

# Louisiana State University Classroom Interactions

<b>LESSON TITLE</b>	
Synthetic Division in the Classroom	
<b>Standards</b> Louisiana State Standards for Science and Math; Science must include appropriate PE, SEP, DCI, and CCC. Math must include appropriate Math Standards and Practices	<b>Key Concepts</b> Concepts include both tangible objects and abstract ideas. Identify the <u>key</u> concepts, knowledge, and skills that describe what the students will need to understand. Use the concept map you created for reference.
<b>A2:A-APR.B.2:</b> Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number $a$ , the remainder on division by $x - a$ is $p(a)$ , so $p(a)=0$ if and only if $(x-a)$ is a factor of $p(x)$ .  <b>A1: A-APR.A.1:</b> Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.	<ul style="list-style-type: none"> <li>- Synthetic Division</li> <li>- Long Division</li> <li>- Remainder Theorem</li> </ul>
<b>Big Idea</b> Big ideas are important, enduring, and transferable beyond the scope of core concepts, principles, theories and process.	<b>Essential Questions</b> Essential questions are thought provoking questions used to engage students' interest and to facilitate inquiry throughout the learning cycle of the instructional plan. Essential questions stimulate discussion and thinking over time.
Polynomial operations can be used in a variety of settings in and outside of the scope of mathematics.	<ul style="list-style-type: none"> <li>- How do synthetic division and long division compare?</li> <li>- How is synthetic division and long division similar?</li> </ul>
<b>Prior Knowledge</b> Identify common preconceptions and prior student knowledge.	<b>Key Vocabulary</b> List all new <u>key</u> vocabulary for the lesson. Use the concept map you created for reference.
<ul style="list-style-type: none"> <li>- Long Division</li> <li>- Division</li> <li>- Polynomials</li> <li>- Remainder Theorem</li> <li>- Synthetic division only works for divisors in the form of <math>(x-k)</math></li> </ul>	<ul style="list-style-type: none"> <li>- Coefficients</li> <li>- Leading Coefficient</li> <li>- Zero coefficients</li> <li>- Remainder</li> <li>- Polynomials</li> <li>- Quotient</li> </ul>
<b>Learning Objectives</b> Instructional learning objectives state the specific learning outcome in an observable and measurable format.	<b>Assessment(s)</b> Include both formal and informal assessments used throughout the lesson.
SWBAT: <ul style="list-style-type: none"> <li>- determine the quotient of two polynomials using both synthetic and long division</li> </ul>	During the duration of the lesson, students understanding of concepts will be examined using informal assessments. The two informal assessments the lesson will contain are bell ringer and exit ticket.

<ul style="list-style-type: none"> <li>- find the error in a student's work</li> <li>- Apply the Remainder Theorem to synthetic division</li> </ul>	<p style="text-align: center;"><b>Entrance Ticket:</b></p> <p><b>Q:</b> Use synthetic division to solve the following problem <math>(x^2+5x-3) \div (x-5)</math>  <b>SR:</b> <math>x+10+(47 \div x-5)</math>  <b>Q:</b> <math>(6x^4+3x^3+13x^2-x-5) \div (3x^2-1)</math>  <b>SR:</b> <math>2x^2+x+5</math></p> <p style="text-align: center;"><b>Exit Ticket:</b></p> <p><b>Q:</b> Use synthetic division to solve <math>(x^3+3x^2-10x-24) \div (x+4)</math>  <b>SR:</b> <math>x^2-x-6</math>  <b>Q:</b> Use synthetic division to solve <math>(-5x^5-2x^4+32x^2-48x+32) \div (x-2)</math>  <b>SR:</b> <math>-5x^4-12x^3+24x^2-16x-80-(128 \div x-2)</math></p>
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**Advanced Preparations/Safety**

Advanced preparations include all tasks and activities that may be used to preparing the learning experience. Also include any safety concerns expected throughout the lesson.

Before the lesson, the teachers will need to create the worksheets required for the explore/explain activity. We will also be required to print out the handouts and assign a Plickers card to each student's name.

There is a student with accommodations to have advanced completion time of problems, so we will need to prepare for that in our planning.

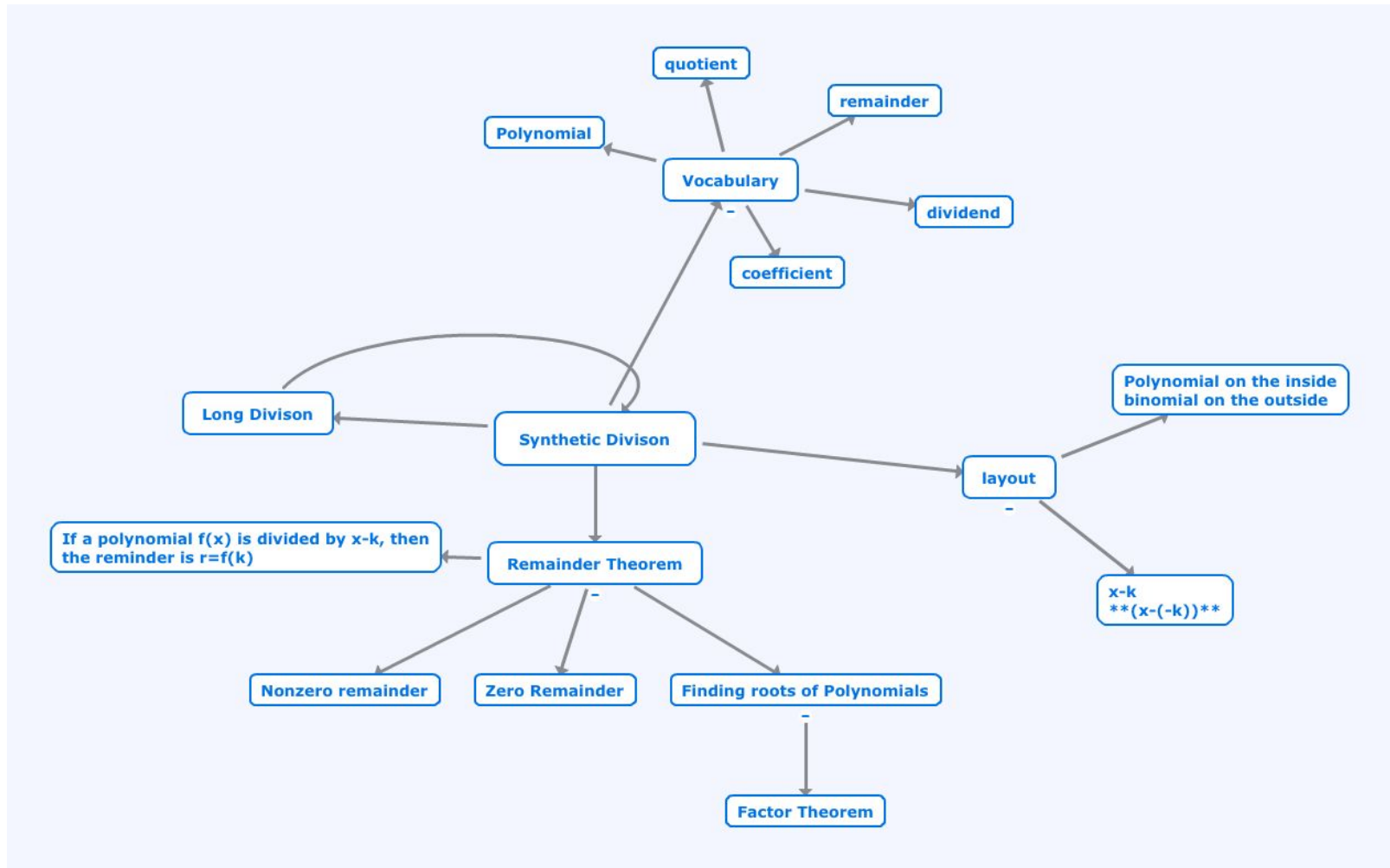


**5E Instructional Learning Cycle**  
**Louisiana State University**  
**Geaux Teach 5E Lesson Plan**  
**EDCI 3550 - Classroom Interactions**



<b>Teacher Candidate Team Members:</b> Kiara Ferrygood and Mary Margaret Sanford	<b>Mentor Teacher:</b> Richard Harsch	<b>Course:</b> Algebra II
<b>2</b>	<b>School:</b> Baton Rouge High School	<b>Classroom:</b> 1124
<b>Time Lesson to be Taught:</b> 8:15-9:44	<b>Grade Level:</b> 10/11	<b>Lesson Topic:</b> Synthetic Division

**[Insert computer-generated concept map]**



## ENGAGEMENT

Approximate Time: 15 Minutes

Pique students' interest and introduce them to the big ideas and essential questions. During the ENGAGEMENT students make connections between past and present learning experiences begin to ponder upcoming learning experiences. Students are recalling prior knowledge pertaining to key concepts and/or developing their own questions about a phenomenon.

**Overview** *In narrative format, provide an overview of the engagement phase of the lesson.*

Using Plickers, a pre-assessment will be given to the students to assess prior knowledge of long division. Recalling previous acquired knowledge from long division will assist students understanding of synthetic division. (Reference: "Entrance Ticket")

What the Teacher Will Do	Eliciting Questions/ Student Responses	What the Students Will Do
Pass out plickers cards to students individually and given instruction on how to use Plickers.	<b>Q:</b> $15 \div 3$ (this will be used to get the students used to the Plickers cards) <b>SR:</b> 5	Solve Problems on Long Division
Monitor Student Responses and offer assistance if needed.	<b>Q:</b> When the division process is complete, will the degree of the remainder be less than than the degree of the divisor? <b>SR:</b> Yes, the degree of the remainder will be less than the degree of the divisor.	Record Responses using Plicker Question Cards
Instruct students whose plicker response is correct to share solutions if the class responses show clarification of long division is needed.		Ask for assistance from peers or teacher if needed.

### TRANSITION (Engagement to Exploration)

*What question(s)/task are you asking of students that demonstrates proficiency? Successfully answering this question or completing this task shows that the teacher can move on to the next part of the lesson. If students do not demonstrate proficiency, how will you remediate? Provide both student outcomes.*

Evaluation/Decision Point Assessment	Student Outcomes
<ul style="list-style-type: none"> <li>- Students expected to demonstrate proficiency in computing solutions using long division.</li> </ul>	<ul style="list-style-type: none"> <li>- If 80% answer correctly, then the teacher will move on and monitor 20% throughout the lesson.</li> <li>- If students are not successful, the teacher will clarify misconceptions during the Exploration.</li> </ul>

## EXPLORATION/EXPLAIN

Approximate Time: 20 Minutes

Involve students in EXPLORATION of the lesson topic and concepts. Activities using hands-on activities should be used to help students use prior knowledge, identify and advance their current understandings of the concepts, dispel misconceptions, generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.

**Overview** *In narrative format, provide an overview of the exploration phase of the lesson.*

The teachers will split the class into groups of four by counting the students off. The students will work in groups to attempt to discover the method of synthetic division when presented with a fully solved problem. (Reference: “Find the Process” worksheet).

After completing this worksheet, the teachers will pass out a “notes” sheet with blanks for the students to fill in as they collaborate on the process of synthetic division. (Reference: “Notes”)

What the Teacher Will Do	Eliciting Questions/ Student Responses	What the Students Will Do
The teacher will instruct students to find the method used to solve the problem given.	<b>Q:</b> If the divisor is in the form $x+c$ , is $c$ positive or negative? <b>SR:</b> It will be $-c$ because a negative times a negative is positive.	Work with group members to find the method of synthetic division using a solved problem.
Following the discovery of the synthetic division method, clarification will be provided if needed.	<b>Q:</b> If each degree following the highest isn't shown in the problem, what should you do? <b>SR:</b> Add the missing $x$ 's with zeros as the constant.	Students will describe their respective suggestions about the method used to solve the problem.
The teacher will confirm if the students' suggestions are correct or incorrect.	<b>Q:</b> If the problem has a remainder, how should we write it in the solution. <b>SR:</b> Remainder/Divisor	Students will critique reasoning of others if needed.
The teachers will pass out the worksheet titled “Notes”		The students will fill in their notes with the process of synthetic division

## TRANSITION

What question(s)/task are you asking of students that demonstrates proficiency? Successfully answering this question or completing this task shows that the teacher can move on to the next part of the lesson. If students do not demonstrate proficiency, how will you remediate? Provide both student outcomes

Evaluation/Decision Point Assessment	Student Outcomes
The explore and explain portion of the lesson will coincide. The teachers can assess the knowledge of the students when they present ideas to the class.	If the students seem to understand the method of synthetic division, the teacher can proceed to the elaborate. If students have misconceptions or have flawed explanations, the teachers use guided instruction and discussion to steer the students towards the correct method.

## EXPLANATION/EXPLORE

Approximate Time: 25 Minutes

*Students communicate with others to make rich connections and to provide an EXPLANATION for what they have experienced and learned during the Exploration phase of the lesson. As students' communicate, they demonstrate their conceptual understanding, process skills or behaviors. Vocabulary is presented in correct context to redirect misconceptions.*

**Overview** *In narrative format, provide an overview of the explanation phase of the lesson.*

Following the discovery portion, students will play a synthetic division game in their groups of four.

**The game:** Each student will be given a synthetic division problem to solve on their own. Each answer will correspond to a word. Each group's answers should come together to form a popular phrase (such as "thank you, next"). The first group to finish their phrase and turn it in will receive a prize. The remaining groups will also receive a prize when they finish their phrase, but the first place prize will be bigger (this will encourage the remaining students to still complete their problems).

(Reference: "Group Work Game"/"Teacher Key"/"Student Key")

What the Teacher Will Do	Eliciting Questions/ Student Responses	What the Students Will Do
The teacher will monitor the students and make sure they are playing the game correctly. The teachers will also assist the students if they are struggling with their division problem.	<p><b>Q:</b> what is the first step in solving a synthetic division problem?</p> <p><b>SR:</b> bring down the coefficient of the first term</p>	The students will attempt to solve their own problem and complete the phrase based on their solutions.
The teachers will allow the students to ask each other questions before going to the teacher, in an attempt to further their understanding of the content.	<p><b>Q:</b> what is the next step?</p> <p><b>SR:</b> multiply the number you brought down by the number on the outside</p>	If a student answer is incorrect, then the group will assist their group member in finding the error preventing the solution from being correct.

## TRANSITION

*What question(s)/task are you asking of students that demonstrates proficiency? Successfully answering this question or completing this task shows that the teacher can move on to the next part of the lesson. If students do not demonstrate proficiency, how will you remediate? Provide both student outcomes.*

Evaluation/Decision Point Assessment	Student Outcomes
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When the first group finishes their phrase, the teachers assess how the remaining groups are doing with their problems.	<p>If two groups are struggling with their problems, then the teachers will re-evaluate their lesson and possibly review synthetic division one more time.</p> <p>If all of the groups understand how to solve the problem, they were just working slower, then we will move on to the next part of the lesson.</p>
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<b>ELABORATION</b>	Approximate Time: 20 Minutes
<i>Students use new information to explore additional ideas and concepts; students revise explanations correctly apply vocabulary and develop connections between and across content. Teachers ask students to ELABORATE by using information in new ways.</i>	

**Overview** *In narrative format, provide an overview of the elaboration phase of the lesson.*  
 The students will receive a sheet of paper with two student’s work; one has an error. The students will need to find the error and state which student is correct in their reasoning and why. (Reference: “Find the Error” worksheet)

What the Teacher Will Do	Eliciting Questions/ Student Responses	What the Students Will Do
The teacher will inform student of the activity and issue out the handout.	<b>Q:</b> How would you solve this problem? <b>SR:</b> *student explains thought process on how to solve the problem*	The students will work through the assignment, attempting to determine where the flaw is in the students’ work.
The teacher will provide assistance if necessary.	<b>Q:</b> Where do you see a difference in your reasoning and one of the reasoning here? <b>SR:</b> Their flaw is _____.	The students will collaborate with each other and help each other find the flaw
The teachers will ask a student who got the question correct to present their solution		A student with the correct answer will present their reasoning

<b>TRANSITION</b>
<i>What question(s)/task are you asking of students that demonstrates proficiency? Successfully answering this question or completing this task shows that the teacher can move on to the next part of the lesson. If students do not demonstrate proficiency, how will you remediate? Provide both student outcomes.</i>

Evaluation/Decision Point Assessment	Student Outcomes
We will assess the students’ understanding of the lesson based on the success of the students on the problem.	If 30% fail to find the flaw we can further explain the process of synthetic division.

## EVALUATION

Approximate Time: 10 Minutes

*Students answer questions that explain or show their thinking. They can describe the lessons big ideas, they successful create a product, and they successfully answer all essential questions. The teacher EVALUATES student understanding by providing insight into students' progress throughout the lesson as well as at the end of a lesson.*

**Overview** *In narrative format, provide an overview of the evaluation phase of the lesson.*

A plickers-based assessment will be conducted to evaluate students' understanding of synthetic division. (Reference: "Exit Ticket")

What the Teacher Will Do	Eliciting Questions/ Student Responses	What the Students Will Do
The teachers will present a problems for the students to solve using synthetic division using plickers.	<b>Q:</b> Use synthetic division to solve $(x^3+3x^2-10x-24) \div (x+4)$ <b>SR:</b> $x^2-x-6$	The students will solve problems using synthetic division and record their answer using the Plickers cards.
If time permits, the teacher will allow students with correct solutions to share their solutions.	<b>Q:</b> Use synthetic division to solve $(-5x^5-2x^4+32x^2-48x+32) \div (x-2)$ <b>SR:</b> $-5x^4-12x^3+24x^2-16x-80-(128 \div x-2)$	The students will explain their solution to the given problem.
The teachers will monitor student progression.		

## Closure

*Provide a overview of the lesson closure.*

In an attempt to confirm the students' understanding of the lesson, the teachers will ask the students to explain the process of synthetic division. The students will need to explain the process of solving a division problem, as well as how to set up the problem to be able to solve it.



### Resources

*Include all professional and student resources and references needed for this teaching and learning cycle.*

Springboard Algebra 2 Textbook

### Assessments

*Formal and informal assessments throughout the learning cycle should be used to determine progress and to make adjustments in the learning cycle. Identify assessments used for prior knowledge and for individual and collective learning objectives. Attach all instruments and answer keys.*

During the duration of the lesson, the following informal assessments will be used: bellringer, exit ticket, observations, plicker percentages, and the asking of essential questions. The lesson will not contain formal assessment.

### Accommodations

*Identify any special accommodations or adjustments that may be needed for this lesson to meet the needs of individual students for this lesson. How can you ensure equitable lessons for all?*

Special accommodations will need to be made for the lesson to meet the needs of one particular student. The student will need an increased time for completion. The accommodations for the student will be made by ensure the student has an adequate amount of time to complete the task.

GeauxTeach Students: Mary Margaret Sanford and Kiara Ferrygood	Mentor Teacher: Mr. Harsch	
Date to be Taught: February 21, 2019	Grade Level: 10/11th	
Time to be Taught: 8:15-9:45 AM	Lesson Topic: Synthetic Division	
DATE Requested for Pick-up:	DATE to be returned:	

TIME Requested for Pick-up: (pick up in 217B)	TIME to be returned: (return to GeauxTeach Lair)	
<b>Material Request (only materials not available in the mentor's classroom)</b>		
<b>Items Requested</b>	<b># Requested</b>	<b># Returned</b>
Plickers Cards	38	
Entrance Ticket	38	
Exit Ticket	38	
Answer Key	2	
Find The Error Worksheet	38	
Worksheet-Game	38	
Worksheet- Key for Game	9	
Find the Process	38	

## Entrance Ticket

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**TEST PROBLEM:** What is  $15 \div 3$ ?

- a. 12
- b. 5
- c. 5,437
- d. 45

**Directions:** Find the solution to the following polynomials using long division.

1.  $(x^2+5x-3) \div (x-5)$

a.  $5x^2 - 3x + 5$

b.  $x - 3$

c.  $x - (3 \div x-5)$

d.  $x + 10 + (47 \div x-5)$

2.  $(6x^4+3x^3+13x^2-x-5) \div (3x^2-1)$

a.  $2x^2 + x + 5$

b.  $x^2 + 3x + 6$

c.  $2x^3 + x^2 + 5x + 5$

d.  $2x^2 - x - 5$

## Exit Ticket

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Directions:** Find the solution to the following problems using synthetic division.

1.  $(x^3 + 3x^2 - 10x - 24) \div (x + 4)$

a.  $x^2 - x - 6$

b.  $x^3 - x^2 - 6x$

c.  $x - 3$

d.  $x^2 - x + 3$

2.  $(-5x^5 - 2x^4 + 32x^2 - 48x + 32) \div (x - 2)$

a.  $x^4 + 5x^3 + 6x^2 + 3x - 75$

b.  $-5x^4 - 12x^3 + 24x^2 - 16x - 80 - (128 \div x - 2)$

c.  $-5x^4 + 12x^3 - 12x^2 + 16x - 80$

d.  $5x^5 - 80 - (128 \div x - 2)$

# Answer Key

## Entrance Ticket

Test Problem: B

1. D
2. A

## Exit Ticket

1. A
2. B

## Find the Error

1. Neither of the students are correct. Leah should have put the divisor as 7 instead of -7 and Jacob did not put 0 in for the powers which were not present.

## Find the Process

1. Set up the synthetic division
2. Bring down the leading coefficient to the bottom row
3. Multiply the divisor by the value just written on the bottom row
4. Add the column created in step 3
5. Repeat until done
6. Write out the answer

## Notes

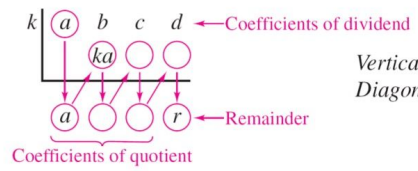
1-6: same as “Find the Process”

Algorithm for synthetic division works only for divisions in the form  $\underline{x-k}$

$X+k = x-(-k)$

### Synthetic Division (for a Cubic Polynomial)

To divide  $ax^3 + bx^2 + cx + d$  by  $x - k$ , use the following pattern.



Vertical pattern: Add terms.  
Diagonal pattern: Multiply by  $k$ .

## Find the Error

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Two students, Leah and Jacob are solving a polynomial division problem and found they had two different solutions.

This was the problem Leah and Jacob were given:

$$(x^4 - 6x^3 - 40x + 33) \div (x - 7)$$

Leah says the divisor is  $-7$  and the dividend is  $x^4 - 6x^3 + 0x^2 - 40x + 33$

Leah believes the answer is :  $x^3 - 13x^2 + 91x - 677 + (4772 \div x - 7)$

Jacob says the divisor is  $7$  and the dividend is  $x^4 - 6x^3 - 40x + 33$

Jacob believes the answer is:  $x^3 + x^2 - 33x - 198$

Who is correct? Are either of the students correct? Correct the student(s)' incorrect answers and state your reasoning behind your corrections.

## Find the Process

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Directions:** Below, you have a problem completely solved using synthetic division. Determine the process for solving a problem using synthetic division. Fill in the blanks with the proper steps for solving synthetic division

Step 1:	
Step 2:	
Step 3:	
Step 4:	
Step 5:	
Step 6:	

Problem: 
$$\frac{-2x^4 + 6x^3 + 3x - 1}{x - 2}$$

$$\begin{array}{r|rrrrr}
 2 & -2 & 6 & 0 & 3 & -1 \\
 & \downarrow & -4 & 4 & 8 & 22 \\
 \hline
 & -2 & 2 & 4 & 11 & 21
 \end{array}$$

Answer:  $-2x^3 + 2x^2 + 4x + 11 + \frac{21}{x-2}$



## Notes

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Steps for completing synthetic division of polynomials:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

The algorithm for synthetic division works **only** for divisors of the form \_\_\_\_\_

Remember:  $x + k =$  \_\_\_\_\_

## Synthetic Division (for a Cubic Polynomial)

To divide  $ax^3 + bx^2 + cx + d$  by  $x - k$ , use the following pattern.

