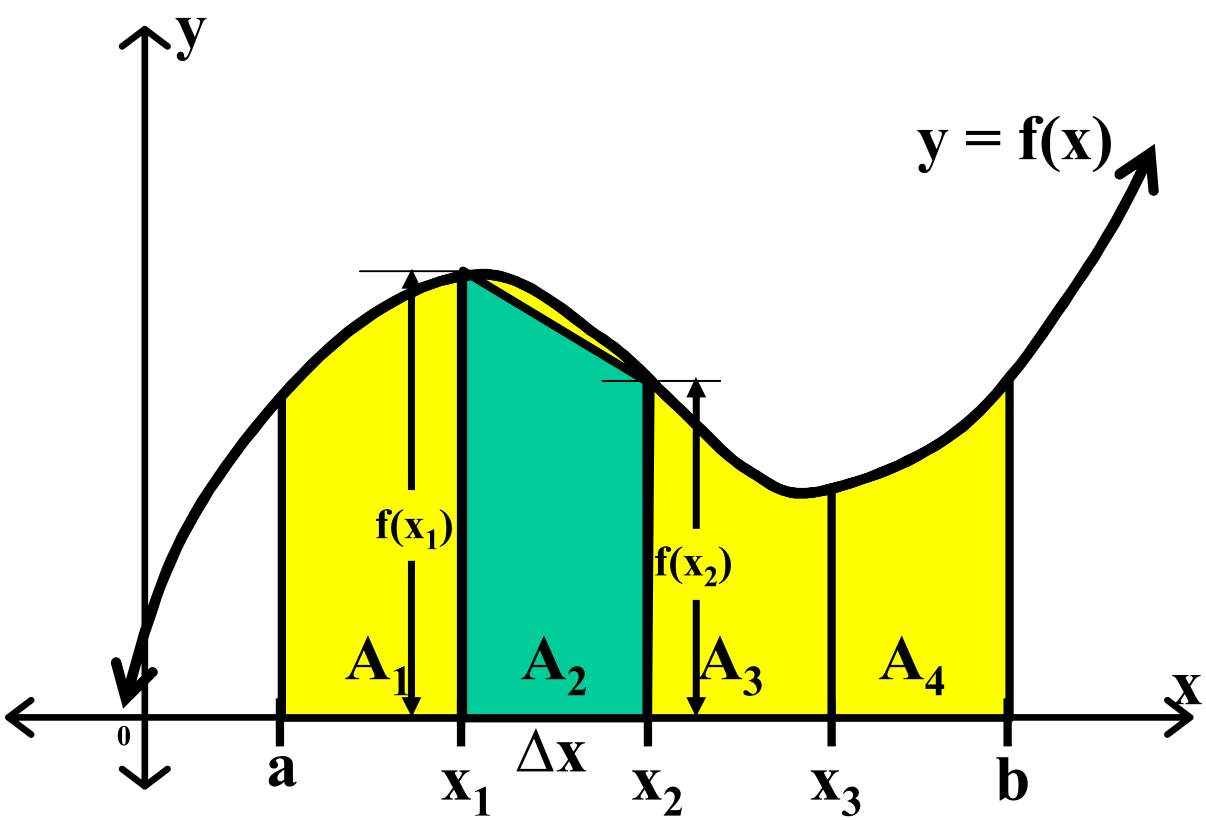

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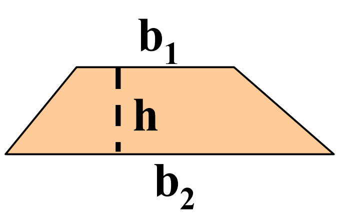

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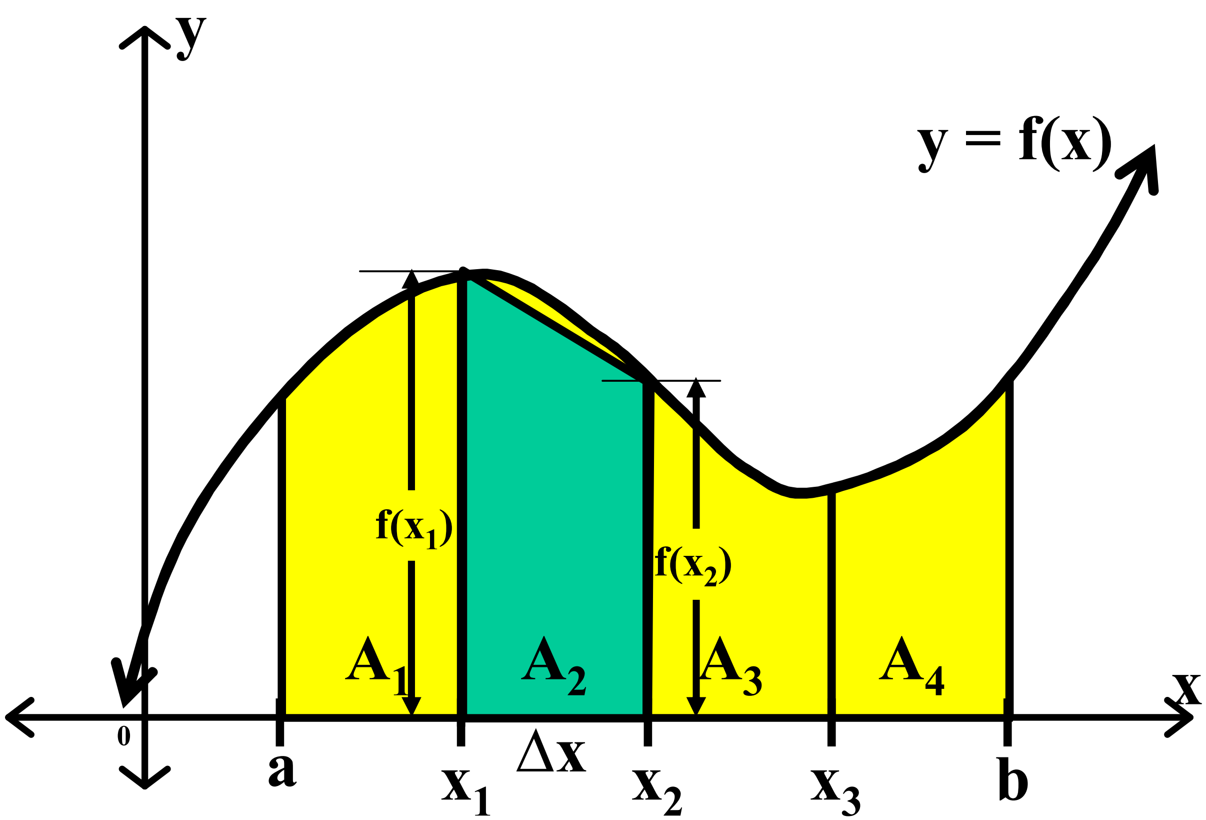

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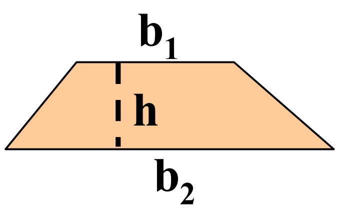

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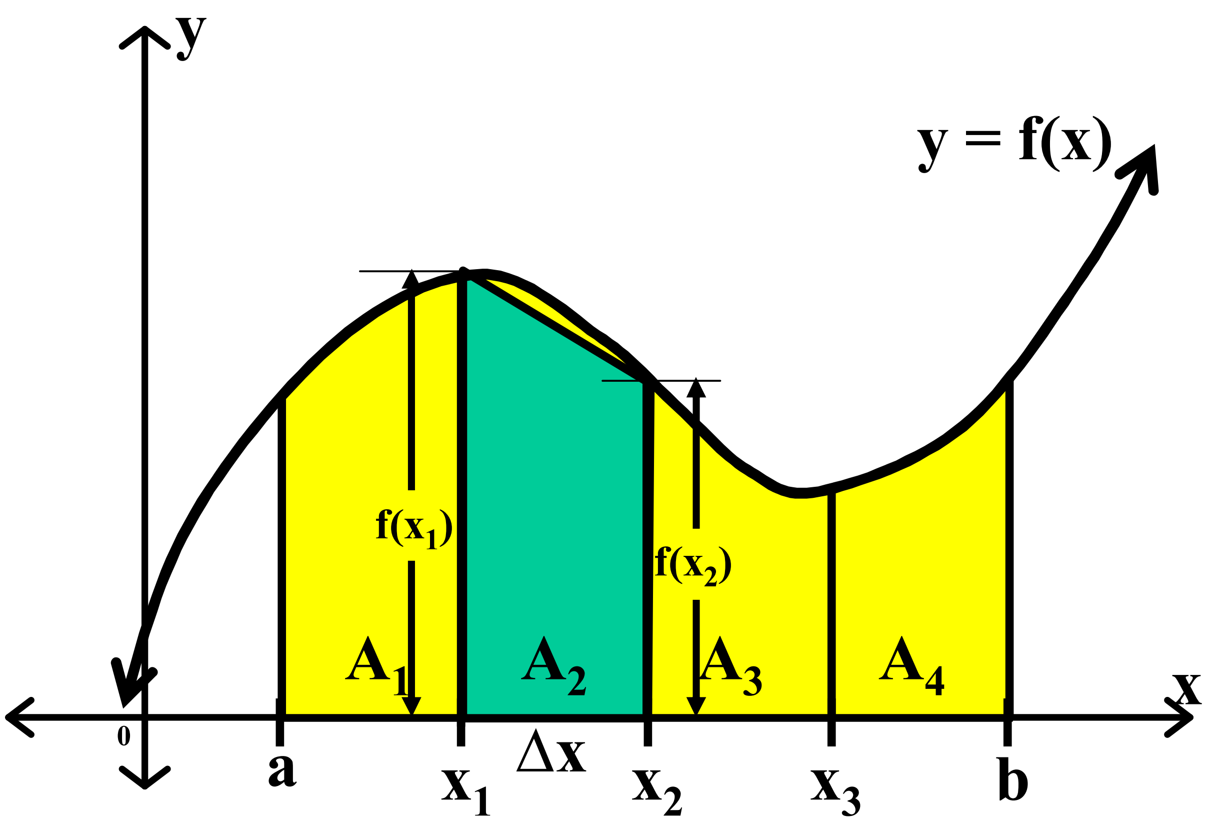

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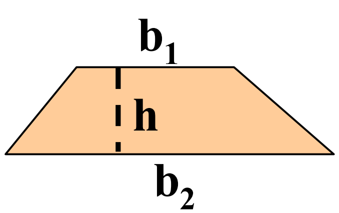

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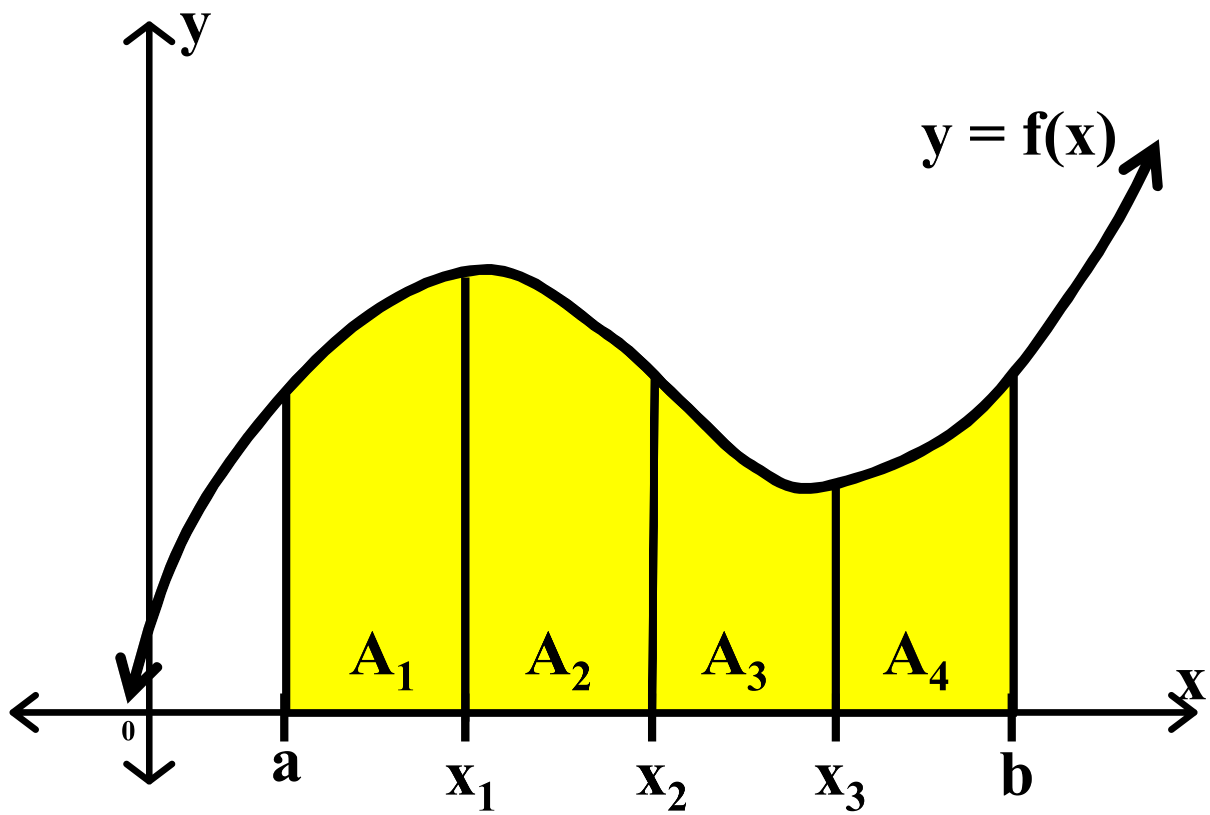

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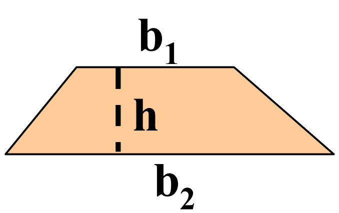

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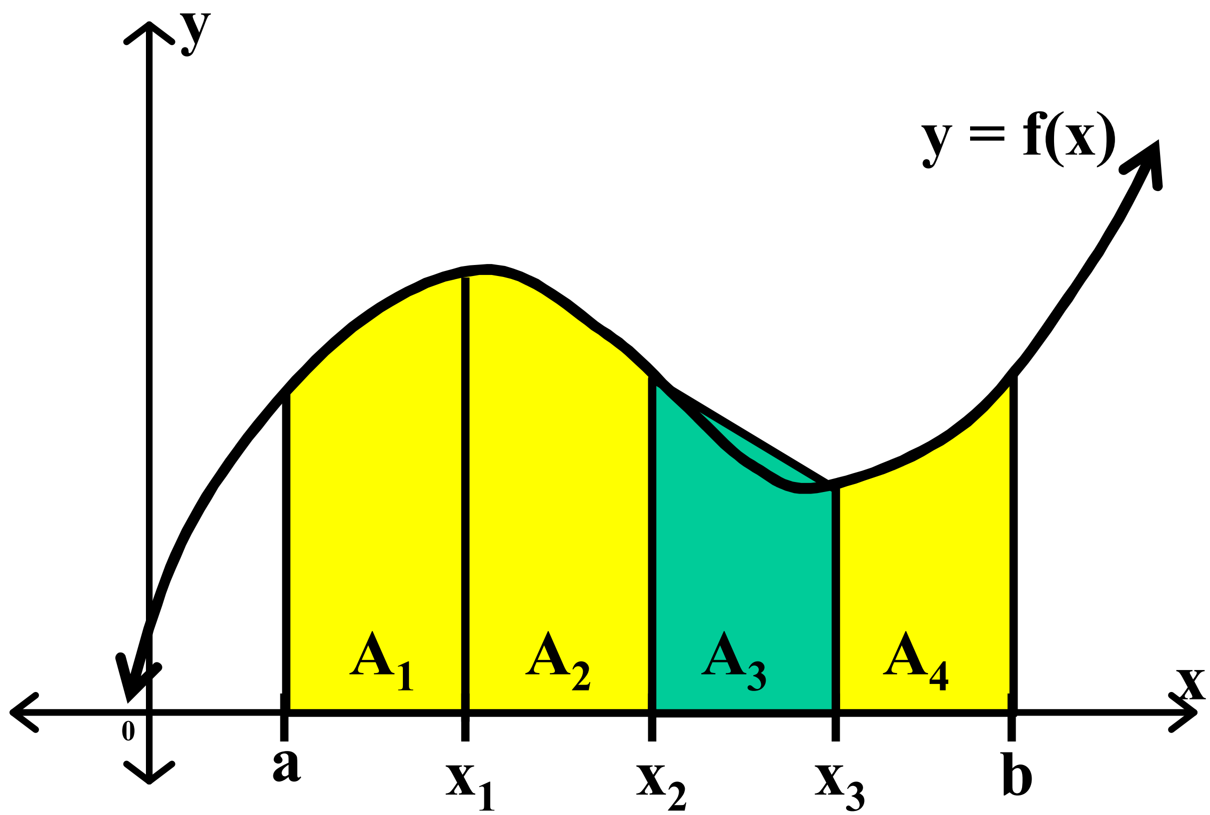

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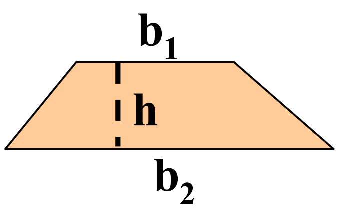

Area = ½*h(b_1 + b_2)

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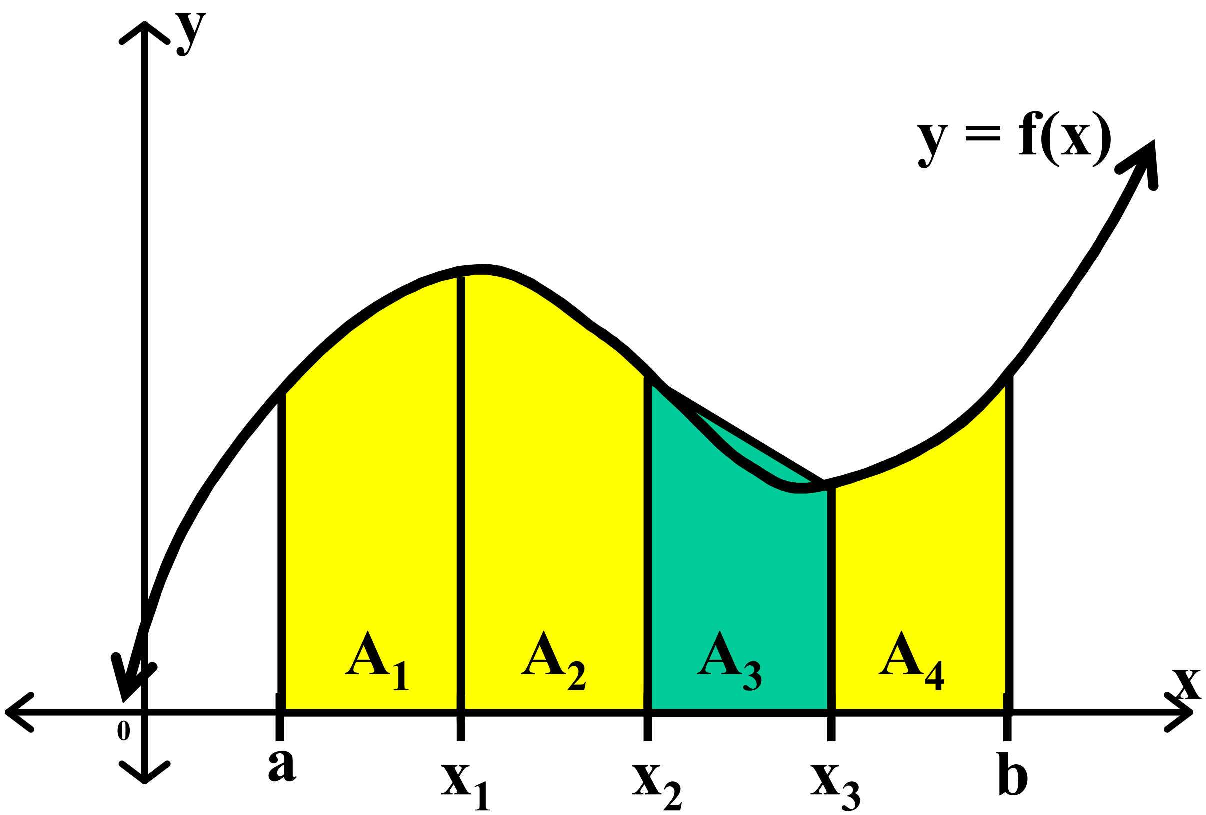

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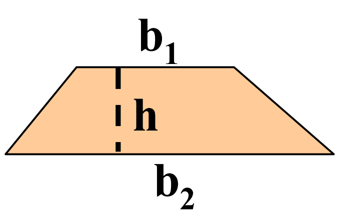
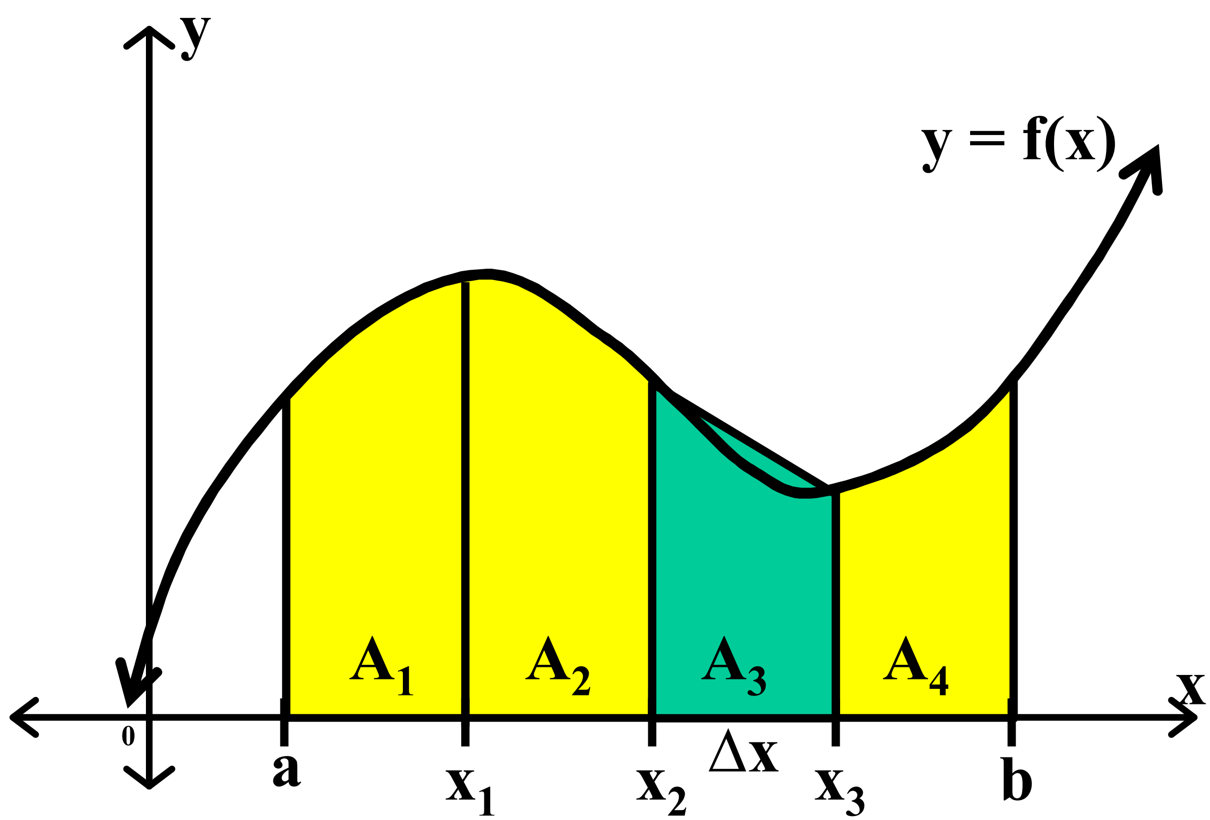


Area = $\frac{1}{2} * h(b_1 + b_2)$

$A_1 \approx \frac{1}{2} * \Delta x[f(a) + f(x_1)]$ $A_3 \approx$

$A_2 \approx \frac{1}{2} * \Delta x[f(x_1) + f(x_2)]$



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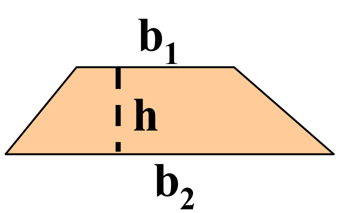

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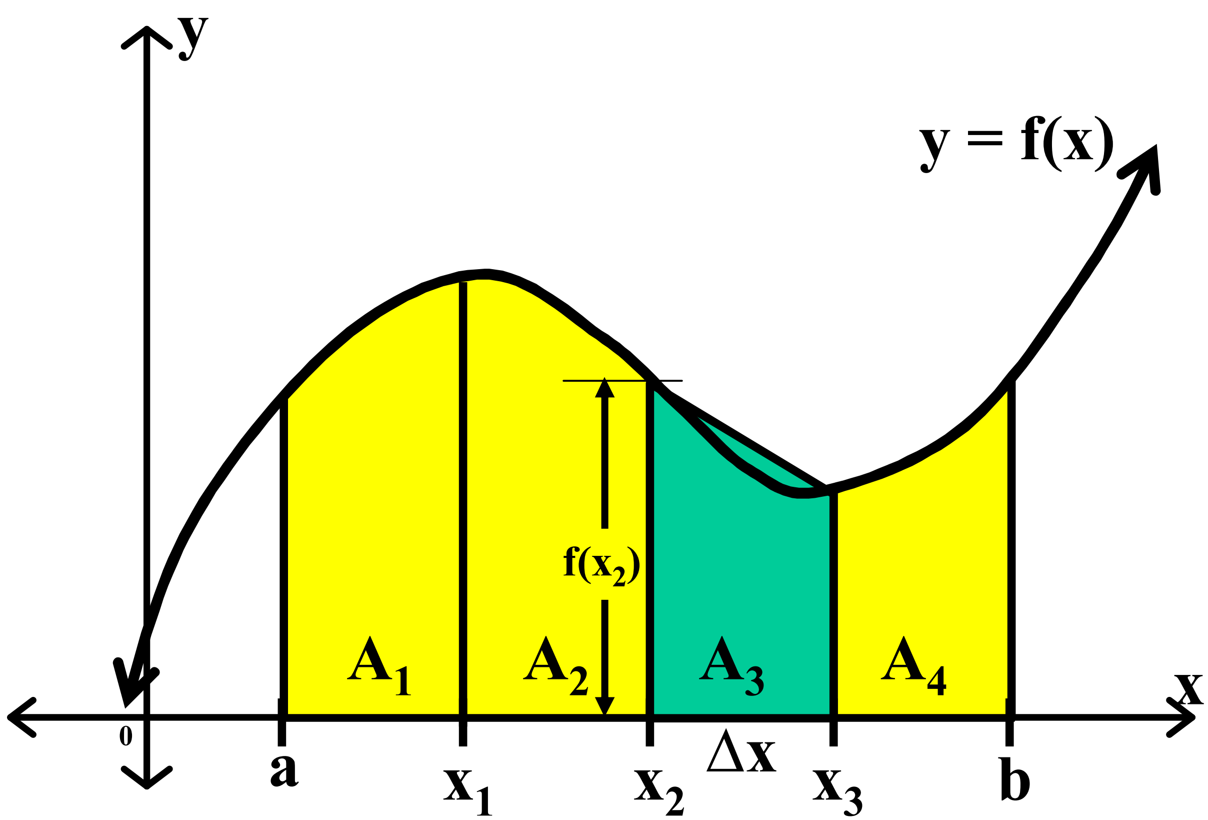

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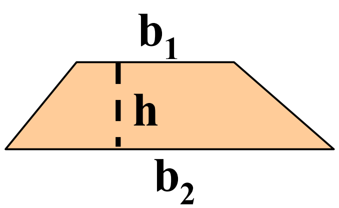

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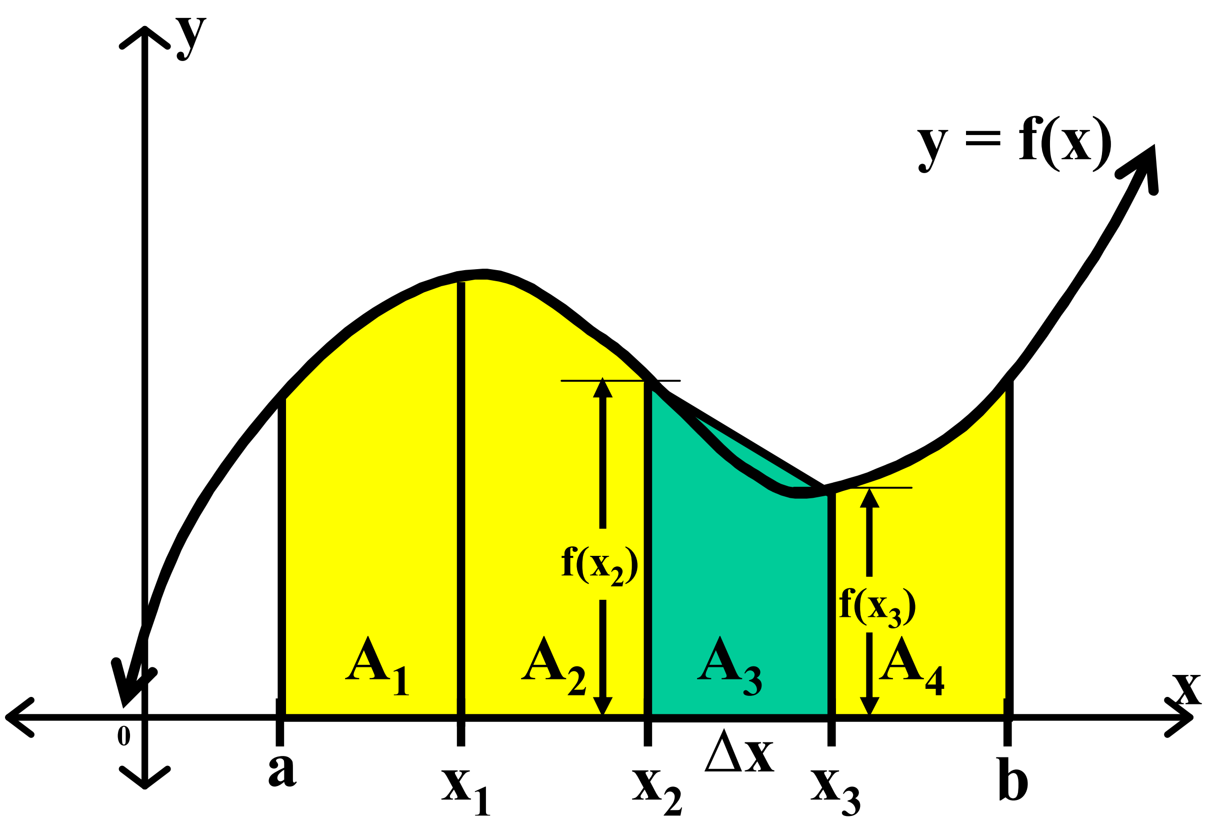

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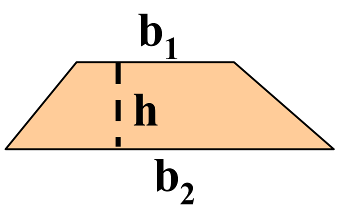

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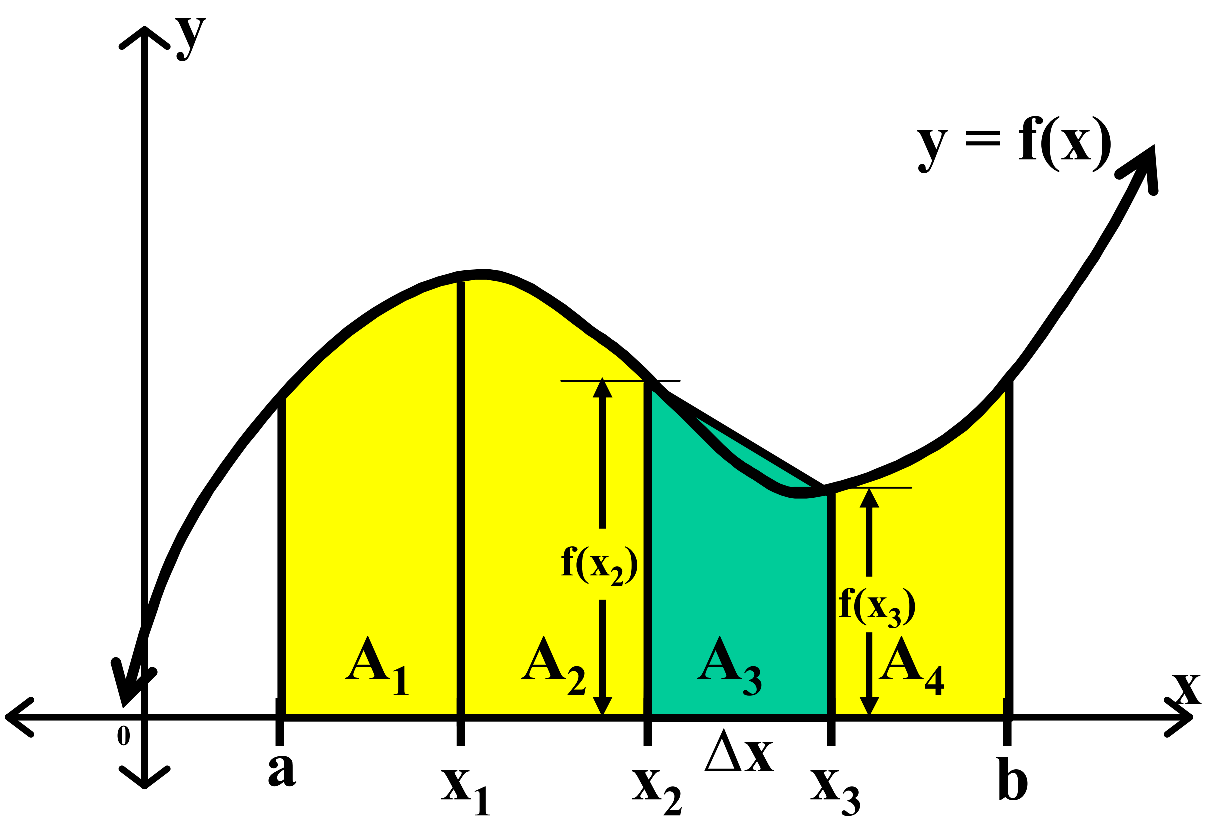

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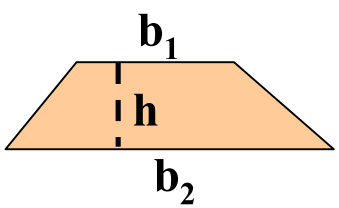

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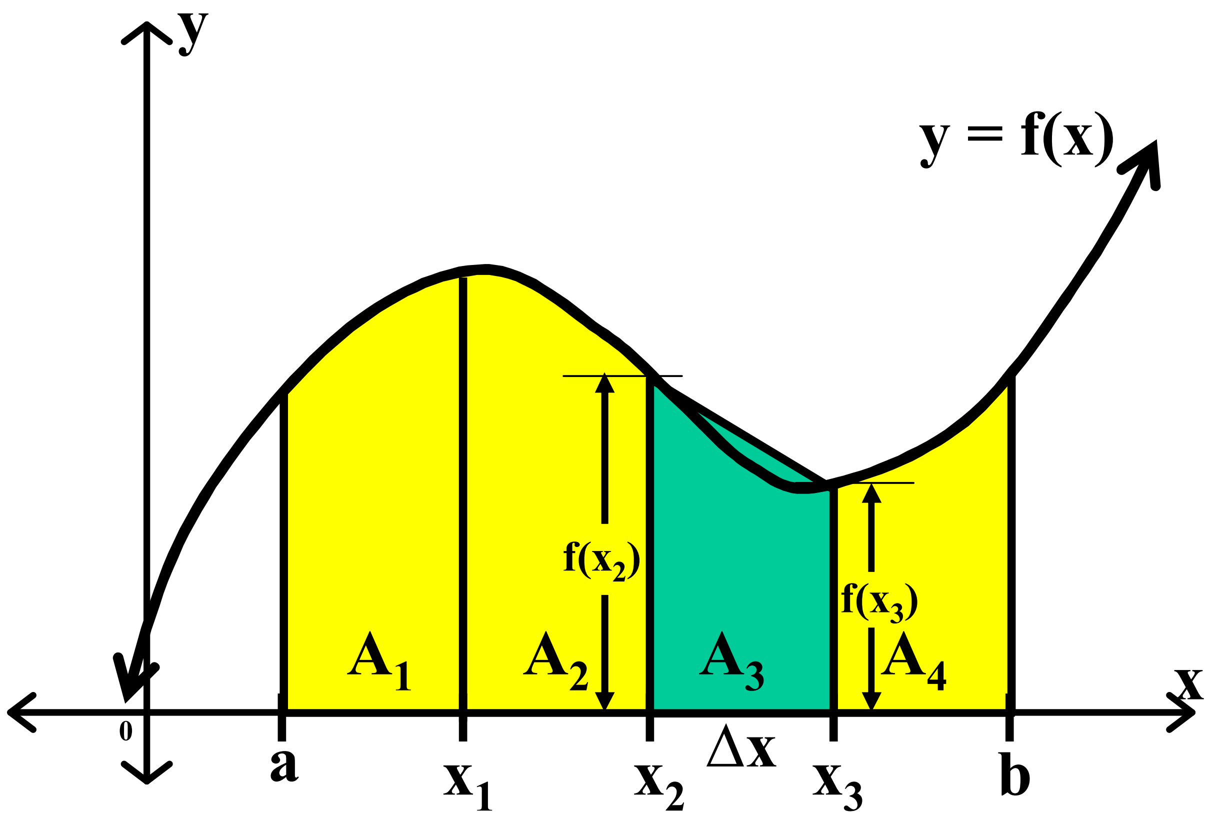

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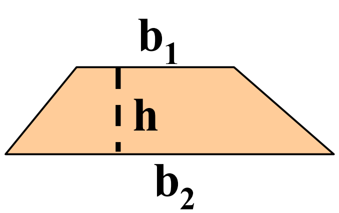

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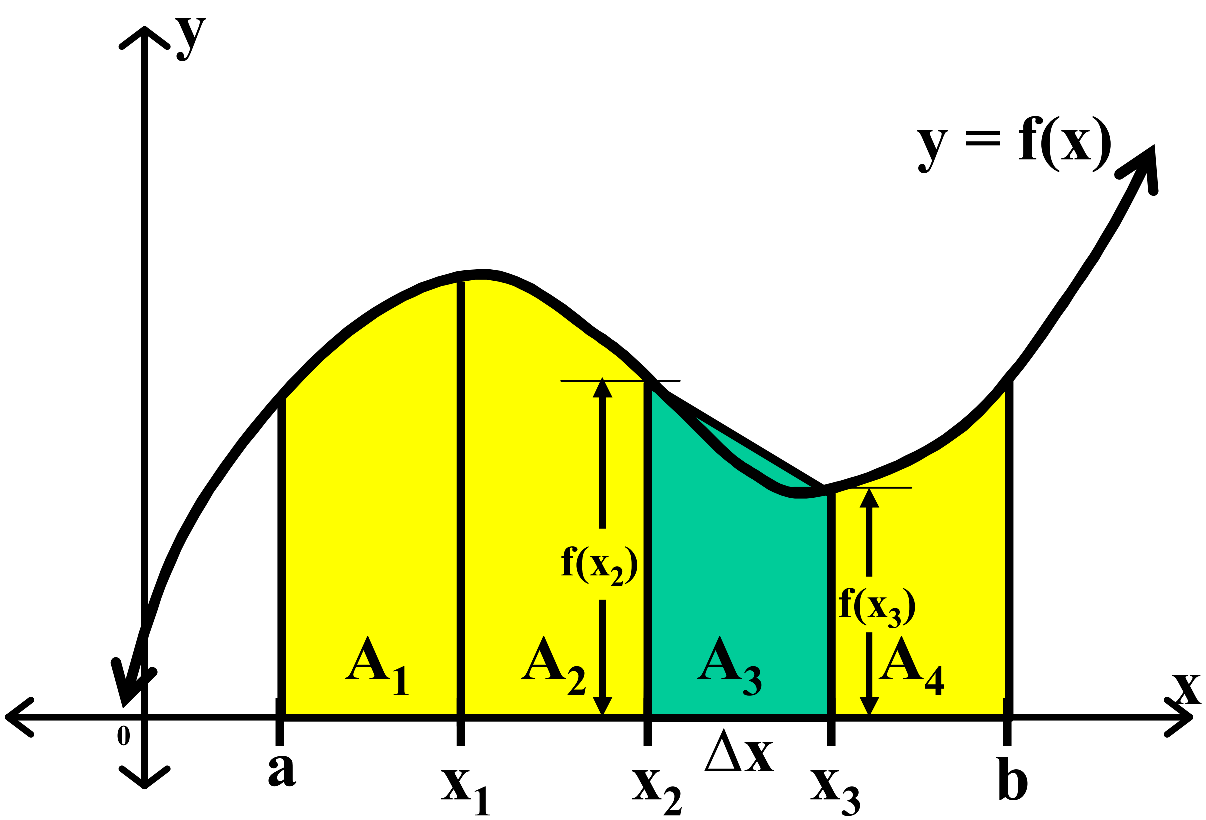

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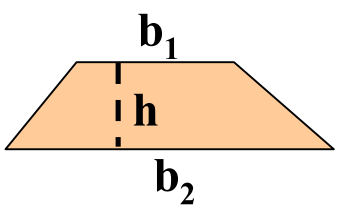

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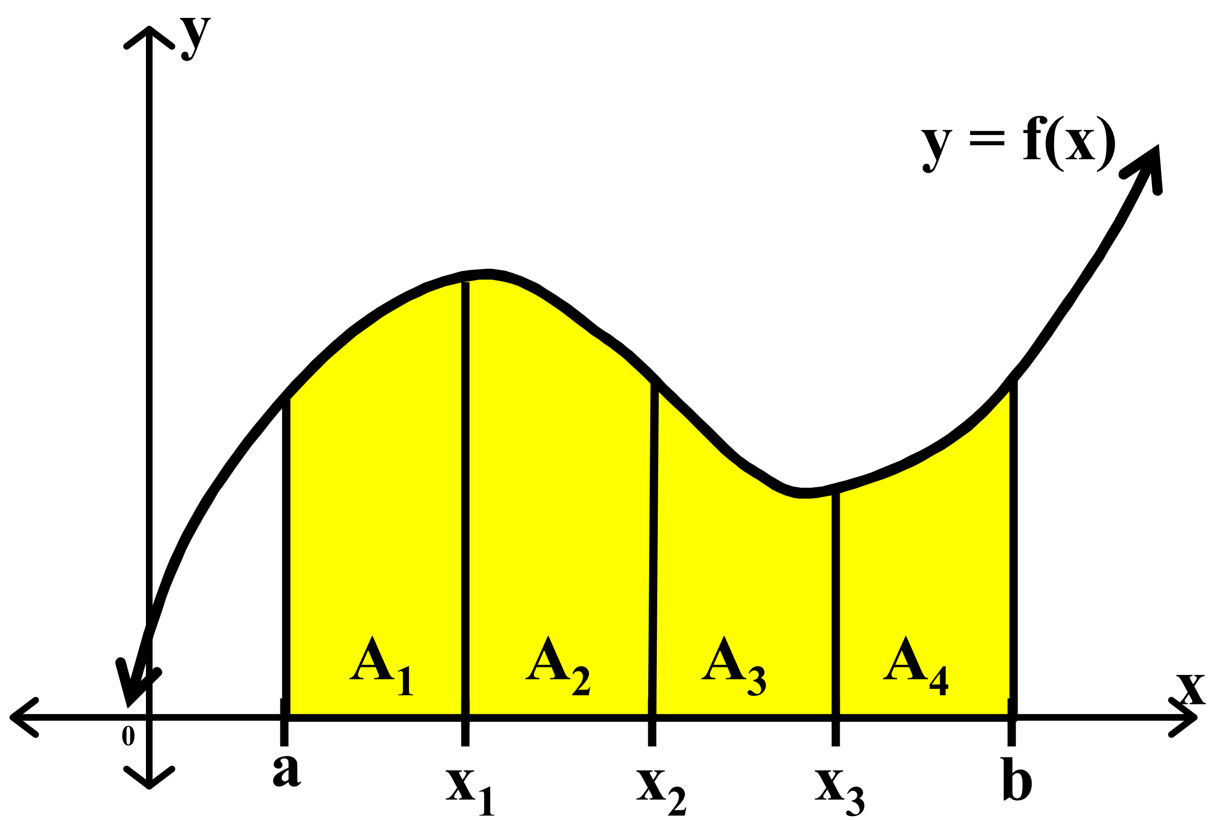

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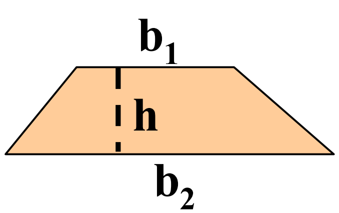

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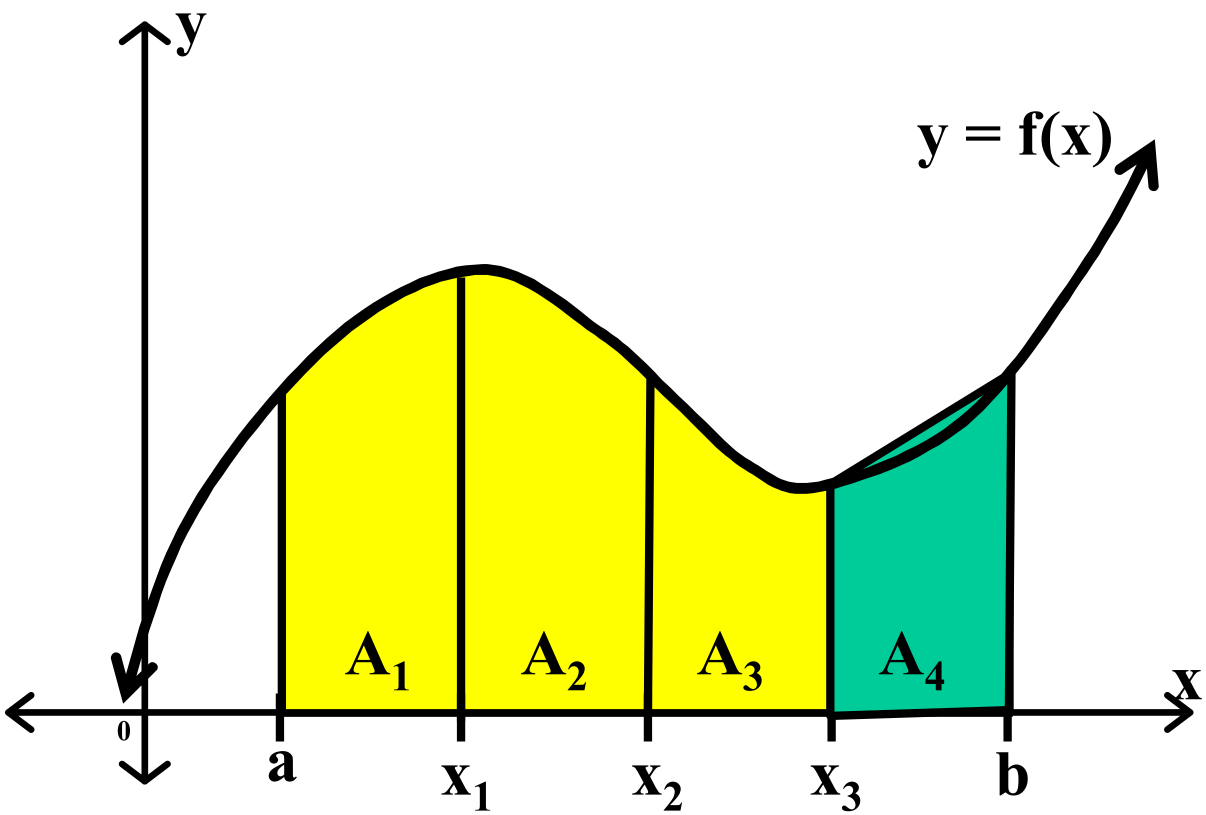

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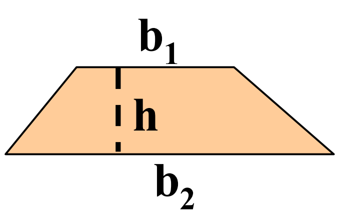

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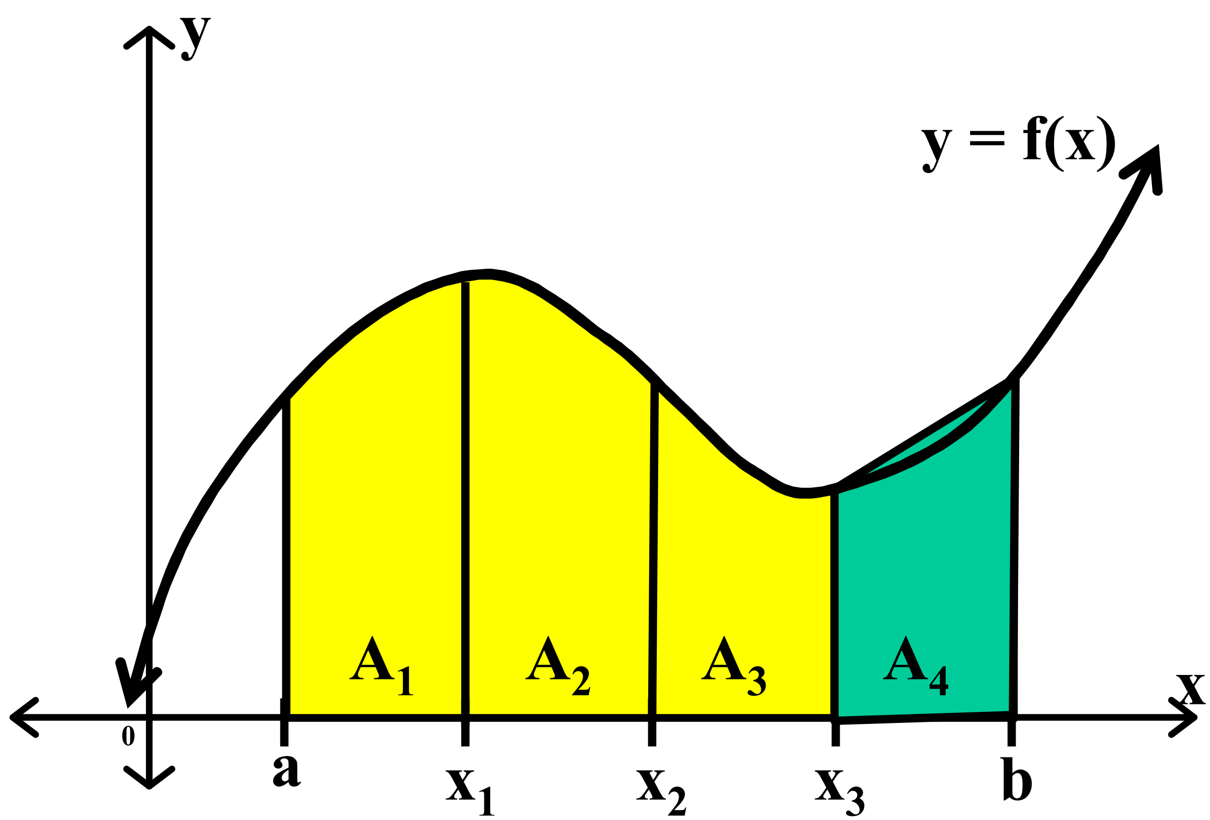

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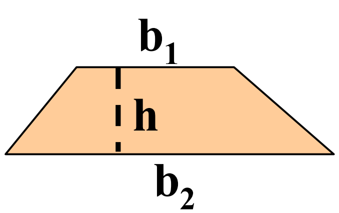

Area = $\frac{1}{2}*h(b_1 + b_2)$

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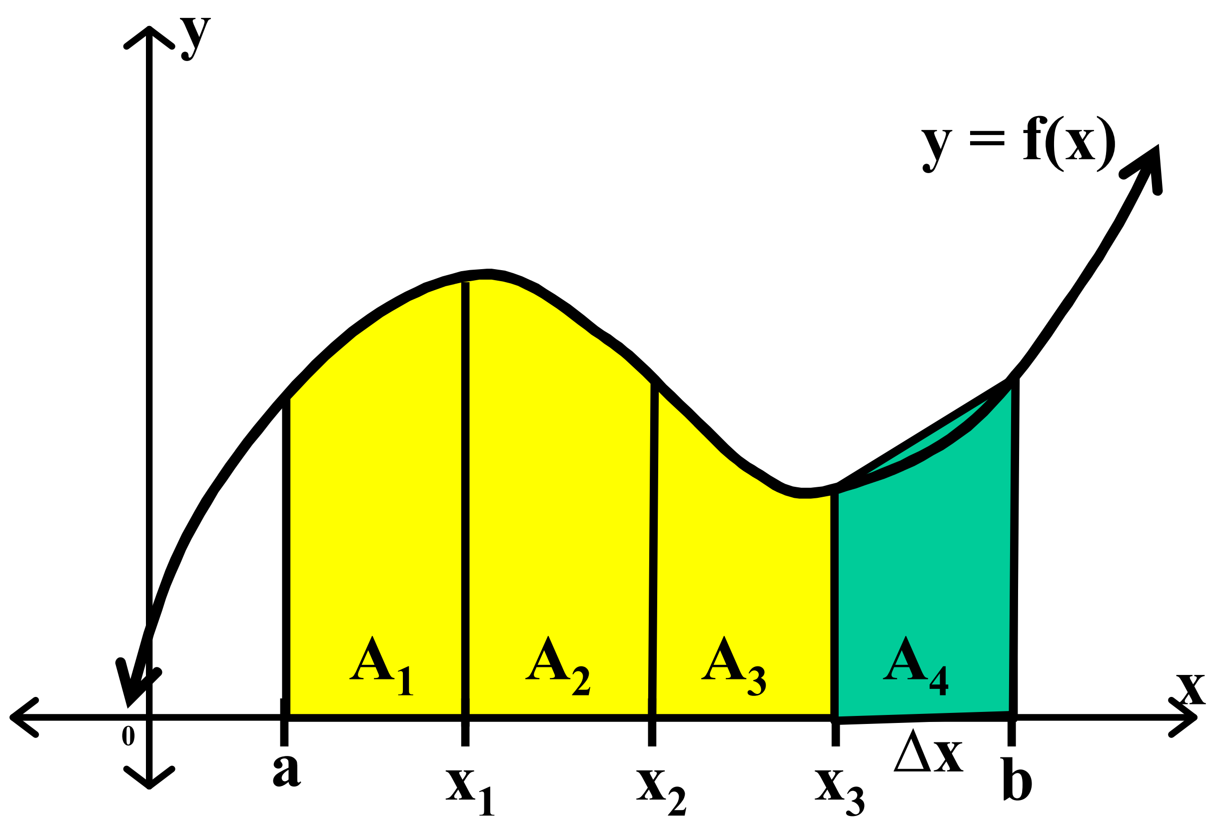
$A_2 \approx \frac{1}{2}*\Delta x[f(x_1) + f(x_2)]$

$A_3 \approx \frac{1}{2}*\Delta x[f(x_2) + f(x_3)]$

$A_4 \approx$



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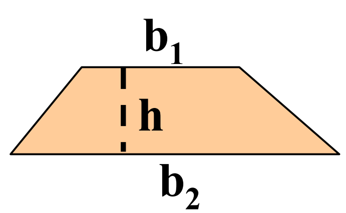

Area = $\frac{1}{2} * h(b_1 + b_2)$

$A_1 \approx \frac{1}{2} * \Delta x[f(a) + f(x_1)]$

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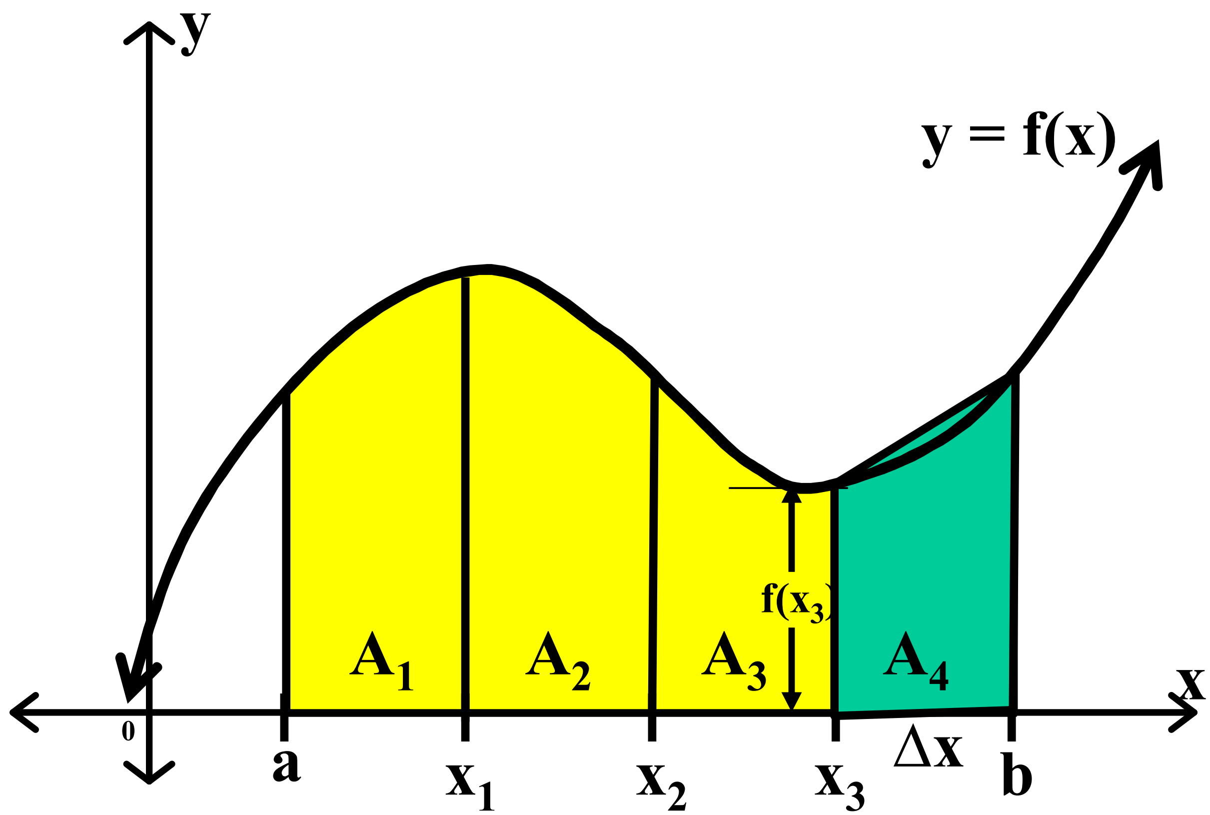
$h = \Delta x$



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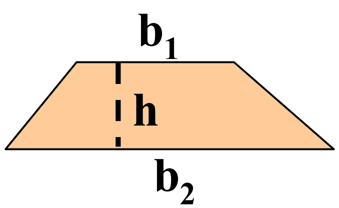

Area = $\frac{1}{2} * h(b_1 + b_2)$

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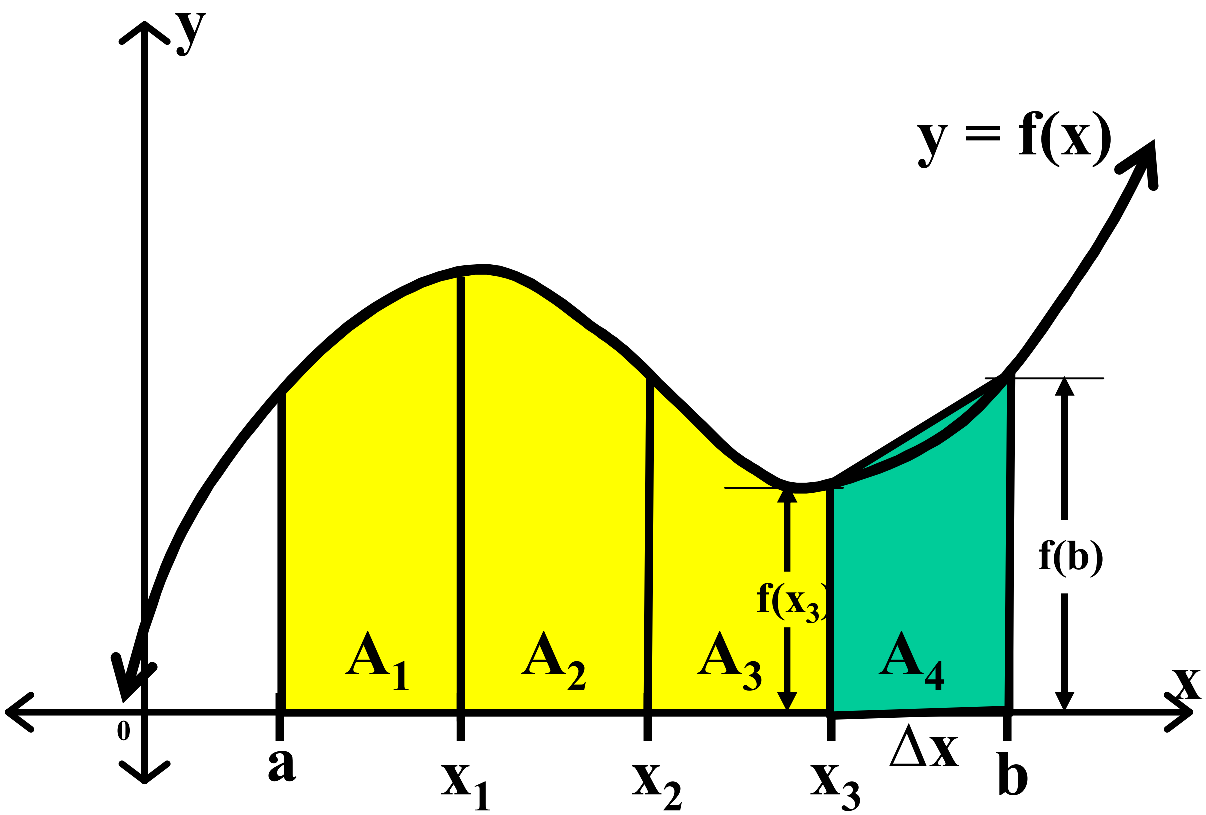
$A_4 \approx$

$h = \Delta x \quad b_1 = f(x_3)$



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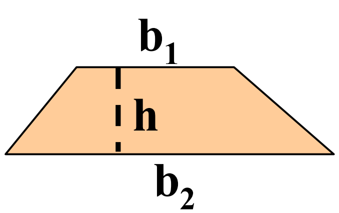

Area = $\frac{1}{2} * h(b_1 + b_2)$

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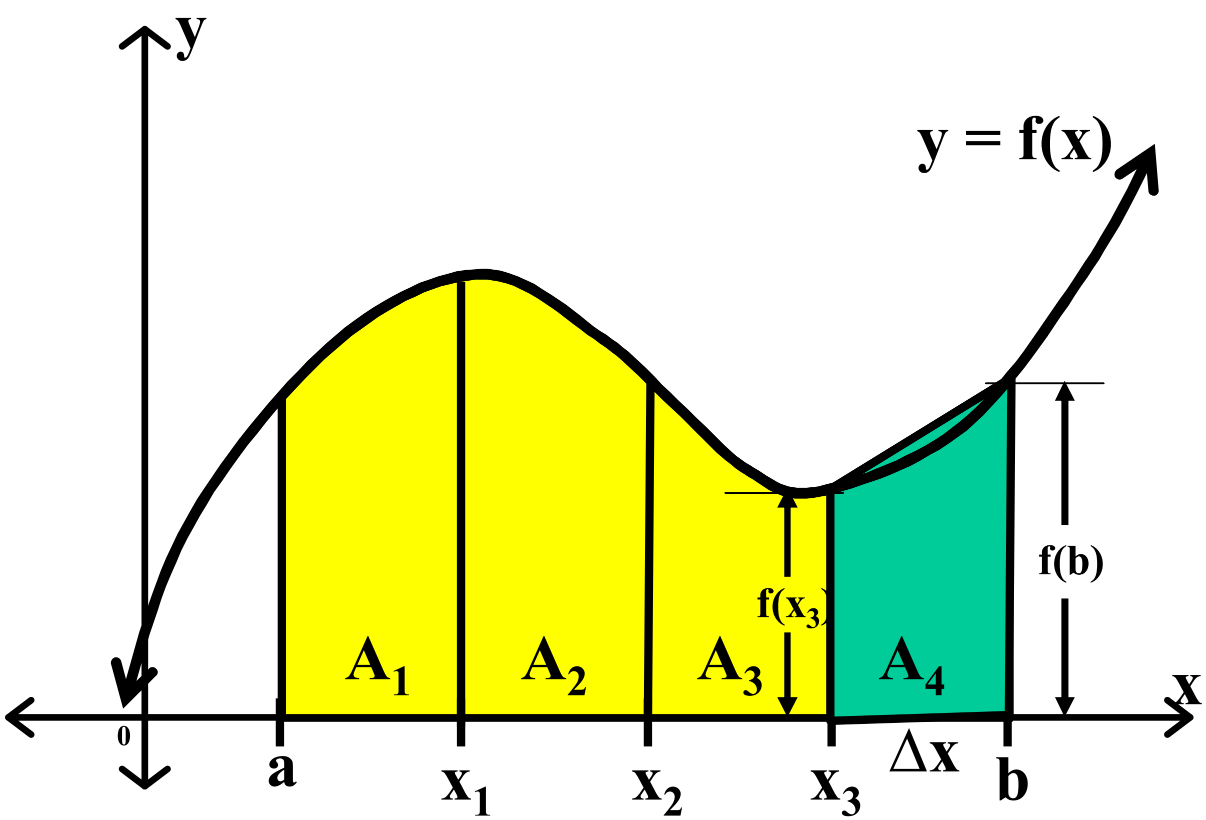
$h = \Delta x \quad b_1 = f(x_3) \quad b_2 = f(b)$



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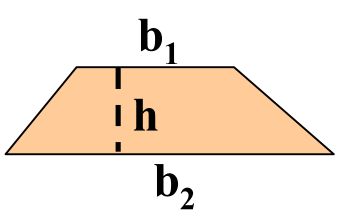

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$A_4 \approx \frac{1}{2} * \Delta x$

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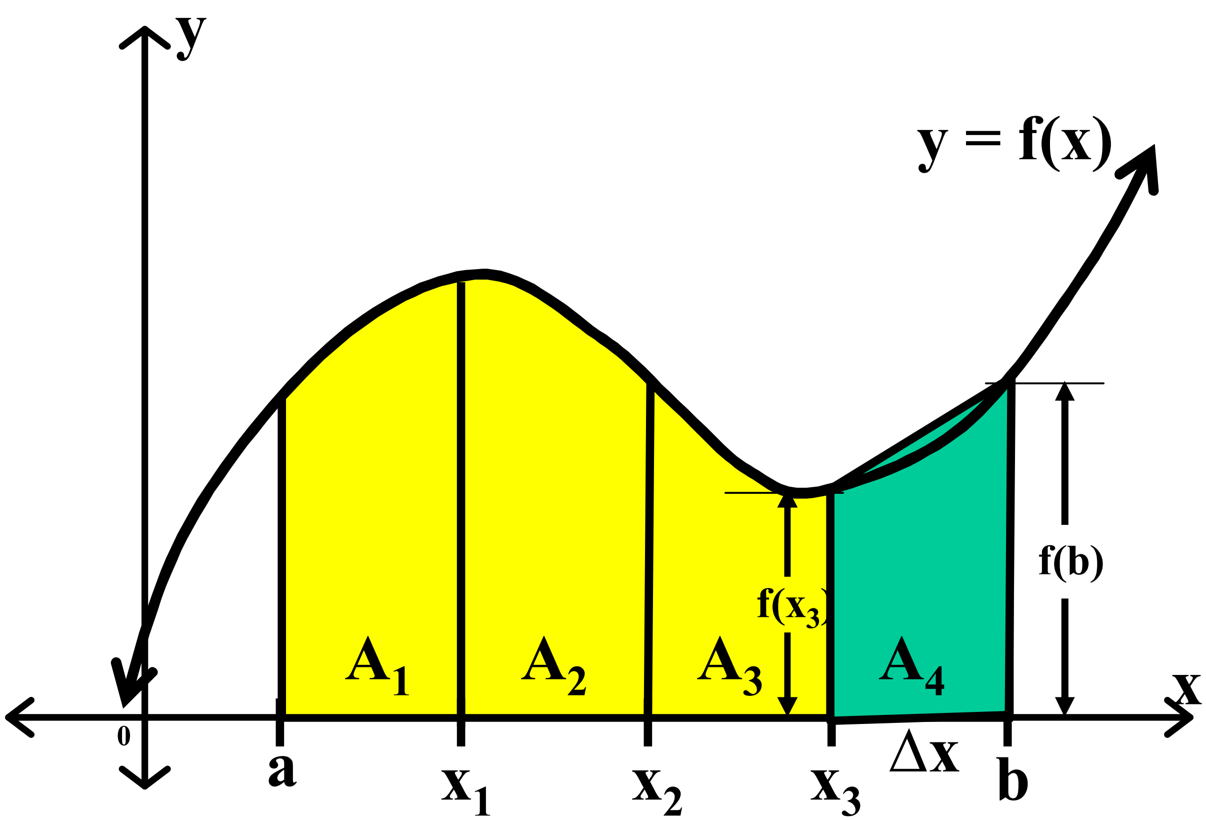

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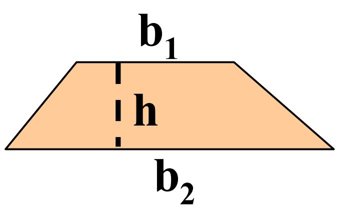

Area = $½*h(b_1 + b_2)$

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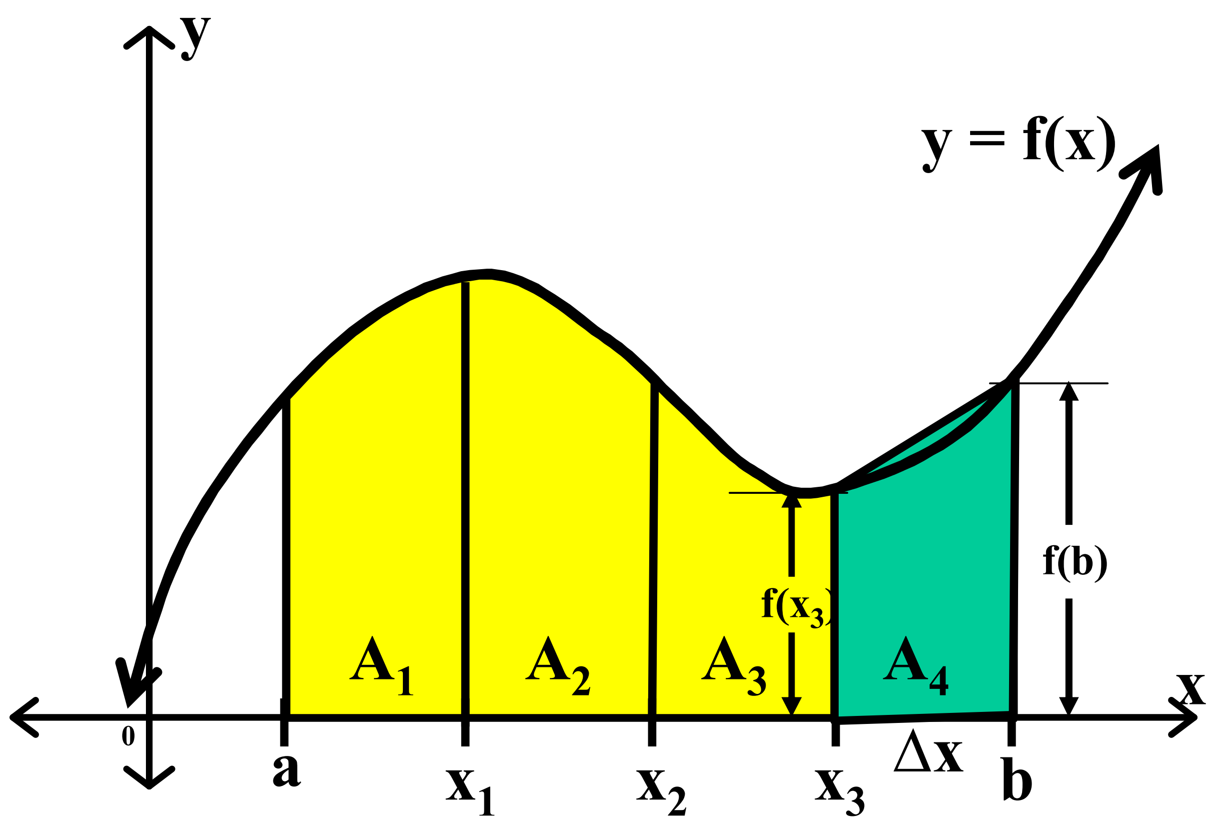

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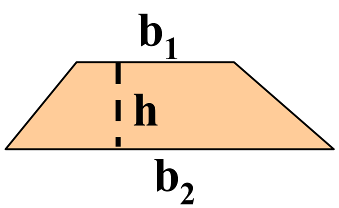

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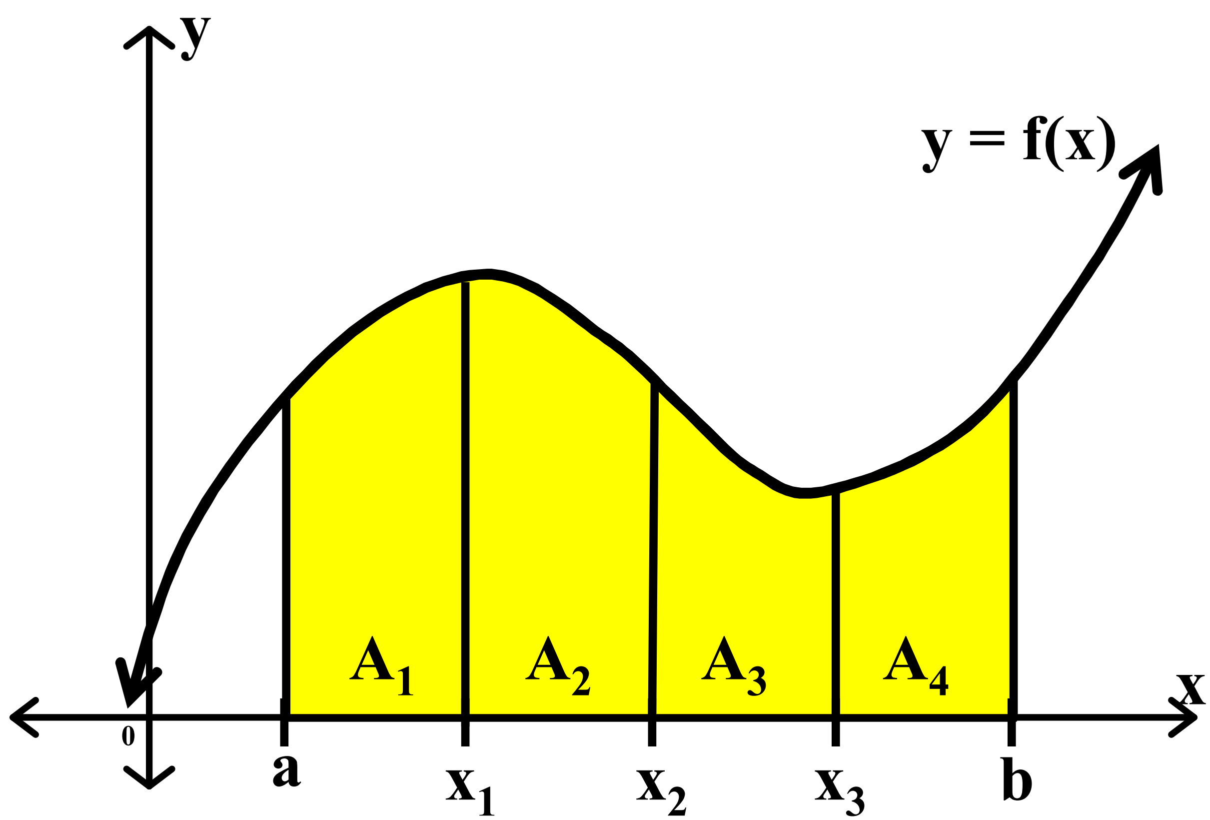

$A_1 \approx ½*\Delta x[f(a) + f(x_1)]$ $A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$

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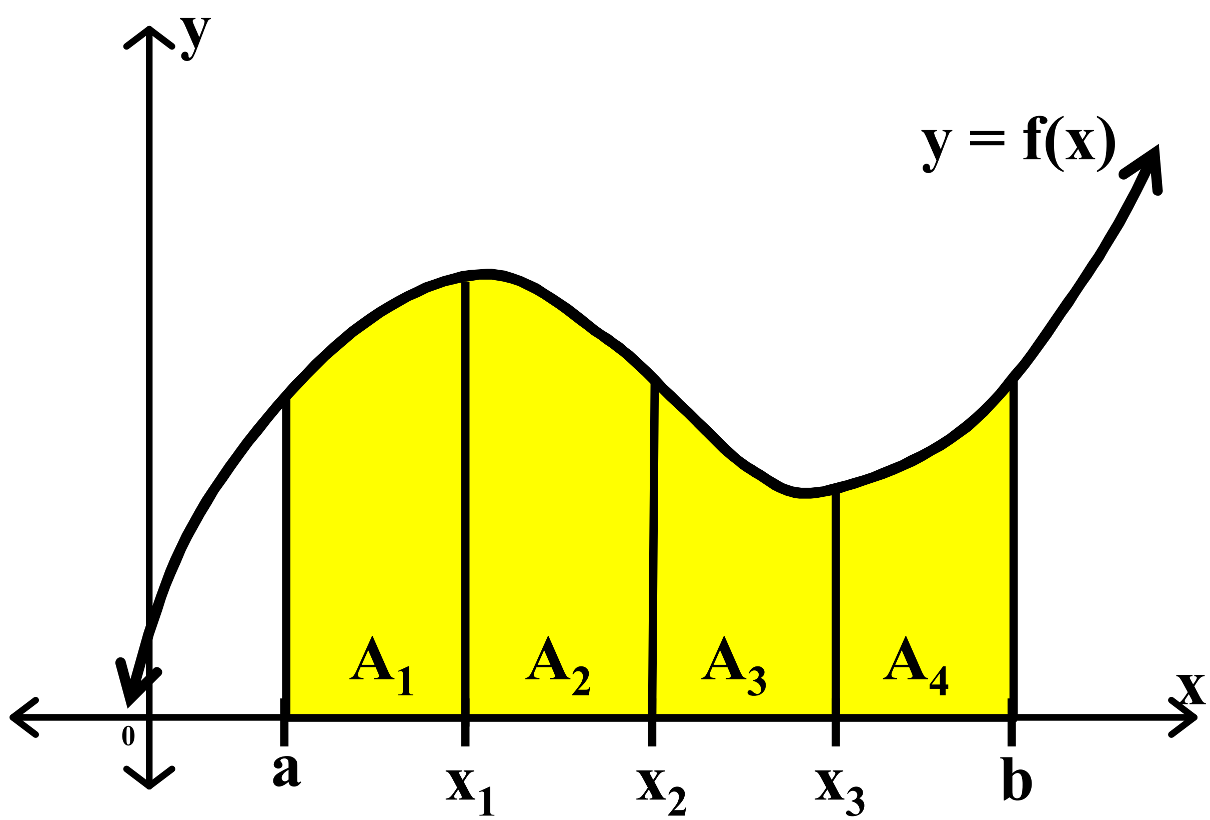

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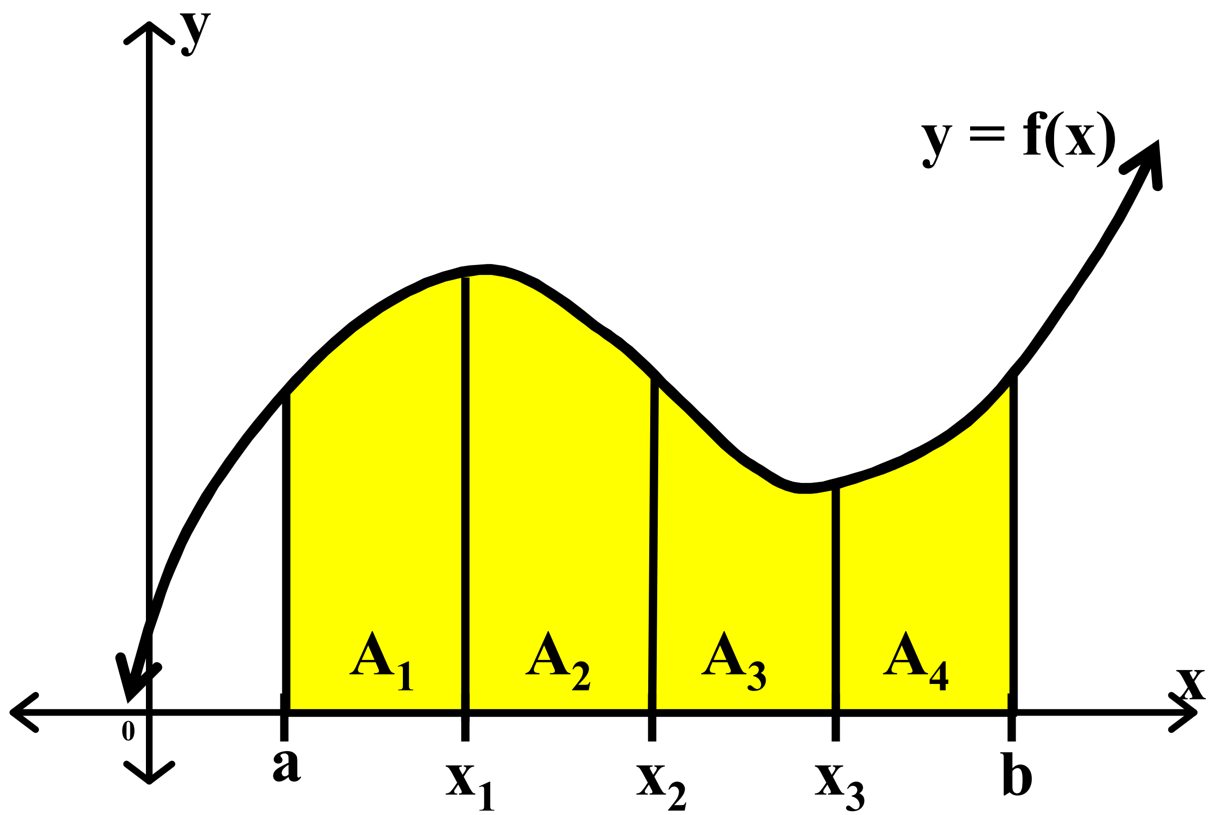
$$A = \int_a^b f(x)dx$$



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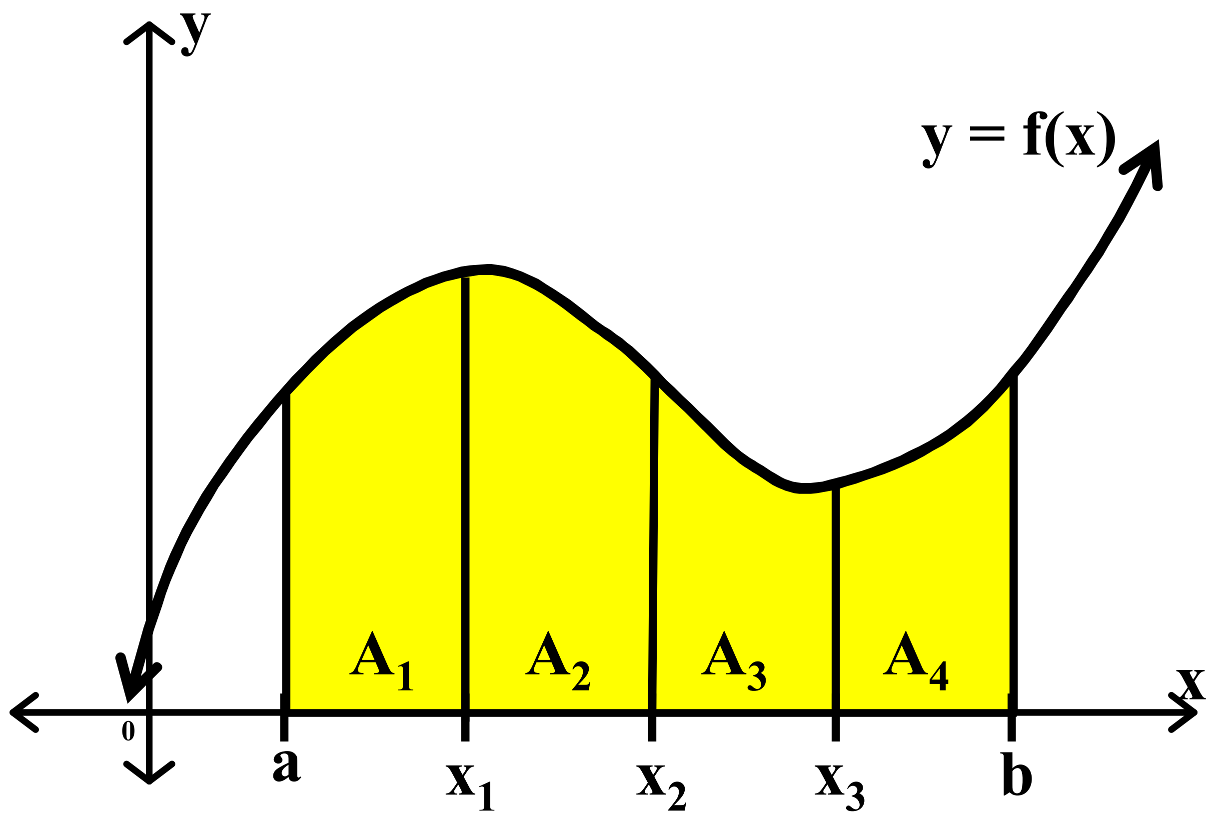
$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4$$



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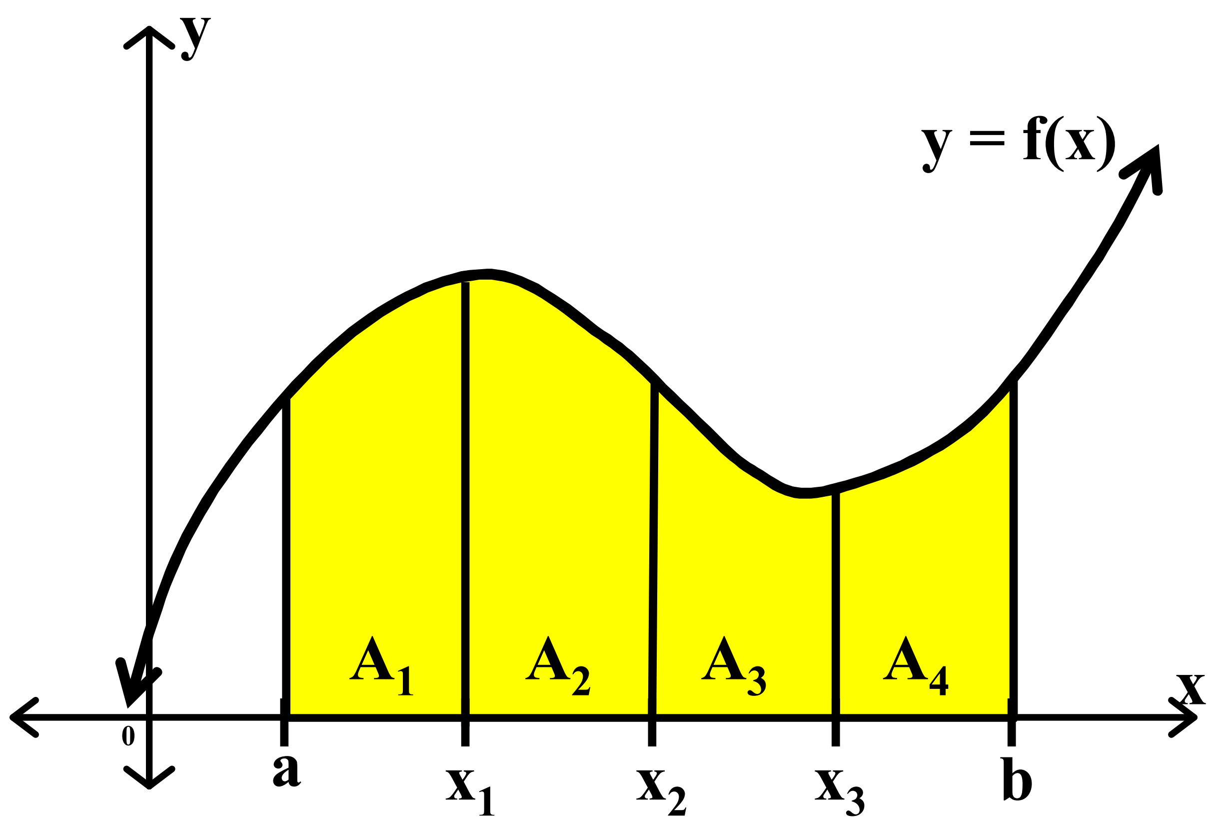

$A_1 \approx ½ * \Delta x[f(a) + f(x_1)]$ $A_3 \approx ½ * \Delta x[f(x_2) + f(x_3)]$

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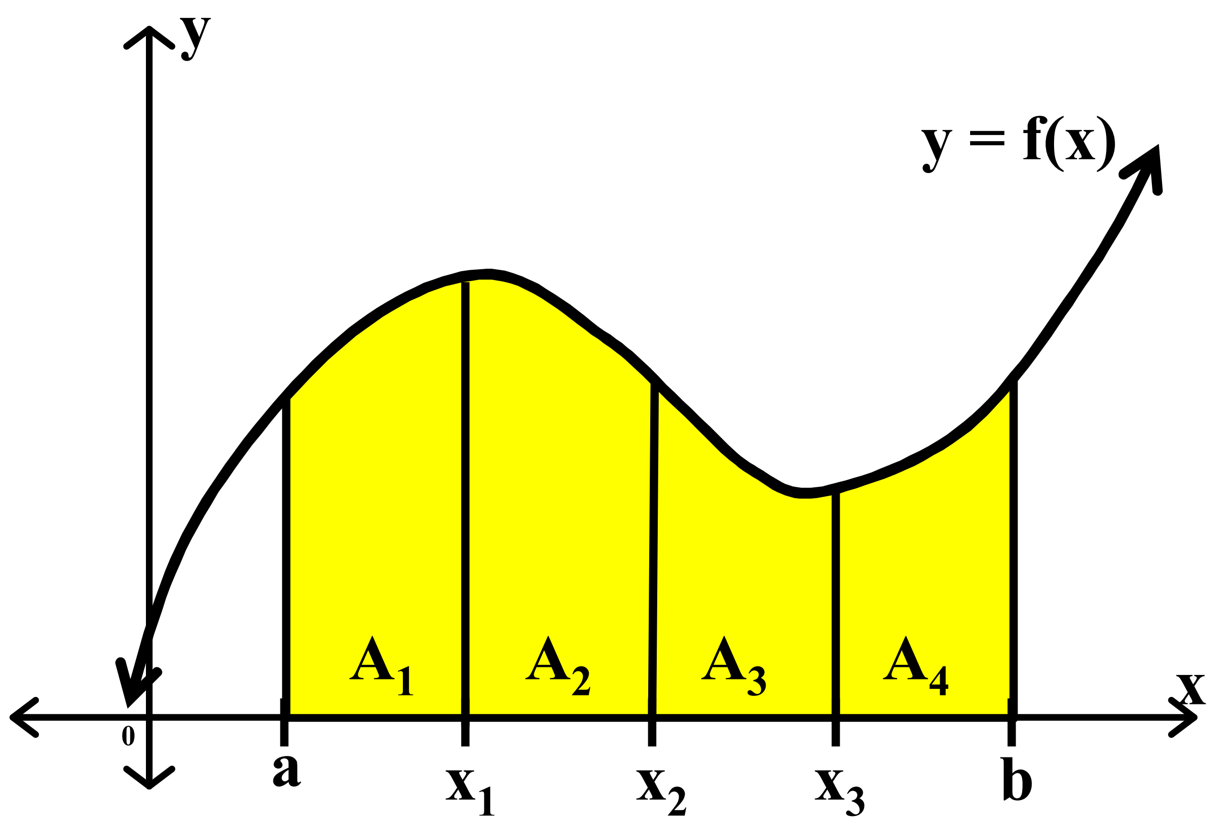
$$A = \int_a^b f(x)dx = A_1 + A_2 + A_3 + A_4 = \sum_{i=1}^{n} A_i$$ (In this case, n = 4.)



$A_1 \approx ½*\Delta x[f(a) + f(x_1)]$ $A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$

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$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A_1 \approx \tfrac{1}{2} * \Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2} * \Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2} * \Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2} * \Delta x[f(x_3) + f(b)]$$

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$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$A \approx$

$A_1 \approx \frac{1}{2} * \Delta x[f(a) + f(x_1)]$ $\quad A_3 \approx \frac{1}{2} * \Delta x[f(x_2) + f(x_3)]$

$A_2 \approx \frac{1}{2} * \Delta x[f(x_1) + f(x_2)]$ $\quad A_4 \approx \frac{1}{2} * \Delta x[f(x_3) + f(b)]$

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$A \approx \frac{1}{2} * \Delta x[f(a) + f(x_1)]$

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$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2} * \Delta x[f(a) + f(x_1)] + \tfrac{1}{2} * \Delta x[f(x_1) + f(x_2)]$$

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$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

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$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

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‘Factor out’ the Δx factor from each of the four terms of the expression.

$A_1 \approx ½*\Delta x[f(a) + f(x_1)]$ $A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$

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$A \approx$

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$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] +$$

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‘Factor out’ the Δx factor from each of the four terms of the expression.

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$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

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$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) +$$
$$+$$

Now do the indicated multiplication.

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \quad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

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$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3)$$

Now do the indicated multiplication.

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \quad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \quad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + $$
$$+ ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + $$
$$+ ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + $$
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$$+ ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + $$
$$+ ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + $$
$$+ ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)$$

Now do the indicated multiplication.

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \quad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \quad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

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$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

Now combine like terms.

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \quad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx$$

Now combine like terms.

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a)$$

Now combine like terms.

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

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$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + $$
$$+ \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + $$
$$+ \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + $$
$$+ \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + $$

Now combine like terms.

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \quad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1)$$

Now combine like terms.

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \quad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \quad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + $$
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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + $$
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$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + $$
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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) +$$

Now combine like terms.

$$A_1 \approx \tfrac{1}{2} * \Delta x[f(a) + f(x_1)] \quad A_3 \approx \tfrac{1}{2} * \Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2} * \Delta x[f(x_1) + f(x_2)] \quad A_4 \approx \tfrac{1}{2} * \Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2} * \Delta x[f(a) + f(x_1)] + \tfrac{1}{2} * \Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2} * \Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2} * \Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + f(x_1) + f(x_2)$$

Now combine like terms.

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + $$
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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) +$$

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$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

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$$+ ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) +$$
$$+ ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)$$

Now combine like terms.

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \quad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \quad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx$$

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx$$

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx \Delta x[½f(a)$$

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx \Delta x[½f(a) +$$

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + f(x_1) + f(x_2) + f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x[\tfrac{1}{2}f(a) +$$

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx \Delta x[½f(a) + \sum$$

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx \Delta x[½f(a) + \sum f(x_i)$$

$A_1 \approx ½*\Delta x[f(a) + f(x_1)]$ $A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$

$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)]$ $A_4 \approx ½*\Delta x[f(x_3) + f(b)]$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx \Delta x[½f(a) + \sum_{i=1} f(x_i)$$

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \quad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \quad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx \Delta x[½f(a) + \sum_{i=1}^{n-1} f(x_i)$$

$$A_1 \approx ½*\Delta x[f(a) + f(x_1)] \quad A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)] \quad A_4 \approx ½*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx ½*\Delta x[f(a) + f(x_1)] + ½*\Delta x[f(x_1) + f(x_2)] + \\ + ½*\Delta x[f(x_2) + f(x_3)] + ½*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ ½[f(a) + f(x_1)] + ½[f(x_1) + f(x_2)] + \\ + ½[f(x_2) + f(x_3)] + ½[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ ½f(a) + ½f(x_1) + ½f(x_1) + ½f(x_2) + \\ + ½f(x_2) + ½f(x_3) + ½f(x_3) + ½f(b)\}$$

$$A \approx \Delta x\{ ½f(a) + f(x_1) + f(x_2) + f(x_3) + ½f(b)\}$$

$$A \approx \Delta x[½f(a) + \sum_{i=1}^{n-1} f(x_i)$$

In this example, n = 4.

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + f(x_1) + f(x_2) + f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x[\tfrac{1}{2}f(a) + \sum_{i=1}^{n-1} f(x_i) +$$

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + f(x_1) + f(x_2) + f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x[\tfrac{1}{2}f(a) + \sum_{i=1}^{n-1} f(x_i) +$$

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + \\ + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + \\ + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + f(x_1) + f(x_2) + f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x[\tfrac{1}{2}f(a) + \sum_{i=1}^{n-1} f(x_i) + \tfrac{1}{2}f(b)$$

$$A_1 \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] \qquad A_3 \approx \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)]$$

$$A_2 \approx \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] \qquad A_4 \approx \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

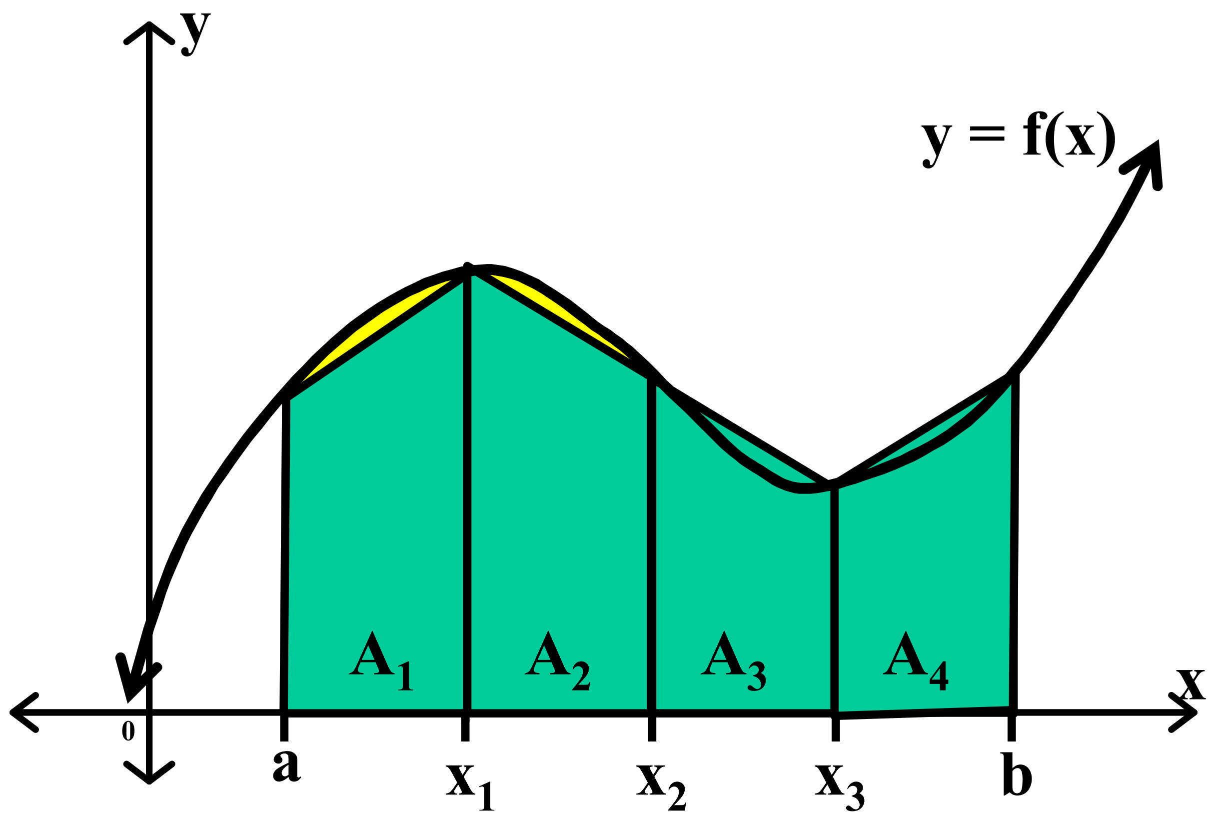
$$A \approx \tfrac{1}{2}*\Delta x[f(a) + f(x_1)] + \tfrac{1}{2}*\Delta x[f(x_1) + f(x_2)] + + \tfrac{1}{2}*\Delta x[f(x_2) + f(x_3)] + \tfrac{1}{2}*\Delta x[f(x_3) + f(b)]$$

$$A \approx \Delta x\{ \tfrac{1}{2}[f(a) + f(x_1)] + \tfrac{1}{2}[f(x_1) + f(x_2)] + + \tfrac{1}{2}[f(x_2) + f(x_3)] + \tfrac{1}{2}[f(x_3) + f(b)]\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_1) + \tfrac{1}{2}f(x_2) + + \tfrac{1}{2}f(x_2) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(x_3) + \tfrac{1}{2}f(b)\}$$

$$A \approx \Delta x\{ \tfrac{1}{2}f(a) + f(x_1) + f(x_2) + f(x_3) + \tfrac{1}{2}f(b)\}$$

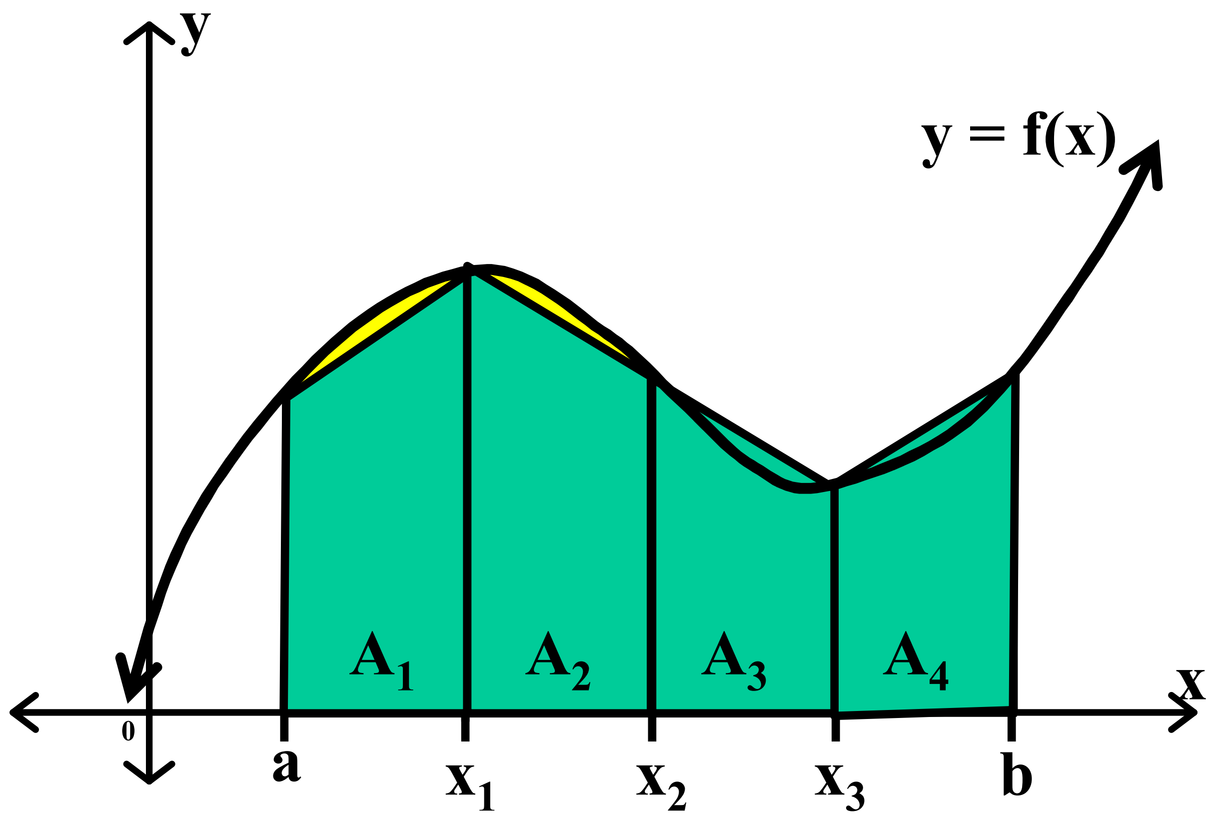
$$A \approx \Delta x[\tfrac{1}{2}f(a) + \sum_{i=1}^{n-1} f(x_i) + \tfrac{1}{2}f(b)]$$



$A_1 \approx ½*\Delta x[f(a) + f(x_1)]$ $A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$

$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)]$ $A_4 \approx ½*\Delta x[f(x_3) + f(b)]$

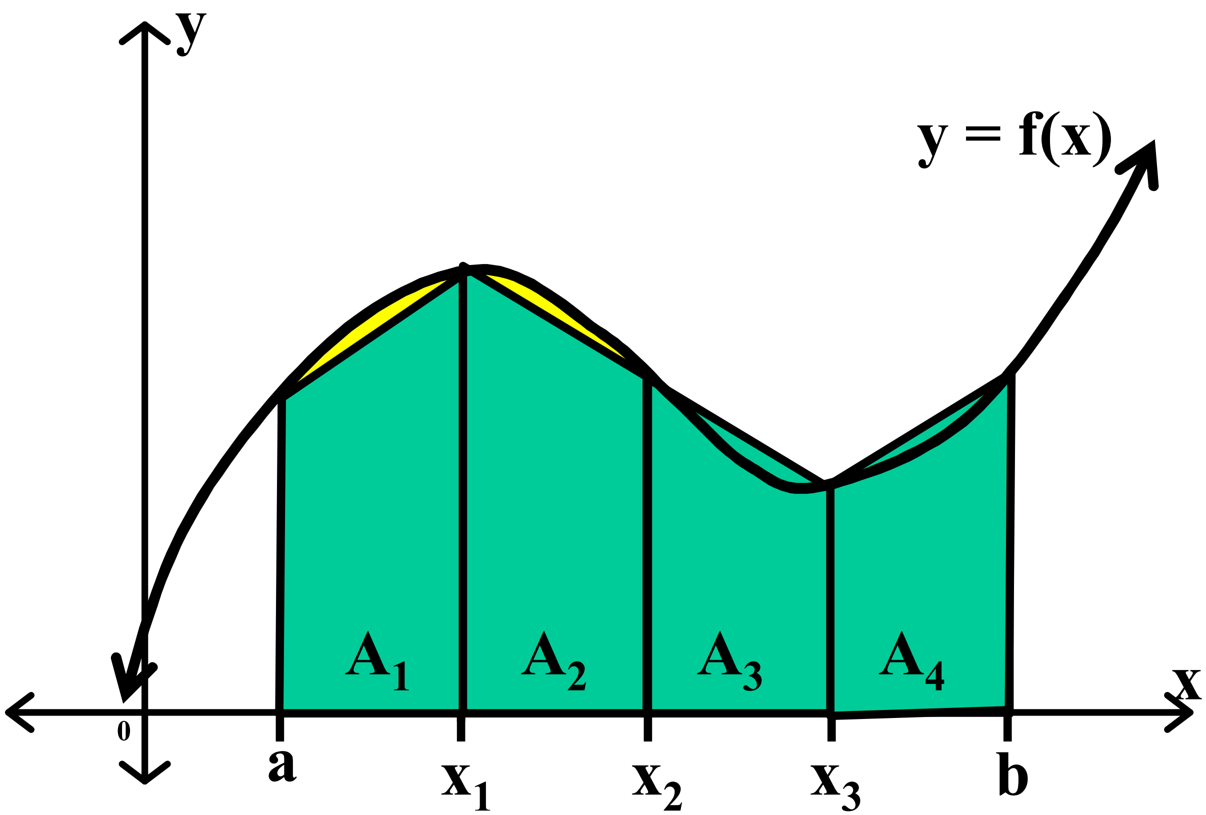
$$A \approx \Delta x\left[½f(a) + \sum_{i=1}^{n-1} f(x_i) + ½f(b)\right]$$



$A_1 \approx ½*\Delta x[f(a) + f(x_1)]$ $A_3 \approx ½*\Delta x[f(x_2) + f(x_3)]$

$A_2 \approx ½*\Delta x[f(x_1) + f(x_2)]$ $A_4 \approx ½*\Delta x[f(x_3) + f(b)]$

$$A \approx \Delta x[½f(a) + \sum_{i=1}^{n-1} f(x_i) + ½f(b)] = S_T$$



$$S_T = \Delta x\left[\tfrac{1}{2}f(a) + \sum_{i=1}^{n-1} f(x_i) + \tfrac{1}{2}f(b)\right]$$

The Trapezoidal Approximation

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

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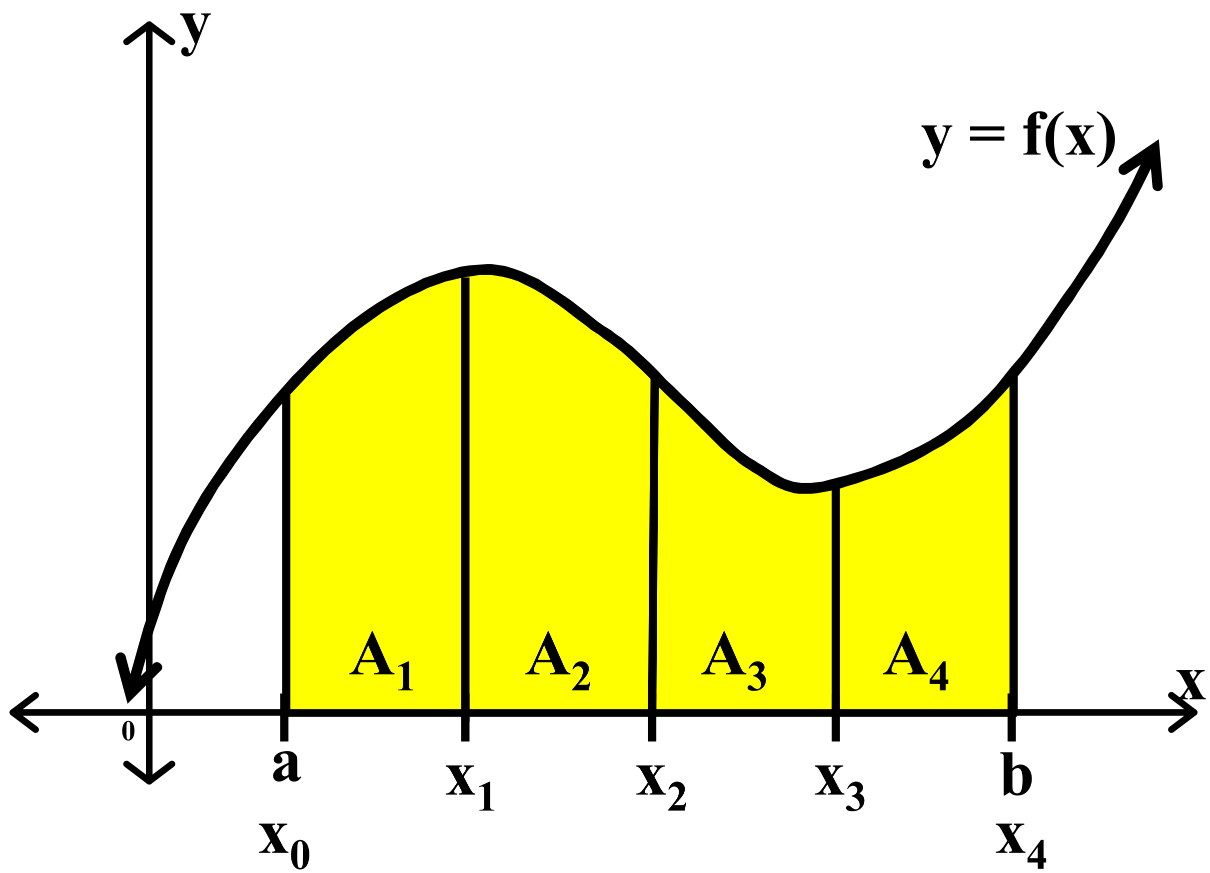
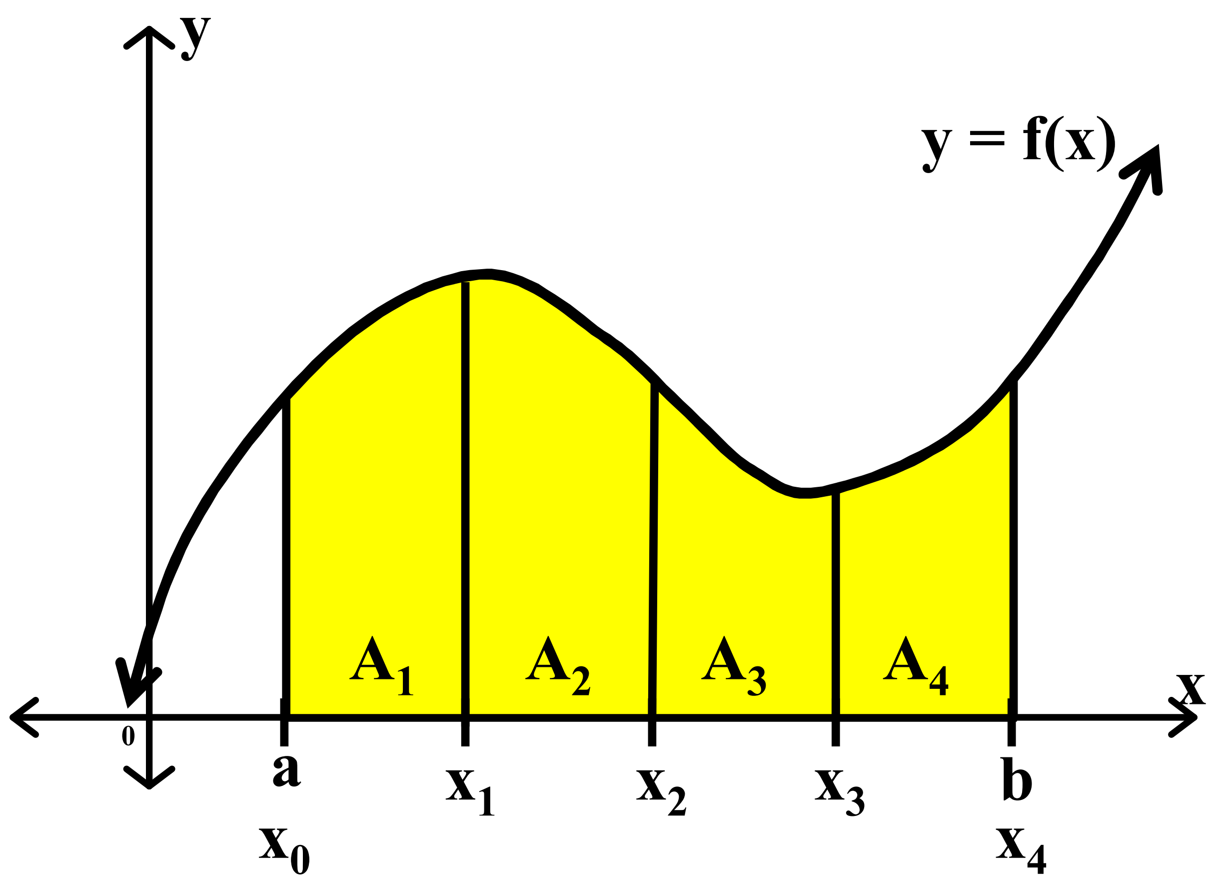
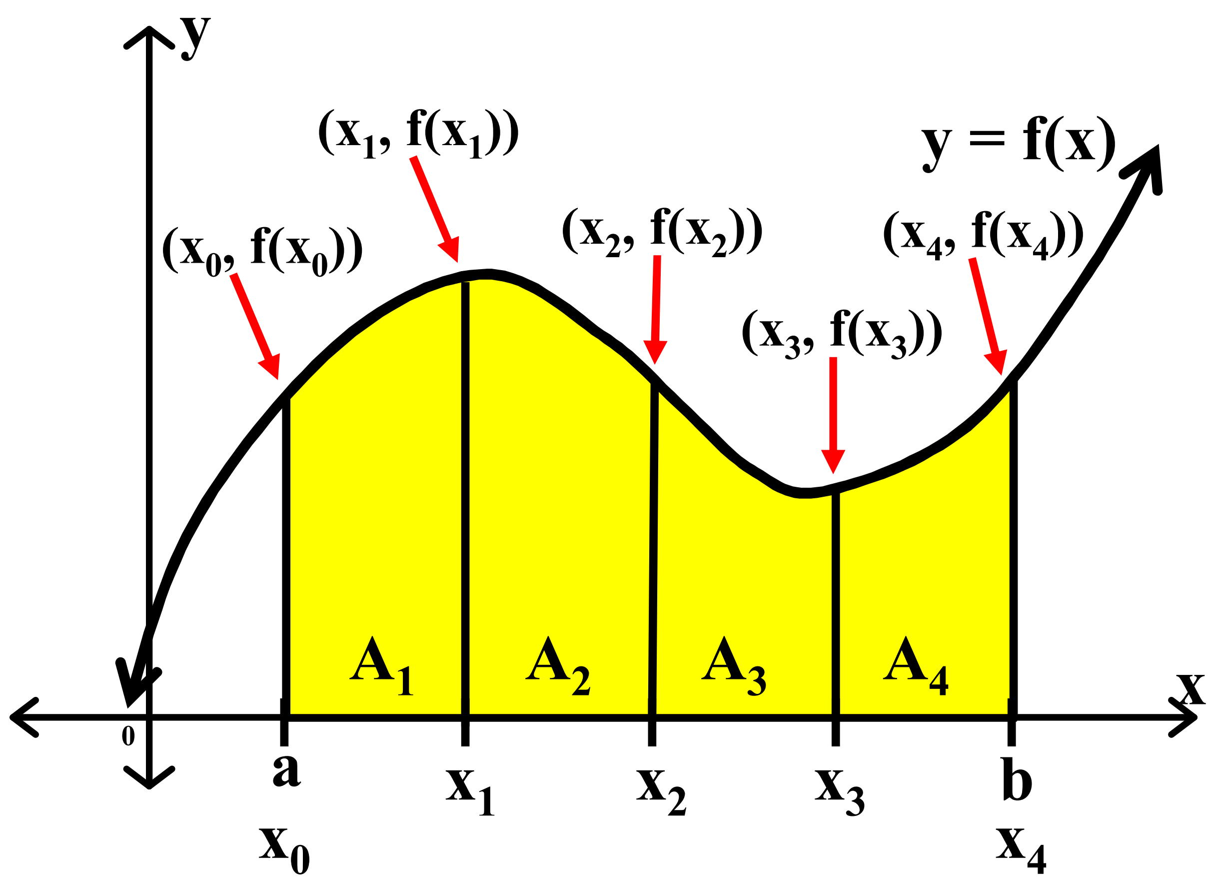
$$S_T \approx 19.30$$


y
y = f(x)
A_1
A_2
A_3
A_4
x
0
a
x_0
x_1
x_2
x_3
b
x_4



The trapezoidal approximation ‘connects the ‘key points’ on the graph of function f



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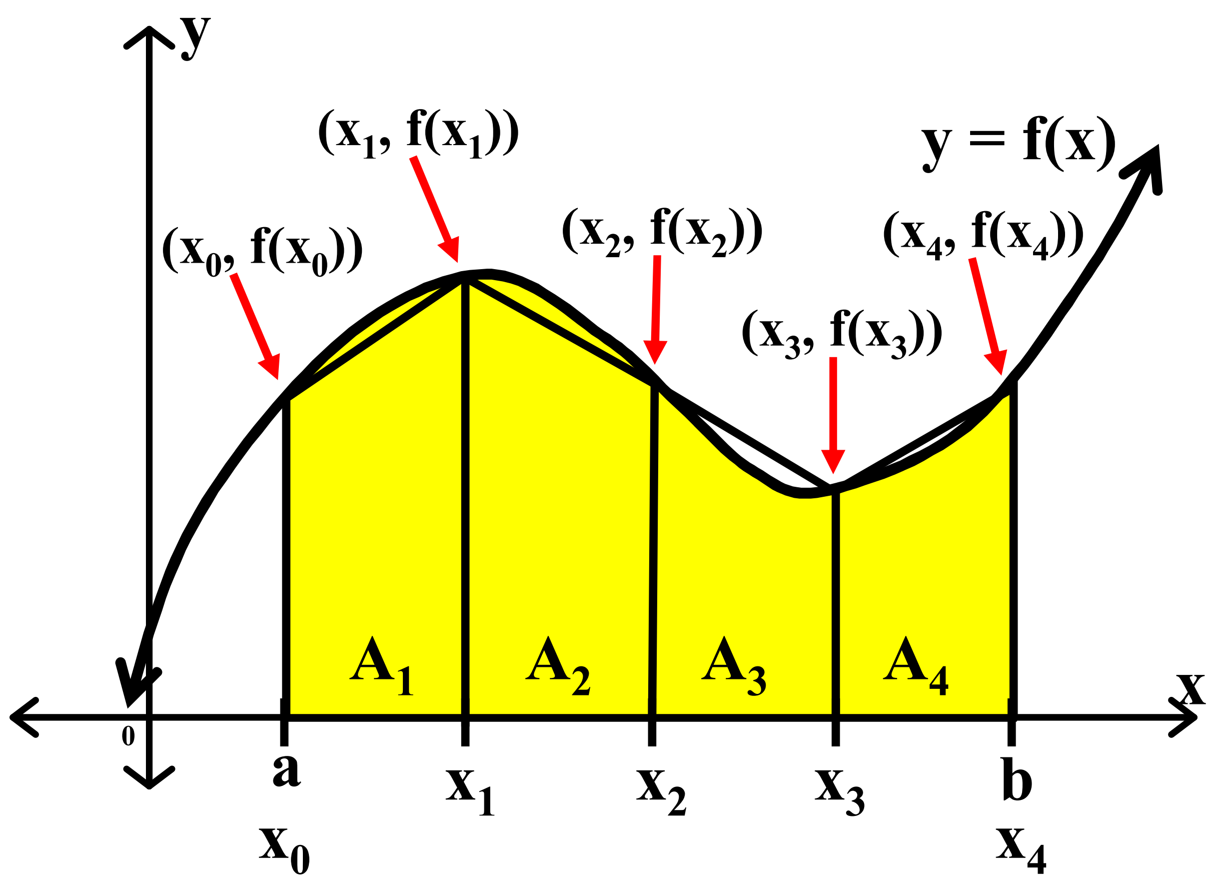
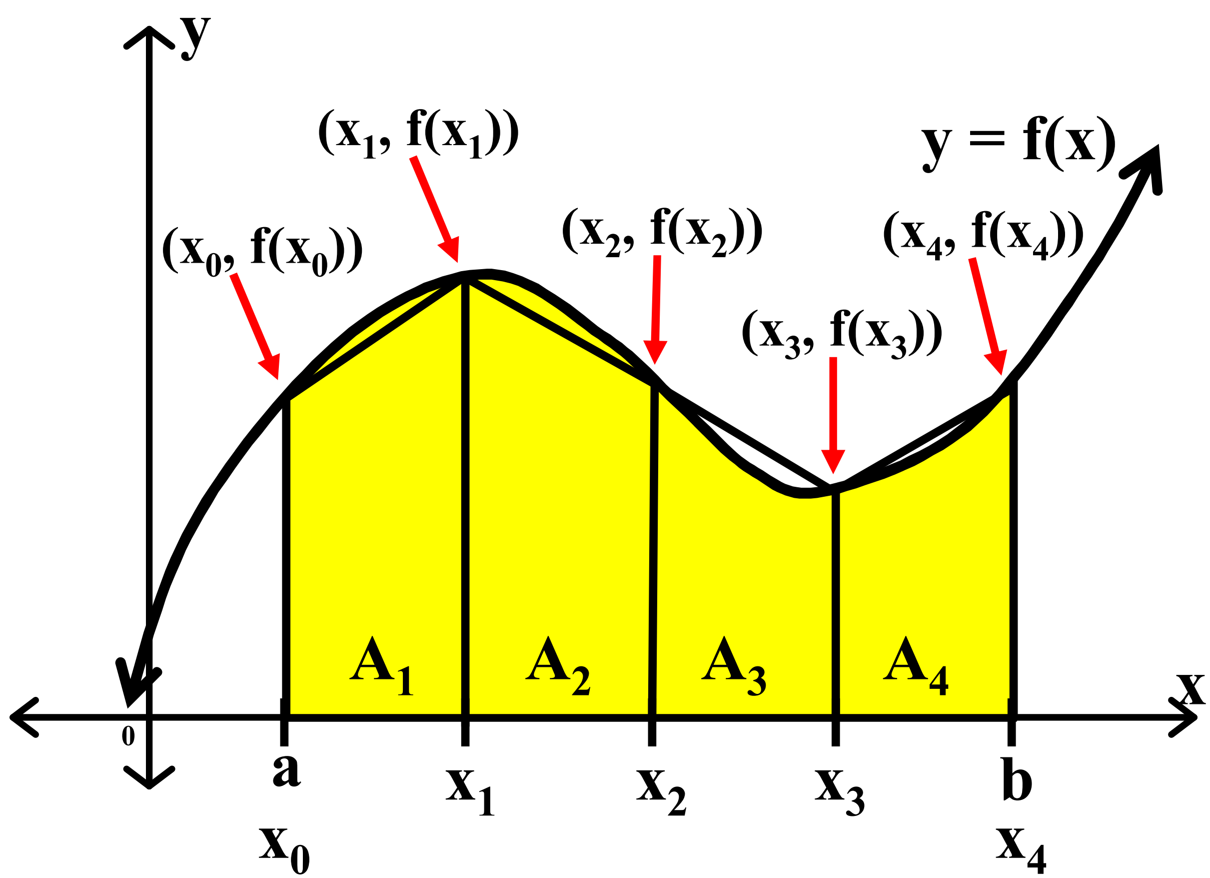
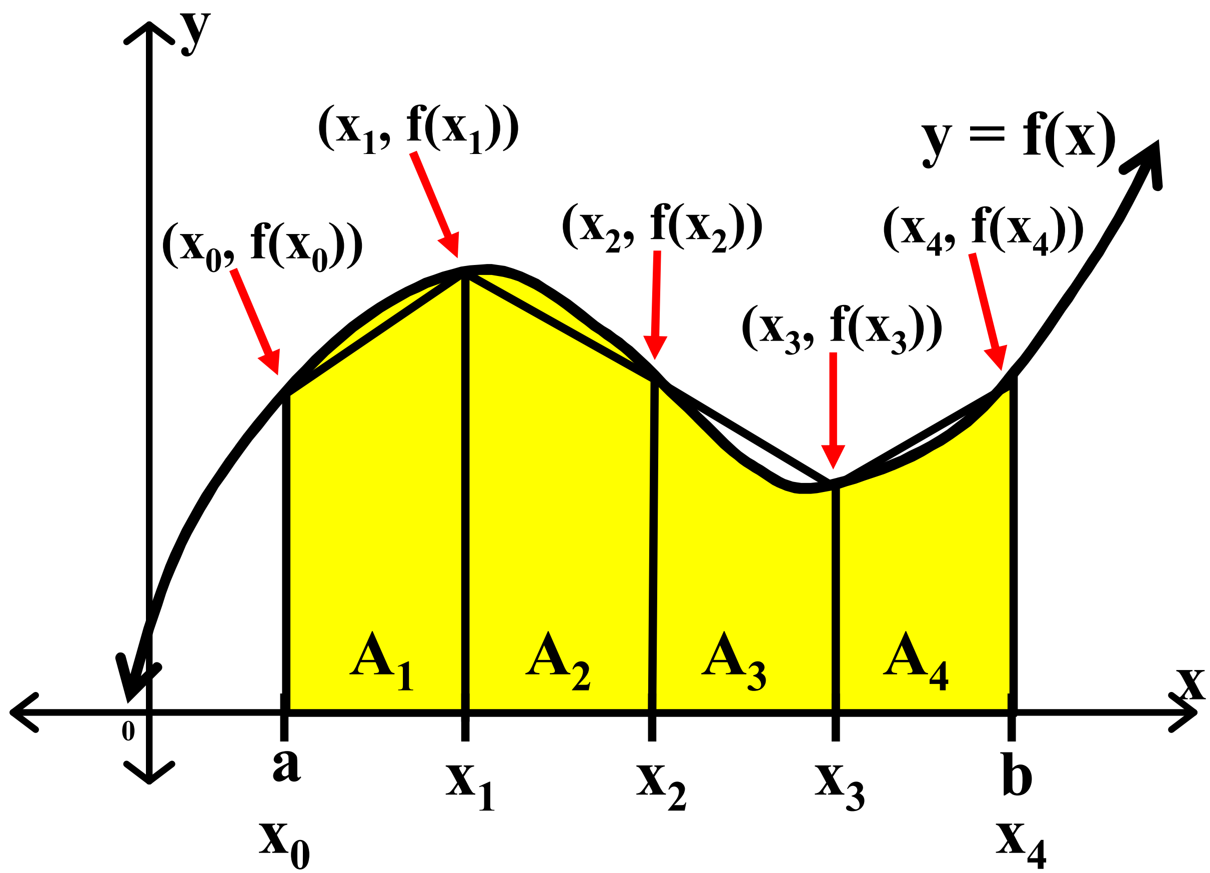


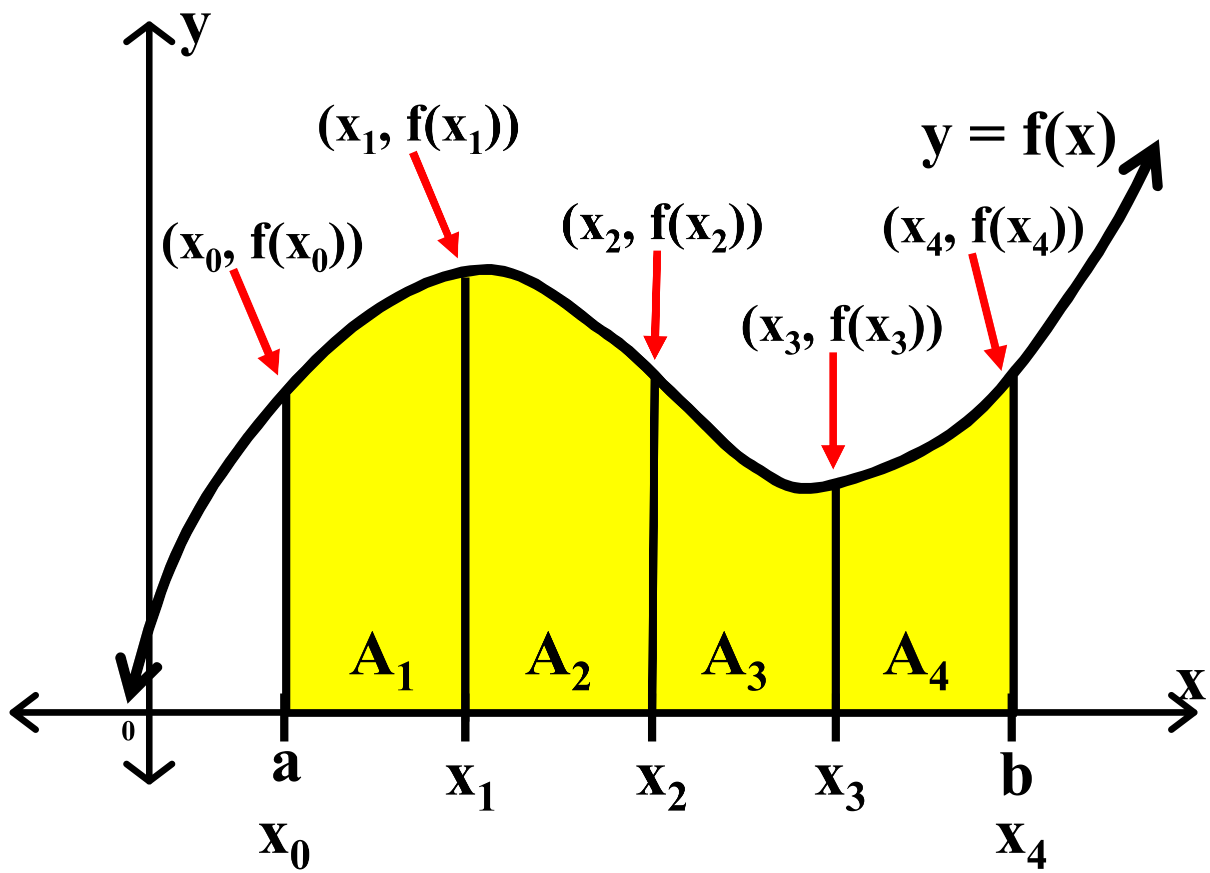
The trapezoidal approximation 'connects the 'key points' on the graph of function f with a series of line segments forming the trapezoids.

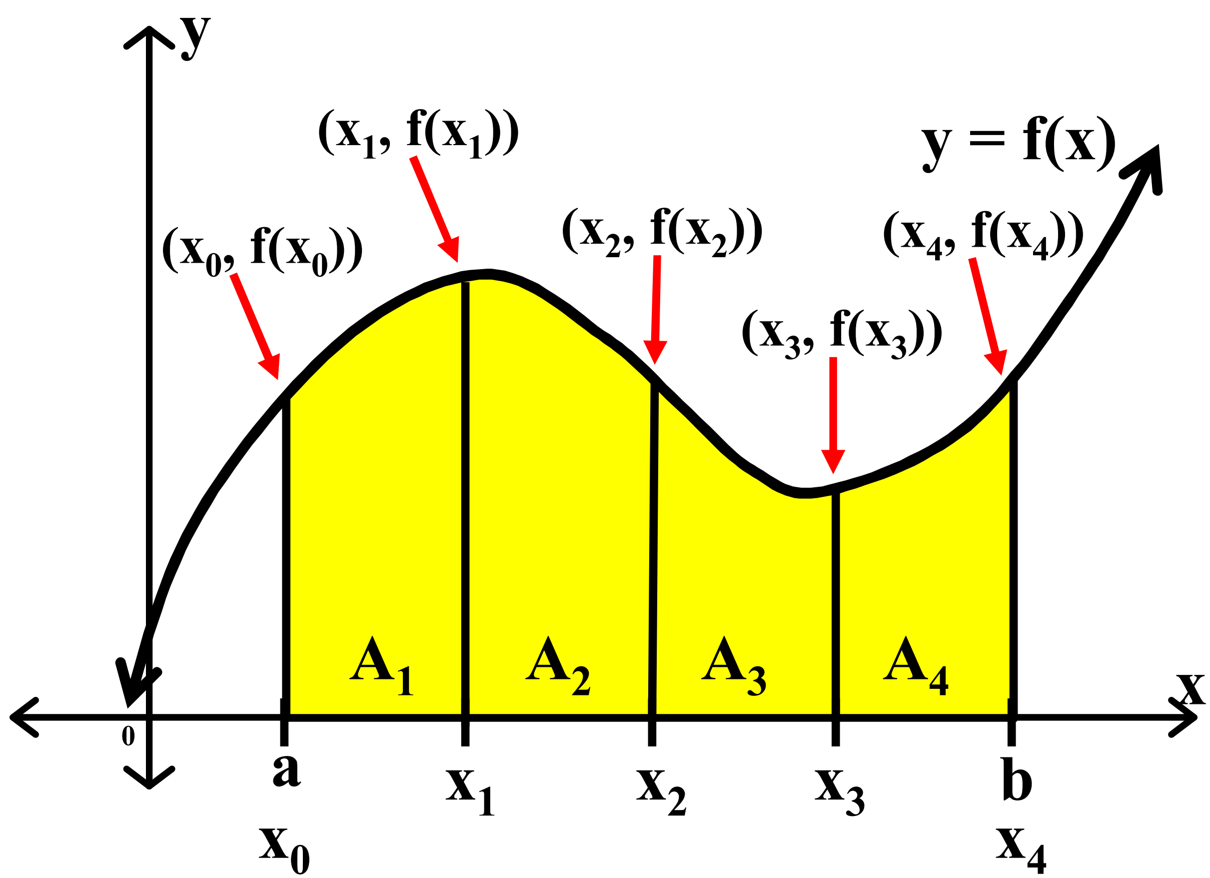


The trapezoidal approximation 'connects the 'key points' on the graph of function f with a series of line segments forming the trapezoids. (This is called a polygonal path.)

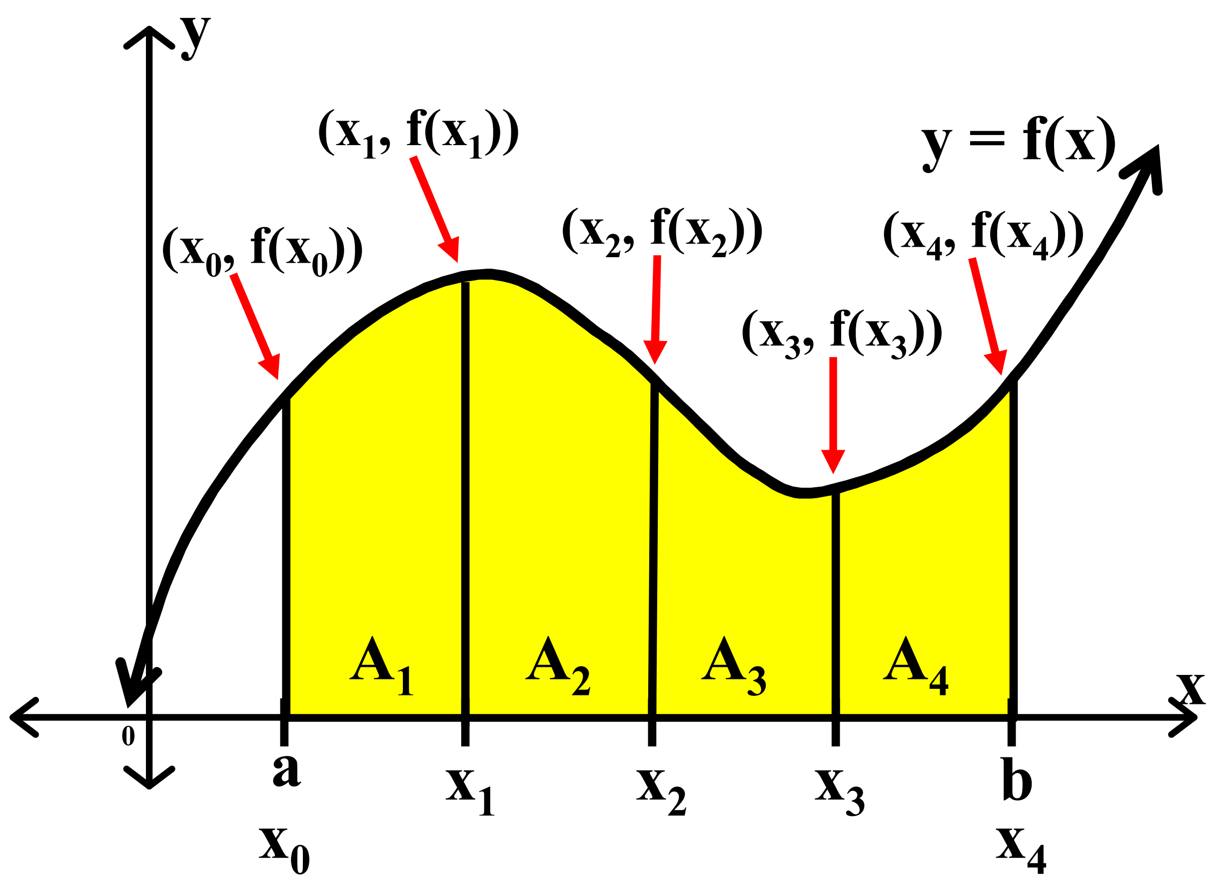


y
y = f(x)
(x₀, f(x₀))
(x₁, f(x₁))
(x₂, f(x₂))
(x₃, f(x₃))
(x₄, f(x₄))
A₁
A₂
A₃
A₄
x
0
a
x₀
x₁
x₂
x₃
b
x₄

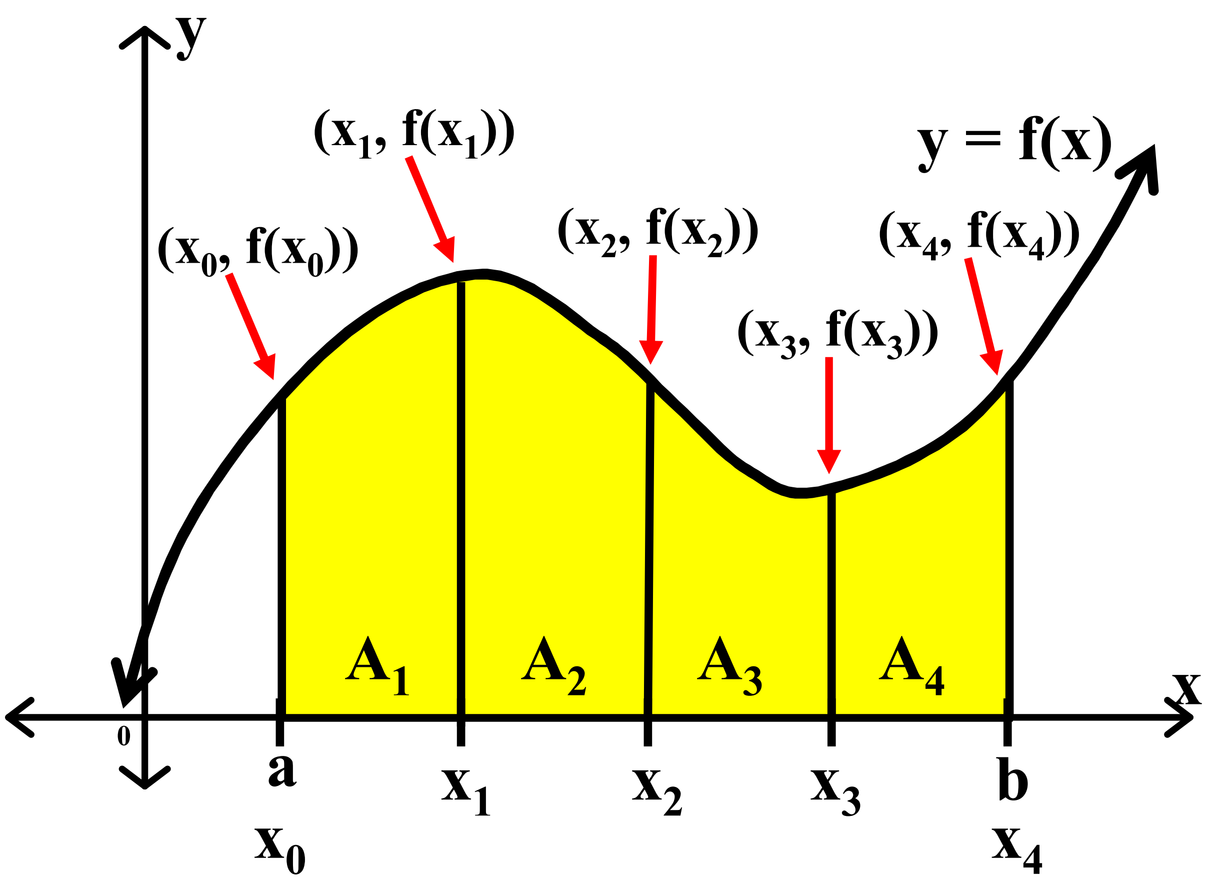

y
(x1, f(x1))
y = f(x)
(x0, f(x0))
(x2, f(x2))
(x4, f(x4))
(x3, f(x3))
A1
A2
A3
A4
x
0
a
x1
x2
x3
b
x0
x4



The last of or approximation techniques is called Simpson's Rule.



The last of or approximation techniques is called Simpson's Rule. This technique connects the key points using 'arcs of parabolas'.



The last of or approximation techniques is called Simpson's Rule. This technique connects the key points using 'arcs of parabolas'. Consider the following.

Simpson’s Rule

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Given any three non-collinear points <u>on the graph of any function</u>,

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Given any three non-collinear points <u>on the graph of any function</u>, there exists a second degree function

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Given any three non-collinear points on the graph of any function, there exists a second degree function (a parabola),
$y = Ax^2 + Bx + C$,

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Given any three non-collinear points on the graph of any function, there exists a second degree function (a parabola), $y = Ax^2 + Bx + C$, that contains them.

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Given: Points P(-2, -8), Q(1, 13), and R(4, -2)

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Given: Points P(-2, -8), Q(1, 13), and R(4, -2)
Find the coefficients A, B, and C of a second degree function that would contain these points.

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Consider point P.

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$$-8 = A(-2)^2 + B(-2)$$

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Given any three non-collinear points <u>on the graph of any function</u>, there exists a second degree function (a parabola), $y = Ax^2 + Bx + C$, that contains them. Consider this example.

Given: Points P(-2, -8), Q(1, 13), and R(4, -2)
Find the coefficients A, B, and C of a second degree function that would contain these points.

Consider point P. Since y = -8, when x = -2,

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This leads to the equation $4A - 2B + C = -8$

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Therefore, the parabola that would contain points P, Q, and R is
$y = -2x^2 + 5x + 10$.

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Now consider the second degree function $g(x) = Ax^2 + Bx + C$.

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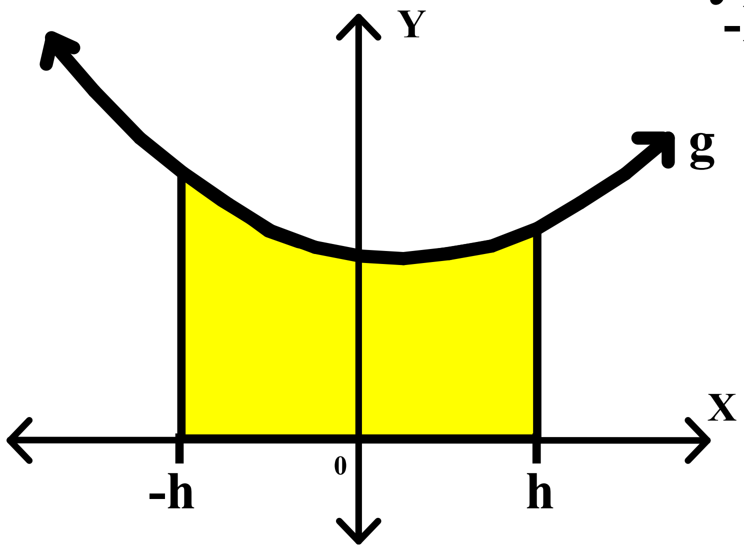

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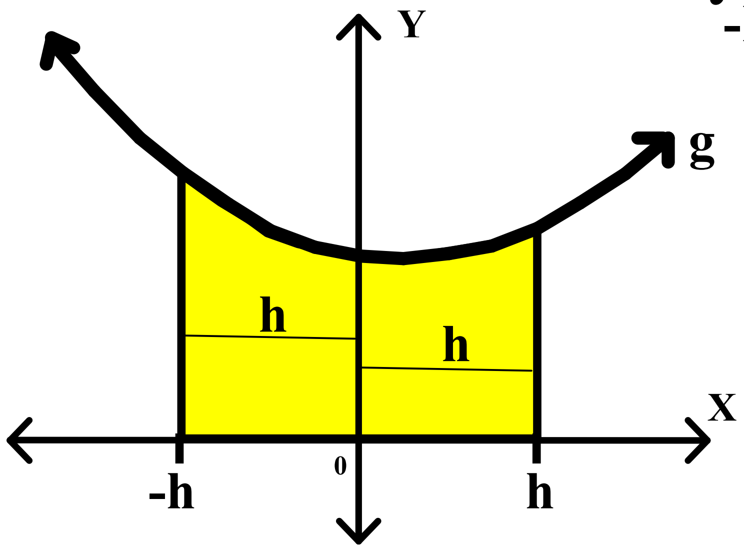

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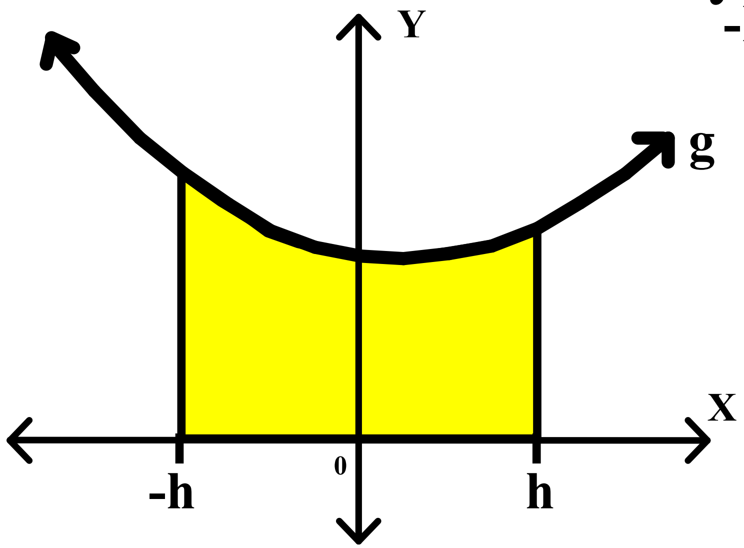

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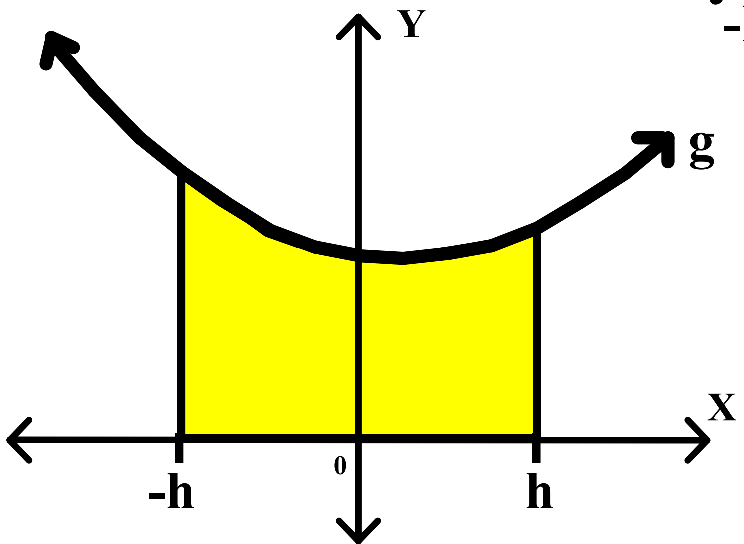

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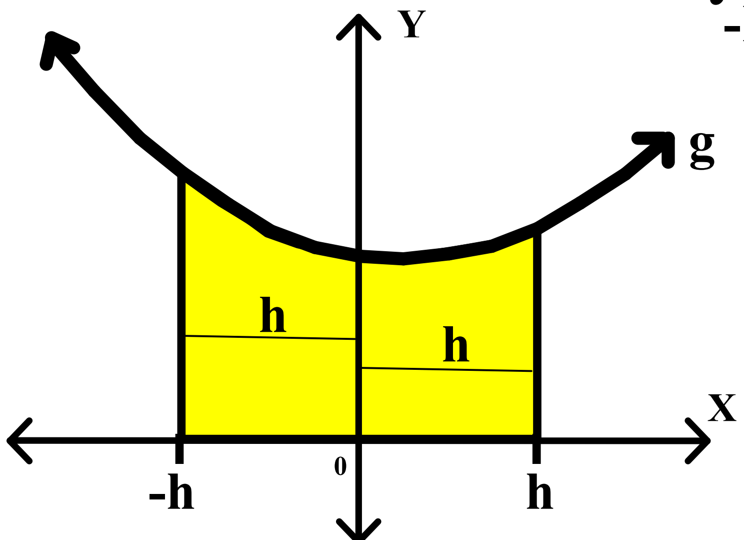

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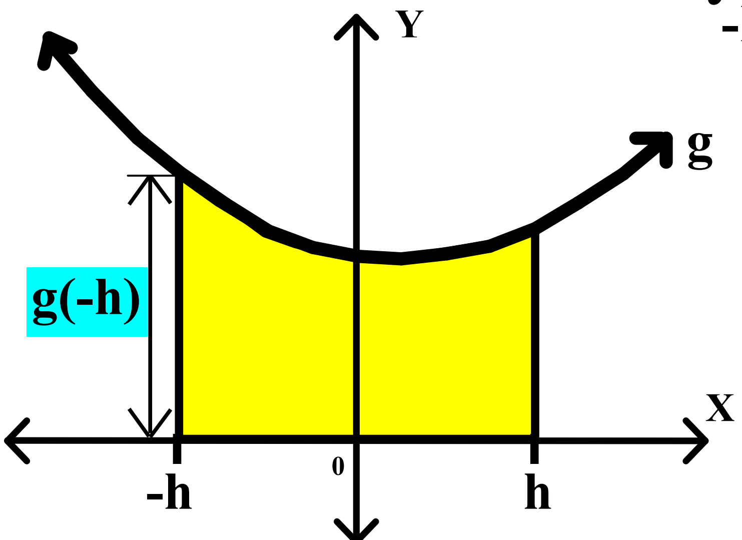

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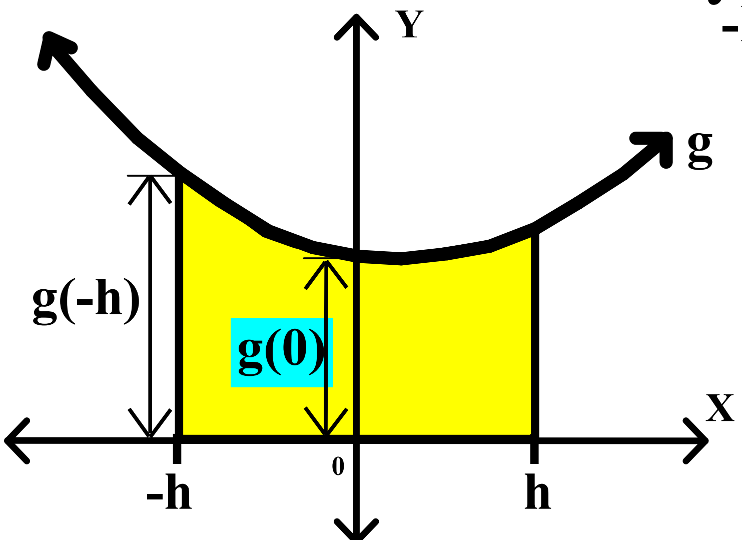

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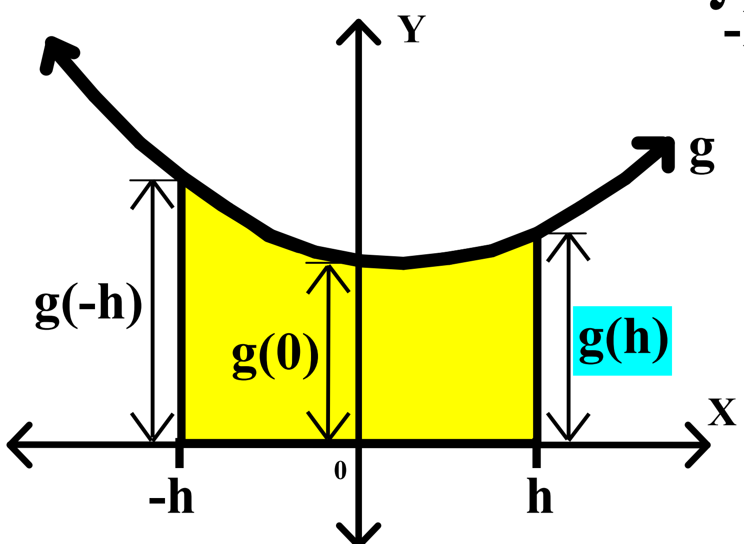

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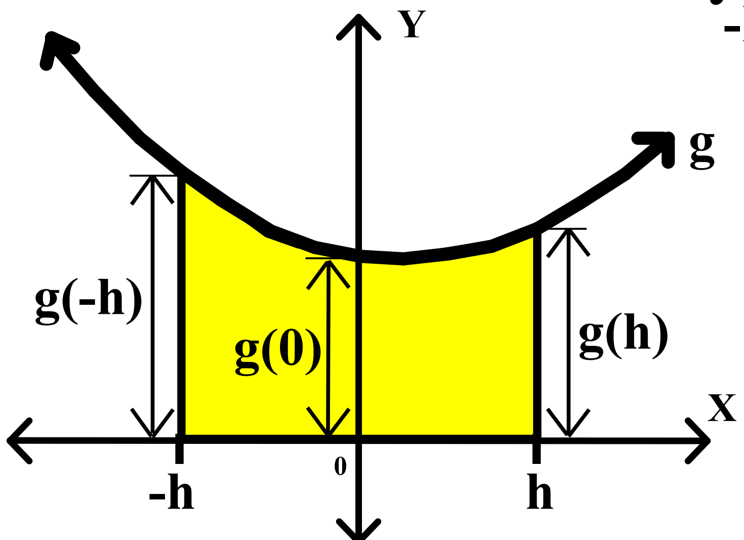

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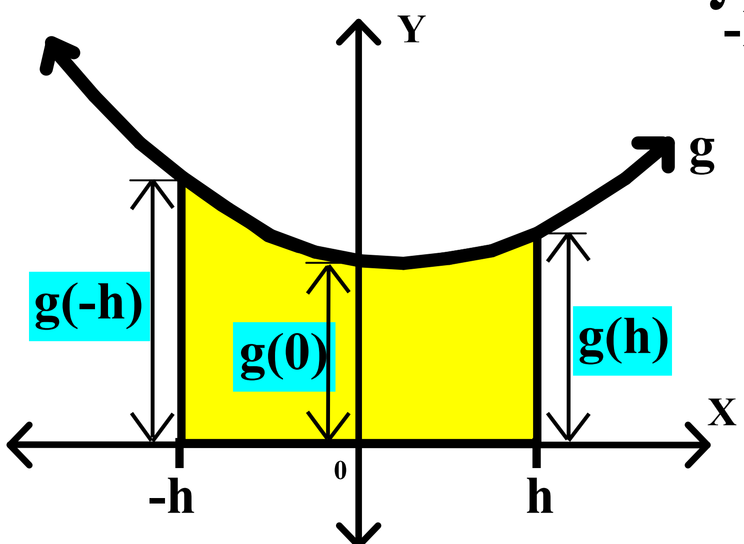

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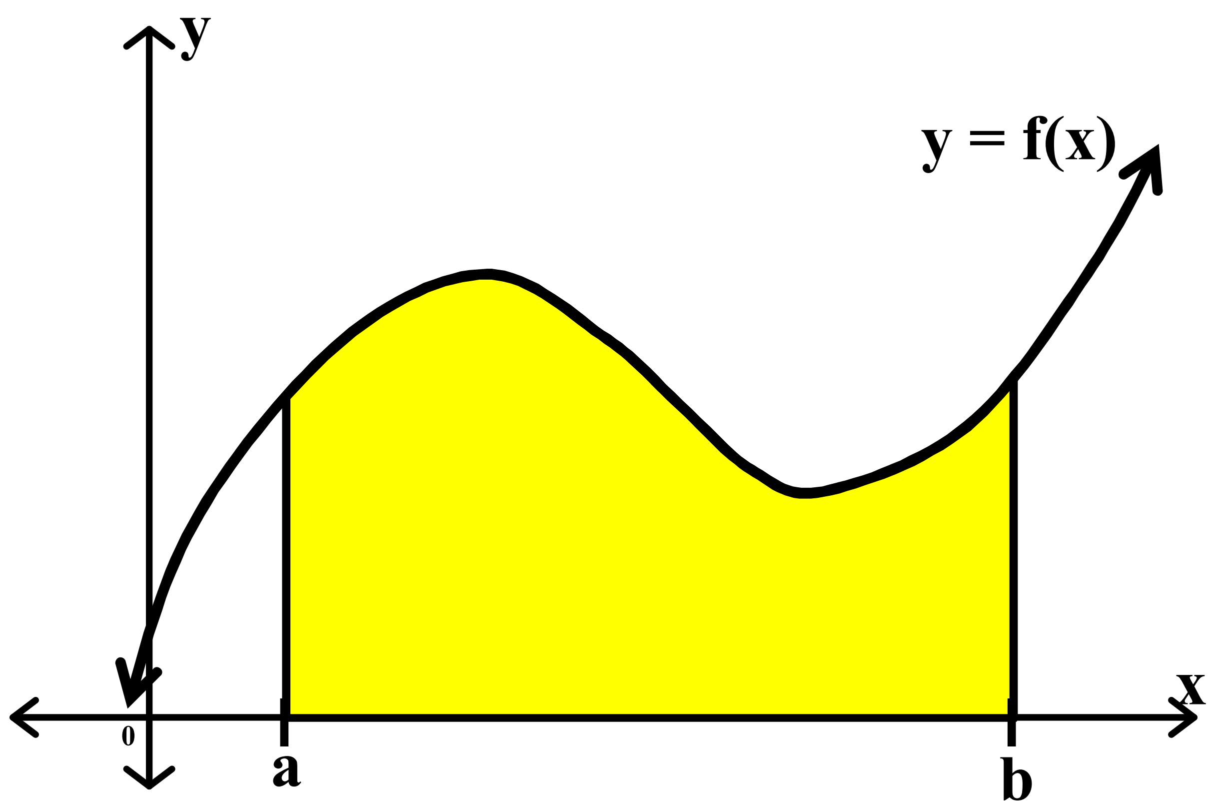

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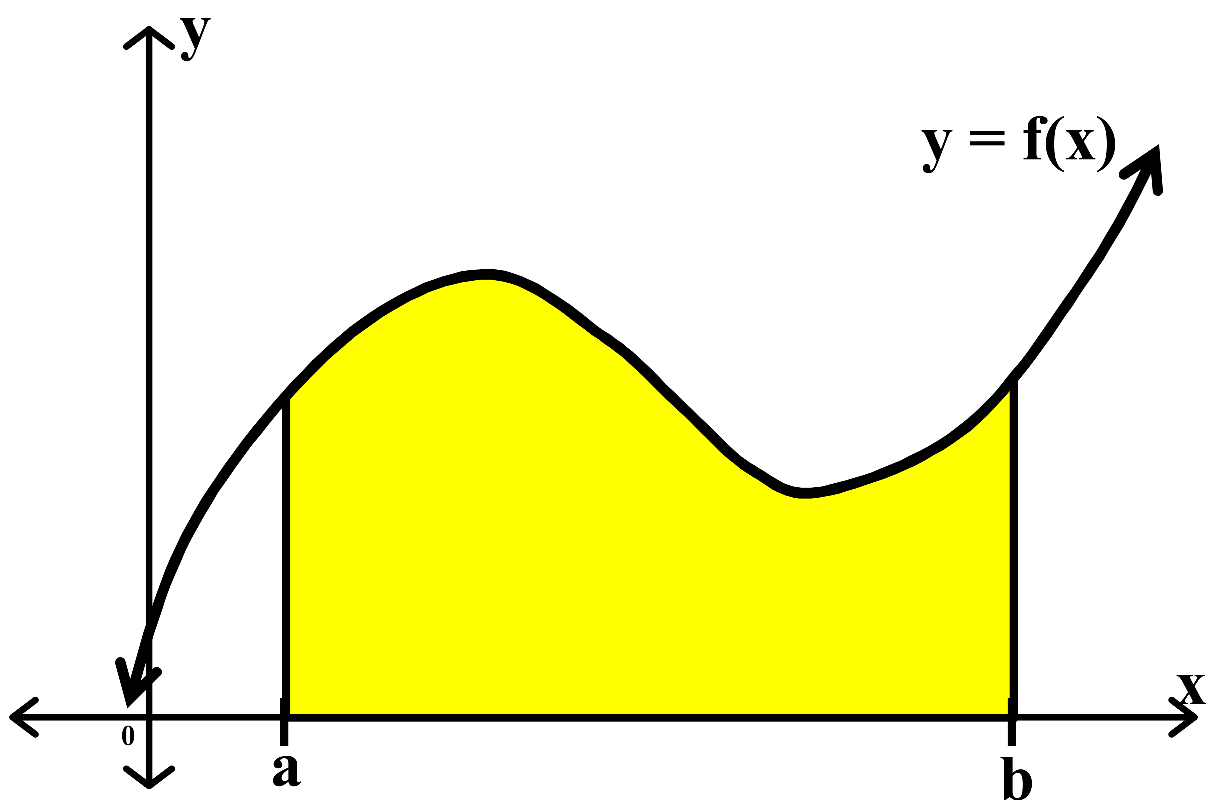

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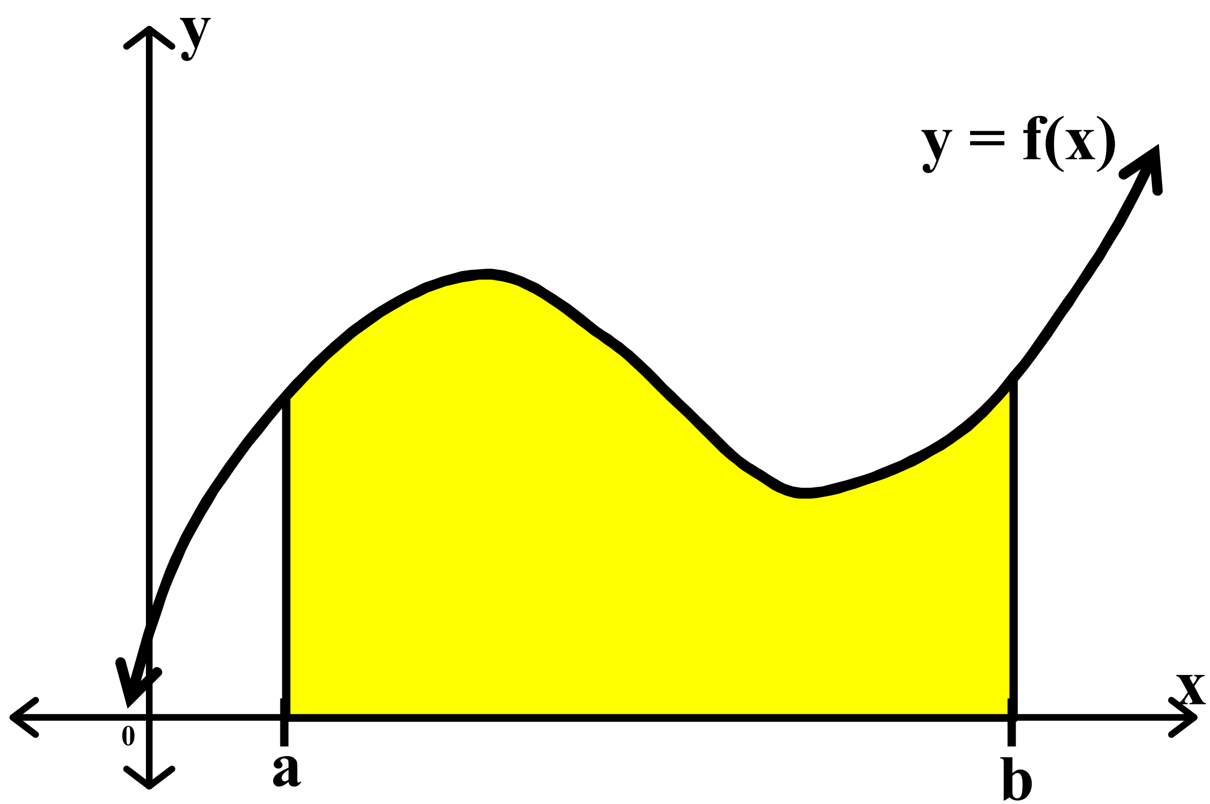

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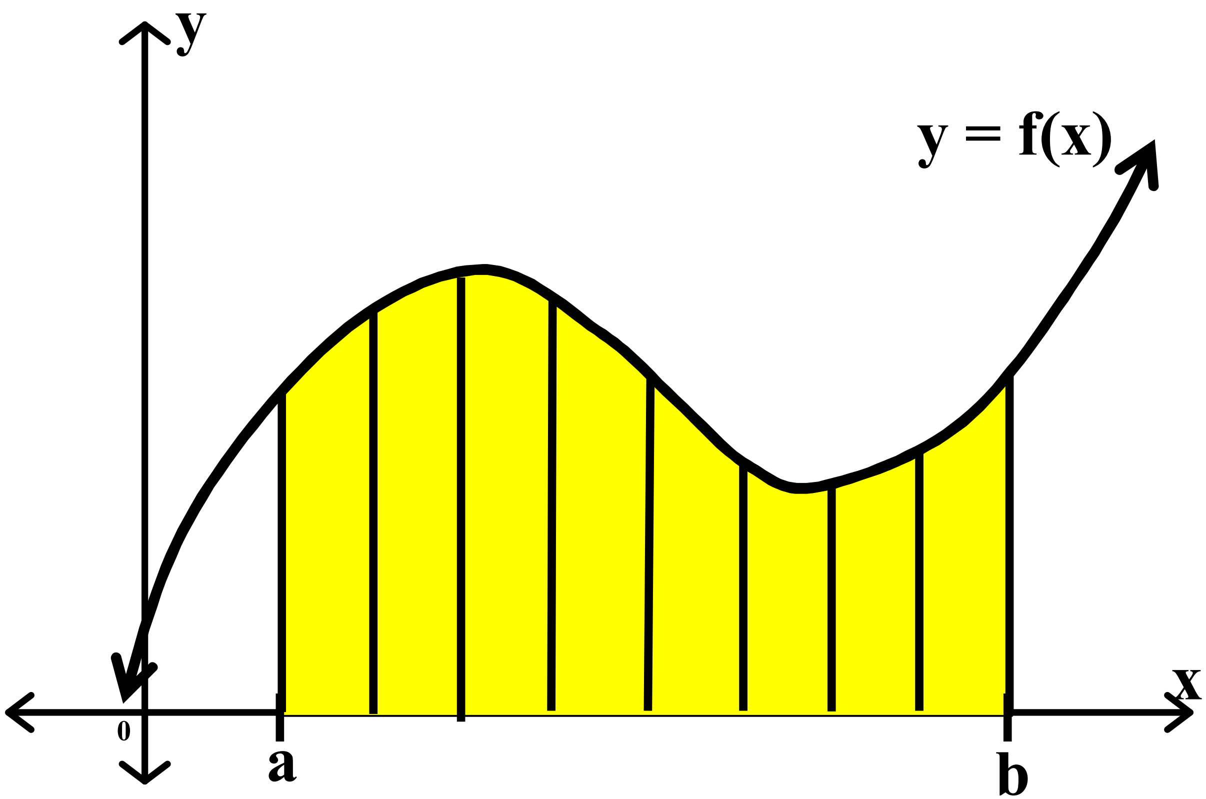

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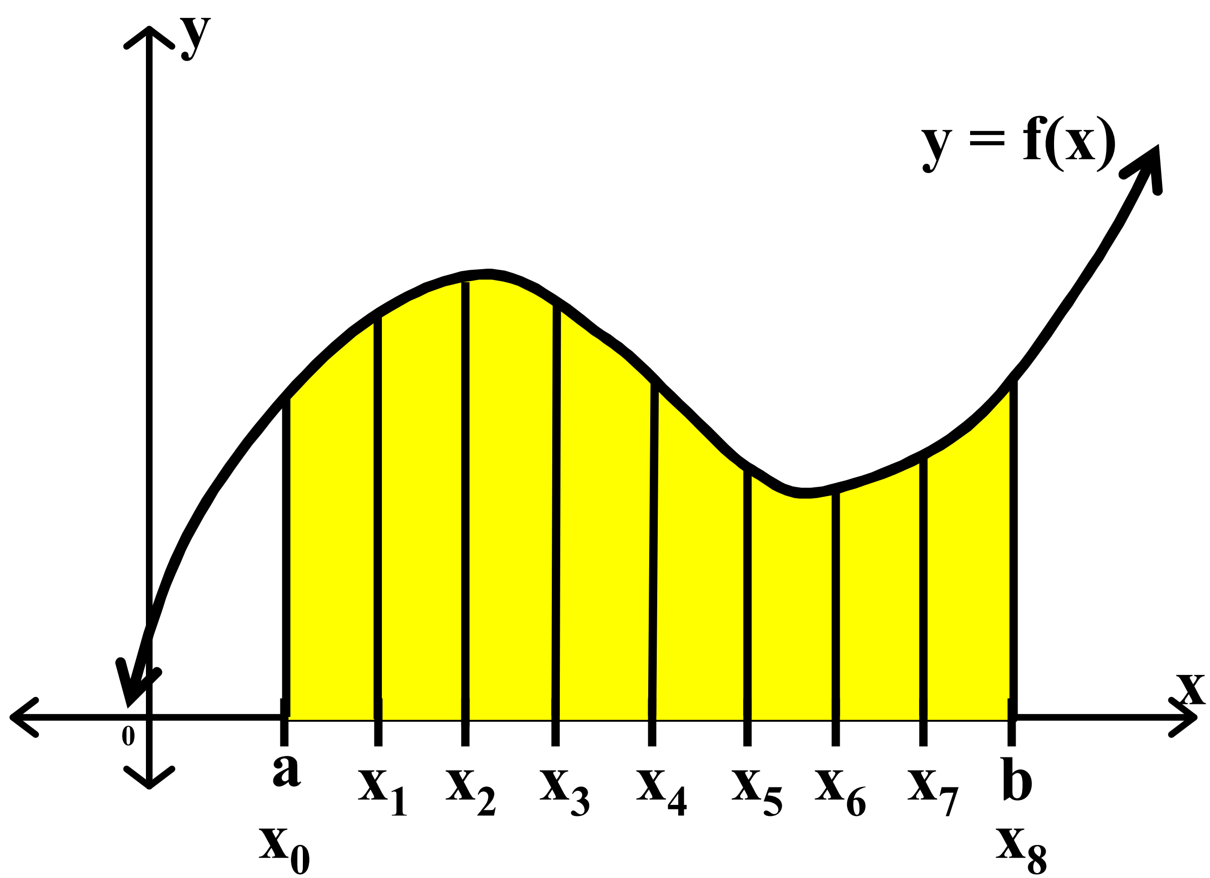

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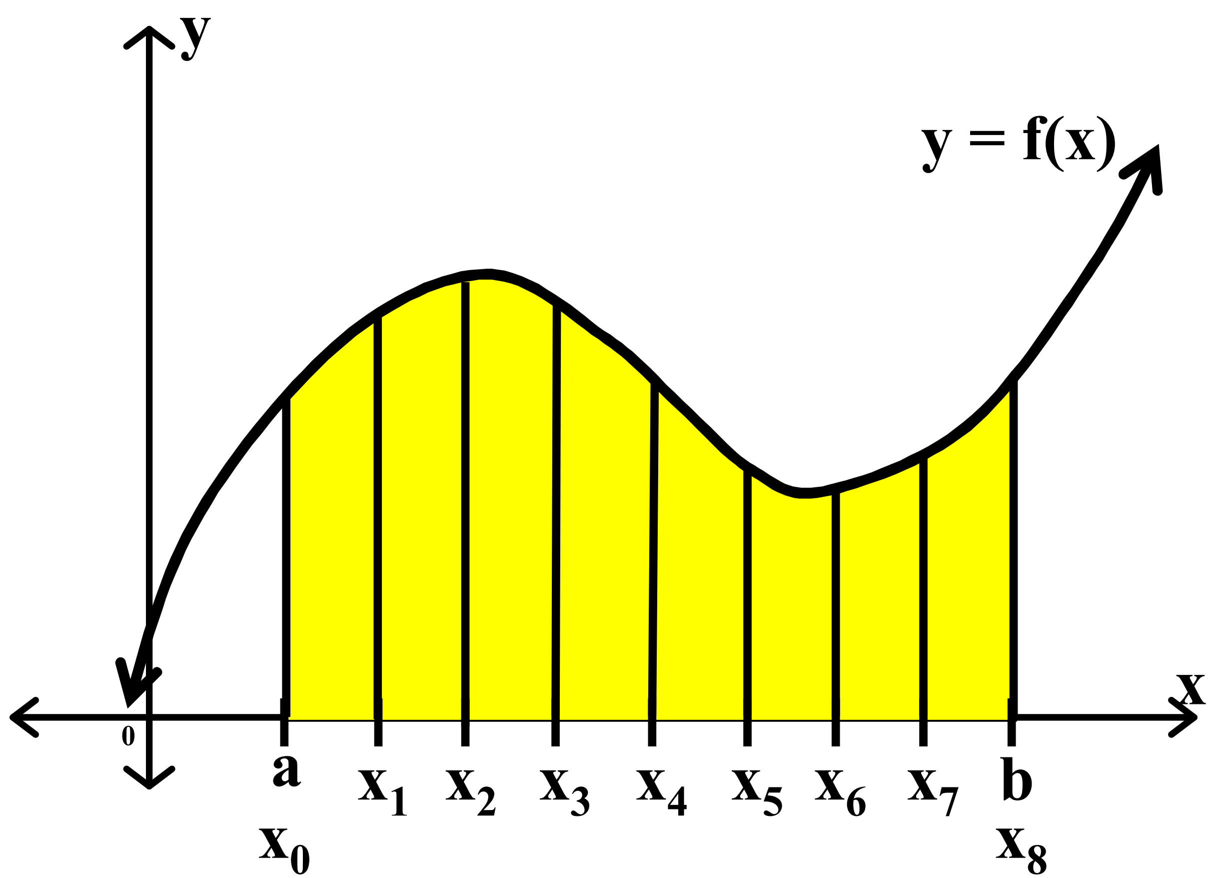
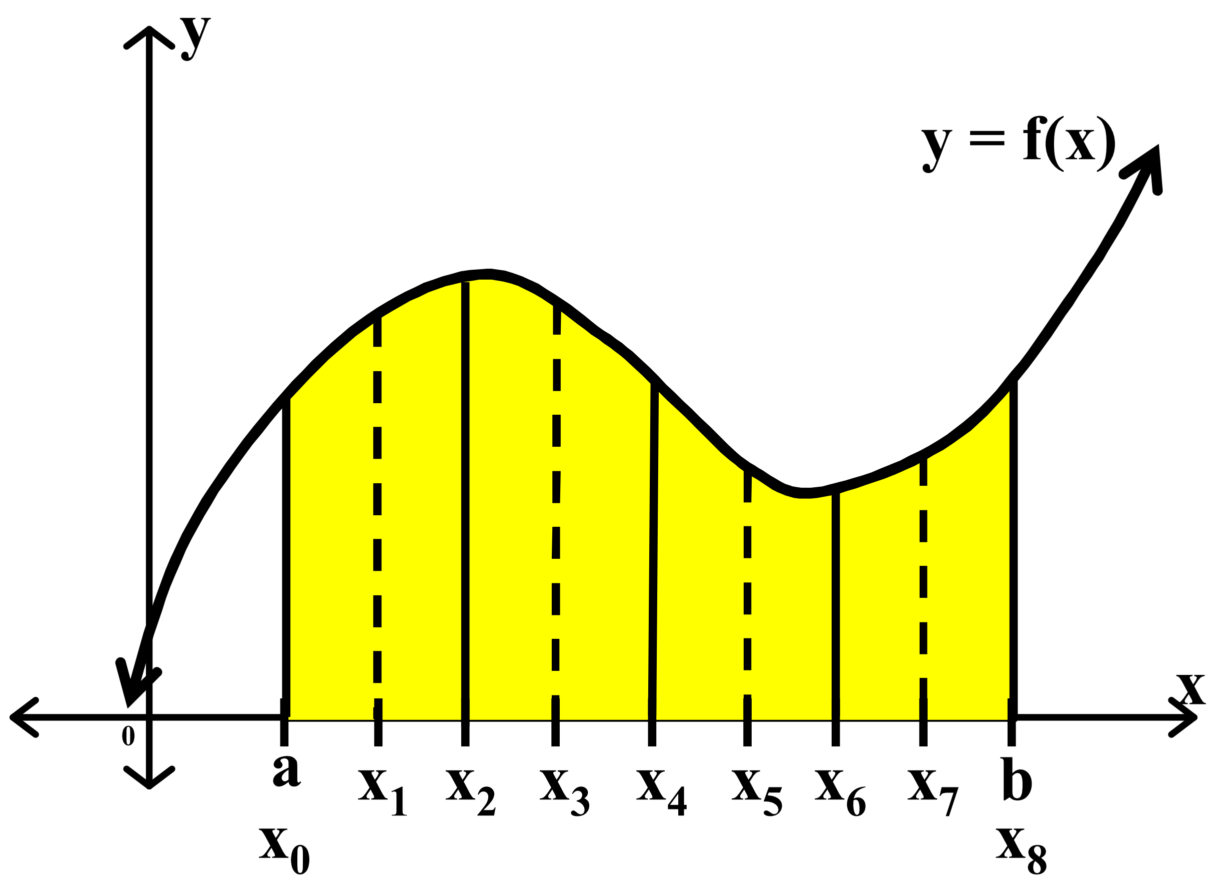


Divide the interval [a, b] into <u>2n</u> subintervals, each of width Δx.
In this example, $2n = 8$.

Simpson's Rule



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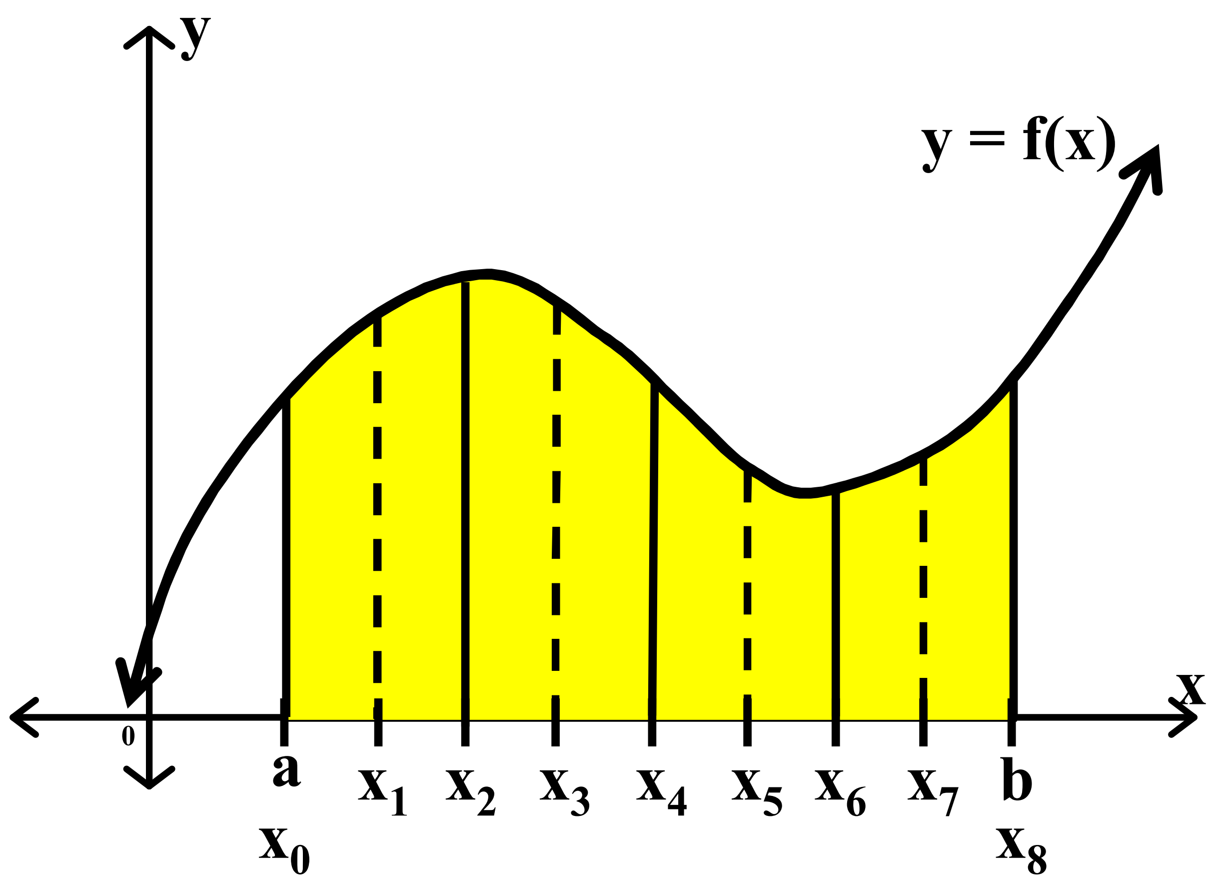

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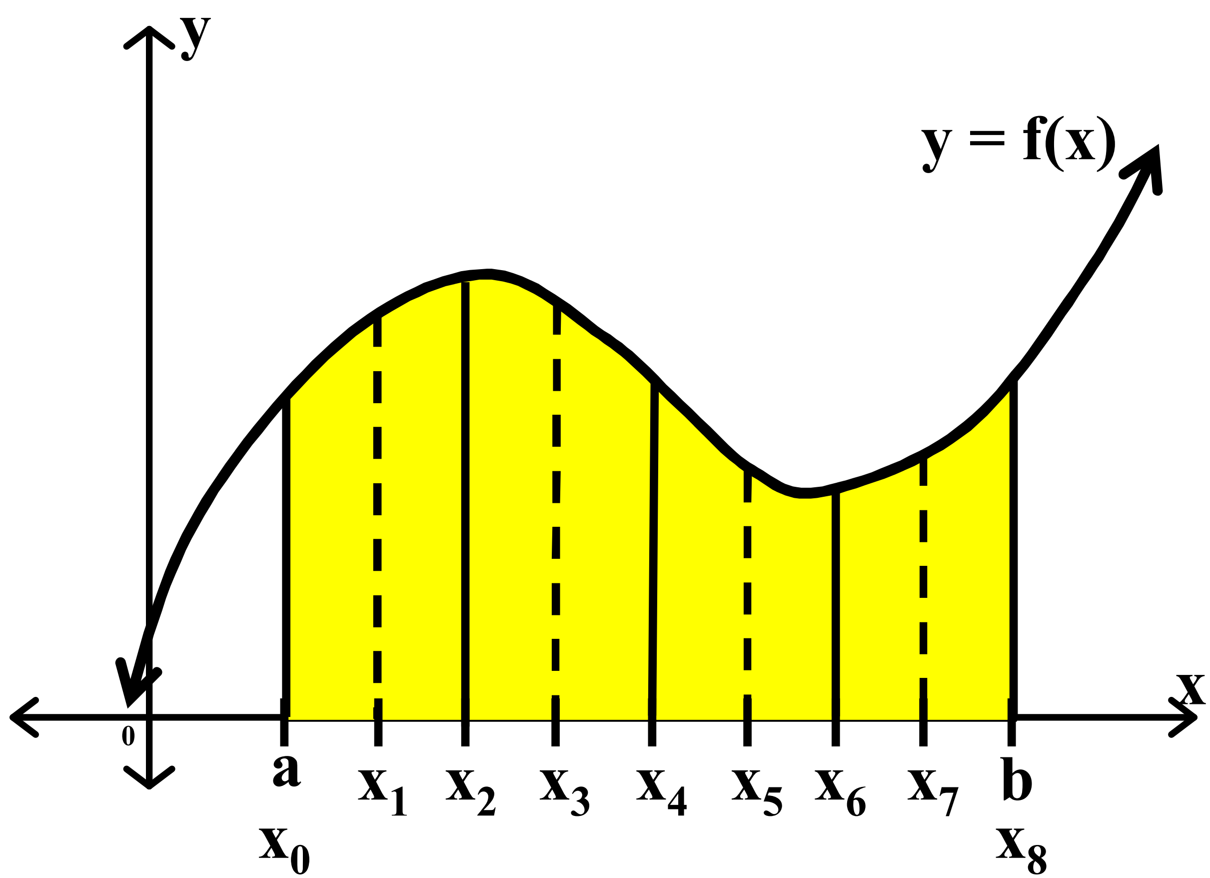

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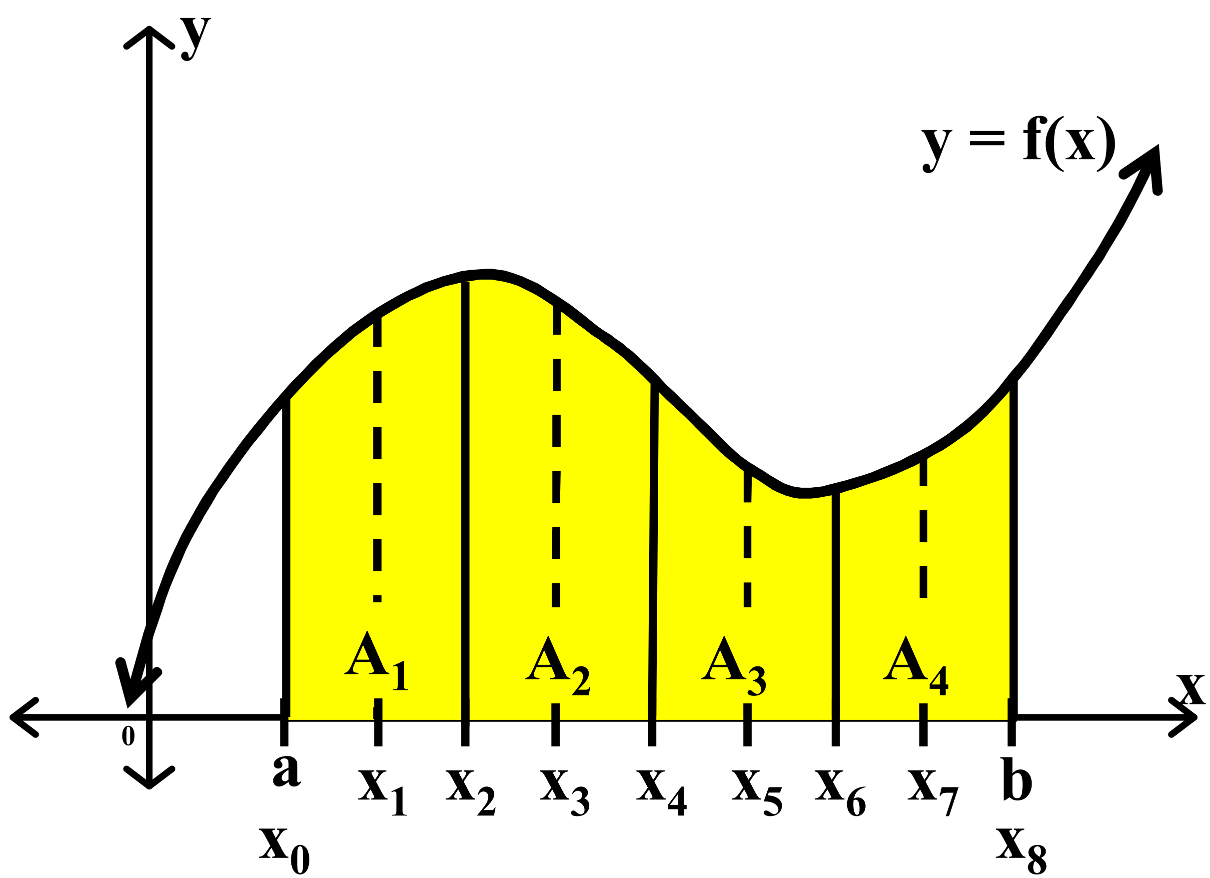

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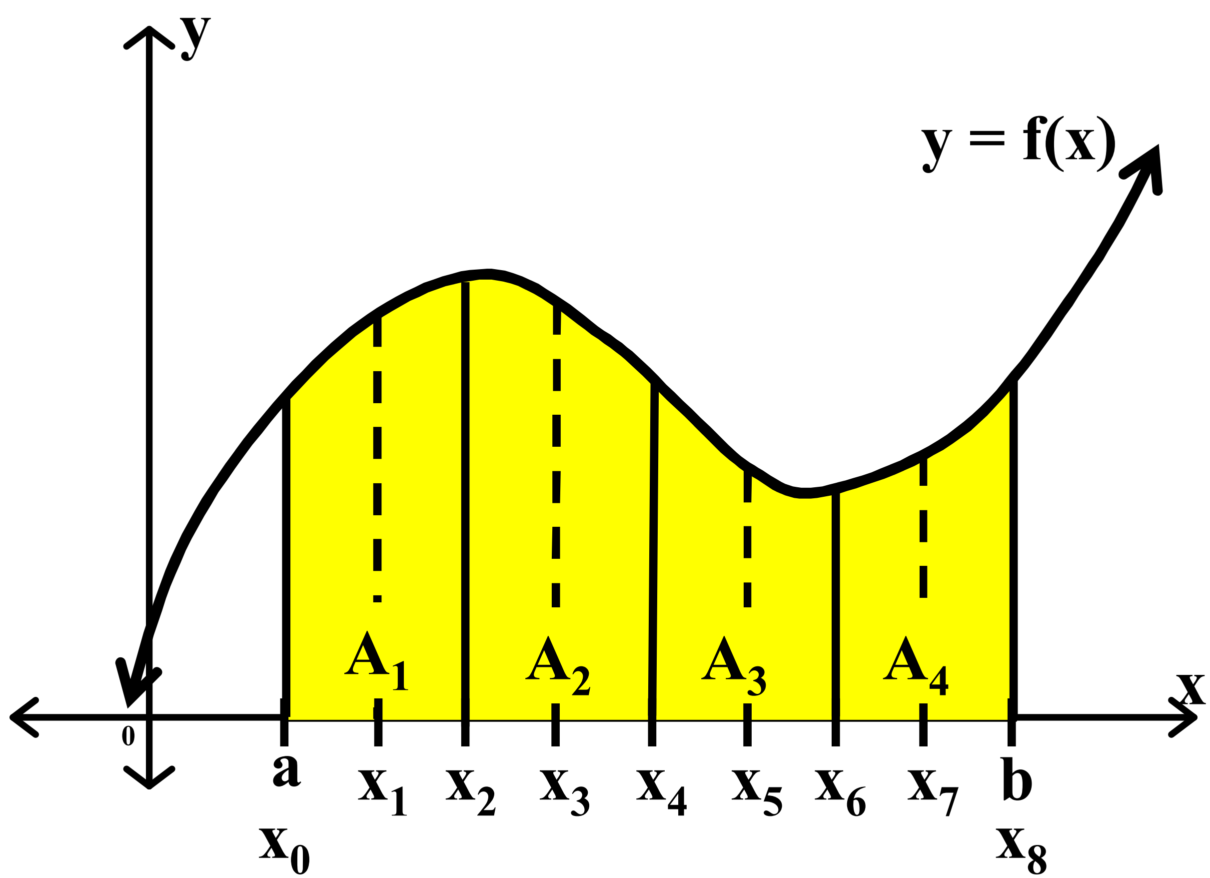

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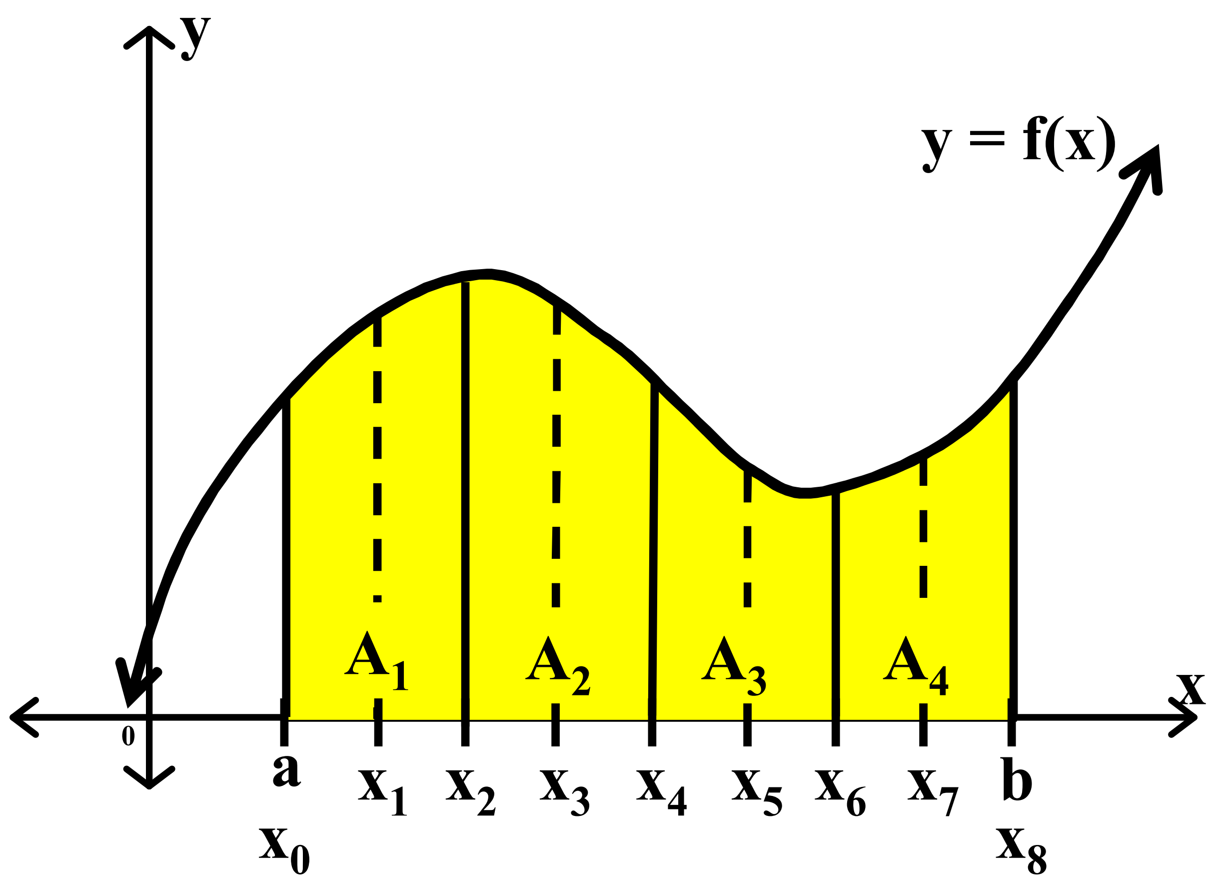
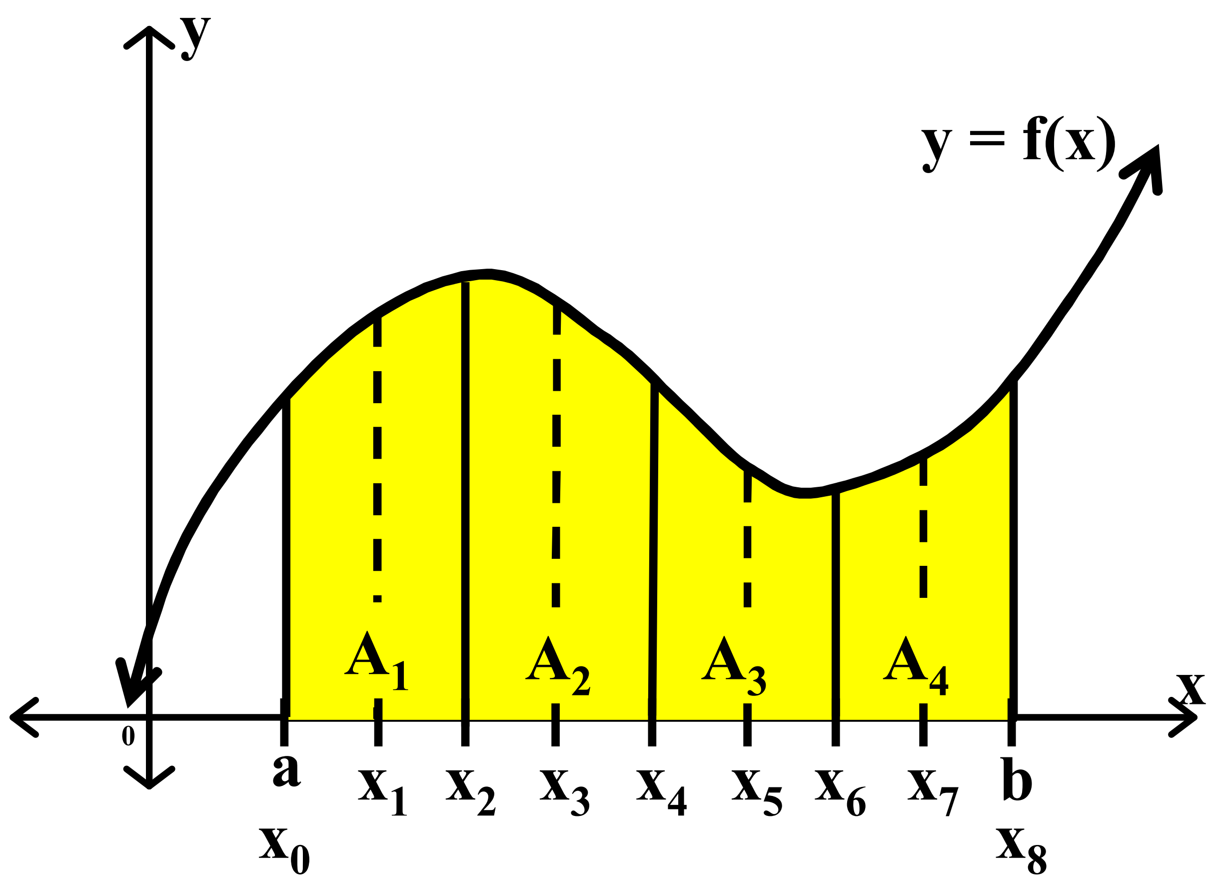


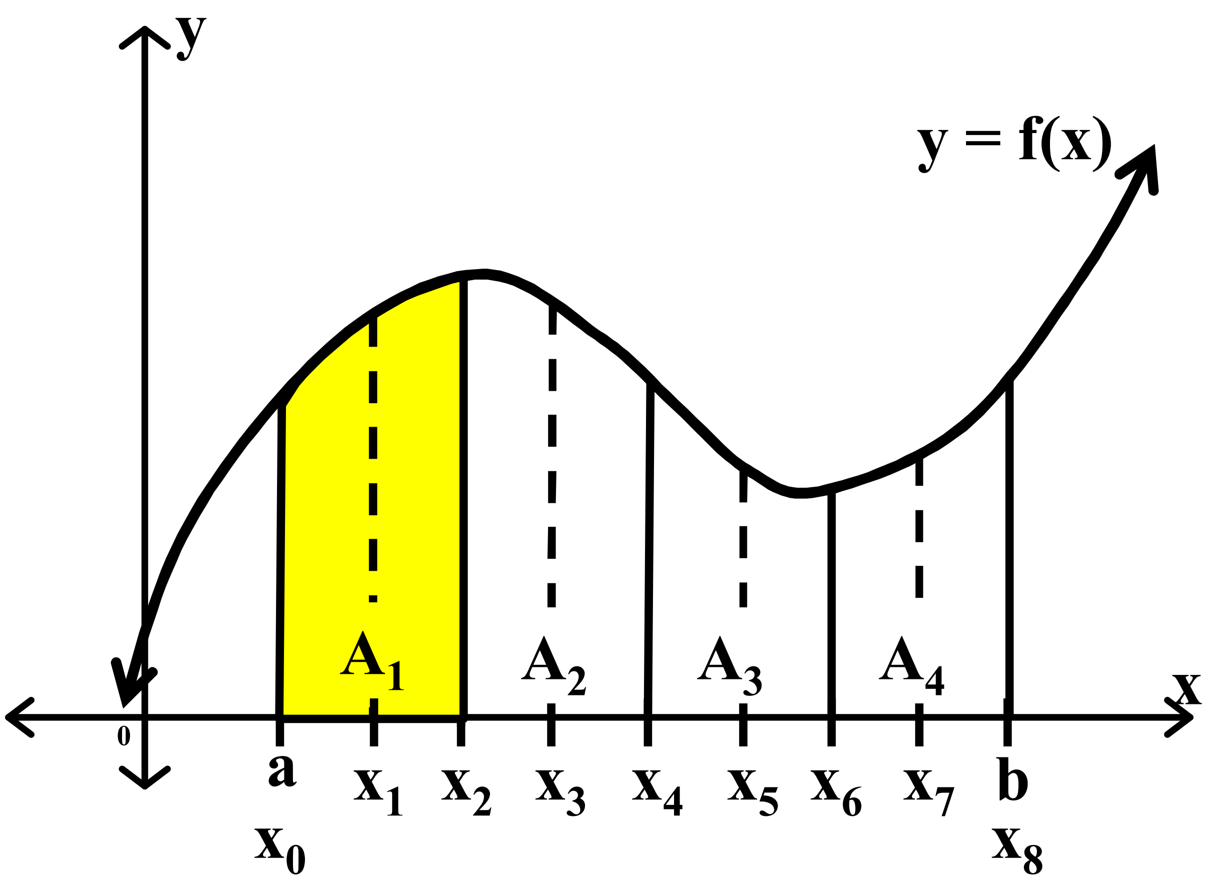
Simpson's Rule can be used to approximate the area of each of these 'double strips'.

Simpson's Rule

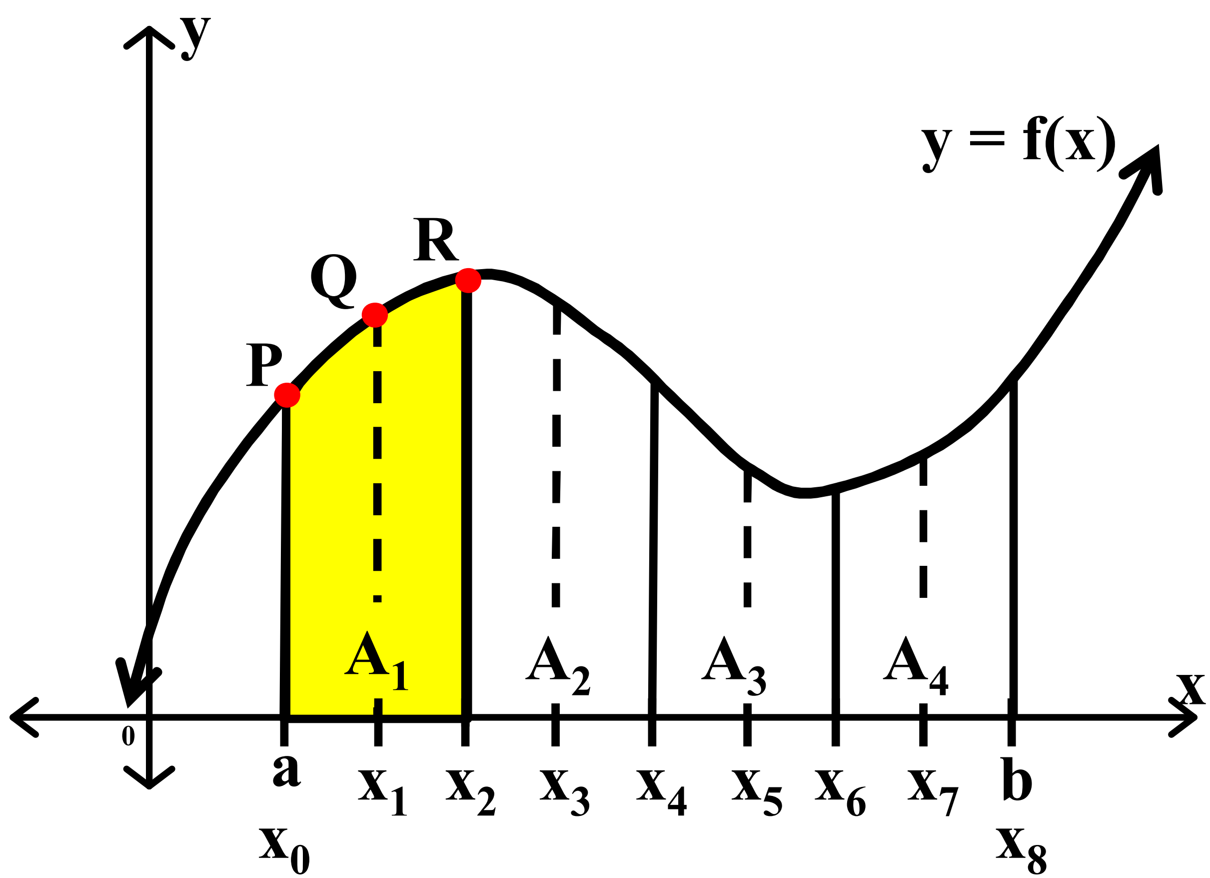


Simpson's Rule can be used to approximate the area of each of these 'double strips'. Consider area A_1.

Simpson's Rule

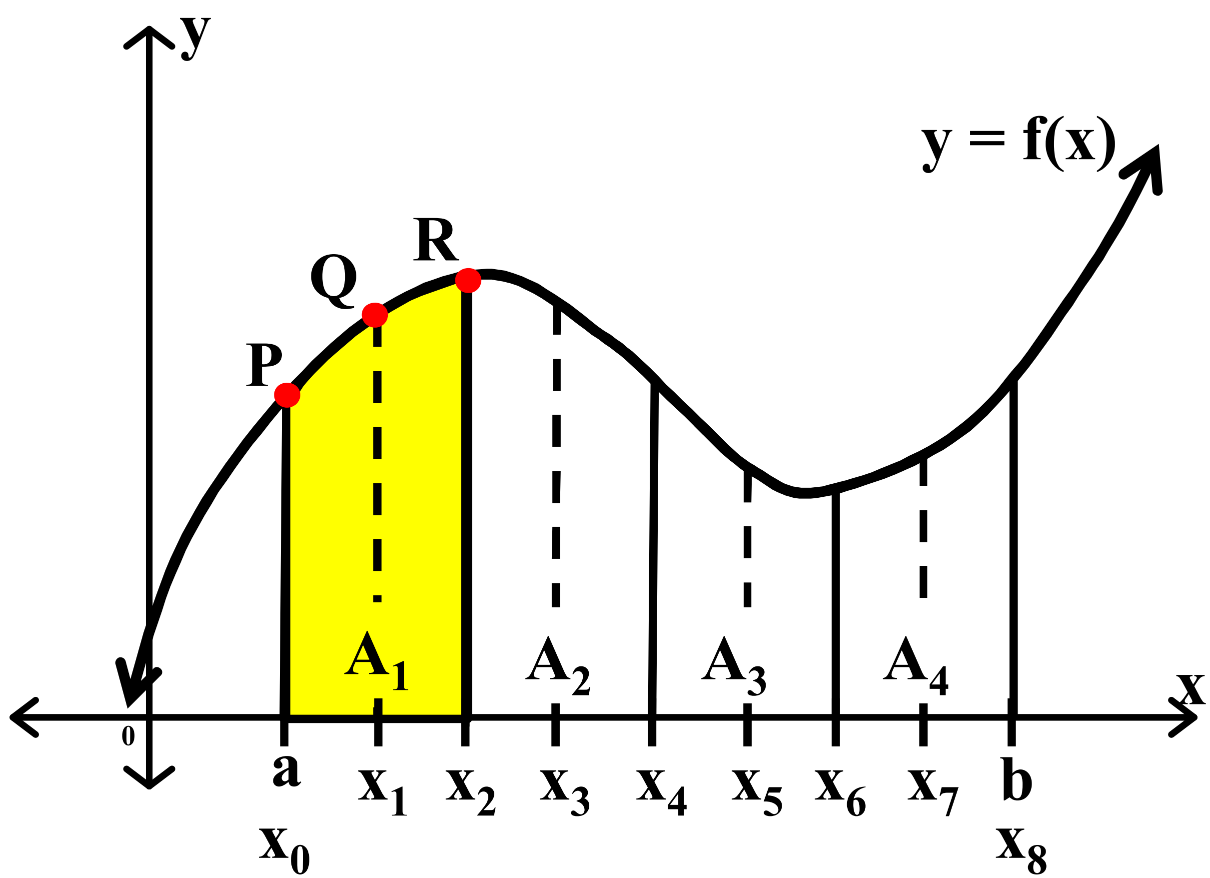


Simpson's Rule



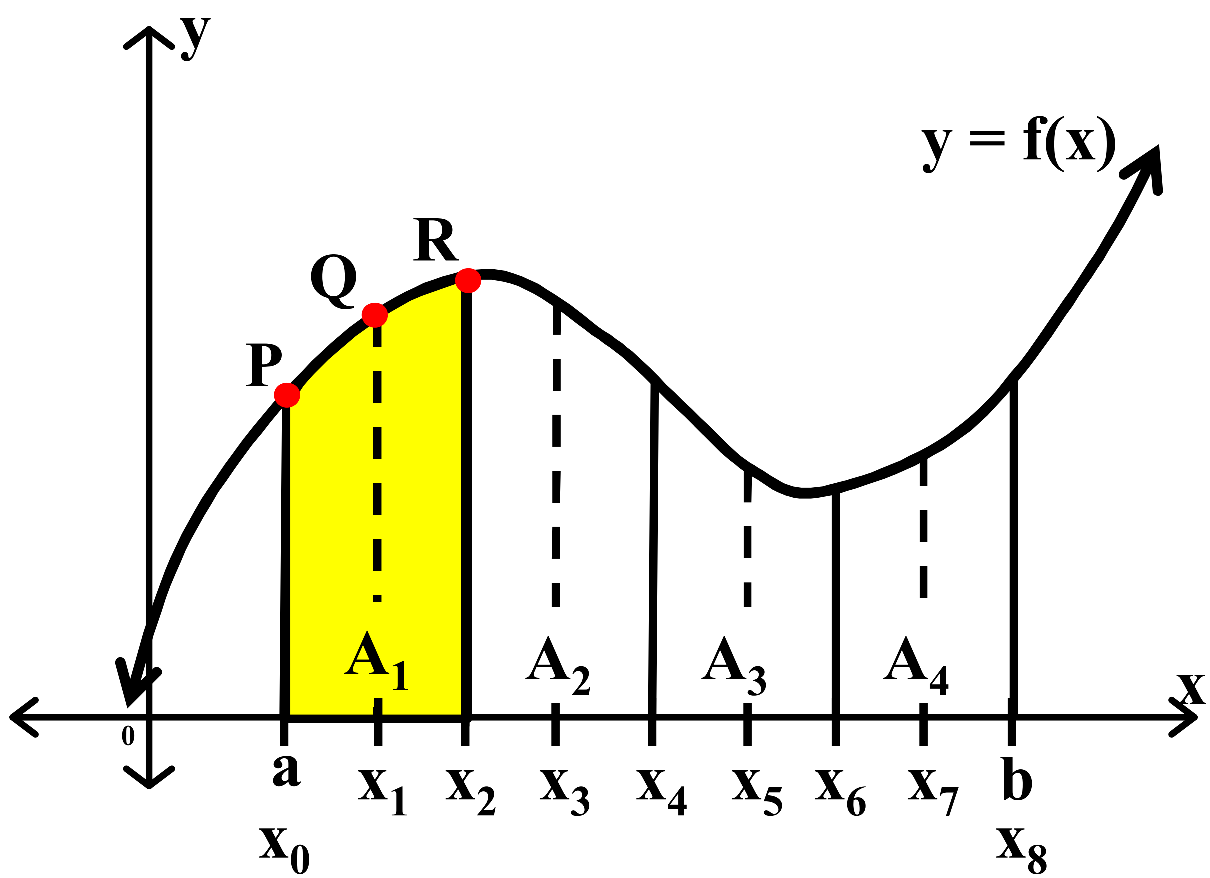
Given points P, Q, and R on the graph of function f,

Simpson's Rule



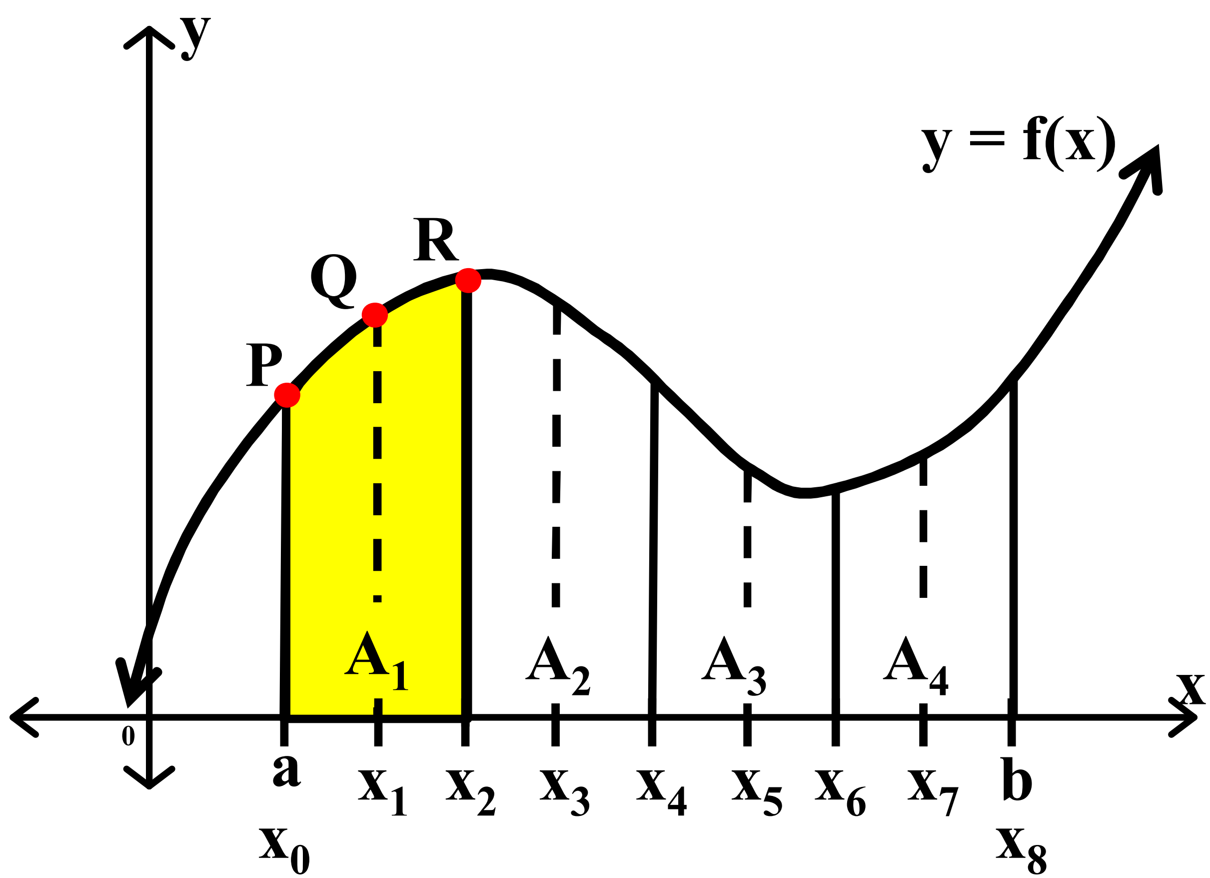
Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown),

Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them.

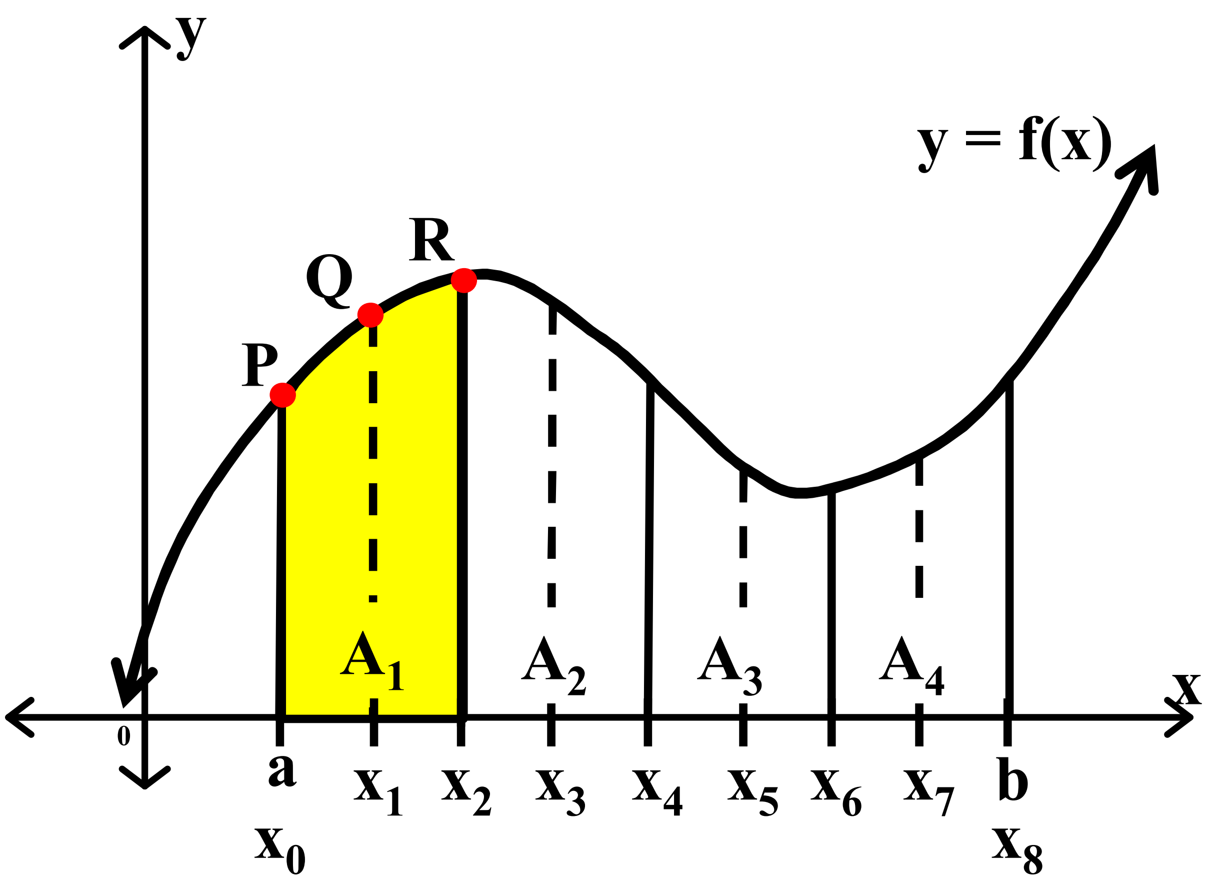
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$A_1 \approx$

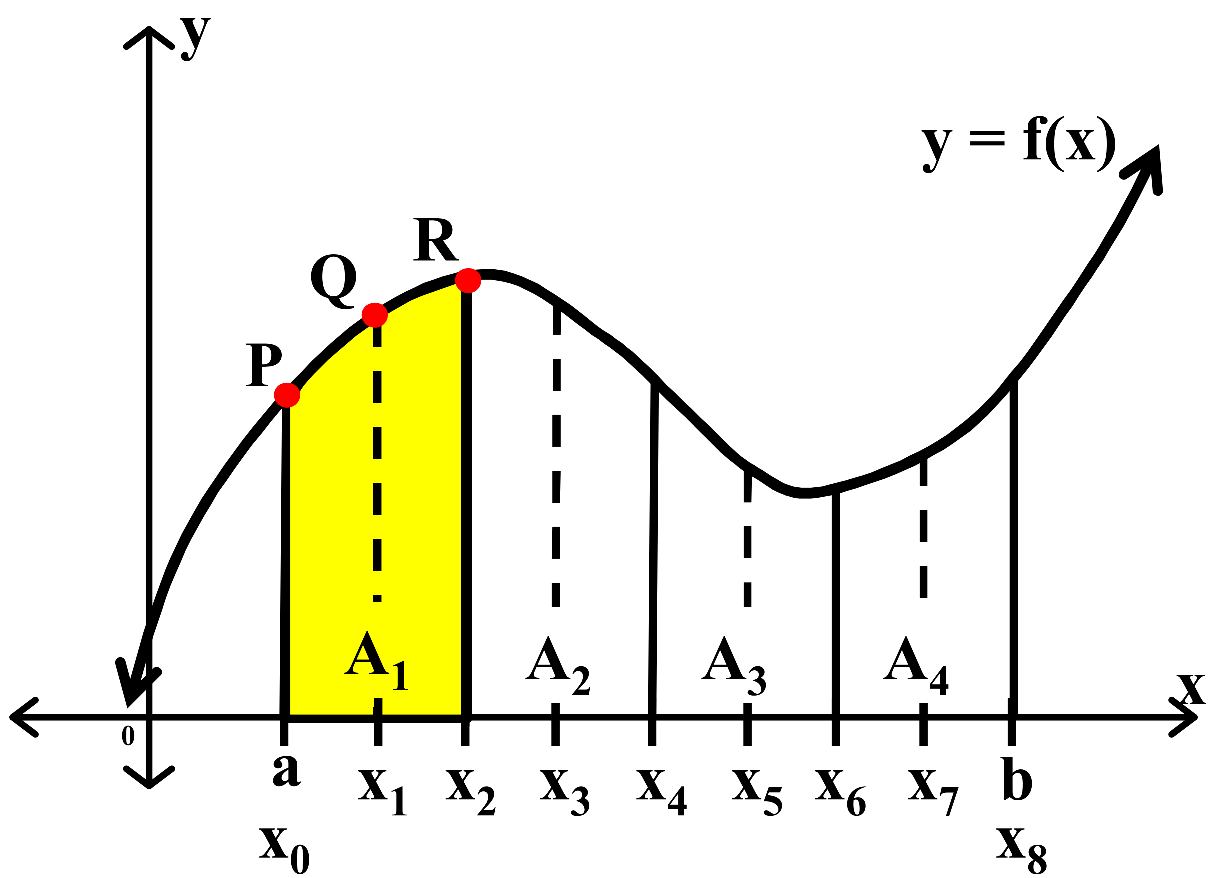
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x$$

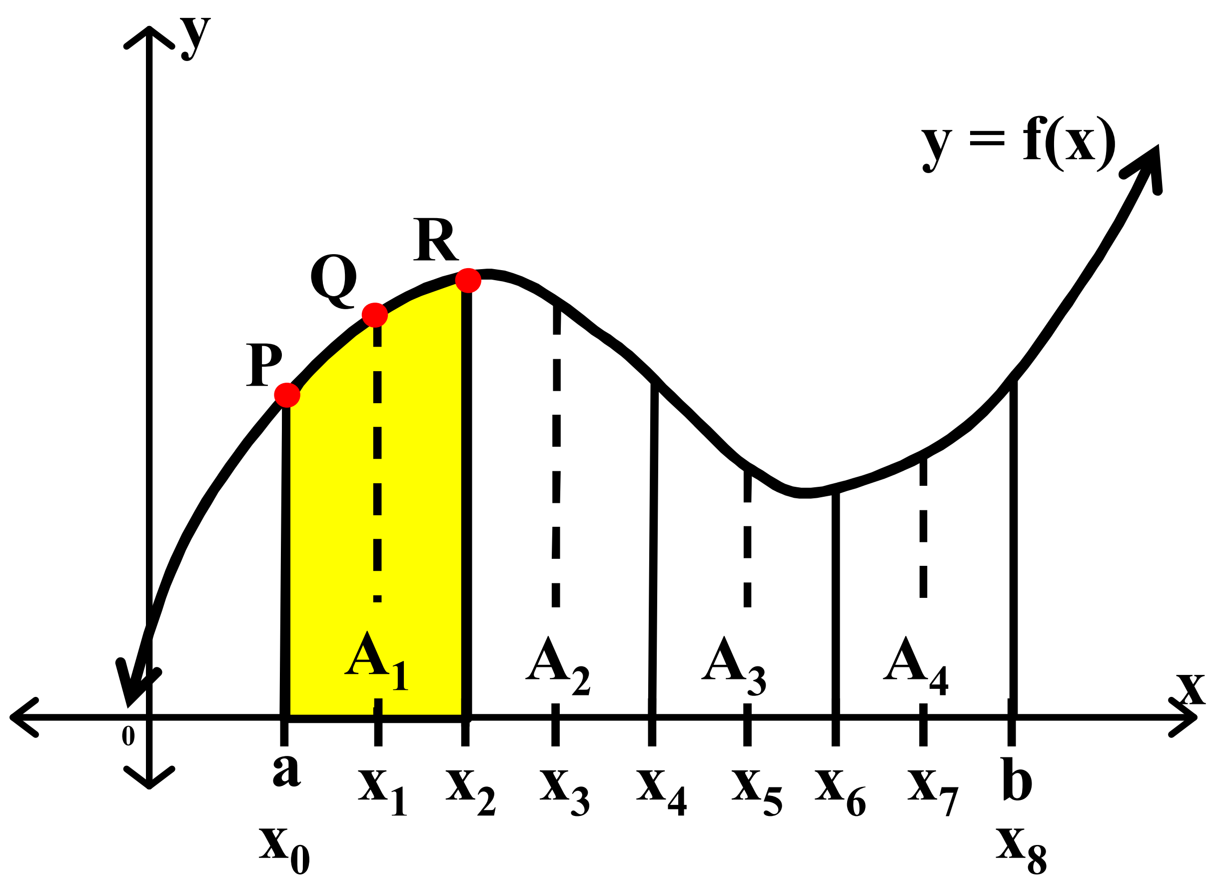
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x$$ ← **the width of each strip**

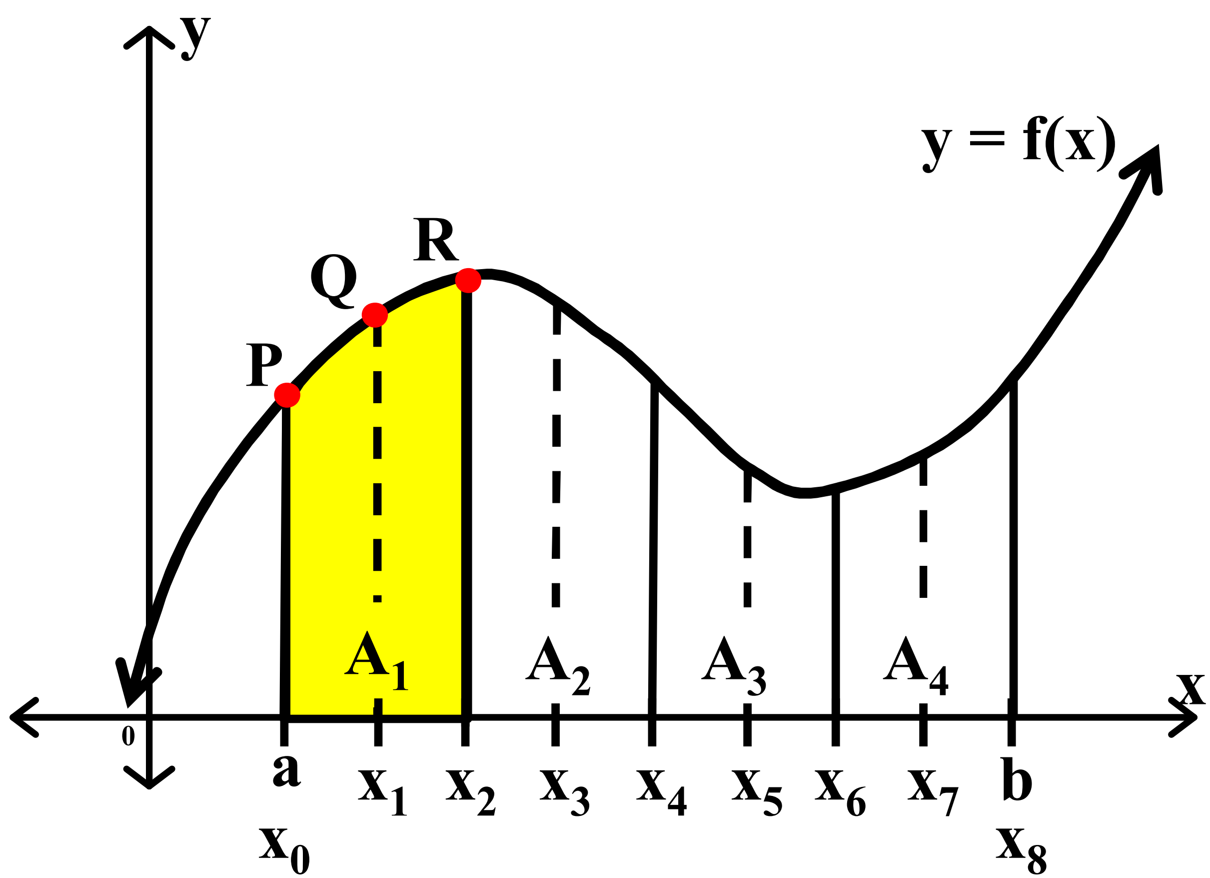
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x$$

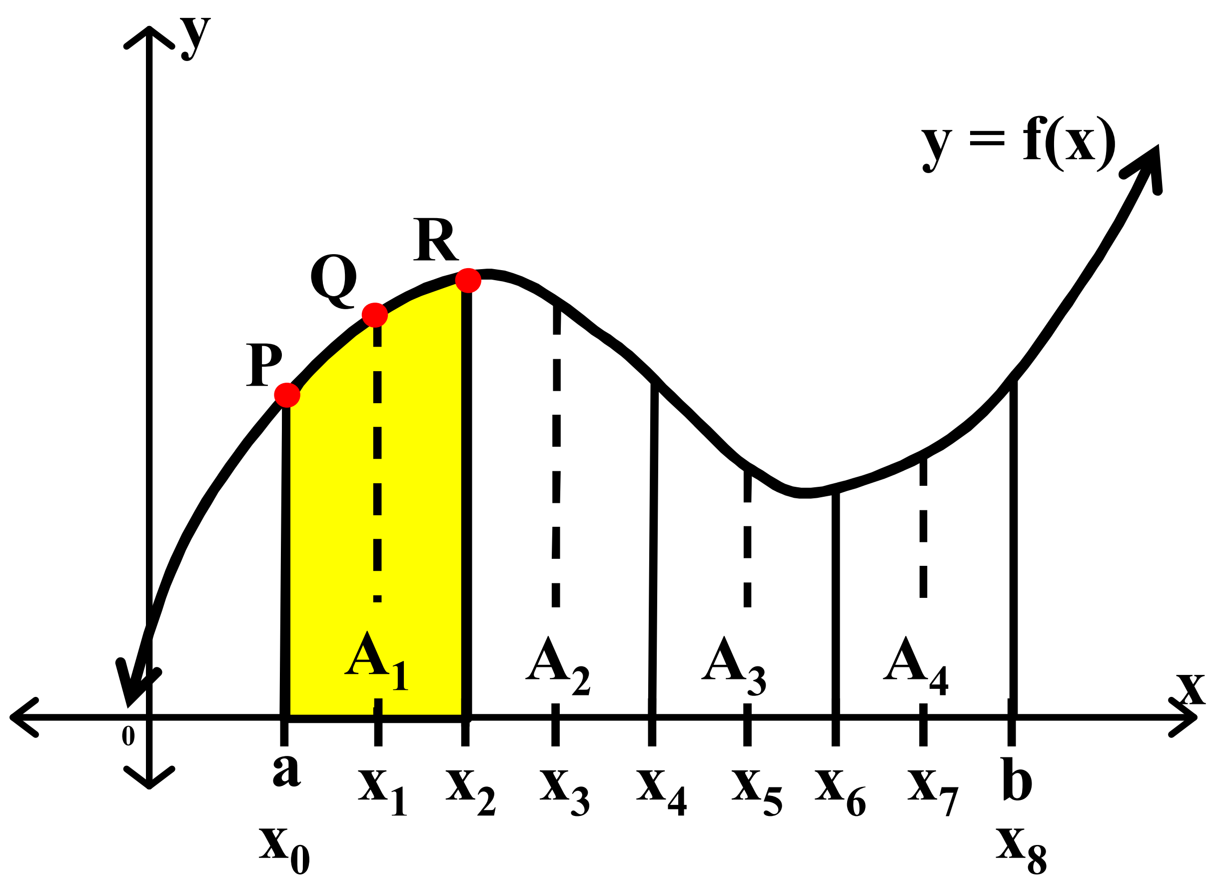
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a)$$

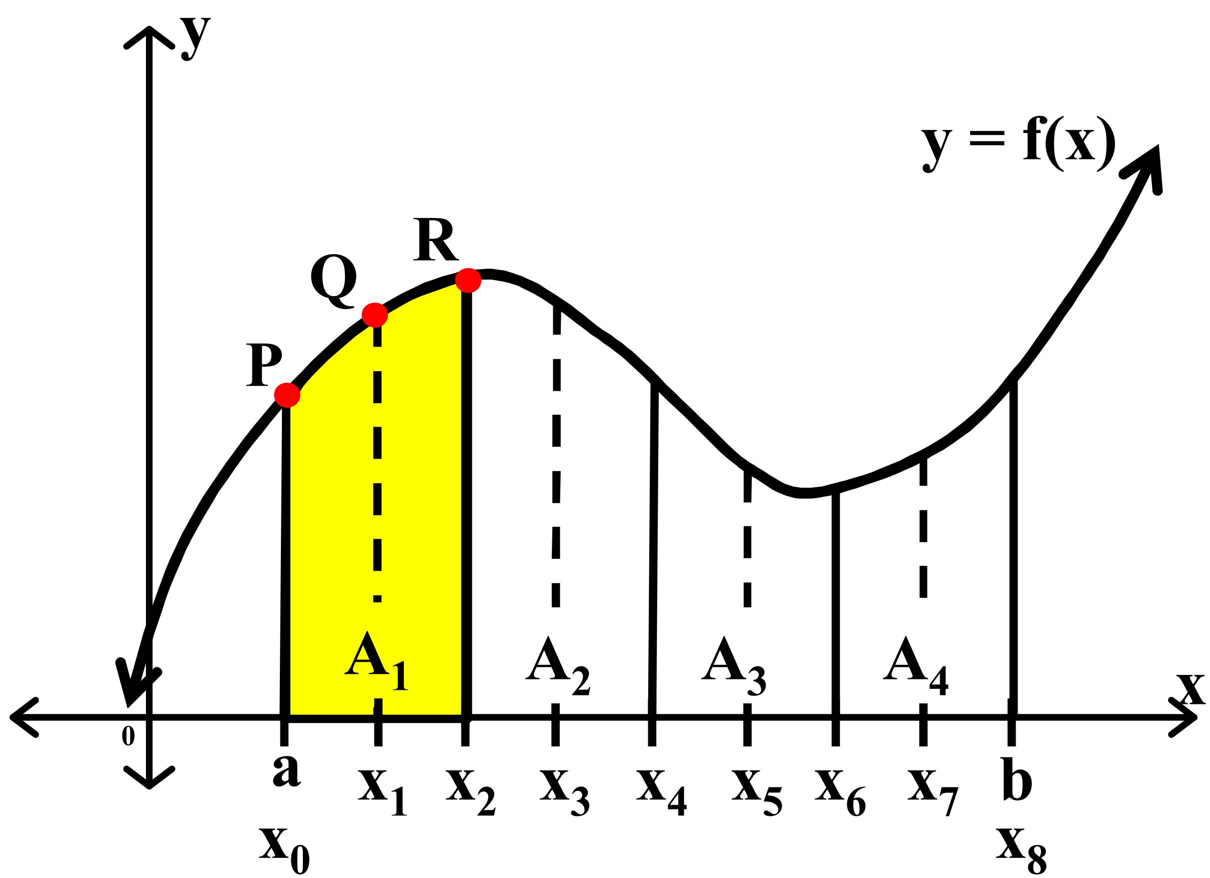
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$A_1 \approx \frac{1}{3}\Delta x[f(a)$ ← the height of the left boundary

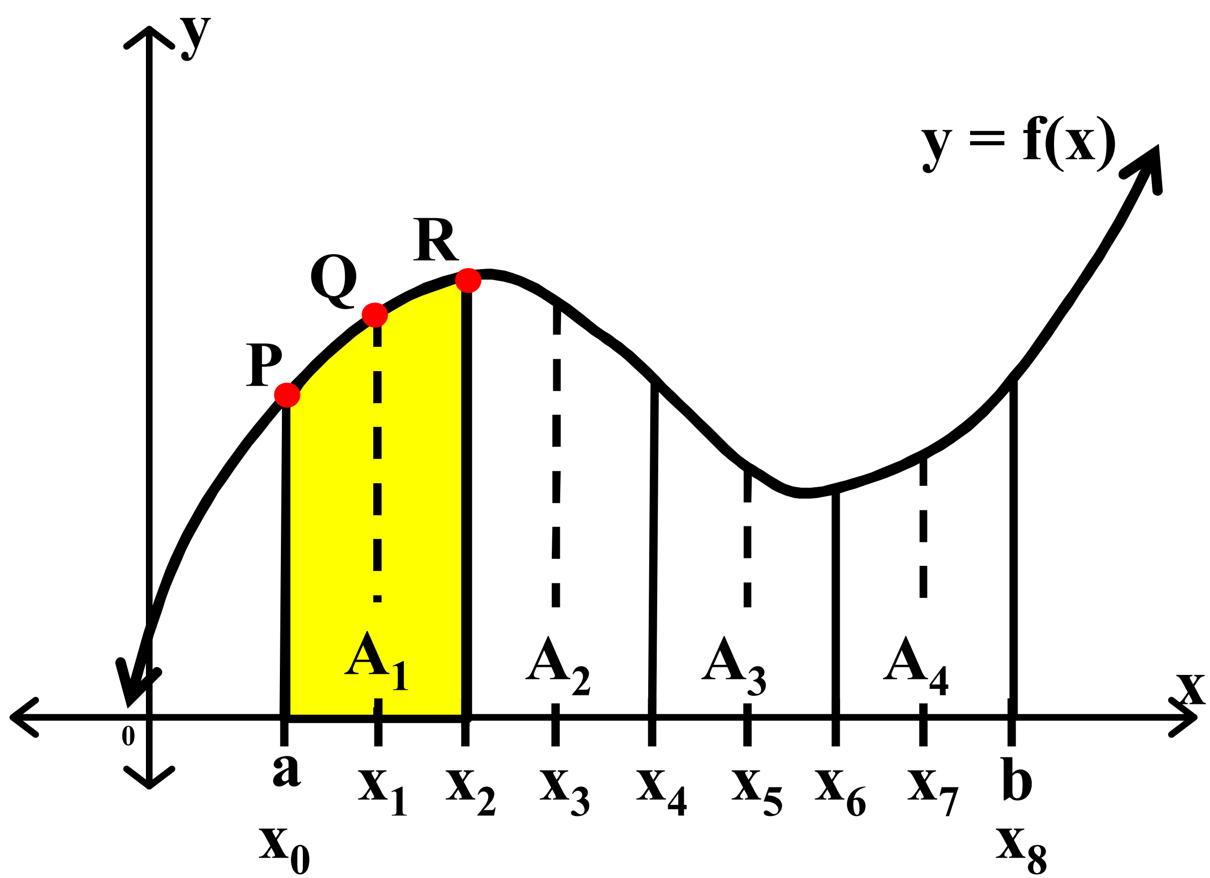
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a)$$

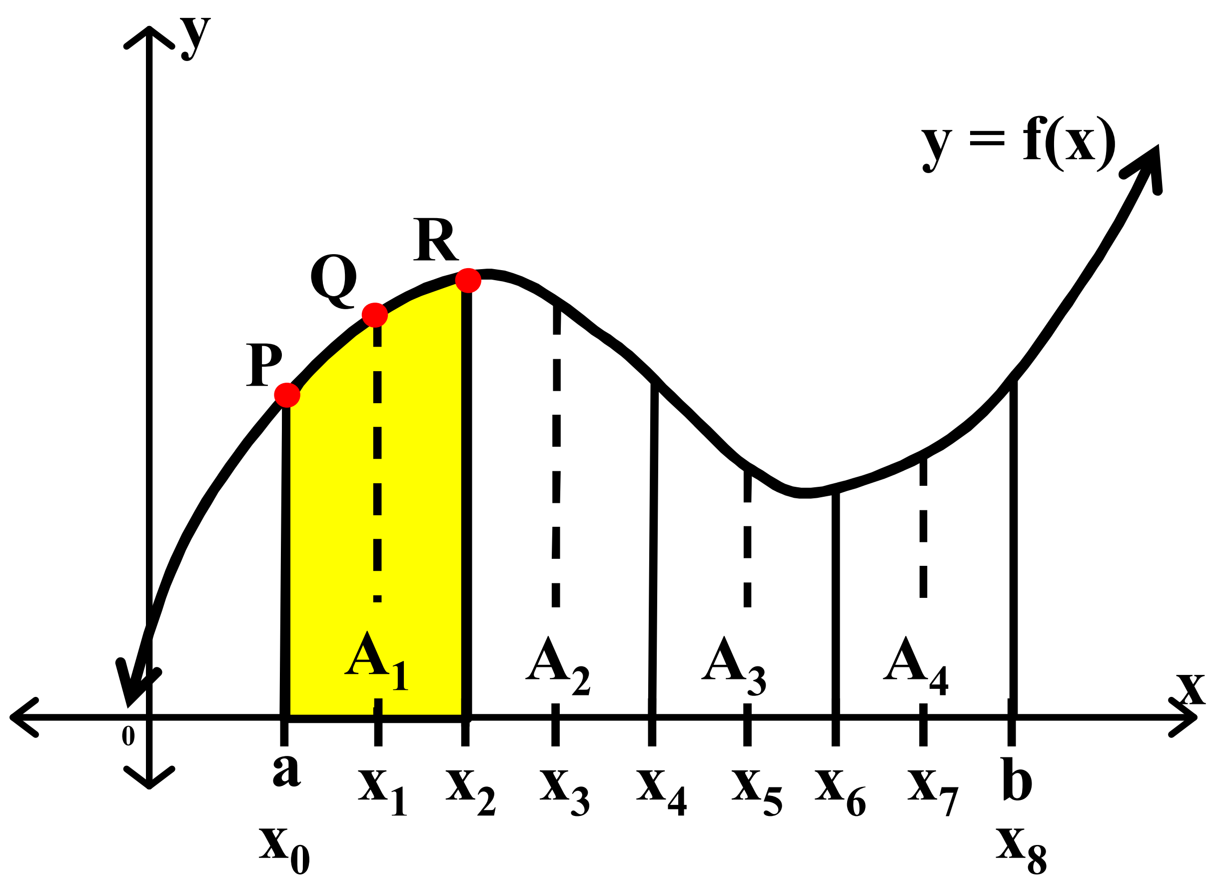
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1)$$

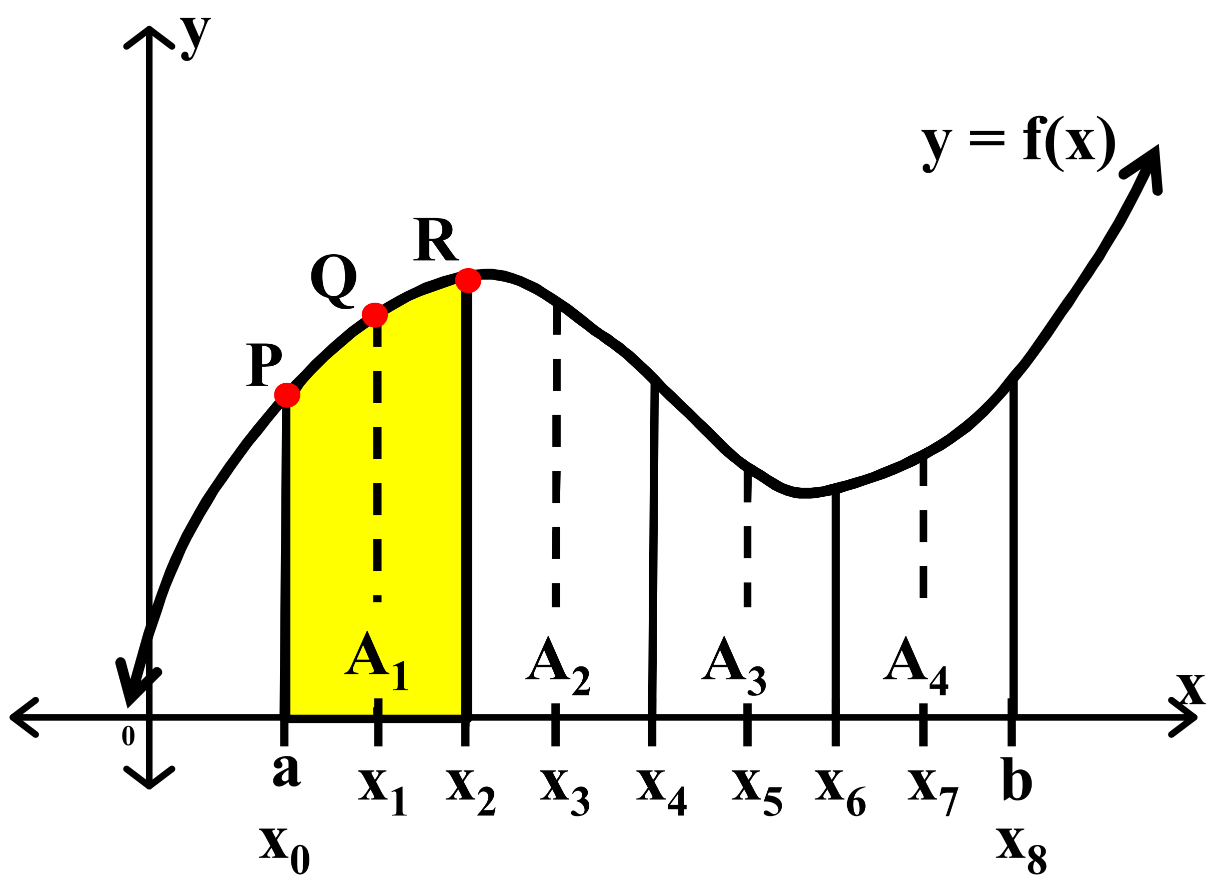
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1)$$ ← **the height in the center**

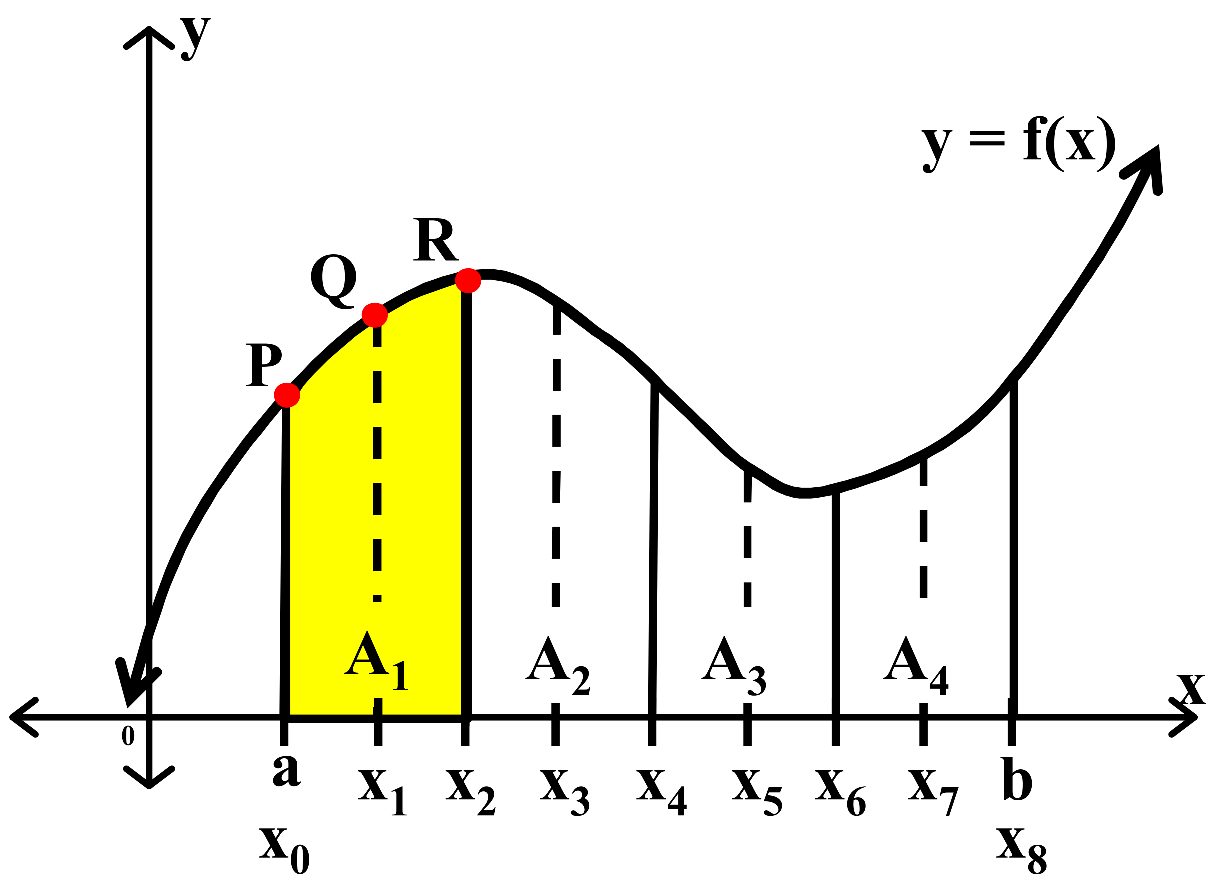
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1)$$

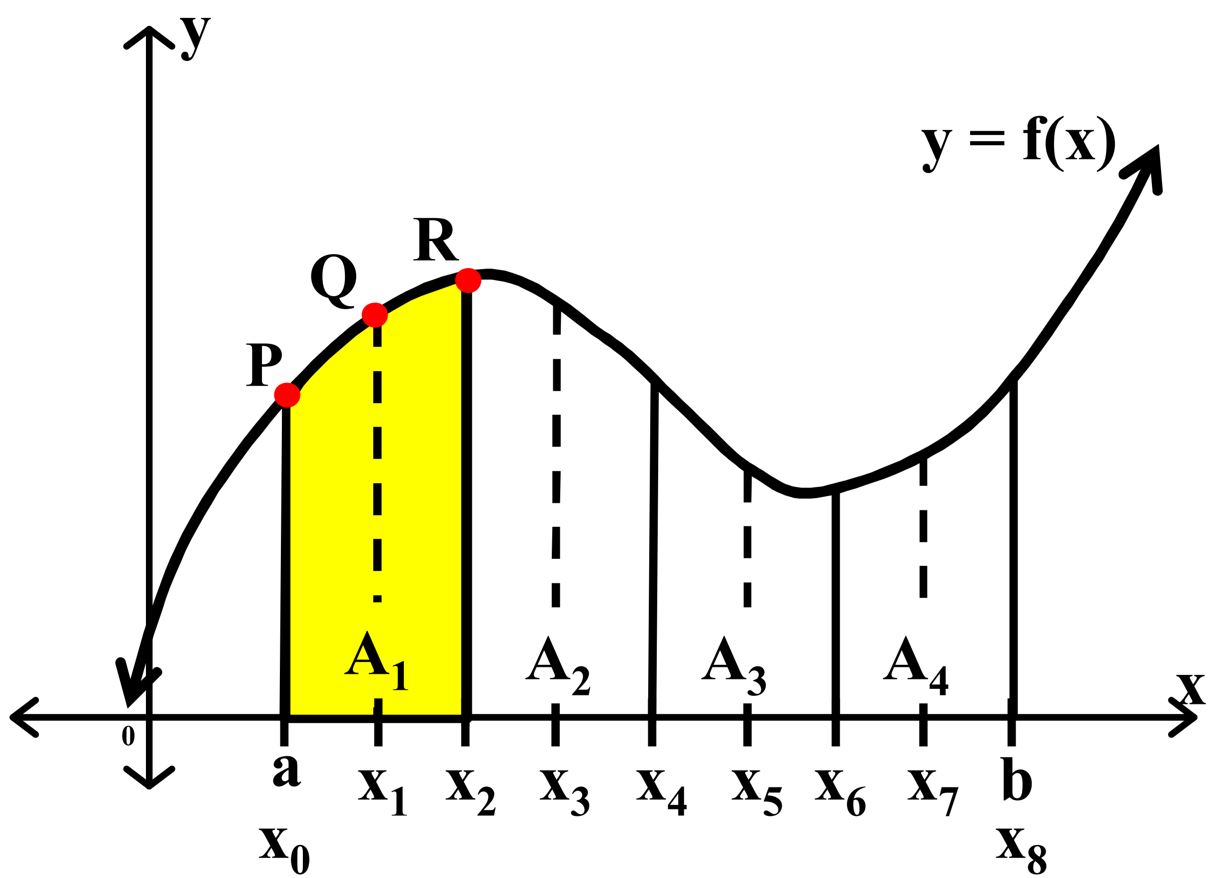
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)$$

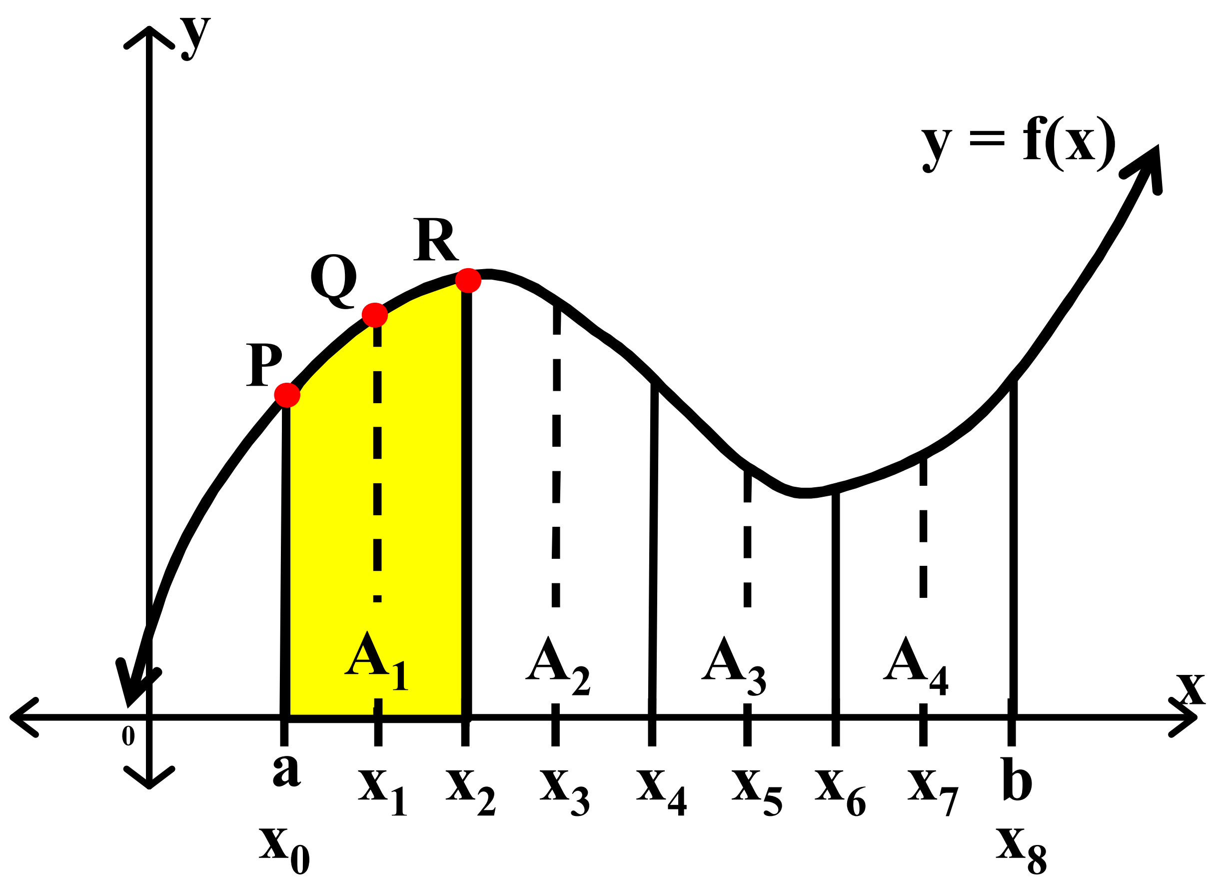
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)$$ ← **the height of the right boundary**

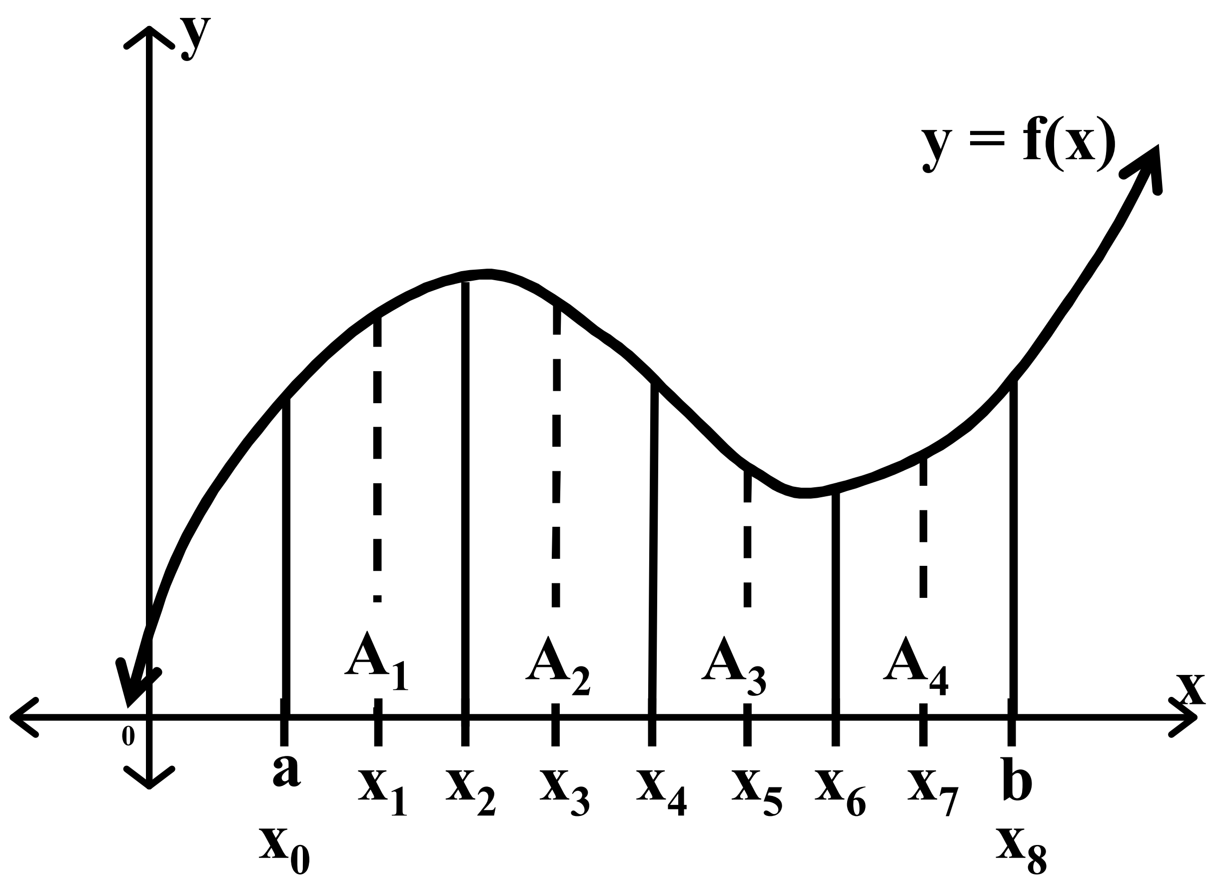
Simpson's Rule



Given points P, Q, and R on the graph of function f, there exists a second degree function, the arc of a parabola (not shown), that contains them. According to Simpson's Rule

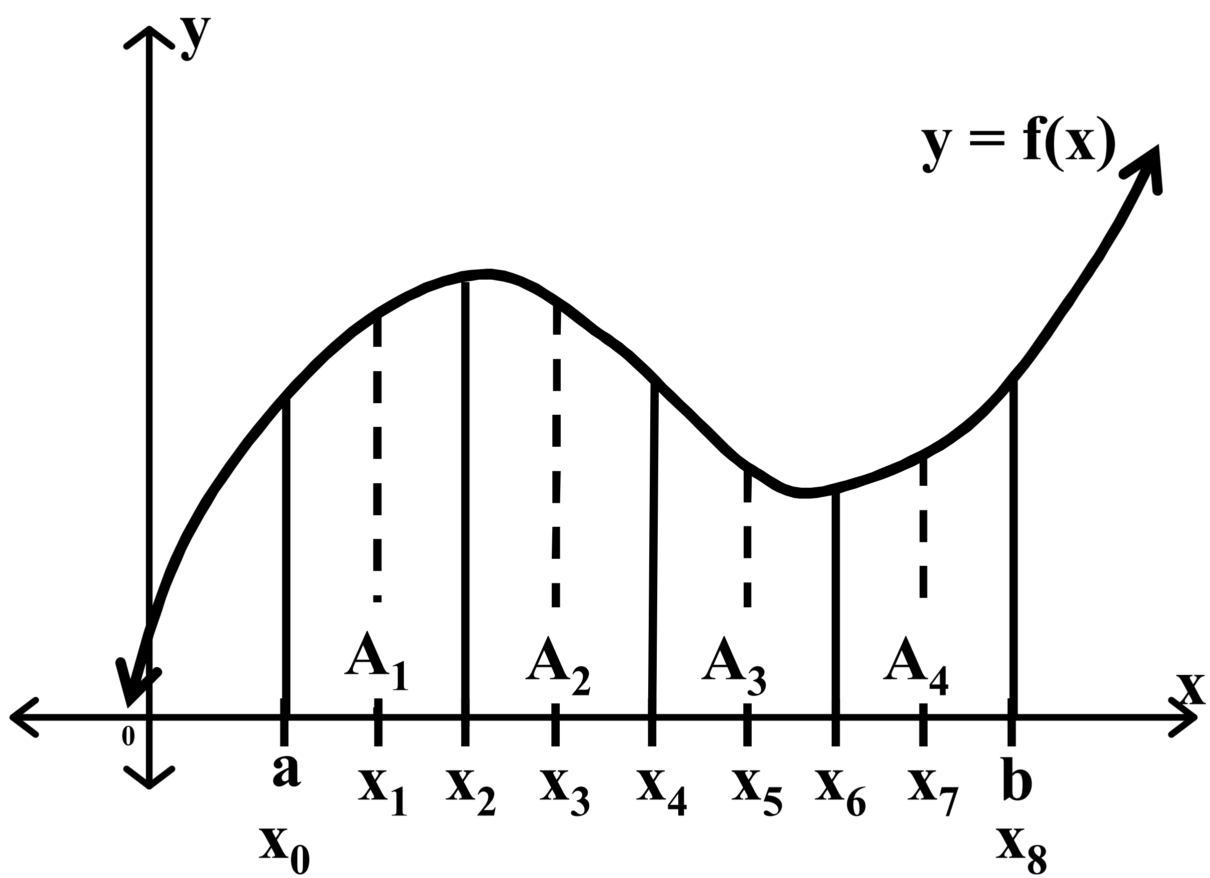
$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)].$$

Simpson's Rule



$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

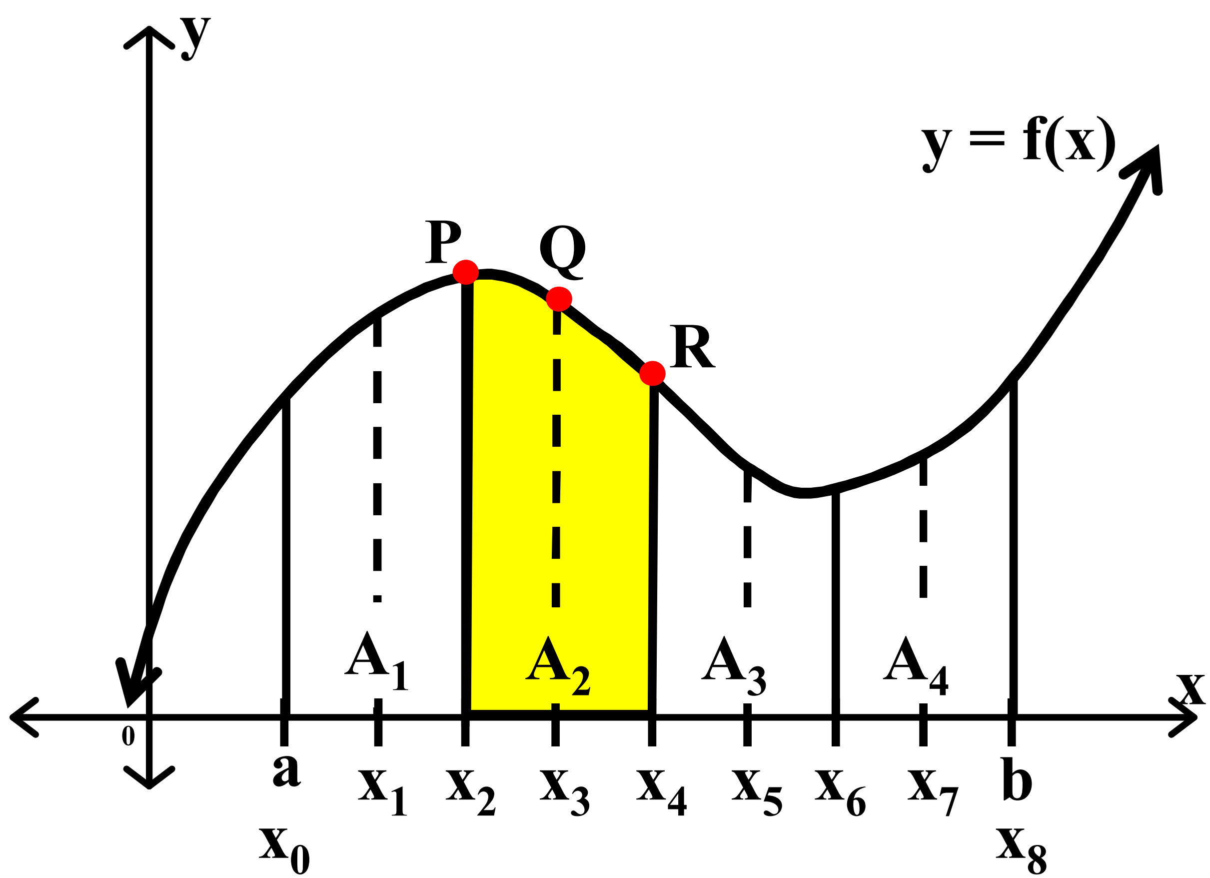
Simpson's Rule



$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

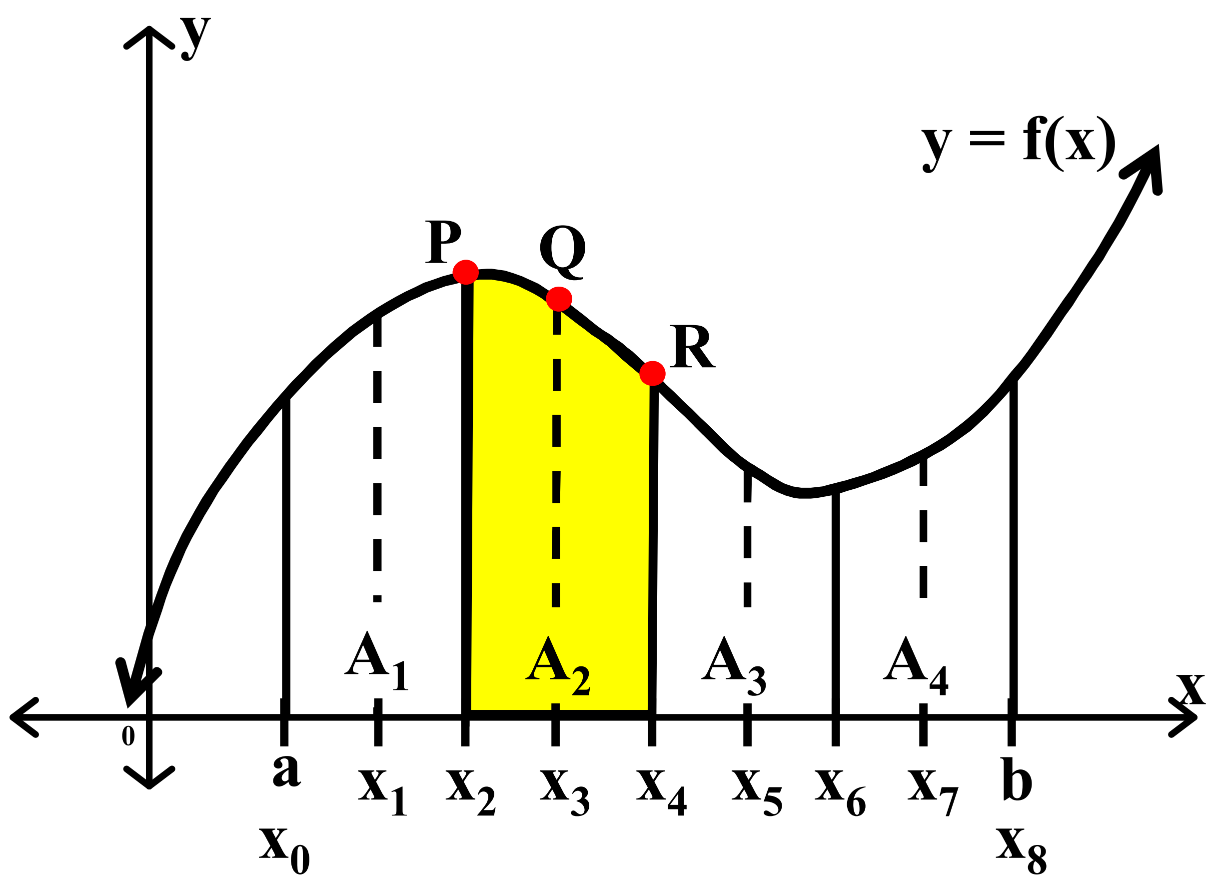
In the same way, the areas of the other 'double strips' can be approximated.

Simpson's Rule



$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

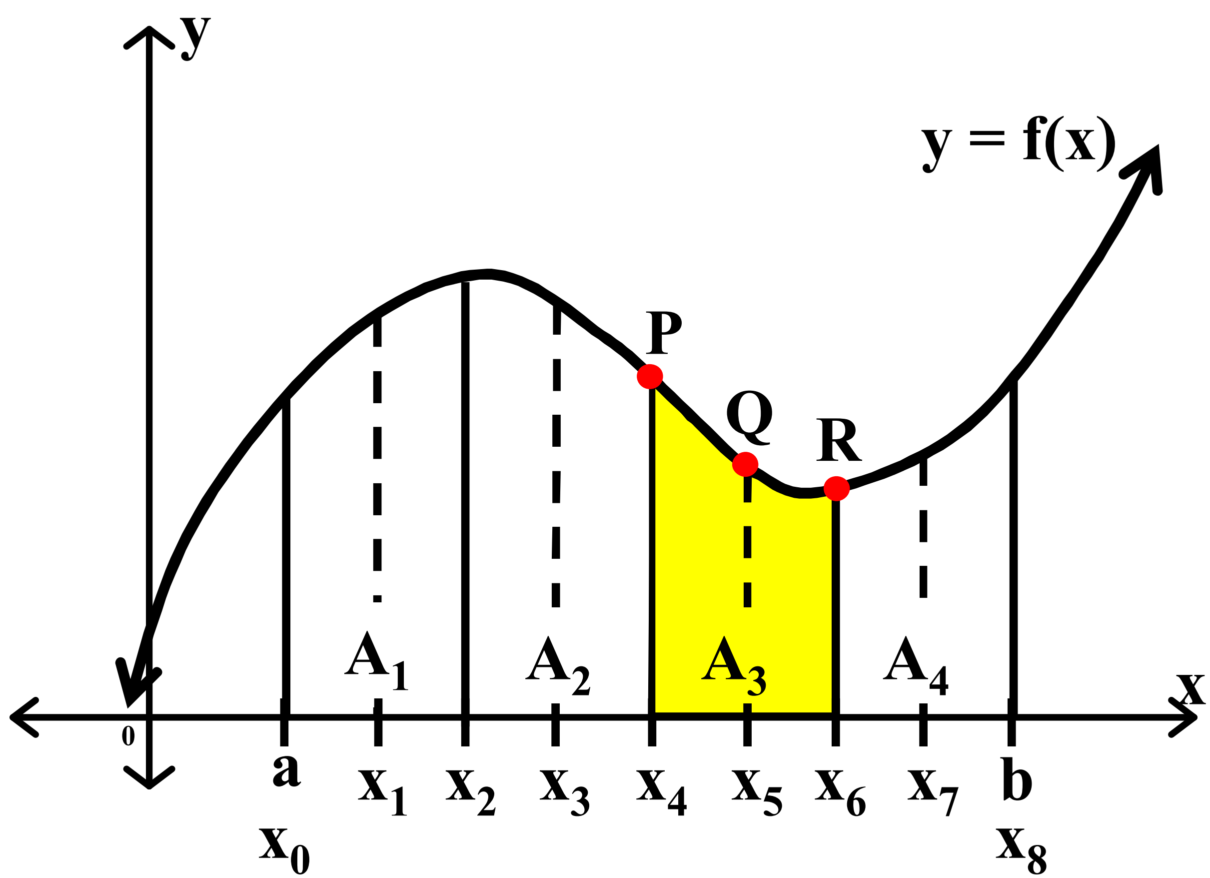
Simpson's Rule



$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$$

Simpson's Rule



$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

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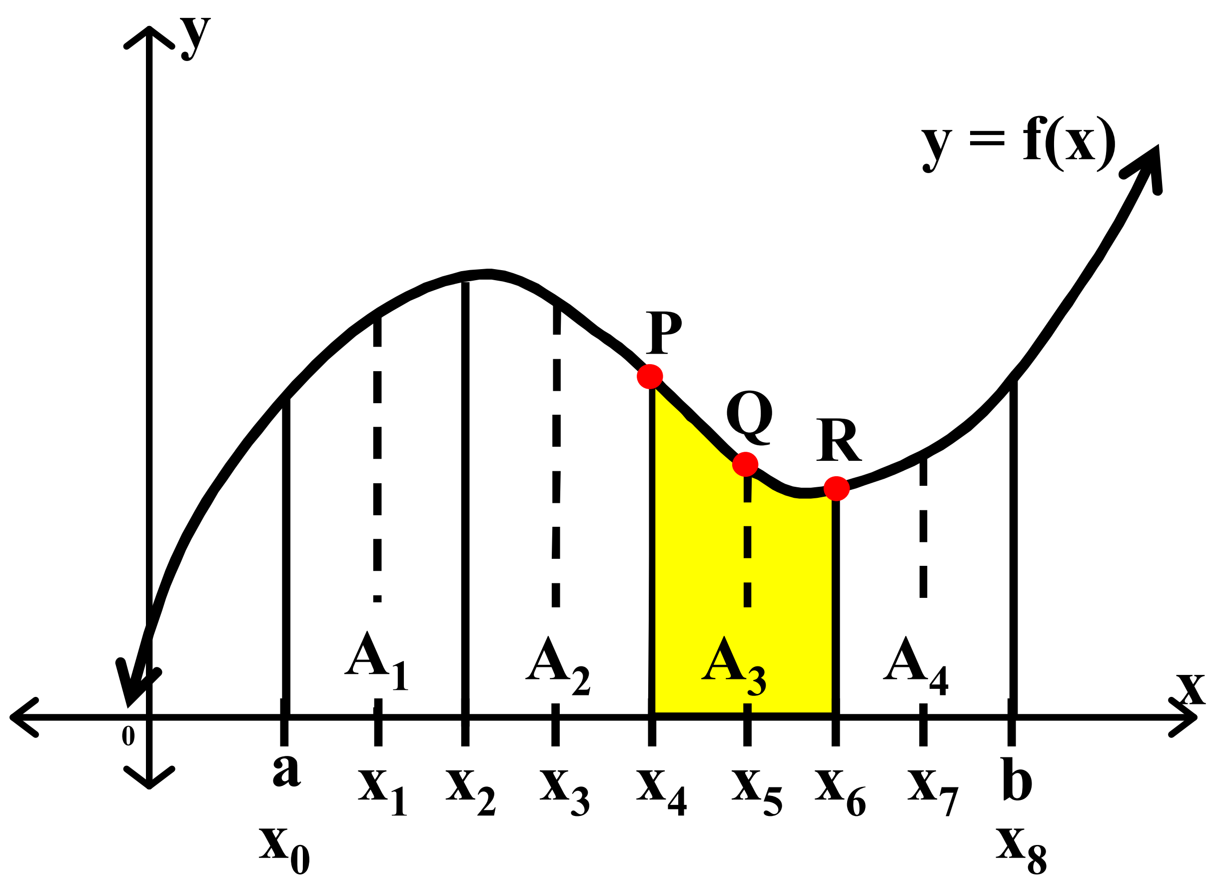
Simpson's Rule

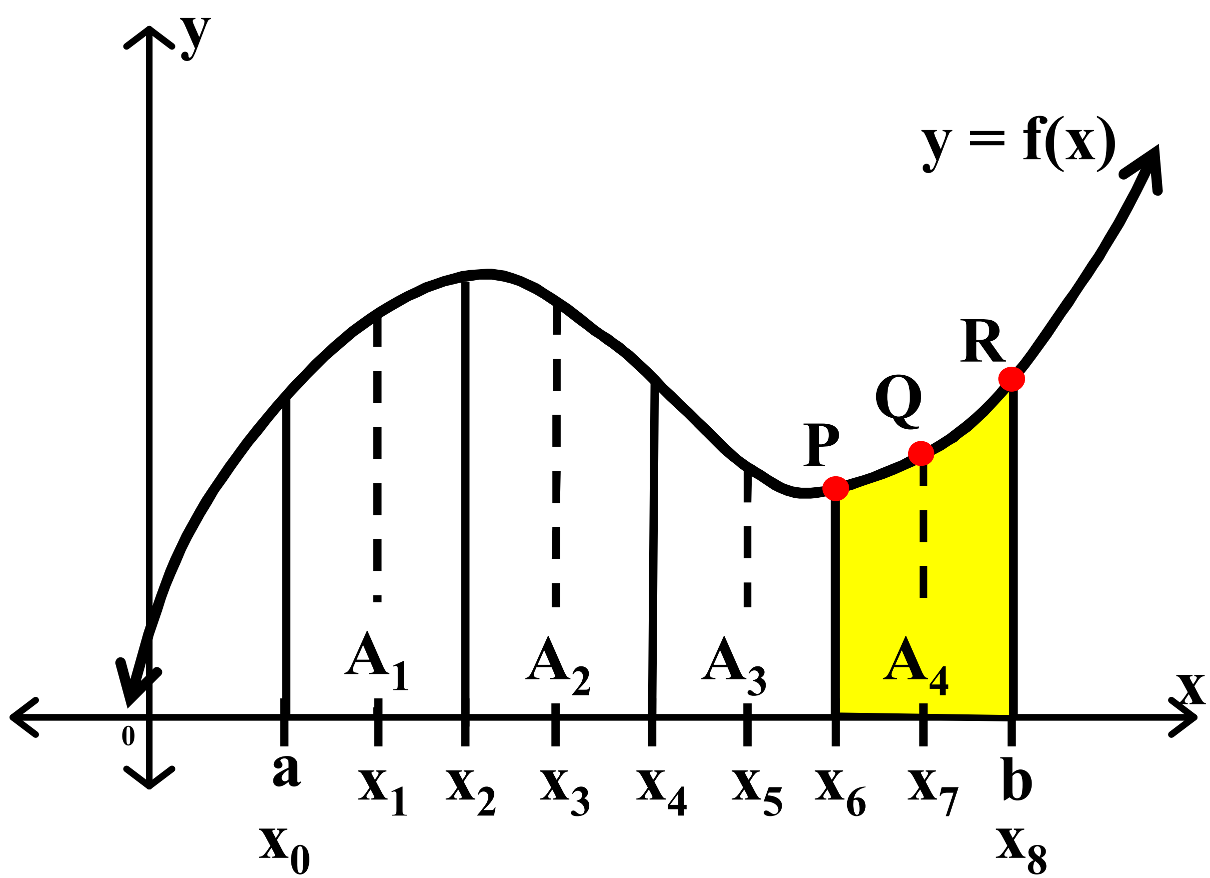


$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

$$A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$$

Simpson's Rule



$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

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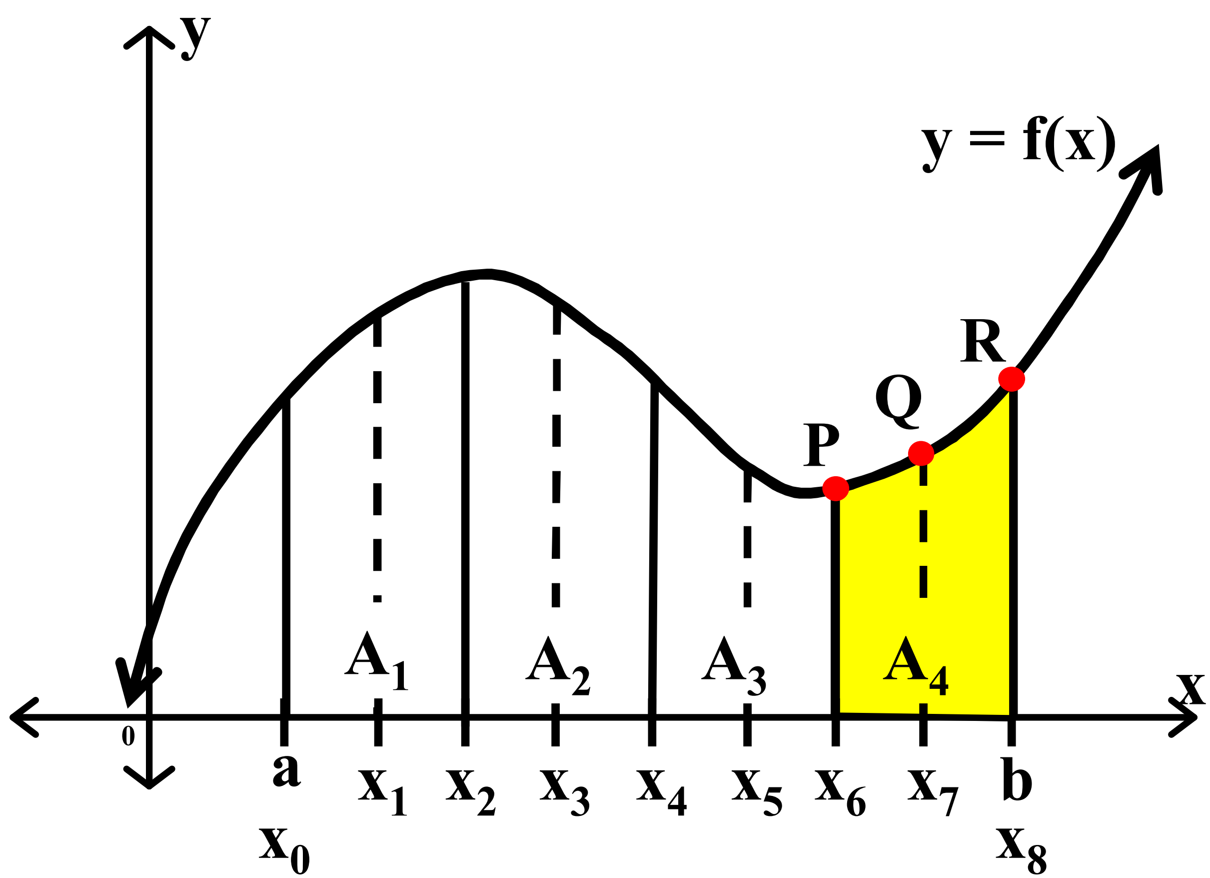
$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$$

Simpson's Rule



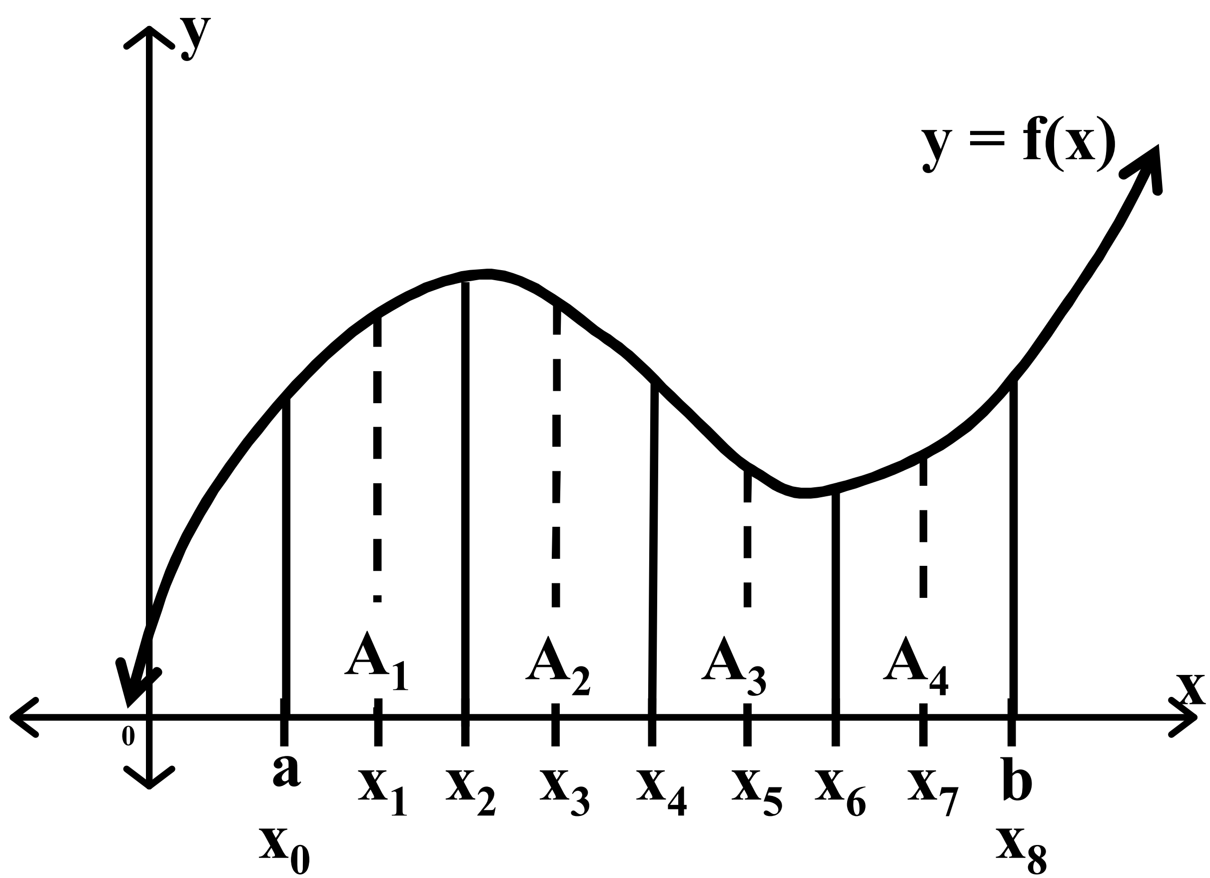
$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

$$A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$$

$$A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

Simpson's Rule



$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

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$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$$

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Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \quad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \quad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] \quad A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A \approx$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

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$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$$

$$A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

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In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] \qquad A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] +$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] \qquad A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] + \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$$

Simpson's Rule

$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$ $A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$

$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$ $A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] + \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] +$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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In our example, n = 4.

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$$+ \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] \qquad A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] + \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] +$$

$$+ \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)] +$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] + \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] +$$

$$+ \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)] + \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \quad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] \quad A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] + \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] + $$
$$+ \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)] + \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

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$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] + \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] + $$
$$+ \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)] + \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + $$
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Rearrange and combine like terms.

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$$A \approx$$

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$$+ f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) +$$
$$+ 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum$$

Simpson's Rule

$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)]$ $\quad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$

$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)]$ $\quad A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] + \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] + $$
$$+ \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)] + \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + $$
$$+ f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) + $$
$$+ 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n}$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] \qquad A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

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$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + \\ + f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) + \\ + 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1})$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \quad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + \\ + f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) + \\ + 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1})$$

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$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) + \\ + 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1})$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

$$A_2 \approx \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] \qquad A_4 \approx \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A = \int_a^b f(x)dx = \sum_{i=1}^{n} A_i$$

In our example, n = 4.

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] + \frac{1}{3}\Delta x[f(x_2) + 4f(x_3) + f(x_4)] + $$
$$+ \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)] + \frac{1}{3}\Delta x[f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + $$
$$+ f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) + $$
$$+ 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1}$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + \\ + f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

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$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i})$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \quad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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Simpson's Rule

$$A_1 \approx \tfrac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \qquad A_3 \approx \tfrac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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$$A \approx \tfrac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + \\ + f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \tfrac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) + \\ + 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \tfrac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i})$$

Simpson's Rule

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$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + + f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) + + 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x\left[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i}) + f(b)\right]$$

Simpson's Rule

$$A_1 \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2)] \quad A_3 \approx \frac{1}{3}\Delta x[f(x_4) + 4f(x_5) + f(x_6)]$$

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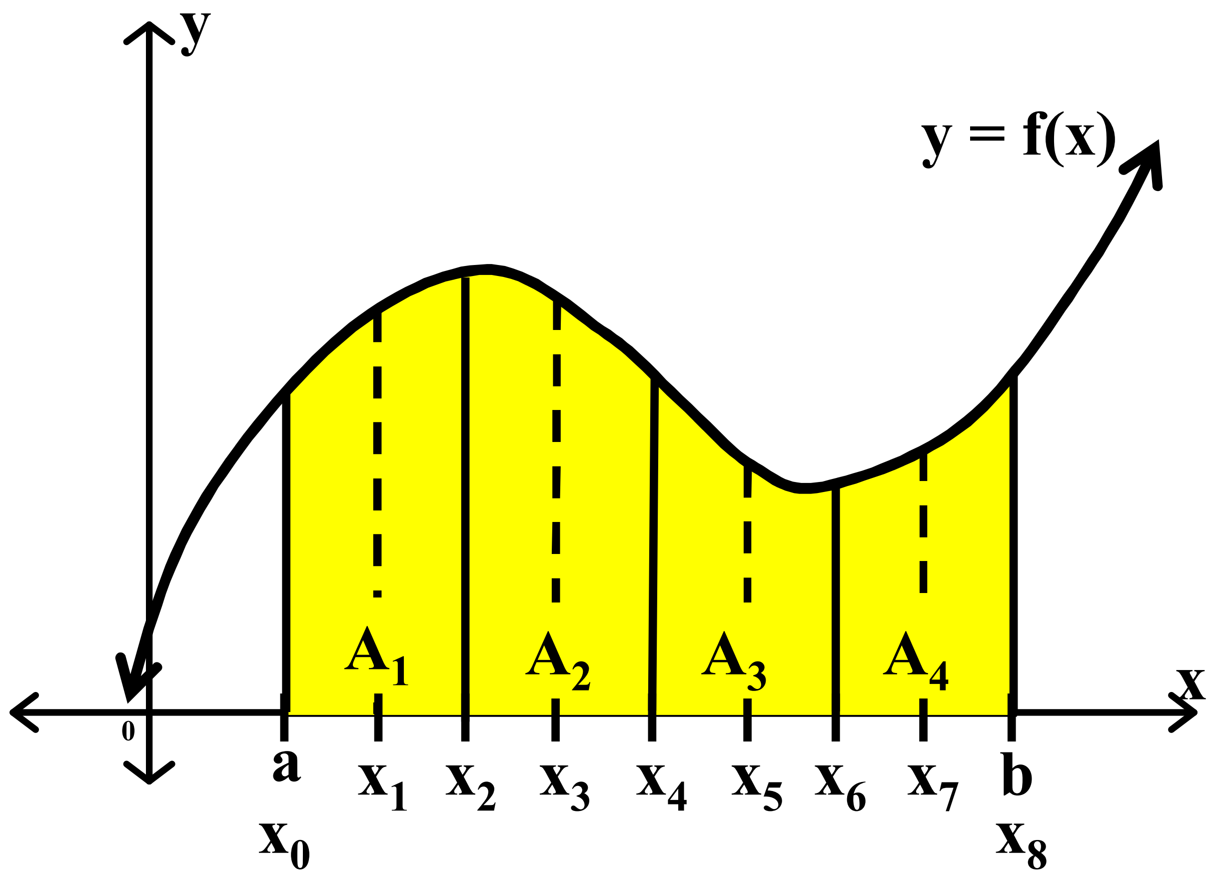
$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + f(x_2) + f(x_2) + 4f(x_3) + f(x_4) + \\ + f(x_4) + 4f(x_5) + f(x_6) + f(x_6) + 4f(x_7) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4f(x_1) + 4f(x_3) + 4f(x_5) + 4f(x_7) + \\ + 2f(x_2) + 2f(x_4) + 2f(x_6) + f(b)]$$

$$A \approx \frac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i}) + f(b)] = S_S$$



$$S_S = \frac{1}{3}\Delta x\left[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i}) + f(b)\right]$$

Simpson’s Rule Approximation

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2 \qquad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5 \qquad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3 \qquad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5 \qquad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4 \qquad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5 \qquad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5 \qquad f(x_6) = f(b) = f(5) = \sqrt{122}$

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$x_6 = b = 5 \qquad f(x_6) = f(b) = f(5) = \sqrt{122}$

$$S_S = \frac{1}{3}\Delta x\left[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i}) + f(b)\right]$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

(a) S_L (Left Rectangular), (b) S_R (Right Rectangular), (c) S_M (Midpoint Rectangular), (d) S_T (Trapezoidal), and (e) S_S (Simpson's).

Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals.

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

$x_1 = 2.5$ $\quad f(x_1) = f(2.5) = \sqrt{12.625}$

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

$x_3 = 3.5$ $\quad f(x_3) = f(3.5) = \sqrt{39.875}$

$x_4 = 4$ $\quad f(x_4) = f(4) = \sqrt{61}$

$x_5 = 4.5$ $\quad f(x_5) = f(4.5) = \sqrt{88.125}$

$x_6 = b = 5$ $\quad f(x_6) = f(b) = f(5) = \sqrt{122}$

$$S_S = \tfrac{1}{3}\Delta x\left[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i}) + f(b)\right]$$

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $2n = 6$

$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ $\quad f(x_0) = f(a) = f(2) = \sqrt{5}$

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$$S_S = \tfrac{1}{3}\Delta x\left[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i}) + f(b)\right]$$

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $2n = 6$ → $n = 3$

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

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Class Worksheet #5 Unit 11

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$$S_S = \tfrac{1}{3}\Delta x\left[f(a) + 4\sum_{i=1}^{3} f(x_{2i-1}) + 2\sum_{i=1}^{2} f(x_{2i}) + f(b)\right]$$

Class Worksheet #5 Unit 11

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$S_S = \frac{1}{3}(.5)[$

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$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$	$f(x_0) = f(a) = f(2) = \sqrt{5}$
$x_1 = 2.5$	$f(x_1) = f(2.5) = \sqrt{12.625}$
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$x_3 = 3.5$	$f(x_3) = f(3.5) = \sqrt{39.875}$
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$$S_S = \tfrac{1}{3}\Delta x\left[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i}) + f(b)\right]$$

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$$S_S = \tfrac{1}{3}\Delta x[f(a) + 4\{f(x_1) + f(x_3) + f(x_5)\} + 2\{f(x_2) + f(x_4)\} + f(b)]$$

$$S_S = \tfrac{1}{3}(.5)[\sqrt{5} + 4\{\sqrt{12.625} + \sqrt{39.875} + \sqrt{88.125}\} + 2\{\sqrt{24} + \sqrt{61}\} + \sqrt{122}\,]$$

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$$\int_2^5 \sqrt{x^3 - 3}\, dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a = 2$ | $f(x_0) = f(a) = f(2) = \sqrt{5}$

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$$S_S = \tfrac{1}{3}\Delta x\left[f(a) + 4\sum_{i=1}^{n} f(x_{2i-1}) + 2\sum_{i=1}^{n-1} f(x_{2i}) + f(b)\right]$$

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$$S_S = \tfrac{1}{3}(.5)\left[\sqrt{5} + 4\{\sqrt{12.625} + \sqrt{39.875} + \sqrt{88.125}\} + 2\{\sqrt{24} + \sqrt{61}\} + \sqrt{122}\right]$$

$$S_S \approx 19.29$$

Class Worksheet #5 Unit 11

Approximate the following definite integral using each of the following approximation methods.

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Show your complete solutions neatly organized. In every case, divide the interval [a, b] into 6 sub-intervals. $2n = 6 \rightarrow n = 3$

$$\int_2^5 \sqrt{x^3 - 3}\,dx \qquad \Delta x = \frac{b-a}{n} = \frac{5-2}{6} = 0.5 \qquad f(x) = \sqrt{x^3 - 3}$$

$x_0 = a$

Good luck on your homework !!

b)]

x_1

$x_2 = 3$ $\quad f(x_2) = f(3) = \sqrt{24}$

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$$S_S = \tfrac{1}{3}\Delta x[f(a) + 4\sum_{i=1}^{3} f(x_{2i-1}) + 2\sum_{i=1}^{2} f(x_{2i}) + f(b)]$$

$$S_S = \tfrac{1}{3}\Delta x[f(a) + 4\{f(x_1) + f(x_3) + f(x_5)\} + 2\{f(x_2) + f(x_4)\} + f(b)]$$

$$S_S = \tfrac{1}{3}(.5)[\sqrt{5} + 4\{\sqrt{12.625} + \sqrt{39.875} + \sqrt{88.125}\} + 2\{\sqrt{24} + \sqrt{61}\} + \sqrt{122}]$$

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