Calculus 1 Name: ________________________

Maple Lab #4 Phone Number: ________________

*Revised 8/4/15* Graphs of Polynomial Functions

In this lab you will utilize the first and second derivative of a polynomial, and use that information to help you sketch the graph of the function. *(Notice step C1 and C2 on the last page . When you do the lab at the Learning and Advising 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 indicated space. You will be contacted if the lab is not complete and correct.)*

## A. For the function $f(x) = x^3 - 3x + 2$:

### Step 1: *(finding critical values and intervals of increase and decrease)*

**Type:**
```
f := proc(x) x^3 -3*x +2 end
f1 :=  diff (f(x),x)
solve(f1 = 0)
solve(f1 >= 0)
solve(f1<=0)
```

Use the information that you get from the Maple output to do the following:

a. Place the critical values on the $f'(x)$ number line provided.

b. Indicate the intervals on which the function is increasing, and the intervals on which the function is decreasing. Note local extrema.

$f'(x)$

### Step 2: (*Finding inflection points and intervals of up and down concavity.)*

**Type:**
```
f2 := diff (f1, x)
solve (f2 = 0)
solve (f2 >= 0)
solve (f2 <= 0)
```

a. Place the potential inflection points on the $f''(x)$ number line provided.

b. Indicate the intervals on which the function is concave up, and the intervals on which the function is concave down. Note inflection points.

$f''(x)$

**Step 3:** *Sketching the graph of f(x) using the information from steps 1 and 2:*

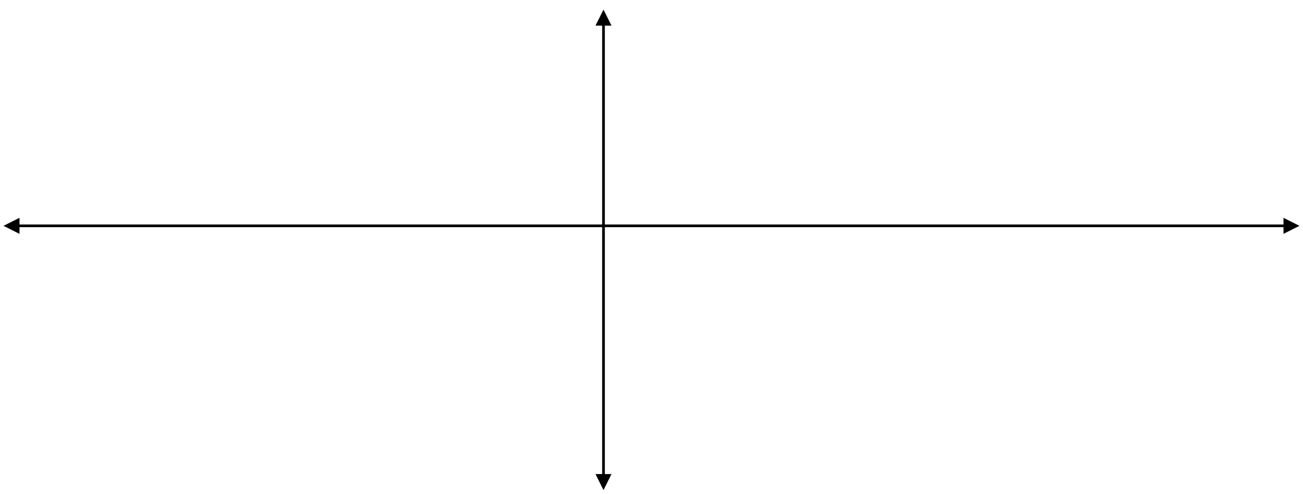
*Hints:*
**Find x intercepts by inputting:* $solve(f(x) = 0)$
**Inputting f(1) gives you the y coordinate of the first critical point*

a. x intercepts: ____________________________________ y intercept:_______________________

b. Critical points (must include x **and y coordinates**) __________________________________

c. Inflection points (must include x **and y coordinates**) __________________________________

*(Another hint: plot the critical points, and check the first derivative number line to make a rough sketch. Then refine the sketch to correctly include the x intercepts and the inflection points.)*



Now let's see what Maple comes up with.

Type: **plot(f(x),x)** Maple's graph does not look like yours. Whose do you think is closer to being correct? ____________________ The problem is that the scale that Maple is using is keeping the important aspects of the graph from being visible. If we limit the x axis to values right around the important points(critical and inflection points), then Maple will show us what we need to see.

Type: **plot(f(x),x=-2.5..2.5)** This graph should be similar to the one that you draw. If it is not, go back and find your mistake.

## B. For the function $f(x) = x^5 - 4x^4 - x^3 + 5x^2 - 1$:

First, we will try to use exactly the same steps to help you sketch a graph of
$f(x) = x^5 - 4x^4 - x^3 + 5x^2 - 1$

**Step 1:** **Type:** **f := proc(x) x^5 – 4*x^4 + 5*x^2 - 1 end**
**f1 := diff (f(x),x)**
**solve(f1 = 0)**

Oh no!!! That looks awful. That's because f(x) has irrational roots. The fsolve command will give decimal approximations of the roots, so let's try that instead.

**Type:**
**fsolve(f1=0)**

The x value of the critical points: (round to one decimal point) ______________________

That worked for the roots, but it will not work for the inequalities.

You will be able to put the critical values on the number line, but will have to come up with some other way to figure out where the function is increasing and decreasing. What you can do is plug a number from each interval into the first derivative, and keep track of whether you get a negative number (which means the function is decreasing on that interval) or a positive number (which means the function is increasing on that interval.)

Now, to find the intervals of increase and decrease:

**Type:** **subs (x = -1, f1)**
**subs (x = -.5, f1)**
**subs (x = .5, f1)**
**subs (x = 1, f1)**
**subs (x = 4, f1)**

a. Place the critical values on the first derivative number line.
b. Indicate the intervals on which the function is increasing, and the intervals on which the function is decreasing.

$f'(x)$

Step 2:
Now for the second derivative (inflection points and concavity)

**Type:** **f2:= diff (f1, x)**
**fsolve (f2 = 0)**

The values of the potential inflection points are (round to one decimal): ______________

a. Place the potential inflection points on the $f''(x)$ number line provided.
b. Substitute a value from each interval into the second derivative:

( Type: subs( x= _____,f2) for an number in each interval.)

c. Indicate the intervals on which the function is concave up, and the intervals on which the function is concave down, and the inflection points.

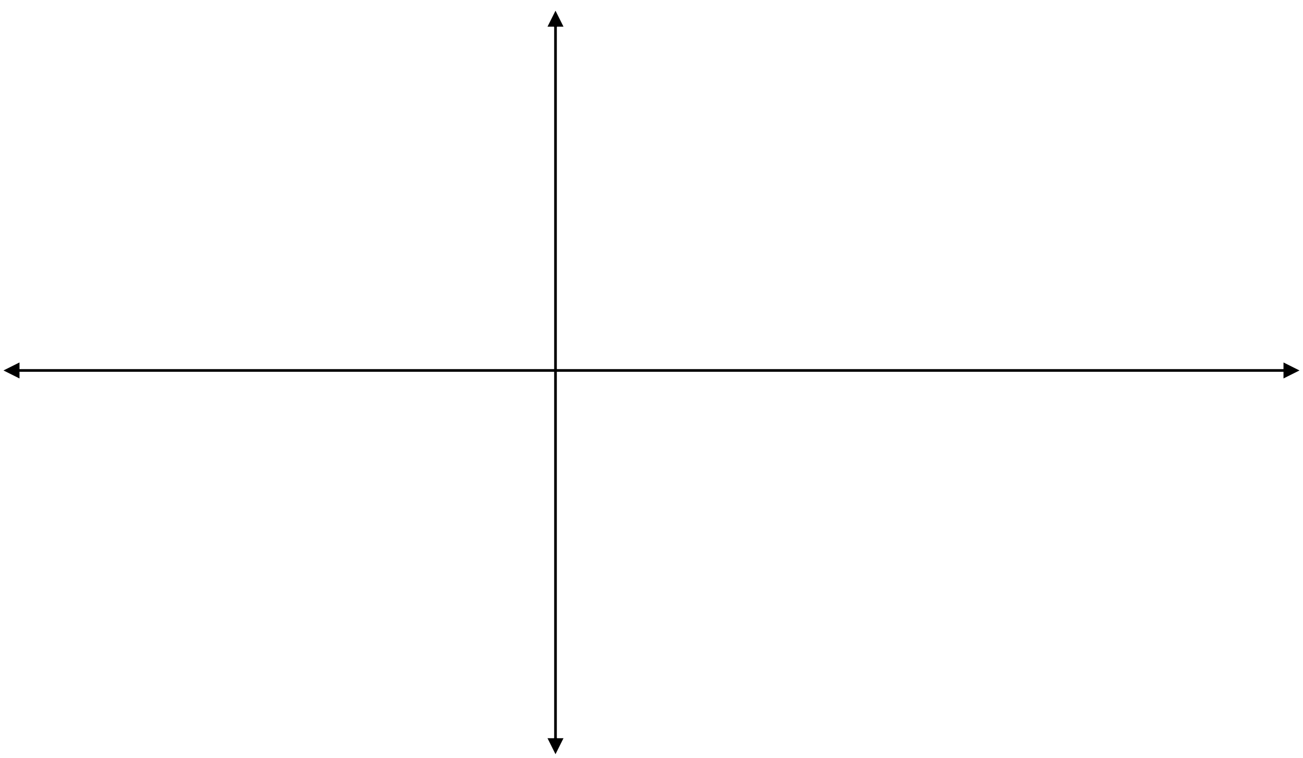
$f''(x)$

**Step 3:** Sketch the graph of f(x) using the information from steps 1 and 2 and:

x intercepts: _______________________________________________________y int:_________________
(round to one decimal place)

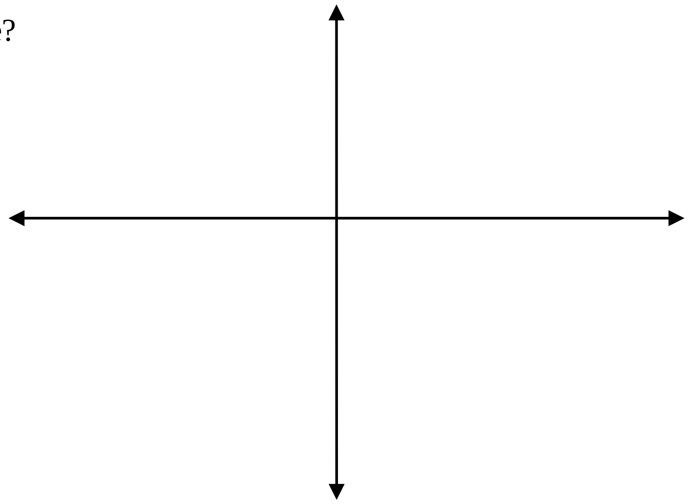
Critical points (must include x and y coordinates) ________________________________________________

Inflection points (must include x and y coordinates): _________________________________



Again, get Maple to sketch the graph by typing : **plot(f(x))**

What does that graph look like?



Play around with the x axis limits until you get a good picture that includes all of the important regions you found above, and it looks more like your graph. What x axis values do you come up with?

____________________________________

**C1** . Take this sheet to the lab assistant. He will check the lab for accuracy. If the lab is incomplete, or any of your answers are incorrect, he will direct you back to your computer for you to complete or correct them. This lab cannot be handed in until it is completely correct.

This lab is complete and correct. ____________________ _______

Lab assistant date

or

**C2.**

I completed this lab on my own at ____________________ ________

date

| | agree | | | disagree | |
|---|---|---|---|---|---|
| This lab has helped me better understand how to use Calculus to graph functions. | 5 | 4 | 3 | 2 | 1 |
| In general, these labs have helped me to understand the course material. | 5 | 4 | 3 | 2 | 1 |

How long did it take you to complete this lab?

In what way can the directions be improved?