If you are doing the lab at the library, you need to open the program "Maple 2016". Go to the list of programs accessible from the bottom left of the screen. Choose "Maple 2016", and from that drop down menu, choose "Maple 2016" again. Click on "new worksheet" and you are ready to go.

Revised 1/18/18 Calculus II

Name:

Maple Lab #1: Areas as Limits Email: _____

The main purpose of this Maple lab is to reacquaint you with the technique of finding an approximation of an area under a curve. In the end, the connection is made between the area under a curve, and the definite integral. (*Notice step 25a and 25b on the last page. When you do the lab at the Academic Success Center and get the signature, you are guaranteed credit for it. If you are not doing the lab at the Math Computer Lab at the Academic Success Center, indicate where you did it in the given space. You will be contacted if the lab is not complete and correct.)*

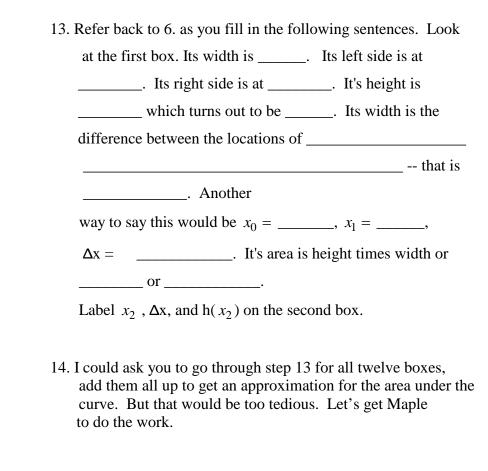
Туре:	Directions and explanation:
h := proc(x) 9 - x^2 end h(5)	1. Let's work with the function $h(x) = 9 - x^2$. When a function is defined it this manner (I would read it as "h of x is equal to nine minus x squared."), we can find the output for a particular input by just typing the function with the input.
plot(h(x), x = 0 3, y = -2 10)	 Read this entry as "Graph h(x). Make the x axis go from zero to three, and make the y axis go from negative two to ten."
with(student);	
	3 The "with(student)" command makes some additional commands available to you. Now, suppose you want to estimate the area under this curve from where x is 0 to where x is 3.
rightbox(h(x),x=03,3)	4. Read this entry as "Graph h(x). Make the x axis go from zero to three. Then draw three inscribed rectangles under the curve."
	5. Either print the graph out, or draw it on a separate sheet of paper. (Including the boxes.) (Must do this for credit!)
	6. Look at the first box. It's width is 1. It's left
	side is at $x = 0$. Its right side is at $x = 1$. It's height is $h(1)$
	which turns out to be 8. Its width is the difference
between	
	the locations of the x coordinates of its left and right side –

that is 1 - 0 = 1. Another way to say this would be, $x_0 = 0$
$x_1 = 1, \Delta x = x_1 - x_0 = 1$. Its area is height times width or 8*1
or $h(1)^* \Delta x$.
Label x_0 and x_1 on the graph. Label the height and
width of the first rectangle (h(1) = 8 and $\Delta x = 1$.)
7. Refer back to 6 as you fill in the following sentences. Look at
the second box. Its width is 1. Its left side is at
Its right side is at It's height is which
turns out to be Its width is the difference between
the locations of
that is
Another
way to say this would be $x_1 = $, $x_2 = $,
$\Delta x =$ It's area is height times width or
or
Label x_2 , Δx , and h(x_2) on the second box.
8. You cannot see the third box because
, and its area is
, and its area is
·
9. If I asked you to find $\sum_{k=1}^{3} (9-k^2)\Delta x$ you would be finding the
sum of the areas of these three rectangles.
Find $\sum_{k=1}^{3} (9-k^2) \Delta x =$
10. On your picture, color the area you found in 9.
11 The area estimate you came up with in 9 is

- 11. The area estimate you came up with in 9 is too high/too low (circle one) compared to the actual area under the curve.
- 12. In order to get a better estimate of this area, we could make more boxes, each with a smaller width

rightbox(h(x),x=0 .. 3,12)

You do not have to draw this picture. Just refer to it as you complete step 13.



```
delta_x := 1/4
approx_area := sum(h(k*delta_x)*delta_x, k = 1 ..12)
evalf(%)
```

Look at the result, and explain what each of the previous 4 command lines means.3

delta_x := $\frac{1}{4}$ means
approx_area := means
$sum(h(k*delta_x)*delta_x, k = 112)$ means
evalf(%) means

- 15. $\sum_{k=1}^{12} (9 (k * (\Delta x))^2) \Delta x$ is what the computer just did for you.
- 16. What number did Maple return as the answer, and what does it mean?
- 18. What could be done to make the area approximation even more accurate?
- 19. Let's change the approx_area definition to make it easier to make more and more rectangles.

n:=20 delta_x := 3/n approx_area := sum(h(k*delta_x)*delta_x, k = 1 ..n) evalf(%)

20. Change the values of n (from 20 to: 100, 1000, 10000) to complete the following table to 5 decimal places:

approx area

21. If everything was done correctly, it should be easy to fill in the last row by guessing.

	22.	As you probably know, the calculus operation of finding the antiderivative, or integral, can be used to find the area under a curve. Maple can perform this operation in a simple step. (Remember, in step 1 you defined $h(x) = 9 - x^2$).
int(h(x), x)	23.	This command returns the indefinite integral of $h(x)$. What is it?
int(h(x), x = 03);	24.	This command returns the definite integral of $h(x)$, for x between 0 and 3. What is it?
	your con	assistant date
26. How long did it take you to com	plete thi	s lab?
27. Doing this lab gave me a better	understa	Strongly agree strongly disagree nding of integrals and areas.

5 4 3 2 1

28. Comments . . .?