Calculus Lesson #3 Unit 11

Class Worksheet #3

Solids of Revolution

Shells

Calculus Class Worksheet #3 Unit 11 Solutions

Use "shells" to find the volume generated by rotating the given region about the given line. For each problem, you must

a) sketch the generating region, showing a typical generating rectangle,
b) write an expression for the volume generated by this rectangle,
c) express the exact volume of the solid as a definite integral, and
d) evaluate the integral.

Sample 1A. The region enclosed by $y = 8x - 2x^2$ and the x-axis is rotated about the y-axis.

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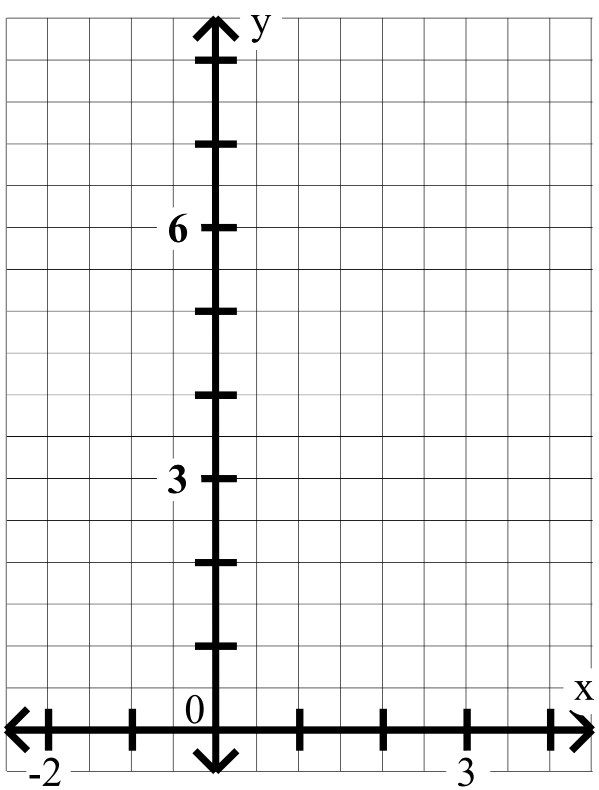

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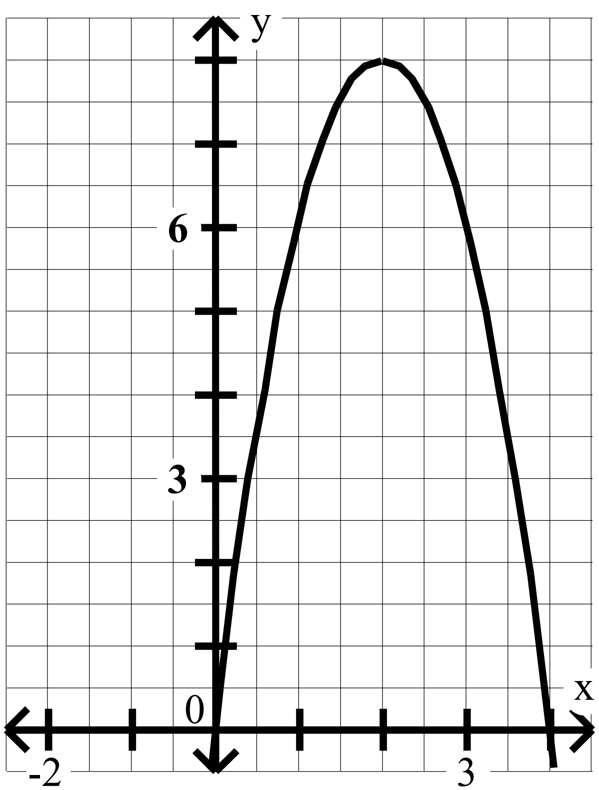

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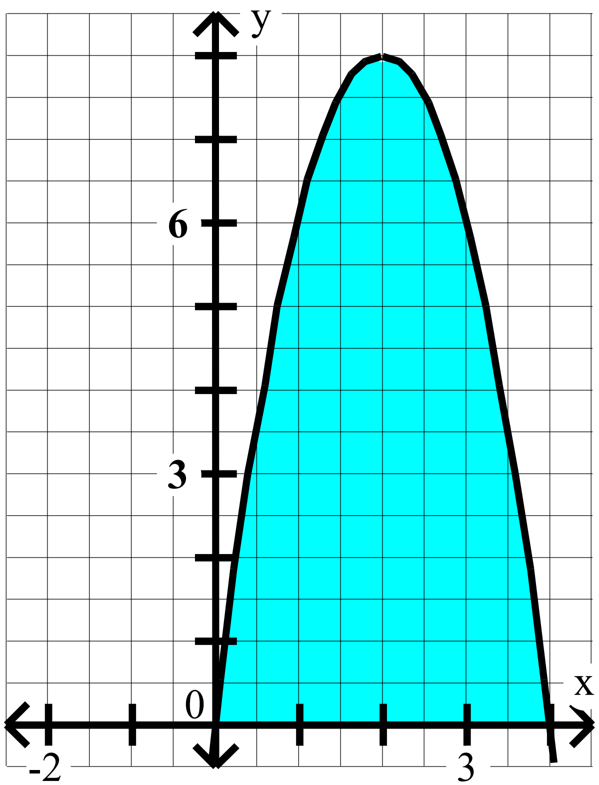

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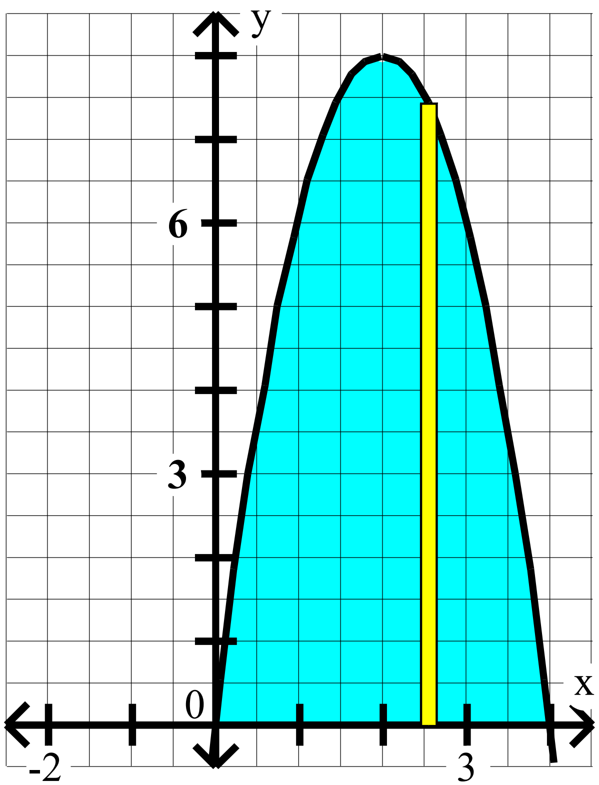

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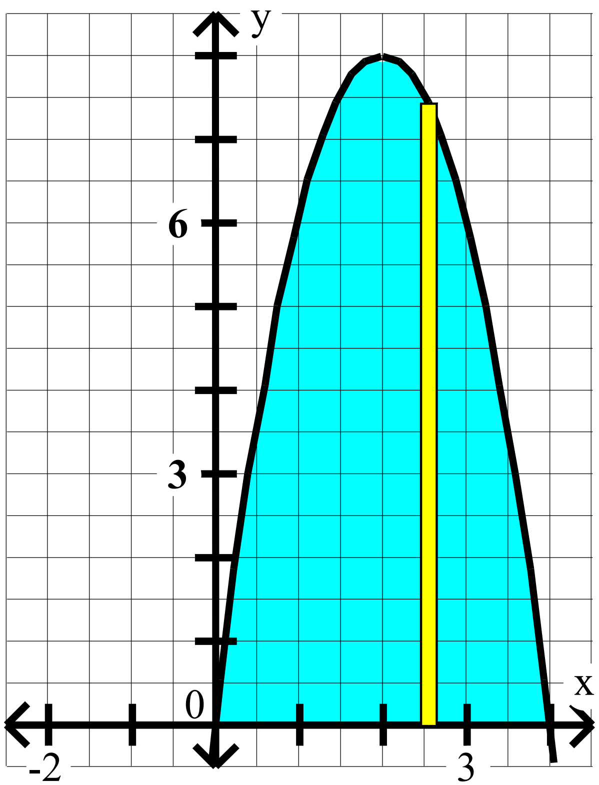

Shells: $V = 2\pi r h \Delta r$

$r =$

$h =$

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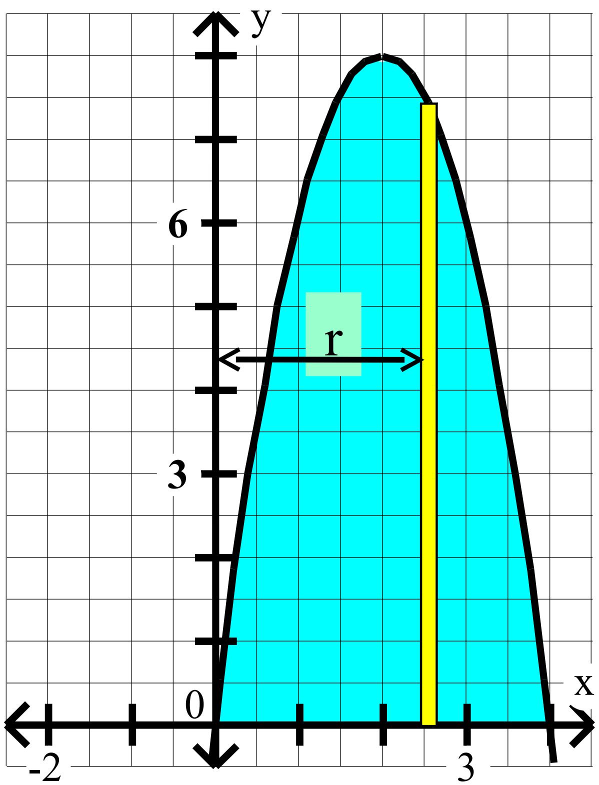

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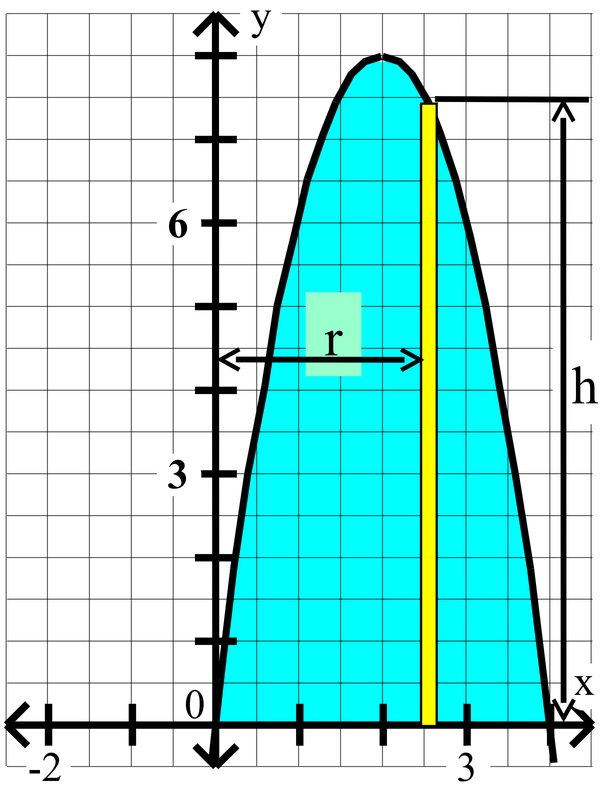

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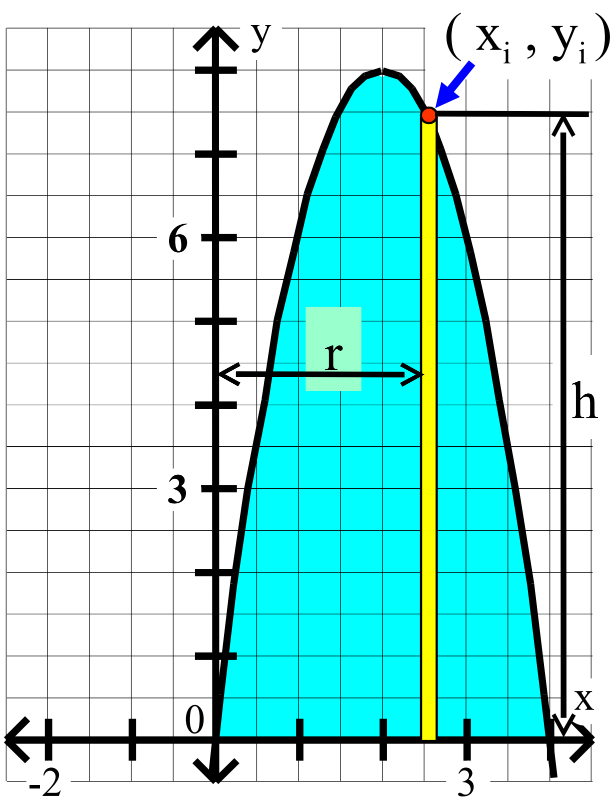

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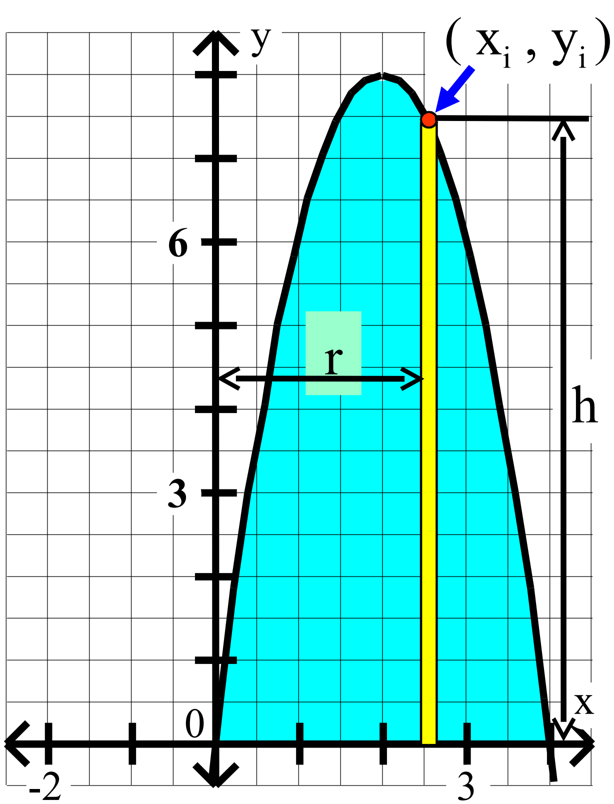

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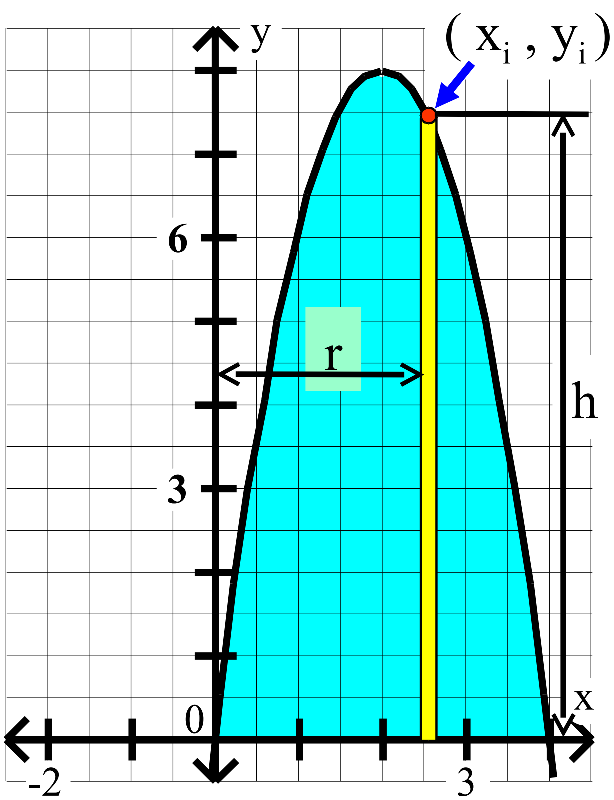

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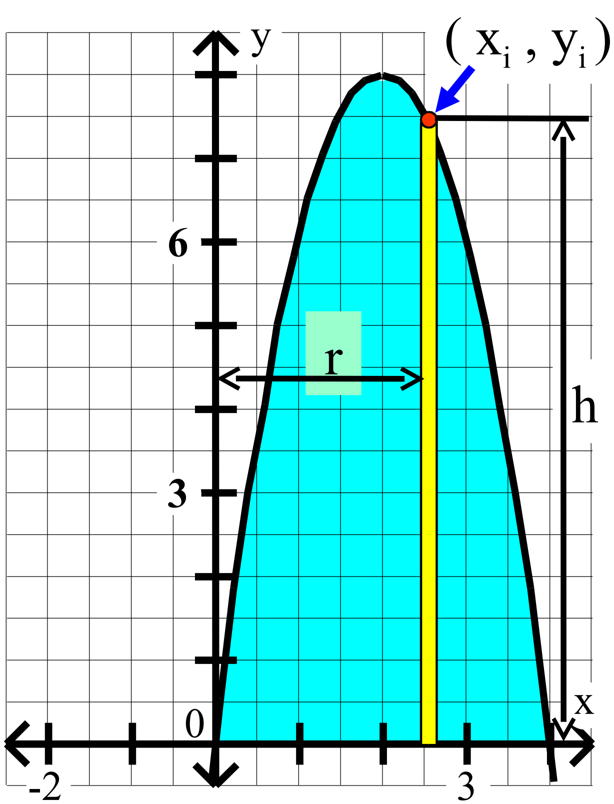

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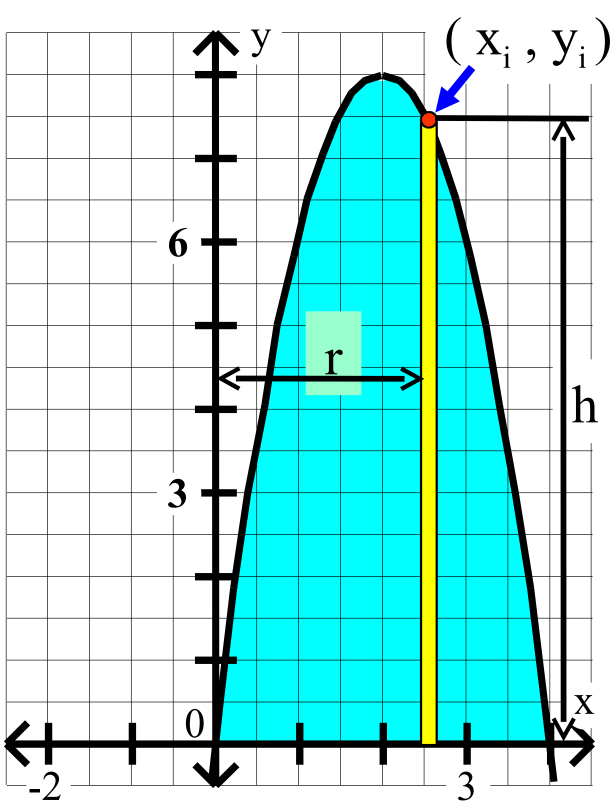

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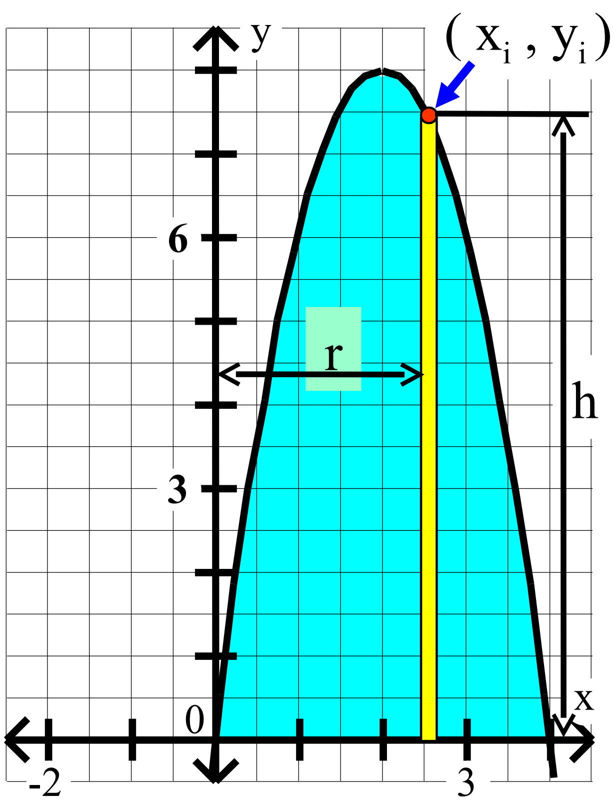

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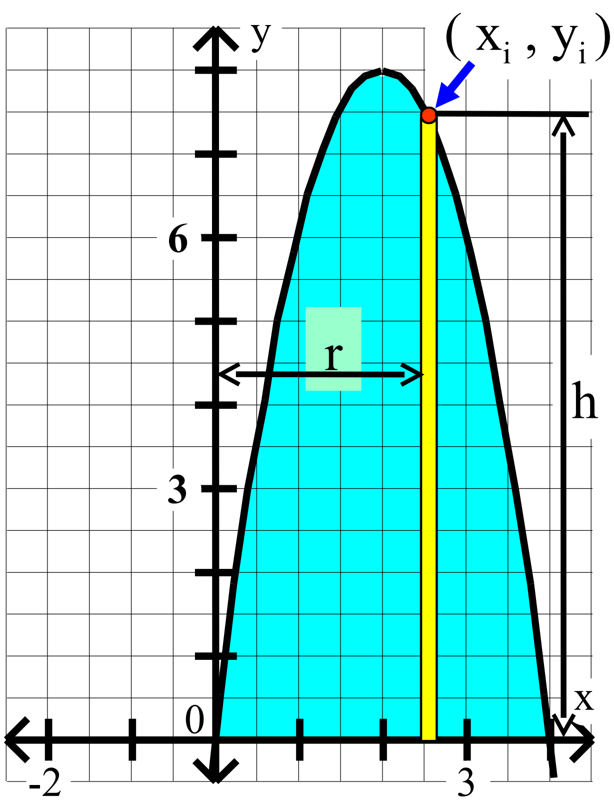

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b. $V_i =$

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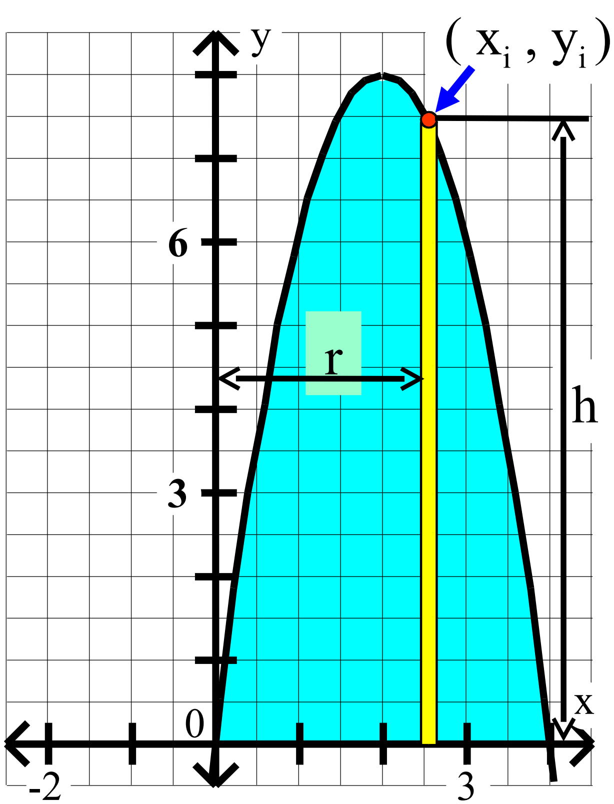

Shells: $V = 2\pi rh\Delta r$

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b. $V_i = 2\pi$

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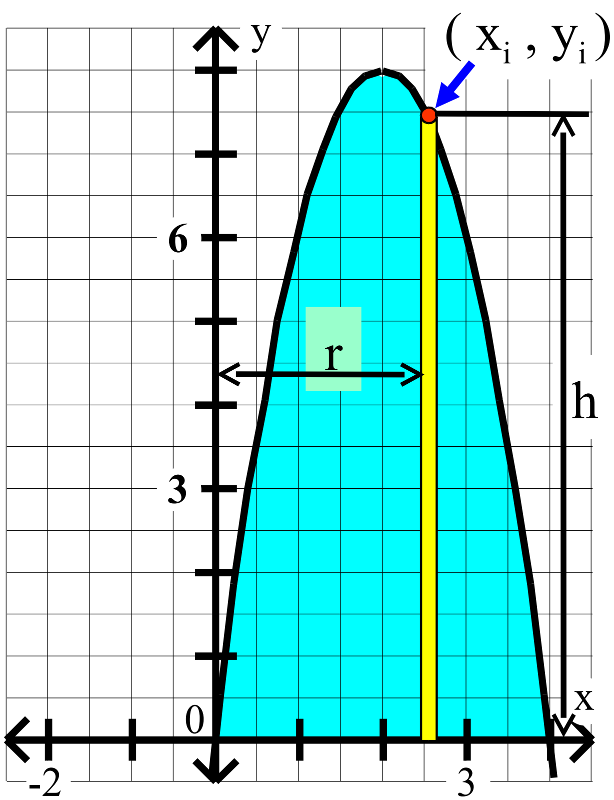

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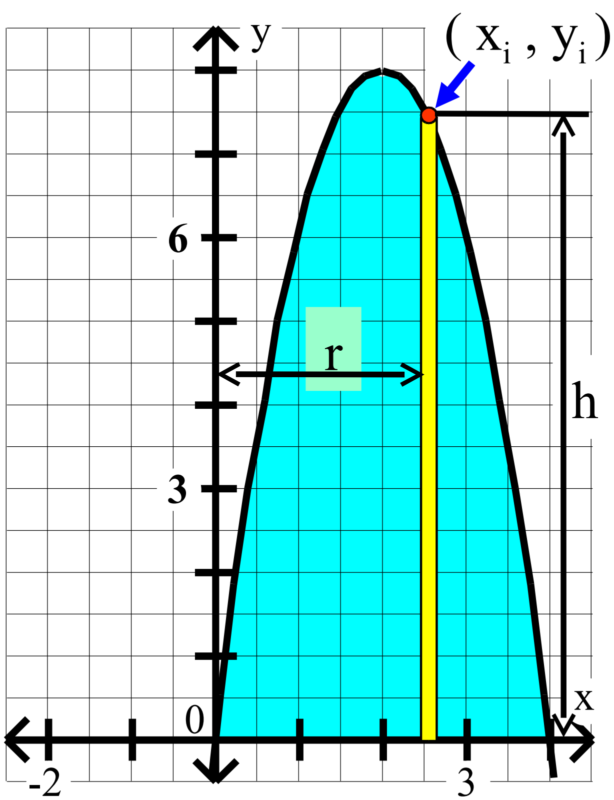

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$r = x_i$

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b. $V_i = 2\pi x_i(8x_i - 2x_i^2)$

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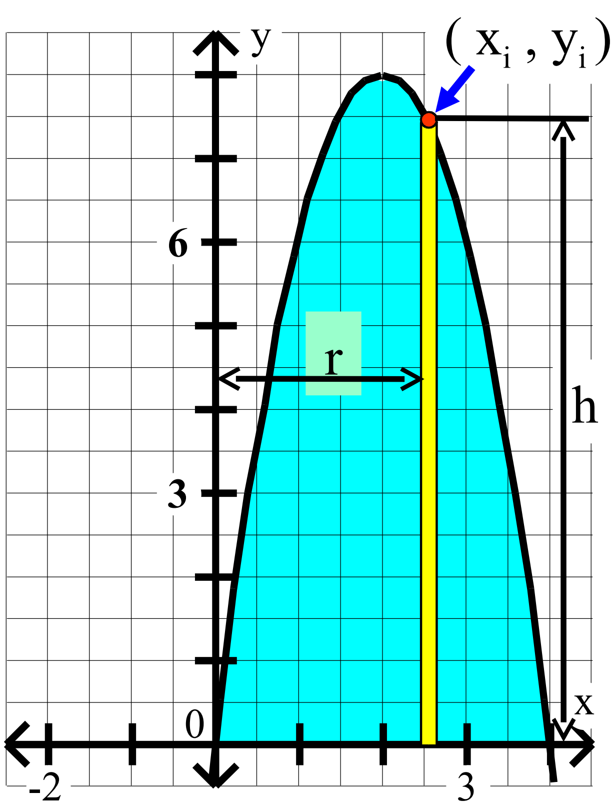

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b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

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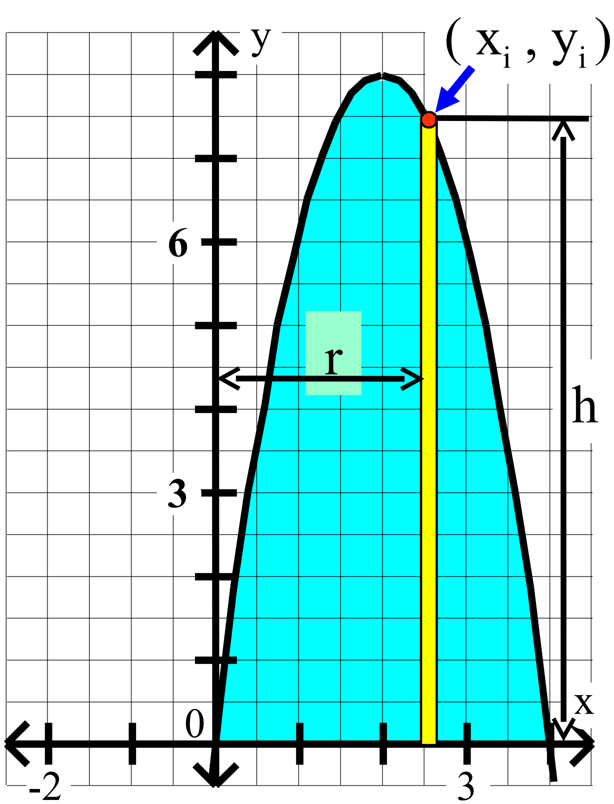

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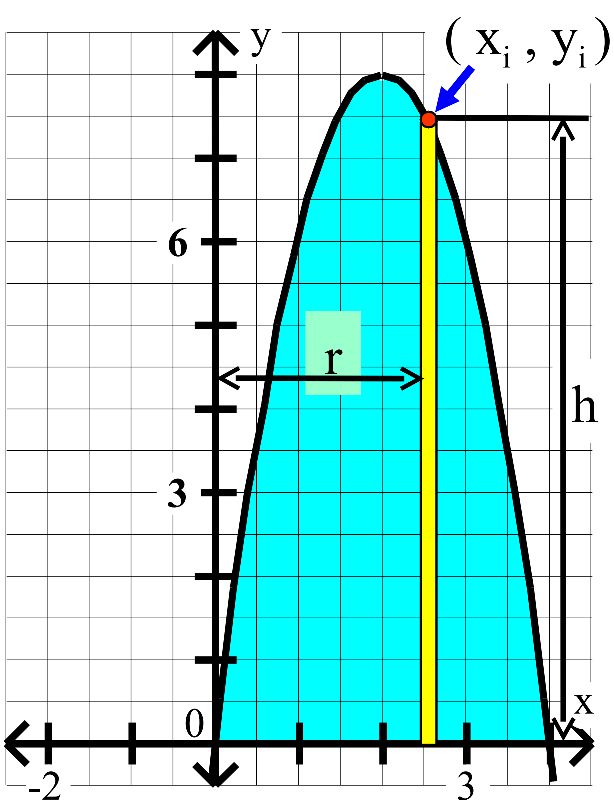

Shells: $V = 2\pi r h \Delta r$

$r = x_i$

$h = y_i = 8x_i - 2x_i^2$

$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

c. $V =$

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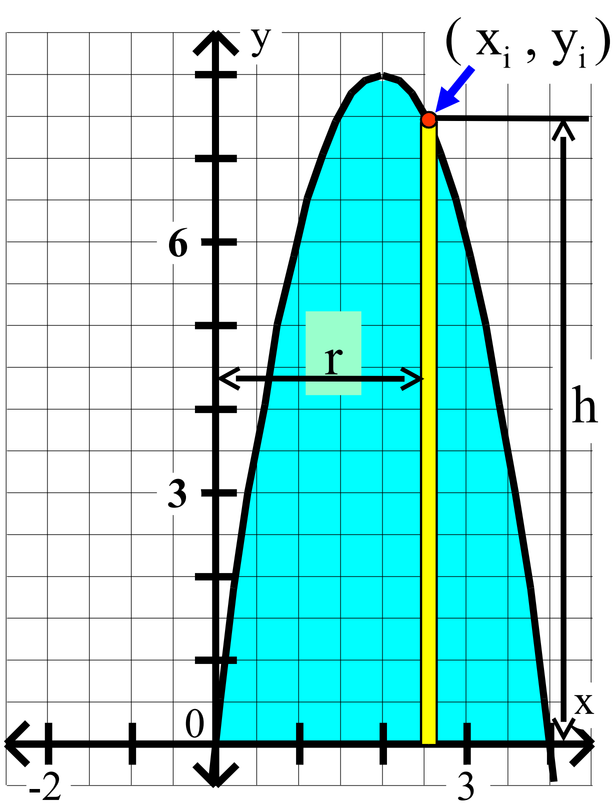

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$r = x_i$

$h = y_i = 8x_i - 2x_i^2$

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b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi$

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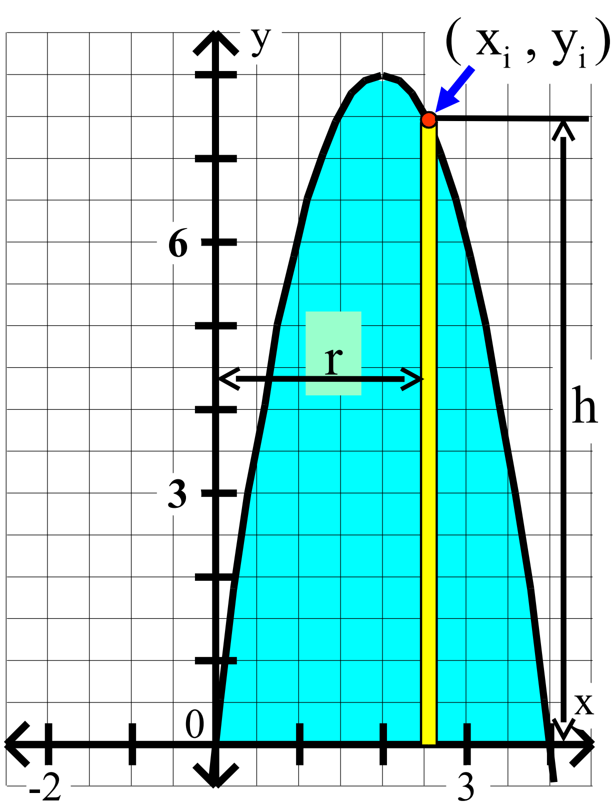

Shells: $V = 2\pi r h \Delta r$

$r = x_i$

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b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

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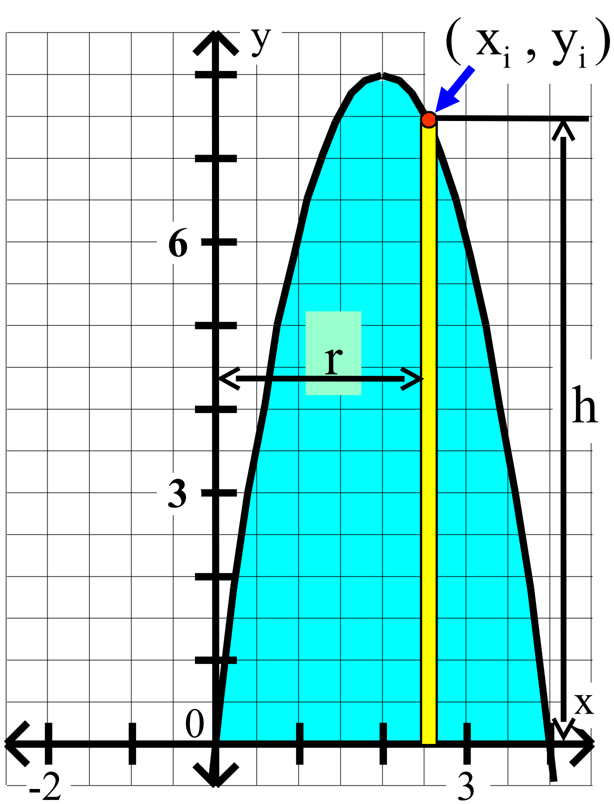

Shells: $V = 2\pi r h \Delta r$

$r = x_i$

$h = y_i = 8x_i - 2x_i^2$

$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi\int(x(8x - 2x^2))\,dx$

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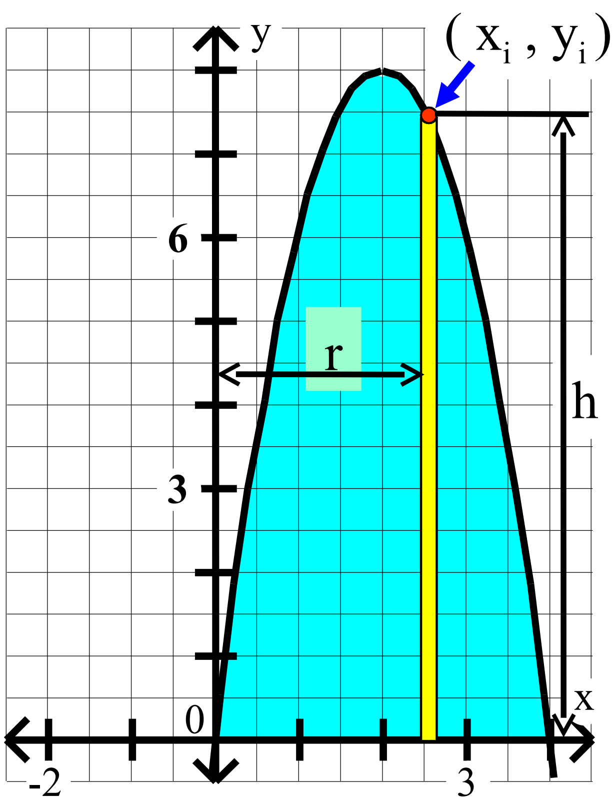

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b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi\int_0 (x(8x - 2x^2))\,dx$

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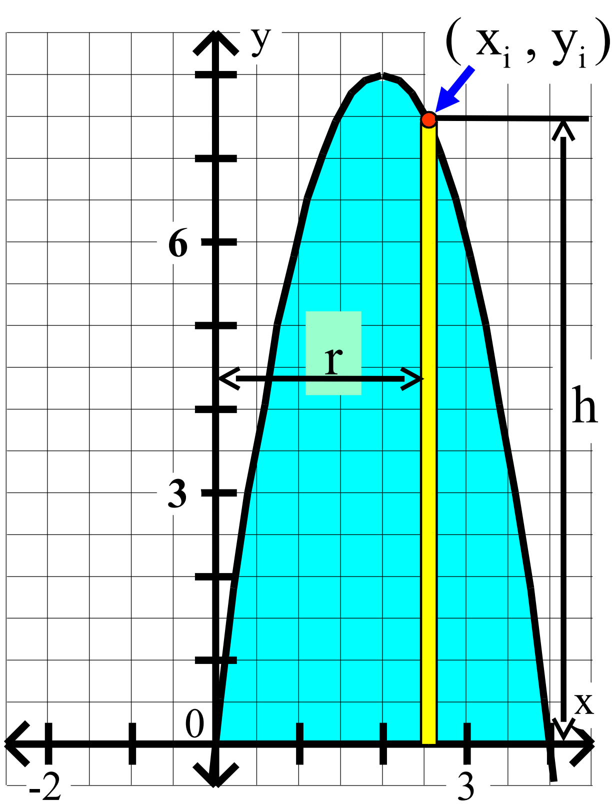

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$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi \int_0^4 (x(8x - 2x^2))\, dx$

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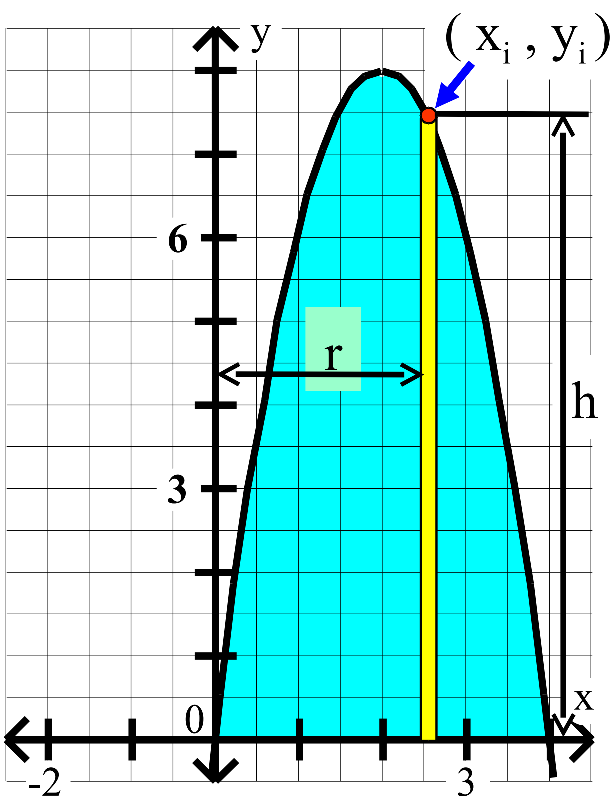

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c. $V = 2\pi\int_0^4 (x(8x - 2x^2))\, dx$

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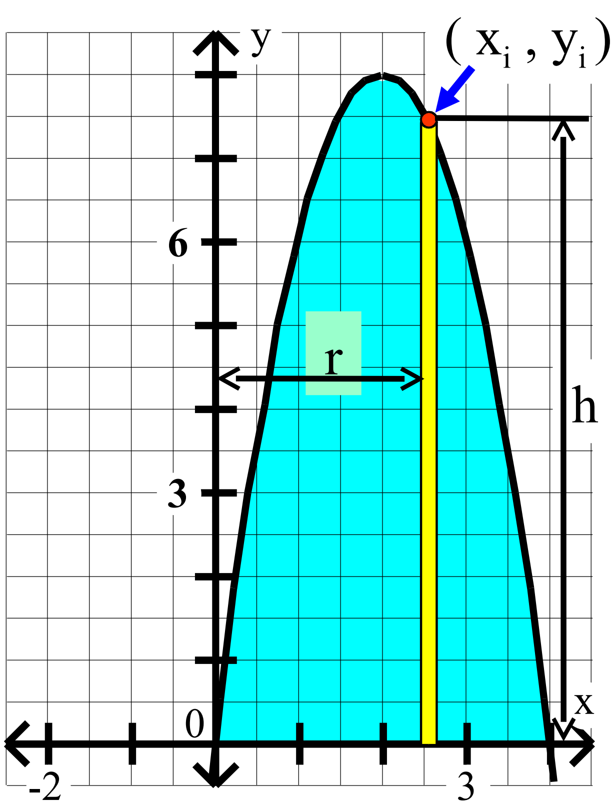

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$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi\int_0^4 (x(8x - 2x^2))\, dx$

$V = 2\pi\int_0^4 (8x^2 - 2x^3)\, dx$

Calculus Class Worksheet #3 Unit 11 Solutions

Use "shells" to find the volume generated by rotating the given region about the given line. For each problem, you must

a) sketch the generating region, showing a typical generating rectangle,
b) write an expression for the volume generated by this rectangle,
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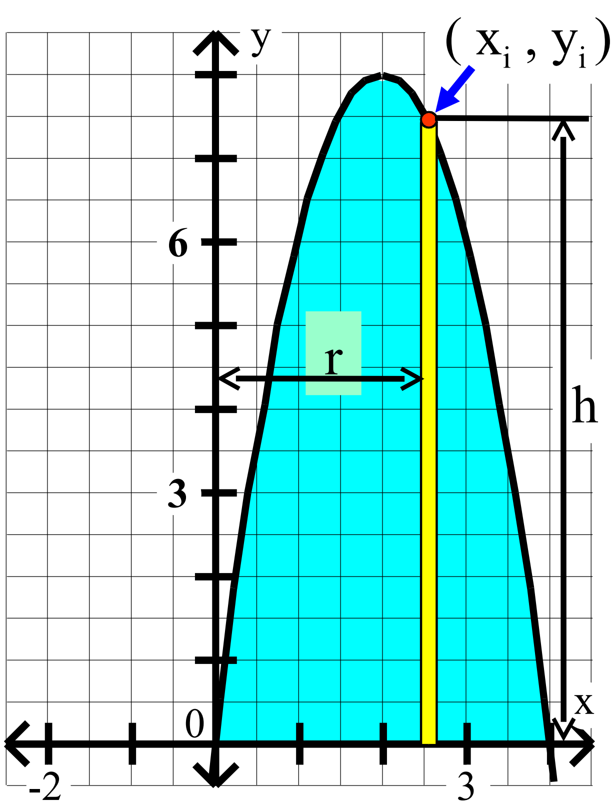
d) evaluate the integral.

Sample 1A. The region enclosed by $y = 8x - 2x^2$ and the x-axis is rotated about the y-axis.

a.



Shells: $V = 2\pi r h \Delta r$

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c. $V = 2\pi\int_0^4 (x(8x - 2x^2))\,dx$

$V = 2\pi\int_0^4 (8x^2 - 2x^3)\,dx$

d. $V \approx$

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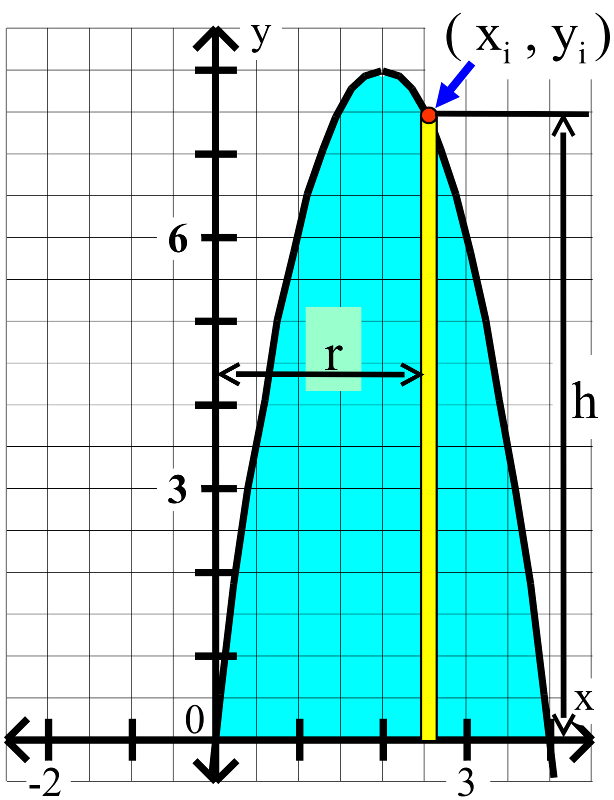

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b. $V_i = 2\pi x_i(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi\int_0^4 (x(8x - 2x^2))\, dx$

$V = 2\pi\int_0^4 (8x^2 - 2x^3)\, dx$

d. $V \approx 268$ cu. units

Calculus Class Worksheet #3 Unit 11 Solutions

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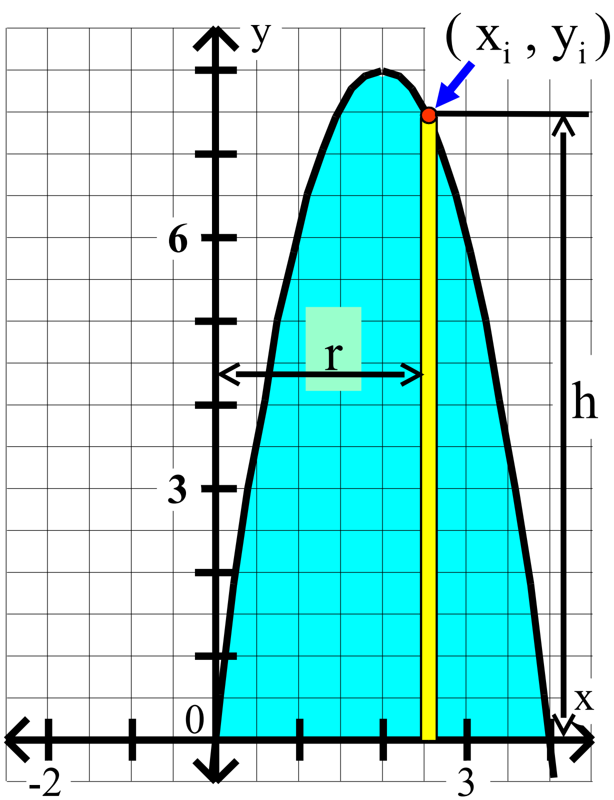

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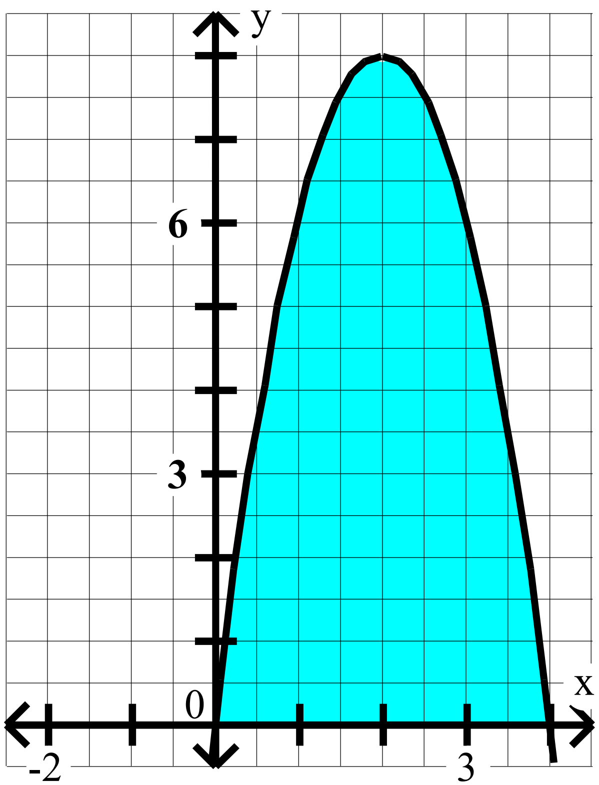

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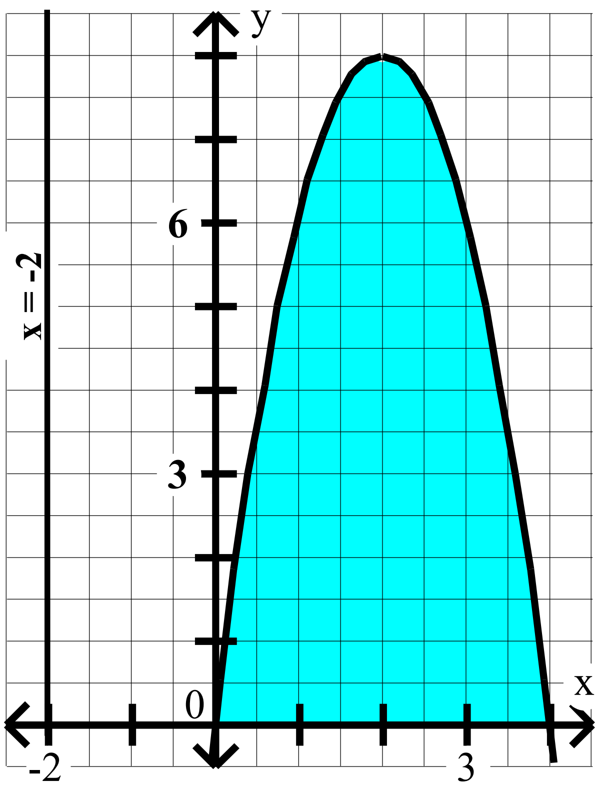

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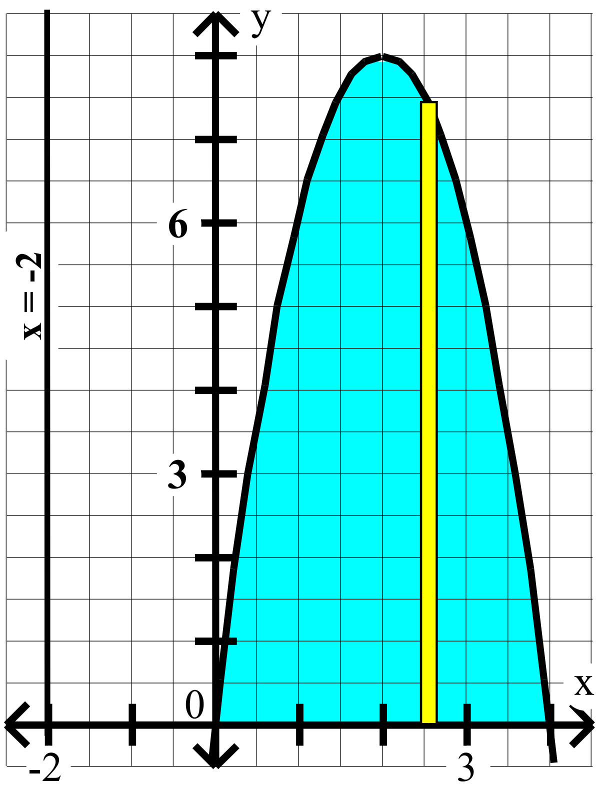

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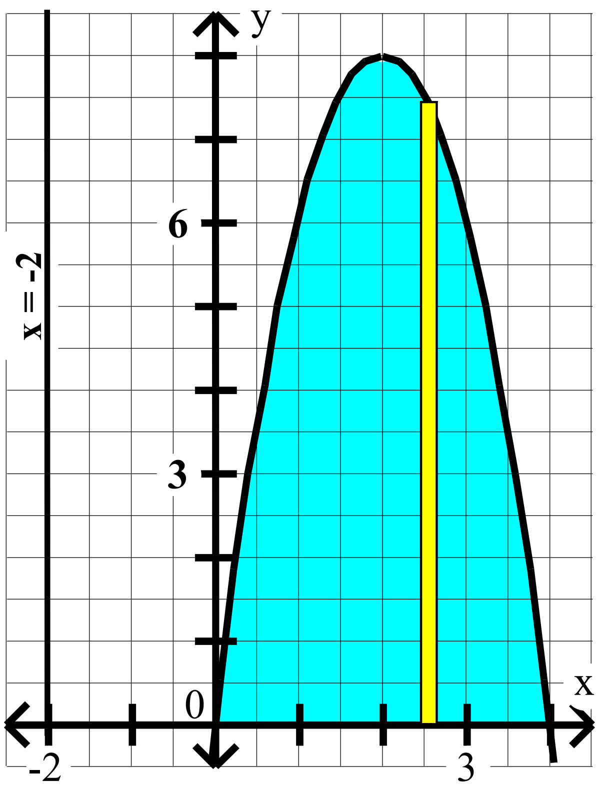

Shells: $V = 2\pi r h \Delta r$

$r =$

$h =$

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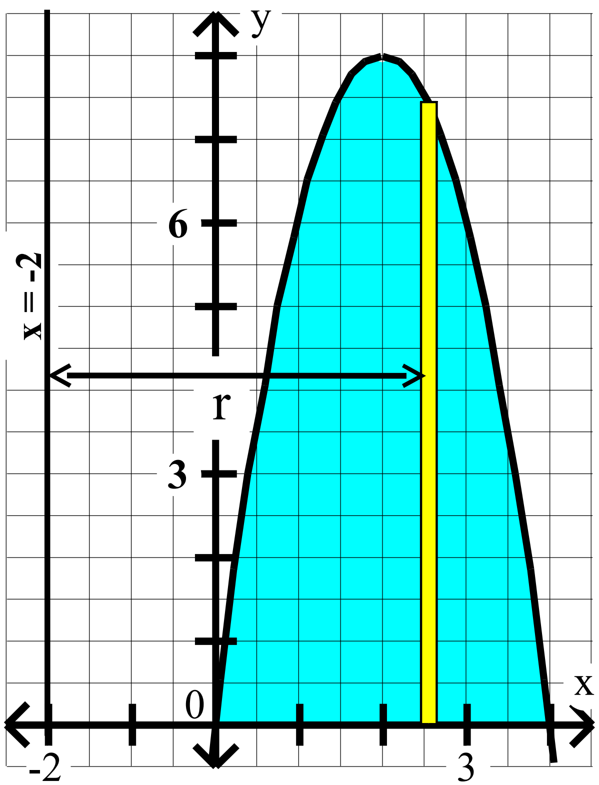

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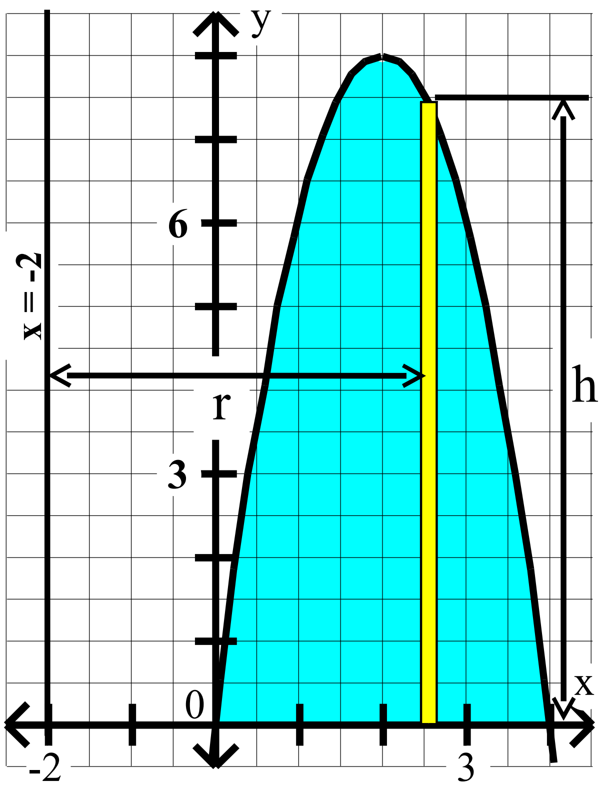

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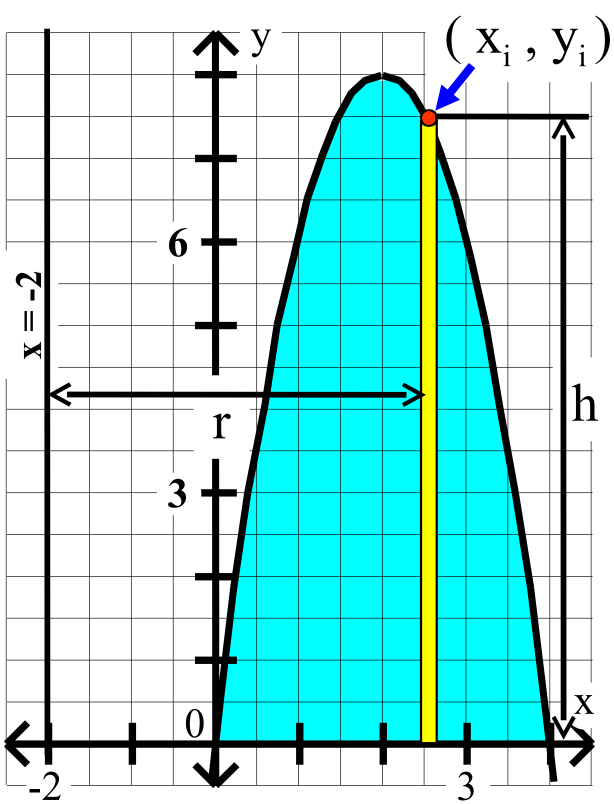

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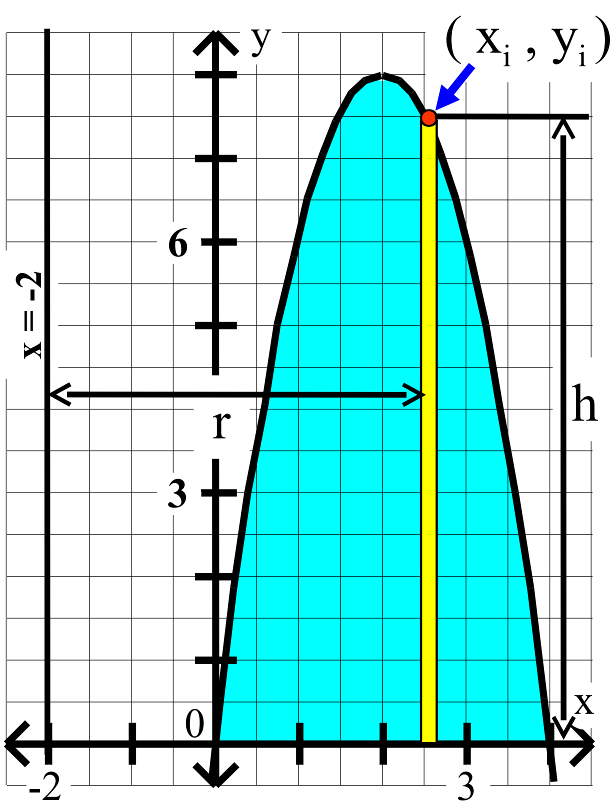

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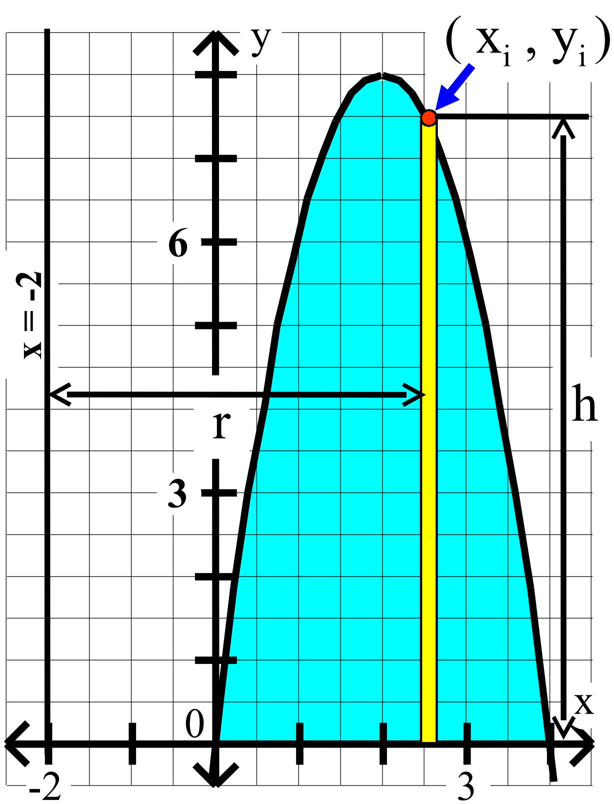

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Calculus   Class Worksheet #3   Unit 11   Solutions

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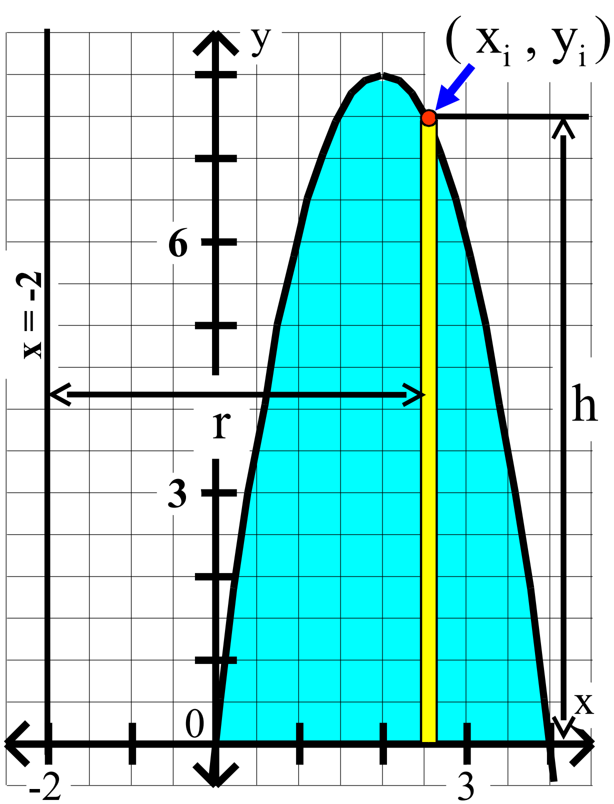

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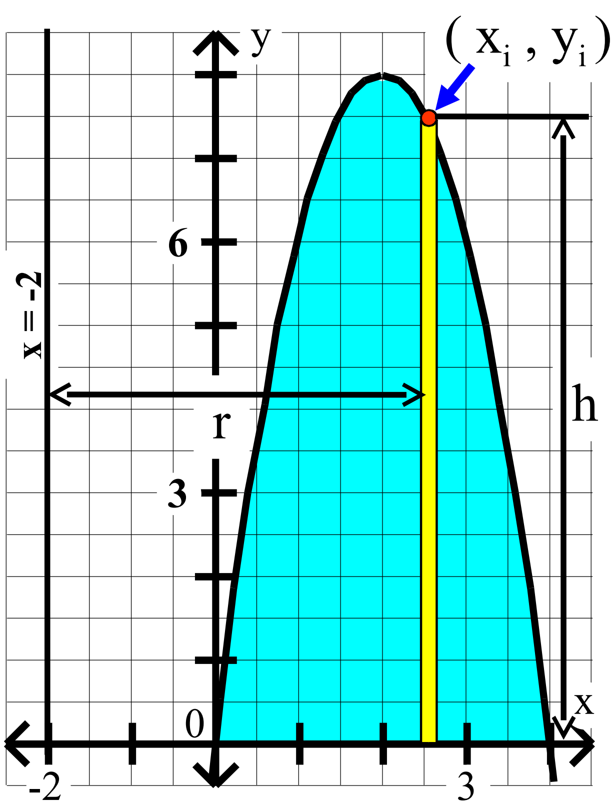

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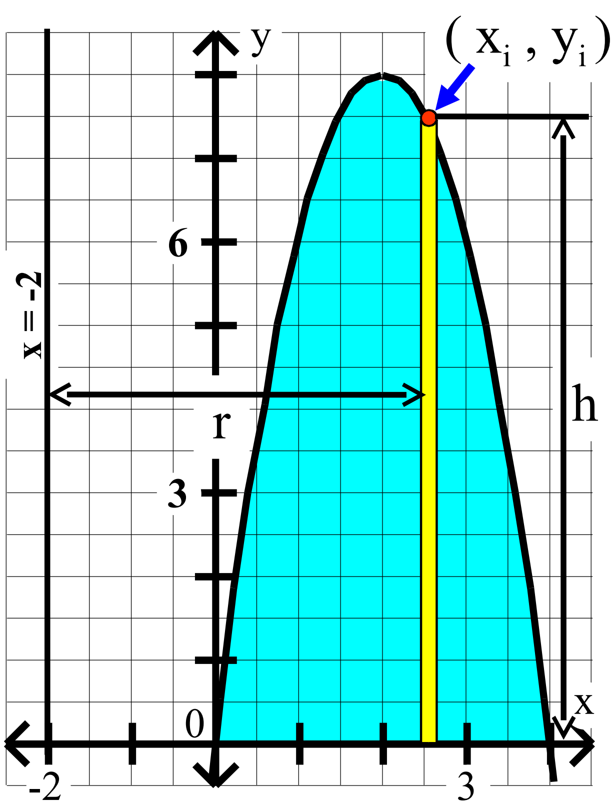

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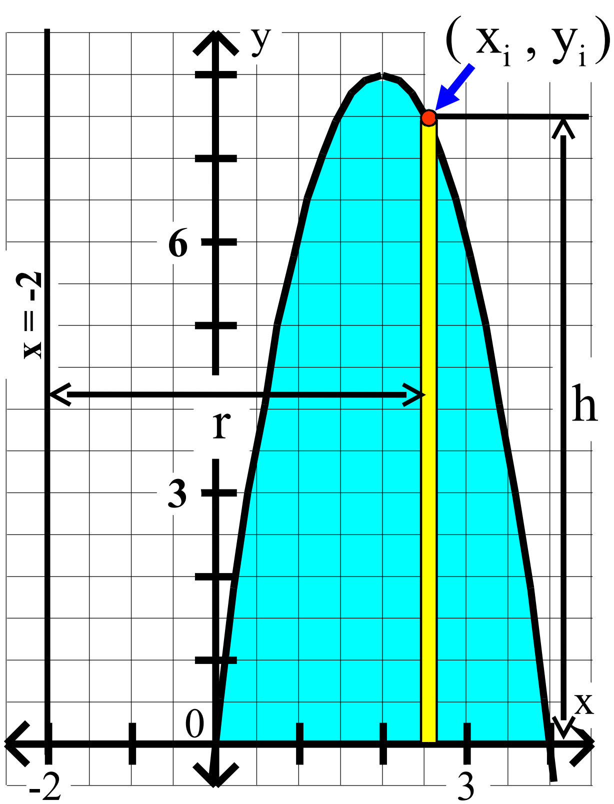

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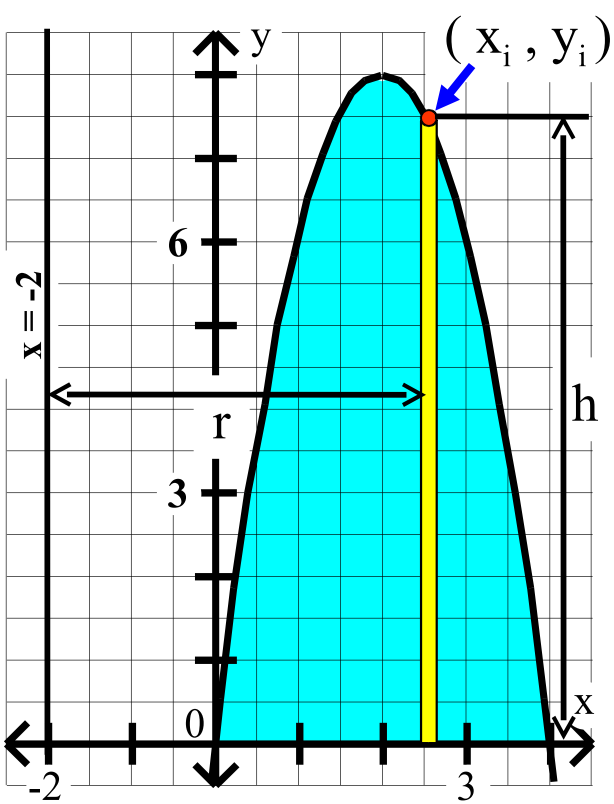

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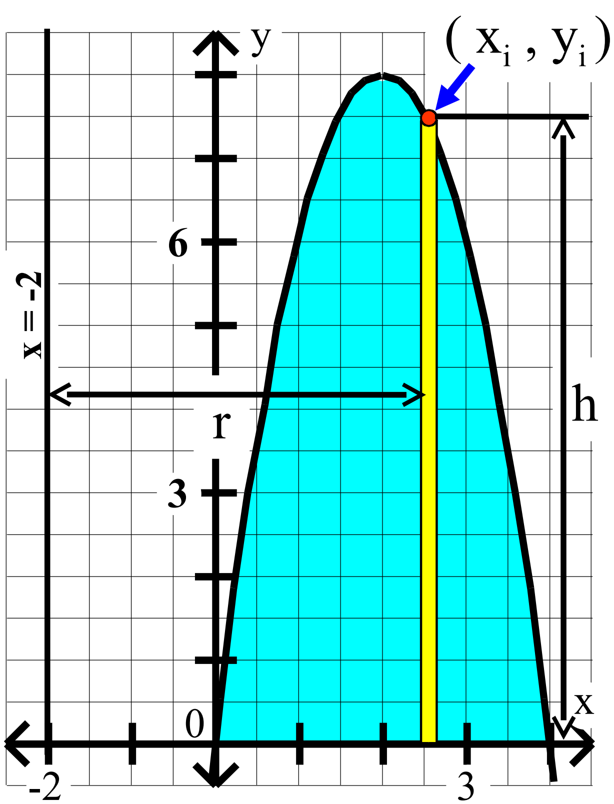

Shells: $V = 2\pi r h \Delta r$

$r = x_i + 2$

$h = y_i = 8x_i - 2x_i^2$

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b. $V_i = 2\pi(x_i + 2)$

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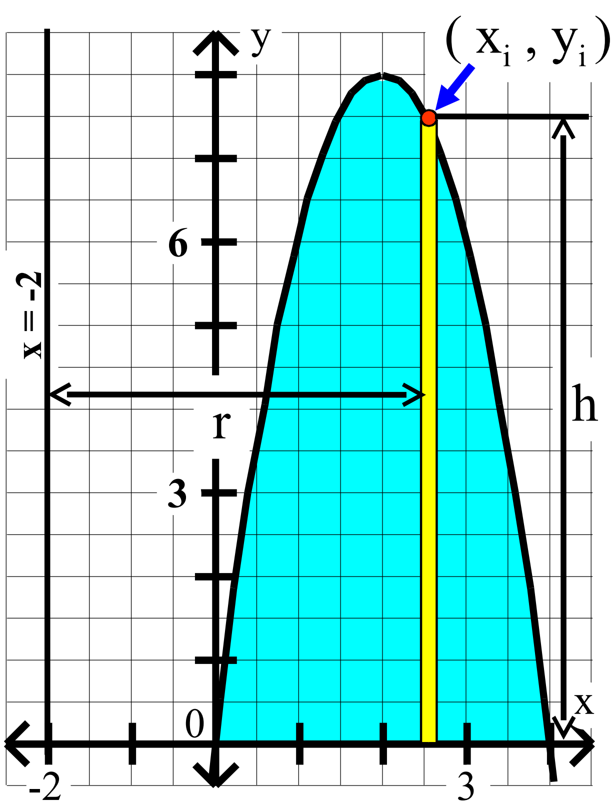

Shells: $V = 2\pi rh\Delta r$

$r = x_i + 2$

$h = y_i = 8x_i - 2x_i^2$

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b. $V_i = 2\pi(x_i + 2)(8x_i - 2x_i^2)$

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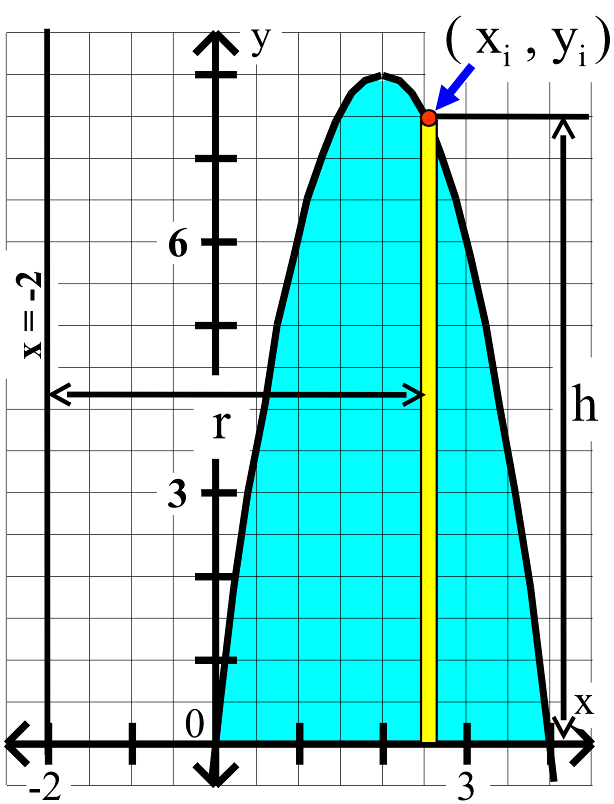

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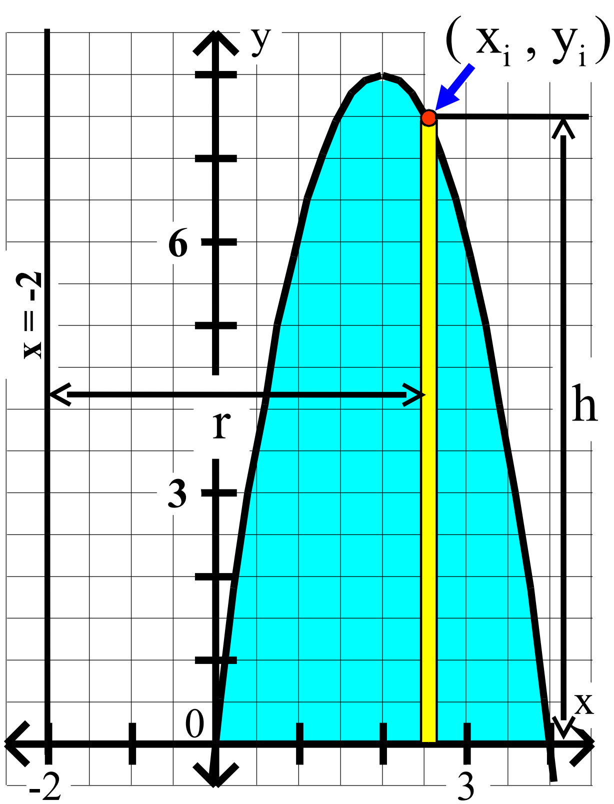

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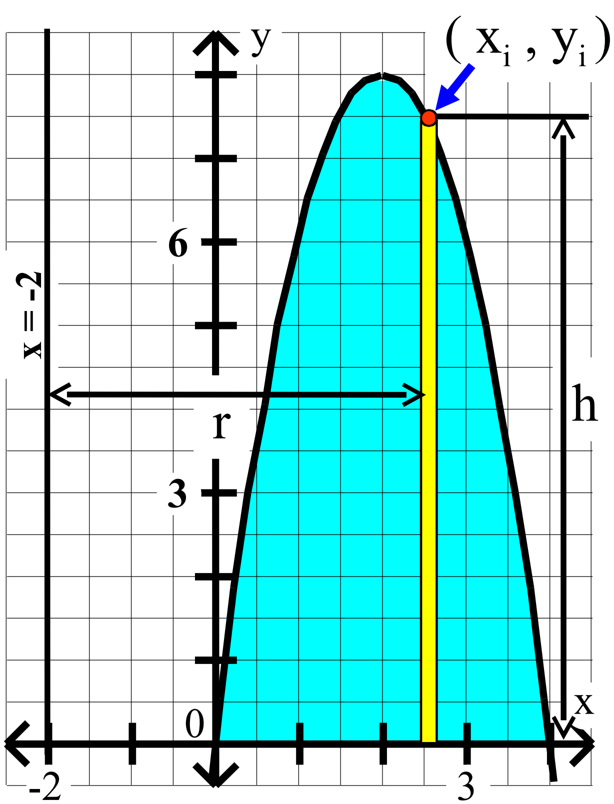

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b. $V_i = 2\pi(x_i + 2)(8x_i - 2x_i^2)\Delta x$

c. $V =$

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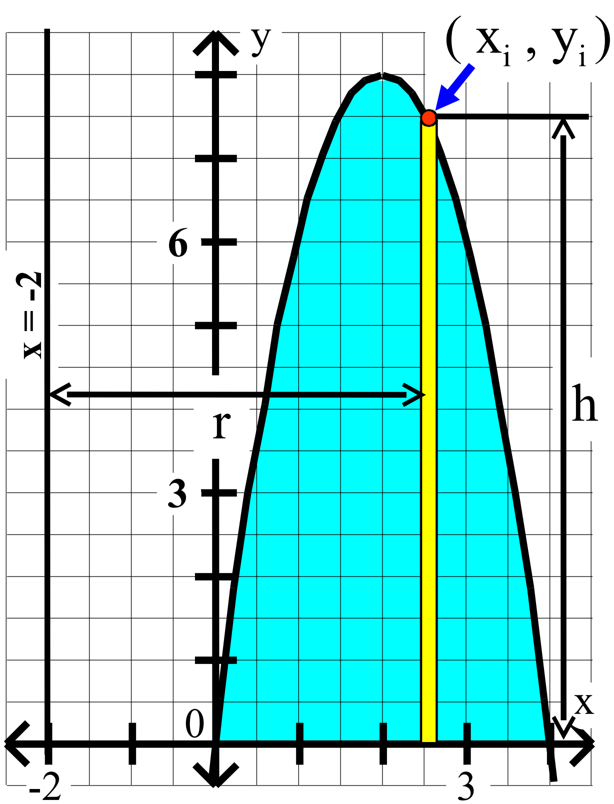

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b. $V_i = 2\pi(x_i + 2)(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi$

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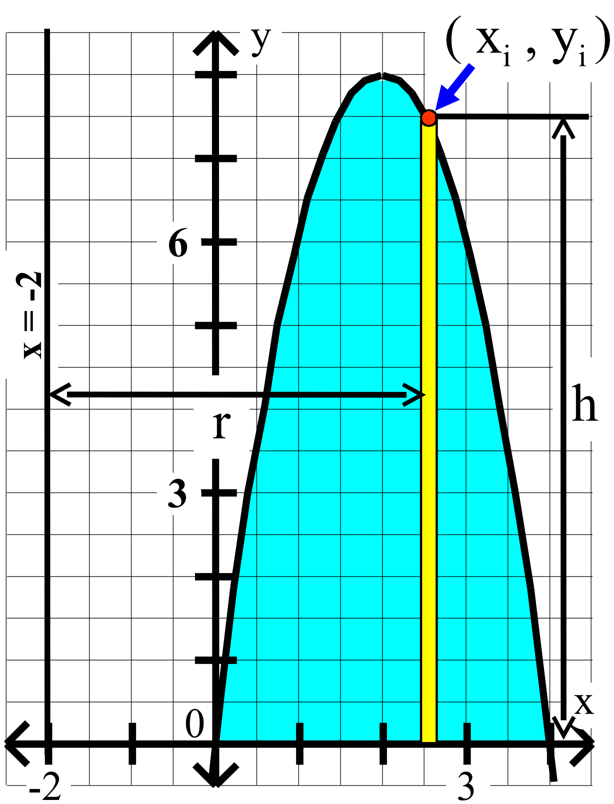

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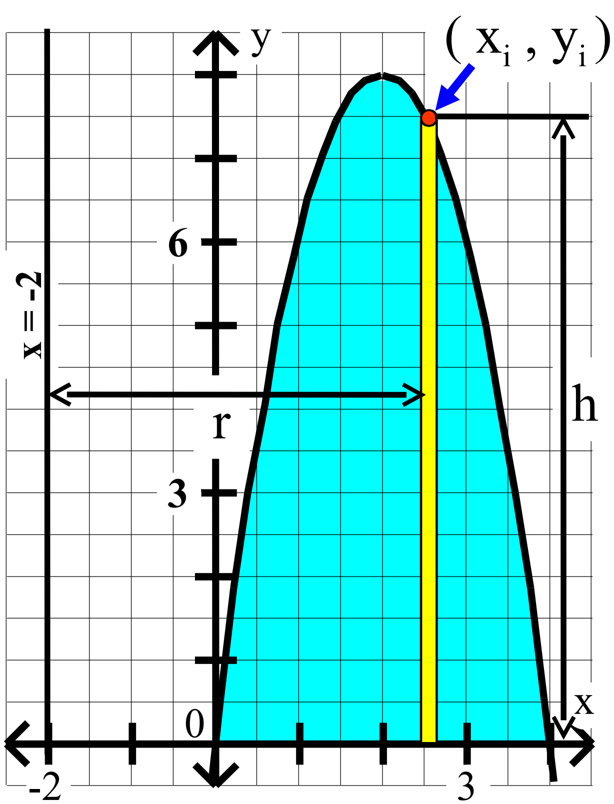

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$h = y_i = 8x_i - 2x_i^2$

$\Delta r = \Delta x$

b. $V_i = 2\pi(x_i + 2)(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi \int ((x + 2)(8x - 2x^2))\, dx$

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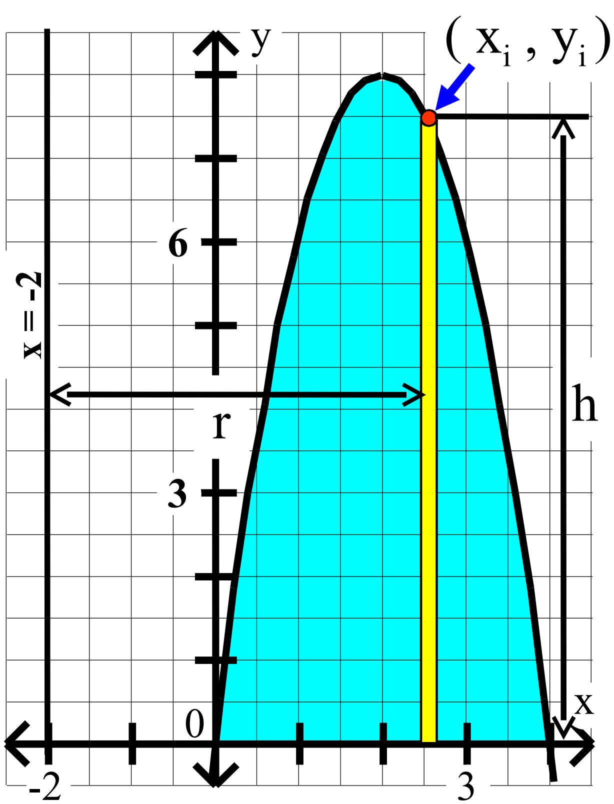

Shells: $V = 2\pi r h \Delta r$

$r = x_i + 2$

$h = y_i = 8x_i - 2x_i^2$

$\Delta r = \Delta x$

b. $V_i = 2\pi(x_i + 2)(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi\int_0((x + 2)(8x - 2x^2))\, dx$

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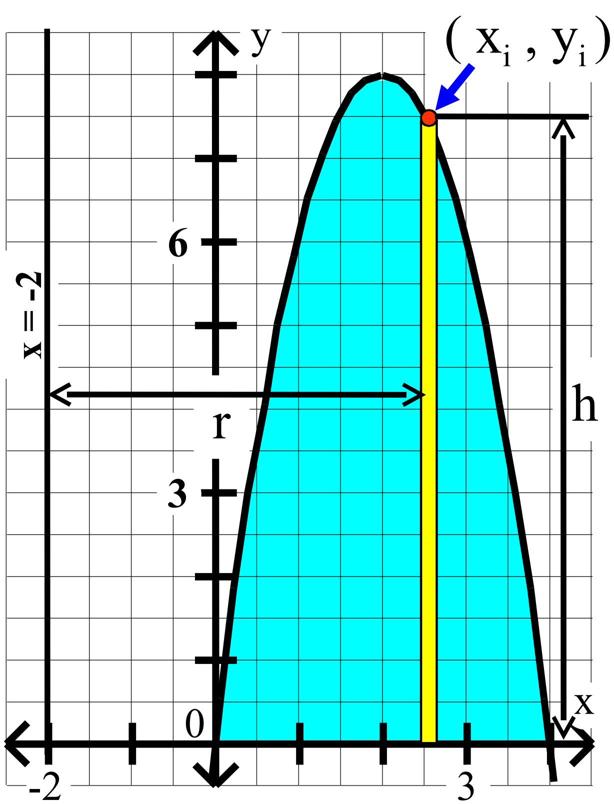

Shells: $V = 2\pi r h \Delta r$

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$h = y_i = 8x_i - 2x_i^2$

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b. $V_i = 2\pi(x_i + 2)(8x_i - 2x_i^2)\Delta x$

c. $V = 2\pi\int_0^4 ((x + 2)(8x - 2x^2))\, dx$

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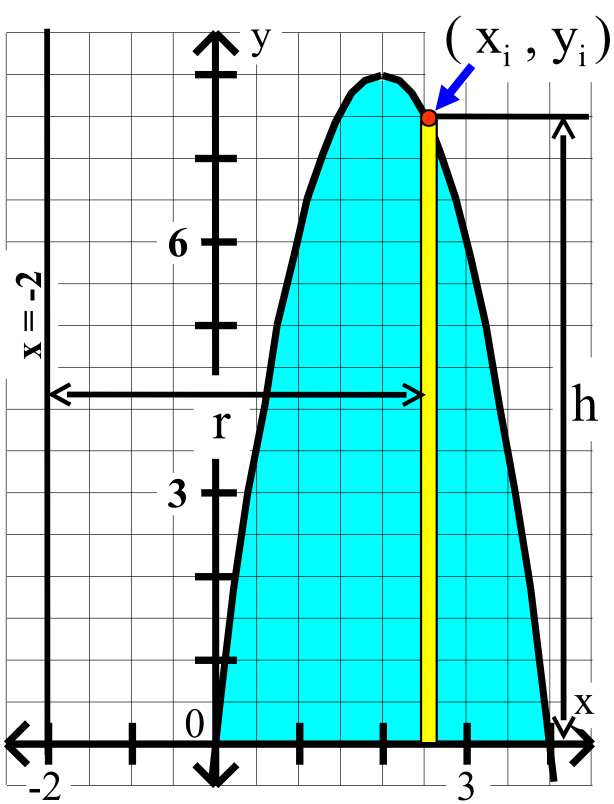

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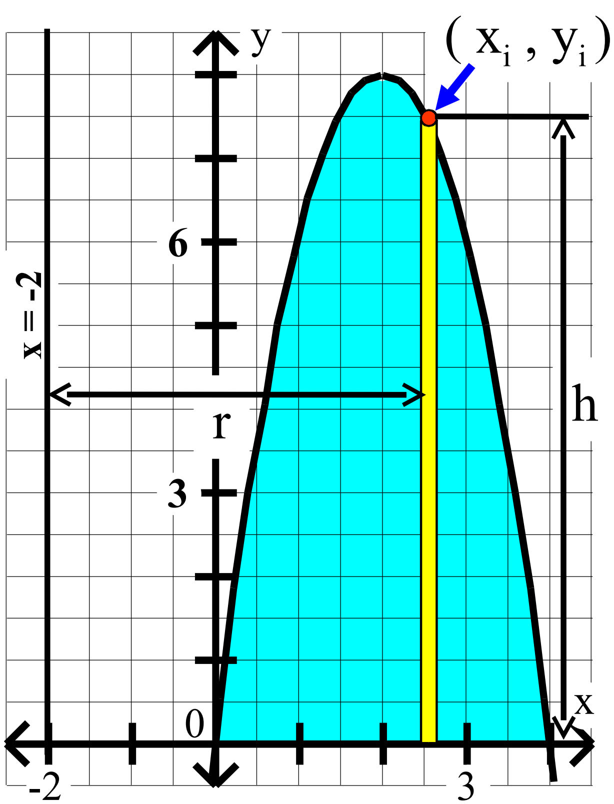

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c. $V = 2\pi\int_0^4 ((x + 2)(8x - 2x^2))\, dx$

$V = 2\pi\int_0^4 (-2x^3 + 4x^2 + 16x)\, dx$

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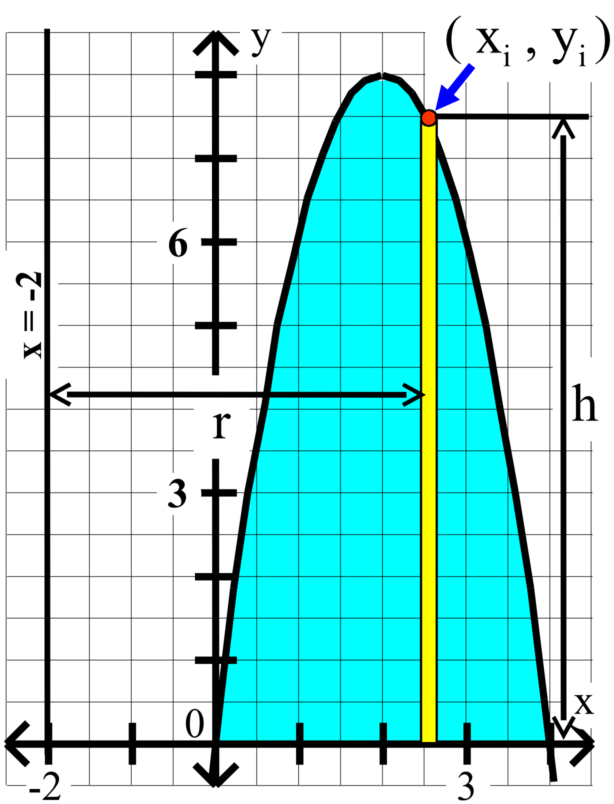

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d. $V \approx$

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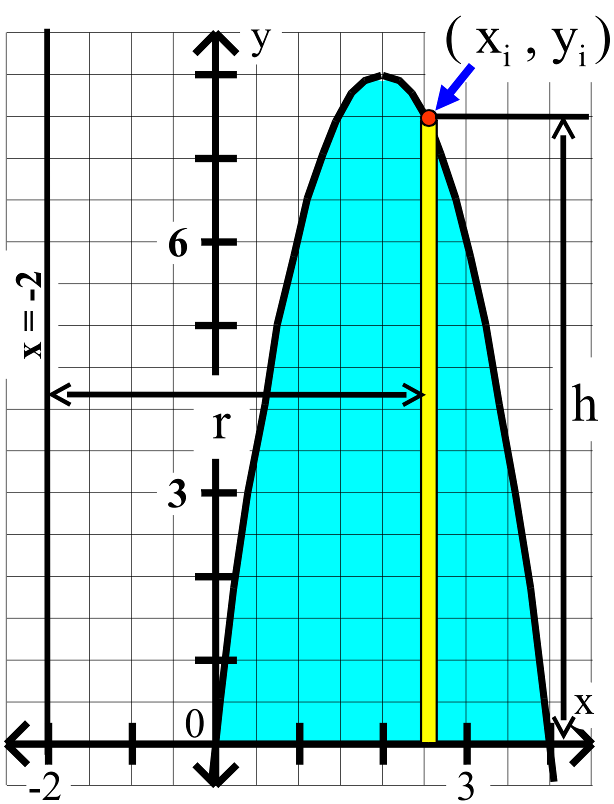

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d. $V \approx 536$ cu. units

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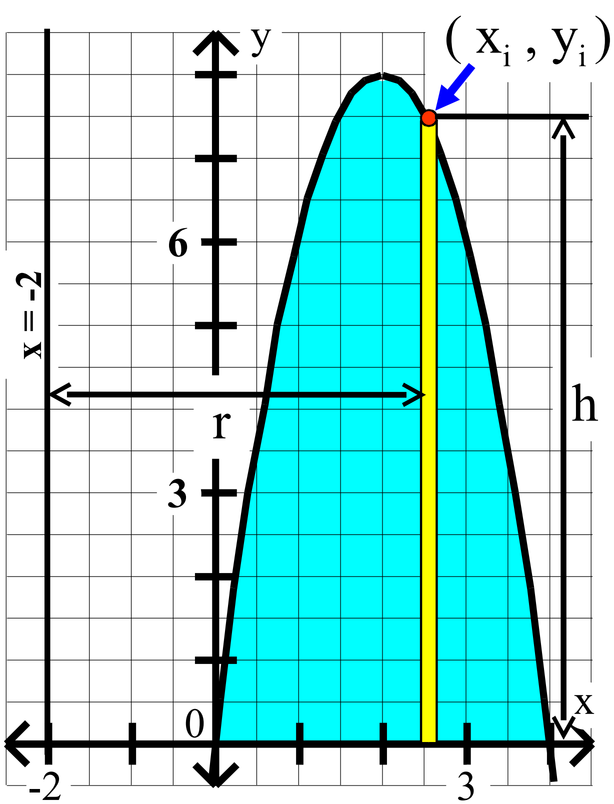

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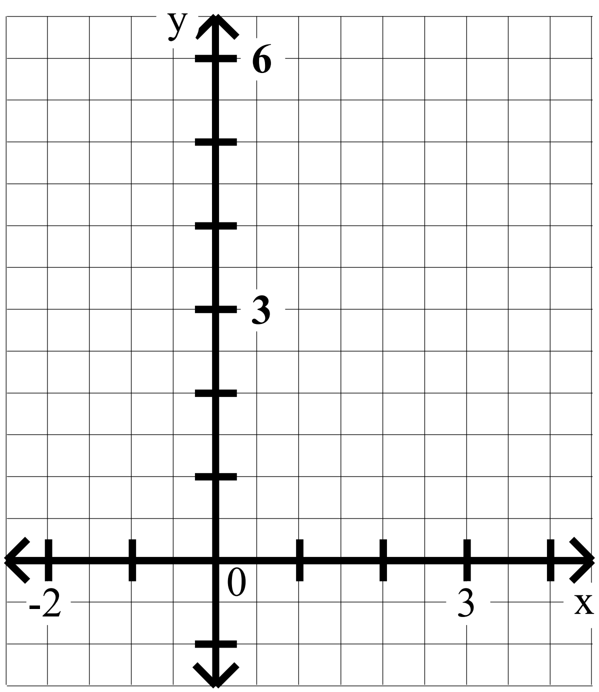

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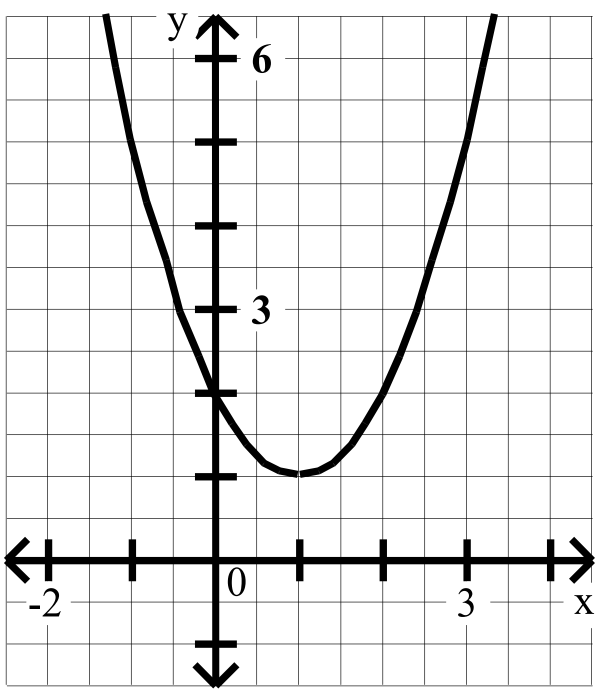

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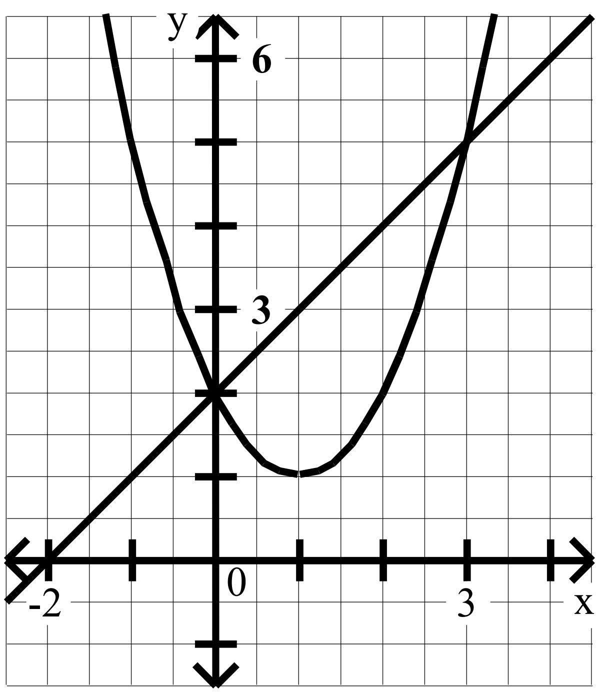

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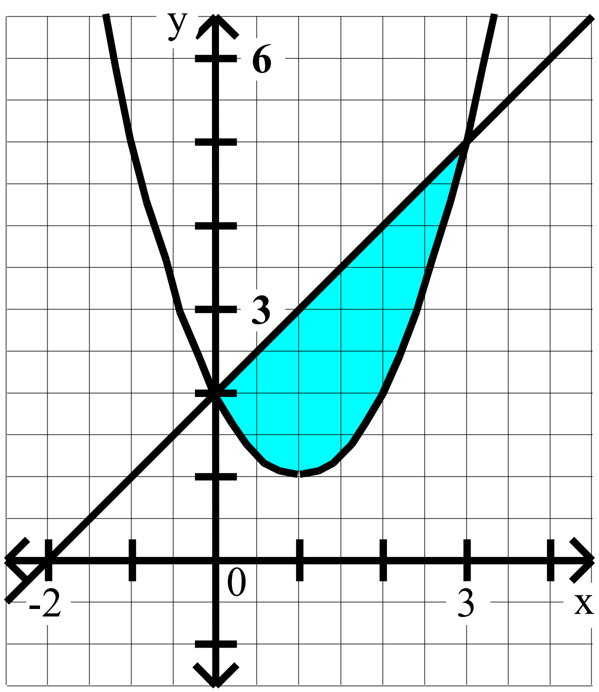

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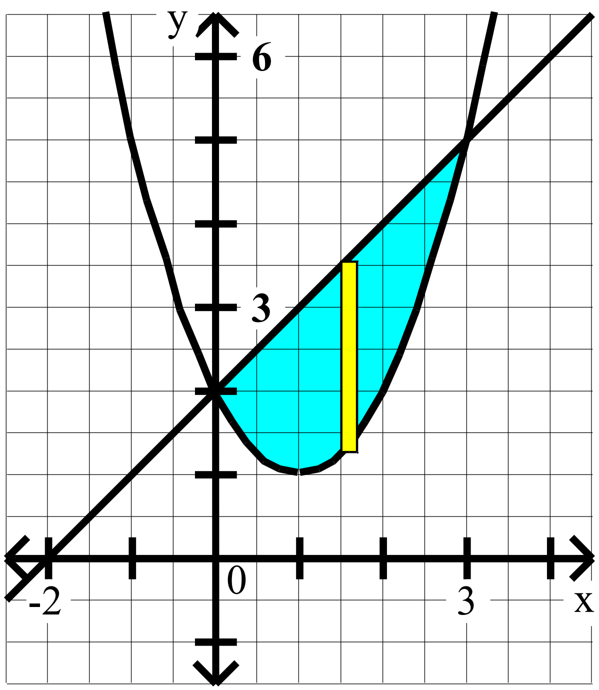

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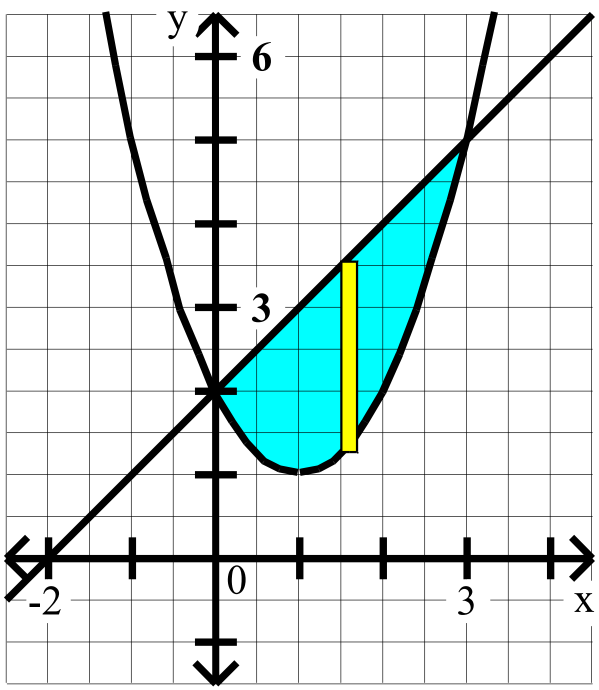

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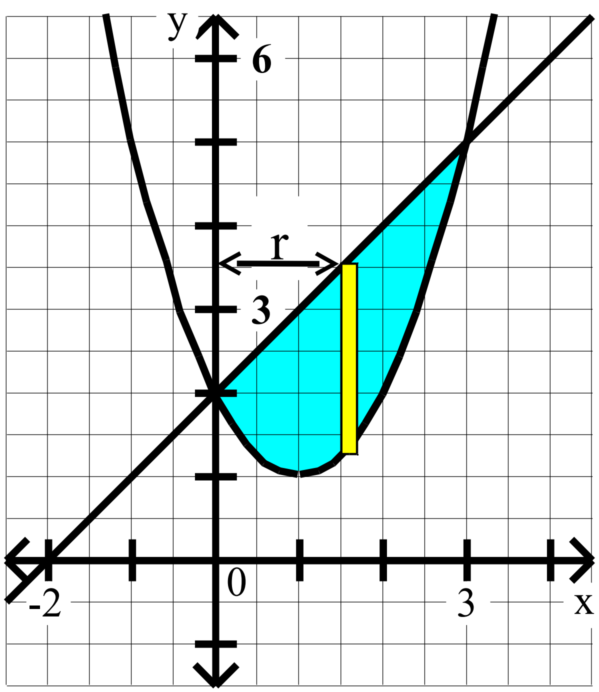

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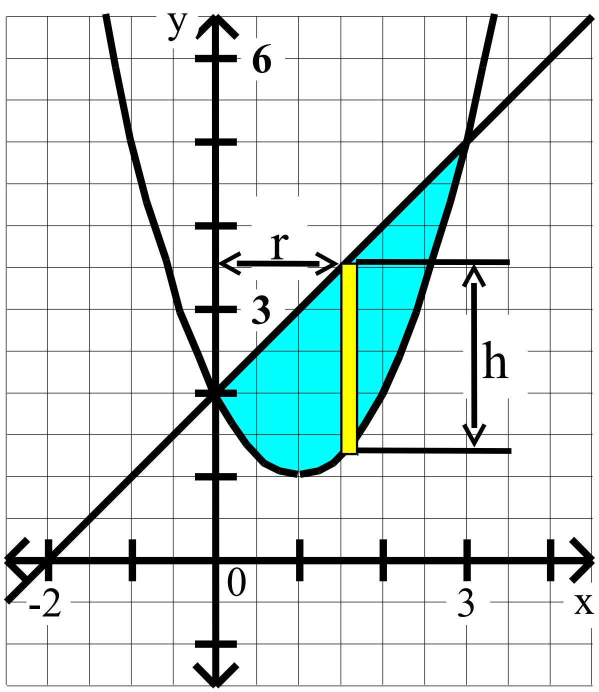

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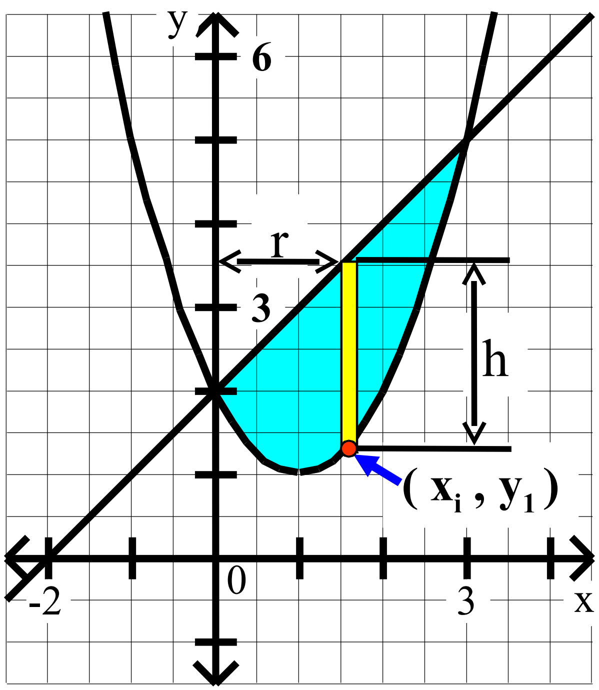

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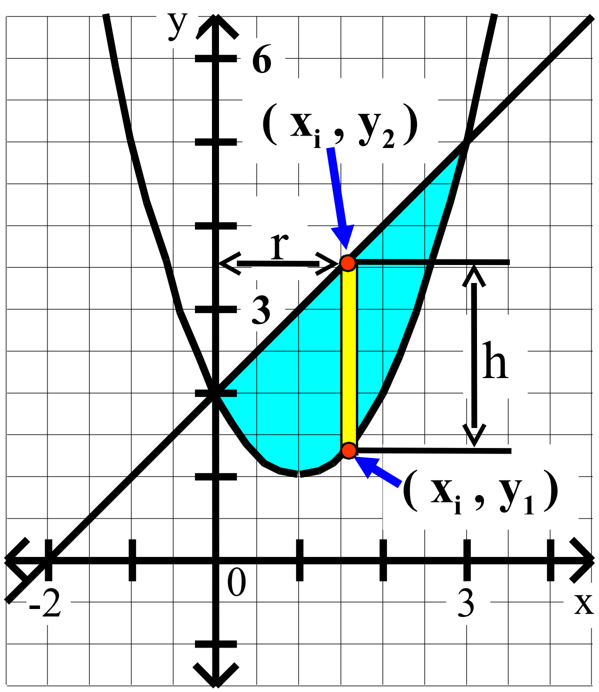

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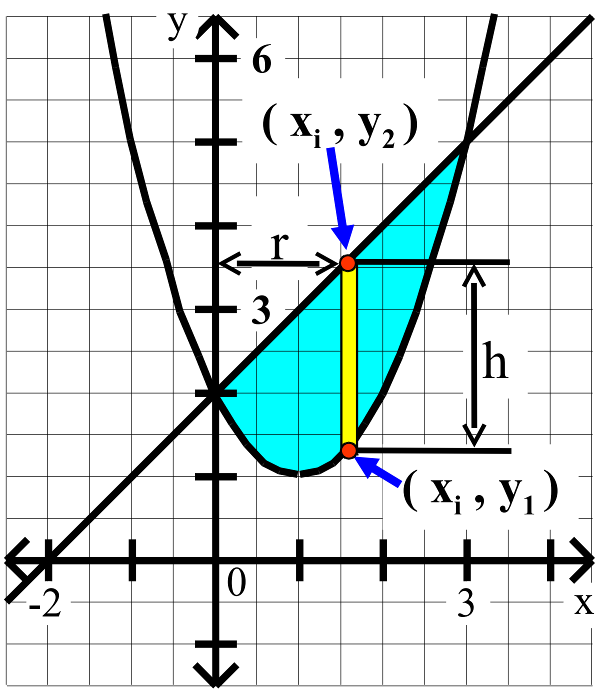

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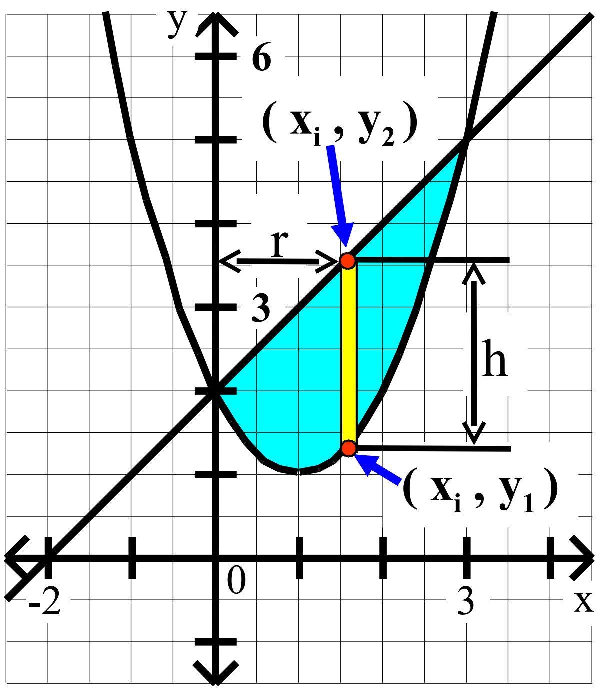

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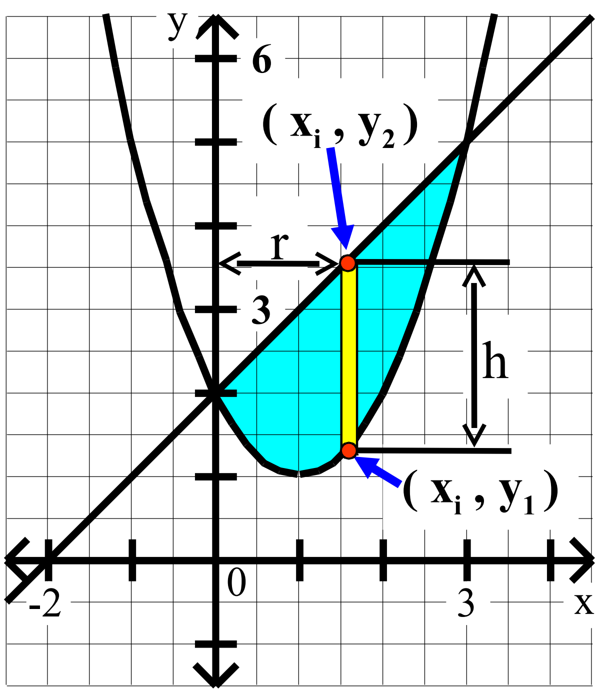

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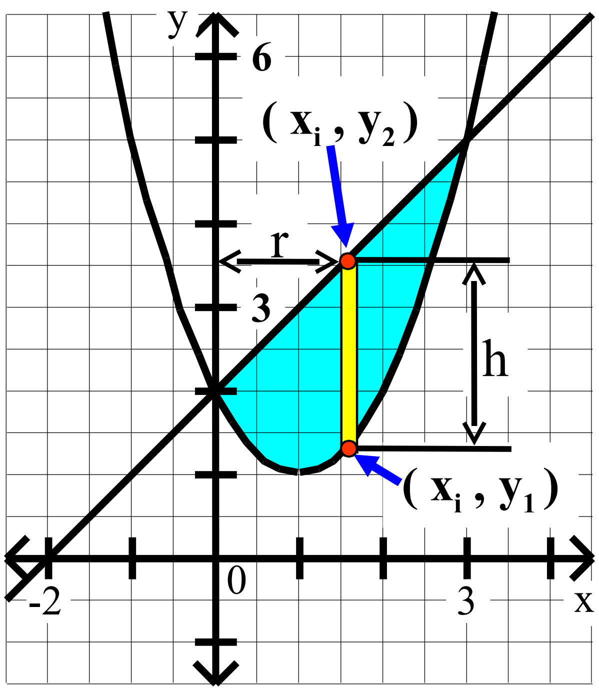

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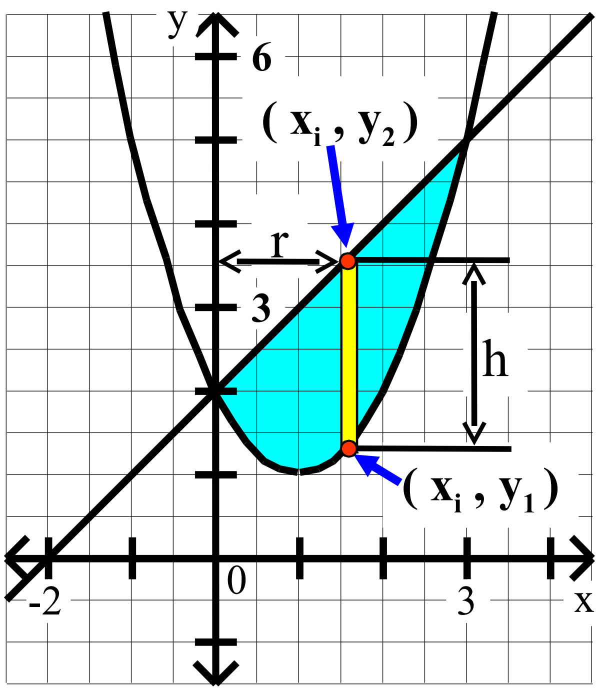

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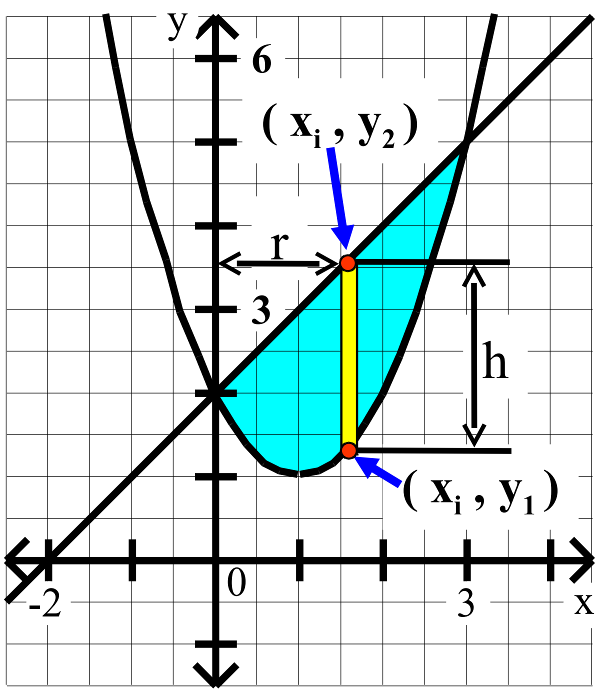

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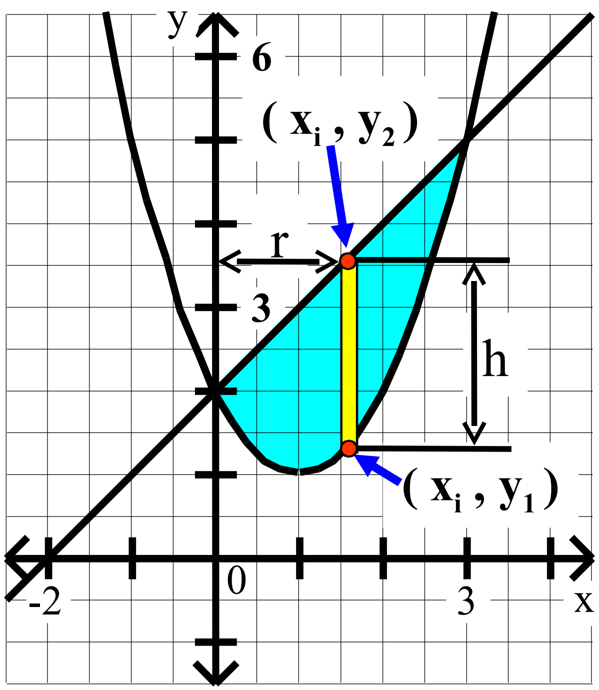

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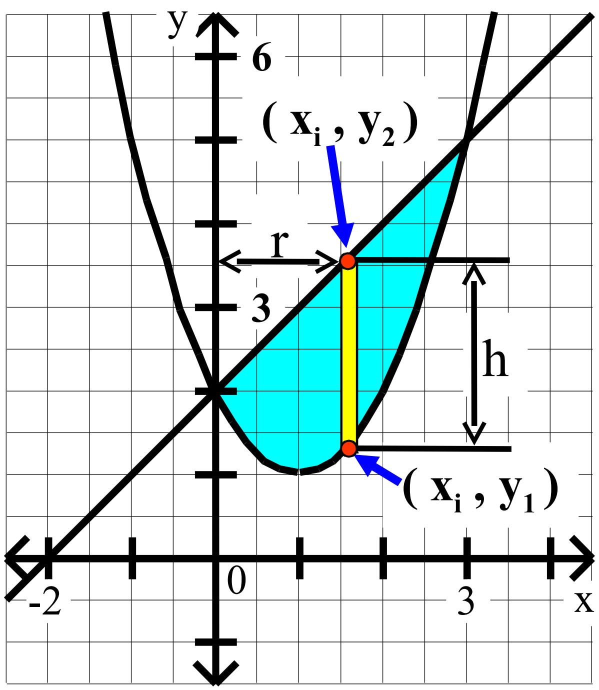

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$h = y_2 - y_1 = \mathbf{(x_i + 2) -}$

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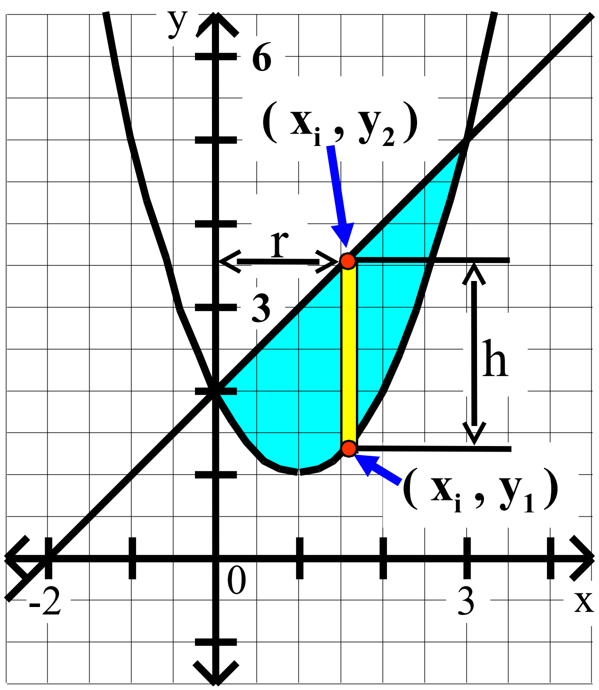

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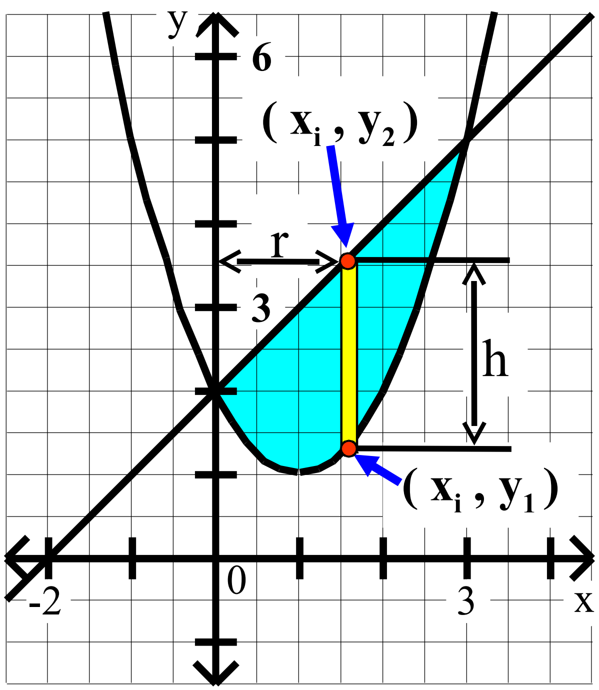

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$h = y_2 - y_1 = (x_i + 2) - (x_i^2 - 2x_i + 2) =$

$\Delta r = \Delta x$

Calculus Class Worksheet #3 Unit 11 Solutions

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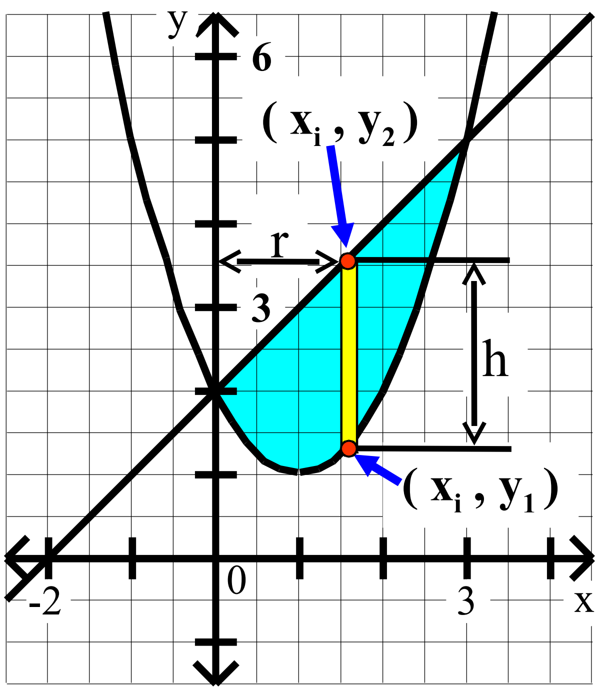

Shells: $V = 2\pi r h \Delta r$

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Calculus   Class Worksheet #3   Unit 11   Solutions

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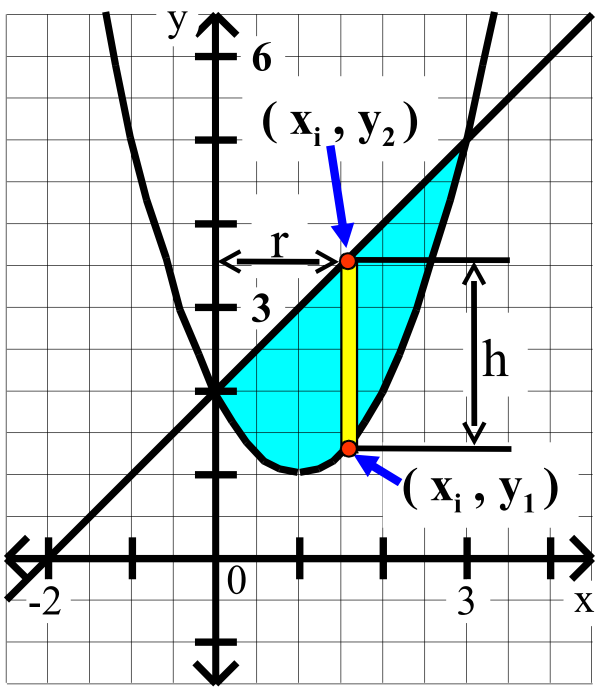

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Calculus Class Worksheet #3 Unit 11 Solutions

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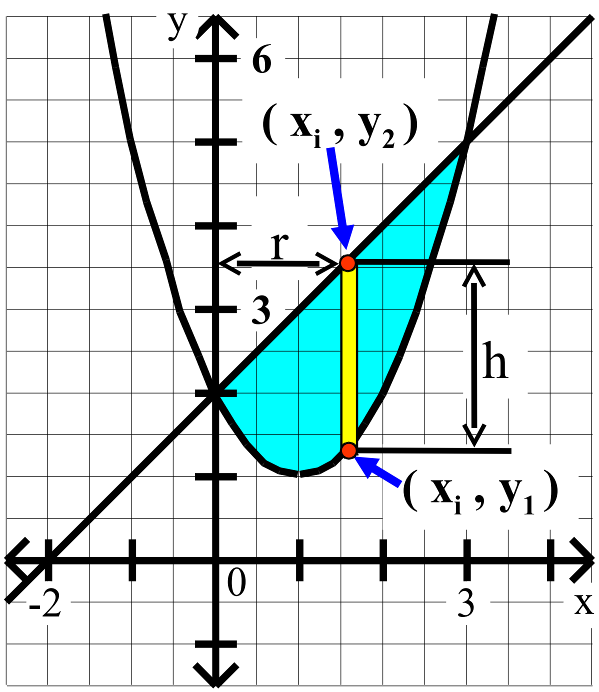

Shells: $V = 2\pi r h \Delta r$

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Calculus Class Worksheet #3 Unit 11 Solutions

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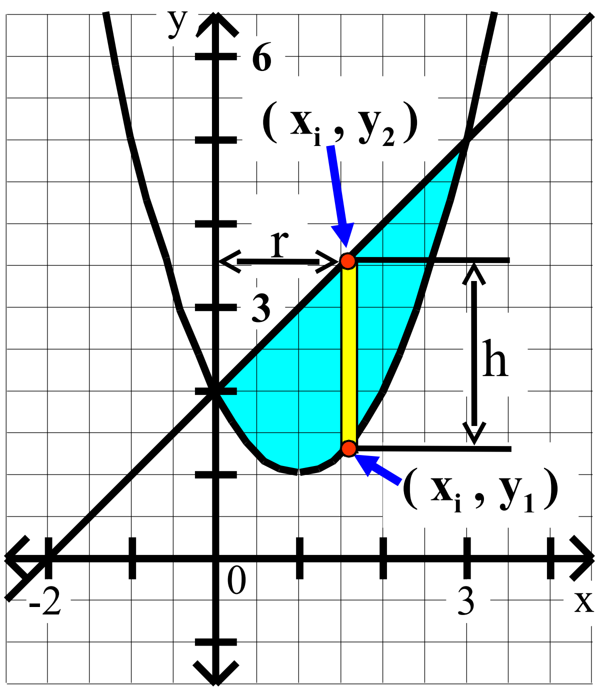

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Calculus Class Worksheet #3 Unit 11 Solutions

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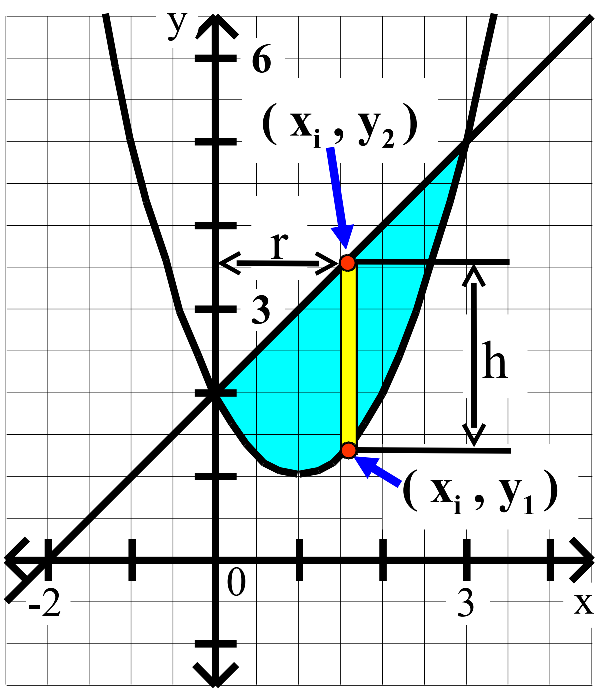

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b. $V_i = 2\pi x_i(3x_i - x_i^2)$

Calculus Class Worksheet #3 Unit 11 Solutions

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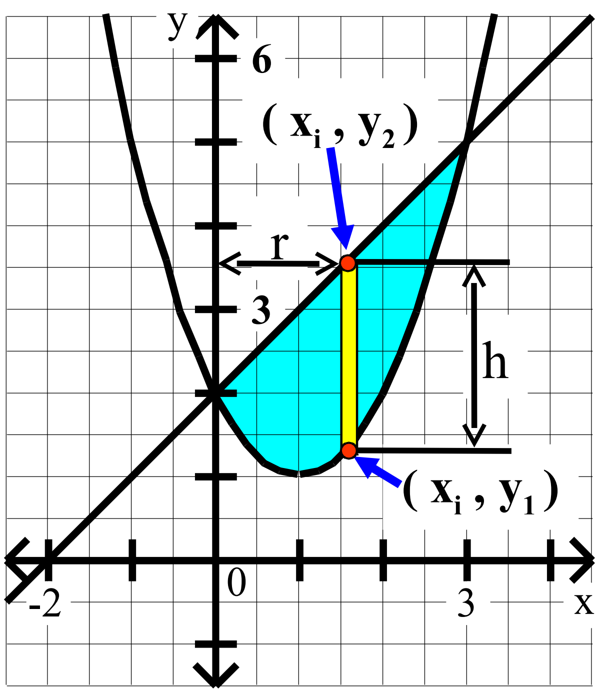

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b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

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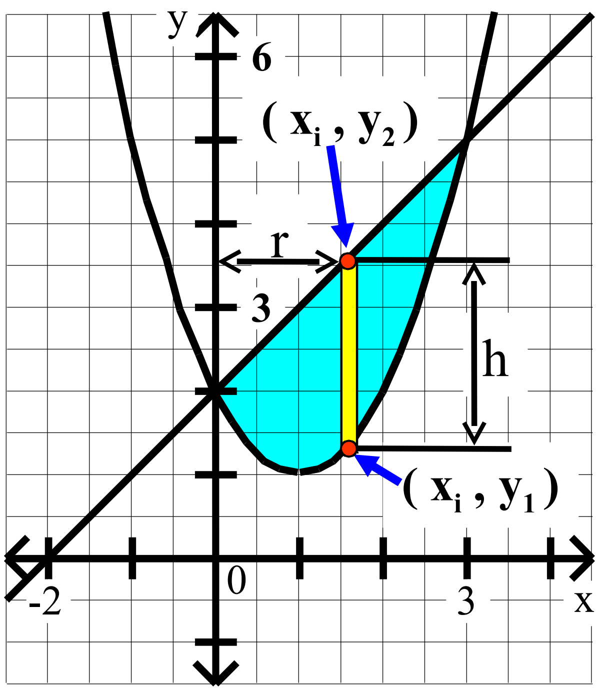

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b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

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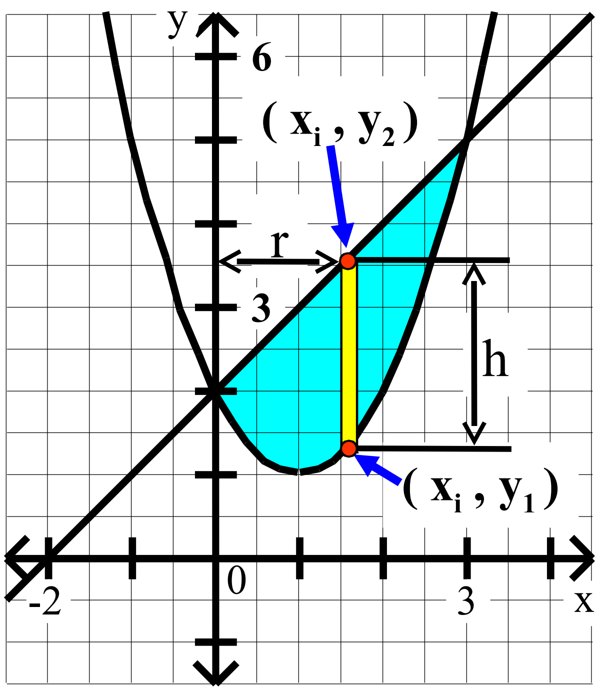

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$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

c. $V =$

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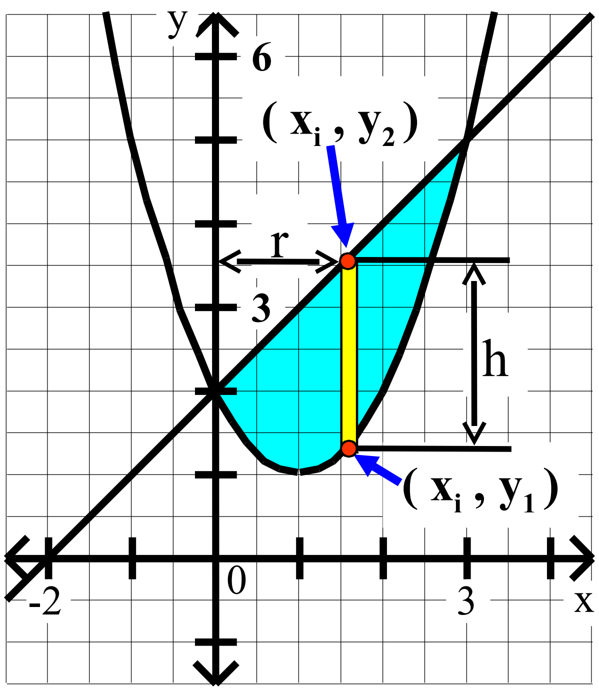

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$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

c. $V = 2\pi$

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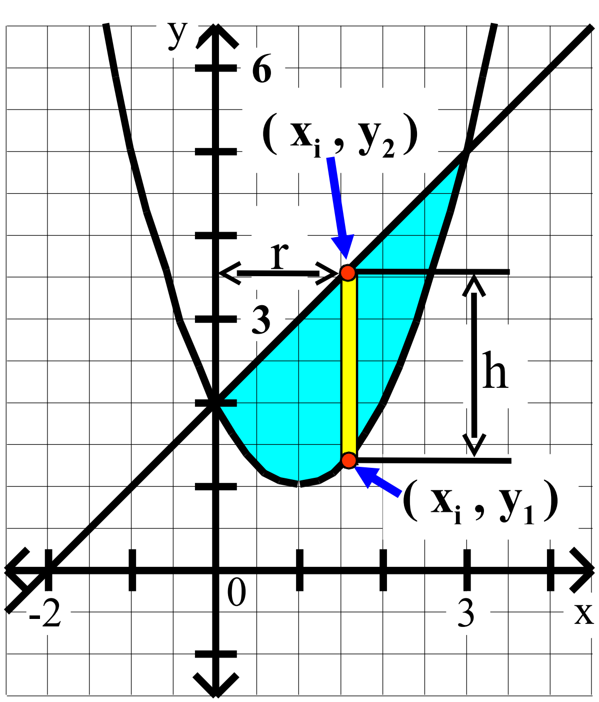

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$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

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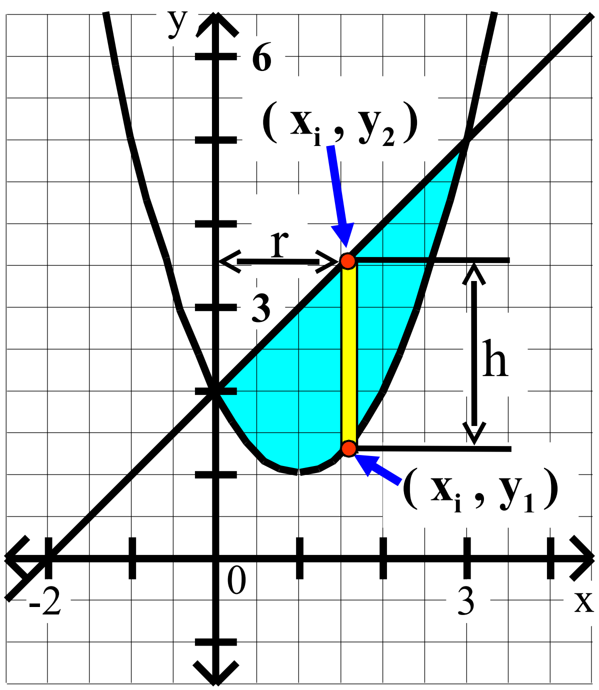

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b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

c. $V = 2\pi \int (x(3x - x^2))\, dx$

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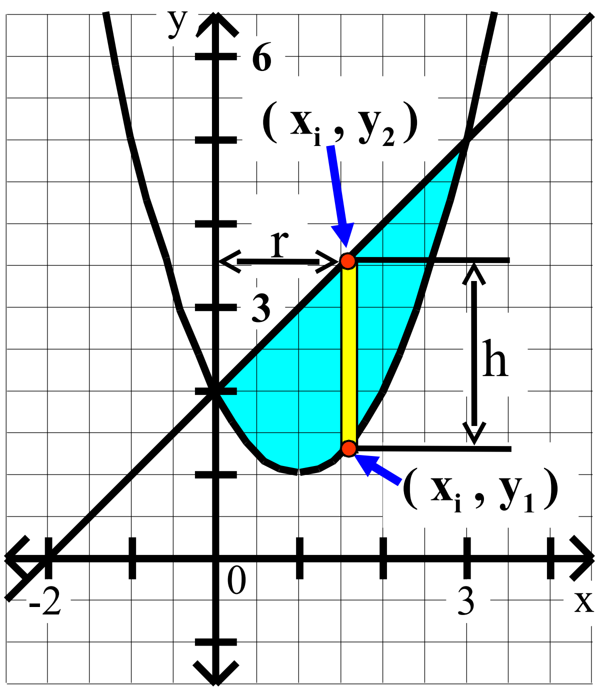

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b. $\boxed{V_i = 2\pi x_i(3x_i - x_i^2)\Delta x}$

c. $V = 2\pi \int_0 (x(3x - x^2))\, dx$

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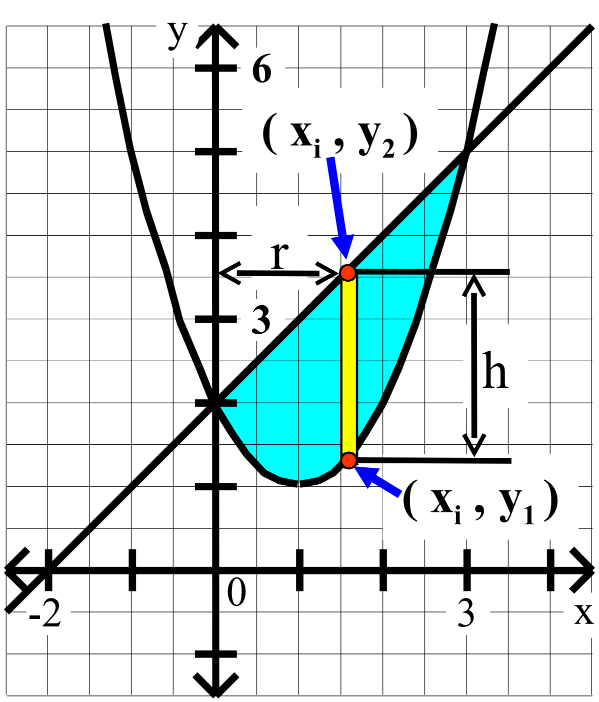

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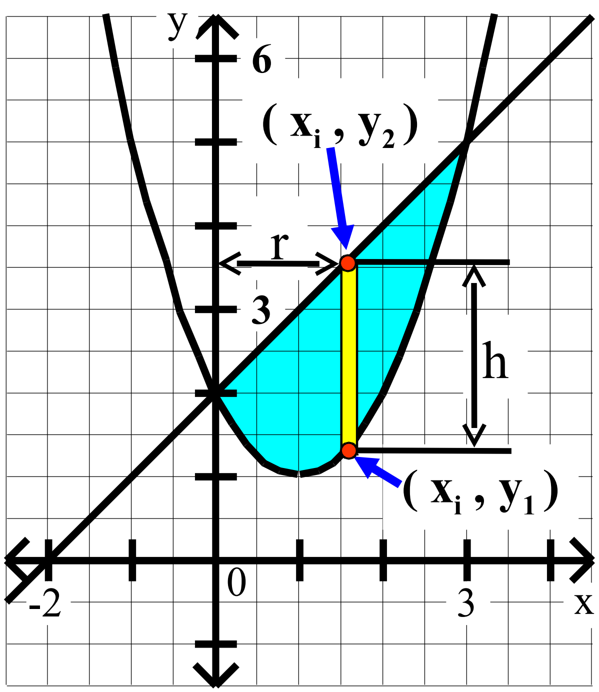

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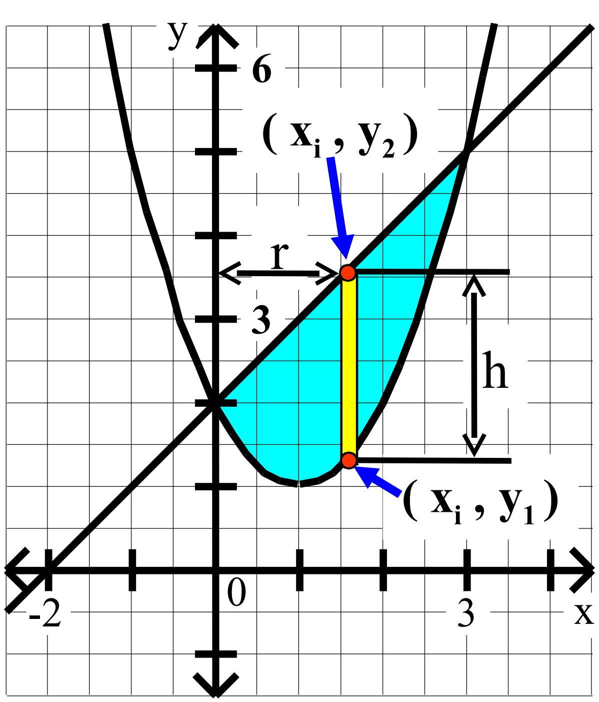

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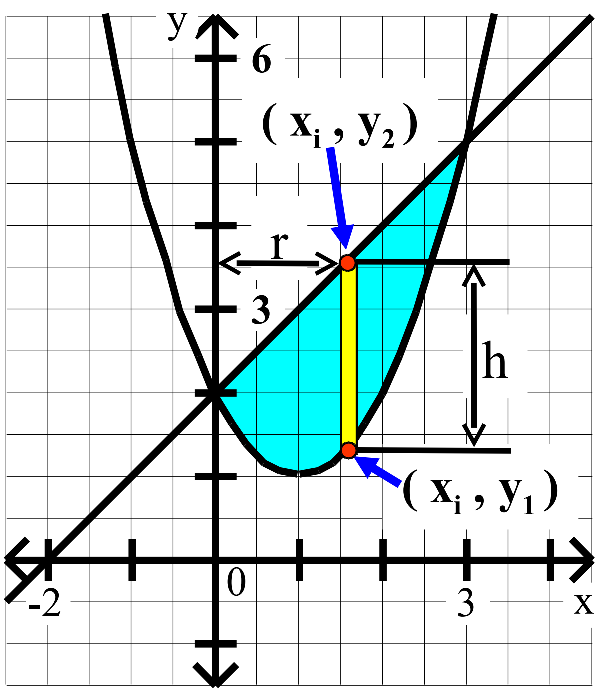

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b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

c. $V = 2\pi\int_0^3 (x(3x - x^2))\, dx$

$V = 2\pi\int_0^3 (3x^2 - x^3)\, dx$

d. $V \approx$

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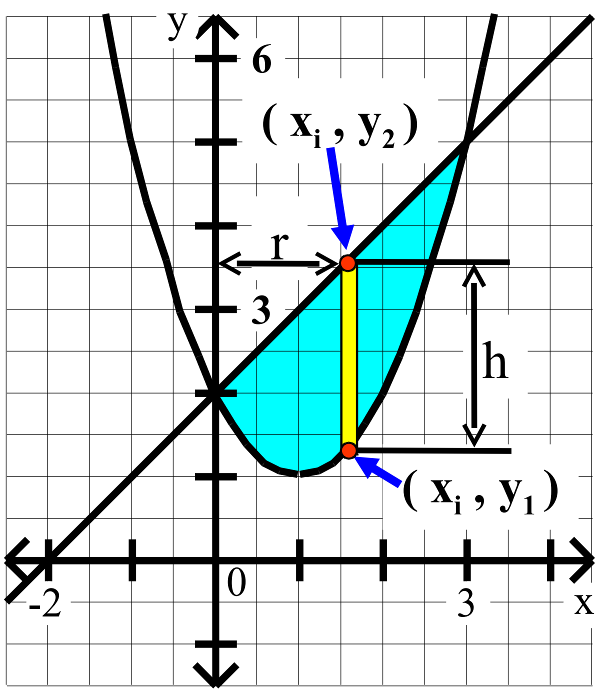

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$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

c. $V = 2\pi \int_0^3 (x(3x - x^2))\,dx$

$V = 2\pi \int_0^3 (3x^2 - x^3)\,dx$

d. $V \approx 42.4$ cu. units

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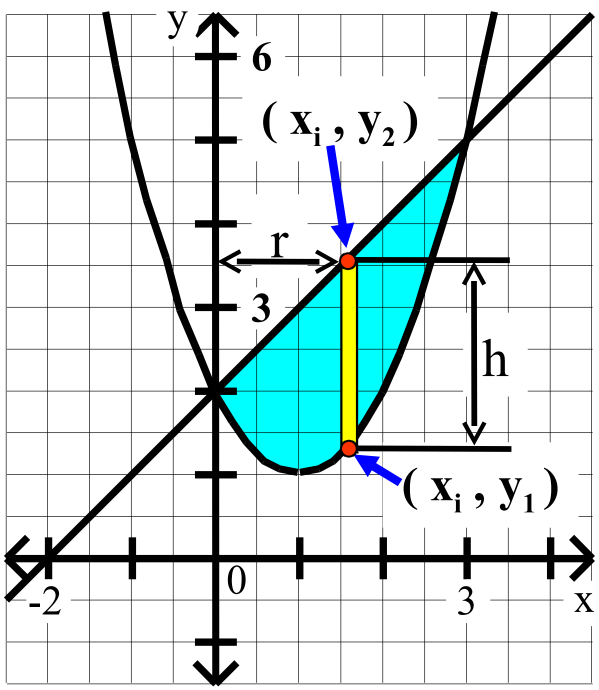

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$\Delta r = \Delta x$

b. $V_i = 2\pi x_i(3x_i - x_i^2)\Delta x$

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Sample 2B. The region enclosed by $y = x^2 - 2x + 2$ and $y = x + 2$ is rotated about the line $x = 4$.

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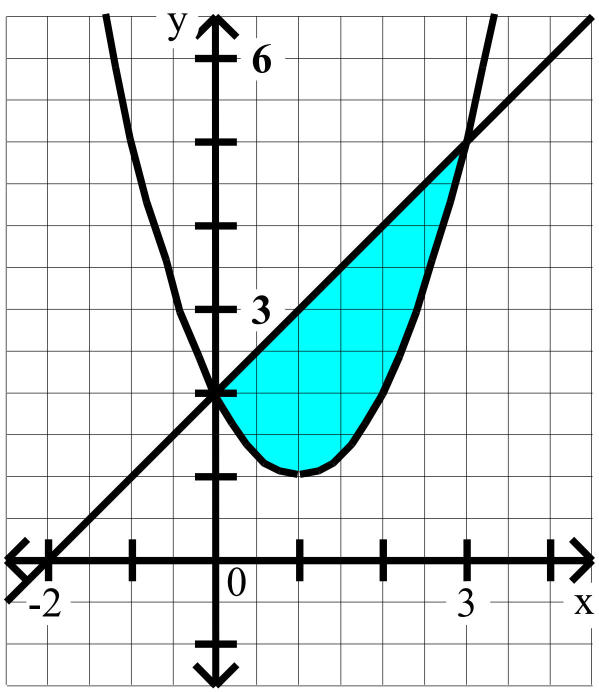
a.



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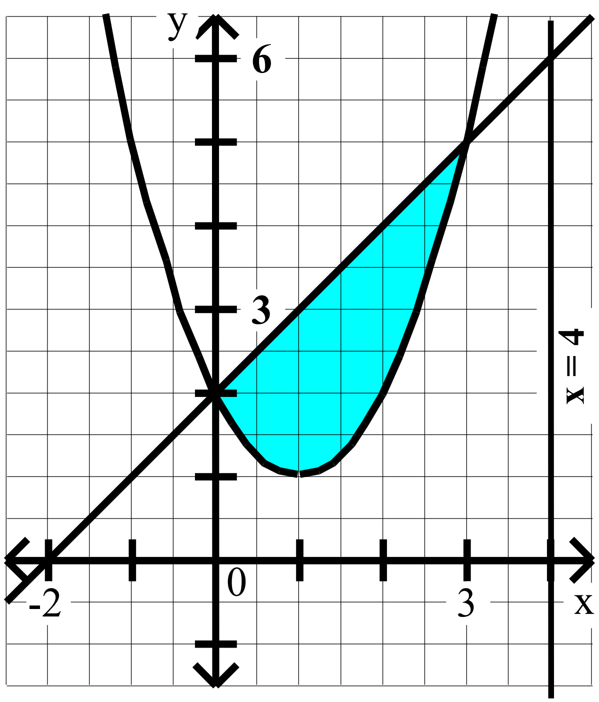

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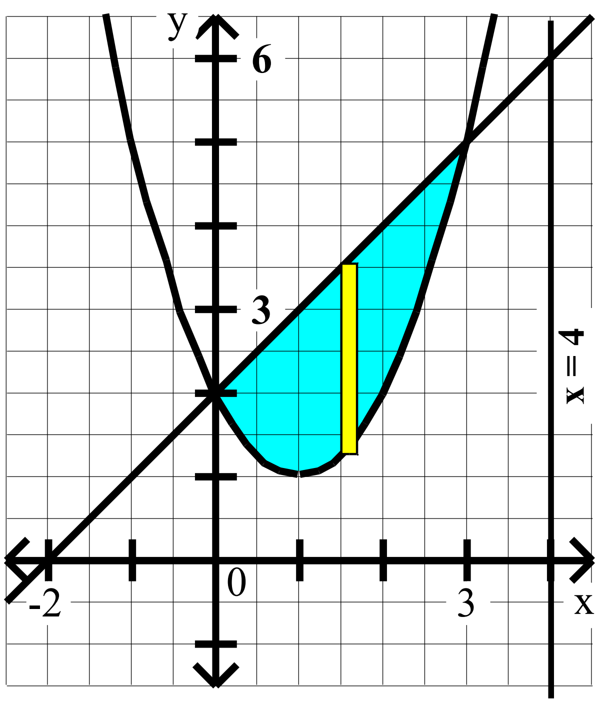

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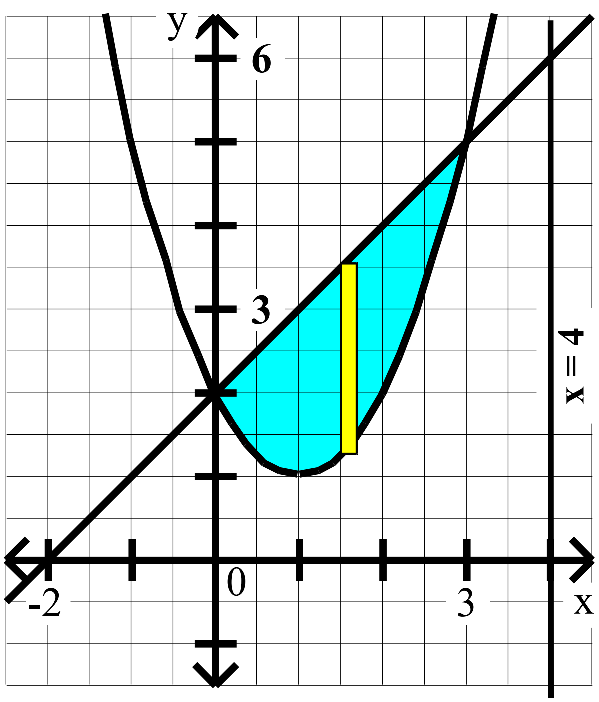

Shells: $V = 2\pi r h \Delta r$

$r =$

$h =$

$\Delta r =$

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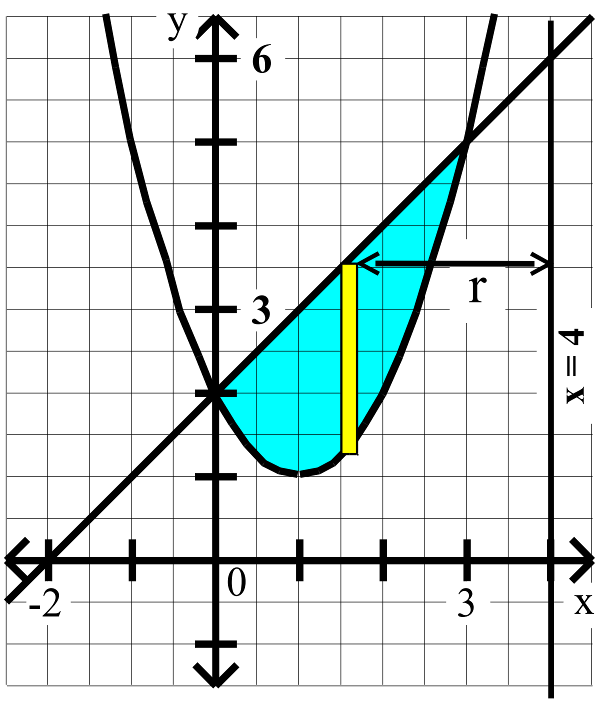

Shells: $V = 2\pi r h \Delta r$

r =

h =

Δr =

Calculus Class Worksheet #3 Unit 11 Solutions

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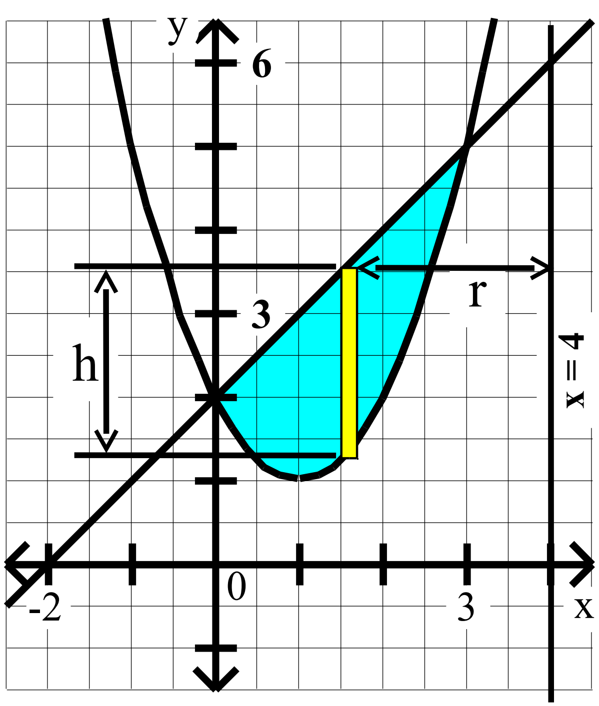

Shells: $V = 2\pi r h \Delta r$

$r =$

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$\Delta r =$

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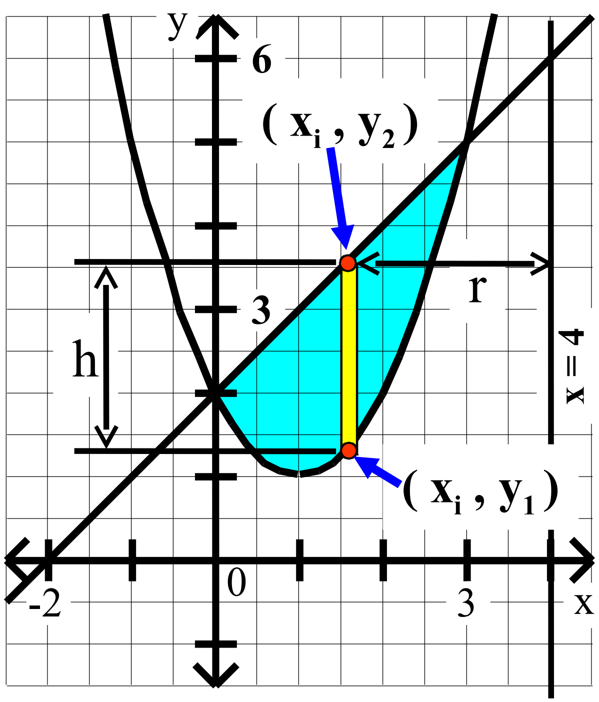

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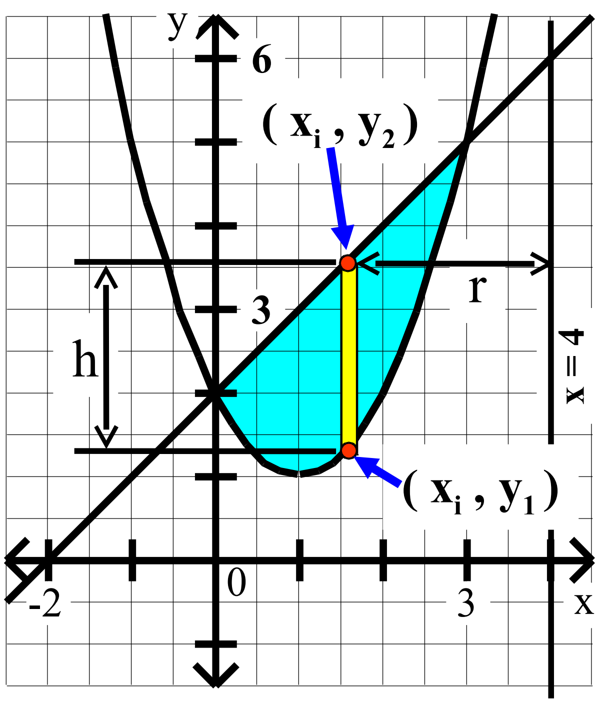

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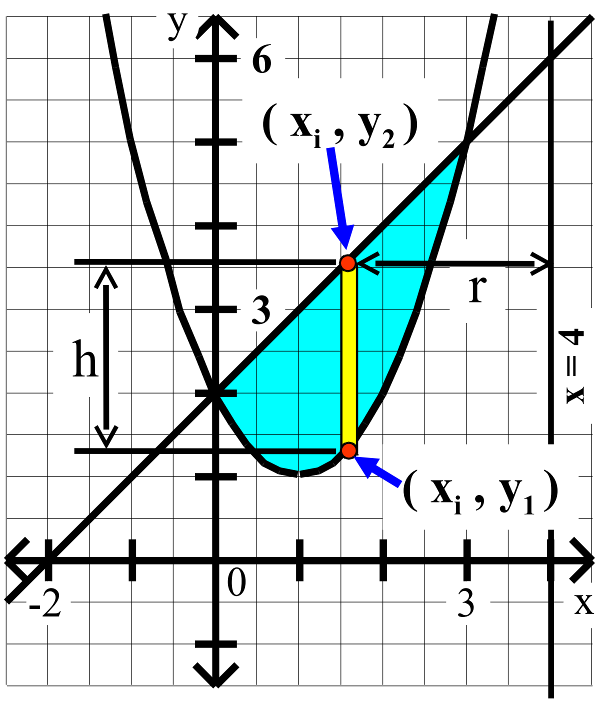

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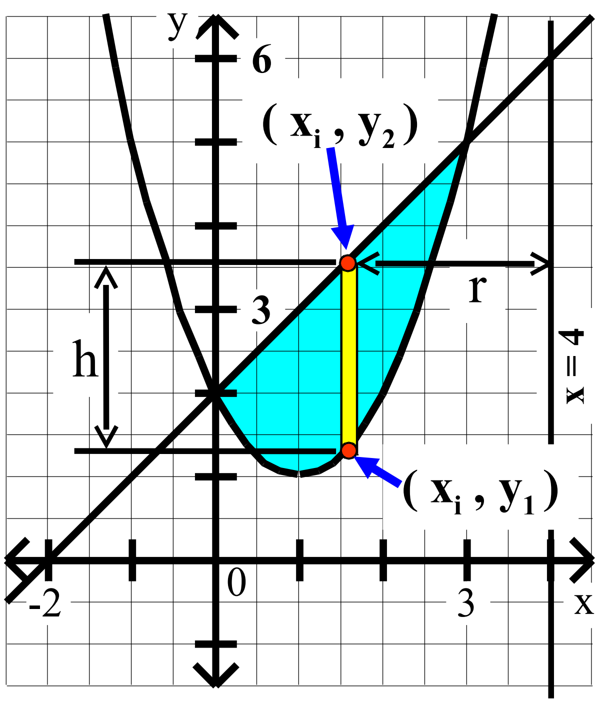

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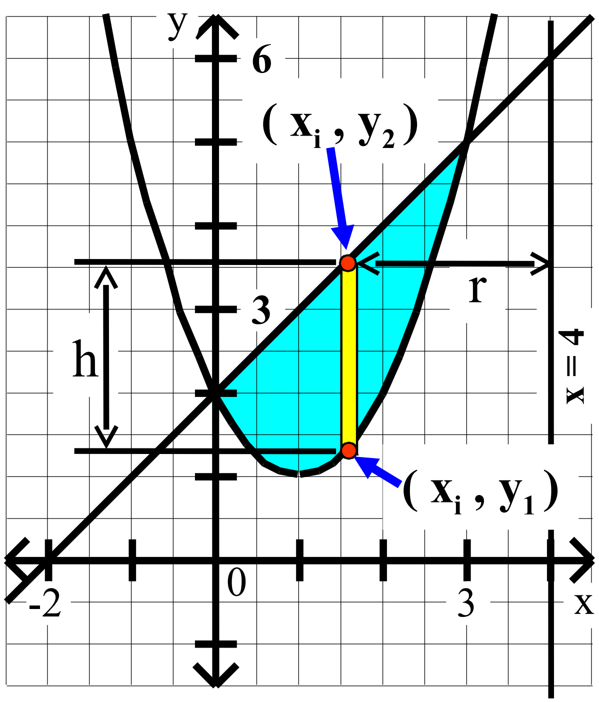

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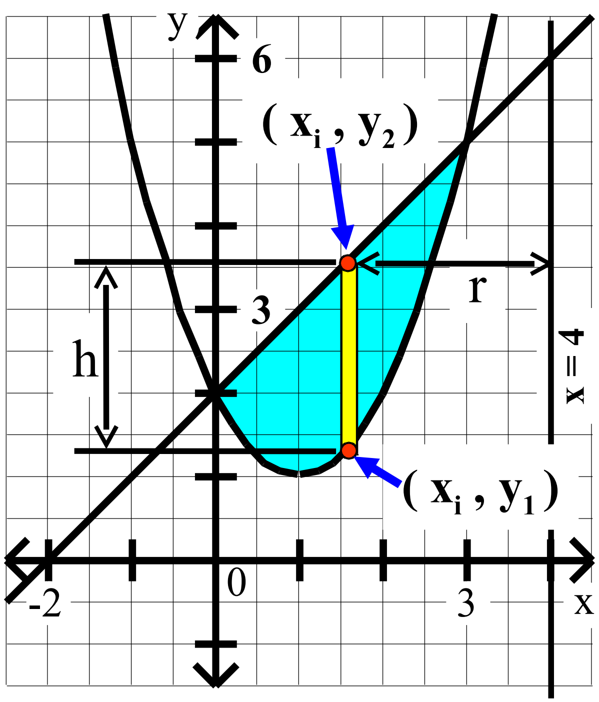

Shells: $V = 2\pi rh\Delta r$

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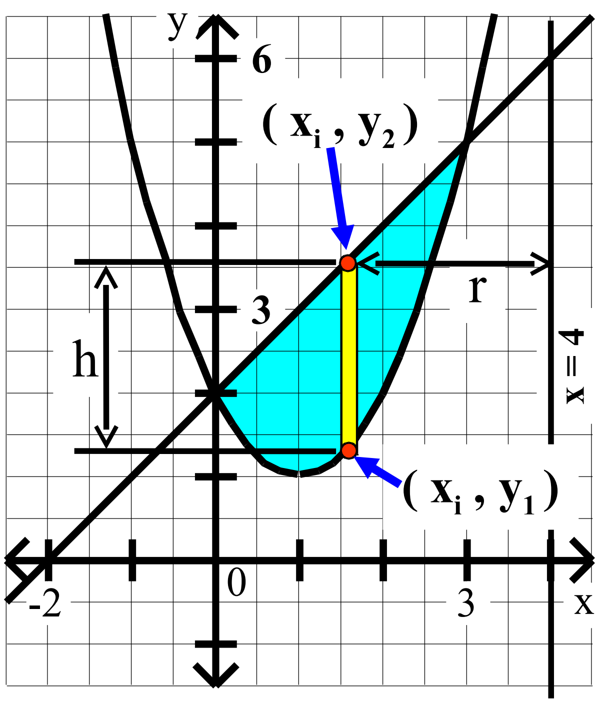

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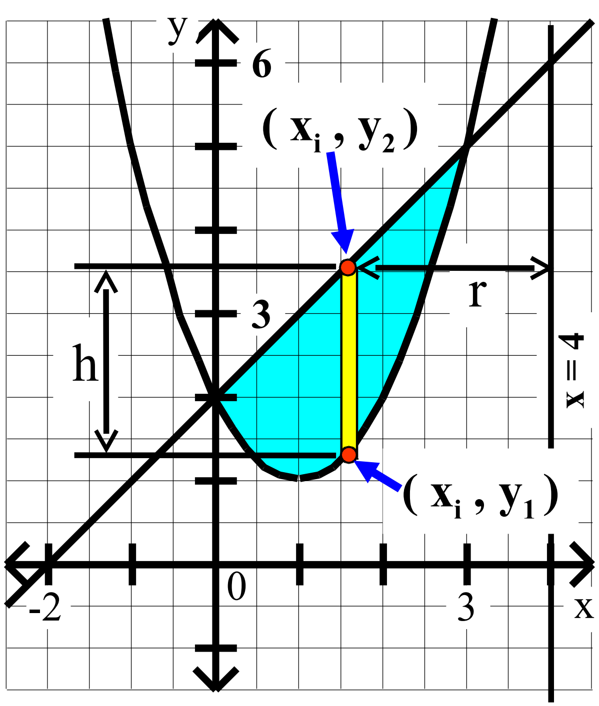

Shells: $V = 2\pi r h \Delta r$

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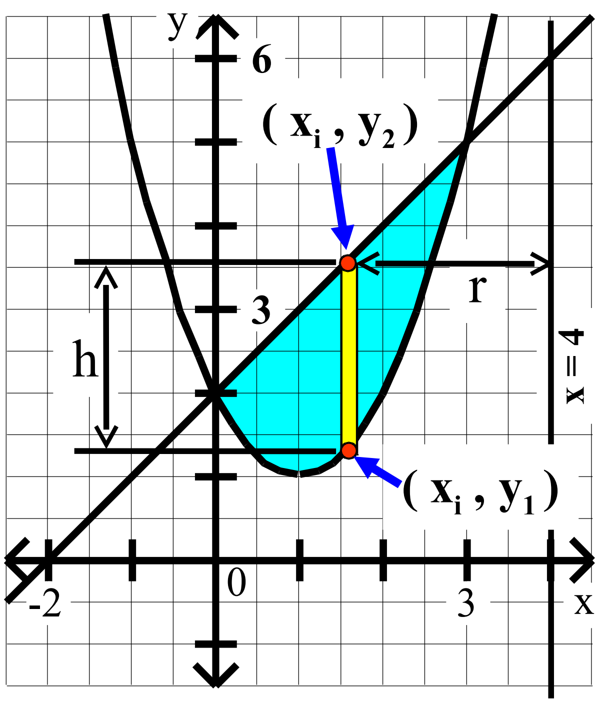

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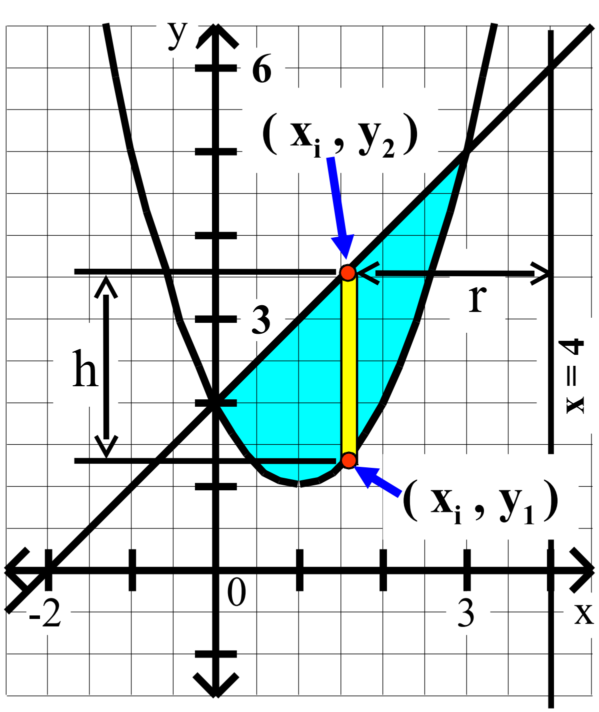

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$\Delta r = \Delta x$

b. $V_i = 2\pi$

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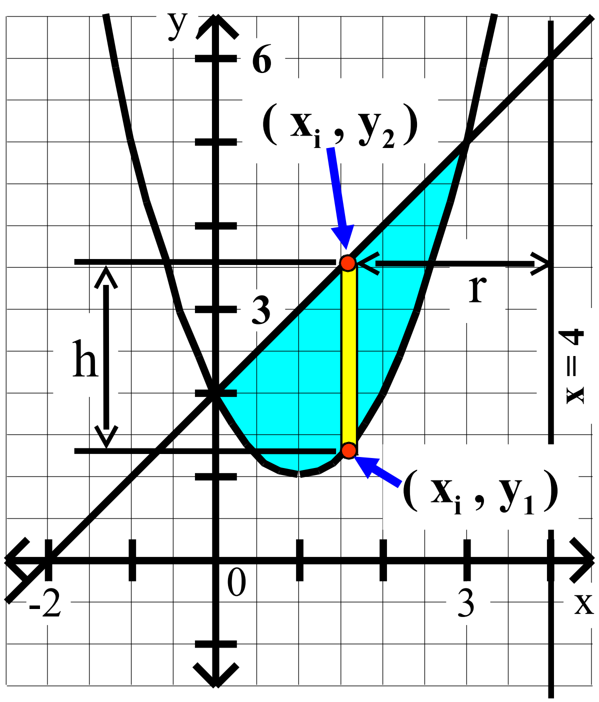

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$\Delta r = \Delta x$

b. $V_i = 2\pi(4 - x_i)$

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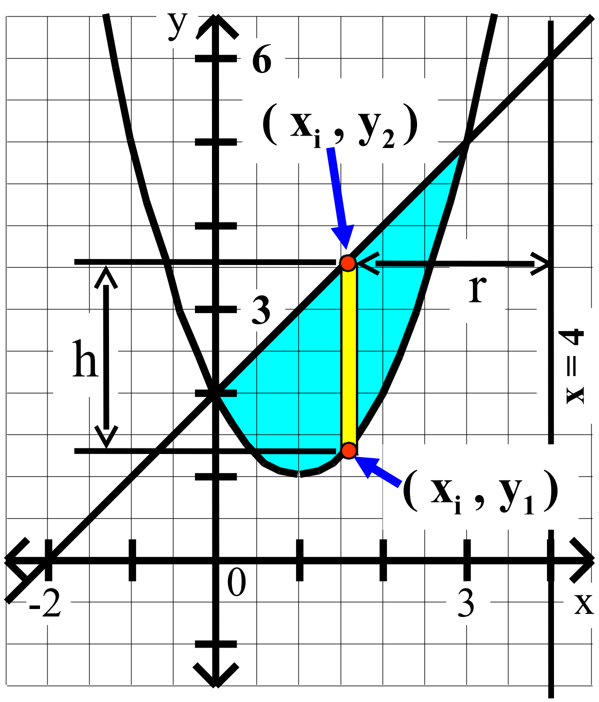

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b. $V_i = 2\pi(4 - x_i)(3x_i - x_i^2)$

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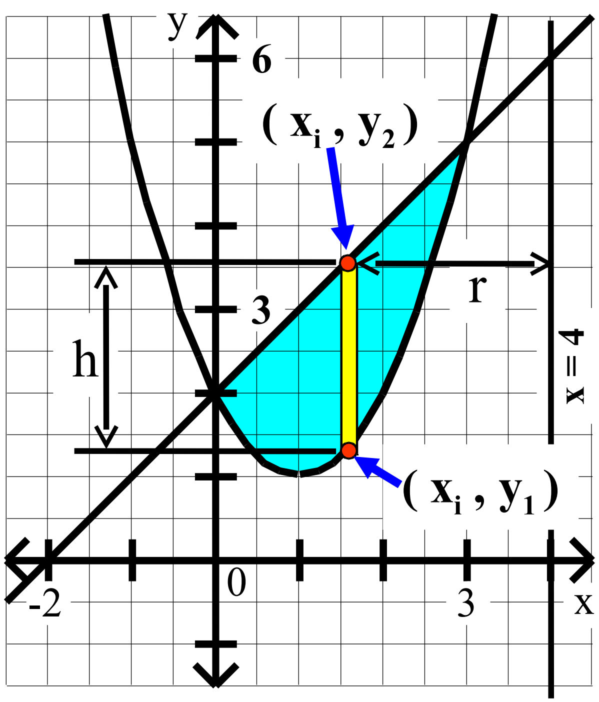

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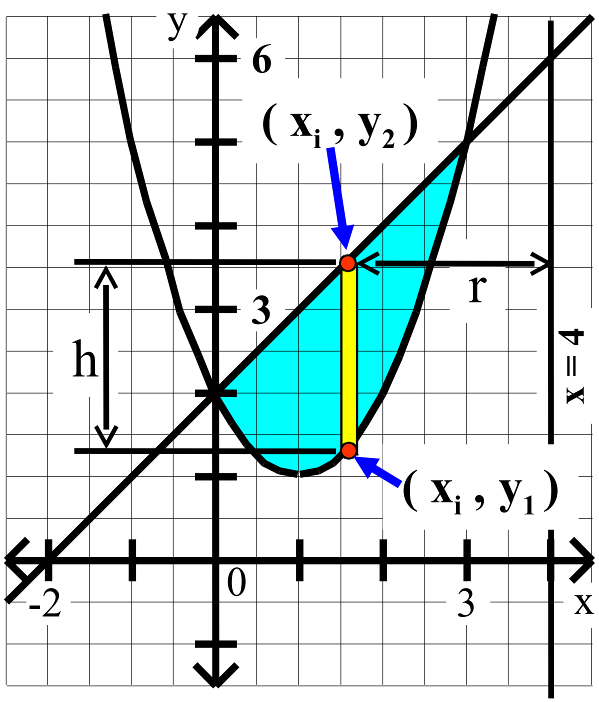

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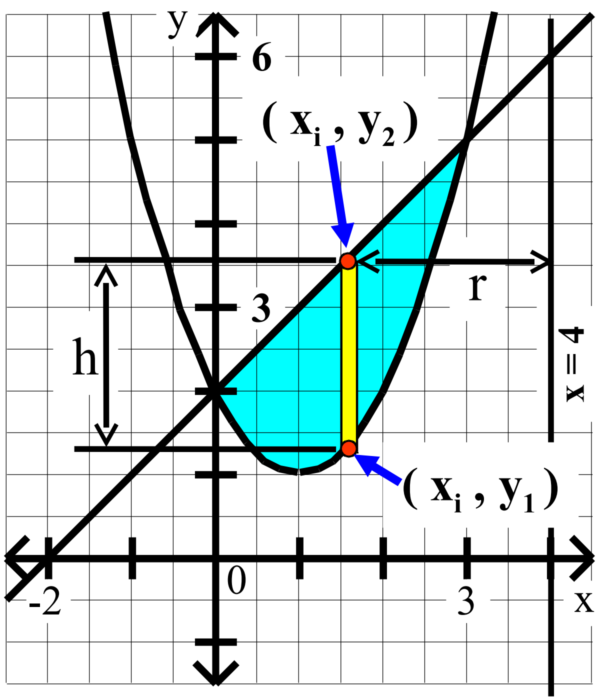

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$\Delta r = \Delta x$

b. $V_i = 2\pi(4 - x_i)(3x_i - x_i^2)\Delta x$

c. $V =$

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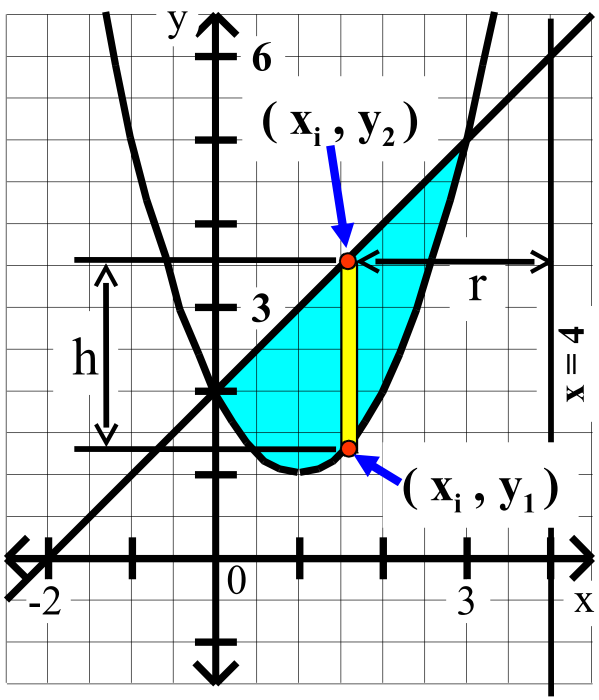

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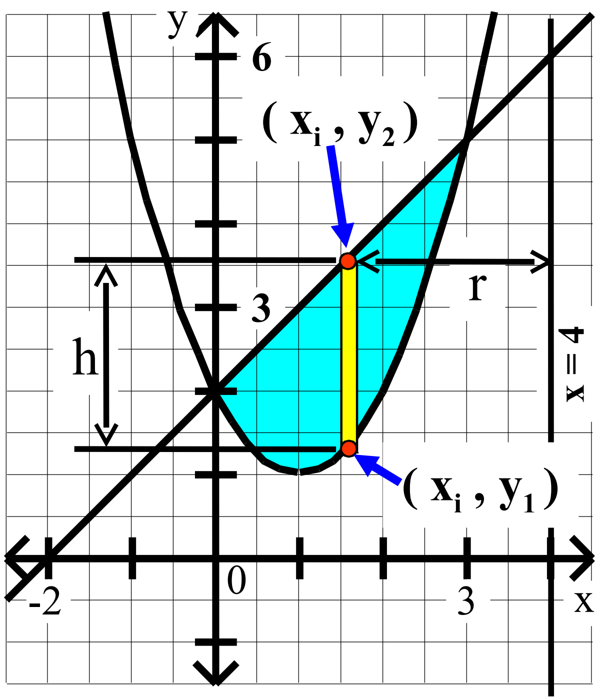

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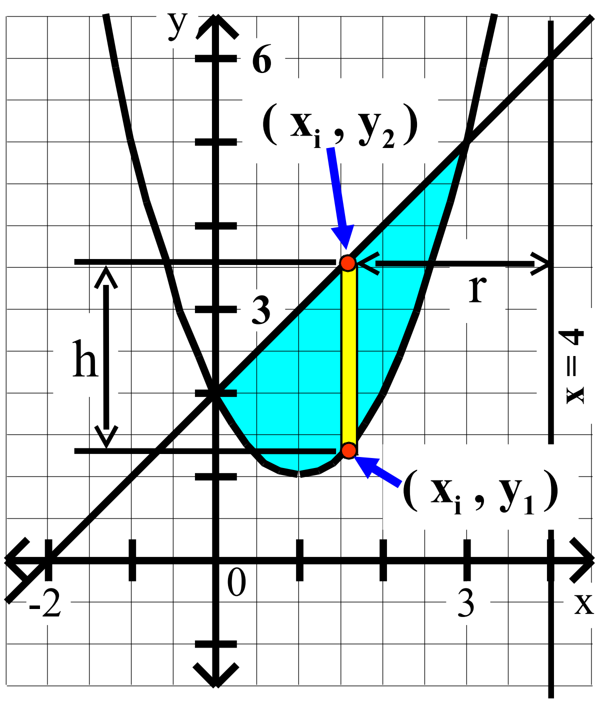

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b. $V_i = 2\pi(4 - x_i)(3x_i - x_i^2)\Delta x$

c. $V = 2\pi\int((4 - x)(3x - x^2))\, dx$

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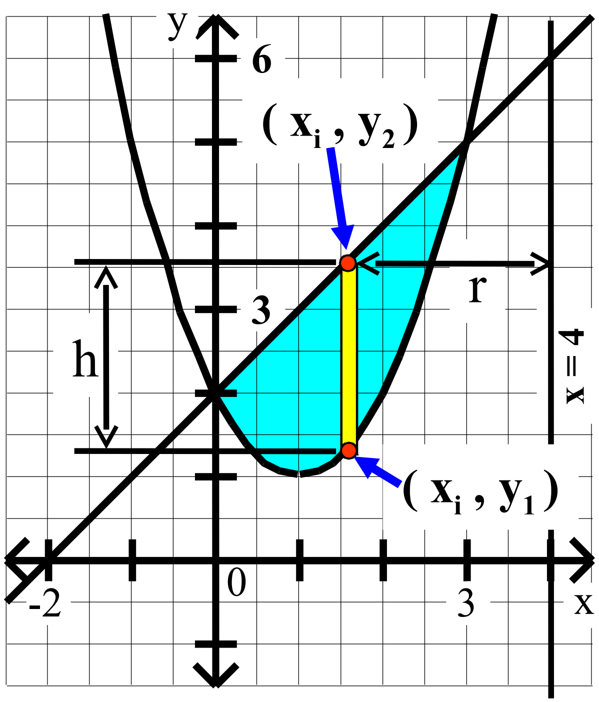

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b. $V_i = 2\pi(4 - x_i)(3x_i - x_i^2)\Delta x$

c. $V = 2\pi\int_0 ((4 - x)(3x - x^2))\, dx$

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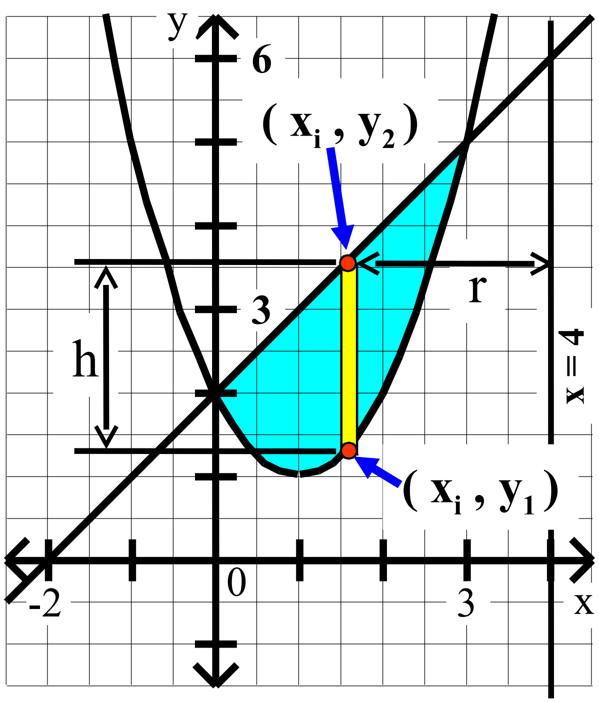

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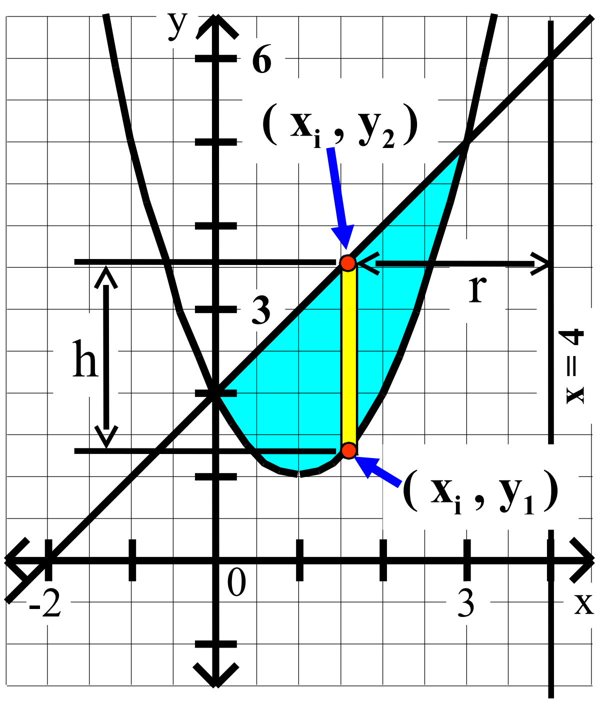

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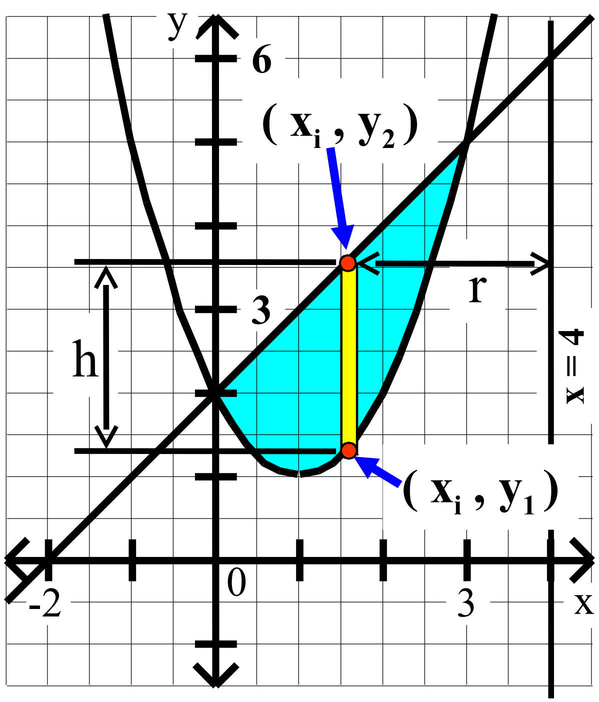

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$\Delta r = \Delta x$

b. $V_i = 2\pi(4 - x_i)(3x_i - x_i^2)\Delta x$

c. $V = 2\pi\int_0^3 ((4 - x)(3x - x^2))\,dx$

$V = 2\pi\int_0^3 (x^3 - 7x^2 + 12x)\,dx$

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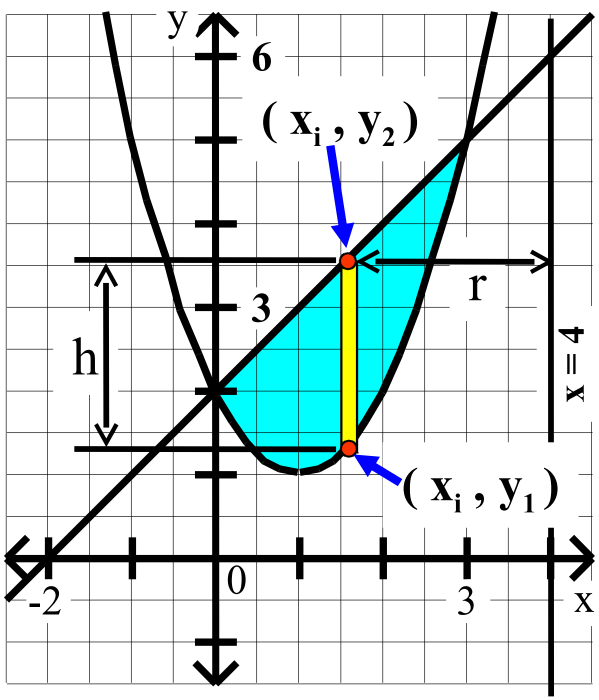

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$r = 4 - x_i$

$h = y_2 - y_1 = (x_i + 2) - (x_i^2 - 2x_i + 2) = 3x_i - x_i^2$

$\Delta r = \Delta x$

b. $V_i = 2\pi(4 - x_i)(3x_i - x_i^2)\Delta x$

c. $V = 2\pi\int_0^3 ((4 - x)(3x - x^2))\,dx$

$V = 2\pi\int_0^3 (x^3 - 7x^2 + 12x)\,dx$

d. $V \approx$

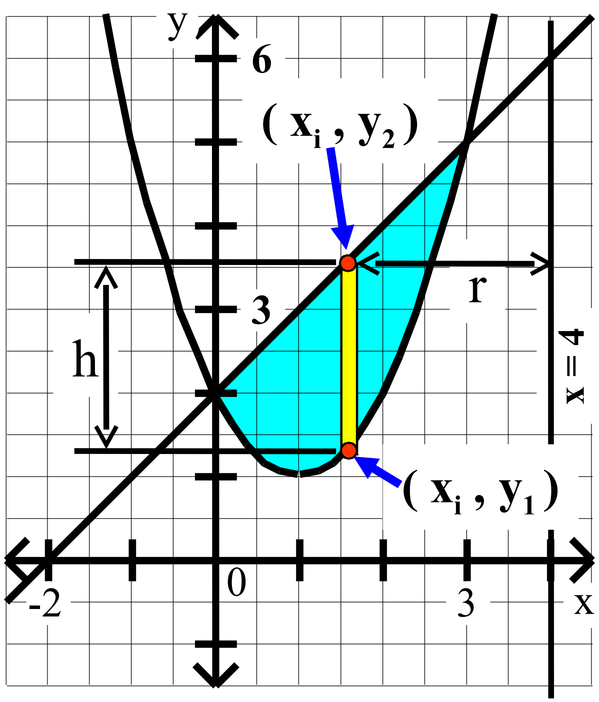
Calculus Class Worksheet #3 Unit 11 Solutions

Use "shells" to find the volume generated by rotating the given region about the given line. For each problem, you must

a) sketch the generating region, showing a typical generating rectangle,
b) write an expression for the volume generated by this rectangle,
c) express the exact volume of the solid as a definite integral, and
d) evaluate the integral.

Sample 2B. The region enclosed by $y = x^2 - 2x + 2$ and $y = x + 2$ is rotated about the line $x = 4$.

a.



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d. $V \approx 70.7$ cu. units

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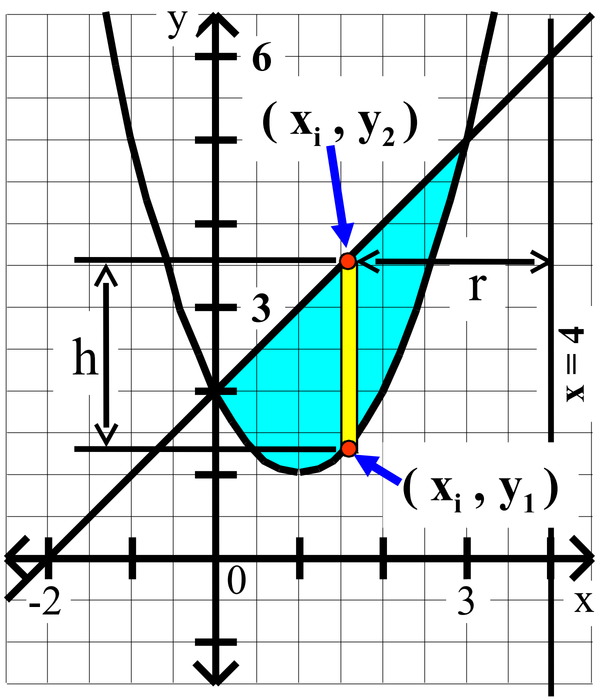

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$\Delta r = \Delta x$

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